QUANTIFICATION OF THE COST of ALTERNATIVE FORMS of HOUSING MARKET INTERVENTION in CANADA

by

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ABSTRACT

This thesis is concerned with the estimation of the cost involved in supporting minimum housing standards under alternative forms of government intervention. No attempt is made to rationalize what minimum housing standards should be. The intent is to highlight what the relative costs would be to support alternative housing standards, utilizing potentially alternative policy approaches.

To rationalize the numerous policy/program alternatives available to governments, attention is focused on six policy alternatives that reflect varying degrees of "leakage" of the provided subsidy to the consumption of non-housing goods and services. These alternatives cover the continuum from pure cash (income) subsidies, wherein up to a 100% "leakage" to the consumption of non-housing goods and services may occur, to direct product intervention, wherein the recipients may be required to reduce the consumption of non-housing goods and services in order to improve their housing standards.

The six options are classified by type either as a "cash" subsidy (where the use of the subsidy is not constrained) or a "direct product" subsidy (where the subsidy is used directly for the subsidization of capital and/or operating costs).

Under the "cash" subsidy approaches two benchmark options are considered:

1. an "income" policy that involves the subsidization of incomes such that the recipients are free to choose consumption levels. This policy corresponds to pure income redistribution.

2. a "constrained cash" or "in kind" policy that involves the subsidization of incomes at a level dependent on either the level of housing consumption or expenditure on housing consumption. Such a policy covers programs comparable to rent certificates and general housing allowances.

The options considered as "direct product" approaches are more arbitrary in nature, reflecting alternative benchmarks:

1. a "direct constrained" policy wherein recipients are forced to reduce their consumption of other goods and services to offset the required increase in expenditure on housing. This policy form is taken as the lower benchmark for the policy continuum, reflecting the potential impact of zoning and occupancy regulations.

2. a "direct quantity" policy wherein recipients are compensated for the cost of the additional quantity of housing consumed only.

3. a "direct expenditure" policy wherein recipients are subsidized in the amount of the total increase in expenditure on housing incurred.

4. a "direct price" policy wherein the subsidy is provided to buy down the unit price of housing. Such a policy covers mortgage market intervention and compensated rent control programs.

The computation of these costs, for selected Canadian Metropolitan Areas, (CMAs), is undertaken using a simulation model based on a long run (ten year) regional housing market model developed by the Urban Institute, Washington DC, during the early 1970's. This model traces the interaction inherent in the supply and demand of housing in each of many separate, but highly inter-dependent housing submarkets. For this study the demand side of the model has been respecified to allow the incorporation of a tenure option, the use of after tax incomes and the direct estimation of the demand functions.

The essence of the modified model is a microeconomic perspective on households and owners contracting for housing at prices and quantities determined in several submarkets. A selected CMA is represented in the form of several residential

zones that reflect variations in the housing stock, income levels and distance from the Central Business District.

On the demand side, model households are classified into one of ten groupings (reflecting age, family status and income earners) each having different preference schedules. These preference schedules are based on translog utility functions which compare housing consumption, after-tax income, leisure time and neighbourhood quality.

On the supply side, a housing unit is characterized by the quantity of "housing services" (combination of size and quality) and the price per unit of service. Several different quality levels are distinguished to correspond to the many alternative quality submarkets in an actual housing market. Profit maximizing behaviour by the owners is assumed to imply linear supply curves (of varying slope for each type of housing unit) as an approximation of the price-quantity relations that govern the behaviour of owners over a ten year period. An unlimited volume of new construction is allowed at fixed unit prices, and in any size that provides a quantity of services greater than a defined minimum.

The major inputs to the model are a CMA's set of supply and demand parameters, the 1971 decade-end demand profile and the 1961 decade-start market state. A model solution is an estimate of the market conditions at decade-end. The predicted market conditions are based on an assignment procedure which sets unit prices such that no household has incentives to relocate and owners have no incentive to provide an alternative quantity of "housing services".

While the model is conceptually simple and assumes

convenient forms for the household preferences and dwelling supply curves, it captures many aspects of housing markets important in distinguishing the impact of alternative subsidy policies. Policy alternatives may be introduced by simply adjusting the demand and/or supply functions to allow straightforward simulations of the necessary subsidy costs under alternative policy options.

Eight CMAs were selected for the intervention cost study, reflecting a distribution with regard to geographical location, population and income growth during the 1961-71 decade. In implementing the model for a CMA the number of decade-end model households and dwellings is set at 100, reflecting a ratio of actual dwellings to model dwellings ranging from 287 to 3455 for the selected CMAs while the model parameters have been estimated alternatively from Census data or the 1974 Survey of Housing Units data. Certain parameters relating to neighbourhood externalities and the supply functions must be estimated by comparing model solutions with actual decadal performance.

The computed costs of intervention derived from the simulations show a significant variation firstly in terms of the alternative forms of policy and secondly by CMA, reflecting the relative states of the existing housing stock. The most generous form of government support lies with an "income" policy wherein households are provided with sufficient income to consume the minimum quantity of housing by choice. The other end of the scale is represented by a "direct constrained" policy whereby households are forced to increase their housing standards, but the compensation level is only sufficient for them to achieve their prior level of overall satisfaction.

The simulated difference in cost between these two alternatives is in the range of a factor of 10. That is, it could cost the government up to ten times more per annum to support housing standards via an "income" policy. The margin between the costs associated with the "income" policy and other alternative "direct product" oriented modes is in the range of a factor of 4 to 5.

The results suggest that a general "direct product" oriented policy, tied directly to the change in the quantity of housing consumed (supplied) will cost less than one-third of the amount associated with a general "cash" policy. At present costs this margin corresponds to an additional amount in the region of six billion dollars per annum for Canada.

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CHAPTER 01: INTRODUCTION

Senior Government involvement in housing and urban programs in Canada has grown rapidily but haphazardly during the period since World War II. This involvement has resulted not necessarily from any explicit decision by governments to be responsible for housing welfare, but as a result of the linkage between the housing commodity and general economic welfare. Public sector involvement with the housing commodity is not peculiar to Canada, or for that matter, to North America. It is a more or less universal phenomenon, with European government involvement frequently far in excess of that seen in North America. This widespread participation of the public sector in the housing market suggests that there must be good reasons why housing should be a matter of public concern over and above its impact on general economic welfare. Many alternative reasons and justifications have been offered for a government's role, but few have been completely substantiated by research or analysis.

Throughout their history Canadian housing markets have revealed complexities that still seem to baffle contemporary policy makers. John Saywell (1975; p2), in reviewing these markets, notes that;

> '..... the immobility, durability and high initial cost of housing have meant that the problem has been one not simply of the aggregate amount of housing stock in existence, but its location and kind in relation to the movement, growth, and composition of the population, level of income, household formation and family size. Even farsighted planning on a national level could not have completely anticipated the regional and occupational pattern of Canadian economic and social development. Private enterprise has found it impossible. Housing has seldom kept pace with urban population growth, and low income groups have always been inadequately housed in urban Canada.'

A structured Canadian housing policy has been slow in developing. Until the 1970's public policies were directed towards maximizing the regional and national economic growth through state-aided industrial development. While these policies encouraged regional growth, the private sector was left to provide the necessary housing and other goods and services for the rapidly expanding urban and industrial society. The last decade saw a shift in policy whereby housing was viewed not solely as a good or service, the consumption of which should be subject to usual income or wealth constraints, but rather as a fundamental right for all.

Smith (1976, p114), indicates that this position is clearly reflected in statements made by the then Minister of Urban Affairs, that the Federal government has "adopted the basic principle that it is the fundamental right of Canadians, regardless of their economic circumstances, to enjoy adequate shelter at reasonable cost", and by the Ontario Ministry of Housing that "adequate housing at affordable prices is a basic right of all residents of Ontario". The resulting federal programs showed a substantial growth in direct government participation in housing and a widespread use of housing policy as a vehicle for resource redistribution. This point of view is taken by Smith (1976, p114).

> 'Consistent with the notion that housing is a fundamental right to be shared by all, Canadian housing policy in the 1970's encouraged home ownership, discouraged private ownership of rental dwellings, provided for government and non-profit ownership of rental dwellings, and redistributed income in favour of lower income households.'

While evidence offered by Hellyer (1969) and Dennis and Fish (1972) supports the need for government intervention if sufficient adequate housing is to be provided for all Canadians, the debate arises over the <u>level</u> and the <u>mode</u> of that intervention and the

long run efficiency of existing policies and programs in meeting social objectives. The evaluation of the desired level of intervention requires a "normative" economic framework that necessitates the derivation of a social welfare criterion against which to judge alternatives. This issue arises because "sufficient adequate" housing is defined in terms of a combination of the quantity and quality of a housing unit rather than in absolute quantity terms. This leaves the subject open to varying political and technical interpretations. The question of the mode of intervention is more open to theoretical and empirical analysis. Alternatives of the latter can be evaluated utilizing available data and analytical tools. The objective of this thesis is not an attempt to justify government involvement in the housing markets in terms of a social or political philosophy or to justify a particular level of involvement, but to take a current housing concern - that of the low income household - and to analyse the long run economic impact and economic cost of alternative modes of involvement directed at this concern.

As a housing market analyst the first question one must ask is whether governments should intervene; the next questions are what level of support should be given and where. Then, for any degree of support, there remains the question of how it should be provided. It is this latter question of the mode of support that this thesis addresses.

1.1 Introduction

> 'Public subsidies are undertaken for many reasons other than improving the self-perceived well-being of recipients; benefits may also accrue to neighbors of the recipients or to all citizens of the city or country in which he lives. The essential point is to distinguish among benefits to the recipient, benefits to others and costs.' (Aaron(1972, p45))

Housing issues have seen extensive research and analysis via a multitude of disciplines, each focusing on a different aspect considered of importance within that discipline. Because of the complexity of the interrelationships involved in an urban housing market, many important linkages have been overlooked. This study does not pretend to consider the social or environmental implications but focuses solely on the economic aspects of alternative government housing market policies. The approach follows the format of several previous attempts to use the techniques of quantitative economics in modeling the intricacies of an urban housing market. Such delineation of the key features of an urban housing market and the understanding of how they affect each other are considered crucial in determining the impact of government policies on urban housing welfare and the manner in which the current stock of housing will be utilized in the future.

While the main focus of this research is towards an overall evaluation of the impact of alternative <u>modes</u> of housing subsidization, the study concentrates on the evaluation of the impact of alternative supply side (direct product) subsidies on regional housing markets. These supply-oriented subsidies are viewed as an alternative, and/or complement, to the general class of demand side (cash consumption) subsidies now frequently advocated as the most realistic means of meeting the "aims" of the

current social housing philosophy, concerned with the plight of the low income households.

In studing housing markets one does not have the single homogeneous market of neoclassical economics. In fact the most distinctive characteristic of a housing market is its diversity. To deal satisfactorily with the possible effects of government intervention into housing markets requires moving beyond an elementary economic framework into questions of timing, to the distinctions between the new and the existing housing stock and to formulations of housing submarkets with different characteristics.

The analytical portion of this thesis thus comprises simulation results generated by a regional housing market simulation model initially developed by the Urban Institute (U.I.), (de Leeuw and Struyk (1975) and MacRae (1978)), with refinements and modifications that allow its application in a Canadian context. With an emphasis on policy formulation, the model deals with long term regional housing quality and cost rather than short run fluctuations in the market state. This thesis, therefore, indicates possible future directions for housing policies in terms of the mode of intervention and highlights potential regional disparity under a unified national policy but does not make reference to the actual short run mechanics of the delivery.

1.2 Overview

Social concern with, and debate over, housing consumption levels has been politically evident in Canada throughout this century, (Saywell (1975)). As a result this period has seen numerous Federal and Provincial programs directed at improving the quality of the housing stock. Generally, intervention has been geared towards increasing the size of the housing stock by focusing on new construction; a policy necessary to satisfy a backlog of demand created by the world wars and changing social attitudes. Current evidence suggests that this aim has been met:

> '.... Canadians entered the 1970's extremely well housed. In comparison to other nations, Canada ranked second only to the United States in the provision of basic equipment, was tied with the United States for the lowest occupation density with 1.6 rooms per person, and ranked first in the Western World with an average of 5.3 rooms per dwelling. Furthermore, new residential construction exceeded net new family formation by 62% during this period ....' (Smith (1976, p118))

This current standard of housing has been achieved via programs that concentrate on supply side intervention. During the 70's these supply side programs have been severely criticised in both the U.S. and Canada. Some critics will argue that the supply side approach is justified for housing but that the previous programs have not met the high expectations set for them because of their structure, administration and financing. Other critics attack the basic goals of such policies, while an ever-increasing number argue that these goals can be better achieved with income transfers (Saffran (1976, p234)). The main criticism of "housing" policies in Canada, most notably from Dennis and Fish (1972), is concerned with the fact that supply side programs rely heavily on the construction of new housing units. This has meant that the subsidies have been dwelling-specific and have thus induced

horizontal inequities because of the limited number of units supported. Furthermore, the direct construction of social housing has faced additional criticism because of the clustering of such activity in specific locations, which may induce a welfare stigma.

Under pressure from these changing attitudes and in keeping with a philosophy of providing access to "adequate" and "affordable" housing to all, housing policy in Canada in the 1970's has gravitated towards the widespread use of housing policy as a means of income redistribution, rather than primarily to improve or maintain the standard of the total housing stock. In accordance with this changing focus, a myriad of confusing and sometimes conflicting policies and programs have been introduced at all levels of government, as regulators strive to implement the new philosophy. Have Canadian regulators now become too preoccupied with the affordability and redistribution issues, losing sight of the significance of the quality of the housing stock? Smith (1976, p126), in reviewing government intervention in Canada notes that:

> 'The nature of the Canadian housing market has thus changed drastically in the last few years in response to government policies. This change was clearly the result of a substantive philosophical change with respect to housing and not the result of a market failure, since housing policy has become primarily a transmission mechanism for income redistribution rather than for improving the nation's housing standards. It is therefore unlikely that this change will improve housing standards, although it will redistribute income in Canada.'

Evidence offered by demand side consumption subsidy enthusiasts, while indicating that income problems exist, provides no proof that such subsidies offer "better" long run social and housing solutions than either a purely supply side involvement or a blending of both supply and demand side policies and offers no

strong evidence of the relative cost.

In order to rationalize the potential impact of the numerous policy/program alternatives available to governments, this thesis focuses on six policy scenarios that reflect varying degrees of "leakage" of the provided housing subsidy to the consumption of non-housing goods and services. These alternatives cover the continuum from pure cash (income) subsidies, wherein up to a one hundred percent "leakage" to the consumption of non-housing goods and services may occur, to direct product intervention, wherein the recipients may be required to reduce their consumption of non-housing goods and services in order to improve their housing standards.

The computation of the cost incurred by the government under the six alternative scenarios, for selected Canadian cities, is undertaken using a simulation model based on a long run (ten year) regional housing market model developed in the U.S. during the early 1970's. This model traces the interaction inherent in the supply and demand of housing in each of many separate, but highly inter-dependent, housing submarkets.

This model is derived from a microeconomic perspective on households and owners contracting for housing at prices and quantities determined in several submarkets. A selected CMA is represented in the form of several residential zones that reflect variations in the housing stock, income levels and distance from the Central Business District.

On the demand side, model households are characterized into one of ten groupings (reflecting age, family status and income earners) each having different preference schedules. These preference schedules are based on translog utility functions which

compare housing consumption, after-tax income, leisure time and neighbourhood quality.

On the supply side, a housing unit is characterized by the quantity of "housing services" (combination of size and quality) and the price per unit of the service. Several different quality levels are distinguished to correspond to the many alternative quality submarkets in an actual housing market. Profit maximizing behaviour by the owners is assumed to imply linear supply curves (of varying slope for each type of housing unit) as an approximation of the price-quantity relations that govern the behaviour of owners over a ten year period. An unlimited volume of new construction is allowed at fixed prices, the only constraint being that a minimum level of housing services must be provided by a new dwelling.

Submarkets are derived in the model because dwellings are not perfect substitutes for one another in either supply or demand. Thus it is possible for the price per unit of housing service to differ amoung dwellings in equilibrium, although prices cannot differ too much because of the price responsiveness of demand.

A model solution is represented by a decade-end set of household locations and quantities and prices of housing services for which no one has any incentive to change. This solution is based on a CMA's set of supply and demand parameters, a 1971 decade-start household profile and the 1961 decade-start market state. The predicted market conditions are based on an assignment procedure which sets unit prices such that no household has incentives to relocate and owners have no incentive to provide an alternative quantity of housing services.

While the model is conceptually simple and asssumes convenient

forms for household preferences and dwelling supply curves, it captures many aspects of housing markets important in distinguishing the impact of alternative policy subsidies. Policy alternatives are introduced by simply reformulating alternatively the demand and/or supply functions to allow straightforward simulations of the necessary subsidy costs under the alternative policy scenarios.

The model has been applied to eight CMAs reflecting a distribution with regard to geographical location, population and income growth during the 1960-70 decade in order to obtain values for the key supply and demand parameters. The application to a number of metropolitan areas was considered necessary because several of the behavioural parameters are obtained through repeated simulation of the model for an area. These parameters based on empirical applications determine what the model actually says about the market effects of the different policies and the implied costs associated with supporting minimum housing standards.

1.3 Conclusions

It is argued in this thesis that given the historical and current states of the housing markets in Canada, the most efficient solution to existing and forseeable housing problems is a combination of supply and demand side interventions. By focusing on the most intractable and enduring housing problem, that associated with low income households, policies that reflect alternative approaches to intervention have been evaluated in terms of their cost to support a given standard of housing within selected Canadian metropolitan areas.

The alternative forms of intervention reflect various levels of "resource" redistribution in association with the market support. In selecting intervention scenarios that involve varying degrees of "leakage" of subsidy dollars to the consumption of other goods and services, this study has been successful in quantifying the relative costs and "resource" efficiencies of alternatively advocated means of intervention and support.

The basic premise of the argument presented in this thesis is that a "direct product" subsidy program will support a minimum standard of housing stock at a cost lower than that associated with a demand side "income" or "in-kind" subsidy program. The suggested important differences between these three alternative policy forms are;

1. an "income" policy approach involves the subsidization of incomes such that the recipient will select by choice the supported minimum quantity of housing.
2. an "in-kind" policy approach involves the subsidization of incomes at a level dependent on either the supported minimum quantity of housing or the associated required expenditure.

3. a "direct product" policy approach involves either the direct subsidization of capital and/or operating costs, or the direct provision of an additional quantity of housing services.

The theorectical and empirical evidence indicates that the "income" and "direct product" policies form, respectively, the upper and lower extremes of the policy continuum in terms of cost efficiency: the "in-kind" approach fills the gap between these two extremes. Under certain extreme market conditions or subsidization levels, "in-kind" policies may be equivalent to an "income" or a "direct product" subsidy. The computed magnitude of the typical difference in subsidization cost (and consequently efficiency under a supported minimum quantity scenario) between the two extreme forms of intervention is in the range of a factor of 10 to 12. That is, it is suggested that an "income" based form of intervention will "cost", in subsidy dollars, at least ten times more than the most efficient form of "direct product" intervention.

At a typical current cost of $30.00 per month to support a "reasonable" level of housing via a "direct product" policy, the cost of a corresponding "income" based policy will be in the region of $300.00 per month. On a national basis this would involve approximately 250,000 households, suggesting total alternative subsidy bills of either 60 million dollars or 900 million dollars, respectively.

CHAPTER 02: POLICY ALTERNATIVES in SUPPORTING HOUSING CONSUMPTION

Housing literature frequently addresses politically sensitive short run concerns with the state of housing and associated markets while neglecting the long run forces underlying the operations of the markets. All too often authors suggest government intervention to treat the symptoms, not the disease. Under such policies, the disease simply generates alternative symptoms and the process begins yet another cycle. Typical of this situation is the mixture of rent control, taxation policies and rental housing construction subsidy programs that have been implemented in Canada over the last decade.

The real "economic issues" of housing (and thus the source of housing "problems") are associated with the long run market forces that determine the level and distribution of housing consumption. These fundamental issues give rise to the more readily visible superficial problems faced in day to day confrontations, but the association between the day to day problems and the underlying long run forces is very complex. In a general economic sense, these "economic issues" arise either because of market "failure" in terms of efficiency concepts, or resource distribution concerns as reflected in terms of equity concepts.

The "problems" with the housing market are generally traced to concerns with the equity of the distribution of the housing stock while the real economic "issues" facing the market will arise from the long run efficiency of housing market operation. Equity issues concerning the distribution of housing resources must thus be handled within the context of efficiency considerations.

One of the successes of economic theory has been the derivation of the conditions under which competitive markets produce efficient resource utilization. These ideas date back to Adam Smith, but it has only been in recent years that the theory has been completed (De Salvo (1976, p305)). In considering housing issues, two of the governing propositions of competitive markets are of interest. The first is that a competitive equilibrium is efficient; the second is that any efficient allocation of resources can be achieved by competitive markets, given a suitable reallocation of the initial resources held. It is these same propositions that provide the rationale for private enterprise to operate through a competitive market system without government intervention. Nevertheless, the conditions for competitive markets are based on certain assumptions that may not hold for specific markets. In such cases, the basic propositions justifying decentralized decision-making no longer hold, and there is a need for some kind of collective decision-making that will induce market efficiency.

Potential violations of these necessary conditions for a competitive market fall into two groups. The first is with markets where several factors simply distort the competitive nature; the second concerns markets where the structure prevents competition. It can be shown that in otherwise competitive markets, externalities, public goods, uncertainty and incomplete information render the market solution inefficient. With these factors absent, markets showing increasing returns to scale and non-competitive markets in general render the same result, (De Salvo (1976, p307)).

In addition to efficiency considerations, there is another major reason for government intervention into private markets; the

redistribution of resources in socially desired ways. In other words, efficiency in the distribution of resources does not necessarily imply equity in the resultant distribution. One of the propositions of competitive markets is that redistribution of the initial resources is sufficient to obtain any desired final distribution of resources by a competitive market. Even with efficient markets there is thus justification for intervention to redistribute the resources held by individual households.

2.1 Housing Market Intervention

Reported housing problems range from concerns with the cost of home ownership and the tightness of the rental market to locational concerns such as those associated with the inner city: typically concerns with equity. The most consistently and commonly voiced concern of all involves housing standards for low income households. However, since no national housing objectives exist, housing problems are all too frequently defined in terms of the commentator's social stance. As a result, a housing concern that may be viewed as a problem by one commentator is not seen the same way by another, or in the eyes of the public at large. The perceived magnitude of the problem may also vary. For example, commentators' attempts to define an income to expenditure ratio problem deviate in three areas. The first involves what is considered to be the income, the second concerns the defining of expenditure and thirdly, value judgments vary in determining what expenditure-income ratio reflects a problem. But within the maze of stated problems there exist several common concerns which are attracting the attention of governments.

Where does one start in analysing housing problems? However portrayed, housing problems reflect concerns with perceived needs of the members of society. How one defines these needs is a complex and perplexing question in itself. Any attempt to define such needs takes one into a very contentious, value-filled area (Smith (1971, p9)).

Under a political assertion that Canadians have the right to "adequate" and "affordable" housing continuing government support will be a necessity. It is considered that the "debate" over the

form of such intervention often arises in a large part from purely political/social considerations that are beyond the realm of technical analysis. Such considerations include differences in opinion as to the relative importance of various housing and non-housing goals, and frequent disagreement over what is an equitable distribution of national income and wealth. In other instances, conflicting assumptions regarding the social, economic and market forces which generate our housing problems underlie many of the differences under debate.

Policy alternatives available range from purely demand or purely supply oriented national policies through to complex regional policies combining both demand and supply oriented elements.

Program options range from continued investor subsidization via the taxation system, or direct product subsidization as with the former Assisted Rental Program (ARP), the Assisted Home Ownership Program (AHOP) and the Residential Rehabilitation Assistance Program (RRAP), to direct consumption subsidization via unconditional income transfers or conditional shelter allowance transfers. Just how poverty is defined is of considerable significance to the analysis of the housing subsidization question. Several alternatives can be offered, in terms of a minimum income, a minimum utility level or and minimum quantities of "merit" goods. Each suggests a different theoretical platform and therefore a significantly different solution regarding government intervention.

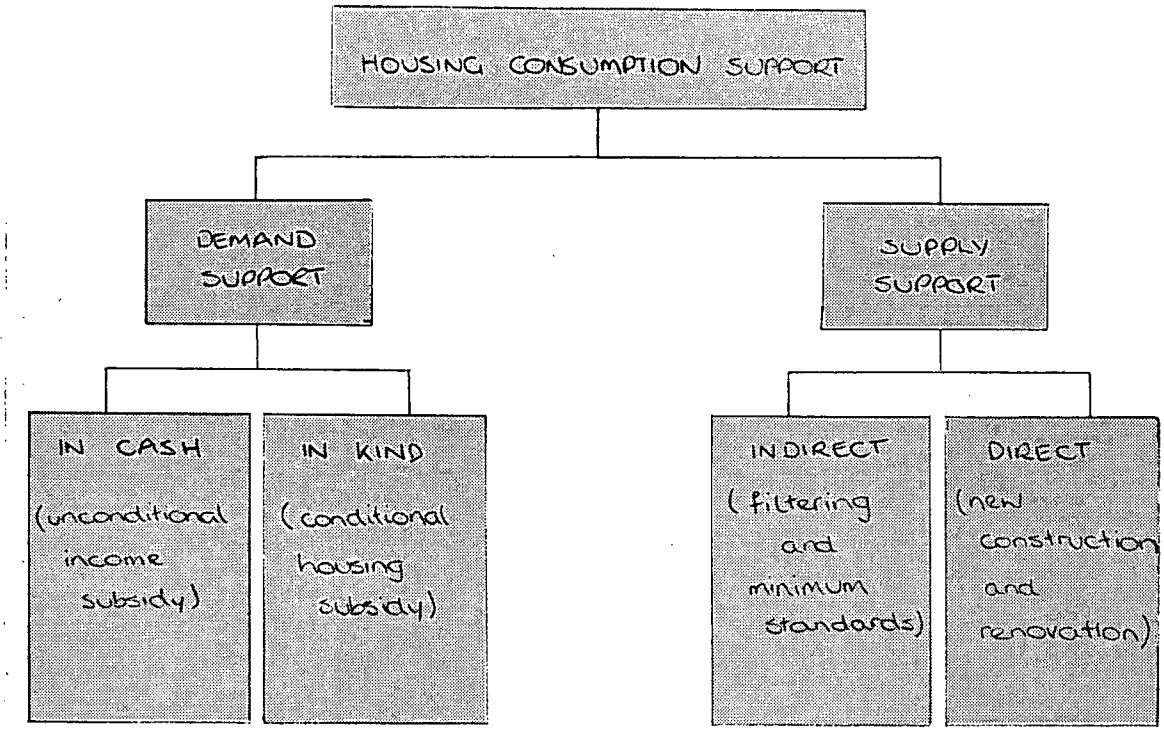


Figure 01: Intervention Policy Forms

Society holds an option on whether it should make a minimum level of income, defined in dollars or in terms of utility, available to all households, or whether a minimum quantity of necessary consumption items be made available. The option depends on whether the concern is with housing poverty or poverty per se. Musgrave (1976, p221), in arguing the option in the U.S. context, concludes that;

> 'A view of distributive justice as setting poverty floors in terms of meeting "essential needs" is part of our country's social mores and not just a reflection of special pressures or failure to grasp the underlying economics. This being the case, one must take a somewhat skeptical view regarding the conclusion reached by standard economic reasoning that housing support is inefficient because the welfare gain, as valued by the receiving household, would have been larger with a cash grant. Such is the case only if the policy objective is taken to be general income support without interference in income use.'

One must differentiate between the concept of "welfare"

inefficiency associated with placing limitations on consumer sovereignty and a "resource" inefficiency, which may result for example, because subsidies are so structured as to induce over capital-intense developments or an "excess" consumption of other goods and services. Musgrave considers the latter to be obvious elements of inefficiency that can readily be avoided by redesigning the subsidy mode or terms. The former, however, involves a judgment that distributional adjustments should be ruled out and that the entire approach in terms of minimum quantities should be held inadmissable. Such is the case only if the stated policy objective is taken to be general income support without interference in the use of the income.

Given that there currently exist government imposed market constraints (zoning, occupancy and building bylaws) on minimum housing consumption levels, as evidenced by the current "affordability" problem, it is extremely difficult to dismiss a subsidy approach in terms of merit goods. This is taken not to imply a rejection by society of pure income redistribution, but a recognition of "housing poverty" in its own right. If one accepts concern with minimum consumption levels, then another concern, the poverty associated with that consumption good, is implicit. Housing is one good where such a concern exists.

2.2 Generalized Forms of Intervention Policies

The alternative general policy forms considered are presented graphically in Figure 02. The actual nature of the subsidy is best visualised in terms of the proportion of the resultant expenditure on "housing" services (PX*QX) met from subsidies.

In Figure 02(a) an "income" subsidy, which is independent of the level of expenditure on housing, PX*QX, may range from a small percentage of the expenditure (zero in fact or PX*A as an example) to a multiple of the expenditure, for example PX*B. The typical income subsidy options available consist of either a flat guaranteed minimum income or a negative income tax policy, where the guaranteed minimum income is effectively a function of the income level. These options are represented as;

a. Subsidy = POL1 * (GMI - AY)

where AY < GMI and POL1 = 1.
and

AY is the unsubsidized income level
GMI is the guaranteed minimum income
POL1 is a policy parameter

That is, the recipient receives a guaranteed minimum income of GMI with the subsidy amount equal to the guaranteed minimum income minus actual income.

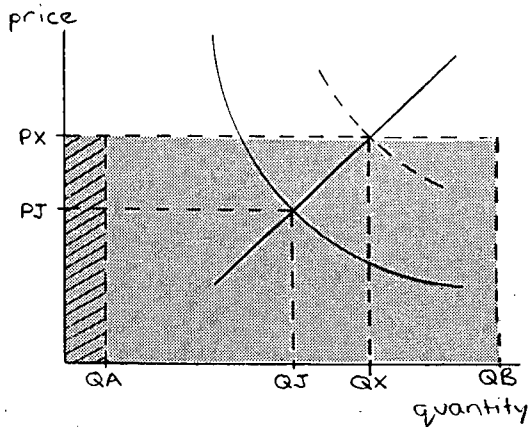
and

b. Subsidy = POL1 * (GMI - AY)

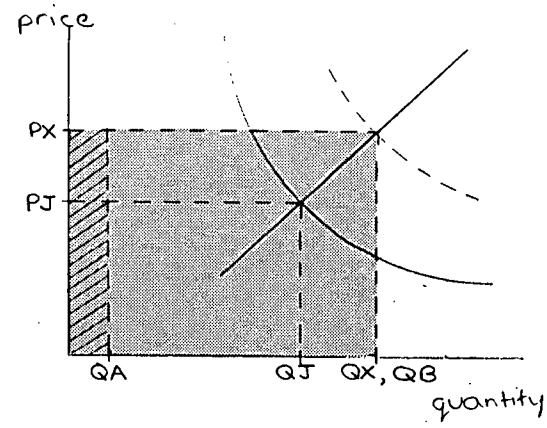
where AY < GMI and $0 < POL1 \leq 1$.
and

AY is the unsubsidized income level
GMI is the guaranteed minimum income
POL1 is a policy parameter

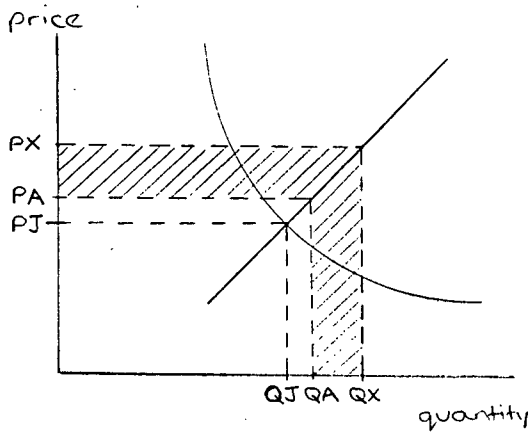
That is, the recipient receives only a percentage of the highest supported income, GMI. For example, with a POL1 parameter of 0.5 and support to $100., a recipient with zero income will receive only $50.



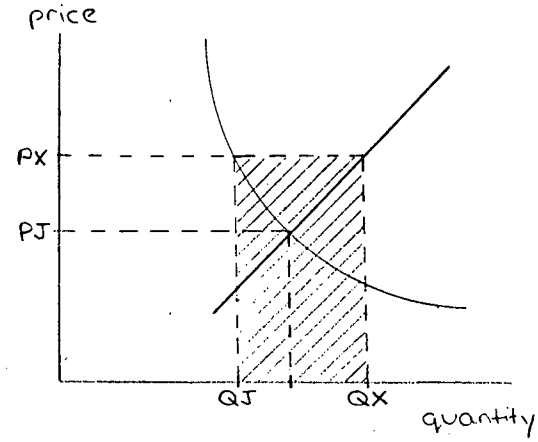
(a) INCOME SUBSIDY



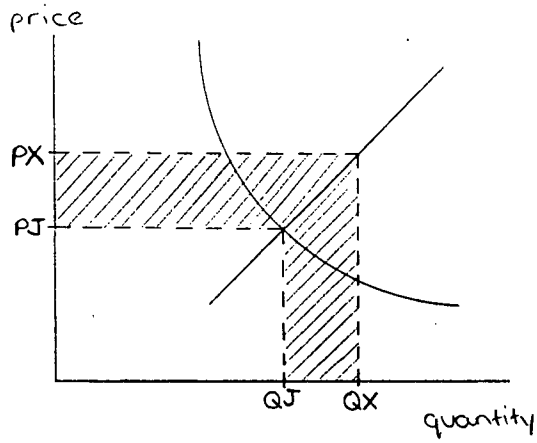
(b) CONSTRAINED CASH SUBSIDY



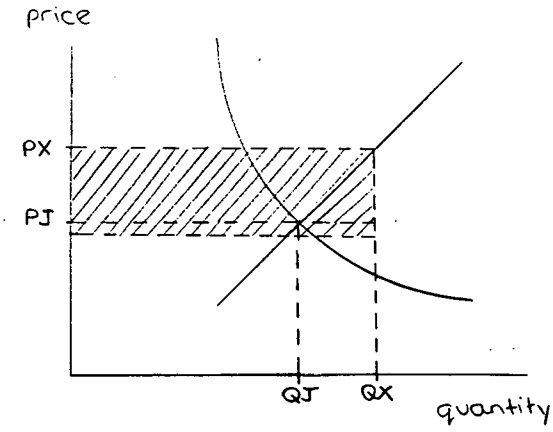
(c) DIRECT CONSTRAINED SUBSIDY



(d) DIRECT QUANTITY SUBSIDY



(e) DIRECT EXPENDITURE SUBSIDY



(f) DIRECT PRICE SUBSIDY

Figure 02: Alternative Forms of "Housing" Consumption Subsidies

In modeling the "income" subsidy option (considering the support of a minimum quantity, QX), the subsidy specification becomes independent of any guaranteed minimum income. Instead, the amount of the subsidy required is given by;

$$\text{Subsidy} = YS - AY$$

where,

YS is the income level at which the household would choose to consume QX units of "housing" services
AY is the unsubsidized income level.

The subsidy amount is calculated by deriving the income level at which the household chooses to consume QX and subtracting the actual income.

A "constrained cash" or "in-kind" demand subsidy program (Figure 02(b)) may be viewed as involving a conditional income subsidy, where the maximum subsidy amount is constrained to an amount equal to the expenditure on housing, PX*QX, and thus may range between zero and PX*QX.

The common forms of "constrained cash" subsidy follow the Housing Gap and Rent Conditioned Housing Gap formulas, as outlined in Carlton and Ferreira (1977, pp222-224). The standard Housing Gap formula is actually an "income" subsidy and requires the inclusion of a consumption constraint. It is formulated as

a. $\text{Subsidy} = POL1*(POL3 - POL4*AY)$

subject to

$$EXPEND > SUB$$

where $AY < POL3/POL4$

and

AY is the unsubsidized income level
EXPEND is the per-period expenditure on "housing" services

and POL1, POL3 and POL4 are parameters of the program

where $0 < POL1 \leq 1.$, $0 < POL3$ and $0 < POL4 \leq 1.$

That is, the recipient recevies a maximum of either POL1*POL3 or their expenditure on housing, EXPEND, at a zero income, with the subsidy then declining as a percent of the increasing income.
If the expenditure constraint is not binding then the formulation acts as a pure "income" transfer formula.

The self earmarking Rent Conditioned Housing Gap formula is a composite of an "in-kind" and an "income" formulation. It is formulated as

$$b.\ \text{Subsidy} = \begin{cases} POL1 * (POL2*EXPEND - POL4*AY) \\ \quad \text{for } EXPEND < POL3/POL2 \\ POL1 * (POL3 - POL4*AY) \\ \quad \text{for } EXPEND \geq POL3/POL2 \end{cases}$$

where $AY < POL2*EXPEND/POL4$
and
AY is the unsubsidized income level
EXPEND is the per-period expenditure on "housing" services

and POL1, POL2, POL3 and POL4 are parameters of the program

where $0 < POL1 \leq 1.$, $0 < POL2 \leq 1.$, $0 < POL3$ and $0 < POL4 \leq 1.$

That is, for recipients with expenditures, EXPEND, less than POL3/POL2 the subsidy amount is constrained by their expenditure on housing; for expenditures greater than POL3/POL2 the subsidy amount is constrained by the parameter POL3 and acts as an "income" subsidy.

Again, in modeling the support of a minimum quantity, QX, the subsidy specification becomes independent of the formulation and the amount of the subsidy is given by the lesser of;

$$\text{Subsidy} = \begin{cases} YS - AY \\ PX*QX \end{cases}$$

where,

YS is the income level at which the household would choose to consume QX units of "housing" services

AY is the unsubsidized income level

PX*QX is the market rent for QX units of "housing" services.

"Direct product" subsidy programs may theoretically take one of four general forms: the difference lies in what factor of the increase in "housing" expenditure is subsidized. The actual instrument of the transfer may be common across each of the four general forms. The most stringent form of direct product intervention is one that leaves the supported household indifferent between consuming the unsubsidized and subsidized quantity of housing. This form is termed a "direct constrained" subsidy in Figure 02(c). In such situations the household would be forced to reduce its consumption of other goods and services in order to provide some of the additional increase in housing consumption. This idealistic formulation is modeled by providing the household with the additional units of housing at a price discount such that the decline in utility from the lost consumption of other goods and services is matched by the consumption of additional housing funded from the subsidy and the reduced expenditure on other goods and services. This scenerio provides the most cost efficient form of intervention considered.

The second form, termed a "direct quantity" subsidy (Figure 02(d)), involves providing the household with an additional quantity of "housing" services directly. This form of intervention requires the household to pay for any resulting price inflation associated with their unsubsidized level of consumption through the reduction of the consumption of other goods and services.

Acceptable reductions in the consumption of other goods and services range from zero to an amount corresponding to that under an equivalent "direct constrained" subsidy. Correspondingly, the change in utility will range from a maximum as derived from consuming an additional (QX-QJ) units of "housing" services to a minimum of zero when the subsidy is equivalent to a "direct constrained" formulation. The subsidy amount is specified as;

$$\text{Subsidy} = (QX-QJ) * PX$$

where,

QX is the supported quantity of "housing" services
PX is the price per unit of "housing" services at the supported level
QJ is the unsubsidized quantity of "housing" services consumed

The third form of "direct product" intervention involves the situation where a household receives a subsidy equal to the increase in expenditure involved. In this situation the household maintains the same utility from consuming other goods and services but increases its utility from consuming housing. The subsidy amount involved is given by

$$\text{Subsidy} = QX*PX - QJ*PJ$$

where,

QX*PX is the subsidized expenditure
QJ*PJ is the unsubsidized expenditure

The final form, the "direct price" subsidy, detailed in Figure 02(e), involves the more general form of direct product policy where the subsidy per unit of "housing" services consumed corresponds to a reduction in either operating and/or capital cost. Examples would included a 100% mortgage loan subsidized at a below market rate or a front end capital subsidy (below market land) that reduces per period payments. The subsidy amount can range between

zero and PX*QX. In formulating this option it is considered that the household faces the reduced prices with its unsubsidized income. This results in a leakage to the consumption of other goods and services, but for a given level of "housing" services consumption the total utility level will be constant across all alternative dwellings. Under a general specification;

$$\text{Subsidy} = a^* QX^*PX$$

where,
"a" is the decimal percentage reduction in the price offered.

In modifying the four alternatives to consider the support of a minimum quantity QX at a market price PX, the following conditions exist. With a "direct constrained" subsidy the subsidy amount is obtained by calculating the price reduction required to match subsidized and unsubsidized utility from housing and other goods and services. The subsidy amount is calculated as

$$\text{Subsidy} = a^* PX^*QX$$

where,
"a" is the decimal percent reduction in the price

That is, the household is prepared to pay PX for QX units of "housing" services if receiving a subsidy of a*PX*QX.

With a "direct quantity" subsidy the subsidy amount corresponds to the required additional quantity of "housing" services times the market price PX and is specified as

$$\text{Subsidy} = (QX - QJ) * PX$$

where,
QJ is the unsubsidized quantity of "housing" service consumed

That is, the household receives PX*(QX-QJ) towards an additional expenditure of PX*QX-PJ*QJ and thus must pay an additional amount (PX-PJ)*QJ by reducing the consumption of other goods and services.

Under a "direct expenditure" subsidy the subsidy amount is calculated as the difference between the subsidized and unsubsidized expenditures.

$$\text{Subsidy} = QX * PX - QJ * PJ$$

where,

QJ is the unsubsidized quantity of "housing" service consumed

PJ is the price associated with consuming at the unsubsidized level.

To derive the "direct price" subsidy the procedure involves solving for "a" the required discount from the market price PX, when the quantity demanded is QX. This involves calculating the price at which the household would consume QX units of services at its unsubsidized income level. The subsidy involved is then given by

$$\text{Subsidy} = a * PX * QX$$

where,

"a" is the decimal percent reduction in price required for the household to consume QX units of "housing" services.

In evaluating the alternative approaches to intervention one must either quantify both "welfare" and "resource" inefficiencies or quantify the "resource" inefficiencies associated with a given level of "welfare" inefficiency. Since no quantitative tools exist that allow one to price "welfare" inefficiencies, the latter approach is employed in this thesis.

"Resource" inefficiencies are measured as the difference in cost associated with achieving the same partial state of the world under alternative forms of market intervention. Short run inefficencies can be grouped in accordance with those associated with the mode of intervention and those associated with the state of the market being subsidized. Not only will these inefficiencies vary with the mode of intervention but also with the form of the low-income concern being addressed and from housing market to housing market.

In order to obtain "equivalent" partial states under alternative policy scenarios, consideration can be made of the relative subsidization costs to support the same minimum quantity of "housing services" consumption. In particular, the concept of redistribution in terms of a minimum "income" level is defined as the income at which a household would by choice consume the defined minimum quantity of "housing services". A recipient under a "direct quantity" policy would maintain current levels of consumption of other goods and services while consuming the defined minimum quantity of housing services. A "direct constrained" scenario involves forcing the household to consume the defined minimum quantity of housing services at its unsubsidized utility level. These three alternatives are detailed in Figure 03.

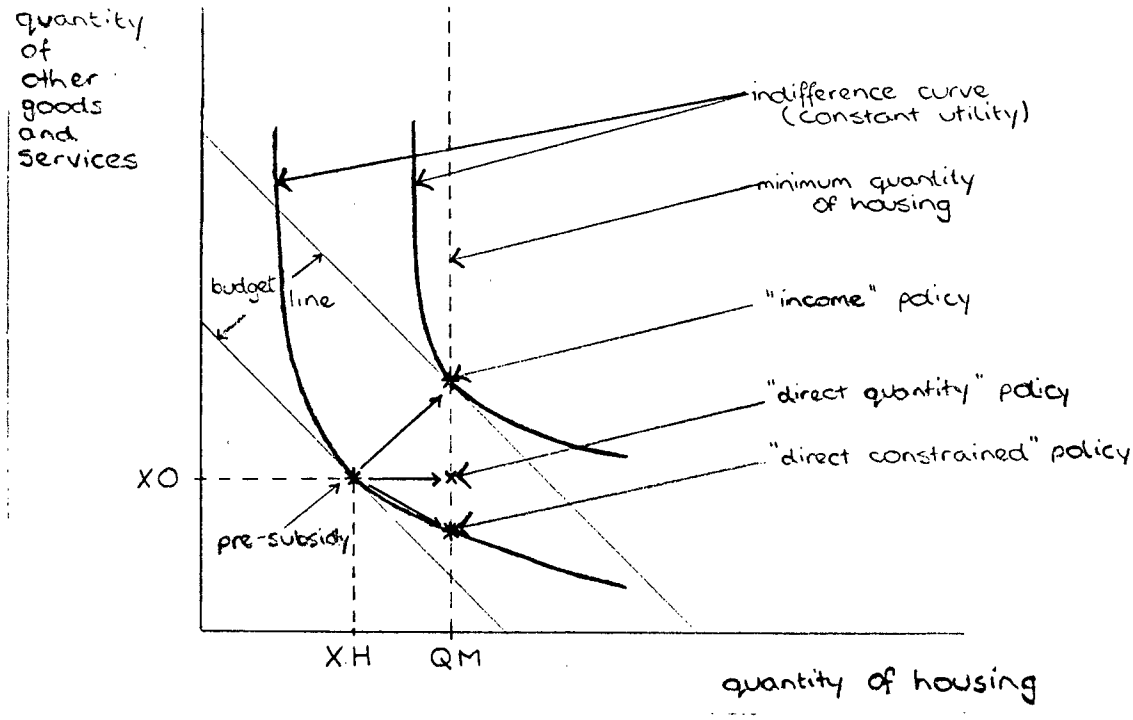


Figure 03: Consumption Level Changes Under Alternative Policies

Under an assertion that Canadians have the right to adequate and affordable housing one will see a continuing government involvement in housing markets in Canada. In order to quantify the potential relative cost to the government of supporting minimum housing standards under alternative forms of intervention six general policy scenerios have been detailed in this chapter. The next four chapters detail a housing market simulation model developed to aid in quantifying these costs. The final two chapters present the simulation results derived for eight CMAs and general conclusions for Canada as a whole.

CHAPTER 03: MODELING POLICY ALTERNATIVEs

In the study of housing markets one does not find the single homogeneous market of neo-classical economics. In fact the most distinctive characteristic of a housing market is its diversity. This diversity results in a series of overlapping submarkets, each differentiable via characteristics such as structure type and age, location, tenure use, financing and the applicability of subsidy programs. Therefore no two housing units can be considered identical and to obtain completely homogeneous submarkets one would have to model a housing market by isolating each housing unit into its own separate, but interdependent, submarket. Such a breakdown would lead to insurmountable analytical problems. In modeling a housing market one must then strike a balance between the "homogeneity" of submarkets and analytical "simplicity".

A number of models have been developed in the U.S. to analyse urban problems, each focusing on a different problem area. A review of the four most successful; Disaggregated Residential Allocation Model, Engle-Rothenberg Model, Urban Institute Model and the NBER Model (see Ingram (1977) for details of these models) indicated that the Urban Institute (UI) Housing Model provides the most suitable theoretical and analytical basis for the derivation of a Canadian policy oriented model (See Hobart and Johnston (1979)). The major advantages afforded by the UI model are that the data employed to make it operational at an empirical level are available from published sources and the model is readily adaptable for policy simulations.

3.1 The Urban Institute's Model

The UI model, detailed by De Leeuw and Struyk (1975), is concerned with the changes over a decade in housing quality and household location within a metropolitan area. DeLeeuw and Struyk (1975, p12) note that this capsule description of their model contains four key phrases; "decade changes", "housing quality", "household location" and "within a metropolitan area". Each of these phrases serves to distinguish the model from other models or studies; in particular from short run explanations of housing market dynamics, from location-free theories of the filtering process, and from macroeconomic analyses with a national focus. The model makes use of conventional assumptions that households seek to maximize their satisfaction and that owners seek to maximize their profits in a formulation that emphasizes two characteristics that distinguish housing from most other goods: the durability of housing and the inescapable link between housing and the neighbourhood environment.

The model in effect represents the metropolitan housing market as a set of demand and supply functions for closely related submarkets. Since the submarkets are not perfect substitutes, solution prices need not be the same: on the other hand prices will be closely related as substitution is of sufficient strength to cause vacancies or over-occupancy if the price in any submarket is out of line. The matching process simulated by the model's solution algorithm reflects these possible substitutions.

In essence this model is a microeconomic perspective on households and owners contracting for housing services with the characteristics of an individual metropolitan area captured through

"model zones", "model households" and "model dwellings". In particular, the spatial characteristics of the metropolitan area are represented in the form of several residential zones that reflect variations in the characteristics of the housing stock, income levels and distance from the Central Business District (CBD).

Each model household represents several hundred or thousand actual households as of the end of a decade. The exact number depends on the end-of-decade size of the metropolitan area to which the model is being applied. Each household is allocated to one of several "household types" (reflecting age and family status) and assigned an average income. Based on these two characteristics, the behaviour of the households consists of deciding which of all possible dwellings, including a new dwelling at any desired level of services (subject to a minimum constraint), to occupy.

A model dwelling, like each model household, also represents several hundred or thousand actual cases and is characterized by the residential zone in which it is located and the quantity of housing services which it supplies at the start of the decade. The level of housing services - one of the basic concepts of the model - refers to an index of all things of value which a physical structure provides; space, shelter, privacy, design and a host of others. It does not refer to the neighbourhood characteristics associated with each dwelling; these are measured by the attributes of the residential zone in which the dwelling is located. The model allows an unlimited volume of new construction within a separate homogeneous residential zone at a fixed price per unit of housing service. The only constraint on new construction is that the dwellings must provide at least a minimum level of services.

A solution to the model involves a decade-end representation of the housing stock. This solution is based on a set of supply and demand parameters, a representation of the housing market at the start of the decade and a representation of housing demand at decade-end. The predicted market conditions are derived via an assignment procedure which sets unit prices such that no household has incentives to relocate and owners have no incentive to provide an alternative quantity of housing services.

The three components of this model are the demand functions, the supply functions and the solution procedure. In deriving the demand functions each household is assigned a utility function represented by;

$$Uij = Hij, Xij, Z_1, Z_2, Z_3$$

where

Uij is the total utility household "i" derives when consuming the housing services provided by dwelling "j".

Hij is the partial utility derived

Xij is the partial utility derived from the consumption of non-housing goods and services

Z1,Z2,Z3 are the partial utilities associated with the zone in which dwelling "j" is located

The partial utilities associated with housing and non-housing goods and services are based on a concept of a minimum acceptable consumption level which resembles the constant term in utility functions of the so-called linear expenditure form. That is, utility is measured as a function of the excess over these minimum levels rather than the excess over zero. Demand functions derived from such utility functions are not suitable for parameter estimation by regression; parameter values must be estimated via a

calibration process in which model solutions under various parameter values are compared to actual decadal changes.

On the supply side, profit maximizing behaviour on the part of owners is assumed to imply linear supply curves (of varying slope for each type of housing unit) as an approximation to the price-quantity relationship that governs the behaviour of owners over a ten year period.

The solution algorithm associated with the original model (DeLeeuw and Struyk (1975, pp33-55)) is based on an approach that allows the owners to act as monopolists extracting the maximum price possible from households. An alternative stacked assignment solution algorithm proposed by McRae (1978) employs a competitive behaviour assumption: the solution price-quantity corresponds to the interception of the supply and demand functions. (See Hobart and Johnston (1979, pp14-20) for a review of these two algorithms.)

The model is conceptually simple and while assuming conveniently simple forms for household preferences and dwelling supply curves it does capture many important aspects of particular interest in formulating housing subsidy policies (Carlton and Ferreira (1977, p227)). In particular, it distinguishes several types of households and dwellings, allows for neighbourhood and access effects in household preferences, separates changes in price from changes in quantity of housing consumption and considers a continuous range of household incomes. The model also allows for different supply behaviour on the part of owners located in different quality submarkets and makes explicit that the market equilibrium depends on the underlying distribution of purchasing power and quality of housing and on the competition between neighbouring quality submarkets.

In summary the basic and key theoretical features underlying the model framework are:

1. Market segmentation - submarkets by quantity of housing services and locational differences.

2. Imperfect Substitutes - submarkets close but not perfect substitutes. This will result in prices differing between submarkets and allow policies to have a larger impact on some submarkets than others.

3. Durability - separation of housing supply into new and existing stock with the latter accounting for most of the supply even in a ten-year span.

4. Elastic new supply - extremely elastic supply over a 10 year period, with the construction industry building those dwellings demanded.

5. Inelastic existing Supply - supply of housing services from existing dwellings is far from being perfectly elastic.

6. Supply trends - services from existing dwellings change very slowly.

7. Demand trends - assumption of a growth of real income per household over time, which is responsible for a normal excess demand for high quality units and a more variable outcome in the low end of the quality spectrum.

3.2 Canadian Version of the UI Model

After implementing their basic model the U.I. undertook tentative development work on a tenure version (de Leeuw and Struyk (1975, p151)). Their reasoning for incorporating the tenure choice was

1. to highlight any significant differences between owner-occupant demand behaviour and tenant demand behaviour,
2. to evaluate the difference in tax treatment, and
3. to support any evidence on the differential behaviour of landlords and owner-occupiers as suppliers of housing services.

Their initial incorporation of the tenure differentiation was based on the assignment of fractional probabilities of ownership to each "model" household. A household's housing consumption choice was then based on a "weighted" household. This approach raises a dilemma inasmuch as owner-occupiers and renters will evaluate the same "model" dwelling differently: the model lacked such a freedom. A latter reformulation (Andreassi (1978)) involved the exogenous division of households by type into owner-occupiers and renters but not the dwellings. In addition, incomes were adjusted to reflect income taxes with the owner-occupier's budget being respecified to include itemized deductions. To implement the model the demand function parameters were simply adjusted to compensate for the reduced income levels. The other model parameters used were as for the basic model.

In implementing the model for Canadian metroploitan areas the use of the computationally more efficient McRae stacked assignment algorithm and the availability of the comprehensive 1974 Survey of Housing Units cross-sectional data set has allowed the

incorporation of several enhancements. These include a new tenure based formulation for the demand system, an increase in the degree of representation from 30 or 40 model households to 100 model households and the modification of the computational procedure to allow the endogenous computation of several alternative subsidy forms.

The major changes made to the model include;

1. the reclassification of the households from eight to ten type groups that reflect rental or owner-occupier mode of occupancy.
2. an 'a priori' classification of the "model" dwellings as either rental or owner-occupied,
3. the provision of after tax incomes as model input including imputed income to owner-occupiers from the equity component of dwelling value and government transfers,
4. the treatment of owner-occupiers' expenditures not as a "rent" but as a "user cost" based on actual cost data,
5. the specification of the demand system in a form that may be directly estimated, and
6. the respecification of the existing stock supply system to reflect end of decade prices, not <u>average</u> decade prices.

It should be noted that the restructured model does not have the potential for tenure switching. Such an implementation has been hampered by both the lack of data on household wealth and suitable data from which a switching function may be estimated. Indications are (Lowry (1979, p89)) that the expected volume of tenure changes would be too small to be of significance with only 100 model representations for an urban area.

CHAPTER 04: The DEMAND SYSTEM

In restructuring the demand side of the model three major changes have been incorporated. The first involves the regrouping of the households into ten alternative groups based on tenure; the second involves the use of after tax incomes, while the third involves the respecification of the demand system to incorporate functions for which the parameters may be directly estimated from the 1974 Survey of Housing Units (SHU) dataset.

In regrouping the households consideration has been made of tenure, the age of the head, the number of income sources and the presence of children. Five groups of renters and five groups of owner-occupiers are created. Within each tenure set one group is assigned to the elderly (65 and over). The other four groups are classified by the number of sources of income; single source or two or more sources and whether or not the household has children, as indicated in Figure 04.

Type	1	2	3	4	5	6	7	8	9	10
head's age	65+	<65	<65	<65	<65	65+	<65	<65	<65	<65
"Y" sources	S/M	S	M	S	M	S/M	S	M	S	M
children	Y/N	No	No	Yes	Yes	Y/N	No	No	Yes	Yes
tenure	rent	rent	rent	rent	rent	o-o	o-o	o-o	o-o	o-o

note: S/M indicates both single and multiple income sources
: S indicates single income source
: M indicates multiple income sources
: Y/N denotes either option included
: rent denotes renters; o-o denotes owner-occupier

Figure 4:01 Household Type Groups

The main considerations in forming these groups were with regard to preferences for "housing" services, eligibility for subsidies and household similarity for taxation calculations. With the large variation between CMAs in terms of the percentage split between rented and owner-occupied dwellings, the groupings were formulated to ensure at least four percent of the total households were included for each household type across the eight CMAs included in the study.

In addition to using regrouped households the modified model shifts the emphasis from the household's gross income to the net (disposable) income through the computation of taxes. The household's income taxes are calculated exogeneous to the simulation process and all subsidies associated with policy simulations are assumed to be net of taxes.

The most significant change made to the model involves changing the utility function associated with the household's preferences. The utility system employed is that outlined by Christensen, Jorgenson and Lau(1975) which they refer to as a direct transcendental logarithmic utility function, or more simply a direct translog utility function. Under such a formulation the demand system has been estimated indirectly through the estimation of expenditure share functions based on the household's disposable income.

4.1 Derivation of the Expenditure Share

The traditional approach to formulating a demand system involves the specification of a system of demand functions relating the quantity of each commodity consumed to total expenditures and the price of all commodities that are consistent with utility maximization. As noted by Christensen, Jorgensen and Lau (1975, p367), additive and homothetic utility functions have been important in formulating tests of the theory of demand; 'If the utility function is homothetic, expenditure proportions are independent of total expenditure. If the utility function is additive and homothetic, elasticities of substitution among all pairs of commodities are constant and equal.'

The utility system used in specifying the demand functions for the UI model follows from the work of Houthakker (1960) and Stone (1954). As specified, it retains the assumption of additivity while dropping the assumption of homotheticity. Christensen, Jorgensen and Lau introduce a representation of a utility function that relaxes both the additivity and homotheticity assumptions. Their approach consists of representing the utility function by functions that are quadratic in the logarithms of the quantity consumed. The resulting utility functions will provide a local second order approximation to any utility function. These utility functions allow expenditure shares to vary with the level of total expenditure and permit a greater variety of substitution patterns among commodities than those from functions based on a constant and equal elasticity of substitution among all pairs of commodities.

Christensen, Jorgensen and Lau refer to their representation of the direct utility function as the direct transcendental

logarithmic utility function, or more simply, the direct translog utility function: the utility function is a transcendental function of the logarithms of quantites consumed. Similarly, they refer to their representation of the indirect utility function as the indirect translog utility function.

While it is normal for the consumption decision to involve the derivation of the quantity, given the prices faced by the consumer, with housing consumption the process may be reversed. This arises from the basic inability of the consumer to draw a fine distinction between units of "housing" services and variations in the price per unit of "housing" service. For this reason, this study focuses on the direct translog utility system where expenditure shares are estimated in terms of the quantities consumed, as opposed to an indirect system where the expenditure shares are estimated in terms of the ratio of prices to total expenditure.

In outlining the derivation of the expenditure share equations under a direct translog utility function, this next section follows closely Christensen, Jorgensen and Lau (1975, pp 369-370). With the housing market model it is assumed that only two commodities are consumed; "housing" services and other goods and services which includes savings. Thus the direct utility function, U, can be represented in the form:

$$\ln(U) = \ln(U(X1,X2))$$

where,

X1 = the quantity of "housing" services consumed
X2 = the quantity of other goods and services consumed

The consumer maximizes utility subject to the budget constraint;

$$P1*X1 + P2*X2 = M \qquad \ldots 4.01$$

where,

P1 = the price per unit of "housing" service
P2 = the price per unit of other goods and services
M = total expenditure

The first order conditions for a maximium of utility can then be written as;

$$\frac{\partial \ln(U)}{\partial \ln(X1)} = mu * \frac{P1*X1}{U} \quad ; \quad \frac{\partial \ln(U)}{\partial \ln(X2)} = mu * \frac{P2*X2}{U} \qquad \ldots 4.02$$

where,

mu = the marginal utilty of income

Considering the consumption of "housing" services, from the budget constraint one can obtain the relationship:

$$\frac{\partial mu}{\partial U} = \frac{1}{M} * \left[\frac{\partial \ln(U)}{\partial \ln(X1)} + \frac{\partial \ln(U)}{\partial \ln(X2)} \right] \qquad \ldots 4.03$$

so that,

$$\frac{\partial \ln(U)}{\partial \ln(X1)} = \frac{P1*X1}{M} * \left[\frac{\partial \ln(U)}{\partial \ln(X1)} + \frac{\partial \ln(U)}{\partial \ln(X2)} \right] \qquad \ldots 4.04$$

To preserve symmetry with their treatment of the indirect utility function, Christensen, Jorgensen and Lau approximate the negative of the logarithm of the direct utility function by a function quadratic in the logarithms of the quantities consumed:

$$- \ln(U) = A0 + \sum Ai * \ln(Xi) + \frac{1}{2} \sum\sum Bij \ln(Xi) * \ln(Xj) \qquad \ldots 4.05$$

$$(i,j = 1,2)$$

Using this form for the utility function they obtain;

$$Ai + \sum Bij*\ln(Xi) = \frac{Pi*Xi}{M} \sum (Ai + \sum Bij*\ln(Xi)) \qquad \ldots 4.06$$

$$(i,j= 1,2)$$

which yields the expenditure share equations;

$$\frac{Pi*Xi}{M} = \frac{Ai + \sum Bij * \ln(Xj)}{Am + \sum Bmj * \ln(Xj)} \qquad ...4.07$$

$$(i = 1,2)$$

Since these equations for the expenditure shares are homogeneous of degree zero in the parameters, a normalisation of the latter is required for estimation. The normalisation used by Christensen, Jorgensen and Lau is to set $Am = \sum Ai = -1$.
Further, the budget constraint implies that:

$$\frac{P1*X1}{M} + \frac{P2*X2}{M} = 1 \qquad ...4.08$$

so that given the parameters of one of the budget share equations, the parameters of the other equation can be detemined from the definitions of Ai and Bmi (i = 1,2). The resulting expenditure share of "housing" services equation to be estimated is thus of the form;

$$\frac{Ph*XH}{M} = \frac{A1 + B11*\ln(XH) + B12*\ln(XG)}{-1 + Bm1*\ln(XH) + Bm2*\ln(XG)} \qquad ...4.09$$

where,

XH = the quantity of "housing" services consumed
XG = the quantity of other goods and sevices consumed
Ph = price per unit of "housing" service
Pg = price per unit of other goods and services
M = total expenditure or disposable income

In estimating the expenditure share equation, consideration must be made of the impact of the household's demographics; such as the age of head of the household, number of children, etc., which are major determinants of household consumption patterns. As noted by Pollak and Wales (1980, p596), the specification of

theoretically plausible demand systems involving demographic variables can be described in three separate but interrelated steps: 1. the specification of a class of demand systems for every admissible demographic profile, 2. the specification of those parameters which depend on the demographic variables and those which do not, and 3. the specification, for each parameter so dependent, of a functional form relating it to the demographic variables.

For this study the method used in incorporating demographics is controlled by the final use of the resulting functions in the simulation framework. In particular, household demographics are identified in the models by household type grouping alone; these being differentiated by the head's age, the number of income sources and the presence of children. To simplify the operation of the simulation model an independent demand system is estimated for each of the ten household type groupings in preference to the estimation of a system in which the dependent demographics are identified, together with the functional relationships between them and the dependent parameters.

The estimation of the expenditure share equation does not allow the computation of the A0 parameter directly. In order to assume that A0 = 0. the data must be normalised so that the logarithmic values of the mean quantities have zero values. This involves dividing the values of XH and XG by their sample means. This results in the parameter A1 approximating the negative of the mean share and U taking a value of 1.0 at the means.

4.2 Price Elasticity of Demand

The derivation of the price elasticities for the translog demand system follows from the Allen partial elasticity of substitution (see Allen (1949, pp503-505)).

Given that

$$x = f(X1, X2, X3, \ldots Xn)$$

for any combination of factors, define

$$kr = \frac{Xr\ fr}{X1*f1 + X2*f2 + xi*fi \ldots Xn*fn} \qquad (i = 1,2,3, \ldots n)$$

hence

$$k1 + k2 + k3 + \ldots + kn = 1$$

At an equilibrium position, f1, f2, f3 ... fn are proportional to the prices P1, P2, P3 ... Pn of the factors, thus

$$kr = \frac{Xi*Pi}{X1*P1 + X2*P2 + \ldots + Xn*Pn} = \frac{X1*P1}{M}$$

That is, kr is the proportion of the total budget (M) spent on the factor Xr.

Let $F = \begin{vmatrix} 0 & f1 & f2 & f3 & \ldots & fn \\ f1 & f11 & f12 & f13 & \ldots & f1n \\ f2 & f21 & f22 & f23 & \ldots & f2n \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ fn & fn1 & fn2 & fn3 & \ldots & fnn \end{vmatrix}$

and let Frs denote the co-factor of frs in F (i,j =1,2,3, ... n)

$$\text{Denote } \varepsilon ij = \frac{X1*f1 + X2*f2 + \ldots + Xn*fn}{Xi*Xj} * \frac{Fij}{F}$$

$$(i,j = 1,2,3, \ldots n)$$

This factor εij is the partial elasticity of substitution.

In particular, for the two good case

$$\varepsilon ij = \frac{X1*U1 + X2*U2}{Xi*Xj} * \frac{Fij}{F}$$

$$= \frac{\lambda*P1*U1 + \lambda*X2*U2}{Xi*Xj} * \frac{Fij}{F}$$

where

$$\lambda * P1 = U1 \quad \text{and} \quad \lambda * P2 = U2$$

In addition,

$$F = \begin{vmatrix} 0 & U1 & U2 \\ U1 & U11 & U12 \\ U2 & U12 & U22 \end{vmatrix} = \begin{vmatrix} 0 & \lambda P1 & \lambda P2 \\ \lambda P1 & U11 & U12 \\ \lambda P2 & U12 & U22 \end{vmatrix}$$

From the first order conditions associated with the direct utility function

$$\frac{\partial \ln(U)}{\partial \ln(Xi)} = \lambda * \frac{Pi * Xi}{U} = \frac{Ui * Xi}{U}$$

Given that the utility function is of the form

$$\ln(U) = -[A0 + A1*\ln(X1) + A2*\ln(X2)$$

$$+0.5*[B11*\ln(X1)*\ln(X1) + 2.*B12*Ln(X1)*\ln(X2) + B22*\ln(X2)*\ln(X2)]]$$

$$\frac{\partial \ln(U)}{\partial \ln(X1)} = \frac{A1 + B11*\ln(X1) + B12 * \ln(X2)}{-1. + Bm1*\ln(X1) + Bm2 * \ln(X2)}$$

$$\frac{\partial \ln(U)}{\partial \ln(X2)} = \frac{A2 + B21*\ln(X1) + B22 * \ln(X2)}{-1. + Bm1*\ln(X1) + Bm2 * \ln(X2)}$$

thus

$$\lambda = \frac{U}{P1 * X1} * \frac{A1 + B11*\ln(X1) + B12 * \ln(X2)}{-1. + Bm1*\ln(X1) + Bm2 * \ln(X2)}$$

$$\lambda = \frac{U}{P2 * X2} * \frac{A2 + B21*\ln(X1) + B22 * \ln(X2)}{-1. + Bm1*\ln(X1) + Bm2 * \ln(X2)}$$

Define the expenditure shares as

$$Si = \frac{Pi * Xi}{M} = \frac{Ai + \sum Bij \ln(Xj)}{-1. + \sum Bmj \ln(Xj)} = F1(Xj) * F2(Xj) \qquad ...4.10$$

thus

$$\frac{\partial Si}{\partial Xj} = \frac{\partial F1}{\partial Xj} * F2 + \frac{\partial F2}{\partial Xj} * F1$$

where

$$F1 = \frac{1}{(-1. + \sum Bmj \ln(Xj))} \quad ; \quad F2 = Ai + \sum Bij \ln(Xj)$$

$$\frac{\partial F1}{\partial Xj} = \frac{0 - \sum Bmj/Xj}{(-1. + \sum Bmj \ln(Xj))**2} \quad ; \quad \frac{F2}{Xj} = \frac{\sum Bij}{Xj}$$

giving

$$\frac{\partial Si}{\partial Xj} = \frac{1}{Xj *(-1.+\sum Bmj \ln(Xj))} * \left\{\frac{-(Ai+ \sum Bij \ln(Xj))*Bmj}{(-1.+ \sum Bmj \ln(Xj))} + Bij\right\}$$

$$= \frac{Xi *U *Uij - Ui *Xi *Uj}{U **2} = \frac{Xi *U *Uij - \lambda**2 *Pi*Pj *Xi}{U **2}$$

Define

$$PSUM = -[-1. + Bm1 * \ln(X1) + Bm2 * \ln(X2)]$$

$$PSUMi = -[Ai + Bi1 * \ln(X1) + Bi2 * \ln(X2)]$$

then

$$Uij = \frac{\lambda^{**2} * Pi * Pj}{U} + \frac{U}{Xi} * \left[\frac{1}{Xj * PSUM}\right] * \left[\frac{-PSUMi * Bmj}{PSUM} + Bij\right].$$

The co-factors in F are

$$F11 = \begin{vmatrix} U11 & U12 \\ U12 & U22 \end{vmatrix} \qquad F12 = \begin{vmatrix} \lambda P1 & \lambda P2 \\ U12 & U12 \end{vmatrix}$$

$$F21 = \begin{vmatrix} \lambda P1 & U12 \\ \lambda P2 & U21 \end{vmatrix} \qquad F22 = \begin{vmatrix} 0 & \lambda P1 \\ \lambda P1 & U22 \end{vmatrix}$$

giving the determinants

$$|F11| = U11 * U22 - U12 * U12$$

$$|F12| = \lambda P1 * U22 - \lambda P2 * U12$$

$$|F21| = \lambda P1 * U22 - \lambda P2 * U21$$

$$|F22| = 0 * U11 - \lambda P1 * \lambda P1$$

The own price elasticity is then given by

$$\epsilon 11 = \frac{\lambda * P1 * X1 + \lambda * P2 * X2}{X1 * X2} * \frac{|F11|}{|F|} \qquad \ldots 4.11$$

4.3 Income Elasticity of Demand

To derive the income elasticity of demand we require the percentage change in the quantity associated with a given percentage change in income: the latter being represented by the after tax budget constraint M. Working from first principles we take the general expenditure share equation;

$$Si = \frac{Pi * Xi}{M} = \frac{Ai + \sum Bij * \ln(Xj)}{-1. + \sum Bmi * \ln(Xj)}$$

Factorizing

$$-Pi * Xi + Pi * Xi * Bmi * \ln(Xi) = M * Ai + M * Bij * \ln(Xj)$$

Taking the total differential

$$-Pi * \Delta Xi + Pi * \Delta Xi * Bmi * \ln(Xi) + Pi * Xi * \sum Bmi * \Delta \ln(Xi)$$
$$= M * Ai + Ai + \Delta M * Bij * \ln(Xj) + M * \sum Bij * \Delta \ln(Xj)$$

giving

$$\frac{\Delta Xi}{Xi} * \left[-Pi*Xi + Pi*Xi*Bmi * \ln(Xi) + \frac{Xi**2}{\Delta Xi} * Pi * \sum Bmi * \Delta \ln(Xi) \right]$$

$$\frac{\Delta M}{M} * \left[M * Ai + M * Bij * \ln(Xj) + \frac{M**2}{\Delta M} * \sum Bij * \Delta \ln(Xj) \right]$$

giving

$$\frac{\Delta Xi / Xi}{\Delta M / M} =$$

$$\frac{M}{Pi * Xi} * \frac{\left[Ai + \sum Bij * \ln(Xj) + \frac{\Delta M}{M} * \sum Bij * \Delta \ln(Xj) \right]}{\left[-1 + \sum Bmi * \ln(Xi) + \frac{\Delta Xi}{Xi} * \sum Bmi * \Delta \ln(Xi) \right]}$$

With static analysis, it is assumed that the other quantities are constant thus $\Delta \ln(Xj) = 0$ when j not equal i.

thus

$$\varepsilon y = \frac{[Ai + \sum Bij * \ln(Xj) + \frac{\Delta M}{M} * Bii * \Delta \ln(Xj)]}{[-1 + \sum Bmi * \ln(Xi) + \frac{\Delta Xi}{Xi} * Bmi * \Delta \ln(Xi)]} \quad \ldots 4.12$$

With the UI's model formulation the implicit income elasticity is one. This formulation degenerates to such an implicit elasticity if it is assumed that Bmi = 0 and $\Delta \text{Ln}(Xi) = 0$ as follows.

The income elasticity is given as

$$\varepsilon y = \frac{[Ai + \sum Bij * \ln(Xj) + \frac{\Delta M}{M} * Bii * \Delta \ln(Xj)]}{[-1 + \sum Bmi * \ln(Xi) + \frac{\Delta Xi}{Xi} * Bmi * \Delta \ln(Xi)]}$$

with Bmj = 0, $\Delta \ln(Xj) = 0$.

$$\varepsilon y = \frac{M}{Pi * Xi} * \frac{[Ai + \sum Bij * \ln(Xj)]}{-1.}$$

but under the conditions that Bmi =0, ln(Xj) = 0 from Equation 4.10

$$-[Ai + \sum Bij \ln(Xj)] = \frac{Xi*Pi}{M}$$

thus

$$\varepsilon y = 1.$$

To test that the income elasticities are significantly different from one (Bm1, Bm2 not equal to 0) the share equations can be re-estimated under the constraint that Bm1 = Bm2 = 0 and the value of the likelihood functions for the constrained and unconstrained

estimates are compared employing a test statistic based on the likelihood ratio "r" where:

$$r = \frac{\text{maximum likelihood value (constrained)}}{\text{maximum likelihood value (unconstrained)}}$$

...4.13

This likelihood ratio is the ratio of the maximum value of the likelihood function L for the share equation subject to the restrictions, to the maximum value of the likelihood function for the equation without restriction. For normally distributed disturbances the likelihood ratio is equal to the ratio of the determinant of the restricted estimator of the variance-covariance matrix of the disturbances to the determinant of the unrestricted estimator, each raised to the power -(n/2) (Christensen, Jorgenson and Lau (1975, p379)). The test statistic is based on minus twice the logarithm of the likelihood ratio. Under the null hypothesis this test statistic is distributed asymptotically, as chi-square with the degrees of freedom equal to the number of restrictions.

4.4 Estimating the Expenditure Share Functions

The estimation of the expenditure share function requires detailed data on household expenditures on housing and other goods and services. The only available source of such information on a consistent basis for Canadian CMAs is the 1974 Survey of Housing Units (SHU) data prepared by Census Canada for the Central (now Canada) Mortgage and Housing Corporation. This dataset involves individual records for approximately 3000 statistically selected households for each of 23 CMAs. These data are based on a survey performed in 1974 using annual data for 1973 on dwelling and household characteristics with the selection of the households included being based on 1971 Census data for the CMA.

The major drawback with the SHU data is that no information on total household expenditures is available. One is therefore required to make the assumption that total expenditure is equal to the after-tax income of the household, incuding transfer payments and opportunity income from home ownership. Net savings are thus included as other goods and services. (See APPENDIX A2.31 for details of the calculation of the after-tax income.) The monthly expenditure on housing (Ph*XH) is either the rent or user cost plus opportunity cost. For the renter, housing expenditure is taken as the reported rent plus any non-inclusive utilities. With owner-occupiers the monthly expenditure is comprised of the reported monthly interest payments, utilities payments, repairs, maintenance and a computed opportunity cost of equity. The most difficult, yet most crucial step in deriving the monthly expenditure for the owner-occupiers is the calculation of the opportunity cost of equity, where the derivation of the correct rate of return on

equity is the issue. In many publications (Shelton (1968), Laidler (1969), Sunley (1970), Aaron (1970) and Clayton (1974)), the rate has been expressed either as the current mortgage interest rate, a function of the mortgage interest rate or the interest rate on a market bond. For this study it is assumed that the equity holding (reported expected net sale price minus the mortgage balance) is an additional mortgage to the owner earning tax free interest at the current market rate. Thus, while this amount is an opportunity cost in calculating the monthly expenditure it is also included as a part of the owner-occupier's after-tax income. The expenditure on other goods and services is simply the after-tax income (total expenditure) minus the calculated expenditure on housing.

To correspond to the treatment within the simulation model the quantity of housing, "XH", must be expressed in terms of "relative housing" services, under the assumption that the mean of the distribution of "neighbourhood" services is zero. That is, the quantity of "housing" services, in decade-end units, will correspond to the mean expenditure on housing. In deriving the individual household values for "XH" from the actual expenditures, two adjustments are made. The first involves the adjustment for neighbourhood conditions; the second the conversion of 1971 units of quantity to 1961 units of quantity. This necessitates the calculation of an effective price that is a function of the ratio of the 1971 expenditures and the 1971 relative "housing" services, together with the mean price index for the decade: the latter being differentiated by household type. (See APPENDIX A2.32 for details). The quantity of other goods and services ("XG") is then simply the residual expenditure deflated by the CMA's consumer price index for the decade.

In deriving the quantities of "housing" services separate rental and owner-occupier hedonic equations were estimated for each CMA utilizing the SHU data. A total of thirty independent variables were considered, with the final equation incorporating sixteen: six of these variables were taken as representing neighbourhood characteristics. Full details on the included variables and the estimated equations are shown in APPENDIX A2.31.

Sample selected statistics on the input variables for the expenditure share function estimates, by household type, for Vancouver are detailed in Table 01. In deriving these input data all households with a computed housing expenditure share greater than 100% were rejected.

translog variables

	M	Ph*XH	Ph	Pg	Ph*XH / M
Type 1					
mean	454.9	132.7	1.532	1.270	0.3533
min	88.3	34.4	1.423	1.270	0.0910
max	2038.9	470.7	1.913	1.270	0.9369
Type 2					
mean	448.5	129.4	1.564	1.270	0.3568
min	63.3	39.1	1.423	1.270	0.0690
max	2237.5	342.4	1.890	1.270	0.9773
Type 3					
mean	844.1	162.1	1.593	1.270	0.2316
min	83.1	38.3	1.423	1.270	0.0265
max	3241.9	465.2	1.938	1.270	0.9823
Type 4					
mean	587.3	170.8	1.654	1.270	0.3466
min	179.7	39.9	1.423	1.270	0.0596
max	3241.6	408.9	1.913	1.270	0.9004
Type 5					
mean	756.8	185.1	1.665	1.270	0.2768
min	141.8	46.9	1.423	1.270	0.0806
max	2231.9	469.9	1.957	1.270	0.9372
Type 6					
mean	837.4	329.6	2.305	1.270	0.4544
min	238.0	65.2	1.534	1.270	0.0701
max	3842.4	949.6	2.505	1.270	0.9593
Type 7					
mean	764.9	295.5	2.364	1.270	0.4232
min	218.7	98.3	1.564	1.270	0.1378
max	2090.4	834.4	2.565	1.270	0.9298
Type 8					
mean	1256.4	327.9	2.426	1.270	0.2825
min	371.8	78.1	1.573	1.270	0.0605
max	3576.6	838.8	2.584	1.270	0.7154
Type 9					
mean	1055.1	354.1	2.156	1.270	0.3543
min	347.0	55.1	1.396	1.270	0.0729
max	3500.6	999.0	2.284	1.270	0.9135
Type 10					
mean	1110.1	343.5	2.475	1.270	0.3280
min	267.1	98.0	1.593	1.270	0.0926
max	3538.0	948.5	2.596	1.270	0.8770

Table 01: Translog Input Variable Statistics
[Vancouver]

With the non-linear form of the share function formulation, the only parameter about which an 'a priori' statement can be made is A1. When the other four parameters (B11, B12, BM1, BM2) are zero, A1 approximates a housing expenditure to income ratio and thus has an absolute value in the region of the mean value for Ph*XH/M if the independent variables are normalised so that the A0 parameter can be assumed to take a value of zero. This normalisation involves dividing the respective quantities by their sample means so that their logarithmic values are zero at the means.

As detailed in Section 4.11 the expenditure share equations are homogeneous of degree zero and the normalization used involves the inclusion of a -1 value in the denominator of the share equations. As a result of this -1 value the estimated values for A1 will display a negative sign.

To provide function estimates suitable for incorporation into the simulation model the estimation of independent equations for each income quartile for each of the ten household types for each CMA was required. The need for the groupings results from the restricted applicability of the translog function. Small shifts in data values from the mean conditions result in functional instability which makes the use of a single function to represent a range of income levels in the simulation algorithm impossible. Several alternative groupings of the households by income level were evaluated and for this reason three sets of estimates were made for each CMA. The first involves a single equation for each of the ten household types; the second involves two equations for each household type (grouped by above and below mean incomes) while the third involves four equations for each household type (grouped

by income quartile).

Results for the three sets of estimates for Vancouver are shown in Tables 02 to 08. The estimates for eight selected CMAs are shown in the APPENDIX as Tables A3-16 through A3-24. (Additional details on the estimation procedure are included in Section A2.32).

In considering the estimates for the eight CMAs all five hundred and sixty functions estimated had significant coefficients and correct signs for the A1, B11 and B12 parameters. The BM1 and BN2 parameters show a variation in significance. This results from a change in the sign on BM2 as the mean expenditure level increases. Generally, at lower income levels both BM1 and BM2 have significant positive signs but with the increasing mean income through the quartiles the trend is for BM2 to become significantly negative, reflecting an increase in the decline of the housing share that accompanies an increased level of consumption of other goods and services.

Little interpretation can be placed on the magnitude of the coefficients except the A1 parameter whose absolute value reflects the estimated expenditure share at the mean. Typically as the income level increases, the share of the total expenditure spent on housing declines. With the estimates based on all households the estimated share at the mean is significantly below the computed mean expenditure ratio, reflecting the non-symetrical distribution of the expenditure share with respect to income across a household type grouping. On a household type basis these shares range from a low of 17% to a high of 40% across the CMAs. A comparison of the above and below mean estimates on a household type basis indicates a significant decline in the share with increasing incomes. This

decline is further supported by the estimates based on the income quartile groupings. On a household type basis these latter estimates reflect a range across the CMAs from a low of 25% through 60% for the lowest income quartile, with a range of 11% through 30% for the highest income quartile.

While rental and owner-occupier quartile groupings cannot be directly compared, an inter-quartile comparison shows a significantly higher expenditure share for owner-occupiers than renters with comparable mean incomes. This differential is indicated to be as high as 20% but varies noticeably between CMAs and household type groupings.

$$SHARE = \frac{A1 + B11 * \ln(XH) + B12 * \ln(XG)}{-1. + BM1 * \ln(XH) + BM2 * \ln(XG)}$$

Type	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3050	-.1757	0.1980	0.0645	-.0152	86.6	253.7	454.9	259
	(195.)	(28.5)	(51.9)	(3.59)	(2.60)				
2	-.3041	-.1986	0.2220	-.0122	0.0376	82.8	251.2	448.5	438
	(196.)	(20.3)	(60.5)	(0.49)	(7.78)				
3	-.2040	-.1839	0.1512	-.1244	-.0447	101.2	537.0	844.1	384
	(130.)	(20.7)	(33.8)	(4.27)	(6.12)				
4	-.3020	-.1689	0.1854	0.1091	-.0303	102.8	328.0	587.3	139
	(127.)	(15.7)	(33.0)	(3.81)	(3.34)				
5	-.2518	-.1370	0.1747	0.2238	-.0325	110.6	450.1	756.8	125
	(120.)	(12.3)	(30.8)	(7.74)	(3.87)				
6	-.4068	-.2117	0.2368	-.0042	0.0554	142.4	399.8	837.4	243
	(159.)	(18.2)	(37.4)	(0.15)	(6.16)				
7	-.3948	-.2344	0.2456	-.0209	0.0425	124.7	369.7	765.0	130
	(153.)	(16.1)	(26.7)	(0.60)	(3.17)				
8	-.2635	-.1430	0.1380	0.1422	-.1672	135.1	731.1	1256.4	281
	(221.)	(23.2)	(25.1)	(7.19)	(13.5)				
9	-.3439	-.1980	0.2062	0.0110	-.0023	164.6	552.0	1055.1	217
	(199.)	(24.0)	(31.1)	(0.46)	(0.21)				
10	-.3146	-.1896	0.1890	0.0508	-.0483	138.6	603.6	1110.0	357
	(343.)	(33.2)	(44.6)	(3.24)	(6.64)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Table 02: Direct Translog-Expenditure Share (Vancouver)
[all income levels]

$$SHARE = \frac{A1 + B11 * \ln(XH) + B12 * \ln(XG)}{-1. + BM1 * \ln(XH) + BM2 * \ln(XG)}$$

Type	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4069	-.1563	0.2545	0.1451	0.0647	72.7	130.7	277.3	153
	(198.)	(14.3)	(27.4)	(4.74)	(4.59)				
2	-.4285	-.2223	0.3015	-.0035	0.1380	76.1	131.2	285.7	231
	(225.)	(14.1)	(43.7)	(0.10)	(15.2)				
3	-.2703	-.2193	0.2250	-.0825	0.0457	94.3	335.5	574.4	217
	(150.)	(14.7)	(27.8)	(1.93)	(3.42)				
4	-.4105	-.1562	0.2639	0.1493	0.0792	95.9	180.5	385.4	76
	(140.)	(12.5)	(21.9)	(5.00)	(4.17)				
5	-.3109	-.1101	0.2248	0.3347	0.0269	99.8	288.3	530.9	68
	(125.)	(7.70)	(19.3)	(8.77)	(1.80)				
6	-.5261	-.2447	0.3181	-.0513	0.1636	131.1	218.2	580.5	153
	(193.)	(11.8)	(20.1)	(1.26)	(7.91)				
7	-.4583	-.2198	0.3009	-.0156	0.1173	107.4	242.3	558.2	78
	(133.)	(7.95)	(16.1)	(0.32)	(4.50)				
8	-.3112	-.1633	0.1546	0.1048	-.1589	120.6	511.0	940.3	161
	(189.)	(14.7)	(12.0)	(3.50)	(5.95)				
9	-.3712	-.1658	0.2782	0.0872	0.1008	139.4	409.4	817.4	130
	(170.)	(12.8)	(18.0)	(2.49)	(4.09)				
10	-.3646	-.2030	0.2363	0.0338	0.0149	125.8	431.7	857.1	203
	(256.)	(19.9)	(23.6)	(1.35)	(0.93)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Table 03: Direct Translog-Expenditure Share (Vancouver)
[below mean income]

$$SHARE = \frac{A1 + B11 * \ln(XH) + B12 * \ln(XG)}{-1. + BM1 * \ln(XH) + BM2 * \ln(XG)}$$

Type	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2356	-.1321	0.1635	0.1867	-.0451	106.7	431.3	711.2	106
	(176.)	(19.8)	(19.7)	(6.97)	(1.57)				
2	-.2233	-.1334	0.0970	0.1255	-.3342	90.3	385.1	630.1	207
	(220.)	(21.9)	(12.3)	(5.25)	(11.1)				
3	-.1577	0.0561	0.1521	0.6029	0.9694	110.2	798.9	1194.5	167
	(60.8)	(6.68)	(61.4)	(14.2)	(788.)				
4	-.2268	-.1305	0.0999	0.1680	-.2895	111.0	505.8	830.9	63
	(107.)	(9.92)	(8.02)	(3.34)	(5.60)				
5	-.2082	-.1410	0.1175	0.1470	-.1495	123.4	643.2	1026.2	57
	(98.4)	(6.88)	(5.90)	(1.53)	(1.50)				
6	-.2970	-.1613	0.1598	0.1022	-.1095	161.5	708.7	1274.1	90
	(95.3)	(12.1)	(10.4)	(2.22)	(2.78)				
7	-.3364	-.1579	0.1699	0.1836	-.1419	150.5	560.8	1075.1	52
	(118.)	(9.34)	(6.43)	(3.70)	(2.21)				
8	-.2240	-.0989	0.1171	0.3104	-.1996	154.5	1026.4	1680.5	120
	(142.)	(10.1)	(9.23)	(7.69)	(4.18)				
9	-.3128	-.1627	0.1377	0.0960	-.2053	202.3	765.1	1410.3	87
	(150.)	(8.75)	(9.92)	(1.77)	(5.32)				
10	-.2706	-.1468	0.1284	0.1659	-.2215	155.3	830.1	1443.4	154
	(612.)	(42.4)	(23.3)	(13.8)	(12.5)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Table 04: Direct Translog-Expenditure Share (Vancouver)
[above mean income]

$$SHARE = \frac{A1 + B11 * \ln(XH) + B12 * \ln(XG)}{-1. + BM1 * \ln(XH) + BM2 * \ln(XG)}$$

Type	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.5082	-.1933	0.3239	0.0561	0.1634	65.3	77.3	198.3	78
	(207.)	(14.2)	(20.4)	(1.76)	(7.12)				
2	-.5744	-.2315	0.3552	-.0207	0.2229	70.1	65.9	194.0	110
	(204.)	(11.9)	(28.5)	(0.53)	(13.7)				
3	-.3386	-.1756	0.2897	0.0271	0.1344	89.4	226.6	427.0	108
	(122.)	(6.74)	(16.8)	(0.40)	(4.94)				
4	-.4893	-.1254	0.3258	0.2126	0.1708	90.5	119.7	297.2	41
	(133.)	(8.64)	(17.5)	(5.88)	(7.05)				
5	-.3790	-.1337	0.2729	0.2738	0.0888	95.9	203.8	417.6	31
	(135.)	(9.87)	(22.5)	(8.65)	(5.94)				
6	-.5897	-.1724	0.3858	0.0640	0.2556	117.4	147.9	457.2	71
	(122.)	(4.15)	(11.3)	(0.85)	(5.75)				
7	-.5574	-.2369	0.3527	-.0788	0.1956	99.8	150.0	422.8	34
	(117.)	(4.28)	(11.2)	(0.80)	(4.55)				
8	-.3635	-.1922	0.1825	0.0692	-.1219	113.6	380.6	758.5	73
	(138.)	(8.60)	(6.50)	(1.26)	(2.13)				
9	-.4251	-.1653	0.3425	0.0851	0.1932	129.1	305.6	663.8	57
	(140.)	(7.56)	(12.4)	(1.57)	(4.41)				
10	-.3929	-.1727	0.2728	0.0669	0.0602	110.5	331.0	688.7	87
	(153.)	(8.89)	(15.3)	(1.75)	(2.15)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Table 05: Direct Translog-Expenditure Share (Vancouver)
[quartile 01]

$$SHARE = \frac{A1 + B11 * \ln(XH) + B12 * \ln(XG)}{-1. + BM1 * \ln(XH) + BM2 * \ln(XG)}$$

Type	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3402	-.1139	0.2057	0.2636	-.0663	80.4	186.3	359.5	75
	(195.)	(8.24)	(7.65)	(5.37)	(1.06)				
2	-.3425	-.2149	0.1100	-.0728	-.3401	81.5	190.6	369.1	121
	(221.)	(12.7)	(4.00)	(1.57)	(5.08)				
3	-.2171	-.0721	0.1988	0.4723	0.0750	99.1	443.4	720.5	109
	(187.)	(4.15)	(12.0)	(7.66)	(1.34)				
4	-.3443	-.0912	0.3300	0.2897	0.1877	102.3	251.7	488.7	35
	(95.7)	(3.47)	(11.0)	(4.15)	(3.55)				
5	-.2695	-.1295	0.1355	0.1449	-.3409	103.0	359.1	625.9	37
	(87.4)	(3.11)	(1.37)	(0.91)	(1.08)				
6	-.4871	-.1467	0.4115	0.1129	0.2797	142.9	279.0	687.3	82
	(174.)	(4.06)	(13.5)	(1.48)	(6.57)				
7	-.4031	-.2168	0.2922	-.0978	0.0068	113.4	313.7	662.9	44
	(95.8)	(3.68)	(3.67)	(0.71)	(0.04)				
8	-.2812	-.1500	0.1442	0.0792	-.2269	126.4	619.2	1091.1	88
	(134.)	(5.96)	(3.04)	(0.89)	(1.71)				
9	-.3379	-.1340	0.2846	0.1500	0.0855	147.3	490.4	937.3	73
	(127.)	(6.98)	(7.14)	(2.75)	(1.39)				
10	-.3472	-.1555	0.2885	0.1708	0.1288	137.3	507.3	983.4	116
	(205.)	(6.60)	(5.66)	(2.25)	(0.92)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Table 06: Direct Translog-Expenditure Share (Vancouver)
[quartile 02]

$$SHARE = \frac{A1 + B11 * \ln(XH) + B12 * \ln(XG)}{-1. + BM1 * \ln(XH) + BM2 * \ln(XG)}$$

Type	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2744	-.1164	0.2307	0.2478	0.1167	98.9	318.9	555.5	67
	(185.)	(11.4)	(11.4)	(6.55)	(1.90)				
2	-.2534	-.1369	0.1076	0.1107	-.4050	85.1	307.1	523.2	133
	(201.)	(12.8)	(4.46)	(2.86)	(5.18)				
3	-.1656	-.0920	0.0761	0.2552	-.4452	102.4	656.7	999.6	110
	(141.)	(6.20)	(2.28)	(3.23)	(2.59)				
4	-.2663	-.1182	0.1407	0.2364	-.2131	109.1	398.2	691.0	44
	(107.)	(4.84)	(3.09)	(2.72)	(1.38)				
5	-.2339	-.0800	0.2340	0.5284	0.4395	121.4	531.2	879.1	36
	(81.5)	(2.24)	(4.27)	(3.55)	(2.06)				
6	-.3169	-.1431	0.2223	-.0168	-.1579	142.1	542.6	1009.5	60
	(85.2)	(5.38)	(4.75)	(0.18)	(1.43)				
7	-.3495	-.1410	0.2842	0.1973	0.0370	129.3	450.7	881.3	32
	(71.0)	(3.18)	(3.35)	(1.37)	(0.19)				
8	-.2398	-.0863	0.1895	0.3776	0.0128	139.9	840.0	1405.9	75
	(115.)	(4.53)	(4.16)	(4.78)	(0.09)				
9	-.3381	-.3006	-.0144	-.3528	-.7105	179.0	608.6	1162.6	57
	(179.)	(15.0)	(0.41)	(5.91)	(8.98)				
10	-.2786	-.1432	0.1537	0.1984	-.1685	139.6	713.6	1255.0	99
	(484.)	(17.9)	(8.63)	(6.69)	(2.89)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Table 07: Direct Translog-Expenditure Share (Vancouver)
[quartile 03]

$$SHARE = \frac{A1 + B11 * \ln(XH) + B12 * \ln(XG)}{-1. + BM1 * \ln(XH) + BM2 * \ln(XG)}$$

Type	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1866	-.0729	0.0887	0.4145	-.3473	120.2	624.3	978.8	39
	(103.)	(5.68)	(5.43)	(7.95)	(5.42)				
2	-.1894	-.1202	0.0874	0.1517	-.3289	99.5	525.4	822.2	74
	(140.)	(12.2)	(8.33)	(3.45)	(6.61)				
3	-.1322	-.0795	0.0394	0.2580	-.5449	125.3	1073.5	1570.8	57
	(96.3)	(9.25)	(3.31)	(4.56)	(6.82)				
4	-.1677	-.1101	0.0577	0.2374	-.4817	115.4	755.1	1154.8	19
	(53.8)	(4.72)	(3.19)	(2.27)	(4.31)				
5	-.1700	-.1164	0.0485	0.1375	-.5397	126.8	835.2	1278.4	21
	(50.9)	(2.66)	(1.09)	(0.54)	(2.03)				
6	-.2714	-.1653	0.1511	0.1097	-.1399	200.3	1040.7	1803.4	30
	(295.)	(30.9)	(24.5)	(5.50)	(7.58)				
7	-.3251	-.1276	0.2229	0.2386	-.0095	184.4	736.9	1385.1	20
	(144.)	(8.33)	(7.33)	(5.32)	(0.10)				
8	-.2059	-.0942	0.1113	0.3190	-.2071	178.8	1337.1	2138.3	45
	(82.1)	(7.50)	(3.90)	(4.93)	(1.71)				
9	-.2817	-.1319	0.1168	0.1447	-.2997	246.6	1062.4	1881.0	30
	(69.0)	(4.07)	(4.36)	(1.34)	(3.85)				
10	-.2595	-.1193	0.1462	0.2509	-.1294	183.7	1040.0	1782.7	55
	(477.)	(28.9)	(25.8)	(16.3)	(7.74)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Table 08: Direct Translog-Expenditure Share (Vancouver)
[quartile 04]

4.5 Demand Elasticities.

Two sets of elasticities have been calculated to indicate the responsiveness of demand to variations in either the household disposable income or the price per unit of "housing" services. To derive the income elasticity it is necessary to calculate the percent change in the income level. The income elasticities shown in Table 09 have been computed on a type basis at the mean for each quartile, then alternatively at the means for the quartile households with above and below mean incomes. At each of the three mean points the computed elasticity is based on the calculated change in the quantity consumed resulting from a 1% increase in income. This involves assuming that the price is set at the respective mean and computing the quantities, utilizing the estimated expenditure share function, at both the mean and the shift points. The reported elasticities are computed utilizing Equation 4:12, with the elasticities for Vancouver shown in Table 09 and on a CMA basis in APPENDIX Table A3:23.

	Household Types									
	1	2	3	4	5	6	7	8	9	10
Q01										
mean	0.73	0.78	0.53	0.76	0.67	0.80	0.74	0.60	0.64	0.61
below	0.74	0.78	0.53	0.76	0.69	0.81	0.74	0.60	0.64	0.60
above	0.75	0.79	0.52	0.79	0.71	0.81	0.73	0.59	0.64	0.60
Q02										
mean	0.60	0.57	0.46	0.59	0.49	0.71	0.59	0.48	0.56	0.59
below	0.61	0.52	0.54	0.61	0.45	0.71	0.56	0.46	0.55	0.60
above	0.61	0.51	0.54	0.61	0.47	0.71	0.57	0.46	0.55	0.61
Q03										
mean	0.47	0.50	0.37	0.50	0.45	0.54	0.61	0.48	0.51	0.52
below	0.51	0.43	0.34	0.50	0.64	0.44	0.61	0.51	0.47	0.52
above	0.52	0.44	0.34	0.50	0.70	0.46	0.61	0.53	0.47	0.52
Q04										
mean	0.42	0.39	0.33	0.40	0.39	0.49	0.56	0.41	0.53	0.48
below	0.43	0.36	0.29	0.36	0.33	0.49	0.58	0.43	0.48	0.50
above	0.44	0.35	0.27	0.35	0.33	0.49	0.60	0.44	0.47	0.51

note: 1. "mean" - elasticity base of mean values for all household in quartile
"below" - elasticity base of mean values for all household in quartile with incomes below the mean
"above" - elasticity base of mean values for all household in quartile with incomes above the mean

Table 09: Income Elasticities (Vancouver)

To test for the existence of unity income elasticities, the share equations were re-estimated under the restriction that BM1=BM2=0. For these estimates the equation is linear and O.L.S. estimates are sufficient. A test statistic based on the ratio of the maximum likelihood values is computed. A value computed as twice the difference between the logarithm of the likelihood function for the unconstrained (non-linear) model and the logarithm of the likelihood function for the constrained estimates is distributed, asymptotically, as chi-square with two degrees of freedom. The critical values for such a chi-square distribution

are given in Table 10.

	level of significance				
	.10	.05	.025	.010	.005
2 df	4.61	5.99	7.38	9.21	10.60

source: Johnston (1972, p427)

Table 10: Critical Values for Chi-Square: 2 Degrees of Freedom

The logarithms of the likelihood functions and the test statistics for Vancouver are reported in Table 11. The table columns correspond to the seven alternative estimates for each household type. Corresponding test statistics on a CMA basis are included as APPENDIX Table A3:24. Of the 320 statistics tested for the estimates grouped by quartile, less than 0.5% indicate an income elasticity that was not significantly different from unity at a 99.5% confidence level (test statistic less than 10.60). Of those indicating elasticities not significantly different from one at the mean, the majority involve owner-occupiers; either elderly or single income source household type groups.

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
Type 1							
normal	617.03	366.50	314.68	207.43	222.21	208.48	127.35
BM1=BM2=0	605.92	353.27	269.01	180.93	189.92	173.98	103.86
statistic	22.20	26.45	91.33	53.01	64.58	68.98	46.98
Type 2							
normal	917.51	525.04	615.62	258.65	340.14	390.05	233.93
BM1=BM2=0	884.34	418.23	526.40	179.53	327.34	345.16	204.92
statistic	66.35	213.63	178.43	158.26	25.60	89.78	58.03
Type 3							
normal	812.03	494.16	284.38	239.61	343.49	346.76	188.78
BM1=BM2=0	796.30	465.32	448.61	205.80	297.92	328.53	144.89
statistic	31.45	57.68	-328.46	67.63	91.14	36.47	87.78
Type 4							
normal	317.36	186.21	181.53	104.79	91.67	125.21	61.05
BM1=BM2=0	303.07	172.28	147.77	91.84	84.13	107.07	52.05
statistic	28.58	27.85	67.54	25.89	15.08	36.28	18.01
Type 5							
normal	305.33	179.73	161.40	89.75	100.20	106.38	64.25
BM1=BM2=0	282.50	150.18	142.07	66.71	91.10	94.06	59.49
statistic	45.65	59.10	38.67	46.08	18.20	24.63	9.51
Type 6							
normal	472.04	327.43	202.05	145.92	199.46	136.06	123.05
BM1=BM2=0	449.97	274.30	188.18	117.17	165.23	132.05	87.99
statistic	44.14	106.25	27.72	57.49	68.46	8.02	70.12
Type 7							
normal	291.92	178.83	132.89	81.93	106.11	77.17	69.43
BM1=BM2=0	286.33	163.95	125.58	67.07	103.57	75.82	58.53
statistic	11.17	29.76	14.62	29.71	5.08	2.69	21.80
Type 8							
normal	735.88	418.99	334.74	190.44	233.46	207.31	129.17
BM1=BM2=0	640.06	383.57	288.81	182.96	216.96	189.39	110.58
statistic	191.64	70.84	91.85	14.96	32.99	35.83	37.19
Type 9							
normal	509.87	310.76	237.97	145.32	183.19	172.17	81.61
BM1=BM2=0	509.63	301.67	211.63	128.06	179.12	162.26	65.75
statistic	0.47	18.20	52.67	34.52	8.14	19.81	31.72
Type10							
normal	974.86	529.27	606.47	218.86	327.86	393.80	235.14
BM1=BM2=0	943.42	528.24	472.46	216.15	324.05	339.15	154.49
statistic	62.87	2.06	268.03	5.41	7.62	109.30	161.30

Table 11: Test of Unity Income Elasticity (Vancouver)
[Log Likelihood Statistics]

The computation of the price elasticities is based on equation 4:11, outlined in Section 4.12. The Urban Institute's model reflects an implicit price elasticity of -1.0. With the translog formulation the price elasticity is also -1.0 at the mean, but will have an absolute value significantly greater than 1 for below mean income levels and less than 1 for high income levels. As for the income elasticities, the price elasticities have been computed on a household type and quartile basis with estimates at the quartile mean and at the mean for the households with below and above mean incomes. Results for Vancouver are shown in Table 12 while a complete set of results for each CMA is shown in APPENDIX Table A3:23.

	HOUSEHOLD TYPEs									
	1	2	3	4	5	6	7	8	9	10
Q01										
mean	-1.02	-1.01	-1.08	-1.02	-0.99	-1.02	-1.06	-1.01	-1.07	-1.06
below	-1.46	-1.95	-1.88	-1.45	-1.43	-1.51	-1.87	-1.50	-1.52	-1.60
above	-0.69	-0.64	-0.83	-0.77	-0.81	-0.74	-0.71	-0.81	-0.87	-0.86
Q02										
mean	-1.03	-1.04	-1.00	-1.08	-1.06	-1.08	-1.13	-1.04	-1.08	-1.03
below	-1.21	-1.31	-1.12	-1.23	-1.15	-1.29	-1.28	-1.17	-1.19	-1.19
above	-0.90	-0.88	-0.91	-0.95	-1.01	-0.91	-1.02	-0.93	-0.99	-0.91
Q03										
mean	-1.02	-1.05	-1.02	-1.01	-0.95	-1.18	-1.06	-1.01	-1.05	-1.00
below	-1.21	-1.17	-1.15	-1.15	-1.07	-1.37	-1.24	-1.13	-1.18	-1.10
above	-0.86	-0.91	-0.91	-0.88	-0.85	-1.02	-0.89	-0.89	-0.94	-0.90
Q04										
mean	-0.99	-1.00	-1.00	-0.98	-1.00	-0.99	-1.02	-0.99	-1.04	-1.00
below	-1.30	-1.27	-1.25	-1.30	-1.22	-1.35	-1.32	-1.22	-1.29	-1.21
above	-0.70	-0.58	-0.67	-0.47	-0.75	-0.57	-0.74	-0.73	-0.73	-0.72

note: 1. "mean" - elasticity base of mean values for all household in quartile
"below" - elasticity base of mean values for all household in quartile with incomes below the mean
"above" - elasticity base of mean values for all household in quartile with incomes above the mean

Table 12: Price Elasticities (Vancouver)

CHAPTER 05: The SUPPLY SYSTEM

The supply system for the Urban Institute's model assumes that all dwellings are controlled by landlords with owner-occupiers renting to themselves. The formulation takes the quantity of "housing" services that a dwelling supplies at the start of the decade and incorporates a physical depreciation factor to indicate the decade-end quantity available if no maintenance-repair-renovation work is undertaken and a price elasticity factor to indicate the marginal changes in maintenence-repair work as the value of the source of a unit of "housing" service increases.

The issue of the responsiveness of the owners of the existing stock to price movements has seen the most detailed discussion under the guise of the "filtering" process. While there have been as many definitions of filtering as analysts discussing it, the most useful definition is based in terms of changes in housing prices. Weicher (1979, p63) notes that

> 'It has been argued in the literature on filtering that a price decline cannot occur, at least in the long run, because any fall in the sales price or rent will ultimately be matched by a decline in the quality of the unit, perhaps through reduced maintenance. The price for housing of a given quality therefore will not change. This conclusion was first reached by Lowry (1960), who was also the first analyst to define filtering explicitly as a process of relative price changes for housing of different qualities. Restated in more technical terms, his argument is essentially that the long-run supply of housing services, from the existing housing stock, is infinitely elastic at points to the left of the initial equilibrium position.'

The point that this block of literature misses is the impact of differential price increases over time between different components of the housing stock. An owner needs to receive a price per unit equal to his marginal cost (including the necessary

maintenance-repairs) to maintain a constant long run supply of "housing" services. With a subsidized housing production process (subsidies directed to new dwellings only) there exists the potential for a substantial differential to occur between actual supply prices and the true cost of production. Thus, while a fall in the per unit of "housing" services price below the nominal marginal cost will result in a decline in the quantity of services provided, the price per unit of service from existing structures may fall below the marginal cost of providing services from new dwellings without a resulting decline in the quality of the stock. In addition, given the durability of the sources of "housing" services, a household can consume the "stock" as well as the "services" for an extended period by providing no maintenance or repairs. The household will pay a price below the normal marginal cost, but will face a declining level of housing consumption. Given that most people who live in substandard housing do so not just because they are poor but because they are ignorant of or indifferent to defects that reduce the quantity of "services" provided (Lowry (1979, p93)) this "over" consumption can occur for an extended period (twenty years plus) and provides a significant proportion of the total "housing" services in a society. In formulating the supply system the potential must exist for households to consume housing at a price below the normal "marginal" cost.

On the other hand the potential for a household to increase the quantity of "services" provided by a dwelling is constrained by physical factors such as the structure type and property boundaries and regulatory factors such as zoning and building codes. With sources of rental "housing" services based most frequently on

multiple unit structures the only real potential for increasing the quantity of services provided will exist only if the structure has previously been allowed to physically depreciate. For detached owner-occupier structures the potential for extensions and remodeling is much greater and consequently owners will be more responsive to price increases. With condominium ownership, given the multiple unit structures and an additional political level, the potential for increasing the quantity provided becomes even less than with rental structures.

Thus while the reduction in quality will be slow and relatively uniform, increases in quantity will typically be lumpy and less uniformly distributed across a submarket. Consequently one would expect non-symmetrical responses to alternative "real" price increases and decreases. Within a long run context these changes will reflect alternatively as average nominal price increases above or below increases in the marginal operating cost and one would thus expect discontinuous supply functions.

Hence, in formulating a supply system the functions should reflect the potential to supply decade-end quantities ranging from a situation where the dwelling is depreciating without maintenance and repairs through to situations where the dwelling supplies more than the decade-start quantity as a result of renovations and remodeling activity, with independent elasticities above and below the normal marginal operating cost.

The formulation of realistic yet efficient supply functions for the model is hampered by both a lack of theoretical development and the lack of suitable data sets from which it is possible to differentiate between price and quantity changes over time. The following section details two alternative theoretical formulations,

structured to enable the derivation of flexible supply functions, that were empirically tested but were not suitable for implementation because of a lack of appropriate data. The subsequent section details the compromise systems implemented for the policy studies.

5.1 Alternative Theoretical Supply Systems

Following the approach utilized for the demand system wherein the demand function was based on a translog representation, two alternative formulations for estimating a supply system have been considered. The U.I. formulation assumes that all dwellings are controlled by landlords with owner-occupiers renting to themselves. The approaches formulated here assume that all occupants control their dwellings and are responsible for the production of "housing" services in addition to other services such as domestic services, income generating services and entertainment services. That is, the household provides both "human" and "housing" services from which they derive a profit. As such, this formulation is applicable only to owner-occupiers.

The household's production function is represented by the general form

$$Y\ (QHS,\ QOS,\ K) \qquad \ldots 5.01$$

where,

QHS represents the quantity of "housing" services produced
QOS represents the quantity of all other non- housing service including personal produced.
K represents the household's capital holding of "housing" services.

It is assumed that there exists a separable function for "housing" services such that the production function can be represented by the form

$$Y1(QHS,\ K) * Y2(QOS) \qquad \ldots 5.02$$

Further, it is assumed that the household's profit function associated with the production of services can be represented by the translog form

$$\ln(\text{profit}) = L0 + L1*\ln(u) + L2*\ln(K) + 0.5\,H11*\ln(u)*\ln(u) + H12*(\ln(u)*\ln(K)) + 0.5*H22*\ln(K)*\ln(K) \qquad \ldots 5.03$$

where,

u represents the per period cost associated with the production of QHS units of "housing" services

K represents the household's capital holding of "housing" services at period start.

By taking the logarithmic partial derivatives d ln(profit)/d ln(u) we find

$$\frac{\partial \ln(\text{profit})}{\partial \ln(u)} = \frac{\partial(\text{profit})}{\partial(u)} * \frac{u}{\text{profit}}$$

$$= \frac{QHS * u}{\text{profit}}$$

giving

$$\frac{QHS * u}{\text{profit}} = L1 + H11 * \ln(u) + H12 \ln(K) \qquad \ldots 5.04$$

To obtain the supply system, the parameters of the translog profit share function are estimated from this semilogarithmic equation via ordinary least squares. It is assumed that the translog form is an exact representation of the share equation: any deviations in the shares are assumed to be the result of errors in maximization behaviour. A classical additive disturbance is thus specified for the equation for estimation.

An alternative approach is based on a translog specification of the household's cost function. Again one assumes all occupants control their dwellings and are responsible for the production of "housing" services in addition to "personal" services from which they derive benefits. The cost of providing such services is

indicated by a cost function of the form;

$$C = C(uh, up, W) \qquad ...5.05$$

where,

uh represents the per period cost associated with the production of QHS units of "housing" services.

up represents the per period cost associated with the production of QPS units of "personal" services.

W represents the household's combined housing and human wealth.

Normalizing in terms of the cost per period of "personal" services, the function is of the form;

$$C = C(uh, 1, W) = C(uh, W)$$

Now this function can be represented by a translog function of the form;

$$\ln(cost) = L0 + L1*\ln(u) + L2*\ln(W) + 0.5\ H11*\ln(u)*\ln(u) + H12*(\ln(u)*\ln(W)) + 0.5*H22*\ln(W)*\ln(W) \qquad ...5.06$$

where,

u represents the per period cost associated with the production of QHS units of "housing" services

W represents the household's combined housing and human wealth at period start.

By taking the logarithmic partial derivatives as for the profit function, the cost share function can be derived as;

$$\frac{QHS * U}{cost} = L1 + H11 * \ln(u) + H12\ \ln(W) \qquad ...5.07$$

where,

$$cost = Y + u * QHS$$

when

Y represents the household's after tax (disposable) income

In a manner similar to the profit share function, the parameters are estimated from this semilogarithmic equation via ordinary least squares. Again it is assumed that the translog form is an exact representation of the share equation and a classical additive disturbance is incorporated.

Unlike the formulations utilized in the UI model where it is assumed that all dwellings are controlled by landlords with owner-occupiers renting to themselves, these two alternative formulations assume that the occupant controls the dwelling and is responsible for the production of housing services. As such these formulations are applicable only to owner-occupiers. Furthermore the housing market model requires supply functions that reflect market changes over a ten year period: to estimate suitable functions requires matched data sets from which both period-start and period-end data can be obtained. The only source of such information in Canada is Census data, but it lacks both detailed dwelling information and data on expenditures. Such information is available from the SHU dataset and the two alternative functions were estimated using the cross-sectional information (see APPENDIX A2.4). Significant estimates of the coefficients for the functions were obtained but the cross-sectional form of the data used prevents their use in the simulation model where the supply functions reflect change over a ten year period. Consequently, the only currently available approach to obtaining supply functions for the model is to use simplistic representations and a calibration method to obtain the parameter values.

5.2 Supply System

The UI's approach to deriving a supply function, while based on acceptable profit maximization theory, degenerates to an ad hoc formulation through the incorporated assumptions necessary to derive a supply equation of a usable form. With the constraint imposed by calibration the following functions have been drawn from the original UI's function under an alternative set of assumptions. The formulation, separable by tenure, is of the general form

$$SQj = \begin{cases} [BETA1 + BETA2 * fn(Pj] * QIj & \text{for } Pj > \text{marginal "operating" cost} \\ BETA1 * QIj & \text{for } Pj \leq \text{marginal "operating" cost} \end{cases} \quad ...5.08$$

where

$$fn(Pj) = \frac{Pj - OC}{PM}$$

for

OC = the marginal "operating" cost

PM = average "cost" per unit of "housing" service from the existing stock.

Three parameters are sufficient to deterime the form and positioning of these functions

1. BETA1 to determine the position of the depreciated quantity constraint BETA1 * QIj
2. OC to determine the intercept point between the two functions, and
3. a slope coefficient, BETA2 for the elastic section of the function

Both BETA1 and BETA2 must be derived by calibration while the alternative exists either to specify 'a prior' OC drawing from

available data on operating expenses, repairs and maintenance or incorporate OC as a linear function of PM and derive the coefficient via calibration. The first approach has been utilized in this study.

This supply function is derived from the U.I. approach under the simplifying assumptions that the marginal "operating" cost includes the cost of financing and that the marginal increase in the quantity of services provided over the initial quantity has an associated average cost per unit equal to "PM" reflecting equilibrium conditions with respect to prices and costs. Implicit in this formulation is the assumption that all revenues and operating costs increase at the same constant rate providing a constant real profit over the decade.

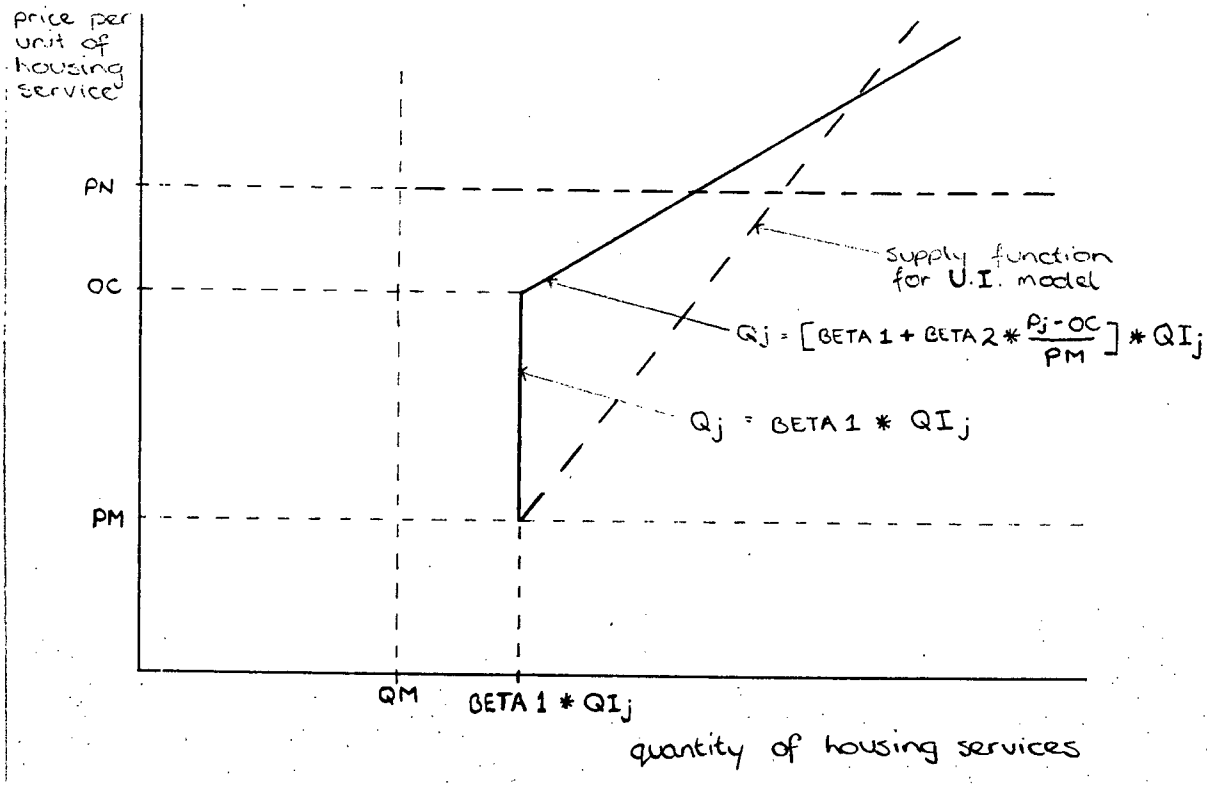


Figure 05: Typical Supply Curve

As with the UI formulation, a minimum price has been incorporated on the assumption that anticipated land value appreciation provides an additional yield to owners of unmaintained dwellings operating below OC but only up to a point where revenue does not cover hard operating costs. This price has been set at 27% of PM to reflect a typical operating to revenue ratio for residential properties. A graphical representation of the supply function and a comparable function from the original model are presented as Figure 5:01. As formulated the discontinuous linear supply functions are more elastic in the critical area (at prices close to the price per unit of new housing service) than those associated with the original model. Consequently under policy simulations the modified supply system will yield cost estimates lower than those obtained with the original formulations as smaller price increases will be required to achieve comparable increases in the quantity supplied. As a means of testing for the significance of the variance in the elasticity the policy simulations have been run using both models.

With the lack of suitable data from which to derive long run supply functions, the supply side of the model greatly limits the reliability of the model and consequently the confidence one can place in any detailed simulation results.

CHAPTER 06: INITIALIZING the MODEL

This chapter describes briefly how the theoretical concepts associated with the simulation model are empirically measured, and how the model is initialized for the individual CMAs in preparation for "policy" simulation analyses. The majority of the related theoretical and empirical analyses are contained in the APPENDIX Sections A1 and A2; this chapter, therefore, provides only a general overview of the process involved. The basic approach and techniques employed generally follow those outlined in de Leeuw and Struyk(1975) and the associated Urban Institute publications. The first section details the selection of CMAs for this study with the subsequent section covering the process involved in generating a "model" representation of a specific CMA. The final section covers the calibration procedures whereby function parameters not estimated by regression are estimated through simulation of actual decadal performance.

6.1 Selecting the CMAs

For the purposes of this study, the model has been calibrated for eight CMAs selected to provide a sampling of a range of housing market caharacteristics that affect the behaviour of households and dwelling owners. Since the impact of introduced policies will vary with the characteristics of the market under consideration the sampling of CMAs provides a more realistic statistical base than a single CMA. Factors important in the long run simulation of housing market conditions include population growth, income growth and the distribution of income. Of particular importance is the percentage of households which can be classified as "low income", since it is toward this group that the policies under evaluation are directed. Other micro factors to be considered are the relative cost of housing services, CMA size and commuting distances to the centre of the city.

In selecting representative Canadian CMAs two other criteria considered important were the location of the CMAs by region and the location of the CMAs relative to each other. It was considered desirable to obtain a representative geographical sample and concentrate on the smaller centres but closely related CMAs such as Toronto and Hamilton where cross-commuting occurs were eliminated. This latter size consideration is important in order to increase the degree of disaggregation associated with the generated "model" households and dwellings.

The Canadian CMAs for which the required data are available are presented in Table 13.

	Population 1971	Growth of Population 1961-71(%)	Growth in Income 1961-71(%)	%Households 1971 Income Under $5000
Calgary	403,319	36.4a	72.3b	15.2b
Chicoutimi	133,703	4.7b	61.2b	19.0a
Edmonton	495,702	31.8a	78.2a	16.3b
Halifax	222,637	14.1b	81.0a	15.8b
Hamilton	498,523	21.7a	78.3a	14.2b
Kitchener	226,846	37.7a	80.3a	12.7b
London	286,011	23.2a	118.6a	15.0b
Montreal	2,743,208	21.3b	71.0b	18.4a
Ottawa-Hull	602,510	27.5a	82.6a	13.1b
Quebec City	480,502	23.6a	77.6b	16.9a
Regina	140,732	21.2b	60.4b	19.8a
St.Cat-Niag	303,429	16.3b	79.2a	16.2b
St. John's	131,814	21.1b	76.5b	28.0a
Saskatoon	126,449	27.8a	63.5b	20.7a
Sudbury	155,424	19.8b	90.3a	9.7b
Toronto	2,628,043	31.2a	81.9a	13.4b
Vancouver	1,082,352	26.8a	81.2a	18.4a
Victoria	195,800	22.8a	77.7b	19.1a
Windsor	258,643	17.4b	109.5a	14.9b
Winnipeg	540,262	12.5b	70.0b	17.4a

note: [1] "a" denotes a CMA above the median
"b" denotes a CMA below the median

CMAs Grouped by the Combined Ranking of the Two Growth Factors and the Percent of Low Income Households

group		
1	aaa	Vancouver
2	aab	Hamilton, Kitchener, London, Ottawa-Hull, Toronto, Edmonton
3	abb	Calgary
4	aba	Quebec City, Saskatoon, Victoria
5	bbb	none
6	bba	Chicoutimi, Montreal, Regina, St. John's,
7		Saint John, Winnipeg
8	baa	none
9	bab	Halifax, St. Catherines-Niagara, Sudbury, Windsor

source: Ray, M.D. (ed.), Canadian Urban Trends Volume 1, National Perspective, Government of Canada, 1977.

Table 13: Selected Statistics for Canadian CMA's

Two CMAs, Thunder Bay and Saint John, were eliminated because of inadequate data.

In the second section of Table 13 each CMA is classified according to whether or not it lies above the median CMA with regard to the following selected variables for the decade under consideration; decade population growth, decade income growth and the decade-end percentage of households with incomes of less than $5,000. These groupings provide a basis on which to select a sample of CMAs.

The eight CMAs considered are: Calgary, Kitchener, Quebec City, St. John's, Saskatoon, Sudbury, Vancouver and Winnipeg. This provides a distribution with respect to population of one CMA in the one million plus category, three in the 400,000 to one million category and four in the 100,000 to 400,000 . The spatial distribution is as follows; one in the Maritimes, one in Quebec, two in Ontario, three in the Prairies and one in British Columbia.

In terms of the study, the most important distributional aspects are concerned with population growth, and income growth and distribution. One CMA has been selected from each of the six groupings shown in Table 13, with the two additional CMAs being selected to provide both a regional contrast and an emphasis on the poorer and smaller CMAs. The size of the selected CMAs provides a range of actual to "model" ratios of a low of 287 for St. John's to a high of 3,454 for Vancouver.

Additional selected statistics for these CMAs, indicating their diverse nature, are contained in APPENDIX A3.

6.2 "Model" Data Generation

The major data inputs required by the model for an individual CMA are the income distributions for each of the ten household TYPEs and equity to value ratios for the five owner-occupier household TYPEs; rent and user cost distributions for the dwellings and CBD access and wealth parameters for each of five geographic zones. Secondary data includes information on new construction costs and the minimum quantities associated with a new dwelling. The income distributions for each household TYPE are divided to create the "model" households: the rent and user cost distributions are deflated to "relative housing" services and divided to create independent rental and owner-occupier "model" dwellings.

Briefly, the steps involved in generating the data sets for initializing the demand side, then the supply side are:

1. delineate the CMA into the specified number of locational zones (five zones are employed for this study), and calculate by zone the average income and average access for use in determining zonal externalities.

2. create the 1971 "model" households and data on mean incomes by household type. Income data from the 1974 Survey of Housing Units deflated to a 1971 mean are used.

3. estimate the 1971 hedonic coefficients to be used to convert actual 1971 rents and prices from "residential" services to "housing" services. These coefficients are estimated via multiple regression utilizing 1971 census data incorporated in the 1974 SHU data. Using the 1971 hedonic coefficients the 1971 "model" dwellings are then created. These "model" dwellings are represented in the MODELs by the mean adjusted monthly rent (or an equivalent user cost) and the zone in which they are located. In addition, characteristics of the actual 1971 households by household type and zone are used to provide a basis for calibration calculations.

4. the calculation of separate new construction parameters for the renter and owner-occupier markets.

The demand function parameter sets (A1,B11,B12,BM1,BM2) are then estimated utilizing the 1974 SHU data by differentiating households first by household type and then by income into four quartiles to

reflect additional variations with income and to enable the generation of relatively smooth demand functions. Details of this procedure are outlined in Section 4.4. These operations provide the data required to estimate the two zonal externality parameters: EXT1 and EXT2 via a calibration process.

5. estimate zonal externality parameters via calibration using the 1971 model households and dwellings and the estimated demand function formulations. These zonal externality parameters reflect the household's preferences for being located in a residential zone with good central business district (CBD) access and with high income residents.

The next step involves generating the alternative data set required for estimating via calibration the parameters of the supply functions. Step 3 must be repeated to generate the 1961 "model" dwellings. This involves;

6. estimating the 1961 hedonic coefficients, again via multiple regression, but using the 1961 Census data aggregated at the enumeration area level. This then allows the generation of the 1961 "model" dwellings using the 1961 hedonic coefficients and 1961 Census tract data. In addition, calibration data representing the change in market conditions over the decade are derived. This involves utilizing both the 1961 and the 1971 hedonic coefficients in conjunction with the 1961 and 1971 Census tract data to generate price indicies by zone. Additional data on decade-end household and dwelling characteristics are also derived from the 1971 data.

6.21 Neighbourhood Zones

The "residential" services that a housing unit provides are viewed as a combination of the "housing" services associated with the actual structure and those associated with the characteristics of the neighbourhood in which the unit is located. In order to derive the neighbourhood aspect, a CMA must be divided into a series of zones. With household utility from housing services

consumption being considered a function of access to employment opportunities and neighbourhood externalities, in addition to "housing" services consumed, it follows that within-zone homogeneity with respect to these factors should be the major criterion for determining zonal boundaries.

In the Urban Institute studies, the zones were delineated using personal judgment. Tentative boundaries were drawn by placing primary emphasis on the racial and rent characteristics and then adjusted for major discrepancies with regard to the other factors. This study employs cluster analysis, a simple statistical grouping technique. Details on this process are given in APPENDIX A1.412. The clustering "keys" employed are the 1961 Census Tract rents, housing values and incomes as "services" and "wealth" criteria, and distance from the central city as an access criterion. An exception occurs with Quebec City, where many 1961 census tracts have no reported housing values and clustering was necessarily based on the three remaining "keys". Census tracts annexed in the 1971 Census are simply grouped and assigned to the zone with the closest average mean value for the clustering "keys". Maps outlining the zones generated by this method are presented for each CMA in APPENDIX: Figures A3:02.

One concern that arises with the clustering technique is that no control over group size is available unless a contiguity constraint is imposed. Since clustering has been undertaken without imposing such a constraint, some CMAs isolate a single census tract as a zone. Generally, the stock in a single tract for these CMAs corresponds to three or four "model" dwellings and is thus not a problem. The exception is Winnipeg, where a single "wealthy" 1961 tract is isolated with stock corresponding to less

than a single "model" dwelling. In this case the annexed tracts which have mean incomes, rents and values in excess of all other zones have been included with the single tract. The distribution of the tracts by zone is given in Table 14 for each of the CMAs.

	ZONE						zone for annexed tracts.
	1	2	3	4	5	"A"	
Calgary							
1961	9	2	8	4	4		
1971	16	4	39	5	4	9	1
Kitchener							
1961	10	10	3	5	2		
1971	11	15	3	12	2	2	5
Quebec City							
1961	27	18	23	7	7		
1971	27	19	22	10	8	11	5
St. John's							
1961	5	2	2	7	4		
1971	5	2	2	8	4	6	5
Saskatoon							
1961	6	3	4	2	1		
1971	7	3	4	2	1	1	4
Sudbury							
1961	4	7	5	3	2		
1971	6	8	5	3	2	4	5
Vancouver							
1961	19	35	5	48	13		
1971	28	37	9	80	18	6	5
Winnipeg							
1961	39	25	12	21	1		
1971	41	30	12	20	1	2	5

note: "A" indicates number of tracts with no matching 1961 tract.

Table 14: Distribution of Census Tracts by Zone

6.22 "Model" Households

The characteristics of the "model" households for each of the ten TYPEs are derived from the 1974 Survey of Housing Units data. For each CMA a total of 100 "model" households are formed, each being represented by the actual 1971 after tax income, taxes and TYPE group. In addition for owner-occupiers, their percent equity

holding in their actual dwelling is included.

"Model" households are formed from a distribution by income of actual households in each TYPE group by dividing the continuum by the ratio of actual to "model" households. The result is that each "model" household within a CMA represents approximately the same number of actual households, grouped regardless of their location in the CMA. The derived distribution of "model" households by TYPE is outlined on a CMA basis in Table 15.

	HOUSEHOLD TYPE									
	renters					owners				
CMA	1	2	3	4	5	6	7	8	9	10
Calgary	5	12	10	9	7	5	7	11	14	20
Kitchener	4	9	12	6	9	10	5	12	11	22
Quebec City	8	15	15	12	8	6	3	7	14	12
St John's	3	5	8	11	9	10	8	12	14	21
Saskatoon	6	10	11	6	7	10	6	10	14	20
Sudbury	4	11	8	12	7	8	6	9	15	20
Vancouver	8	15	11	4	3	11	9	14	9	16
Winnipeg	6	12	11	7	5	10	7	12	13	17
average	5.9	12.1	11.9	9.0	7.5	7.9	5.6	10.3	12.3	17.6

Table 15: Distribution of Households by TYPE

The required after tax income (and taxes) and the equity holding are not directly available on the SHU data sets. This has required their calculation from reported household and household members' gross incomes, with deductions based on the household's characteristics. The method by which taxes are calculated is described in APPENDIX A2.31. The mean gross and net household incomes on a CMA basis are shown in Table 16.

	HOUSEHOLD TYPE									
	1	2	3	4	5	6	7	8	9	10
Calgary										
Gross	3113	7257	10897	8121	10323	5917	9826	14094	12210	13587
Net	2882	5703	8919	6637	8672	5135	7480	11244	9383	10837
Kitchener										
Gross	5394	6234	11314	6612	9751	5838	9359	15574	12376	13981
Net	4694	5178	9351	5689	8345	5104	7484	12309	9579	11427
Quebec City										
Gross	5638	5864	9968	7516	10781	10195	10251	16197	12349	16168
Net	4929	4720	8195	6264	8952	7872	7642	12281	9189	12219
St. John's										
Gross	5385	5459	9260	5383	9064	6338	8577	12928	8584	13473
Net	4620	4499	7749	4787	7674	5412	6690	10412	6961	10777
Saskatoon										
Gross	3840	4851	8836	5829	9150	5266	7796	12225	10116	12651
Net	3418	4057	7329	5056	7749	4578	6198	9853	8115	10230
Sudbury										
Gross	5687	7459	14059	8542	13317	6944	10712	16097	11947	17420
Net	4871	6056	11163	7123	10899	5961	8178	12601	9505	13474
Vancouver										
Gross	4723	6208	12266	7429	10076	7411	8867	15802	12847	13436
Net	4182	5058	9748	6176	8510	6222	6940	12437	9964	10976
Winnipeg										
Gross	4017	5862	10774	6468	9898	6501	7811	14030	11033	14445
Net	3501	4709	8838	5434	8299	5507	6300	10972	8681	11422

Table 16: Gross and Net Incomes by TYPE and CMA
[1971 Tenured "Model" Representations]

In estimating the demand functions it is assumed that for owner-occupiers a tax free return on their equity holding is included as after tax income. Based on the assumption that the current mortgage rate applicable to their property represents their opportunity cost, the degree of owner-occupier leverage is indicated by the percentage of their expenditure that is an opportunity cost. These percentages are calculated as:

$$\%EQUITY = \frac{\text{opportunity cost on equity}}{\text{actual expenditure + opportunity cost on equity}}$$

The calculations of these costs and expenditures are shown in APPENDIX A2.31. The mean values for the five owner-occupier household TYPEs are detailed in Table 17.

	OWNER-OCCUPIER HOUSEHOLD TYPES				
CMA	6	7	8	9	10
Calgary	69.1%	50.8%	41.7%	38.4%	40.0%
Kitchener	61.8%	58.5%	56.6%	47.3%	45.4%
Quebec City	56.7%	52.2%	48.9%	37.1%	40.1%
St. John's	53.5%	52.1%	47.6%	38.6%	40.7%
Saskatoon	59.4%	51.2%	44.7%	37.8%	39.4%
Sudbury	64.1%	59.9%	55.5%	47.4%	46.7%
Vancouver	75.4%	57.5%	59.6%	58.9%	47.0%
Winnipeg	66.3%	60.7%	51.3%	44.7%	45.2%

Table 17: Mean Equity Holdings by CMA and TYPE

6.23 "Model" Dwellings

The complete implementation of the model requires the creation of two sets of "model" dwellings; a 1971 set to be employed for calibrating for neighbourhood externalities and a 1961 set for use in "base" calibrations and "policy" simulations.

The calculation of "housing" services distributions is

possibly the most difficult task involved in applying the housing market model to a CMA. This difficulty arises because the model's demand and supply functions are formulated in terms of units of "housing" services, thus requiring the conversion of the observable "residential" services, "RS", to the location-free quantity of services measure. Theoretically, this relationship between "residential" and "housing" services is of the form;

Residential Services = Housing Services + Neighbourhood Services

where the "neighbouhood services" component may be either positive or negative. That is, a structure yielding 100 units of "housing" services placed in a high quality neighbourhood may yield a total of 120 units of "residential" services, indicating that the neighbourhood environment generates an additional 20 units of service. On the other hand, if this same structure is placed in a poor quality neighbourhood, the total "residential" services may only be 90 units; a discount of 10 units of service.

To derive the "housing" services component of the "residential" services associated with dwellings in a CMA, an equation of the form

RS = f(structural attributes) + f(neighbourhood attributes)

is estimated via regression analysis, (see APPENDIX A1.31). The output from these regression analyses consists of separate rental and owner-occupier models, in which rents, or alternatively estimated values, (being proxies for "residential" services) are explained in terms of the structural characteristics of the housing stock and neighbourhood-related variables. Ideally, the

neighbourhood effect is simply the difference between the actual rent-quantity of "residential" services and the calculated quantity of "housing" services. A problem arises, however, since the included neighbourhood variables are highly correlated with the "structural" variables that have been eliminated from the regression equations. Consequently, if the included structural variables alone are employed to calculate the quantity of "housing" services, the quantity will be severely underestimated. Thus, with current data sources it is impossible to calculate the theoretical separation of "residential" services. Although not explicitly stated, the U.I. calculates what may be termed "relative housing" services, "RHS", as a substitute. These relative quantities are calculated by substituting the CMA average values for the "neighbourhood" characteristics in addition to the relevant "structural" variable values. Thus our dwelling that provides 120 units of "residential" services, of which 100 are "housing" services, may provide 110 units of "relative housing" services, while the equivalent dwelling in an inferior neighbourhood will also provide 110 units of "relative housing" services. Correspondingly, an alternative dwelling providing 90 units of "housing" service would provide approximately 101 units of "RHS".

Now if the average "residential" services and average RHSs are calculated on either a tract or zonal basis, the difference between the two averages will indicate the relative value of the neighbourhood conditions within the grouping. An average RHS lower than the "residential" services average indicates a premium associated with the neighbourhood attributes; a higher RHS indicates a discounting and therefore an inferior neighbourhood. From the relationship between "residential services" (rent or

value) and "relative housing" services obtained, zonal quantity ADJUSTORS are calculated which allow the conversion of a distribution of "residential" services to an equivalent distribution of relative "housing" services. The calculation of the ADJUSTORs on a zonal basis involves two steps.

1. the calculation for each zone of the ratio of average RHS-rent to the average rent and the equivalent for owned dwellings; RHS-own to value. The weighted average of these two ratios is taken as the "actual" ADJUSTOR for the zone.
2. since the direct use of these ADJUSTORs will result in an "effective" unit price for the "housing" services different from one, these adjustors are then divided by an equivalent city-wide ADJUSTOR calculated from census tract data, giving "weighted ADJUSTORs", with a CMA mean of 1.00.

Implicit in this adjustment process is the assumption that the mean of the distribution of the "neighbourhood" services is zero. That is, total rents or "rent equivalence" for owner-occupied dwellings equal the total expenditure on "relative housing" services. This adjustment process is in fact adjusting "housing" services to compensate for the exclusion from the demand function of expenditures asociated with the "neighbourhood" services component.

The adjustments will obviously bias the estimated relative utilities associated with the consumption of new and existing dwellings, since no similar adjustments are made on a zonal basis for new construction. Ideally, the household's utility and budget functions should include a "neighbourhood" services component, even if only on a relative basis, allowing the expenditures on housing

to be so differentiated.

To derive the characteristics of the "model" dwellings, actual housing units within the CMA are allocated on a zonal basis. This process involves distributing reported monthly rents and monthly user costs, over a continuum with a range of 1 to 800, (1 to 500 for 1961), with the interval corresponding to a monthly expenditure of $1. This continuum is then divided into the required number of "model" dwellings for each zone with the mean quantity of "residential" services associated with each model dwelling calculated. These "residential" services are then converted into "relative housing" services using the zonal adjustors.

Decade-end quantities so derived will be expressed in terms of a 1971 price per unit of "housing" service of 1.00. Since the model operates in nominal terms with a base price of 1.00, these 1971 quantities must be deflated to equivalent 1961 quantities via relative zonal price indices. With the Urban Institute's model the technique used in adjusting owner-occupied dwelling values to a rent equivalence is based on the assumption that average rental and owner-ocupier dwellings within a census tract provide an equivalent quantity of "residential" services. For this modified model the "user" costs calculated for estimating the demand and supply function are derived independent of such a constraint, resulting in the average user cost for owners being greatly in excess of average rents. Thus in deriving the "model" dwelling the quantities must reflect the relationship between actual user costs and value, not the corresponding rent and value. The "model" dwelling representations are derived from Census data which does not include data on user costs. To convert value to user cost a relationship between user cost and value was estimated from the SHU data using

the functional relationship

$$\frac{\text{EXPENDITURE}}{\text{VALUE}} = a1 + b1 * \text{LOG(VALUE)} \qquad \ldots 6:01$$

with the expectation that the ratio will decline with an increasing value. By normalizing the independent variable VALUE (dividing by the mean), the Intercept (a1) will correspond to the mean value for the expenditure to value ratio given that the logarithm of one is zero.

Estimates of this relationship using the 1974 Survey of Housing Units data, used for the creation of the 1971 "model" dwellings, are detailed in Table 18.

C.M.A	a1	b1	R2	MEAN VALUE
Calgary	0.1161	-0.02232	0.12	24,207
Kitchener	0.1206	-0.02410	0.12	25,488
Quebec City	0.1401	-0.05866	0.32	20,048
St. John's	0.1337	-0.04330	0.29	24,834
Saskatoon	0.1211	-0.03860	0.26	18,730
Sudbury	0.1379	-0.06970	0.23	23,460
Vancouver	0.1219	-0.05344	0.16	32,860
Winnipeg	0.1301	-0.03960	0.24	22,495

Table 18: 1971 Expenditure/Value Ratio Estimates

To derive the distribution of monthly "user costs" from the corresponding values simply involves the substitution of the respective value range parameters into the estimated equation to derive an interval in terms of the "user cost".

In deflating the resulting decade-end quantities of "relative housing" services (1971 "model" dwellings), expressed in terms of a

1971 price per unit of "housing" service of 1.00, to equivalent 1961 quantities, the relative zonal price indicies must adjust not only for the zonal differences but also for the difference in price inflation for owner-occupied dwellings relative to rental dwellings. Because of different structure types and different taxation treatment, this difference in the price inflation ranges from a low of 4.5% to a high of 41.0% across the eight CMAs considered.

The distributions of the 1971 "model" dwellings by tenure and zone are outlined in Table 19 for the eight CMAs. As with the tenured households the distributions are set to provide a total tenure distribution as for the 1971 Census.

	LOCATIONAL ZONEs									
	renters					owners				
CMA	1	2	3	4	5	1	2	3	4	5
Calgary	17	2	15	8	1	18	4	30	2	3
Kitchener	12	12	2	13	1	12	19	7	18	4
Quebec City	15	19	13	7	4	5	6	18	7	6
St John's	9	1	4	13	8	12	2	5	26	20
Saskatoon	11	7	6	13	3	14	9	14	22	1
Sudbury	8	6	12	7	9	16	16	9	4	13
Vancouver	11	13	1	14	2	7	13	3	29	7
Winnipeg	21	11	6	2	1	22	21	3	11	2

source: output from program:D71.FORT

Table 19: 1971 Distribution of Dwellings

The 1961 "model" dwellings are created in a manner similiar to the 1971 model dwellings, but lacking suitable data from which to derive a comparable expenditure to value function, use is made of the function estimates from the 1974 SHU data outlined in Table 18 and the computed 1961 market values and user costs detailed in

APPENDIX Table A2:18. The average user costs and values are used to adjust the mean ratio (intercept) of the 1974 estimates with the assumption that the rate of change remains constant. The resulting parameters are reported in Table 20.

CMA	a1	b1
Calgary	0.0905	-0.02232
Kitchener	0.0954	-0.02410
Quebec City	0.1144	-0.05866
St. John's	0.1087	-0.04330
Saskatoon	0.0961	-0.03860
Sudbury	0.1123	-0.06970
Vancouver	0.0973	-0.05344
Winnipeg	0.1046	-0.03960

source: see APPENDIX Section A2.43

Table 20: 1961 Expenditure/Value Ratio Parameters

The distribution of the 1961 "model" dwellings, based on the tenure split of the 1961 Census are detailed in Table 21.

	LOCATIONAL ZONEs									
	renters					owners				
CMA	1	2	3	4	5	1	2	3	4	5
Calgary	10	1	8	5	1	11	4	20	3	4
Kitchener	7	4	0	6	1	13	15	1	15	1
Quebec City	16	15	5	2	3	6	6	8	4	5
St John's	9	1	3	7	1	14	3	6	20	7
Saskatoon	7	5	3	3	2	14	11	13	9	0
Sudbury	4	5	12	7	4	12	14	12	5	1
Vancouver	5	9	0	6	1	7	14	2	20	5
Winnipeg	14	5	6	1	0	24	19	4	5	0

source: output from program:D61.FORT

Table 21: 1961 Distribution of Dwellings

6.24 New Constrution Parameters

The price or cost per unit of "housing" services from new dwellings, PN, must be measured relative to the same base as other prices incorporated into the model. With this study all simulations utilize 1961 as the base year and thus new construction costs during the decade must be calculated to reflect cost changes over the decade. While all other prices are endogenously determined, construction prices/costs are exogenously determined under an assumption that they are derived independent of housing market forces. As a result new construction costs become an important model parameter and must be carefully specified. For convenience, the model's base price is set to unity with regard to existing "model" dwellings in 1961 and thus values for PN will be in the range 1.00 to 2.00, indicating the increases in construction costs over the decade.

Data on the distribution of operating costs have been derived from the 1969 Survey of Family Expenditure; capital costs distribution data from Canadian Housing Statistics. While distributions of the capital cost components are readily available for all years of the decade, equivalent operating cost data is only available for 1969. These latter data are therefore used to obtain relative component costs to be individually inflated/deflated utilizing available price indices.

Full details on the calculation of the individual components of PN, the price per unit of "housing" service from newly constructed dwellings, for alternatively rental and owner-occupied dwellings are outlined in APPENDIX A1.21 and A1.31.

The other new construction parameter, QM, the minimum quantity

of new housing services is derived by generating "model" dwelling representation in 1971 of alternatively the rental and owner-occupied dwellings constructed during the decade. The value for QM is then taken directly from the assigned quantities for these "model" dwellings. Because of "noise" in the value distribution, and in order to adjust for depreciation of stock constructed in the earlier stages of the decade, the values for QM are taken as the "housing" services associated with the second lowest new "model" dwelling generated for the tenure form. These values for QM, obtained in terms of 1961 "housing" services, represent a constant real quantity over the decade. While one would suspect such a constraint to be increasing in real terms, the solution algorithm has no means of assigning new construction over the decade so that such a constraint could be employed.

The derived values for QM, under a weighted value of PN, range from a low of 27.3 for Sudbury to a high of 62.2 for Kitchener. The majority of the variance in these measurements results from the variation in housing costs by CMA. These estimates of QM, being based on the quantity of "housing" services a dollar would buy in 1961, represent more housing when housing costs are low.

	rental				owner-occupied				PG
	PN	PO	PC	QM	PN	PO	PC	QM	
Calgary	1.65	0.45	1.20	50.	1.87	0.45	1.42	55.	1.282
Kitchener	1.67	0.45	1.22	51.	2.36	0.45	1.91	74.	1.300
Quebec City	1.54	0.41	1.13	52.	1.61	0.41	1.20	80.	1.270
St. John's	1.30	0.35	0.95	67.	1.70	0.35	1.35	77.	1.241
Saskatoon	1.22	0.33	0.89	57.	1.63	0.33	1.30	70.	1.237
Sudbury	1.56	0.42	1.14	45.	1.91	0.42	1.49	77.	1.350
Vancouver	1.59	0.43	1.16	65.	2.23	0.43	1.80	80.	1.270
Winnipeg	1.43	0.39	1.04	66.	1.66	0.39	1.27	79.	1.289

note: PN is the price per unit of "new" housing service
PO is the base operating cost per unit of housing service
PC is the average capital cost per unit of housing service
QM is the minimum quantity of "housing" services provided by a new dwelling
PG is the price per unit of other goods and services

Table 22: Construction Parameters

6.3 Implementation

The implementation of the demand side of the model involves estimating the parameters of the expenditure share functions and then calibrating for the EXT1 and EXT2 parameters to reflect the neighbourhood externalities. The supply side implementation involves calibrating for the BETA1 and BETA2 parameters which define the supply function.

6.31 Demand Function Implementation

In order to incorporate the estimated expenditure share equations into the simulation algorithm the functions must be of a form in which the price per unit of "housing" service can be obtained for a given quantity or the quantity derived for a given price. An initial implementation of the demand system involved the direct substitution of the estimated expenditure share functions. A problem arose from the non-global nature of translog estimates resulting in simulated values being unstable for data points removed from the mean conditions. That is, if the household's income (total expenditure) is significantly different from the mean income associated with the estimation of the equation parameters the nature of the function results in a distortion of the implied expenditure on housing. To bypass this problem the implemented demand system has been based on the use of the "share" elasticities to reflect variations in either the price or quantity from the respective mean values. In addition, by utilizing functions estimated at the mean of each of the income quartiles for each household TYPE grouping, weighting of the parameters to reflect a household with an income falling between the means has been

possible. This implementation results in continuous and stable demand functions for each household TYPE.

The share elasticities reflect the percentage change in the share of the budget spent on housing for a given percentage change in the quantity of "housing" services consumed or the price paid per unit of "housing" service. Working from first principles we take the expenditure share equation to derive the share elasticity with respect to quantity.

$$Si = \frac{Pi * Xi}{M} = \frac{Ai + Bij \ln(Xj)}{-1. + Bmi \ln(Xj)}$$

then

$$\frac{Si}{\ln(Xj)} = \frac{[-1 + Bmi * \ln(Xj)] * Bij - [Ai + Bij \ln(Xj)] * Bmj}{[-1 + Bmj * \ln(Xj)]^{**2}}$$

now if it is assumed that $\ln(Xj) = \ln(Xj) = \ln(1) = 0$

then

$$\frac{Si}{\ln(Xj)} = \frac{[-1 * Bij - Ai * Bmj]}{-1^{**2}}$$

$$= -Bij - Ai * Bmj$$

$$sq = -[Bij + Ai * Bmj] \qquad ...6.02$$

The corresponding share elasticity with respect to price must be obtained indirectly. We have

$$\frac{Si}{\ln(Pj)} = \frac{Si}{\ln(Xj)} * \frac{\ln(Xj)}{\ln(Pj)}$$

but

$$\frac{\ln(Xj)}{\ln(Pj)} = -1$$

thus

$$\frac{Si}{\ln(Pj)} = Bij + Ai * Bmj$$

or

$$esp = [Bij + Ai * Bmj] \qquad \ldots 6.03$$

To solve for price for a given quantity of "housing" services the expenditure share function utilized is as for Equation 6:04.

$$\frac{Ps * Q}{Y} = Sbase + esq * [\ \ln(Q) - \ln(Qm)\ ] \qquad \ldots\ 6:04$$

where,

Q = the known quantity of "housing" services.

Ps = the unknown price per unit of "housing" service that the household is prepared to pay for the "Q" units of "housing" services.

Y = the household's disposable income

Sbase = the "weighted" expenditure share based on the relevant quartile mean, where the weights on the coefficients are derived from the ratio of the household's income to the respective mean incomes. That is, if a household's income lies midpoint between the mean income for quartile 1 and quartile 2, the substituted coefficients will be the mean of the respective quartile values; represented as WA1, WB11, WB12, WBM1, WBM2.
If the household's mean income falls below the mean for quartile 1 or above the mean for quartile 4, the coefficients used are just those for the respective quartile.

$$= \frac{WA1 + WB11 * \ln(Q) + WB12 * \ln(XG)}{-1. + WBM1 * \ln(Q) + WBM2 * \ln(XG)}$$

where,

Q = the known quantity of housing services consumed.

XG = quantity of other goods and services consumed.

esq = the "weighted" share elasticity with respect to quantity

$$= \frac{Si}{\ln (Qj)}$$

$$= -[\ WB11 + WA1 * WBM1\ ]$$

Qm = the "weighted" mean quantity of "housing" services, representing the mean quantities utilized during the

This expression can be factorized such that;

$$Ps = \frac{Y}{Q} * [\ Sbase + sq * (\ln (Q) - \ln (Qm))\ ] \qquad ....6:05$$

and consequently the solution price may be obtained directly.

To solve for the quantity for a given price, the process is similar with the formulation;

$$\frac{Ps * Q}{Y} = Sbase + sq * [\ \ln (Ps) - \ln (Pm)\ ] \qquad ....6:06$$

where,

Pm = the "weighted" mean price per unit of "housing" services representing the mean qualities utilized during the estimations for the respective quartile.

sq = the "weighted" share elasticity with regard to price.

$$= \frac{Si}{\ln (Pj)}$$

$$= WB11 + WA1 * WBM1$$

giving,

$$Q = \frac{Y}{Ps} * [\ Sbase + sq * (\ln (Ps) - \ln (Pm))\ ] \qquad ....6:07$$

6.32 Calibrating for Externalities

In specifying the demand for "housing" services function it has been assumed that the demand function is separable in "housing" services and "neighbourhood services. The function is then specified in terms of "relative housing" services under the additional assumption that the mean of the distribution of expenditures on "neighbourhood" services for a CMA is zero. That is, total rents or "user costs" for owner-occupied dwellings equal the total expenditure on "relative housing" services. To incorporate neighbourhood preferences it is assumed that total utility is log linear, as in the Urban Institute model, incorporating relative wealth and relative access components in addition to the partial utility from the consumption of housing and other goods and services

$$U(i,j) = UX(i,j) * ZW * ZA \qquad ...6.08$$

where,

U(i,j) is the total utility household "i" derives when consuming the "housing" services provided by dwelling "j".

UX(i,j) is the partial utility derived from the consumption of housing and other goods and services

ZW, ZA are the partial utilities derived respectively from neighbourhood amenities and access to the CBD

$$ZW = \{(MY)zone/(MY)city\} ** (EXT1/10.) \qquad ...6.09$$

$$ZA = \{2. - (A/AMAX)\} ** (EXT2/10.) \qquad ...6.10$$

where,

(MY)zone is the mean income of households living in the zone where dwelling "j" is located.

(MY)city is the mean income of all households in the city.

A is a number reflecting distance from the CBD of the zone where dwelling "j" is located.

AMAX is a number reflecting the distance from the CBD of the most distant zone

EXT1 and EXT2 are parameters estimated via calibration

The calibration procedure for the two externality parameters, EXT1 and EXT2 closely parallels that used by the Urban Institute (de Leeuw and Struyk (1975, p86-91)) for calibrating the GAMMA parameters. The difference is that the demand curves, and consequently consumption levels, are fixed with the only changes being in the order in which the "model" household's select "model" dwellings. If two "model" dwellings located in different zones both yield the same price-quantity combination, the order in which they are selected is determined by the values of EXT1 and EXT2 and the zonal characteristics.

Market solution conditions are extremely sensitive to small changes in the EXT1 and EXT2 parameters, particularly the EXT1 parameter which reflects the relative income level for the zone. Outlined in Table 23 are the best fit EXT parameters obtained for the eight selected CMAs. In evaluating the alternative EXT parameters the dominant criterion was the goodness-of-fit between the computed and actual zonal incomes and prices.

			PN		PG
CMA	EXT1	EXT2	rented	owned	
Calgary	0.20	0.10	1.65	1.87	1.282
Kitchener	0.10	0.30	1.67	2.36	1.300
Quebec City	0.10	0.10	1.54	1.61	1.270
St. John's	0.00	0.10	1.30	1.70	1.241
Saskatoon	0.10	0.00	1.22	1.63	1.237
Sudbury	0.30	0.20	1.56	1.91	1.350
Vancouver	0.40	0.10	1.59	2.23	1.270
Winnipeg	0.40	0.10	1.43	1.66	1.289

Table 23: Externality Parameter Estimates

6.33 Supply Function Calibration

With the lack of a data base incorporating information on long run changes in the state of the housing stock suitable for estimation, the implementation of the supply system of the model has, in consequence, been based on a calibration process utilizing the limited data available from the 1961 Census and the 1971 Census.

The calibration of the supply function involves taking the "best fit" zonal externality parameters and varying the parameters of the supply functions until the model provides the best duplication of the decade changes in the market under study. This process corresponds to setting the fixed demand curves as estimated and varying the rate of depreciation and the slope coefficient on the supply functions until the best match of the actual decadal activity has been obtained. As detailed in Section 5.12 three parameters are required to specify the supply functions; BETA1, BETA2 and OC. BETA1 reflects the positioning of the depreciated quantity constraint BETA1 * QI(j); BETA2 the slope coefficient of the elastic section of the function. OC is the price above which it is assumed that the owner will provide repairs and maintenance to offset physical depreciation. This price will vary from owner to owner (consequently dwelling to dwelling) and in particular between a rental dwelling and an owner-occupied dwelling. This price will typically be higher for rental dwellings given the on average higher debt financing commitment and the role personal pride may play in motivating the repair and maintenance of an owner-occupied dwelling.

The assumption is made that owners will not provide any

repairs or maintenance if the price received does not cover normal operating costs plus financing payments. This price is computed on a CMA basis (details in APPENDIX Section A2:22) differentiating by tenure only.

Seperate values for BETA1 and BETA2 are derived for the rental and owner-occupier components of the market. The best fit parameters are reported in Table 24. In deriving these parameter values the dominant criterion used was the number of new dwellings created. A subordinated criterion was the goodness-of-fit between the computed and actual zonal incomes, quantities and prices.

	rental			owners		
	OC	BETA1	BETA2	OC	BETA1	BETA2
Calgary	1.205	0.550	0.300	1.178	0.675	0.350
Kitchener	1.253	0.500	0.380	1.298	0.500	0.310
Quebec City	1.140	0.725	0.450	0.950	0.625	0.400
St John's	0.962	0.800	0.400	0.986	0.810	0.375
Saskatoon	0.927	0.550	0.400	1.043	0.500	0.600
Sudbury	1.170	0.550	0.400	1.031	0.425	0.475
Vancouver	1.193	0.500	0.350	1.115	0.600	0.325
Winnipeg	1.097	0.575	0.350	0.979	0.450	0.550

Table 24: Derived BETA Parameters

6.34 Base Simulation Solutions

The base simulation solution represents the model's best representation of the actual performance of the corresponding CMAs housing market over the decade. This base solution is derived from the interaction of the estimated demand functions, the calibrated values for EXT1 and EXT2 and the estimated supply functions as represented by the BETA1 and BETA2 parameters. That is, for the given decade start stock as represented by the 1961 "model" dwellings and the decade end households represented by the 1971 "model" households, the base solution corresponds to the generated new or existing 1971 "model" dwellings.

The model was successful in closely simulating actual new construction and was successful in allocating all "model" households except for one very low income renter in St. John's unable to consume sufficient housing to bid for any of the dwellings. This following section summarizes the model solutions using the device of the price structure diagram (see de Leeuw and Struyk(1975, p106) for a detailed discription). The points on these curves represent specific model dwellings with the rental dwellings represented by an "r", owner-occupied dwellings with an "o", new dwellings an "n" and with a "*" representing points where more than one dwelling coincide. The two horizontal lines correspond respectively to the price per unit of housing service for new rental and owner-occupied dwellings. Each point on the curves corresponds to the intersection of demand and supply curves. As discussed earlier, the prices for new services will serve as a ceiling for the price per unit of existing services except under special neighbourhood conditions or when a dwelling provides a

quantity of services less than the minimum required of a new unit. The lower limit to unit prices is set by the operating cost per unit of service, OC: if the unit cannot be rented for at least this price it will not be offered in the market. The following eight diagrams correspond to the base solutions for the eight selected CMAs.

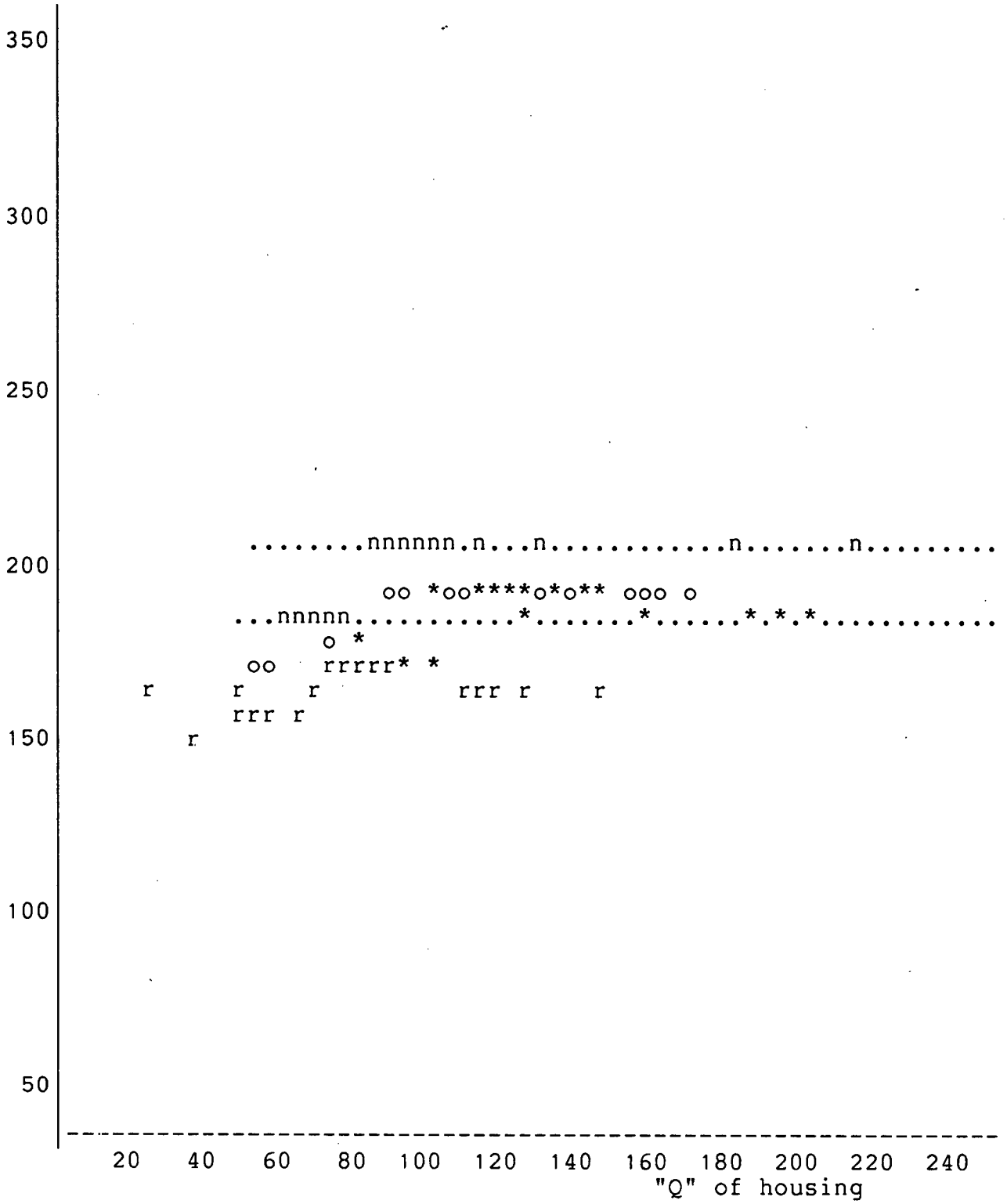


Figure 06: Base Case Price-Quantity Curves (Calgary)

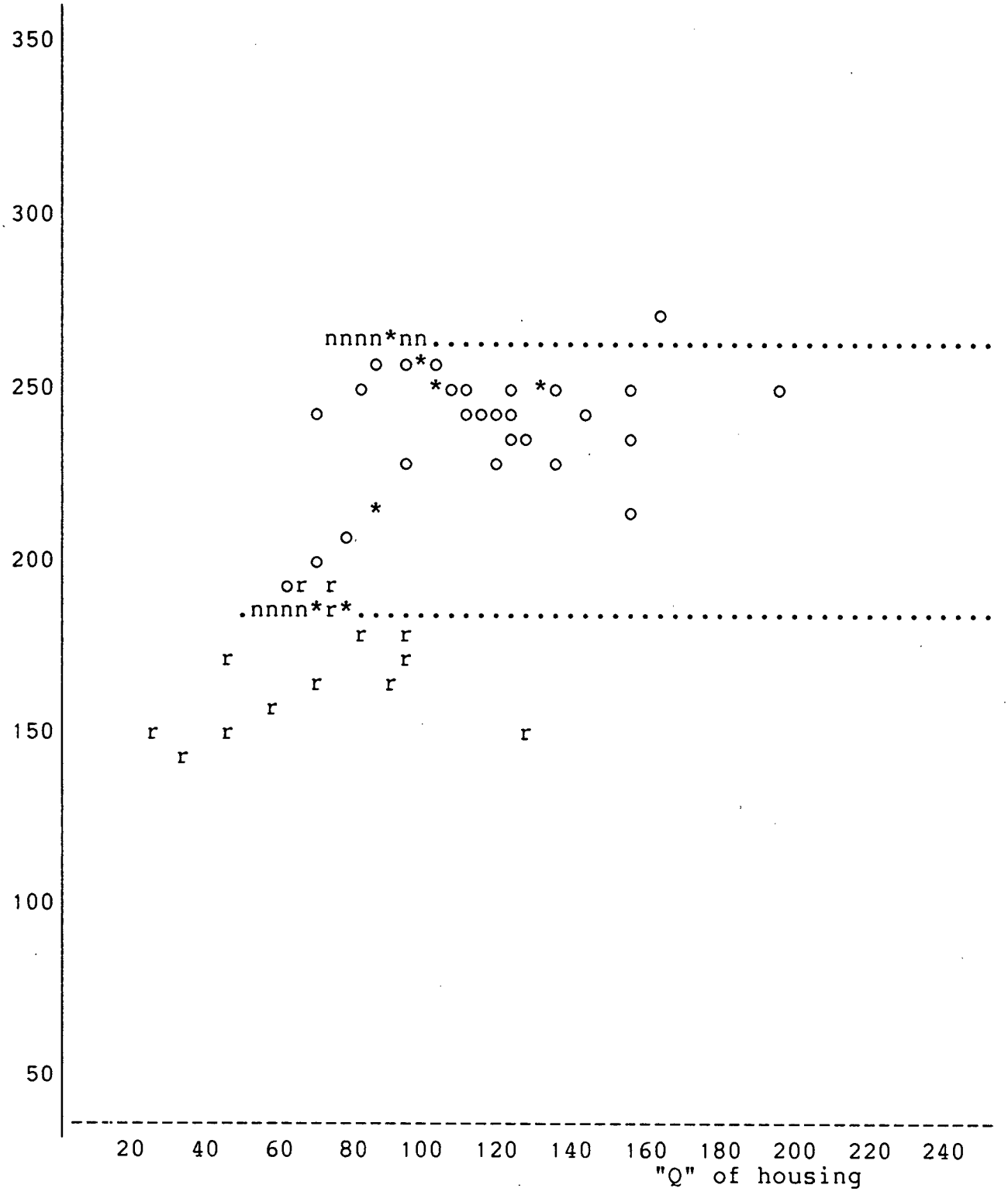


Figure 07: Base Case Price-Quantity Curves (Kitchener)

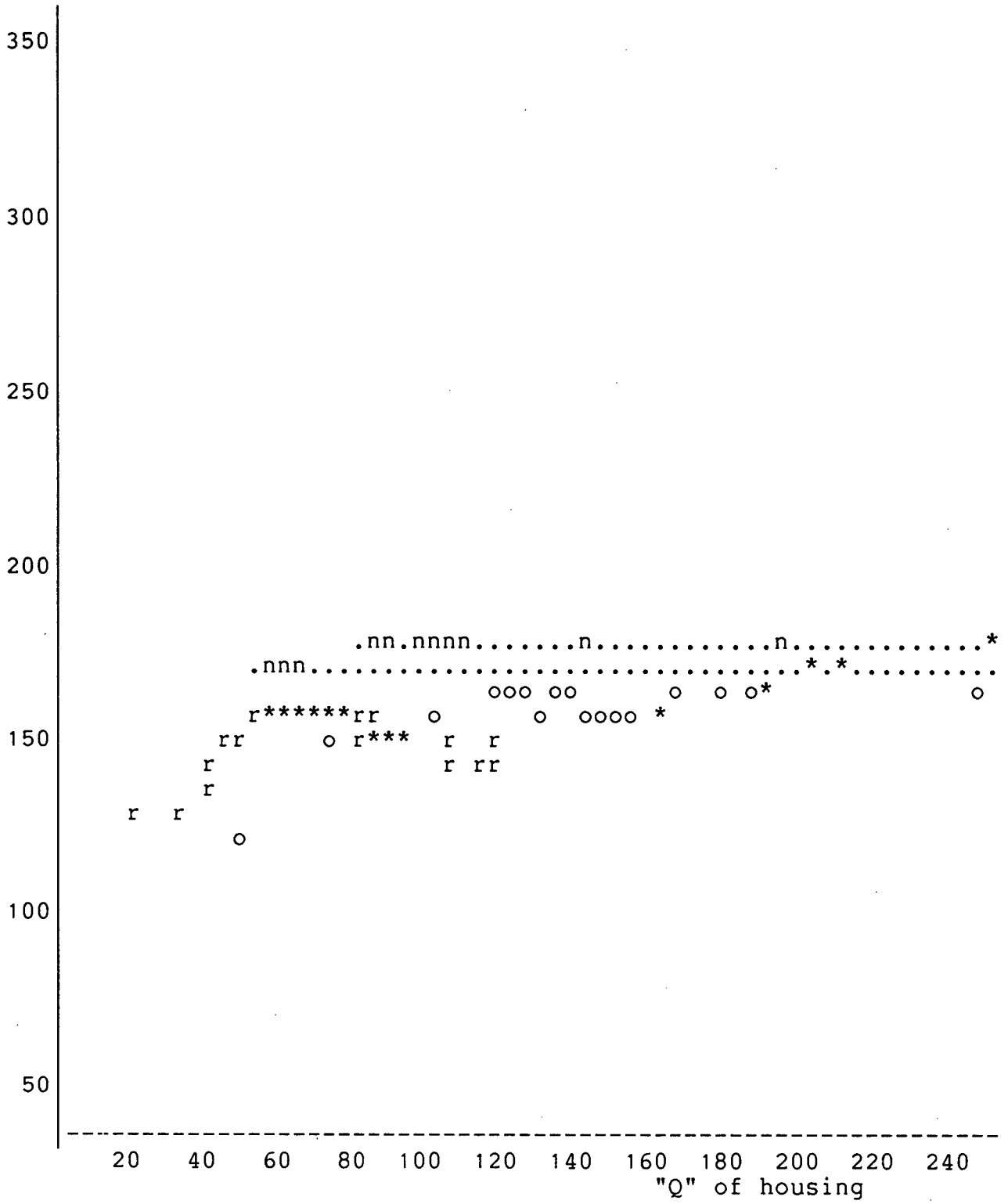


Figure 08: Base Case Price-Quantity Curves (Quebec City)

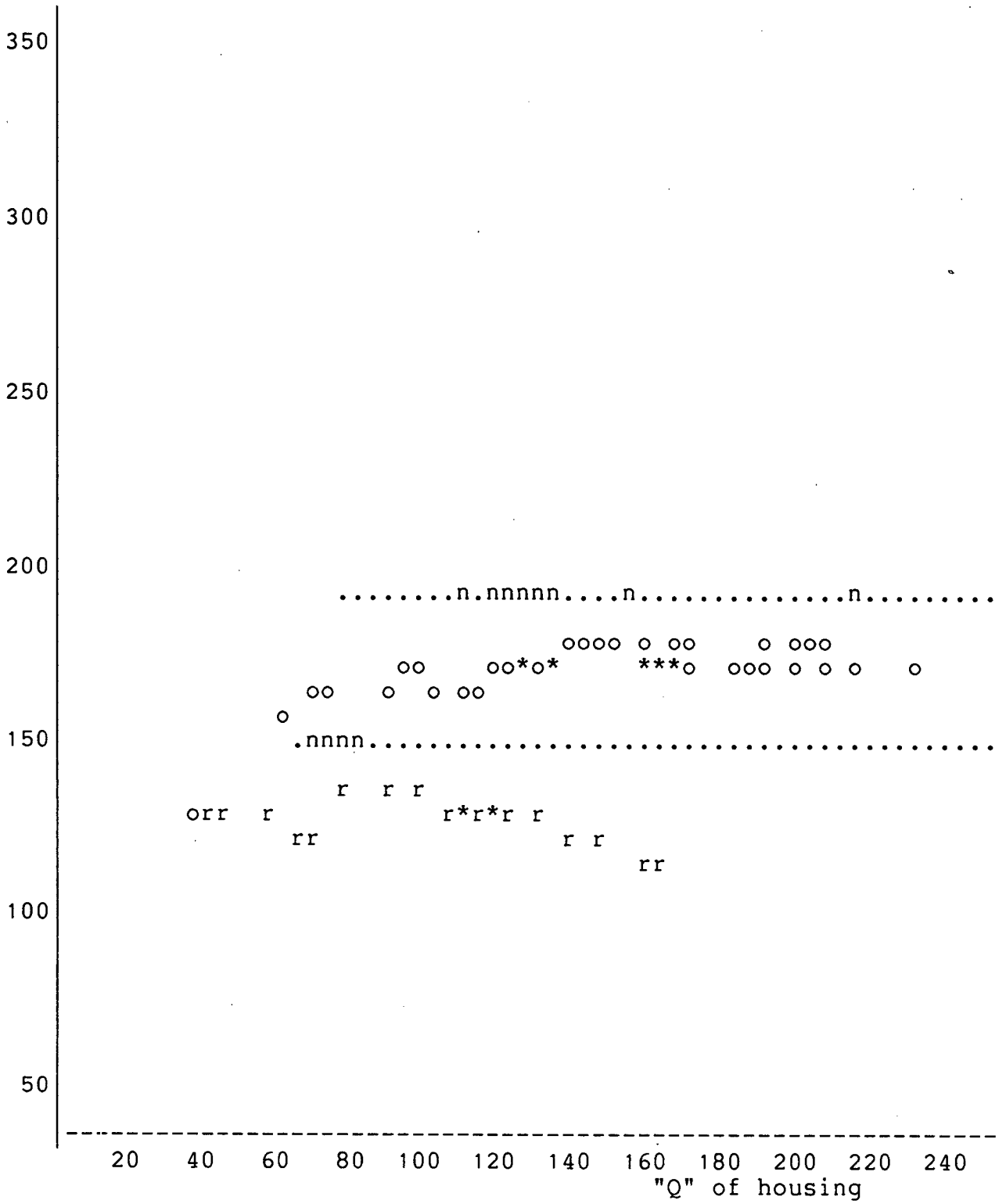


Figure 09: Base Case Price-Quantity Curves (St John's)

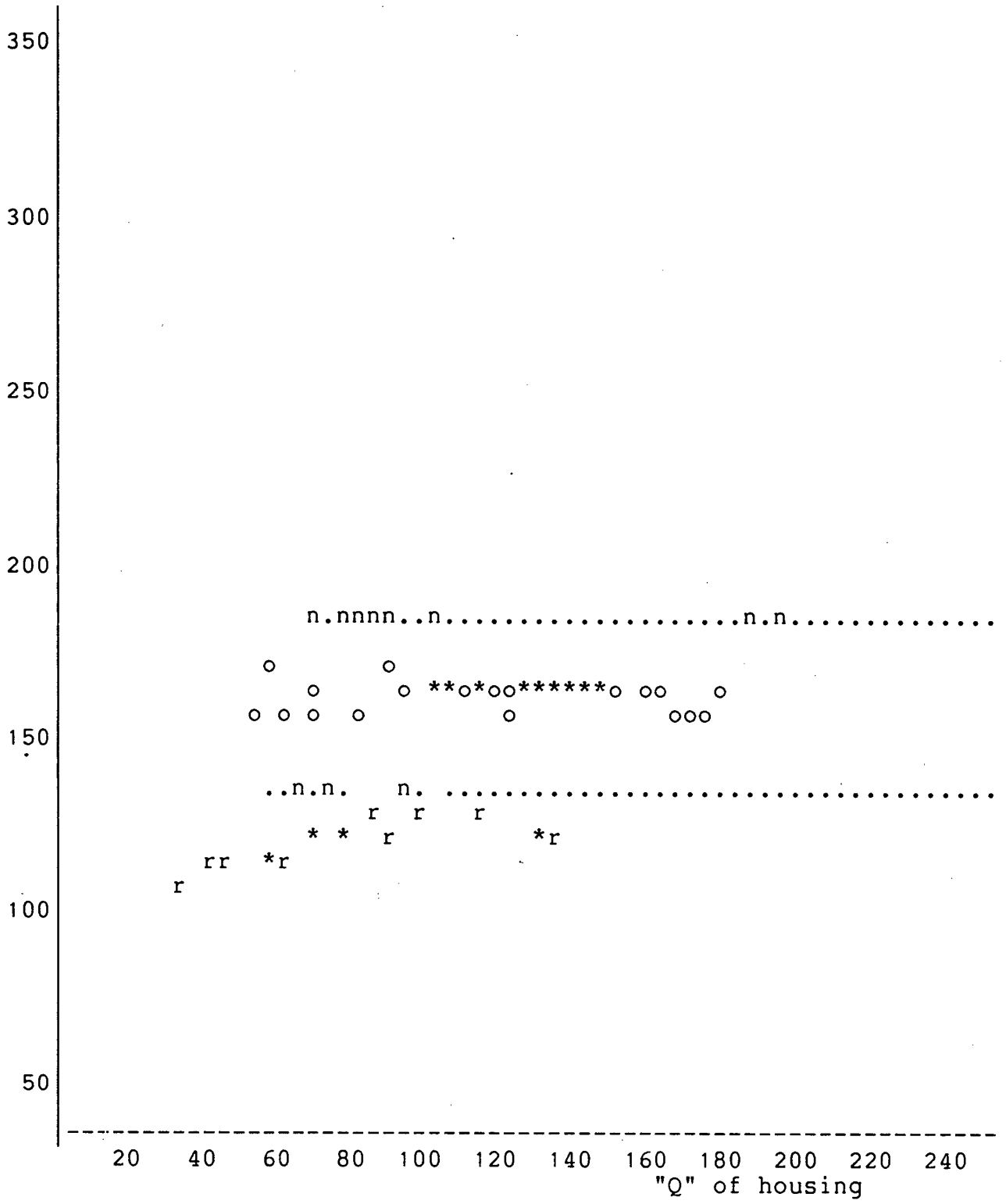


Figure 10: Base Case Price-Quantity Curves (Saskatoon)

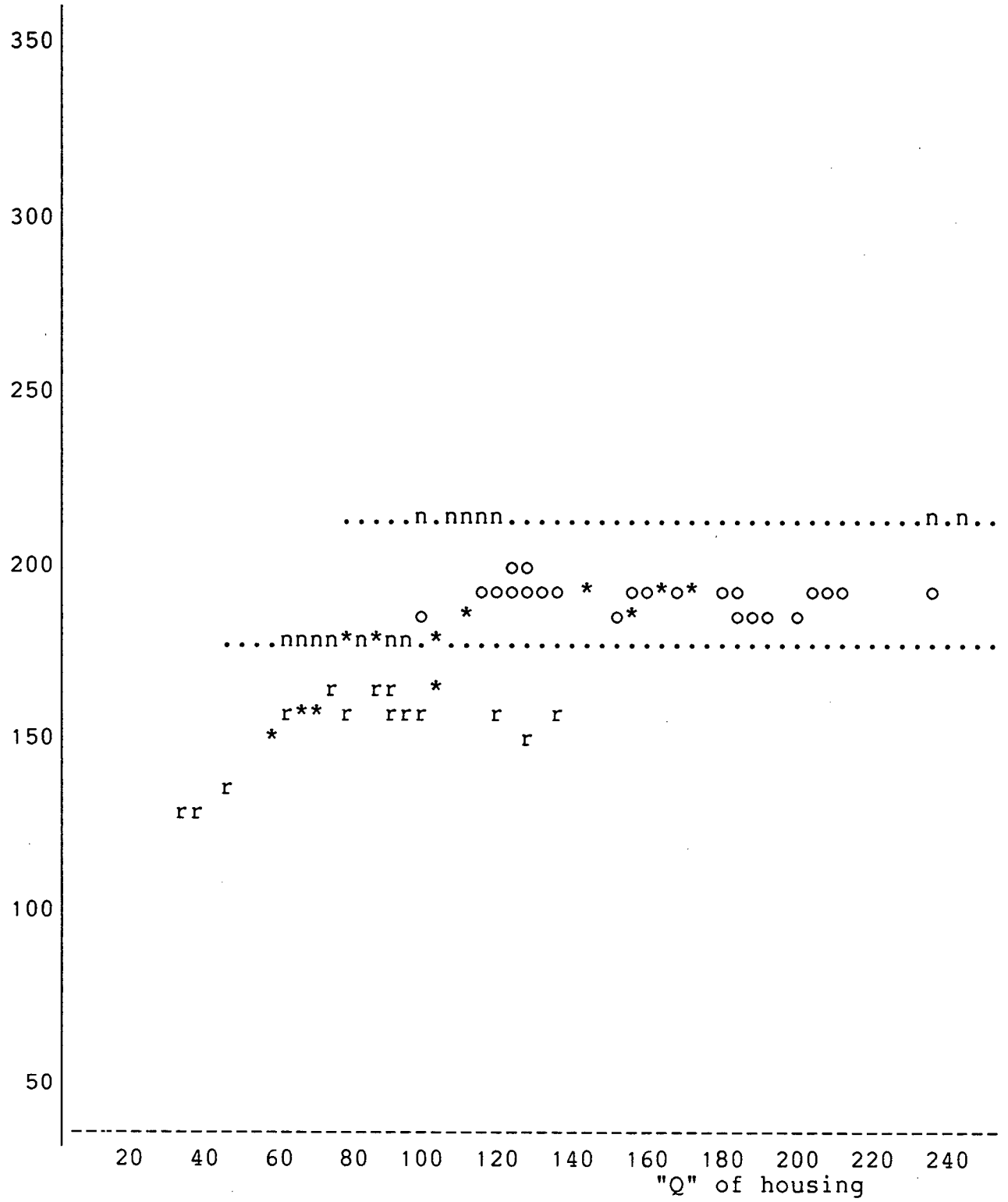


Figure 11: Base Case Price-Quantity Curves (Sudbury)

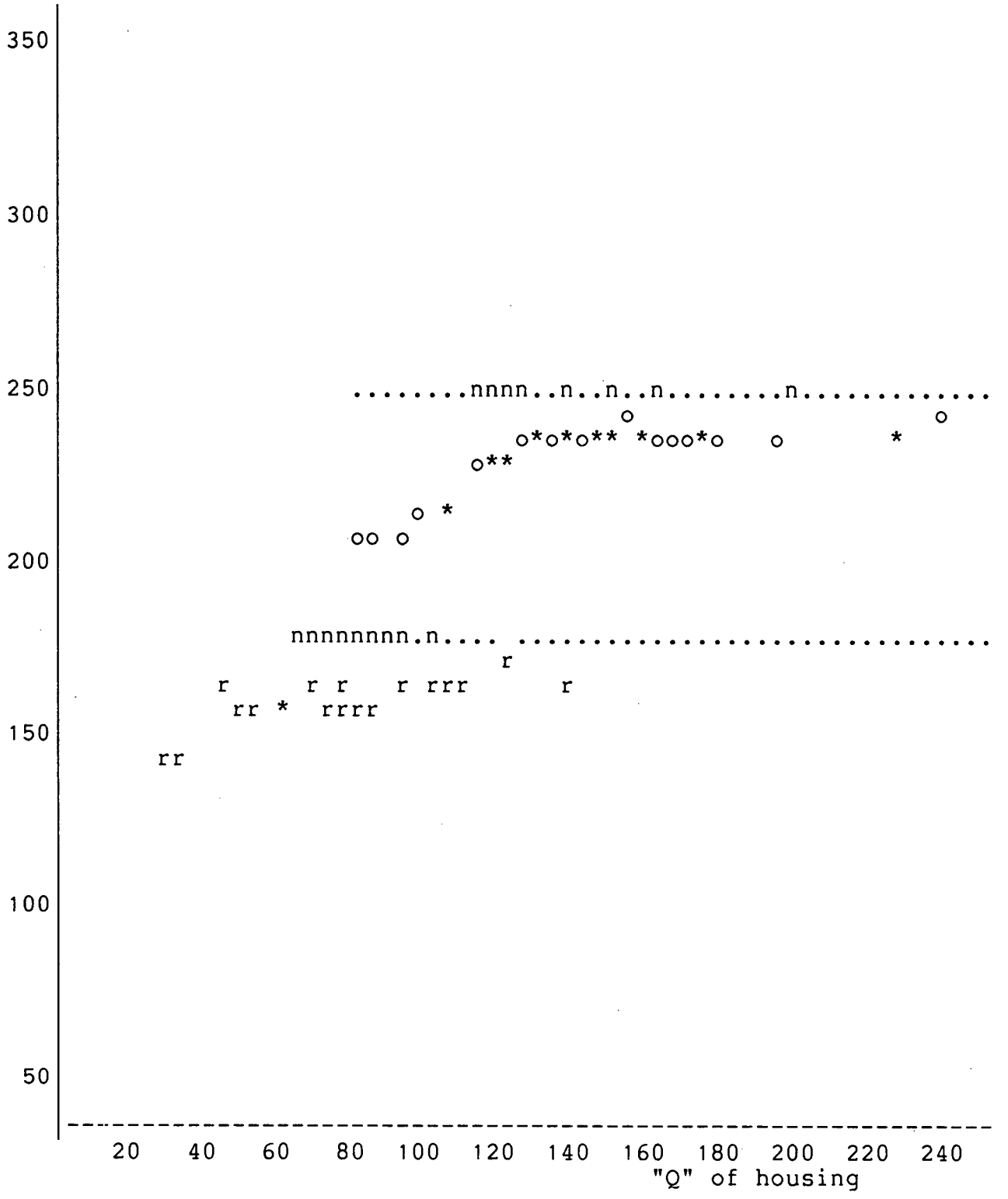


Figure 12: Base Case Price-Quantity Curves (Vancouver)

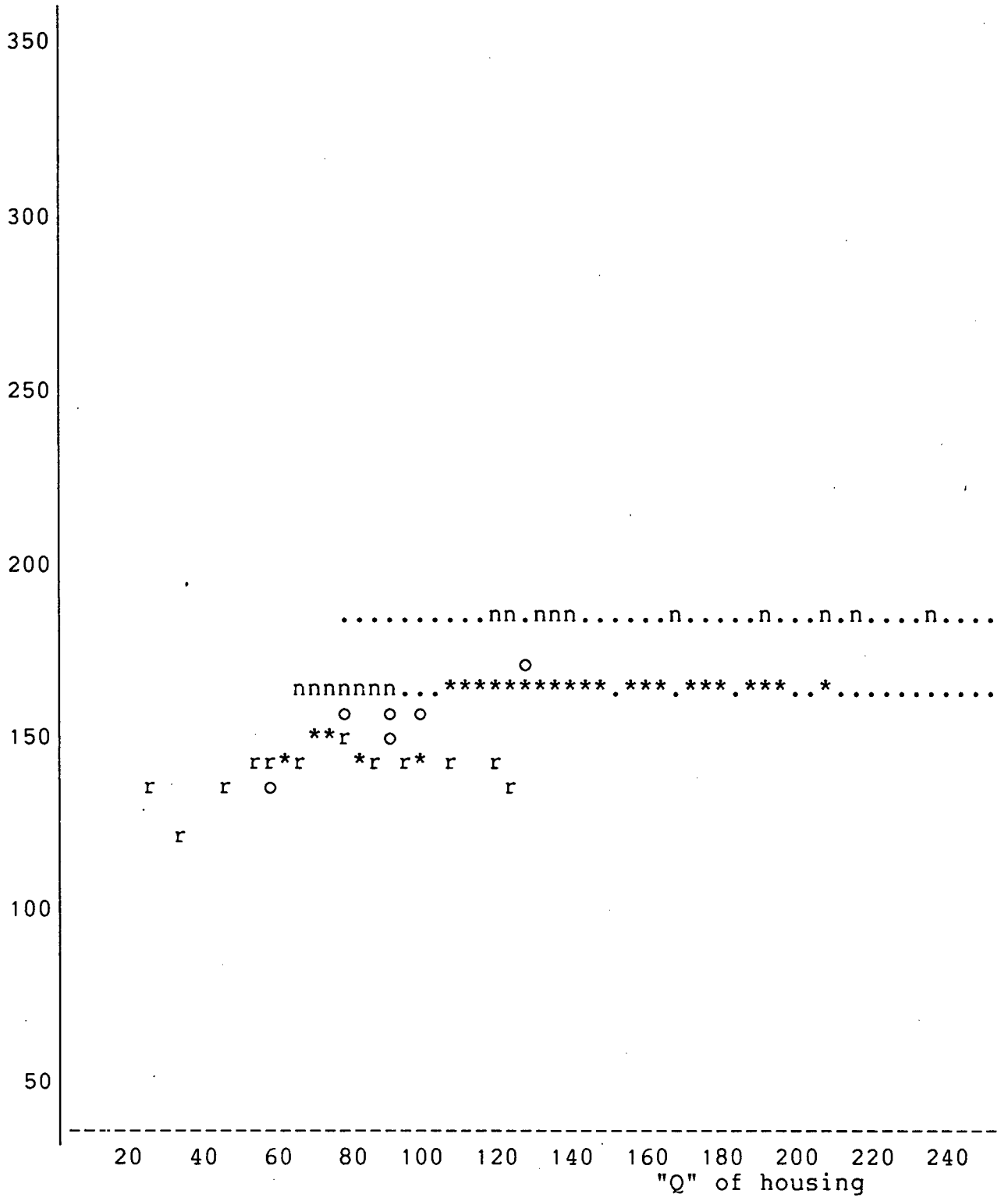


Figure 13: Base Case Price-Quantity Curves (Winnipeg)

CHAPTER 07: POLICY SIMULATIONs and ANALYSIS

In order to quantify the probable costs of supporting a minimum standard of housing under the six policy alternatives introduced in Chapter 2, the simulation model has been modified to "force" all households to consume at least a required minimum quantity of housing. This involves the subsidization of those households which would by choice consume less than a specified minimum quantity of housing. The simulation procedure consists of the calculation of the subsidy required to allow the household to consume the required minimum quantity in accordance with the applicable subsidy formula for the policy form on an individual household/dwelling basis. During the allocation/solution process the households are then forced to select any available unsubsidized dwelling in preference to a dwelling requiring a subsidy and then selecting the subsidized dwelling with the smallest required subsidy. As such the procedure estimates the minimum subsidy cost that would be incurred.

Before proceeding with the policy simulations a few notes of caution are in order concerning the limitations that must be placed in the subsidy cost estimates derived;

1. the nature of the supply system leaves an uncomfortably large range of uncertainty regarding the responsiveness of the existing stock to subsidy stimulation.
2. the model is restricted to a ten year interval and available data necessitates the simulations be performed over the decade of the 1960s.
3. the level of aggregation associated with the model limits its marginal sensitivity to the introduced policies particularly at the zonal level. Policy implications by broad groupings (high quality versus low quality housing, rich versus poor households) are the finest level at which attention to results is warranted.

4. on the demand side, behaviour simply consists of choosing between housing and other goods and services, and among the submarkets. The model ignores the possible effects of the subsidy on work incentives or on household formation.

5. on the supply side the model restricts itself to the markets for new and existing housing, assuming an unrestricted supply of the former. There is no treatment of the basic determinants of land costs or the intricacies of the land market as it affects the housing market.

6. with policy simulations it does not allow noncompliance with policy regulations or with noneconomic influences on household responses; e.g. psychological reasons might lead a household to decline participation even though it stands to gain economically from enrolling.

7. subsidy costs do not include administration costs; typically the more constraining the policy, the higher the cost of its administration.

This model, like all models, contains many simplifying assumptions designed to make it manageable in terms of preparation and use. Thus one should not expect the reported results for an individual CMA to provide precise information on the absolute magnitude of the subsidy costs. The nature of the supply functions,in particular their inherent price responsiveness, create the greatest area of uncertainty with regard to the reliability of the evidence that can be derived on the relative performance of the alternative forms of intervention. Evidence obtained from simulations indicates that as the supply functions become more inelastic both total costs and the percentage margin between the costs associated with the income-oriented policies and the direct product-oriented policies increases. Thus in selecting a supply system with a high price responsiveness for the policy simulations, the derived costs may underestimate the actual costs associated with the policy. To test for the impact of the supply elasticities the policy simulations have been run using both the detailed modified model and a Canadian Version of the original UI model

which incorporates supply functions more inelastic than those associated with the modified model.

7.1 Performance Measures

The central concern of this thesis is to provide estimates of the costs to the government that would be incurred if housing programs were structured to reflect one of six potentially alternative general policies. The major explanation for the difference in the incurred subsidy costs will lie with the "market efficiency" of the policy. In order to evalute subsidy efficiencies, Carlton and Ferriera (1977, p228) suggest two alternative measures. One is the "recipient expenditure" or "earmarking ratio" (ER), which measures the change in housing expenditure among recipients per dollar of allowance cost. It indicates the percentage of the subsidy dollars received actually used for increasing housing expenditure. The other, which they term a "market efficiency" measure, is a cost-standardized measure of housing change within submarkets. It measures the percent increase in the quantity of housing consumed in selected groupings of households, normalized by dividing by the average net dollars transferred to recipients. Carlton and Ferriera group their "model" household into the bottom sixth and the bottom third, with normalization being in terms of the transfer to the bottom third households. Their example of a "market efficiency" measure of 0.30 for the bottom third indicates the following: for an allowance program that involved an average net transfer of $20 per month to each household in the bottom third, the measure of 0.30 indicates a 6% rise in the average housing consumption within the bottom third

of the market. The normal value range for the "market efficiency" measure is from zero to two. For example, a program that produces no change in housing consumption would have an efficiency of zero. A program which left housing prices unchanged and for which recipients spent their entire allowance on an additional quantity would have an efficiency of approximately 2.0.

7.2 Implementation of the Policies

The standard procedure used by the Urban Institute to implement demand side subsidies involved rerunning the model with incomes adjusted to reflect the applicable subsidy. Supply side subsidies were simulated by adjusting the price per unit of housing services for new dwellings (PN). The differences between the predicted decade-end housing market conditions with and without the allowance are then interpreted as a measure of the change that would have resulted if the particular subsidy had been in effect during the ten years.

For this study the model has been modified so that all subsidy amounts are calculated internally. The procedure utilized involves specifying the required minimum quantity of housing services to be consumed (separate values for owner-occupiers and renters) with the model calculating for each individual dwelling either the required income level at which a household would choose to consume the minimum quantity or the price discount required so that the household would, by choice, consume the minimum quantity. In the former cases, the subsidy is taken as being the required increase in income; in the latter, the subsidy is the cost of providing the price discount. The following section briefly reviews the method used for each of the six alternative policy forms considered.

a) Income Subsidy. An income subsidy is taken as the difference between the income level at which the household would choose to consume the required minimum quantity and its unsubsidized income level. In calculating the subsidized income the expenditure share is adjusted in an iterative process to reflect the share's dependence on prices and the income level.

b) Constrained Cash Subsidy. The constrained cash subsidy corresponds to the Income Subsidy but with the maximum subsidy amount limited to the household's expenditure on housing. That is, the maximum subsidy amount made available corresponds to the minimum quantity times the per unit price at which the dwelling will supply the required minimum quantity.

c) Direct Constrained Subsidy. This subsidy form corresponds to the theoretical formulation where households, in being subsidized to consume the minimum quantity of housing, are made no better off (i.e. they remain at the same utility level). Because very low income households tended to be forced from the market under this severe constraint, the simulations have been performed under a "minimization of utility increase" constraint. The impact of the lessening of this constraint ia an increase in the average subsidy amount of the order of 5% to 10%.

d) Direct Quantity Subsidy. This form of subsidy involves providing the household with an additional quantity of "housing services" directly. The quantity provided is the difference between the minimum quantity and the level that would be demanded if unsubsidized. The subsidy amount corresponds to the increase in quantity times the market price at the minimum quantity. This results in the household paying for any resulting price inflation associated with its unsubsidized level of consumption.

e) Direct Expenditure Subsidy. This subsidy is comparable with a direct quantity subsidy except that the household is compensated for the full increase in expenditure required. The subsidy amount corresponds to the difference between the cost of supplying the minimum quantity and the expenditure the household would make by choice.

f) Direct Price Subsidy. The calculation of this subsidy amount involves reducing the effective price to the household until it will consume the required minimum by choice. The required subsidy is the difference between the supply cost for the minimum quantity and the household's expenditure at the reduced price.

The major problem encountered in simulating the policy alternatives was with regard to the selection of meaningful minimum quantity values. The variability of the unit of "housing" service between CMAs and the heterogeneity of the housing stock make it difficult to provide a correspondence between the model's theoretical notion of a minimum quantity of housing and physical reality. The only reference point available is the model's "minimum quantity of new construction" and consequently the policy simulations have been based on a required minimum quantity that reflects a percentage relationship with the "minimum quantity of new construction". With the model's "infinite" supply of new dwellings the relative positioning of the "supported quantity" constraint and the "minimum quantity of new construction" constraint is a critical consideration. If the supported quantity lies below the minimum quantity of new construction, supported

households will only be able to occupy "renovated" dwellings from the existing stock. If the two constraints match, supported households can consume services from new or existing sources. In order to test for the significance of the relative positioning of the "supported quantity" and the "minimum quantity of new construction", four different scenarios have been simulated for each CMA of which two reflect situations where support is restricted to the existing stock only and two allow recipients to occupy new dwellings also.

Since the simulation model utilizes only 100 model representations a 1% participation rate corresponds to one model household receiving a subsidy. Consequently the quantum nature of the model, which prevents fractional participation rates, will distort the derived costs of intervention if participation rates are low. The lowest supported level has been set at a quantity corresponding to 85% of the new construction quantity. This quantity results in a participation rate ranging from 2% to 5% across the eight selected CMAs. Two scenarios with the minimum quantity at 99% and 100% of the new quantity respectively were included to evaluate the impact of the constraint on the availability of new dwellings to subsidized households. The scenarios offer comparable levels of support but with the first case all subsidized households must occupy existing dwellings; in the latter new dwellings may be occupied. The final scenario is at 115% of the new construction quantity to allow the evaluation of the same percentage change in the minimum level above and below the 100% of the new quantity level.

7.3 Simulation Results

The simulation results obtained from the simulation models show important differences from those one may anticipate from a static analysis of the behaviour of a single household. A major reason for this fact is that the simulations reflect the net effect of a mode of intervention on several isolated, but interdependent submarkets and on a mixture of households with different characteristics and income levels. Significant differences in response to similar subsidy forms occur across the eight selected CMAs, reflecting differences in recipient and submarket concentrations and the relative positioning of the price for new and existing "housing" services.

With the uncertainty associated with implementation of the model, care must be taken in both interpreting the results from the individual policy scenarios and undertaking comparative analyses between CMAs. It should be remembered that the simulations are based on dated Census and SHU data and the results presented do not necessarily represent the outcome that would happen if the policy intervention occurred today. First, the model is a long run model and attempts to provide an estimate of the long run impact of the policy. Thus, in interpreting the results it must be kept in mind that short run fluctuations in prices and rents, for example, which might result from a rapid introduction of programs cannot be estimated by the model. Second, the data for the model represents the period 1961 - 1971, not the immediate past decade. It is therefore the characteristics of the individual CMA over this 1961 -1971 period rather than current characteristics that the simulations are based on.

A review of the overall performance of the policy simulations indicates a consistent relative performance, in terms of cost, of the alternative policy options. For all CMAs the costs reflect a ranking of the income policy first, followed by the constrained cash, then the direct quantity, expenditure and price policies with the direct constrained policy, as expected, with the lowest cost.

Static analysis would suggest that the average cost under a direct quantity subsidy would be less than for a comparable scenario under a direct expenditure subsidy. The results obtained from the model for some CMAs tend to indicate the opposite. In the most part these results arise from the dependence of the household's expenditure share on its income level. During the calculation of subsidies an iterative solution process is utilized wherein the expenditure share is recomputed to reflect changes in the after-subsidy income level and changes in the price and quantity of housing consumed. The direct expenditure scenarios have been estimated with the household facing its pre-subsidy price and quantity; the other direct product scenarios are based on the resultant price and quantity and as a result typically reflect a lower expenditure share factor and higher required subsidies. The magnitude of the level of support under comparable policies varies significantly across the CMAs, but with the tentative method by which the "minimum quantity of new construction" and consequently the levels of support are derived, one cannot place any importance on an inter-CMA comparison of the average subsidy costs and participation rates. This problem, combined with the nature of the supply system, the long-run format of the model and the use of data from the 1960 decade means that the only strong conclusions that can be drawn from the results are with regard to the relative

magnitude of the cost margins and the indicated percentage subsidy leakage to the consumption of other goods and services. Within these restrictions the subsidy leakage and the cost margins between the "income" policy and the three general "direct product" options; the "direct quantity", the "direct expenditure" and the "direct price", are of greatest interest.

It should be noted that as formulated the "direct expenditure" policy theoretically represents a situation where the household receives the difference between what it would spend on the dwelling it occupies and the required expenditure at the supported quantity level; a one hundred percent earmarking of the subsidy. The variations in the reported results occur because the policy performance criteria compare the subsidized solution to the non-subsidized base solutions detailed in Chapter 6. Consequently as recipients switch from the dwelling they occupied in the base solution to an alternative dwelling the earmarking coefficient may indicate a subsidy leakage.

The following section provides a brief review of the performance of the alternative forms of intervention across the eight selected CMAs as derived using the modified model. Additional detailed results, derived using both the modified model and a Canadian Version of the original UI model, that include participation rates and efficiency and earmarking coefficients are shown on a CMA basis in APPENDIX Section A5.01.

7.31 Performance of the Individual CMAs

a.) Calgary. In 1971 Calgary had a reported population of 403,319 with approximately 121,100 households. During the 1961-71 decade it had one of the highest rates of population growth, but income growth lagged behind the median for the CMAs.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	115.2	29	278.8	11	50.8	39	84.1	33
constrained cash	73.0	46	58.3	53	46.4	43	73.1	38
direct constrained	9.2	364	11.1	201	3.0	678	4.8	634
direct quantity	38.2	87	35.0	88	22.9	87	32.2	87
direct expenditure	33.5	100	31.1	100	22.1	91	29.8	94
direct price	29.1	115	28.0	112	17.1	117	23.9	117
% households subsidized	2		4		5		8	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 25: Average Monthly Subsidy and Earmarking Coefficients [Calgary]

The results presented typify a CMA where there is a substantial price discount per unit of housing in the low-quality submarkets. This results in the average subsidy costs (column [1]) associated with the "existing stock" only scenarios being significantly higher than those where recipients can occupy new dwellings. In particular, a comparison of the 99% and 100% scenarios indicates the critical importance of the new construction

constraint especially with regard to the "income" policy; the cost when upgrading arises from the existing stock only is indicated to be in excess of 500% greater than the cost when new dwellings are made available.

The potential variation in subsidy leakage at various levels of support is indicated by the "income" policy. With 29% and 11% earmarking coefficients respectively, the "existing stock" only scenarios are outperformed by the 100% and 115% scenarios at 39% and 33% as a result of the constraint on the availability of suitable dwellings. These differences occur as a result of a limited supply of existing dwellings suitable for upgrading.

A comparison of the 85% and 100% scenarios indicates the relatively consistent performance of the alternative policies. In particular, the average costs under a "direct quantity" or "direct expenditure" option in both scenarios correspond to approximately one-third those for the pure income option. Under the 99% scenario the income option compounds the limited availability of suitable existing dwellings with the "direct product" options costing, at most, 15% of the cost under the "income" option. The "constrained cash" option, with the subsidy amount limited to the expenditure on housing, has an average cost consistently twice that under the "direct product" subsidy.

In summary, the simulations for Calgary highlight the potential drastic impact of a constrained supply of housing under a pure income policy, the advantage of constraining such income subsidies to the expenditure on housing and the consistent performance of the "direct product" options.

b.) Kitchener. This CMA, with a population of 226,846 and approximately 66,500 households in 1971, showed above average growth in both population and income during the 1960s. It had a relatively low 12.7% of its households with incomes under $5,000 in 1971 and displayed a stable distribution of the existing stock without price discounting at the lower end of the market.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	64.7	41	74.7	38	86.4	37	320.4	12
constrained cash	61.8	42	69.0	41	75.4	42	159.9	23
direct constrained	17.6	296	16.9	250	7.4	421	5.1	516
direct quantity	28.3	93	41.2	86	34.5	85	35.1	81
direct expenditure	30.5	101	33.2	99	31.0	95	40.2	88
direct price	21.4	124	23.6	120	27.0	118	35.9	104
% households subsidized	2		5		6		25	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 26: Average Monthly Subsidy and Earmarking Coefficients [Kitchener]

Unlike Calgary, the four scenarios for Kitchener reflect a steady increase in the average subsidy (column [1]) as the supported quantity is increased. The only exception is the "direct constrained" policy where the support required for the two "existing" only situations greatly exceeds that for the other two scenarios as a result of the large increases in utility that must be provided to induce the subsidized households to upgrade. The

small margin between the "income" and "constrained cash" options indicates the market's ability to supply the additional housing required without a large price increase. The high participation rate occurring under the 115% scenario is as a result of a concentration of the existing stock in the range of 100% to 115% of the new quantity constraint. Thus while the 15% increase in the supported level in Calgary induced less than a 100% increase in the participation rate, the same increase in Kitchener resulted in an increase in excess of 400%.

With Kitchener's stable housing market and above average income growth rate the average margin in the costs under the alternative policies was less than the average for the eight CMAs.

c.) Quebec City. This city was slightly larger than Calgary in 1971, with a comparable growth (below average) in incomes and population, but a slightly higher number of poor households. A major difference, however, lies in the propensity of the households to consume housing. For Quebec City the estimated share of disposable income spent on housing is frequently up to 15 percentage points less than that for comparable household groupings in Calgary.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	66.3	37	90.1	35	99.4	35	159.0	23
constrained cash	51.5	47	66.5	48	73.3	47	109.9	34
direct constrained	10.1	283	12.9	275	9.3	387	9.5	360
direct quantity	32.0	90	39.9	89	39.3	88	40.7	85
direct expenditure	28.6	100	35.5	99	35.5	98	38.7	92
direct price	20.7	117	27.5	116	30.2	115	32.9	113
% households subsidized	5		8		8		15	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 27: Average Monthly Subsidy and Earmarking Coefficients [Quebec City]

As a result of the lower expenditures on housing levels, the relative costs of the subsidies are more modest in Quebec City than in Calgary. Generally, the margin between the costs under the "direct product" and "income" options is only slightly in excess of a factor of 2. The important trend to note is the increasing spread between the costs under the demand orientated options and the supply orientated options as the supported quantity is increased. The increase from the 85% scenario to the 115% scenario under the "income" option is approximately 140% for the average cost; 650% for the total cost. Under the "direct expenditure" option the increase in the average cost is only 47%, while that for the total cost is 315%.

d.) St. John's. In 1971 St. John's had a population of 131,814 with approximately 28,700 households. During 1961-71 it had a below average rate of increase in population and household incomes, and in 1971 had 28% of its households with incomes below $5,000. On this latter basis St. John's was the "poorest" CMA considered.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	119.8	37	273.3	19	100.6	37	149.9	27
constrained cash	86.3	52	101.3	51	77.0	48	117.7	40
direct constrained	12.6	258	20.7	229	21.2	180	21.7	213
direct quantity	37.7	86	41.0	90	40.0	92	44.1	92
direct expenditure	31.6	103	46.7	102	37.2	98	43.7	95
direct price	36.1	124	44.1	117	31.2	119	37.1	116
% households subsidized	5		8		10		16	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 28: Average Monthly Subsidy and Earmarking Coefficients [St. John's]

As with Calgary, this market has a substantial price discount per unit of housing in the low-quality submarkets. Consequently, under the "income" policies the "existing stock" only scenarios reflect average costs greater than those arising when new dwellings are made available. Thus while the margin between the "direct product" and "income" options for the 85% and 99% scenarios respectively is a factor of 3.5 and 6.0, the corresponding margin for the 100% and 115% scenarios is only 2.5 and 3.0. St. John's

provides a good example of the potentially high costs associated with attempting to upgrade (support) housing standards in a "poor" city through income subsidies.

e.) Saskatoon. Saskatoon had a 1971 population of 126,449 with approximately 38,600 households. During the decade population growth was above average while income growth was below the median. Approximately 20.7% of households had 1971 gross incomes below the $5,000 mark.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	34.9	39	64.7	35	62.2	37	136.6	22
constrained cash	33.6	41	60.1	38	58.9	39	107.8	28
direct constrained	2.6	522	5.5	434	4.0	577	5.1	578
direct quantity	15.5	88	26.2	91	25.8	89	31.8	89
direct expenditure	13.6	101	23.1	103	23.9	98	29.7	95
direct price	11.3	122	19.0	121	18.8	122	25.8	118
% households subsidized	5		8		8		15	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 29: Average Monthly Subsidy and Earmarking Coefficients [Saskatoon]

For this CMA the performances under the 99% and 100% scenarios were all but equal as a result of a ready supply of "upgradable" existing dwellings. The stability of the market and the supply of such dwellings results in low average costs under all the "direct

product" options, while costs under the "income" option compound as the supported level is increased. The result is that the margin between the two options increases from a cost differential corresponding to a factor of 2.25 for the 85% scenario to a factor in excess of 4.5 for the 115% scenario. As with Quebec City, one finds a significant increase in the spread in the costs as the supported level is increased.

f.) Sudbury. In 1971 Sudbury had a mean household income of $11,990; in excess of $1,500 higher than that for any of the other CMAs. It is also the smallest of the CMAs selected with a 1971 population of 155,424 and approximately 16,500 households.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	7.2	45	41.0	36	44.4	36	109.3	30
constrained cash	7.2	45	41.0	36	44.4	36	100.5	33
direct constrained	0.8	996	1.9	781	2.9	772	4.4	672
direct quantity	3.3	98	17.0	87	18.4	87	40.3	82
direct expenditure	4.2	104	15.2	100	16.4	100	31.9	100
direct price	2.3	140	12.1	123	13.1	123	29.2	114
% households subsidized	2		4		4		7	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 30: Average Monthly Subsidy and Earmarking Coefficients [Sudbury]

As a result of the high average incomes for the CMA (and corresponding lower expenditure on housing shares) the subsidy amounts involved are very low. Even at these low levels the margin between the "income" and "direct product" options is maintained, ranging from a factor of 2.0 through 2.5. Of interest from the Sudbury results is the fact that it is not until the 115% scenario that the constraint on the cash subsidy becomes binding, i.e. costs under the "constrained cash" option are less than for the pure "income" option.

g.) Vancouver. This is the largest of the selected CMAs with a 1971 population slightly in excess of one million and approximately 345,600 households. During the 1961-1971 decade it experienced both relatively high population growth and income growth, but in 1971 still had a relatively high proportion of its households (18.4%) with incomes less than $5,000.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	117.2	27	276.4	14	197.7	19	261.2	13
constrained cash	83.2	38	87.5	45	81.2	39	116.7	29
direct constrained	8.4	379	15.3	255	9.1	332	8.5	424
direct quantity	36.5	87	44.2	88	35.1	91	38.2	88
direct expenditure	32.4	98	39.5	99	33.1	97	36.9	92
direct price	27.7	114	35.1	111	27.2	118	30.0	112
% households subsidized	5		8		8		18	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 31: Average Monthly Subsidy and Earmarking Coefficients [Vancouver]

Vancouver is another example of a CMA with a price discount in the lower quality submarkets. The consequence is that the costs of supporting levels from the existing stock only are greatly in excess of those incurred when new dwellings are made available. The scenarios for Vancouver follow a pattern comparable to that for Calgary with the exception that the average costs associated with the 100% and 115% scenarios are higher as a result of higher "construction costs" in Vancouver. The impact of the higher construction costs is to increase the margin between the "income" and "direct product" options from a factor of 3.5 for the 85% scenario to a factor of 7.0 for the 115% scenario.

h.) Winnipeg. This CMA had a 1971 population slightly in excess of half a million, with below average growth in both population and

average incomes during the decade. In 1971 17.4% of the households had incomes below $5,000; an above average proportion.

Supported Quantity	85%QN		99%QN		100%QN		115%QN	
	[1]	[2]	[1]	[2]	[1]	[2]	[1]	[2]
	$	%	$	%	$	%	$	%
income	71.4	44	273.6	15	92.6	30	277.9	11
constrained cash	59.8	52	88.5	45	67.6	42	118.8	26
direct constrained	19.9	200	23.8	197	13.9	255	9.8	302
direct quantity	43.7	91	46.8	91	31.6	89	36.5	85
direct expenditure	39.7	100	46.7	100	29.8	96	35.7	91
direct price	26.8	117	34.8	115	24.7	114	28.4	109
% households subsidized	5		8		11		23	

note
[1] the average monthly subsidy per recipient
[2] the earmarking coefficient; % of subsidy used to increase housing consumption
[3] supported quantity corresponds to % of "minimum quantity of new construction"

Table 32: Average Monthly Subsidy and Earmarking Coefficients [Winnipeg]

Again a price discount in the lower quality submarkets results in the costs under a 99% scenario being greatly in excess of those under the 100% scenario. The large shift in average subsidy costs between the 85% and 99% scenarios results from the limited supply of "suitable" existing dwellings for upgrading. With these market constraints the margin between the "income" and the "direct product" options varies from a factor of less than 2.0 for the 85% scenario, to a factor of 6.0 for the 99% scenario, down to a factor of 3.0 for the 100% scenario and finally increasing to a factor close to 8.0 for the 115% scenario. These results highlight the sensitivity of the estimated subsidy costs to alternatively the

nature of the housing market and the level of support, but most importantly to the characteristics of the simulation model.

A review of the performance of the individual CMAs highlights the variability of both the impact of the individual policy options and the relative impact as the policy options allow a greater leakage of the subsidy to the consumption of other goods and services. In fact the "earmarking coefficient" under the "income" option ranges from a low of 11% (89% of subsidy leaked) to a high of 45% (55% of subsidy leaked) while those for the "constrained cash" option range from 23% to 53%. When these options are compared with the "direct product" options, with minimal leakages, there are large variations in the cost margin. The actual range on the difference in the costs varies from a low of a factor of 1.72 ("direct expenditure" costs 58% of "income") to a high of 7.69 ("direct expenditure" costs 13% of "income"). The low ratio occurred in the "wealthiest" CMA while the high ratios are typically associated with the 115% (highest) level of support.

The important conclusion to be drawn from the consideration of the performance of policy simulations for the individual CMAs is with regard to the diversity of responses in the different markets to comparable levels of support. As the nature of the existing stock and the households' propensity to consume housing vary from CMA to CMA, so does the net impact of an introduced program. The consequence is that housing policy implementation must reflect the important differences between CMAs. Programs require individual customization for each CMA, suggesting the need for localized housing policies and programs.

7.4 Summary Results

To provide a means by which a typical performance of the alternative policy options across all CMAs can be compared, summary statistics reflecting the weighted average of the individual CMA's simulated costs and performance statistics have been calculated. The weighting has been based on the number of households in the CMA. The data presented in Table 33 provide a comparison of the average cost and the associated earmarking of the alternative forms of intervention as a percentage of the "income" option. Considered are the 85% of the new quantity constraint scenarios (representing scenerios where subsidized households cannot consume new stock) and scenarios at a subsidy level equal to the new quantity constraint (representing scenarios where subsidized households have access to the new stock). The 99% scenarios have not been considered because of the severe distortion introduced in some CMAs by a limited supply of suitable existing dwellings. The 115% scenario has also not been considered as it involves participation levels in excess of reasonable expectations.

It should be noted that since the selected CMA sample was not derived on a statistical basis these results should not be intepreted as a true indicator of the expected overall performance for Canada as a whole.

Supported Quantity	85%QN		100%QN	
Policy Type	Average Subsidy	Earmarking Coefficient	Average Subsidy	Earmarking Coefficient
	%	%	%	%
income	100.00	100.00	100.00	100.00
constrained cash	76.50	121.70	71.40	124.70
direct constrained	13.60	1102.80	9.60	1332.50
direct quantity	39.40	240.90	33.70	262.80
direct expenditure	35.90	270.10	31.20	286.10
direct price	29.40	325.40	25.80	350.00

Table 33: Percentage of "Income" Policy Option Values
[Weighted Average for the Eight CMAs]

The average subsidy values in Table 33 provide a direct comparison of the the difference in cost between the policy options. That is, the average subsidy cost for the "constrained cash" option under the 85% scenario is only 76.5% of the corresponding cost that would be incurred under the "income" option. Correspondingly the average subsidy cost for the "direct price" subsidy is only 29.4% of that for the "income" option. The presented values for the "earmarking coefficients" reflect the percentage increase in the amount of the subsidy used on housing over that associated with the typical "income" policy option. That is for the 115% scenario, under the "constrained cash" option the earmarking coefficient is 24.7% higher, while that for the "direct price" option is 250% higher.

Drawing from the simulated costs, the indicated average percentage leakages for the six policy options are as in Table 34.

Supported Quantity	Percentage Subsidy Leakage to Other Goods and Services	
	85%QN	100%QN
	%	%
income	62.6	66.2
constrained cash	54.5	57.8
direct constrained	-312.6	-350.5
direct quantity	9.9	11.1
direct expenditure	-1.0	3.3
direct price	-21.7	-18.3

Table 34 : Percent Loss of Subsidy to Other Goods and Services [Average for all CMAs]

A negative percent loss indicates situations where households reduce the consumption of other goods and services to meet part of the increased payment for their housing services. That is, the constraint on the minimum housing standards is forcing an increase in the household's own expenditure on housing to above their pre-subsidy expenditure on housing.

These statistics indicate the large leakage and the associated "inefficiency" of income oriented policies in matching solely a minimum housing standard. That is, while the two alternative "income" oriented policies result in a subsidy leakage in the range of 55% to 65%, the leakage associated with the "direct product" options is minimal.

7.5 A Comparision of the Policy Options

In simulating the impact of the alternative forms of government intervention, the technique of utilizing a minimum quantity constraint allows one to effectively normalize the alternative scenarios in terms of changes to the housing stock as reflected by type, quantity and price. For a given CMA a given subsidy level in effect represents a constant decade-end state for the market with the presented subsidy amounts indicating the average cost per household to the government of achieving this given state via the alternative forms of intervention.

The most generous form of government support of the housing market lies with an "income" policy wherein housholds are provided with sufficient income to consume the minimum quantity of housing by choice. The other end of the scale is indicated by the "direct constrained" policy option. This constrained policy option is formulated under the assumption that the government would compensate households forced to increase their level of housing consumption to conform to the imposed minimum quantity. The compensation level (subsidy) would be such that the household would still achieve the same level of overall satisfaction but typically involves reducing their consumption of other goods and services to meet part of the increased expenditure on housing.

The simulated difference in cost between these two alternatives, as indicated in Table 33, corresponds to 85% to 90% of the cost under the "income" option. That is, it could cost the government at least ten times more per annum to support housing standards via an "income" policy than would be necessary under the "direct constrained" option.

The computed margin between the "income" mode and the "constrained cash" (housing allowance) option varies significantly on an individual CMA basis and is particularly sensitive to the supported minimum quantity level. Generally the more pressure placed on the upgrading of the existing stock the greater becomes the margin induced by the expenditure constraint. The average cost under the "constrained cash" subsidy is in the order of 75% of that under the pure "income" option but the range on an individual CMA basis reaches to a low of 25%.

Generally the perfomances of the "direct quantity" and "direct expenditure" policy options are comparable with the required subsidy costs being approximately one-third of those for an "income" policy. These policies involve programs that most closely approximate a zero subsidy "leakage" situation with households compensated only for the required increase in housing consumption.

The "direct price" subsidy, as formulated in the model, tends to encourage households to forego the consumption of other goods and services and consequently the required subsidy tends to be less than under either a "direct quantity" or "direct expenditure" option. In simulations based on a Canadian Version of the original UI model (details of this model are shown in APPENDIX Section 1) the reverse situation tends to result; the cost of the price subsidy was greater than that for the other two. This switching highlights the sensitivity of the estimated costs to both the characteristics of the model's supply and demand functions and the actual implementation of the subsidy formulation in the model.

The major uncertainty with regard to the specification of the model lies in the supply of housing services from the existing stock functions. As implemented, the supply function formulations

provide relatively elastic responses to price increases. The Urban Institute, in their policy simulations, were troubled by their inability to define a suitable elasticity parameter for their supply functions (de Leeuw and Struyk (1975, p126)) and elected to perform their simulations with two sets of supply function parameters, reflecting alternatively elastic and inelastic responses. The elasticity of the supply function is of greatest importance when considering scenarios where the supported minimum is less than the minimum quantity of new construction; all subsidized households will occupy "upgraded" existing dwellings and consequently the subsidy cost will be strongly dependent on the cost of upgrading. To test for the importance of the elasticity of the supply functions on the relative performance of the policies, simulations were performed with the Canadian Version of the UI's model. The results obtained indicate that as the inelasticity of the supply functions is increased the net effect is one of increasing the spread between the costs of the demand and supply oriented policies with the margins being potentially twice those obtained under the modified model.

It should again be emphasized that the computed costs of subsidization do not include any allowance for administration costs, nor do they include any consideration of any costs resulting from "poor" market information and/or program design.

In summary, it can be suggested that a general "direct product" oriented policy, with the subsidy tied directly to the change in the quantity of housing consumed (supplied), will result in typical costs of at most only one-third of those associated with a general income policy. In the extreme the indicated costs of a "direct constrained" policy suggest that with imaginative program

design the actual direct subsidy cost for housing, net of administration costs, could be reduced to as little as one tenth of those associated with a pure income oriented policy.

The key to the cost efficiency of the direct product forms of intervention is that the subsidy is targeted to the increase in housing consumption, minimizing the leakage of the subsidy provided to the consumption of other goods and services. In implementing programs to meet the requirements of such policies the difficulty lies in ensuring that the subsidy is provided to the dwellings with the lowest marginal cost of upgrading. An inter-CMA comparison of the relative performance of the 99% scenario (where the upgrading will be in the form of the renovation of the existing stock) and the 100% scenario (where upgrading can be in both the existing and new stock) highlights the importance of the state of the existing stock in determining suitable programs for the individual CMAs. In five of the eight CMAs considered the total subsidy required to provide the necessary upgrading from existing stock only (99% scenario) was in excess of the total cost when new construction was also used (100% scenario) to meet upgrading requirements. For two of the CMAs the costs under the 99% scenario were in excess of three times those for the 100% scenario. The nature of a suitable program structure will consistently vary from CMA to CMA, particularly in terms of the state of the existing stock. Some CMAs with a sound upgradable existing stock will be best served by programs along the lines of the present Residential Rehabilitation Program, while others will be better served by programs that aid in new construction in addition to renovation activity. The important fact is that each CMA will be best served by a different <u>series</u> of interrelated programs which target varying subsidy amounts to

alternatively renovation and new construction activity.

The ad hoc formulation of the supply of housing services from the existing stock functions incorporated in the model limits any refinement of the simulations to consider program structure. Ideally one could consider alternative combinations of programs focusing on renovation and new construction activity, but the model's structure (with only 100 model representations) prohibits such detailed analysis as the quantum participation rates distort any attempt to differentiate between programs. Further, the uncertainty associated with the true price responsiveness of the upgrading of the existing stock would leave such estimates meaningless. To refine the estimates of the costs that would be associated with alternative programs, strong evidence on the true long run responsiveness of the existing stock is required. Detailed information on repairs and renovation activity is necessary to obtain such data.

Not only are there major differences in the costs associated with alternatively income oriented and direct product oriented forms of intervention, but there are also major differences in the manner in which they can be implemented and the necessity for the continuity of the commitment. Both the pure income and the constrained cash (housing allowance) forms of policy require a continuity of payments, regardless of the state of the general economy in order that the recipients can meet their day-to-day expenditures. Direct product forms of intervention do not necessarily require such a continuity of payments. The subsidy can be in the form of a front-end lump sum payment allowing the matching of the support of housing standards to the general welfare of the country.

The policy simulations have been based on six theoretical policy options to cover a continuum from pure cash (income) subsidies to direct product intervention. The two selected "cash" subsidy benchmark options reflect program structures wherein the recipient is provided with a cash grant potentially on a monthly basis or through a negative taxation program. The difference between the two policy options lies only in terms of the maximum amount of the subsidy for which the recipient is eligible: the delivery mechanism may be identical.

The policy options considered as "direct product" approaches are more arbitrary in nature, reflecting alternative benchmarks and may not, in fact, be capable of representation by administratively feasible programs.

Programs that have the net effect of reducing the unit price paid by the recipients are reflected by the "direct price" policy scenarios. Counterpart programs would include those that reduce mortgage interest rates for owner-occupiers and reduce monthly rents for tenants.

The three remaining "direct product" options simply reflect varying levels of support under potentially identical program structures. Here the major difference lies in the means by which the net amount of the direct subsidy is calculated. The most common form of program would involve either a front-end subsidy or monthly subsidy payments so that the recipient pays the market price for only a part of his housing consumption. One would not expect to implement programs that precisely detail the quantity or expenditure margins for individual housholds but would design programs whose average effect would be as represented by the

concepual policy alternatives. Furthermore, certain program structures (in particular those that are self-funding or require a delayed repayment of the subsidy) may reflect characteristics of each of the alternative policy options as the program moves through its life cycle. For instance the program may on implementation reflect characteristics of a "direct expenditure" policy with the recipients maintaining their presubsidy consumption level for other goods and services. If incomes do not rise over time to meet repayment clauses the net effect may be one of a long run reduction in the consumption of other goods and services, approximating a "direct constrained" policy option.

The only available direct market evidence on the relative cost of alternative forms of housing market subsidisation is that obtained from the US Experimental Housing Allowance Programs (HUD (1976)). These experiments were structured to allow the evaluation of alternative forms of transfer payments. The evidence derived relates in the main to the potential impact during the phasing in of support and lacks any strong evidence on the differential impact of comprehensive sets of programs that would be structured under the general policy options considered in this thesis.

7.6 The Dollar Effect

What are the implications of the computed cost margins on a national basis? There are currently in excess of 8,280,000 independent households in Canada (based on 1981 Census Statistics) and with a 5% participation rate a subsidy program would involve approximately 400,000 households. At a minimum current cost of $30.00 per month, on average, to support even the smallest improvement in the level of housing consumption via a "direct constrained" policy format, the annual current cost would be in the region of $155 million. The comparable cost for a general form of "direct product" subsidy would be close to $460 million. The total subsidy bill under an "income" oriented policy approach will be in excess of $1,150 million.

To support a more desirable level of housing, comparable to the minimum standard for new construction, the required average monthly subsidy cost per household under a "direct constrained" policy approach will be in the order of $150.00, with approximately 8% of the households supported. On this basis some 660,000 households will require subsidies at an annual cost of $1,200 million. The matching "direct product" costs would be in the region of $3,600 million while an "income" oriented policy would require a total subsidy bill in the order of $10,000 million. These amounts contrast sharply with 1980 budgetary expenditure allocations to housing of $997 million and the total 1980 borrowing from government under the National Housing Act of $1,569 million (1980 Canadian Housing Statistics, Table 27).

Current forms of support can be most closely aligned with a "direct constrained" form of intervention because of their potential overall impact on recipients. The stop-start nature of programs oriented towards the owner-occupier market typically results in a subsidized household's level of housing services consumption taking quantum leaps forward, with a corresponding increase in welfare. But as the support is withdrawn, the household is left allocating an increasing proportion of its budget to housing. In the long run households are left consuming a higher quantity of housing, a lower quantity of other goods and services and are, in effect, back to a pre-subsidy level of overall welfare. The net long run effect is that the household is left consuming more housing but fewer other goods and services with only a marginal change in overall satisfaction. The shortcoming of these programsis not in their format but is that they have been implemented on a national basis. As suggested by the diverse performance of the individual CMAs, decentralized program design and implementation can but help to improve the overall efficiency and effectiveness of subsidy programs.

Consequently, in implementing programs to support housing standards per se, the important factors are:

1. the programs should be designed and implemented on a regional basis with their structure and magnitude of support reflecting local market conditions, and
2. consideration must be made of shifting support between the existing stock and new construction, as market conditions vary over time, to match minimum marginal costs of stock upgrading.

CHAPTER 08: REVIEW and CONCLUSIONS

The aim of this thesis has been to quantify the costs and efficiencies associated with alternative forms of long term government intervention into Canadian housing markets. This has been achieved through the use of simulation models derived from development work undertaken in the United States by the Urban Institute (UI) of Washington, D.C. The UI's model has been utilized in the U.S. to examine the market impacts of conditional demand side subsidies for several U.S. cities with reasonable success and it offers the advantages of simplicity, theoretical soundness, portability and a flexible underlying submarket structuring. The initial work associated with this study has involved both the conversion of the original U.S. model for use in the Canadian context and the enhancement of the capabilities of the model. The major conversion modifications made were to reflect differences in data availability and market structures between Canada and the U.S. and to allow a more disaggregated representation of an individual housing market. The major enhancements made to the model include;

1. the classification of the households into ten TYPE groups that reflect rental or owner-occupier mode of occupancy,

2. an 'a priori' classification of the "model" dwellings as either rental or owner-occupied,

3. the use of after tax incomes for households which include an imputed income to owner-occupiers from their equity investment,

4. the treatment of owner-occupiers' expenditures as a "user cost" based on actual cost data, not as a rent equivalence,

5. the specification of the demand functions in terms of translog utility functions with the household's housing expenditure based on derived expenditure shares,

6. the adjustment of the existing stock supply system to reflect end of decade prices, not average decade prices.

The model considers changes in metropolitan housing markets over a decade and has proven to be capable of providing realistic estimates of probable costs of supporting housing standards. The only currently available data for Canadian cities that allows the calibration of the model is that obtained in association with the ten-yearly Census. The latest Census for which such information is available is 1971, and consequently the implementation of the model has been restricted to consideration of the 1961 through 1971 period. As information is made available from the 1981 Census the opportunity will exist for an updating of this study.

The empirical analysis is focused on six alternative abstract policy forms which, in a general sense, can be considered to represent alternative degrees of "leakage" of subsidy receipts to the consumption of other goods and services. The theoretical evidence indicates that the total subsidy costs will increase as the leakage to the consumption of other goods and services increases. What is critical to the relative efficiency of the alternative forms of intervention is the magnitude of the leakage. The aim of the presented empirical analysis is to quantify the magnitude of the relative leakages. In order to derive comparable estimates from the alternative policy scenarios, the simulations are based on supporting or meeting a minimum standard of housing in the market. The implementation of such a minimum standard could be via zoning and building code restrictions or via an earmarking requirement (must meet minimum housing requirement before receiving subsidy) or a combination of the two. As simulated, the implicit action is one of regulating a minimum standard through building and

occupancy code upgrading and enforcement, with households forced to double-up or leave the market if they are not able to "find" suitable accommodation from the available stock.

A model of a housing market is far from a true representation of reality and thus one must have reservations about the validity of the derived results. There are three main areas where concerns with this particular model arise. First, on the demand side, while a major improvement (respecified demand system) has been incorporated, behaviour is still potentially over-simplified, with households merely choosing between housing and other goods and services. The model ignores the possible impact of subsidies on work incentives, or household formation, or tenure switching. Furthermore, no provision is made for noncompliance with policy regulations, nor for noneconomic influences that may impact on a household's response to the provision of a subsidy.

Second, the supply side of the model is relatively weak. This results from a lack of suitable data from which details on the potential responsiveness of the existing stock to price changes may be derived. In addition, the model has restricted itself to a simplistic representation of the construction industry with no treatment of the basic determinants of production costs or of the feedback effects that may result from income redistribution. The net result is that the supply system tends to leave a questionable range of uncertainty regarding the responsiveness of the existing stock to subsidy stimulation.

The final major concern lies with the implementation of policy options. In particular, the limited number of model representations is too aggregative to allow the model to serve as a reliable predictor of the detailed consequences of intervention and

no means is available to evaluate the impact of the manner in which a policy is introduced. Furthermore, the computed subsidy costs do not include administration costs, nor do they allow for leakages incurred due to poor program implementation or consider the design characteristics of programs required to achieve the specific results.

The model is an extremely complex system in itself yet still remains a simplistic representation of a metropolitan housing market with an uncomfortably large range of uncertainty. In incorporating a supply system which tends to bias results against the "direct product" policy options it has been possible to at least provide results that are reliable enough, with regard to direction and magnitude, to warrant serious consideration.

The general conclusions to be drawn from the simulation are with regard to the relative cost efficiencies of the alternative policy forms and the importance of decentralized housing program design and implementation. The modified housing market model simulations indicate that a general direct product oriented policy, with the granted subsidy tied directly to the change in the housing supplied (consumed) will result in subsidy costs of at most only one-third that of those associated with a general income redistribution policy. With well-structured programs, the "direct constrained" policy simulations suggest that the actual direct subsidy cost, net of administration costs, could be reduced to as low as one-tenth the cost of a general income redistribution policy. Simulations peformed using a Canadian Version of the original UI model indicated even wider margins between the costs for the policy alternatives, as a result of the greater inelasticity of the supply functions incorporated (supply of

housing services from the existing stock). The simulated costs associated with the "direct product" forms of intervention are, on average, as low as only 20% of those for the "income" policies, with the cost under a "direct constrained" option dropping to as low as 5%.

While there exist numerous opportunities to refine the structure and performance of the model, the utility of undertaking such work is seriously questioned, given the current shortage of suitable data from which to derive behavioural parameters, in particular those associated with the supply of housing services from the existing stock. This shortage of data severely hampers the implementation of the supply side of the model and it is the responsiveness of the existing stock and the housing production industry to subsidy stimulation that remains as the major determinant of the dollar costs associated with housing market support. With the uncertainty associated with the true price responsiveness of the existing stock and the limited number of model representations (one hundred) incorporated in the model, attempts to refine the simulations to consider the structuring of programs under the alternative policies become futile.

However, what can be concluded from the simulation with regard to policy/program implementation is that the main aim in the implementation must be one of targeting the subsidy to the dwellings with the lowest marginal cost of upgrading. In some CMAs this may imply that all the intervention can be focused on the existing stock; with other CMAs, as highlighted by the Calgary simulation, support of minimum housing standards may be better served by programs focusing on new construction. But housing markets are not static. Policies and programs must change with the

changing state of the existing stock and provide sufficient flexibility such that each CMA is served by its own series of interrelated programs that target varying subsidy amounts to alternatively renovation and new construction activity.

While the simulation model has been successful in highlighting the significant difference in the costs that would potentially be associated with alternative general forms of housing market intervention, the model's overall structure, and in particular its simplistic representation of market behaviour, severely limits any detailed program analyses that can be performed. To successfully quantify the probable impact of particular program structures requires both more current data and data containing more detail on the state of the existing stock than is now available.

This thesis has addressed the issue of "what are the potential costs" that the government would incur if it selected to support housing standards under a series of alternative policy options. The aim has been to measure the degree of the leakage of the provided subsidy to the consumption of other goods and services. But the optimal policy in any one instance is dependent on both political mandate and choice; a decision process beyond the realm of technical analysis.

Approaches to the redistibution of resources in socially desired ways can be polarized into two general camps. The first involves pure income forms of redistribution with little or no interference in the use of the redistributed resource: the second involves redistribution in the form of selected ("merit") goods and services. One can draw the same dichotomy with the selected policy alternatives.

In comparing and contrasting these two alternative approaches

to resource redistribution, an issue not addressed in this thesis is that concerned with Musgrave's (1976) concept of threshold income levels associated with alternative "merit" goods and services. Obviously, under an "income" subsidy one is supporting households at their housing threshold income level, but in so doing, is one allowing the households to exceed their threshold levels for all other goods and services? Experience suggests the affirmative but without a defined socially acceptable minimum level of other goods and services one can not relate combined social support to a pure housing support policy. Alternatively, without socially defined acceptable minimum levels one does not know whether or not the "direct constrained" policy option is politically viable, or whether the alternative forms of "direct product" intervention will provide the total additional resources required to be redistributed.

The aim of this study was to highlight the relative costs of supporting a Canadian housing market under several alternative abstracted policy forms that reflect both general approaches to resource redistribution. In designing and implementing programs to match these policies the two key parameters are the amount of the subsidy and the means of insuring that the housing reaches the required standards. Administration costs typically become a major consideration in program design, but such costs are seen as being correlated with the equity of the program, not necessarily the efficiency. That is, programs which require the subsidy amounts to be distributed throughout the market will typically involve higher administration costs than those depending on filtering to focus the support on a limited sector of the market. However, both forms can achieve the same long run market state. The means by which the

respective policy modes are implemented will technically be determined by the politically desired "equity" of the transfers. Furthermore, one must distinguish between the short run and long run "equity" of the programs. Past programs geared to the support of new construction have been considered inequitable (Dennis and Fish (1972)) because the subsidy is provided to but a few households. While such programs may be inequitable in the short run, the filtering process may allow a redistribution of the subsidy effects, providing for an equitable distribution in the long run.

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APPENDIX:

The purpose of this APPENDIX is to discuss the techniques employed in operationalizing 1961-1971 Canadian Versions of the HOUSING MARKET MODEL, describe the data that is utilized and present example computations based on the Vancouver CMA.

Two alternative simulation MODELs have been developed; the first (termed the ORIGINAL MODEL) is simply a Canadian implementation of the UI's original model, while the second (termed the MODIFIED MODEL) incorporates many improvements developed at the University of British Columbia, Vancouver, and the Canada Mortgage and Housing Corporation, Ottawa.

While the approach to implementing the two alternative MODELs is similar, there are significant differences in the nature of the data used and the structure of the MODEL solution algorithms. In the following SECTIONs the descriptions of the applications for the two MODELs have been separated, with a detailed presentation of the ORIGINAL MODEL being provided in SECTION A1. The decription of the MODIFIED MODEL, contained in SECTION A2, only highlights and details the areas of variation in the approaches. Representative data generated during model implementation for eight selected CMAs are presented on a CMA basis in APPENDIX A3 with the FORTRAN programs utilized listed in SECTION A4. A detailed set of derived policy simulation results are presented in SECTION A5.

SECTION A1: The ORIGINAL HOUSING MARKET MODEL

In implementing the ORIGINAL MODEL three sets of parameters must be estimated: the ALPHAs, the GAMMAs and the BETAs in order. In deriving these parameters all data required for subsequent policy simulations are generated.

In generating the "model" representations of a CMA several interdependent data manipulations are required. These manipulations can be roughly classified into three groups;

1. simple analytical calculations
2. regression analyses, and
3. computerised manipulations.

The general manipulations required to generate the data for a CMA in the case of the ORIGINAL MODEL are:

1. delineate the CMA into the specified number of zones. While the MODELs have the capability of handling up to ten zones, five zones have been employed throughout this study for consistency through the range of CMA sizes [Section A1.41].
2. calculate by zone the average income and average access for use in determining zonal externalities [Section A1.42].
3. create the 1971 "model" households and data on mean incomes by household TYPE. Income data from the 1974 Survey of Housing Units deflated to a 1971 mean are used [Section A1.43].
4. calculate the ALPHA parameters by household TYPE via multiple regression, again utilizing the 1974 SHU data and deflators drawn from 1971 census data [Section A1.32].
5. estimate the new construction price parameters, PN, PO, and PC, used in specifying the supply functions. These calculations involve manipulation of data from the Canadian Housing Statistics [Section A1.31]. The minimum quantity of new construction parameter, QM, is calculated during the derivation of the "BETA" calibration data set [Section A1.45]

6. estimate the 1971 hedonic coefficients that are used to convert actual 1971 rents and prices from "residential" services to "housing" services; the unit of quantity employed in the MODELs. These coefficients are estimated via multiple regression utilizing 1971 census data incorporated in the 1974 SHU data [Section A1.31].

7. by using the 1971 hedonic coefficients in conjunction with the 1971 census data create the 1971 "model" dwellings. These "model" dwellings are represented in the MODELs by their mean adjusted monthly rent (or equivalent user cost) and the zone in which they are located. In addition, characteristics of the actual 1971 households by TYPE and zone are generated and along with actual dwelling characteristics provide a basis for calibration calculations [Section A1.45].

These operations provide the data required to estimate the GAMMA parameters of the MODEL via simulation. For details of this calibration process see Section 8.321. The next steps involve generating the alternative data set required for estimating the BETA parameters. Steps 6 and 7 must be repeated to generate the 1961 "model" dwellings.

8. estimate the 1961 hedonic coefficients, again via multiple regression, but using the 1961 Census data aggregated at the enumeration area level [Section A1.31].

9. generate the 1961 "model" dwellings using the 1961 hedonic coefficients and 1961 Census tract data [Section A1.44].

10. In addition, calibration data representing the change in market conditions over the decade are derived. This involves utilizing both the 1961 and the 1971 hedonic coefficients in conjunction with the 1961 and 1971 Census tract data to generate price indicies by zone. Additional data on decade-end household and dwelling characteristics are derived from the 1971 data [Section A1.34].

A complete BETA calibration data set differs from the GAMMA set in that the 1961 "model" dwellings replace the 1971 "model" dwellings and the alternative calibration data set is included. The BETA calibration process is detailed in Section 8.322.

The final data set required is that for policy simulations. This data set is identical to the BETA calibration data set except that the calibration data is deleted and information on the "base"

solution conditions included as part of the "model" household records. This data set is generated by the solution algorithm program "SIM01.FORT" when in "base" mode. Details of this procedure are contained in Section A1.5: Base Mode.

For purposes of the regression analyses and the computerised manipulations, several data files are created from available machine readable sources for each CMA evaluated. In the following Section these data files are described in detail, followed by an outline of the additional files created by the utility computer programs.

The subsequent Section details the simple analytical calculations and regression analyses required for this VERSION of the MODEL. A further Section outlines the additional computerised data manipulations involved approximately in the order in which they are normally undertaken. The final Section details the solution algorithm program associated with the ORIGINAL MODEL.

A1.1 ORIGINAL MODEL: DATA FILES

For expediency in describing the required data manipulations the relevant data files employed are detailed in full in the following Section.

A1.11 Raw Data Files

Data utilized by the housing market model program are drawn from three major sources.

1. the 1961 Canadian Census
2. the 1971 Canadian Census, and
3. the 1974 Survey of Housing Units (SHU).

These data have been manipulated into specially formatted files for input to the various utility programs that combine to form the MODELs. For consistency, these files have been identified by CMA, year and application. In this APPENDIX these file names are prefixed by "CMA" indicating that in use, a CMA name code is employed as the leading prefix.

Five basic raw data files are required to allow the calibration of the ORIGINAL MODEL for each CMA They are;

1. CMA61.EA 1961 Census data are aggregated at the enumeration area level. These data are used as input to the regression package for estimating the 1961 Hedonic equations.
2. CMA61.INPUT Selected 1961 Census data aggregated at the census tract level. These data are basic household and housing characteristics employed to create the 1961 "model" dwellings.

3. CMA71.INPUT The equivalent 1971 Census tract data file. In addition to the basic household and housing data, this file contains demographic data used in calibrating the model to a CMA
4. CMA71.SHU Contains selected records from the Survey of Housing Units master tape file. This file is used in estimating the 1971 Hedonic Equations, the expenditure-income ratios (ALPHA parameters) and for the creation of the 1971 "model" households.
5. CMA71.TAB Contains data on the spatial relationship between 1961 and 1971 Census tracts. This file allows the transference of zonal clustering based on a 1961 census tract to the 1971 census tract.

In the following Section the record structure of each of these five files is described. In addition, the structure of an intermediate file, CMA71.DIS.V, required in the creation of CMA71.INPUT is detailed.

CMA61.EA FILE: 1961 ENUMERATION AREA DATA

Variable Number	Field Number	Field	Name
0	1	1- 6	census tract identification
1	2	7-16	proportion single detached dwellin
2	3	17-26	proportion owner-occupied dwelling
3	4	27-36	proportion rental dwellings
4	5	37-46	age: proportion pre 20
5	6	47-56	proportion 1920-1945
6	7	57-66	proportion 1946-1959
7	8	67-76	proportion 1960
8	9	77-86	proportion 1961
9	10	87-96	proportion in good condition
10	11	97-106	proportion need minor repair
11	12	107-116	proportion need major repair
12	13	117-126	proportion furnace heat
13	14	127-136	proportion exclusive toilet
14	15	137-146	proportion exclusive bath
15	16	147-156	average number rooms
16	17	157-166	average number bedrooms
17	18	167-176	proportion with garage
18	19	177-186	average monthly rent
19	20	187-196	average annual household income
20	21	197-206	total number of dwellings
21	22	207-216	proportion stove in rent
22	23	217-226	proportion furniture in rent
23	24	227-236	proportion garage in rent
24	25	247-256	average price (divided by 1000)
25	26	247-256	access variable (see note 2:)

note 1: this data is drawn from the 1961 Census summary tapes;
Housing - short form
Family - short form.

note 2: this access variable value is the calculated distance from the CBD for the corresponding census tract. See the note to CMA61.INPUT for a description of its derivation.

CMA61.INPUT FILE : 1961 CENSUS TRACT DATA

Variable Number	Field Number	Field	Name
0	1	1- 10	census tract identification
1	2	11- 20	total dwellings
2	3	21- 30	total single detached dwellings
3	4	31- 40	total owner-occupied dwellings
4	5	41- 50	total rented dwellings
5	6	51- 60	no. dwellings pre-1920
6	7	61- 70	no. dwellings 1920-45
7	8	71- 80	no. dwellings 1946-59
8	9	81- 90	no. dwellings 1960
9	10	91-100	no. dwellings 1961
10	11	101-110	no. dwellings in good condition
11	12	111-120	no. dwellings minor repairs
12	13	121-130	no. dwellings major repairs
13	14	131-140	no. dwellings furnace heated
14	15	141-150	no. dwellings exclusive toilet
15	16	151-160	no. dwellings exclusive bath
16	17	161-170	total no. rooms in C.T.
17	18	171-180	total no. bedrooms in C.T.
18	19	181-190	total owned single detached distribution of prices
19	20	191-200	units: <3000
20	21	201-210	units: 3000- 7999
21	22	211-220	units: 8000-12999
22	23	221-230	units:13000-17999
23	24	231-240	units:18000-22999
24	25	241-250	units:23000-27999
25	26	251-260	units:28000-32999
26	27	261-270	units:33000-37999
27	28	271-280	units:38000+
28	29	281-290	no. dwellings with garage
29	30	291-300	no. dwellings fridge in rent
30	31	301-310	no. dwellings stove in rent
31	32	311-320	no. dwellings furniture in rent
32	33	321-330	no. dwellings garage in rent distribution of rents
33	34	331-340	units: no rent
34	35	341-350	units: 0-29
35	36	351-360	units: 30-39
36	37	361-370	units: 40-49
37	38	371-380	units: 50-59
38	39	381-390	units: 60-69
39	40	391-400	units: 70-79

CMA61.INPUT (Continued)

Variable Number	Field Number	Field	Name
40	41	401-410	units: 80- 89
41	42	411-420	units: 90- 99
42	43	421-430	units:100-109
43	44	431-440	units:110-119
44	45	441-450	units:120-129
45	46	451-460	units:130-149
46	47	461-470	units:150-174
47	48	471-480	units:175+
48	49	481-490	total rent paid
49	50	491-500	total no. of families
50	51	501-510	total family earnings
51	52	511-520	proportion single detached dwellin
52	53	521-530	proportion owner-occupied dwelling
53	54	531-540	proportion rental dwellings
54	55	541-550	age: proportion pre 20
55	56	551-560	proportion 1920-1945
56	57	561-570	proportion 1946-1959
57	58	571-580	proportion 1960
58	59	581-590	proportion 1961
59	60	591-600	proportion in good condition
60	61	601-610	proportion need minor repair
61	62	611-620	proportion need major repair
62	63	621-630	proportion furnace heat
63	64	631-640	proportion exclusive toilet
64	65	641-650	proportion exclusive bath
65	66	651-660	average number rooms
66	67	661-670	average number bedrooms
67	68	671-680	proportion with garage
68	69	681-690	average monthly rent
69	70	691-700	average annual household income
70	71	701-710	total number of dwellings
71	72	711-720	proportion stove in rent
72	73	721-730	proportion furniture in rent
73	74	731-740	proportion garage in rent
74	75	741-750	average price (divided by 1000)
75	76	751-760	access variable (see note 2:)

note: 1. this data is obtained by aggregating enumeration area data drawn as for CMA61.EA.

note: 2. the access variable "75" is calculated as the commuter distance from the CBD It is an index value obtained by measuring the most direct route, (road, rail, ferry) to the city centre.

CMA71.INPUT FILE : 1971 CENSUS TRACT DATA

Variable Number	Field Number	Field	Name
0	1	1- 10	census tract identification
1	2	11- 20	proportion households type 1
2	3	21- 30	proportion households type 2
3	4	31- 40	proportion households type 3
4	5	41- 50	proportion households type 4
5	6	51- 60	proportion households type 5
6	7	61- 70	proportion households type 6
7	8	71- 80	proportion households type 7
8	9	81- 90	proportion households type 8
9	10	91-100	annual income - household head
10	11	101-110	annual income - household
11	12	111-120	total dwellings
12	13	121-130	total owned dwellings
13	14	131-140	total rented dwellings
14	15	141-150	average value (note: 2.)
15	16	151-160	average rent
			distribution of construction
16	17	161-170	owned pre-1946
17	18	171-180	owned 1946-50
18	19	181-190	owned 1951-60
19	20	191-200	owned 1961-65
20	21	201-210	owned 1966-70
21	22	211-220	owned 1971
22	23	221-230	rented pre-1946
23	24	231-240	rented 1946-50
24	25	241-250	rented 1951-60
25	26	251-260	rented 1961-65
26	27	261-270	rented 1966-70
27	28	271-280	rented 1971
28	29	281-290	total pre-1946
29	30	291-300	total 1946-50
30	31	301-310	total 1951-60
31	32	311-320	total 1961-65
32	33	321-330	total 1966-70
33	34	331-340	total 1971
34	35	341-350	average no. rooms - owned
35	36	351-360	average no. rooms - rented
36	37	361-370	proportion with bath - owned
37	38	371-380	proportion with bath - rented
38	39	381-390	proportion apartments
39	40	391-400	blank

CMA71.INPUT (Continued)

Variable Number	Field Number	Field	Name
			distribution of rents
40	41	401-410	units: no rent
41	42	411-420	units: <30 monthly
42	43	421-430	units: 30- 39
43	44	431-440	units: 40- 59
44	45	441-450	units: 60- 79
45	46	451-460	units: 80- 99
46	47	461-470	units:100-119
47	48	471-480	units:120-139
48	49	481-490	units:140-159
49	50	491-500	units:160-179
50	51	501-510	units:180-199
51	52	511-520	units:200-249
52	53	521-530	units:250-299
53	54	531-540	units:300-349
54	55	541-550	units:350+
			distribution of prices
55	56	551-560	units: <3000
56	57	561-570	units: 3000- 7499
57	58	571-580	units: 7500-12499
58	59	581-590	units:12500-17499
59	60	591-600	units:17500-22499
60	61	601-610	units:25500-27499
61	62	611-620	units:27500-32499
62	63	621-630	units:32500-37499
63	64	631-640	units:37500-42499
64	65	641-650	units:42500-52499
65	66	651-660	units:52500-62499
66	67	661-670	units:62500+
67	68	671-680	blank
68	69	681-690	blank
69	70	691-700	blank
70	71	701-710	access variable

CMA71.INPUT (Continued)

Variable Number	Field Number	Field	Name
			distribution of values dwelling built 1960 or before
71	72	711-720	total all units
72	73	721-730	units: <3000
73	74	731-740	units: 3000- 7499
74	75	741-750	units: 7500-12499
75	76	751-760	units:12500-17499
76	77	761-770	units:17500-22499
77	78	771-780	units:25500-27499
78	79	781-790	units:27500-32499
79	80	791-800	units:32500-37499
80	81	801-810	units:37500-42499
81	82	811-820	units:42500-52499
82	83	821-830	units:52500-62499
83	84	831-840	units:62500+
84	85	841-850	mean value "old" (note: 2.)
			distribution of values dwelling built 1961 or after
85	86	851-860	total all units
86	87	861-870	units: <3000
87	88	871-880	units: 3000- 7499
88	89	881-890	units: 7500-12499
89	90	891-900	units:12500-17499
90	91	901-910	units:17500-22499
91	92	911-920	units:25500-27499
92	93	921-930	units:27500-32499
93	94	931-940	units:32500-37499
94	95	941-950	units:37500-42499
95	96	951-960	units:42500-52499
96	97	961-970	units:52500-62499
97	98	971-980	units:62500+
98	99	981-990	mean value "new" (note: 2.)

note: 1. this data is drawn from the following 1971 Census summary tapes; census tract aggregation series:
Family - short form
Household - short form
Housing - short form
Housing - long form

note: 2. these variablee are calculated as the mean of the distribution of prices assuming a mean value for <3,000 of $2,000 and $70,000 for 62,500+.

CMA71.DIS.V: 1971 CENSUS DATA on VALUE DISTRIBUTIONS

Variable Number	Field Number	Field	Name
0	1	1- 10	CMA code
0	2	11- 20	census tract number
			distribution of values dwelling built 1960 or before
1	3	21- 30	total all units
2	4	31- 40	units: <3000
3	5	41- 50	units: 3000- 7499
4	6	51- 60	units: 7500-12499
5	7	61- 70	units:12500-17499
6	8	71- 80	units:17500-22499
7	9	81- 90	units:25500-27499
8	10	91-100	units:27500-32499
9	11	101-110	units:32500-37499
10	12	111-120	units:37500-42499
11	13	121-130	units:42500-52499
12	14	131-140	units:52500-62499
13	15	141-150	units:62500+
			distribution of values dwelling built 1961 or after
14	16	151-160	total all units
15	17	161-170	units: <3000
16	18	171-180	units: 3000- 7499
17	19	181-190	units: 7500-12499
18	20	191-200	units:12500-17499
19	21	201-210	units:17500-22499
20	22	211-220	units:25500-27499
21	23	221-230	units:27500-32499
22	24	231-240	units:32500-37499
23	25	241-250	units:37500-42499
24	26	251-260	units:42500-52499
25	27	261-270	units:52500-62499
26	28	271-280	units:62500+

note: 1. this data is drawn from a special cross-tab file created by Statistics Canada.

CMA.SHU: 1974 SURVEY of HOUSING UNITS

Variable Number	Field Number	Field	Name	
1	1	1- 3	survey area	00
2	2	4- 10	household weight	01
3	3	11- 12	type of dwelling	01
4	4	13- 14	year dwelling constructed	02
5	5	15- 16	running water	02
6	6	17- 18	installed bath or shower	02
7	7	19- 20	toilet facilities	02
8	8	21- 22	subsidization	02
9	9	23- 24	tenure	02
10	10	25- 32	expected selling price	03
11	11	33- 36	number of units	03
12	12	37- 38	water included in rent	04
13	13	39- 40	electricity included in rent	04
14	14	41- 42	gas included in rent	04
15	15	43- 44	oil included in rent	04
16	16	45- 46	parking included in rent	04
17	17	47- 49	number of living rooms	06
18	18	50- 52	number of work rooms	07
19	19	53- 55	number of bedrooms	07
20	20	56- 62	household income	08
21	21	63- 65	household size	08
22	22	66- 70	monthly rent payment	08
23	23	71- 72	exterior condition	09
24	24	73- 75	number of children	09
25	25	76- 78	age of head	09
26	26	79- 80	marital status of head	09
27	27	81- 87	income of head	10
28	28	88- 94	income of spouse	10
29	29	95- 97	distance to work	11
30	30	98-102	date 1st most recent move	11
31	31	103-106	1971: age of head	20
32	32	107-108	1971: marital status	20
33	33	109-116	1971: income of head	20
34	34	117-118	1971: no. years in dwelling	20
35	35	119-121	1971: household size	21
36	36	122-129	1971: household income	21
37	37	130-132	1971: no. of children	21
38	38	133-134	1971: type of dwelling	21
39	39	135-137	1971: no. of units	22
40	40	138-139	1971: period of construction	22

CMA.SHU (Continued)

Variable Number	Field Number	Field	Name	
41	41	140-142	1971: no. of rooms	22
42	42	143-144	1971: no. of bedrooms	22
43	43	145-146	1971: flush toilet in building	22
44	44	147-148	1971: basic facilities present	22
45	45	149-150	1971: tenure	22
46	46	151-152	1971: reason for reduced rent	22
47	47	153-156	1971: monthly cash rent	23
48	48	157-161	1971: payment for utilities	23
49	49	162-163	1971: furniture in rent	23
50	50	164-165	1971: air-cond. in rent	23
51	51	166-167	1971: refrigerator in rent	23
52	52	168-169	1971: stove in rent	23
53	53	169-170	1971: expected selling price	24

CMA71.TAB: 1961-71 CENSUS TRACT CROSS-TAB

This file contains one or more data records for each 1971 Census tract. It is manually created from census tract maps and published census data to allow the cross-tabulation of 1961 and 1971 census tracts. Delineation of zones is based on 1961 census tracts and this file is used to allocated the 1971 tracts to the respective zones. When a 1971 tract comprises more than one 1961 tract, or parts thereof, multiple records are created. The structure of the records is:

Variable Number	Field Number	Field	Name
0	1	1-4	1971: census tract number
0	2	5-8	1961: census tract number
1	3	9-5	proportion of 1961 tract contained in 1971 tract.

A1.12 Generated Data Files

In the process of implementing the MODEL for a city, several additional data files are created by the utility programs. Two are created to indicate the zonal allocation of the 1961 and 1971 Census tracts, respectively. They are the files CMA61.ZN and CMA71.ZN. Three alternative files are created for input to the solution algorithm program, "SIM01.FORT". The alternatives correspond to different solution modes of the solution algorithm.

1. CMA.G5B : input for calibrating the GAMMA parameters
2. CMA.B5B : input for calibrating the BETA parameters
3. CMA.P5B : output from BASE mode runs for POLICY mode runs

note: the number "5" is employed to denote the number of zones.

The structure of these files is outlined in the description of the solution algorithm, "SIM01.FORT".

CMA61.ZN: 1961 Zonal Allocation File

This file is created by the program "ZONE.FORT" from the output of a clustering program. "ZONE.FORT" is structured to alternatively receive CMA61.ZN as input, allowing the exogenous specification of the zonal allocations. The created version of the file has two data fields; a manually created input file may use three. The first record of this file must have the following data fields; "61" in columns 3-4 and the number of zones, excluding the zone of new construction, in columns 6-7. The structure of the remaining records is:

Variable Number	Field Number	Field	Name
1	1	1-2	zone number
2	2	3-6	census tract number
3	3	7-9	census tract number (note: 1.)

note: 1. when manually creating CMA61.ZN, a second census tract number, right justified in colums 7-9, will act as a range delimitor. e.g. 01100110, indicates that census tracts 100 to 110 are in ZONE 1.

CMA71.ZN: 1971 Zonal Allocation File

This file is created by the program "ZONE.FORT" and contains data on the zonal allocation of each 1971 census tract along with the corresponding 1961 tract. The first record of the file is a control and title record. As with CMA61.ZN, this record must contain "71" in columns 3-4 and the number of zones in columns 6-7. The structure of the remaining records is:

Variable Number	Field Number	Field	Name
1	1	1-2	zone number
2	2	3-6	1971 census tract number
3	3	7-9	corresponding 1961 census number - 0 if annexed

A1.2 ANALYTICAL CALCULATIONS

1.21 Distribution of New Construction Costs

The price per unit of "housing" services from new dwellings must be measured relative to the same base as other prices incorporated into the model during a particular simulation run. With the Canadian models all simulations utilize 1961 as the base year and thus new construction costs during the decade must be calculated to reflect cost changes over the decade. While all other prices are endogenously determined, construction prices/costs are exogenously determined under an assumption that they are derived independent of housing market forces. As a result new construction costs become an important model parameter and must be carefully specified. For convenience, the model's base price is set to unity, with regard to existing "model" dwellings in 1961 and thus values for PN will be in the range 1.00 to 2.00, indicating indexed increases in construction costs over the decade.

With the ORIGINAL MODEL specification, where PN=PC+PO, a conflict arises in the use of PN and the two components. Since PN is the driving force behind price inflation with this specification, its value must approximate the decade-end value so that the MODEL generates the appropriate distribution of prices for the existing "model" dwellings with PN as the "ceiling". On the other hand, the profit function specification assumes that PC and PO are appropriate costs over the decade and as such should be derived as an average of prices throughout the decade. The U.I. uses an average decade value for all three variables, that gives a slight additional weight to the final two years of the

decade (de Leeuw and Struyk (1975, p 72)), presumably to effect a compromise. One can alternatively assume that PN, PC and PO correspond to costs in the last operating month of the period under consideration and thus may be calculated as the period-end value. A combination of the two alternatives has PN set independent of PC and PO, allowing PC and PO to be estimated as the decade average while PN is set to correspond to a period-end value. The method used here to calculate PO, PC and PN follows the UI approach directly.

All "model" prices and costs must be derived relative to the price per unit of "housing" services offered by existing "model" dwellings at the decade-start. For model calibration, one must assume that the price per unit of "housing" services for both existing and new units is unity in 1961; that is, the market was in equilibrium, and then calculate PN as a relative price. These relative prices are obtained by estimating the repective relative changes in operating costs, PO, and capital costs, PC, and then weighting the two components to obtain the total cost, PN. Data on the distribution of operating costs has been derived from the 1969 Survey of Family Expenditure; capital costs distribution data from Canadian Housing Statistics. While distributions of the capital cost components are readily available for all years of the decade, equivalent operating cost data is only available for 1969. This data is used to obtain relative component costs to be individually inflated/deflated utilizing available price indices.

The 1969 Survey of Housing Expenditure lists four major expenditure items that may be classified as operating costs. A problem arises with the use of this data inasmuch as the reported average expenditure underestimates the true average as many

households make implicit expenditures but do not report them. For example, renters frequently have utilities included in rents. They accordingly record a zero expenditure for fuel and utilities while reporting actual utility expenditures as a component of their rental payments. To compensate in deriving total average expenditure, the reported expenditures are inflated by dividing the reported average by the percentage of households reporting expenditures. From these average expenditures the proportion allocated to each component is then derived. An example of these calculations for the Vancouver CMA is outlined in Table A1:01.

Item	Average "Reported" Expenditure	% Households Reported	Average Expenditure	Proportion
Property Taxes	174.2	56.9	306.0	0.356
Insurance	16.1	28.5	56.0	0.065
Repairs	98.2	43.2	227.0	0.264
Fuel and Utilities	250.0	86.7	271.0	0.315
Total			860.0	

source: 1969 Survey of Family Expenditure

Table A1:01 VANCOUVER : Distribution of Operating Costs

To obtain the average operating costs for each year over the decade, each of the individual components is multiplied by its price index number in the Consumer Price Index, (CPI). In many instances local CPI components are not available and the corresponding "national" values have to be employed: this factor will obscure important price differential by CMA In Table A1:02 Vancouver's index numbers for each of the years 1961-71 (1969=100) are presented, along with the estimated annual operating costs.

Year	Property Tax	Dwelling Insurance	Dwelling Repairs	Fuel and Utilities	Average Expenditure
1961	69.5	65.5	73.7	93.9	672
1962	72.3	66.5	74.0	93.2	680
1963	74.0	68.3	75.6	82.3	686
1964	76.4	72.6	78.7	90.9	699
1965	79.2	76.8	82.2	90.6	717
1966	82.9	82.3	85.3	90.6	738
1967	86.2	87.1	90.6	93.9	773
1968	92.0	93.5	96.2	97.7	818
1969	100.0	100.0	100.0	100.0	860
1970	107.3	105.6	108.8	104.7	917
1971	110.3	129.4	116.3	111.0	975

source: Statistics Canada

Table A1:02 VANCOUVER : Operating Cost Indices (1961-1971)

The only city-specific data available on construction costs for the duration of the decade are for new single detached dwellings financed under the National Housing Act, published on an annual basis by C.M.H.C. The other component entering the capital cost estimates is the mortgage interest rate, which is available from the same source as an average rate on conventional residential mortgages for the whole of Canada. Again some regional differential is lost. By assuming that the average size of an N.H.A. dwelling over the decade was 1000 square feet, the average total capital cost is calculated as the dwelling lot cost plus 1000 times the construction cost per square foot. To convert this total capital cost to an equivalent annual user cost basis, this total expenditure is multiplied by the conventional mortgage interest rate. These calculations, for Vancouver, are outlined in Table A1:03.

Year	Construction Cost per Square Foot	Dwelling Cost [$]	Lot Cost [$]	Total Capital Cost [$]	Conventional Interest Rate [%]	Annual Capital Cost [$]
1961	10.56	10,560	3,975	14,535	7.00	1,017
1962	10.33	10,330	3,928	14,258	6.97	993
1963	10.37	10,370	3,584	13,954	6.97	973
1964	10.72	10,720	3,586	14,306	6.97	997
1965	11.66	11,660	3,806	15,466	7.02	1,096
1966	12.36	12,360	4,073	16,433	7.66	1,259
1967	13.55	13,550	4,228	17,778	8.07	1,435
1968	14.37	14,370	4,723	19,093	9.07	1,732
1969	15.32	15,320	6,088	21,408	9.86	2,107
1970	15.55	15,550	7,094	22,644	10.45	2,306
1971	16.94	16,940	8,179	25,119	9.43	2,369

source: Canadian Housing Statistics (various years)

Table A1:03 VANCOUVER : Distribution of Capital Costs

To obtain the values of PN, PC and PO corresponding to the basic MODEL specification, weighted mean values of the annual operating and capital costs for 1962-71 are calculated by weighting the values in each year by the ratio of dwelling starts in the given year to total starts over the ten year period. The weighted sum of the two individual components is then divided by total costs in 1961 to derive PO and PC in terms of the base "housing" services price of unity. The sum of these two values provides the value for PN. As indicated in Table A1:04, the corresponding Vancouver values for PO, PC and PN, respectively, are 0.475, 0.965 and 1.440.

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight [1]	Weighted Operating Costs	Weighted Capital Costs
1961	672	1,017	5,588	-	-	-
1962	680	993	7,387	0.059	40.1	58.6
1963	686	973	8,941	0.079	48.7	69.1
1964	699	997	12,791	0.101	70.6	100.7
1965	717	1,086	11,684	0.093	66.7	101.0
1966	738	1,259	9,138	0.072	53.1	90.6
1967	773	1,435	13,896	0.110	85.0	157.9
1968	818	1,732	15,690	0.124	101.4	214.8
1969	860	2,107	17,690	0.140	120.4	295.0
1970	917	2,306	13,437	0.106	97.2	250.8
1971	975	2,369	15,553	0.123	120.0	291.4
Totals					803.2	1630.0

$$PO = \frac{803.2}{1689.0} = 0.475, \quad PC = \frac{1630.0}{1698.0} = 0.965$$

note: [1] calculated as dwelling start/total starts for 1962-71

Table A1:04 VANCOUVER : Calculation of PO and PC

Alternatively, to derive the decade-end value for PN, the sum of the annual operating and capital costs in 1971 is simply divided by the equivalent 1961 sum. For example, the decade-end value for Vancouver is derived as;

$$PN = \frac{975.6+2369.0}{672.0+1017.0} = \frac{3344.6}{1689.0} = 1.980$$

Correspondingly, PO and PC are calculated as the ratio of the two individual components. The decade-end values for Vancouver of PO, PC and PN are 0.578, 1.402 and 1.980 respectively. The calculated values for the various forms of PN, PC and PO are reported on a CMA basis in Figures A3:10.

A1.3 REGRESSION ANALYSIS

Three independent sets of regression analyses are required in generating the "model" representation; one focussing on the household's consumption preferences, the ALPHA parameters; the other two deriving the 1961 and 1971 Hedonic coefficients required in estimating the "model" dwelling representation for 1961 and 1971 respectively. The final form of the equations utilized have been derived after many alternative specifications, using alternative data sets, have been attempted. In particular, the final equation form for the hedonic coefficient is that which provides the best fit across all of the eight selected CMAs subject to data availability in machine-readable form. All regression calculations have been performed utilizing the UBC system program "SHAZAM": Version 2.

A1.31 Hedonic Price Regressions

Four sets of hedonic price coefficients are required in implementing the model. These are derived for 1961 rental units, 1961 owner-occupied units, 1971 rental units and 1971 owner-occupied units, to be used in creating the 1961 and 1971 "model" dwellings and to estimate the price appreciation of existing dwellings over the 1961-71 period. While a detailed discussion of how these results are utilized is presented in Section A1.4, this section simply describes the actual hedonic regressions.

A1.311 "1961" Hedonic Regressions

The data used in these regressions are based on information gathered in the 1961 Canadian Census. Unfortunately, suitable data

on representative individual dwelling units are not available. Rather, individual observations are aggregated into enumeration areas each containing 500 persons on average. Such aggregated census data does have one advantage inasmuch as it reduces distortions associated with the value of the "price" of owner-occupied dwellings·variable. This value is an owner's estimate rather than a value derived from market transactions. Thus, aggregation tends to somewhat balance the optimistic and pessimistic assessments of owners.

Regression models based on both the enumeration area and the more highly aggregated census tract data were attempted for Vancouver. With their higher degree of aggregation, the census tract models performed significantly better when evaluated in terms of goodness-of-fit, "R2". But as a result of this aggregation, the independent variables exhibited a much greater degree of correlation which distorts the derived coefficients. The enumeration area data was used precisely for this reason. At the enumeration area level of aggregation the number of observations available ranged from 135 for St. John's to 1147 for Vancouver.

The required variables are contained in the files CMA61.EA, with the transformations being performed during its generation from Census tapes. The final variables selected for both the rental and owner-occupier models include; the proportion of non-single detached dwellings in the enumeration area, the proportion constructed prior to 1920, the proportion constructed between 1920-45, the proportion of dwelling units classified by the census taker as being in good condition, the average number of rooms per dwelling, the average family income and an access variable based on the census tract in which the enumeration area is located. Details

on the access variable, which is derived independent of the census data, which are contained in the outline of the data file in the previous Section. The average family income, the proportion of apartment units and the access variable are treated as proxies for neighbourhood conditions: the other variables represent structural characteristics.

With the dependent variables, total gross rent in each enumeration area is provided, and thus the dependent variable for the rental model, variable "18", is simply derived by dividing this total rent by the number of rental units. An equivalent value for the owner-occupied stock is not, however, available. Rather, the number of single detached non-farm dwellings in each of the following groups is provided: less than $3,000., $3-7,999., $8-12,999., $13-17,999., $18-22,999., $23-27,999., $28-32,999., $33-37,999. and $38,000. plus. Therefore, variable "24", the average price, is derived by weighting each category's mean dwelling value by the corresponding number of observations. The lower bound was set to $1,500: the upper to $40,000.

Since the data employed is grouped with a non-constant proportion of rental and owner-occupied units in each group (i.e. enumeration area), weighted least squares, W.L.S., rather than ordinary least squares, O.L.S., provide the best linear unbiased estimates of the coefficients. The individual weights for each observation is the square root of the number of owner-occupied and rental units in the owner-occupied and rental models, respectively.

In attempting to generate functional equations suitable across all CMAs, several different forms of both the dependent and independent models (logs, squares, etc.) were tested. The models

that offer the best fit were those utilizing a natural logarithmic specification on the dependent variable. (Although not reported this is also the form of the models used by the U.I.). The final form of the model employed has both income and rooms also in logarithmic form, access as a pure number in the approximate range of 1 to 200 and the remaining independent variables specified as proportions in the range 0.0 to 1.0.

Complete results for both an O.L.S. and a W.L.S. specification are reported on a CMA basis in Figures A3:05. An example set of results for Vancouver is presented in Table A1:05.

For the eight selected CMAs, Vancouver is the only CMA with all coefficients significant at a 90% level of confidence. The majority of equations had only one coefficient not significant although Saskatoon's rental model has three; including the coefficient on the LN income. This is the only coefficient on either the LN ROOMS or LN INCOME that is not significant. Most of the insignificant coefficients were on the age variable 20-45, or the ACCESS variable; probably resulting from correlation problems. The only CMA with intercepts, CONSTANTS, not significantly different from 0.0 was St. John's, where the majority of the explanatory power fell on the LN INCOME variable. For the remaining CMAs, the equivalent values lie between 3.0 amd 7.0: the impact is that the values derived from the St. John's hedonics tended to underestimate the relative quantities of "housing" services. In terms of goodness-of-fit, the reported R2's on the O.L.S. model (W.L.S. upward biases the reported R2's), range from 0.32 to 0.66, with the owner-occupied model providing a better fit on average.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	6.6027	6.6700	4.6985	4.1219
	(28.9)	(37.9)	(15.6)	(17.2)
MULTIPLE	0.6871	0.6275	0.2303	0.2620
	(18.7)	(18.3)	(4.88)	(8.47)
CONSTRUCTED PRE 20	-.2931	-.4124	-.4258	-.3471
	(6.79)	(10.6)	(7.50)	(9.49)
20-45	-.1476	-.1540	-.1377	-.1608
	(5.00)	(6.77)	(3.46)	(4.97)
CONDITION	0.2318	0.1438	0.1758	0.2025
	(6.41)	(4.85)	(3.67)	(6.02)
LN ROOMS	1.1482	1.3975	0.7345	0.5513
	(23.6)	(34.4)	(11.2)	(11.9)
LN INCOME	0.1158	0.0666	0.1388	0.2361
	(4.20)	(3.11)	(3.83)	(8.24)
ACCESS	-.0010	.0008	-.0029	-.0023
	(5.18)	(5.60)	(11.0)	(11.6)
R2	0.50	0.99	0.35	0.99
OBSERVATIONS	1213	1213	1147	1147

note : "t" statistis in brackets
: data source: VAN61.EA
: W.L.S. overestimates the R2 values reported

Table A1:05 VANCOUVER: 1961 HEDONICS

A1.312 "1971" Hedonic Regressions

Data for a selected sample of individual dwelling units gathered for the 1971 Census are available as a component of the 1974 Survey of Housing Units data record, (see CMA.SHU file). The problem with this data is that no means is available to identify the location of the dwelling and thus no spatial variable such as ACCESS can be included. This data set provides approximately 1100

observations per model, per CMA While this data set has this problem, the alternative data source, the 1971 enumeration area data contains errors in critical "value" variables and is not suitable.

Using the SHU data, rental and owner-occupied models similar to those for 1961 are estimated with logarithmic dependent variables. While actual 1971 rents are provided, the 1971 dwelling value is provided in terms of a coded range of values. The options available when generating the 1971 dwelling value data were to deflate the 1974 values provided or set the value equal to the mean of the distribution group. The latter option was taken, with dwellings in the under $3,000 category being given a value of $2,000; those in the $62,000 plus category were given a value of $70,000. The mean values for the other ten categories are; $5,250., $10,000., $15,000., $20,000., $25,000., $30,000., $35,000., $40,000., $47,500. and $57,500. The selected independent variables included in both models were; binary dummy variables for a non-single detached dwelling unit, for the year of construction classified into four groups (pre 20, 20-45, 46-50 and 51-60), and for the presence of all basic facilities as a proxy for condition. Like the 1961 models, the logarithmic values of income and number of rooms were the two final independent variables included. Income and the presence of a multiple dwelling are taken as indicators of neighbourhood attributes; the remainder are taken as structural attributes.

These individual observations in the SHU data are drawn from the 1971 census data on the basis of obtaining a representative sample of the CMA As a result each record contains a weighting factor corresponding to the number of similar dwellings the record

represents. As such, the observation can be treated as the mean representative of a distribution of the population corresponding in size to the weighting factor. The data set is in fact grouped with a non-constant grouping factor and again as in the 1961 models, W.L.S. rather than O.L.S. provides the best linear unbiased estimates of the coefficients where the weighting for the individual observations is the square root of the reported weighting factor.

Complete results for both an O.L.S. and a corresponding W.L.S. specification are reported on a CMA basis in Figures A3:07. An example set of results for Vancouver is presented in Table A1:06.

For the eight selected CMAs less than half of the models contain an insignificant coefficient at a 90% level of confidence. In most of the models all coefficients are significant at a 95% level. Over half of the insignificant coefficients were for the MULTIPLE variable (binary 1 dummy if non-single detached unit), in the rental models. In addition, the fluctuation of the sign on this variable indicates that it is acting as a proxy for access. In the owner-occupier model the sign is determined by the dominance of either access attributes or the disutility asociated with higher densities. Overall the explanatory power of the models is slightly lower than that of the 1961 models, with R2's ranging from 0.29 to 0.49 for the O.L.S. models. Given the disaggregated nature of the data, this level of fit is comparable with other studies reported, (see Ball (1973)).

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	8.6618	8.4802	5.654	5.7846
	(51.9)	(50.0)	(43.0)	(49.5)
MULTIPLE	0.1128	0.1549	-.0560	-.1019
	(3.63)	(4.45)	(1.70)	(3.06)
CONSTRUCTION 51-60	-.1854	-.1886	-.1550	-.1161
	(5.10)	(5.24)	(5.81)	(3.98)
46-50	-.2579	-.2222	-.1859	-.1727
	(6.77)	(5.89)	(4.76)	(4.20)
20-45	-.2836	-.2846	-.2599	-.2463
	(8.34)	(8.53)	(8.79)	(8.08)
PRE 20	-.3499	-.3923	-.3254	-.3119
	(8.62)	(9.80)	(8.50)	(8.26)
FACILITIES	0.1100	0.1287	0.2403	0.2211
	(1.12)	(1.24)	(4.98)	(4.82)
LN INCOME	0.0769	0.0968	0.1447	0.1325
	(5.42)	(6.85)	(10.5)	(10.7)
LN ROOMS	0.5186	0.5031	0.2580	0.2738
	(15.1)	(13.5)	(10.4)	(11.1)
R2	0.31	0.99	0.35	0.98
OBSERVATIONS	1082	1082	1150	1150
WEIGHTED 20-45/PRE 20	-.3008	-.3126	-.2832	-.2696

note : "t" statistis in brackets
: data source: VAN.SHU
: weighted coefficient for 20-45 and PRE 20 used as actual census data combines these variables

Table A1:06 VANCOUVER: 1971 HEDONICS

A1.32 "ALPHA" Parameters

When calibrating the MODELs to a CMA the ALPHA parameters, indicating households' preferences for new "housing" services vis-a-vis other goods and services in the form of a housing expenditure to income ratio, are estimated via regression. While such ALPHA values are expected to vary by household, the demand function employed in the ORIGINAL MODEL requires that these parameters be estimated by household TYPE groupings, since in deriving the demand function via constrained maximization it has been assumed that the ALPHA parameter is constant; for convenience, constant by household TYPE. The first part of this section outlines the estimation of these constant ALPHAs, but since the ALPHA parameter is in fact an income-expenditure ratio and theoretical and tentative empirical evidence suggests that such preferences are also income dependent several alternative specifications for the expenditure-income ratio have also been evaluated, of which four are briefly reported in the latter part of this section.

To estimate the ALPHA parameters use is made of the relationship between price, quantity and income incorporated in the derived demand for new "housing" services function.

$$QNi = \frac{ALPHAi}{PN} * Yi \qquad \ldots A1:1$$

where;

QNi is the quantity of new housing services consumed,

Yi is the "model" income of the household

PN is the price per unit of "new" housing services.

To obtain the basic relationship for estimating purposes from Equation A1:1 the household's expenditure on housing services can be expressed as:

$$Pj * QNj = ALPHAi * Yi$$

$$= R \qquad \text{... A1:2}$$

where;

R is the per period expenditure on housing,

which gives;

$$\frac{R}{Yi} = ALPHAi * (1.0 + u) \qquad \text{... A1:3}$$

where;

u is a disturbance term with a mean of zero

This relationship as such can be estimated to obtain a single ALPHA parameter for a CMA In order to estimate individual ALPHA values for each household TYPE group (eight values with the present groupings), Equation A1:3 is respecified as;

$$\log\left(\frac{R}{Yi}\right) = \log(ALPHA1)+D2+D3+D4+D5+D6+D7+D8+u \qquad \text{... A1:4}$$

where;

Di ,i=2..8 are binary intercept dummies by TYPE

such that;

$\log(ALPHAk) = \log(ALPHA1) + Dk$ for k=2...8

It must also be noted that Yi included in Equation A1:4 is the individual household's "model" income, not reported "actual" income. The relationship between "model" income and "actual" income employed in simulations is given by Equation 6:8 as;

$$Yi = (AYi^{**} e) * (MYtype^{**}(1.-e)) \quad \ldots A1:5$$

where;

Yi is the "model income of household "i"

AYi is the "actual" income of household "i"

MYtype is the mean income of households in the same household type as household "i"

e is the "permanent" income elasticity of demand

Thus, in estimating Equation A1:4, Yi must be calculated for individual households in accordance with Equation A1:5. As noted in Section 6.4, there is no sound empirical evidence available with regard to a suitable value for the "permanent" income elasticity of demand. The ALPHA parameters were therefore estimated over a range of values for "e" (0.5 to 1.0) and the specification of "e" that provided the best fit for Equation A1:4 was selected in deriving the final ALPHA parameter set and for use in the simulation MODELs. Generally, the specification which implied an elasticity of 0.6 provided the best average fit across the selected CMAs and the ALPHAs for all CMAs have accordingly been estimated using such a value.

All data used to make these decade-end estimates are from the 1974 Survey of Housing Units, (CMA.SHU file). This file contains both 1971 and 1974 data as previously indicated. After performing several tests with alternative variable combinations, the estimations were made using actual reported 1974 incomes, rents and values deflated at the mean to reported 1971 census equivalents. The corresponding 1971 and 1974 values are indicated for Vancouver in Table A1:07. In addition, dwelling values must be reduced to an annual equivalent amount corresponding to rents via an estimated

rent to value ratio. These "rent" equivalent adjustors must correspond to the hedonically derived quality ADJUSTORs utilized in generating the "model" dwellings. Accordingly, the rent to value ratios utilized are derived as output from the program "D71.FORT", outlined in Section A1.45.

Since data on expenditures and incomes relates to the existing stock and not new dwellings specifically, in using the outlined procedure to estimate the ALPHAs one must assume that the price per unit of "housing" service from a new dwelling is equal to the price per unit of "housing" service from existing dwellings, (i.e. PN=Pj). Alternatively this assumption implies that a household will make the same expenditure on "new" housing services as on "old". If in fact households spend more for the right to the consumption of new housing services, this approach will tend to underestimate the ALPHA parameter values and consequently the optimal quantity of "new" housing services consumed.

As noted in the previous Section, the SHU data records represent non-constant grouped data and W.L.S. is more appropriate than O.L.S. Complete results under both O.L.S. and W.L.S. are reported along with the derived ALPHAs on a CMA basis in Figures A3:08. The Vancouver example follows as Table A1:07.

One should note that the "t" statistic indicates the level of significance of the difference between the ALPHA parameter and ALPHA1. While the R2 statistics are low, only seven coefficients in the W.L.S. models had standard errors that indicated that the corresponding ALPHAs were not significantly different from ALPHA1 at a 90% confidence level. In general, W.L.S. provided slightly higher values for ALPHA1, but no similar pattern existed for the remaining values.

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	28,871.	62,843.	0.45941
RENT	133.	178.	0.74719
INCOME	9,931.	11,644.	0.85288

R/V ratio: 0.0540 Pj/PN ratio: 1.03382

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.9837 (83.7)	0.1976	3.0581 (83.0)	0.2129	0.2087
DUMMY (TYPE 2)	-.3272 (8.05)	0.1425	-.4533 (10.9)	0.1353	0.1323
DUMMY (TYPE 3)	-.3062 (6.19)	0.1455	-.3968 (7.55)	0.1431	0.1400
DUMMY (TYPE 4)	-.4549 (10.5)	0.1254	-.5489 (12.7)	0.1230	0.1203
DUMMY (TYPE 5)	0.0909 (1.99)	0.2164	0.0024 (0.05)	0.2134	0.2091
DUMMY (TYPE 6)	0.1221 (2.69)	0.2233	0.0282 (0.61)	0.2190	0.2147
DUMMY (TYPE 7)	-.1428 (3.20)	0.1713	-.2075 (4.66)	0.1730	0.1694
DUMMY (TYPE 8)	0.5326 (10.8)	0.3366	0.4426 (9.18)	0.3314	0.3258
R2	0.24		0.84		
OBSERVATIONS	2658		2658		

note:[1] ALPHA values are calculated as;
ALPHA1 = EXP(INTERCEPT)
ALPHAk k=2..8 = EXP(Intercept+Coefficient)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Table A1:07 VANCOUVER: Household ALPHAs

As earlier noted these estimated ALPHA values are derived using the demand for "new" housing services functional relationship but data for existing dwellings. As a result these estimates are biased. The nature of this bias can be evaluated by considering a simplified utility function where zonal characteristics are ignored and the price per unit of "housing" service is set to Pj for all dwellings, (de Leeuw and Struyk (1975)). With these simplifications, the utility-maximising quantity of "housing" services for "model" household "i", Qj, is given as:

$$Qj = \frac{Yi}{Pj} * [ALPHAi - GAMMA1*ALPHAi*(1-ALPHAi)*(1.-\frac{Pj}{PN'})]$$

... A1:06

The expenditure/income ratio for household "i" can thus be written as:

$$\frac{Pj*Qj}{Yi} = ALPHAi - GAMMA1*ALPHAi*(1-ALPHAi)*(1.-\frac{Pj}{PN'})$$

... A1:07

This indicates that the estimated ALPHA values should be adjusted upward by an amount of GAMMA1*ALPHAi*(1-ALPHAi)*(1-Pj/PN'). The final column in Figure A1:07 indicates the adjusted ALPHA values, calculated by assuming GAMMA1 = 0.75 and utilizing the ratio for Pj/PN' calculated in deriving the 1971 "model" dwellings. (See Section A1.454: Hedonic Price indicies for details of the calculation of the equivalent values for Pj and PN'). Since the amount of this adjustment is a function of the GAMMA1 value being employed in a simulation, the solution algorithm program performs this adjustment taking as input the Pj/PN' ratio.

Further examples, indicating the magnitude of the adjustment, are reported on a CMA basis in Figures A3:08.

The second part of this section briefly details a side-line study that evaluates the sensitivity of expenditure-income ratios to income levels. It involves the estimation of alternatively specified regression equations where the expenditure-income ratio is assumed dependent on income levels in addition to TYPE grouping. It should be noted that the nature of the "model" income specification (Equation A1:05) implicitly assumes that the expenditure-income ratio declines with regards reported income, while constant with regards "model" income. This arises from the nature of the "weighting" involved in the "smoothing" process.

The first modified regression equation estimated simply stratifies the households into four income groups by introducing INCOME group binary dummies:

$$\log\left(\frac{R}{Yi}\right) = \log(ALPHA1) + TYPE\ dummies + DY2 + DY3 + DY4 \qquad \text{....A1:08}$$

where,

DY2,DY3,DY4 are binary dummies corresponding to INCOME groups.

In order to obtain uniform INCOME groupings, the boundary points were set in terms of the TYPE mean income, (MYtype), at 0.75*MYtype, MYtype and 1.25*MYtype, with the intercept dummy variables corresponding to the three highest income groupings.

The next two functional forms estimated involved specifying ALPHA(k) as a general function of "model" income as

ALPHAi = aYi**x , or alternatively as

log(ALPHAi) = log(a) + x*log(Yi)

with a substitution being made for log(ALPHA1) in Equations A1:04.

The first of these two specifications results in shifts in the function by TYPE; the latter incorporates additional structural shifts by INCOME group.

The final functional form estimated involves specifying a change in the structural shape of the income component, by INCOME group. This corresponds to estimating alternative exponents of the income function for the four income groups. The estimating equation is of the form:

$$\log\left(\frac{R}{Yi}\right) = \log(a) + \text{TYPE dummies} + DYk*\log(Yi)$$

for k=1...4

....8:4

The expression Yi incorporated in these specifications is the individual household's "model" income and as with the previous equations, these equations are estimated employing a permanent income elasticity of 0.6 in deriving both the expenditure to income ratio and logarithmic function of income.

As anticipated, the "goodness of fit" of the regression models increased significantly with the introduction of firstly the income group stratification and then the direct specification of income. An indication of the variation is given by the reported "R2s" on the OLS regression equations in Table A1:08. Additional details on the "model3" regressions are reported in APPENDIX: Figures A3:09(b).

	R2s for OLS equations				
	model1	model2	model3	model4	model5
Calgary	0.23	0.48	0.61	0.62	0.63
Kitchener	0.23	0.50	0.63	0.63	0.64
Quebec City	0.20	0.42	0.57	0.59	0.59
St. John's	0.07	0.26	0.47	0.50	0.50
Saskatoon	0.22	0.39	0.49	0.51	0.51
Sudbury	0.17	0.38	0.50	0.51	0.51
Vancouver	0.24	0.49	0.60	0.60	0.60
Winnipeg	0.24	0.44	0.57	0.59	0.59

note: model1; log(ALPHA1)+TYPE dummies
model2; log(ALPHA1)+(TYPE+"Y" group) dummies
model3; log(a)+log(Yi)+TYPE dummies
model4; log(a)+log(Yi)+(TYPE+"Y" group) dummies
model5; log(a)+TYPE dummies+("Y" group dummies*log(Yi))

Table A1:08 Expenditure Ratios: R2s for O.L.S. Equations

An example set of results obtained for Vancouver under "model3" are outlined in Table A1:09; columns 1 and 2 for the O.L.S. and W.L.S. models respectively.

The exponent on the income variable ranges from -0.7212 for Saskatoon to -0.8168 for Calgary indicating that the expenditure-income ratio declines on average with income at a rate slightly less than as a function of the reciprocal. The reported "at mean" RATIO values correspond to values obtained by substituting the TYPE groups mean incomes into the estimated equation. Given the skewed nature of the income distribution, (meadian less than mean), these values as expected are lower than the constant by TYPE ALPHA values, corresponding to a declining marginal propensity. The reported "lowest" and "highest" show the range of the resulting RATIOs by TYPE.

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Yi}\right) = \log(a) + \log(Yi)$$

	O.L.S. MODEL	W.L.S. MODEL			
			RATIOs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	10.153 (68.1)	9.8026 (68.2)	0.1964	0.1477	0.3488
DUMMY (TYPE 2)	0.0342 (1.12)	-.0382 (1.21)	0.1271	0.0779	0.2666
DUMMY (TYPE 3)	-.0511 (1.41)	-.0873 (2.23)	0.1378	0.1039	0.2283
DUMMY (TYPE 4)	-.0371 (1.13)	-.0927 (2.80)	0.1140	0.0724	0.2523
DUMMY (TYPE 5)	-.0257 (0.77)	-.0889 (2.51)	0.1895	0.1131	0.3618
DUMMY (TYPE 6)	0.1879 (0.57)	-.0103 (3.58)	0.1963	0.1188	0.4596
DUMMY (TYPE 7)	-.0901 (2.78)	-.1169 (3.58)	0.1519	0.0911	0.3981
DUMMY (TYPE 8)	-.0349 (0.92)	-.1230 (3.30)	0.2838	0.1767	0.5968
LN INCOME	-.8050 (48.8)	-.7643 (47.7)			
R2	0.60	0.91			
OBSERVATIONS	2658	2658			

note: [1] ALPHA values were calculated by the solution algorithm program by substituting the household's "model" incomes. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Table A1:09 VANCOUVER : Household Income-Expenditure Ratios.

An indication of the sensitivity to income level of the expenditure-income ratios associated with the alternative estimating equations is given in Table A1:10, where the range of values for Vancouver is reported on a TYPE basis across the alternative equations.

	ALPHAs	model2		model3		model4		model5	
TYPE		low	high	low	high	low	high	low	high
1	.2129	.1544	.3338	.1477	.3488	.1555	.3522	.1550	.3522
2	.1353	.0960	.2076	.0779	.2666	.0813	.2738	.0816	.2734
3	.1431	.1031	.2229	.1039	.2283	.1099	.2305	.1099	.2303
4	.1230	.0866	.1871	.0724	.2523	.0757	.2598	.0760	.2594
5	.2134	.1392	.3008	.1131	.3618	.1167	.3660	.1167	.3659
6	.2190	.1491	.3223	.1188	.4596	.1233	.4736	.1233	.4734
7	.1730	.1181	.2553	.0911	.3981	.0943	.4128	.0944	.4123
8	.3314	.2108	.4556	.1767	.5968	.1831	.6083	.1821	.6090

Table A1:10 Vancouver: ALPHA value ranges

A problem highlighted by specifying the ALPHAs as a function of "model" income is that households with extremely low incomes, (less than $1,000 per annum), may have a reported expenditure to income ratio in excess of 100%. The main reason for this problem is that reported incomes do not include welfare payments or housing subsidies. The magnitude of this income problem is indicated in Table A1:11, where the range of the actual ratios calculated from reported expenditures and incomes is indicated on a CMA basis, along with the proportion of households with reported ratios in excess of 0.90 (90%).

CMA	range of actual RATIOs		Household's with RATIOs in excess of 90%	
	lowest	highest	number	%
Calgary	0.0087	35.4	5,074	4.2
Kitchener	0.0081	15.4	2,144	3.2
Quebec City	0.0034	13.9	4,024	3.2
St. John's	0.0051	129.7	1,240	4.2
Saskatoon	0.0077	13.0	1,050	2.7
Sudbury	0.0038	14.4	1,072	2.7
Vancouver	0.0032	23.1	11,854	3.4
Winnipeg	0.0096	14.2	5,917	3.6

source: SHU data set. Values adjusted at mean.

Table A1:11 ACTUAL Expenditure-Income Characteristics by CMA

Table A1:08 indicates that on average over 3% of the households report excessively high expenditure to income ratios. This factor adds further to the problems with the estimated ALPHA parameters.

A1.4 ORIGINAL MODEL: COMPUTERIZED MANIPULATIONS

The majority of the data manipulation is performed by tailored utility FORTRAN computer programs that manipulate the two census files, CMA61.INPUT and CMA71.INPUT, and the SHU data set, CMA.SHU, into input data for the solution algorithm program "SIM01.FORT". In the following Section the techniques used, the underlying theoretical implications and the manipulations performed are detailed program by program.

The two initial Sections cover the programs developed to determine the allocation of the "zones" that spatially submarket the existing stock and calculate zonal statistics for both 1961 and 1971. Subsequent sections review the techniques used to create the "model" households and "model" dwellings, respectively. The final Section outlines the more complicated processes involved in generating the data necessary for calibrating the MODELs for a particular CMA; the first part details the data generation for the "GAMMA" calibration while the second contains the "BETA" calibration process.

Each section is structured to provide a brief outline of the process involved, a review of the computational process and pertinent details on how the program is run. Complete listings of the FORTRAN source cards are contained in APPENDIX A4.

A1.41 DELINEATION OF ZONES: Clustering

Outlined in this section is the technique used to delineate the zones for an urban area and to generate the data files used for zonal identification in the other utility programs. This has been achieved by using a UBC system-dependent clustering program together with the program "ZONE.FORT".

The "residential" services provided by a housing unit are a combination of the "housing" services associated with the actual built structure and those associated with the characteristics of the neighbourhood in which the unit is located. The demand and supply equations of the simulatuion analysis use the "housing" service in their specification. Quantities of "residential" services, not "housing" services are directly observable in the market and therefore the latter must be estimated. Housing service, being a location-free measure of the quantities of services, can be calculated from observed residential services using a neighbourhood ADJUSTOR. To obtain such ADJUSTORs spatial aggregation of the housing units into suitable zonal clusters is required.

A1.411 Outline

In delineating such zonal clusters within a metropolitan housing market an increase in the number of zones will increase the spatial sensitivity of the simulation framework. But in increasing the number of zones the number of "model" dwellings per zone is reduced. In so doing, the accuracy of the representation of the market by the "model" dwellings is reduced as important "value" variations are obscured. Computational efficiency requires a

trade-off between spatial sensitivity, the number of "model" dwellings per zone and the total number of model dwellings. While the Urban Institute in their implementations restricted the number of zones to four or five, the "stacked" allocation algorithm allows the efficient usage of ten to twelve zones. The following sections outline the technique employed in selecting the zonal configurations in this study and the generation of data files for subsequent use by other programs.

Housing services must be isolated from residential services since the household's utility function treats these services separately from those attached to the neighbourhood or zonal attributes. With household utility considered as a function of access to employment opportunities and neighbourhood externalities, in addition to "housing" services, it follows that within-zone homogeneity with respect to these factors should be the major criteria for determining zonal boundaries.

Distance in time (when available) from local sources, or as an alternative, the number of miles from centres of employment expressed as an index, is the major travel time criterion in determining boundaries. Since such values are exogenous in the model, period-end values can be used without raising the problem of a simultaneous-relationship bias.

With neighbourhood conditions, major political and physical boundaries, and average income or property value per household as a wealth indicator are the two major criteria. Since the model is attempting to explain property values, period-end values cannot be considered in determining boundaries. Values in the initial year will be utilized instead. On the other hand, the restriction does not apply to information on physical and political boundaries.

In the Urban Institute studies, zones are delineated using personal judgement. Tentative boundaries were drawn by placing primary emphasis on the racial and rent characteristics. Adjustments were then made for sharp departures from the zonal averages of the other characteristics. In a few instances, "pockets" were found within otherwise homogeneous zones and a zone was thus defined to include two non-contiguous parts.

1.412 Clustering

This study employs cluster analysis in delimiting zones. The clustering "keys" are 1961 Census Tract rents, incomes and housing values as wealth criteria; distance from the central city as an access criterion.

Cluster analysis is a simple statistical process that sorts items into groups according to the "keying" characteristics selected. This technique has been widely used in the biological sciences, but seldom in the social sciences. However, a significant study of its applicability with regard to the clustering of census tracts was recently undertaken by Patterson(1972). There are generally two categories of clustering algorithms available: hierarchical and non-hierarchical. The former provides a complete set of clusters, with the number of groups ranging from one to the number of observations, while the latter requires the pre-specification of the number of groups. In this study the program UBC:CGROUP, written for the Computing Centre, University of British Columbia, was used. The algorithm employed is that of Ward (1963). This hierarchical-type program defines each item as a group and then reduces these groups by a

series of step decisions until all items have been classified into one or the other of two groups. The hierarchy of clusters generated allows the examination of zonal characteristics for different numbers of zones. An anticipated problem with this technique is that the clusters may be very diverse in size, but this factor will be compensated for when defining the "model" dwellings.

While clustering algorithms provide no criteria for selecting the optimal combination, the CGROUP program provides an "error value", which in turn gives an indication of "natural" groups. The criterion for selection of a specific number of groups is dependent primarily on the desired application. In this study, the number of zones must lie in the range of five to twelve. Selection can be based on that group associated with the most noticeable error jump within this range. In the analyses conducted to date, the number of zones has been constrained to five to simplify between-cities comparisons.

It should be noted that clustering is undertaken without enforcing a contiguity constraint. Since zones do not have to be continuous, pockets may be created. Figure A1:01 and Figure A1:02 shows the clusters achieved for Vancouver assuming five and ten zones respectively. The change apparent as the number of zones is reduced from ten to five is simply the aggregation of previously contiguous zones.

A1.413 Zonal Allocations: "ZONE.FORT"

A program, "ZONE.FORT", has been developed to create data files indicating to which zone individual census tracts have been allocated. As input it takes either the output from the CGROUP

clustering program or actual 1961 allocations.

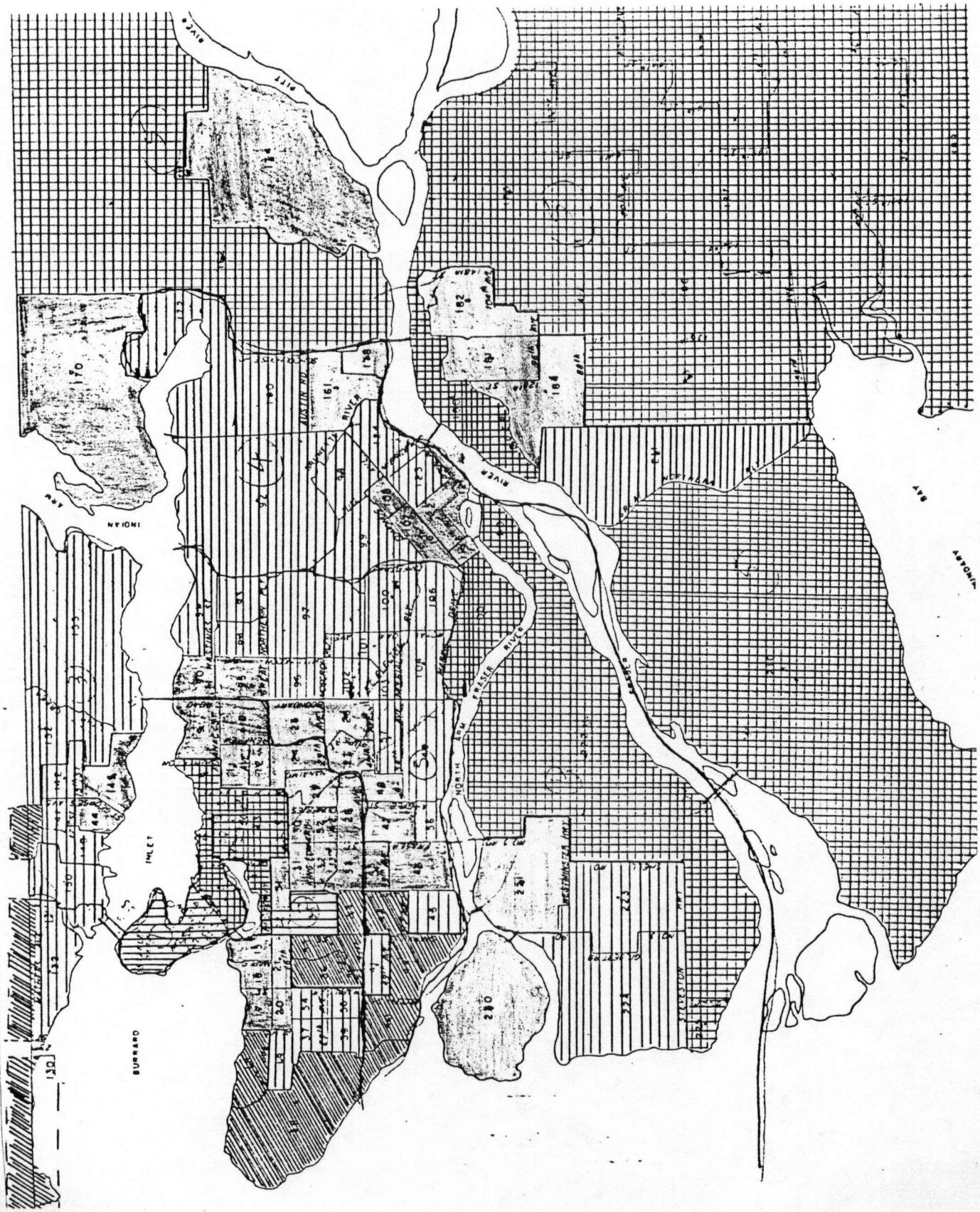


Figure A1:01 VANCOUVER: CLUSTERING (5 zones)

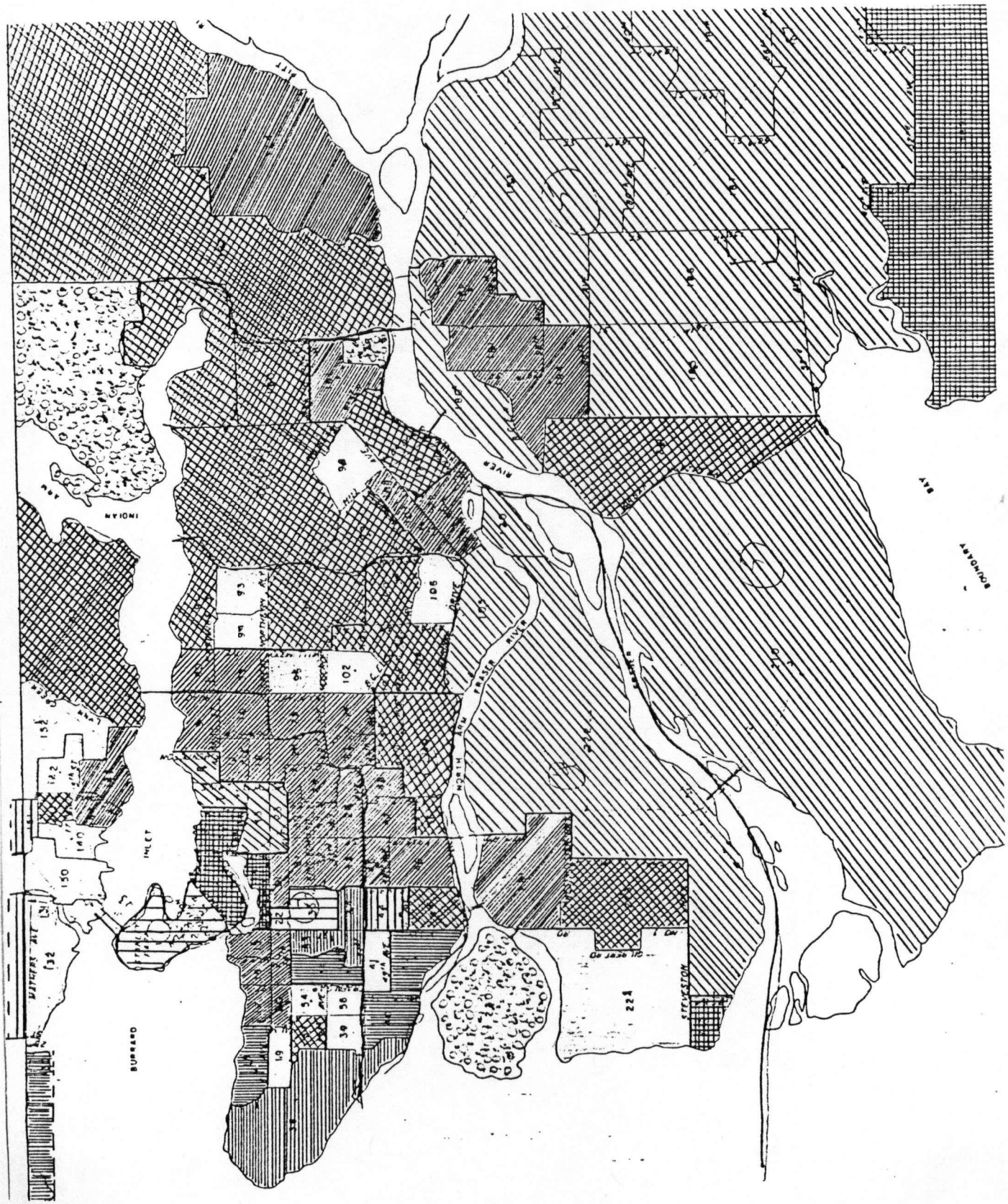


Figure A1:02 VANCOUVER: CLUSTERING (10 zones)

In the former case both 1961 and 1971 data files will be created; in the latter case only the 1971 data file is created. In addition to creating these files, output of selected statistics for each zone can be obtained. Such data will indicate inter-zonal heterogeneity and intra-zonal homogeneity.

This program has been written in MTS:FORTRAN. If the output from CGROUP is being input, the program will initially create CMA61.ZN; the 1961 zonal allocation file. It then uses this file as input for the subsequent creation of the 1971 zonal allocation file, CMA71.ZN along with CMA71.TAB. The latter indicates the correlation between 1961 and 1971 census tracts. The general structure of the program is outlined in the following flow chart (Figure A1:03).

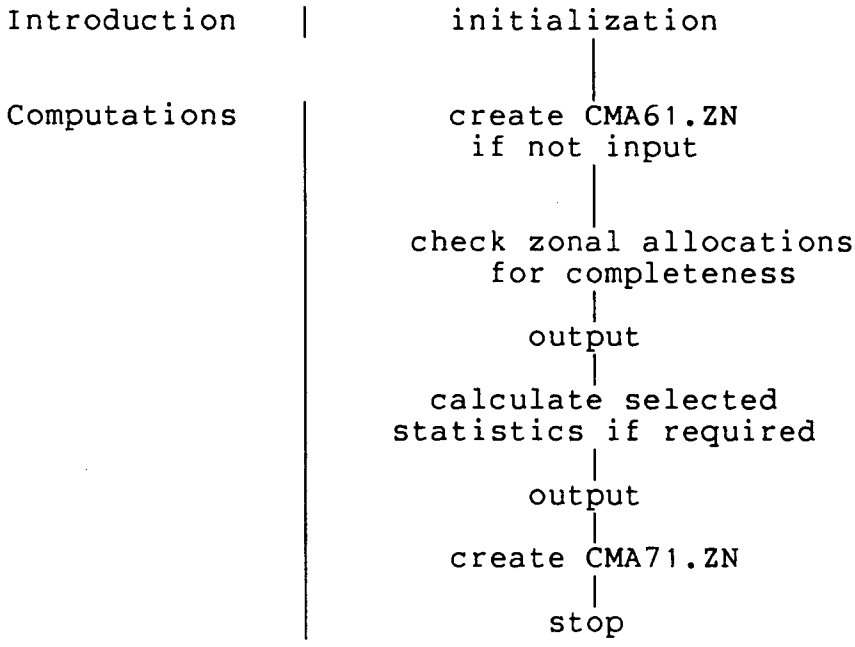


Figure A1:03 Flow Chart of Program Structure: "ZONE.FORT"

A1.414 Program Outline

Input to the program "ZONE.FORT" is obtained from several sources. The main input is from the system-dependent cluster analysis program which can be modified to match alternative clustering program outputs. Additional input files are;

1. 1961 census tract numbers and selected data on CMA61.INPUT
2. 1971 census tract numbers from CMA71.INPUT
3. cross-tabs between 1961 and 1971 from CMA71.TAB

Output includes a review of the clustering of the 1961 census tracts, the maximum, minimum, mean and standard deviation of selected 1961 data and the zonal allocation of files. The example output in this description is based on Vancouver, delineated into five zones.

A single control card is required for "ZONE.FORT".

1. control and title card (2I1,I2,5A4)

This card consists of four data fields. The first (column 1) indicates whether CMA61.ZN is to be input or created, (0 if input; 1 if to be created from CGROUP output). The second field (column 2) indicates whether the calculations on the selected 1961 data are required, (0 if not required; 1 if required). Field three (columns 3-4) indicates the number of zones to be created or specified on CMA61.ZN. The fourth field (columns 5-24) is for the title. This is written as part of the first record on created zonal allocation files for later identification. If CMA61.ZN is input, the program checks to ensure that the specified number of zones corresponds to that on the first record of CMA61.ZN.

A1.415. Computations

In creating CMA61.ZN, the title record is written (e.g. "1961:05 title"), then the cluster output is simply scanned for the cluster size corresponding to the required number of zones. The cluster number for each census tract is then transfered to the output file, one tract per output record. The created file is then rewound for use as an input file.

Next the program loads the 1961 and 1971 census tract numbers from the respective INPUT files. A check is made for unallocated 1961 census tracts, with these being allocated to the next highest zone. That is, if only those tracts allocated to zones 1-4 are input via CMA61.ZN, the remaining tracts will be allocated to zone 5. If in creating the additional zone the number of zones does not correspond to the control number, execution is stopped after the output of the zonal organisation data. This output includes a listing of the number of tracts allocated to each zone.

```
*** 1961 ZONAL ORGANIZATION :Vancouver 05
*NUMBER:ZONES    5  :CT'S  120
:ZONE   :C.T. COUNT
   1         19
   2         35
   3          5
   4         48
   5         13
```

The program then transfers to calculate the statistics on the selected data. The actual variables on which calculations are preformed are indicated in the following example output.

(ZONE 1)

	%S_D.	%O_O.	%RENTAL	%20_45	%46_59
MIN	0.055	0.070	0.054	0.153	0.093
MAX	0.986	0.946	0.930	0.849	0.599
MEAN	0.644	0.620	0.380	0.520	0.335
S.D.	0.372	0.339	0.339	0.220	0.152

(ZONE 2)

	%S_D.	%O_O.	%RENTAL	%20_45	%46_59
MIN	0.169	0.085	0.124	0.071	0.0
MAX	0.965	0.876	0.915	0.728	0.718
MEAN	0.661	0.617	0.383	0.389	0.286
S.D.	0.255	0.239	0.239	0.144	0.191

(ZONE 3)

	%S_D.	%O_O.	%RENTAL	%20_45	%46_59
MIN	0.944	0.905	0.036	0.040	0.085
MAX	0.981	0.964	0.095	0.683	0.890
MEAN	0.962	0.927	0.073	0.290	0.608
S.D.	0.015	0.022	0.022	0.247	0.312

(ZONE 4)

	%S_D.	%O_O.	%RENTAL	%20_45	%46_59
MIN	0.244	0.0	0.056	0.0	0.0
MAX	1.000	0.944	1.000	0.688	0.838
MEAN	0.850	0.757	0.243	0.259	0.598
S.D.	0.142	0.176	0.176	0.130	0.179

(ZONE 5)

	%S_D.	%O_O.	%RENTAL	%20_45	%46_59
MIN	0.838	0.650	0.131	0.199	0.364
MAX	0.978	0.869	0.350	0.546	0.730
MEAN	0.927	0.783	0.217	0.341	0.547
S.D.	0.044	0.077	0.077	0.116	0.124

TOTAL

	%S_D.	%O_O.	%RENTAL	%20_45	%46_59
MIN	0.055	0.0	0.036	0.0	0.0
MAX	1.000	0.964	1.000	0.849	0.890
MEAN	0.775	0.704	0.296	0.348	0.460
S.D.	0.246	0.232	0.232	0.179	0.228

(ZONE 1)

	CONDIT.	BEDRMS	A_RENT	A_INCOME	A_VALUE
MIN	0.735	1.083	66.986	45.114	15.227
MAX	0.932	2.986	125.960	76.181	34.455
MEAN	0.842	2.348	100.955	63.665	21.066
S.D.	0.049	0.739	13.992	10.055	4.423

(ZONE 2)

	CONDIT.	BEDRMS	A_RENT	A_INCOME	A_VALUE
MIN	0.307	1.536	55.893	26.235	11.119
MAX	0.874	2.639	91.201	52.931	17.044
MEAN	0.695	2.201	78.336	44.887	12.784
S.D.	0.140	0.302	8.966	6.550	1.650

(ZONE 3)

	CONDIT.	BEDRMS	A_RENT	A_INCOME	A_VALUE
MIN	0.908	2.982	121.698	73.453	20.092
MAX	0.990	4.016	191.566	93.850	29.606
MEAN	0.946	3.300	148.841	86.016	26.897
S.D.	0.036	0.428	26.073	8.156	3.862

(ZONE 4)

	CONDIT.	BEDRMS	A_RENT	A_INCOME	A_VALUE
MIN	0.601	1.561	35.714	45.567	0.000
MAX	1.000	2.828	105.905	61.959	17.299
MEAN	0.814	2.458	82.084	53.529	13.802
S.D.	0.076	0.217	14.040	3.631	2.710

(ZONE 5)

	CONDIT.	BEDRMS	A_RENT	A_INCOME	A_VALUE
MIN	0.445	1.965	36.629	39.531	8.881
MAX	0.867	2.694	68.222	47.370	13.939
MEAN	0.692	2.369	58.594	43.806	11.811
S.D.	0.108	0.203	9.292	2.369	1.435

TOTAL

	CONDIT.	BEDRMS	A_RENT	A_INCOME	A_VALUE
MIN	0.307	1.083	35.714	26.235	0.000
MAX	1.000	4.016	191.566	93.850	34.455
MEAN	0.776	2.391	84.214	52.913	14.985
S.D.	0.121	0.430	21.586	11.323	4.723

The zonal allocations of the 1971 census tracts are derived by matching cross-tab values from CMA71.TAB to the zonal allocations in CMA61.ZN. Any 1971 census tract with a null 1961 census tract value (assumed to be annexed) is assigned to a new zone; one higher than the specified number. When 1971 "model" dwellings are created (see Section: A1.45 Calibration by Simulation Data) this zone of annexed tracts is assigned to a nominated existing zone. Any 1971 tract not included in CMA71.TAB is indicated as not being assigned and will be rejected in the subsequent utility programs that employ CMA71.ZN. After the allocations have been made, the file title line on CMA71.ZN is written, followed by one record for each tract.

A1.42 NEW CONSTRUCTION and ZONAL CHARACTERISTICS: "CZONE.FORT"

Outlined in the following section is the computer program "CZONE.FORT" which reviews actual construction activity over the decade 1961-1971 and generates the average zonal characteristics for each of the initial zones together with the artificial "zone of new construction". Calculated by zone for input to the simulation program, "SIM01.FORT", are estimates of the "relative" wealth of the zone and an accessibility index.

The use of an artificial zone of new construction, rather than distributing the new construction throughout a metropolitan area, follows the technique employed by the U.I. Apart from the obvious simplification achieved in the formulation of the simulation algorithm, their justification for the use of this device is based on the observation that many new dwellings are located in recently developed suburban areas which tend to have characteristics different from older suburbs and especially from central cities, (de Leeuw and Struyk (1975, p 74)). The output from this program consists of a break-down by census tract of actual construction, allowing consideration of the reasonableness of this assumption. In addition, this program has been structured to allow simple conversion to provide data necessary for a simulation routine that can distribute new construction in accordance with the actual patterns.

The program is written in MTS:FORTRAN utilizing only IBM library functions, making it suitable for IBM system usage in batch mode. It is structured to cross-tab between equivalent 1961 and 1971 census tracts, thus allowing the calculation on a zonal basis of equivalent 1961 and 1971 characteristics.

A1.412 General Outline

Input to this program is drawn from five sources;

1. 1961 census data from the file CMA61.INPUT
2. 1971 census data from the file CMA71.INPUT
3. 1961 zonal allocation of census tracts from CMA61.ZN
4. 1971 zonal allocation of census tracts from CMA71.ZN
5. cross-tabs between 1961 and 1971 from file CMA71.TAB

Output consists of distributions by census tract of construction activity and the calculated contribution of each tract to the zone of new construction. In addition, for each zone the required input for the simulation program, "SIM01.FORT", may be written to file or punched on cards. This description employs a set of computations based on Vancouver data as an example.

A1.422 Input and Initialization

Two program control cards are required.

1. control and title card (2X,I2,5A4)
2. the required number of 1971 "model" dwellings (I3)

The first card consists of three data fields; the first (columns 1-2) is blank, the second (columns 3-4) contains the number of zones, and the third (columns 5-24) is the title. On loading the title card, the program checks to ensure that the number of zones corresponds to that specified on CMA61.ZN and CMA71.ZN. An error stops execution. With the second card, one field (columns 1-3), is used in calculating the equivalent required number of 1961 "model" dwellings after adjustments are made for annexed zones.

A1.423 Zone of New Construction

The distribution of new construction during the 1961-1971 decade is calculated from the 1971 census data; distribution of dwellings by age. Those dwellings constructed in the periods 1961-1965, 1966-1970 and in 1971 are summed to give the number of new dwellings. The percentage of new construction is calculated by census tract in terms of the tract's total stock and the CMA's total new stock. Equivalent statisitics are also derived by zone. To calculate the characteristics of the zone of new construction 1961 data on RENT, INCOME, VALUE and ACCESS are obtained from CMA61.INPUT, using CMA71.TAB to cross-tab for the equivalent 1961 census tract. Annexed 1971 tracts are assigned the CMA's mean value for RENT, INCOME and VALUE, and the maxiumum value for ACCESS.

The characteristics of the zone of new construction are taken as the weighted sum of the individual tract's characteristics, the weighting being the tract's proportion of the CMA's new stock. The detailed calculations are output by 1971 census tract - the equivalent 1961 tract being indicated - grouped by zonal aggregation, followed by a summary for the CMA

Selected data drawn from these outputs are presented on a CMA basis in Figures A3:01 for the eight CMAs. For the eight CMAs the percentage of new dwellings in the stock at decade-end ranged from a low of 25.2% for Winnipeg to a high of 39.7% for Calgary. In the majority of the CMAs new construction is uniformly distributed across all six zones. The exception is Calgary where the annexed tracts account for a higher than average level of new construction. Example output for a single zone is as follows.

*** DISTRIBUTION of NEW CONSTRUCTION during DECADE: Vancouver 05

(Zone 3)

tract	% NEW	% CMA stock	% CMA new		RENT	INCOME	VALUE	ACCESS
10	46.1	0.822	1.124	actual71	225.	18139.	50476.	38.
(44)				actual61	192.	4348.	27948.	38.
				weighted	2.153	48.871	314.2	0.42714
20	20.0	0.188	0.112	actual71	240.	21226.	48441.	32.
(34)				actual61	148.	3659.	28791.	32.
				weighted	0.165	4.082	32.1	0.03570
21	2.8	0.362	0.030	actual71	150.	27289.	55829.	27.
(53)				actual61	122.	4386.	29606.	27.
				weighted	0.036	1.301	8.8	0.00801
117	27.7	0.470	0.386	actual71	195.	15197.	37959.	49.
(151)				actual61	137.	5719.	20092.	49.
				weighted	0.527	22.058	77.5	0.18898
120	36.2	0.315	0.338	actual71	285.	15897.	38044.	49.
(151)				actual61	137.	5719.	20092.	49.
				weighted	0.462	19.337	67.9	0.16567
121	5.9	0.398	0.069	actual71	230.	15569.	34811.	49.
(151)				actual61	137.	5719.	20092.	49.
				weighted	0.095	3.969	13.9	0.03401
122	50.8	0.184	0.277	actual71	215.	13859.	38862.	49.
(151)				actual61	137.	5719.	20092.	49.
				weighted	0.378	15.833	55.6	0.13565
134	28.4	0.378	0.318	actual71	195.	19466.	46584.	43.
(131)				actual61	147.	5576.	28049.	43.
				weighted	0.467	17.735	89.2	0.13677
135	29.3	0.479	0.416	actual71	250.	22673.	53214.	43.
(131)				actual61	147.	5576.	28049.	43.
				weighted	0.610	23.176	116.6	0.17872
TOTAL	28.8	3.596	3.069	actual71	220.	18880.	45809.	42.
				actual61	151.	5130.	25195.	42.
				weighted	4.892	156.4	775.8	1.31

Total Dwellings in ZONE :61 8859.

Total Dwellings in ZONE :71 12425.
Built as of 1961 8848.
Built after 1961 3577.

note: The weighted values are the 1961 contributions to the "zone of new construction".

*** DISTRIBUTION of NEW CONSTRUCTION during DECADE: Vancouver 05

TOTAL number of DWELLINGS: 345530.
TOTAL number of NEW DWELLINGS: 116542.

(Total CMA)

Zone	% NEW	% CMA stock	% CMA new		RENT	INCOME	VALUE	ACCESS
1	34.4	17.716	18.082	actual71	150.	10572.	34979.	26.
				actual61	100.	3633.	21067.	26.
				weighted	17.756	621.3	3912.0	3.77
2	20.8	25.953	16.010	actual71	114.	8221.	25267.	29.
				actual61	79.	3169.	12877.	29.
				weighted	12.598	496.6	2070.3	4.66
3	28.8	3.596	3.069	actual71	220.	18880.	45809.	42.
				actual61	151.	5130.	25195.	42.
				weighted	4.892	156.4	775.8	1.31
4	40.6	39.031	46.990	actual71	136.	10241.	27829.	81.
				actual61	83.	4027.	14250.	81.
				weighted	38.984	1895.1	6704.4	40.62
5	39.1	9.103	10.541	actual71	118.	9410.	26786.	153.
				actual61	58.	2496.	12166.	153.
				weighted	5.892	264.8	1310.9	15.84
A	38.9	4.600	5.310	actual71	102.	8516.	25424.	220.
				actual61	84.	3623.	14985.	220.
				weighted	4.472	192.4	795.7	11.68
TOTAL	33.7	1.000	1.000	actual71	133.	9931.	28871.	69.
				actual61	85.	3616.	15339.	69.
				weighted	84.594	3626.5	15568.9	77.88

note: Zone "A" is the zone of annexed tracts.

The final output from this section of the program is a data set containing the zonal characteristics. A record containing the identification code, the average income and the average access value for each zone, plus an additional record for the zone of new construction, are written to file or alternatively punched on cards. The average income value is the 1971 mean while the access value is the 1961 mean; in the case of the "zone of new construction" they are the weighted means.

A listing of the data output to file is as follows. Zone "6" is the "zone of new construction".

*** ZONAL DATA WRITTEN to FILE.

```
   Vancouver 05          -
40 110572   26           |
40 2 8221   29           |
40 318880   42           |  zonal parameters
40 410060   96           |
40 5 9410  153           |
40 6 9931   69           -
```

A1.424 Distribution of "Model" Dwellings

The final set of computations performed by this program involves estimating the required number of 1961 "model" dwellings that corresponds to the decade-end number being employed in the simulations. A problem arises inasmuch as the majority of the CMAs have undergone annexation during the decade, which means that the 1971 dwelling total includes pre-decade stock not represented in 1961 totals on CMA61.INPUT. To counter this the 1961 number of dwellings is artificially inflated when estimating the number of "model" dwellings. While such an adjustment can be made for completely annexed tracts, the data sets are too aggregated to adjust for partially annexed tracts and the total adjusted 1961 dwellings may still underestimate the true adjusted total for some CMAs. To calculate the adjusted total, the ratio of pre-1961 dwellings existing in 1971 for the unannexed tracts to the total 1961 dwellings from CMA61.INPUT is calculated. From CMA71.INPUT, the number of pre-1961 dwellings existing in 1971 for <u>all</u> tracts is then divided by this ratio to yield the 1961 total adjusted for annexation. The required number of 1961 "model" dwellings is then calculated by dividing this total by the 1971 ratio of actual dwellings per "model". An example of this calculation for

Vancouver is as follows. Similar details for the CMAs are given in Figures A3:04.

*** NUMBER of "MODEL" DWELLINGS

1971 DWELLINGS:	Total	345530.
	: New	116542.
1961 DWELLINGS:	Total	228392.
	: RATIO of EXISTING UNANNEXED/TOTAL	96.0%
	: TOTAL 1961 EXISTING in 1971	228988.
	: TOTAL 1961 adjusted for ANNEXED	238502.

"MODEL" DWELLINGS		
1971	"model" dwellings	100
	Ratio ACTUAL/"model"	3455
1961	"model" dwellings	69

A1.43 ORIGINAL MODEL:"Model" Households: "HH1.FORT"

The characteristics of the "model" households are derived from the 1974 Survey of Housing Units data. These data are used to identify the TYPE grouping of the individual households and to calculate the relative income distributions. The simulation program has the capability to handle up to ten different types of households which may be distinguished in terms of their preferences for consuming housing vis a vis other goods and services. In the ORIGINAL MODEL, eight such household TYPEs have been designated as follows:

GROUP	1	2	3	4	5	6	7	8
Head's age	<30	30-64	<30	30-64	65+	<30	30-64	65+
Spouse	Y/N	Y/N	Yes	Yes	Yes	No	No	No
Children	Yes	Yes	No	No	Y/N	No	No	Y/N

A restriction is placed on the number of household TYPEs, as each marginal increase in the number of type groups decreases the number of "model" households per type group. The resultant stretching of the "model" households across a type group's income continuum reduces the accuracy of the important income parameter. A trade-off between type representation and "income" accuracy has to be made, given the constraint on the total number of "model" households feasable to handle. The program "HH1.FORT" has been developed to generate the "model" households from the household characteristics.

A1.431 General Outline

The main data input for this program is derived from the file CMA.SHU, with additional input from the control deck. Output

consists of an overall income profile indicating the sample distribution by TYPE income continuums and a review of the "model" household characteristics, together with data records for each individual "model" household and household TYPE for input to the simulation program.

A1.432 Input

Three program control cards are required.

1. control and title card (I2,2X,5A4)
2. income deflators to adjust from 1974 to 1971 income (8F54)
3. the required total number of "model" households (I3), or the required number of "model" households per type (10I3)

The control and title card consists of three data fields; the first field (columns 1-2) indicates whether or not the program forces the fitting of the required number of "model" households. The second, (columns 3-4) is blank and the third (columns 5-24) is for the title. In field 1, a "00" value indicates a required number; a "01" value indicates that the program is to select the best fit about the input value on card 3. If field 2 on card 3 is non-zero the program assumes a "00" value. The income deflators can be loaded for each individual household TYPE, or a single deflator for all types. The deflators' data card consists of ten fields each five columns wide, corresponding to the maximum of ten household types. The value for the deflators must lie in the range 0.5 to 1.0. A single value in field one is taken as a common deflator if all other fields are zero or blank. Card 3 has a total of ten fields. If field one is blank or set to one the program stops after outputing the distribution of income by TYPE. If field two is non-zero the program assumes that values are the required

number of "model" households by TYPE.

A1.433 Computation of Income and Population.

The initial operation of the program consists of sorting the individual households by type and allocating their income to the respective continuum. The input data observations are the household head's age, marital status and number of children, to identify the TYPE, the actual 1974 income and a household weighting value. The income value is the total income received from all sources during the calendar year 1973, by all members of the household who were fourteen years of age and over at the time of the survey. The household weighting is a computed factor used to expand the sample of reporting households to a predetermined population size. These weights are based on the sample size, the basic selection probability for each unit chosen and a non-response factor. In allocating an input observation to the respective income continuum, the income is deflated by the relevant input deflator and the asssigned value is set equal to the weighting factor. That is, the weighting factor is taken as the represented number of households considered to have equivalent characteristics and incomes. The percentage distribution of households by type and deflated incomes are output as follows. The "number obs." indicates the number of actual sample households by type with "sum weights" indicating the corresponding population derived from the weighting factors.

*** % DISTRIBUTION of INCOMES by HOUSEHOLD TYPE: Vancouver
source: SHU 1974 survey data deflated

GROUP:	1	2	3	4	5	6	7	8
Head's age	<30	30-64	<30	30-64	65+	<30	30-64	65+
Spouse	Y/N	Y/N	Yes	Yes	Yes	No	No	No
Children	Yes	Yes	No	No	Y/N	No	No	Y/N
INCOME range.								
1- 1000	7.4	0.2	0.3	0.5	1.3	2.8	1.7	5.9
1001- 2000	0.9	0.6	2.4	0.8	3.4	10.7	7.9	21.6
2001- 3000	5.4	1.4	3.5	3.2	15.0	8.3	5.6	25.2
3001- 4000	5.6	2.8	3.0	1.1	13.7	7.7	4.7	11.8
4001- 5000	11.2	2.3	4.7	4.4	19.1	7.7	5.9	10.1
5001- 6000	4.7	3.7	5.4	2.2	7.3	7.5	8.1	6.7
6001- 7000	13.0	6.0	5.8	5.5	7.9	11.2	8.8	5.8
7001- 8000	12.6	4.7	5.9	6.3	5.3	8.8	9.0	3.3
8001- 9000	8.0	8.8	7.1	6.2	3.4	10.4	10.8	2.2
9001-10000	6.6	7.7	7.1	5.2	2.9	4.4	3.7	1.0
10001-11000	7.7	9.5	4.3	8.1	3.1	4.4	5.3	0.9
11001-12000	2.3	6.9	5.8	6.4	3.9	3.7	4.9	1.0
12001-13000	3.0	8.9	6.5	5.7	2.9	2.4	5.5	1.1
13001-14000	1.9	5.8	8.6	4.2	1.4	0.4	4.5	1.8
14001-15000	2.9	2.9	6.8	4.2	0.8	1.1	0.8	0.4
15001-16000	3.0	3.0	2.8	5.1	1.2	1.5	1.2	0.6
16001-17000	0.9	3.1	7.6	3.6	1.1	0.9	3.4	0.4
17001-18000	2.3	5.4	5.3	3.0	0.2	0.7	0.2	0.1
18001-19000	0.0	2.9	2.4	4.0	1.1	0.3	0.3	0.1
19001-20000	0.0	1.6	1.8	3.8	0.3	0.8	1.4	0.0
20001-21000	0.0	2.3	0.3	3.2	1.3	0.0	1.0	0.0
21001-22000	0.5	2.2	0.0	2.2	0.5	0.3	0.4	0.0
22001-23000	0.0	0.5	1.4	2.2	0.0	0.8	0.1	0.0
23001-24000	0.0	0.5	0.3	1.4	0.2	0.4	0.8	0.0
24001-25000	0.0	1.8	0.0	0.2	0.0	0.9	0.0	0.0
25001-26000	0.0	0.8	0.0	0.4	0.4	0.2	0.5	0.0
26001-27000	0.0	0.1	0.3	1.8	0.0	0.0	1.2	0.0
27001-28000	0.0	0.3	0.0	0.1	1.2	0.0	0.3	0.0
28001-29000	0.0	0.4	0.5	0.5	0.0	0.0	0.0	0.0
29001-30000	0.0	0.2	0.0	0.2	0.6	0.0	0.1	0.0
30001-31000	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0
31001-32000	0.0	0.3	0.0	0.5	0.0	0.2	0.0	0.0
32001-33000	0.0	0.4	0.0	0.7	0.1	0.0	0.6	0.0
33001-34000	0.0	0.1	0.4	0.3	0.2	0.6	0.0	0.0
34001-35000	0.0	0.1	0.0	0.4	0.0	0.0	0.0	0.0
35001-36000	0.0	0.0	0.0	0.2	0.0	0.0	0.8	0.0
36001-37000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37001-38000	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0
38001-39000	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
>40000	0.0	1.2	0.0	1.7	0.5	0.8	0.5	0.0
number obs.	175	747	211	436	340	303	382	236
sum weights	12482	63434	13852	41890	23404	23150	35257	2198
mean	7513.	12662.	11106.	13594.	7033.	7436.	9045.	3960

A1.434 Number of "Model" Households

The decade-end number of "model" households is exogenously determined by the computational capabilities of the solution algorithm and must correspond to the decade-end number of "model" dwellings used for GAMMA calibration simulations. In current studies this number has been set arbitrarily at 100. This results in each "model" household representing up to 3500 actual households in the larger cities, one tenth this number in the smaller of the cities. These numbers compare favourably with the 19,000 actual to model ratio used in studies by the U.I.

The required number of "model" households is input on data card "3". From this input value the program calculates the corresponding number of "model" households per type group assuming a constant ratio of actual to model. This constant ratio results in partial "model" households being required in some or all of the TYPE groups. As the solution algorithm program can not handle partial "model" households or dwellings the number of "model" households per TYPE group is rounded to the nearest integer value. The resultant changes in the number of actual households per "model" are summed to give a specification ERROR value. This ERROR term indicates the degree of uniformity of the representation by TYPE. To provide a check on the relative value of the ERROR term, the ERROR associated with a range of specifications of the total number of "model" households are calculated. If the "adjusted" number of "model" households does not correspond to the "required" the program stops. The program must then be rerun with an actual distribution, adjusted to correspond to the required, as input on data card "3".

These calculations of the allocations, with the required

specification of 100 model households denoted, are output as follows:

*** NUMBER OF MODEL HOUSEHOLDS: Vancouver

	Raw #	Raw #/model	Adjusted #	Adjusted #/model	Raw #	Raw #/model	Adjusted #	Adjusted #/model
Totals	94.		94.		96.		96.	
(Group 1)	5.0	2504.	5.0	2496.	5.1	2452.	5.0	2496.
(Group 2)	25.3	2504.	25.0	2537.	25.9	2452.	26.0	2440.
(Group 3)	5.5	2504.	6.0	2309.	5.6	2452.	6.0	2309.
(Group 4)	16.7	2504.	17.0	2464.	17.1	2452.	17.0	2464.
(Group 5)	9.3	2504.	9.0	2600.	9.5	2452.	10.0	2340.
(Group 6)	9.2	2504.	9.0	2572.	9.4	2452.	9.0	2572.
(Group 7)	14.1	2504.	14.0	2518.	14.4	2452.	14.0	2518.
(Group 8)	8.8	2504.	9.0	2443.	9.0	2452.	9.0	2443.
Error:	4956.				Error:	4817.		

	Raw #	Raw #/model	Adjusted #	Adjusted #/model	Raw #	Raw #/model	Adjusted #	Adjusted #/model
Totals	98.		98.		100.		100.	
(Group 1)	5.2	2402.	5.0	2496.	5.3	2354.	5.0	2496.
(Group 2)	26.4	2402.	26.0	2440.	26.9	2354.	27.0	2349.
(Group 3)	5.8	2402.	6.0	2309.	5.9	2354.	6.0	2309.
(Group 4)	17.4	2402.	17.0	2464.	17.8	2354.	18.0	2327.
(Group 5)	9.7	2402.	10.0	2340.	9.9	2354.	10.0	2340.
(Group 6)	9.6	2402.	10.0	2315.	9.8	2354.	10.0	2315.
(Group 7)	14.7	2402.	15.0	2350.	15.0	2354.	15.0	2350.
(Group 8)	9.2	2402.	9.0	2443.	9.3	2354.	9.0	2443.
Error:	5696.				Error:	2969.		
					*********required*********			

	Raw #	Raw #/model	Adjusted #	Adjusted #/model	Raw #	Raw #/model	Adjusted #	Adjusted #/model
Totals	102.		101.		104.		104.	
(Group 1)	5.4	2308.	5.0	2496.	5.5	2263.	6.0	2080.
(Group 2)	27.5	2308.	27.0	2349.	28.0	2263.	28.0	2265.
(Group 3)	6.0	2308.	6.0	2309.	6.1	2263.	6.0	2309.
(Group 4)	18.1	2308.	18.0	2327.	18.5	2263.	19.0	2205.
(Group 5)	10.1	2308.	10.0	2340.	10.3	2263.	10.0	2340.
(Group 6)	10.0	2308.	10.0	2315.	10.2	2263.	10.0	2315.
(Group 7)	15.3	2308.	15.0	2350.	15.6	2263.	16.0	2204.
(Group 8)	9.5	2308.	10.0	2199.	9.7	2263.	10.0	2199.
Error:	4536.				Error:	5436.		

A1.435 "Model" Households

An individual "model" household is identified in the simulation algorithm by its actual income level and the TYPE group to which it belongs. The TYPE group identification are used to allocate ALPHA parameter values and in the calculation of the "permanent" or "model" income. The "model" households are formed from the actual income distributions in each TYPE group without consideration of their location. The income range on each TYPE's continuum is set as $1- $50,000. with a $200. interval step. The distribution values are the sum of the assigned weighting factors for each sample household.

These continuums are individually converted into "model" households by grouping the "actual" households by the predetermined ratio of actual to model for the respective TYPE group. The mean income and the corresponding standard deviation is calculated for each "model" household and output as follows after each income continuum. The following example output is for the largest Vancouver group.

*** DISTRIBUTION of INCOMES by HOUSEHOLD TYPE: Vancouver
source: SHU 1974 survey data deflated

creating MODEL HOUSEHOLDs

(GROUP 2)

Estimated Number Households: 63434.
Number of MODEL Households: 27.
RATIO of ACTUAL to MODEL: 2349.

"Y"	hholds	"Y"	hholds	"Y"	hholds	"Y"	hholds	"Y"	hholds	"Y"	hhold
* 1	59.	85	966.	*169	648.	253	196.	337	0.	421	0.
3	0.	* 87	2205.	171	441.	255	62.	339	0.	423	0.
5	37.	* 89	645.	173	585.	257	53.	341	0.	425	37.
7	0.	91	751.	175	1068.	259	0.	343	47.	427	0.
9	0.	* 93	1181.	*177	730.	261	0.	345	37.	429	0.
11	37.	95	1133.	179	608.	263	37.	347	0.	431	173.
13	167.	97	915.	181	814.	265	0.	349	0.	433	0.
15	37.	* 99	906.	183	37.	267	0.	351	0.	435	0.
17	158.	101	1208.	185	151.	*269	58.	353	0.	437	0.
19	0.	*103	2450.	*187	187.	271	98.	355	0.	439	0.
21	133.	*105	1168.	189	635.	273	0.	357	0.	441	0.
23	0.	107	721.	191	188.	275	36.	359	0.	443	0.
25	527.	109	489.	193	474.	277	0.	361	0.	445	0.
27	210.	*111	1221.	195	125.	279	37.	363	0.	447	0.
29	0.	113	1466.	197	0.	281	0.	365	0.	449	0.
31	458.	*115	728.	199	197.	283	0.	367	0.	451	0.
*33	676.	117	191.	201	53.	285	133.	369	0.	453	0.
35	237.	119	780.	203	231.	287	0.	371	37.	455	0.
37	129.	*121	1043.	*205	569.	289	121.	373	0.	457	0.
39	247.	123	656.	207	608.	291	0.	375	37.	459	47.
41	514.	*125	1677.	209	0.	293	0.	377	98.	461	0.
43	429.	127	851.	211	271.	295	98.	379	0.	463	0.
45	219.	*129	1432.	213	564.	297	0.	381	0.	465	0.
47	284.	131	1032.	215	74.	299	0.	383	0.	467	0.
49	0.	133	201.	217	371.	301	0.	385	0.	469	0.
*51	590.	*135	1006.	219	135.	303	0.	387	0.	471	0.
53	74.	137	855.	*221	179.	305	277.	389	0.	473	0.
55	797.	139	562.	223	135.	307	0.	391	0.	475	0.
57	367.	141	267.	225	0.	309	0.	393	0.	477	0.
59	548.	143	190.	227	0.	311	0.	395	0.	479	0.
*61	606.	145	254.	229	0.	313	0.	397	0.	481	0.
63	924.	*147	658.	231	0.	315	0.	399	0.	483	0.
65	244.	149	439.	233	0.	317	0.	401	7.	485	0.
*67	1004.	151	178.	235	0.	319	197.	403	0.	487	0.
69	1026.	153	470.	237	287.	321	0.	405	0.	489	0.
71	293.	*155	691.	239	43.	323	0.	407	5.	491	0.
73	573.	157	366.	241	197.	325	37.	409	0.	493	0.
*75	402.	159	200.	243	230.	327	234.	411	0.	495	0.
77	1295.	161	168.	245	393.	329	0.	413	0.	497	0.
79	402.	163	307.	247	341.	331	0.	415	0.	*499	516.
*81	1034.	165	574.	249	0.	333	0.	417	0.		
83	711.	167	272.	251	197.	335	37.	419	0.		

note: "Y" is the interval mean: annual income divided by 100.

*** DISTRIBUTION of INCOMES by HOUSEHOLD TYPE: Vancouver
source: SHU 1974 survey data deflated

creating MODEL HOUSEHOLDs

(GROUP 2)

MODEL No.	Household INCOME Mean	S. D.
1	2524.	11863.
2	4178.	6996.
3	5607.	4314.
4	6429.	4577.
5	7067.	3049.
6	7823.	3741.
7	8347.	3051.
8	8752.	3532.
9	9189.	3309.
10	9671.	2931.
11	10166.	3651.
12	10377.	4646.
13	10747.	3182.
14	11258.	1718.
15	11829.	4004.
16	12383.	3404.
17	12797.	3201.
18	13244.	5555.
19	13984.	3465.
20	15143.	5489.
21	16443.	9089.
22	17384.	3854.
23	17997.	3030.
24	19506.	10831.
25	21249.	7098.
26	24455.	9976.
27	36890.	152461.

In addition to the output to file of individual data records for each "model" household, the average income for each TYPE group is also produced. This latter data is used by the simulation program in calculating the "model" incomes. A partial listing of this data is as follows:

```
  Vancouver
1   1 2160     1
1   2 5105     1
     ....
     ....
     ....
1  94 2000     8
1  95 2220     8
1  96 2838     8
1  97 3756     8
1  98 4675     8
1  99 6376     8
110011170      8
20  1 7557
20  212692
20  311133
20  413639
20  5 7049
20  6 7456
20  7 9079
20  8 3705
```

"model" households

"TYPE" groups average incomes (MY)type

Details on the generation of the "model" households for the individual CMAs are contained in Figures A3:03. These Figures outline reported census demographic characteristics, the income deflator employed, the distribution of "model" households by TYPE and the corresponding mean incomes. The actual distributions of "model" households are contained in both the GAMMA and BETA data sets outlined in Figures A3:11 and Figures A3:12 respectively.

A1.44 ORIGINAL MODEL:"1961" "Model" Dwellings: "D61.FORT"

This section describes the computer program "D61.FORT", developed to calculate those characteristics of "model" dwellings required as input to the simulation program "SIM01.FORT" for BETA parameter "calibration" runs and "base" and "policy" analyses. This required input for each "model" dwelling includes the quantity of "housing" services that it supplies in 1961, the start of the simulation period and the zone in which it is located.

The calculation of the initial "housing" services distribution is possibly the most difficult task in applying the housing market MODEL to an urban market. This difficulty arises because the MODELs' demand and supply functions are formulated in terms of units of "housing" services, thus requiring the conversion of the observable "residential" services to the location-free quantity of services measure. The first step in this conversion process is to estimate ADJUSTORs for each of the zones, which will convert market prices - rents for rental, effective market value for owner-occupied - into the equivalent location-free quantity measure. The quantity of initial "housing" services for each "model" dwelling by zone is then calculated from continuums of effective residential services by combining the quantity ADJUSTOR, value-to-rent ratios - R/V - and the distribution of actual rents and values within the zone.

This program has been written in MTS:FORTRAN utilizing general IBM library functions only, thus making it suitable for general IBM system usage in batch mode. The program consists of three sections: in the first the average "housing" services and value-to-rent convertors by census tract and zonal aggregation are

calculated, the second calculates the quantity ADJUSTORs that convert "residential" services to "housing" services, while the third generates the distribution of "housing" services by zone and forms the "model" dwellings. The general structure of the program is outlined in the following flow chart (Figure A1:04).

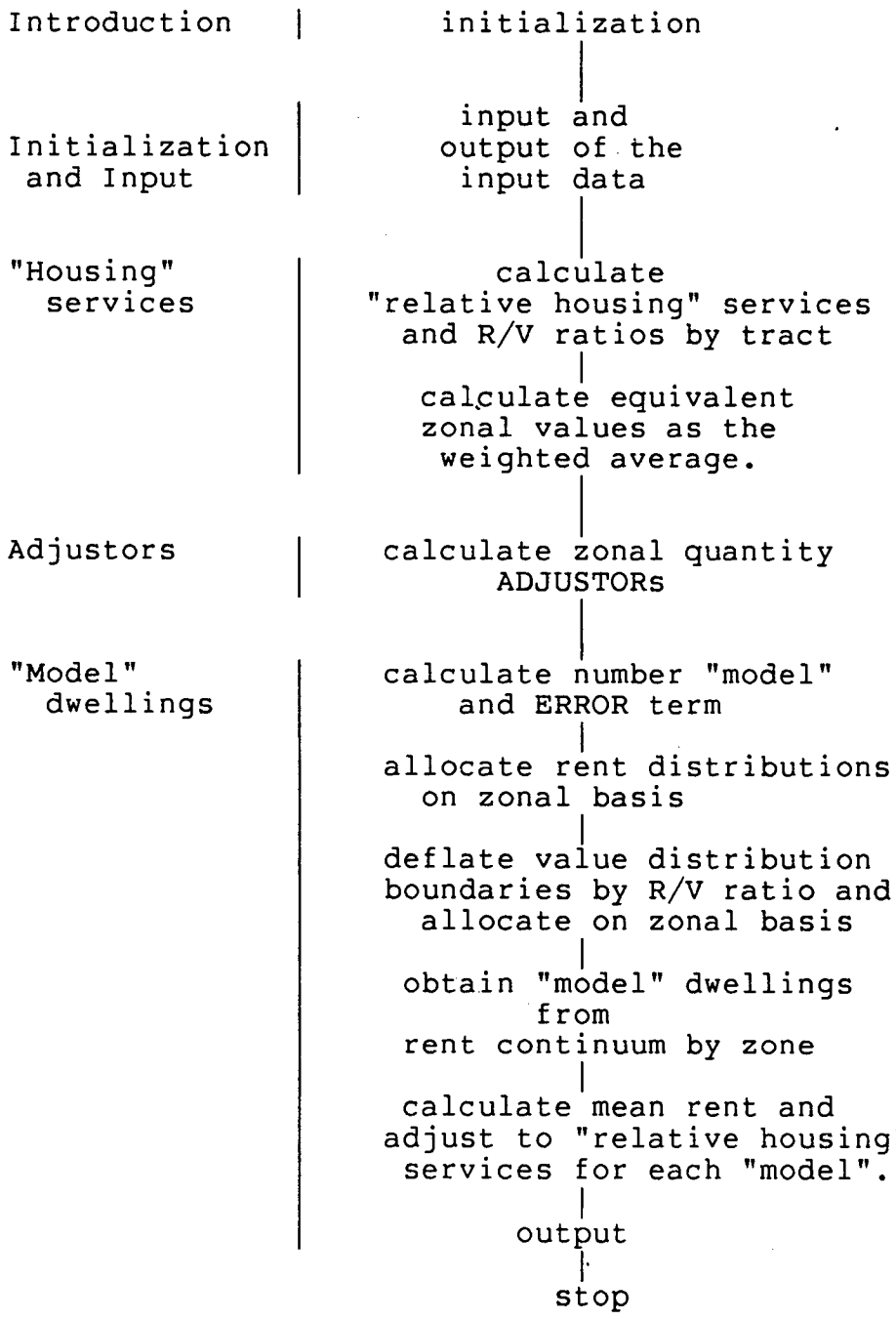


Figure A1:04 Flow Chart of Program Structure: "D61.FORT"

A1.441 General Outline.

Input to this program is derived from three sources;

1. hedonic coefficients and neighbourhood means from the control deck
2. census data from the file CMA61.INPUT, and
3. zonal distribution of census tracts from CMA61.ZN.

Output consists of a break-down by census tract of the average owner-occupier and renter quantities of "residential" and "housing" services, with the corresponding rent-to-value ratios, the quantity ADJUSTORs, and a review of the "model" dwellings. In addition, for each "model" dwelling the required input for the simulation program, "SIM01.FORT", may be written to file or punched on cards. This description employs a set of computations based on Vancouver data as an example.

A1.442 Input and Initialization.

The control card deck consists of seven program cards;

1. control and title card (2X,I2,5A4)
2. rental model: structural coefficients (8F10.0)
3. rental model: neighbourhood coefficients (8F10.0)
4. owner model: structural coefficients (8F10.0)
5. owner model: neighbourhood coefficients (8F10.0)
6. means for the neighbourhood variables (8F10.0)
7. the required number of "model" dwellings (I3),or the distribution of "model" dwellings by zone (10I3).

The program control cards for the Vancouver example with five zones is as follows. Individual cards are described in the subsequent sections.

```
0005 VANCOUVER:05
4.1219     .2025                -.3471     -.1608     .5513
0.2361     .2620     -.0023
6.6700     .1438                -.4124     -.1540     1.3975
.0666      .6275     -.00080
8.1423     .2251      53.4
 69
```

The control and title card consists of three data fields. The first field (columns 1-2) is blank, while the second field (columns 3-4) contains the number of zones and the third (columns 5-24) is the title. On loading the title card, the program checks to ensure that the number of zones corresponds to that specified on CMA61.ZN. An error will stop execution. The first computation involves calculating the average quantity of "housing" services.

A1.443 "1961" Quantity of Housing Services.

The unit of "residential" and "housing" service used by this MODEL may be considered to be equivalent to one dollar of monthly rent in the initial year. This requires that capital values be converted to monthly equivalents. The average quantity of owner-occupier and rental "housing" services is derived from data on housing characteristics, aggregated at the census tract level. Theoretically, the "housing" services are estimated from observed "residential" services under the assumption that the value of a housing unit is comprised of independent component parts, in particular "structural" and "location-neighbourhood".

RS = f(structural attributes) + f(neighbourhood attributes)

= f(HS) + f(NS)

The estimation of this equation under various specifications is outlined in the Section A1.31: 1961 Hedonic Regressions. The output from these regression analyses consists of separate rental and owner models, in which rents, or alternatively estimated values, are "explained" in terms of the structural characteristics of the housing stock and neighbourhood related variables. Ideally, the neighbourhood effect is simply the difference between the actual rent-quantity of "residential" services and the calculated

quantity of "housing" services. A problem arises, however, since the included neighbourhood variables are highly correlated with "structural" variables that have been eliminated from the equation. Consequently, if the included structural variables alone are used in calculating the respective quantites of "housing" services, the quantity will be severly underestimated. For example, if we consider the component contributions at the mean for the 1961 parameters, 44% of the calculated "residential" services are derived from the "structural" component and 56% from the "neighbourhood" component. As a result, only "relative housing services", RHS's, can be calculated. These relative quantities are calculated by substituting the city average values for the "neighbourhood" characteristics in addition to the relevant structural variable values.

The estimated 1961 hedonic coefficients, presented in Figures A3:05: 1961 Hedonics, are loaded as input. Two data cards are required for each of the two models, RENTAL and OWNER, with the first card containing the structural coefficients and the second the neighbourhood. In addition, the city mean values for the neighbourhood characteristics are input on an additional card.

The ordering of the input coefficients and the mean values on cards 2-6 is indicated in the following input review. Each card has eight data fields of ten columns (8F10.0). Those coefficients eliminated from the equations for some cities are simply set to zero.

*** INPUT COEFFICIENTS

RENTAL MODEL				OWNER-OCCUPIER MODEL			
Structural		Neighbourhood		Structural		Neighbourhood	
CONSTANT	4.122	LN INCME	0.236	CONSTANT	6.670	LN INCME	0.067
%G.COND.	0.202	%APT	0.262	%G.COND.	0.144	%APT	0.627
%BATH	0.0	ACCESS	-0.002	%BATH	0.0	ACCESS	-0.00
%20-40YR	-0.347		0.0	%20-40YR	-0.412		0.0
%OVER40	-0.161		0.0	%0VER40	-0.154		0.0
LN RMS	0.531		0.0	LN RMS	1.398		0.0

*** INPUT MEANS of NEIGHBOURHOOD variables

LN INCME	8.142	%APT	0.225	ACCESS	53.400

note: the city mean value for LN income is in log form.

Thus the quantity of "relative housing" services, RHS, is calculated by summing the products of the input coefficients and the respective variable values input from CMA61.INPUT or the supplied city mean values for the neighbourhood variables. Substitutions are made on a census tract basis. Since the 1961 census tract data does not cross-tabulate in terms of rental and owner-occupied dwellings, in some instances the same values for independent variables are substituted into both the rental and owner models. It should be remembered that in calculating the two regression models the dependent variables are of a natural logarithmic form. Substitution of the mean tract values into the equations will generate the LOG of the respective RHS. The actual values are calculated using a single precision EXPONENTIAL function.

The 1961 HEDONIC models are:

RENTAL MODEL

LOG(RHS-rent) =

CONSTANT

+ %G.COND. * proportion of dwellings in good condition

+ %BATH * proportion of dwellings with bath

+ %15-40 * proportion of dwellings built 1920-1945

+ %OVER 40 * proportion of dwellings built pre-1920

+ LN RMS * LOG (average number of rooms)

+ LN INCME * the input value (card 6) for the log of the average income for all households in the urban area

+ %APT * the input value (card 6) for the proportion of apartment dwellings in the urban area

+ ACCESS * the input value (card 6) for the average distance to the Central Business District (see Section A1.221 1961 Hedonics)

OWNER MODEL

LOG(RHS-own) =

CONSTANT

+ %G.COND. * proportion of dwellings considered in good condition

+ %BATH * proportion of dwellings with bath

+ %15-40 * proportion of dwellings built 1920-45

+ %OVER 40 * proportion of dwellings built pre-1920

+ LN RMS * LOG (average number of rooms)

+ LN INCME * the input value (card 6) for the LOG of the average income

+ %APT * the input value (card 6) for the proportion of apartment dwellings in the urban area

+ ACCESS * the input value (see RENTAL model)

The respective quantities of RHS-rent and RHS-own by zonal aggregation are correspondingly calculated from the weighted average of the component census tract variables.

The calculated RHS-rent, the actual average rent, RHS-own and the actual average value are output as follows for each census tract by zonal grouping. The "R/V" columns indicate the ratios of actual rent to actual value, (actual) and calculated RHS-rent to RHS-own, (calc.). The "R/V(calc)." values are used to convert the distribution of owner-occupier dwelling values into a distribution of effective monthly rents, compatible with the rent distributions. This following example from Vancouver is for one zonal grouping only, plus a review by zone for the CMA

*** DISTRIBUTION of HOUSING SERVICES: Vancouver 05

(Zone 1)

	RENTAL MODEL			OWNER-OCCUPIER MODEL			R/V	
Tract	Rent	RHS-rent	#Units	Value	RHS-own	#Units	Actual	Calc
1	95.	75.	2240.	19898.	7800.	394.	0.0048	0.0096
2	102.	82.	2487.	24706.	9205.	419.	0.0041	0.0090
3	89.	76.	2640.	18608.	8128.	268.	0.0048	0.0094
4	81.	69.	2210.	22688.	6874.	165.	0.0036	0.0101
18	67.	98.	428.	23342.	17320.	936.	0.0029	0.0057
19	110.	89.	335.	16702.	14985.	1855.	0.0066	0.0059
22	93.	77.	3157.	23939.	8232.	274.	0.0039	0.0093
35	92.	90.	1149.	20494.	14002.	1766.	0.0045	0.0064
36	114.	101.	528.	20054.	16640.	1602.	0.0057	0.0061
37	107.	88.	215.	15227.	14467.	1756.	0.0070	0.0061
38	91.	102.	450.	34455.	17686.	427.	0.0026	0.0058
39	119.	91.	122.	16970.	15292.	1619.	0.0070	0.0060
40	97.	98.	55.	23132.	17461.	965.	0.0042	0.0056
41	126.	92.	753.	20289.	14094.	1318.	0.0062	0.0065
42	107.	98.	151.	22094.	17055.	2022.	0.0048	0.0057
54	116.	90.	111.	16510.	14511.	1298.	0.0070	0.0062
55	108.	89.	89.	16555.	14881.	1139.	0.0065	0.0060
130	102.	105.	235.	25025.	18496.	1637.	0.0041	0.0057
132	103.	97.	638.	19575.	15718.	2745.	0.0053	0.0062
Totals	95.	82.	17993.	20008.	15250.	22605.	0.0048	0.0054

*** DISTRIBUTION of HOUSING SERVICES: Vancouver 05 (CMA)

	RENTAL MODEL			OWNER-OCCUPIER MODEL			R/V	
ZONE	Rent	RHS-rent	#Units	Value	RHS-own	#Units	Actual	Calc
1	95.	82.	17993.	20008.	15250.	22605.	0.0048	0.0054
2	77.	81.	28238.	12506.	12066.	46918.	0.0062	0.0067
3	142.	122.	629.	25062.	23444.	8230.	0.0057	0.0052
4	82.	95.	18385.	14320.	14802.	65318.	0.0058	0.0064
5	58.	92.	3932.	11993.	13326.	16144.	0.0049	0.0069
Totals	83.	86.	69177.	14912.	14356.	159217.	0.0056	0.0060

The differences between RHS-rent and the "actual" rent, and RHS-own and the "actual" value reflect the relative value of neighbourhood conditions within the individual tracts and on average within the zones. An RHS lower than the "actual" indicates a premium associated with the neighbourhood attributes; a higher RHS indicates a discounting and therefore an inferior neighbourhood.

A1.444 Quantity ADJUSTORs

From the relationship between "residential services" - rent or value - and "relative housing" services obtained, zonal quantity ADJUSTORS are calculated which allow the conversion of a distribution of "residential" services to an equivalent distribution of relative "housing" services. The calculation of the ADJUSTORs on a zonal basis involves two steps.

1. the calculation for each zone of the ratio of average RHS-rent to the average rent and the equivalent for owned dwellings; RHS-own to value. The weighted average of these two ratios is taken as the "actual" ADJUSTOR for the zone.

2. the direct use of these ADJUSTORs will result in an "effective" unit price for the "housing" services different from one. For this reason these adjustors are then divided by an equivalent city-wide ADJUSTOR, calculated from census tract data, giving "weighted ADJUSTORs", to give a CMA mean of 1.00.

Listed by zone below are the respective calculated values for the example city.

*** "Residential" to "Relative Housing" SERVICES quantity ADJUSTOR RATIOs: "RHS"/ACTUAL ADJUSTORS

	rental	owner	"actual"	"weighted"
(Zone 1)	0.8572	0.7622	0.8043	0.7953
(Zone 2)	1.0458	0.9648	0.9952	0.9841
(Zone 3)	0.8555	0.9354	0.9298	0.9194
(Zone 4)	1.1576	1.0336	1.0609	1.0490
(Zone 5)	1.5761	1.1111	1.2022	1.1888
		city ADJUSTOR	1.0113	

Total number of units 228392.

A1.445 Number of "Model" Dwellings

Actual housing units within an urban area are allocated to "model" dwellings on a zonal basis. The first step involves the determination of the ratio of actual dwellings to "model" dwellings, then the distribution of "model" dwellings to each zone. These factors are determined by the end-of-the-decade number of actual dwellings per "model" dwelling, or correspondingly the number of actual households per "model" household to be utilized. The required number of "model" dwellings as calculated by the program "CZONE.FORT" is input on data card "7". From this input value the program calculates the corresponding number of "model" dwellings per zone and indicates the accuracy of the allocation via

an error term. The calculated ERROR term indicates the degree of uniformity of the representation by zone after the number of "model" dwellings per zone is rounded to the nearest integer value. The error term is calculated as the sum over all the zones of the difference (after rounding) between the specified and the implied number of dwellings per "model" dwelling for each "model" dwelling. In addition, errors on a range of "model" dwellings specifications are calculated as a check on the specified allocation. Below is an example output of these calculations for four alternative specifications, with the required specification denoted.

*** NUMBER OF MODEL DWELLINGS Vancouver 05

	Raw		Adjusted		Raw		Adjusted	
	#	#/model	#	#/model	#	#/model	#	#/model
Totals	67.		68.		69.		69.	
(Zone 1)	11.9	3408.	12.0	3383.	12.3	3310.	12.0	3383.
(Zone 2)	22.1	3408.	22.0	3416.	22.7	3310.	23.0	3268.
(Zone 3)	2.6	3408.	3.0	2953.	2.7	3310.	3.0	2953.
(Zone 4)	24.6	3408.	25.0	3348.	25.3	3310.	25.0	3348.
(Zone 5)	5.9	3408.	6.0	3346.	6.1	3310.	6.0	3346.
error:	3712.				error:	4092.		
					**********required**********			

	Raw		Adjusted		Raw		Adjusted	
	#	#/model	#	#/model	#	#/model	#	#/model
Totals	71.		71.		73.		73.	
(Zone 1)	12.6	3216.	13.0	3123.	13.0	3128.	13.0	3123.
(Zone 2)	23.4	3216.	23.0	3268.	24.0	3128.	24.0	3132.
(Zone 3)	2.8	3216.	3.0	2953.	2.8	3128.	3.0	2953.
(Zone 4)	26.0	3216.	26.0	3219.	26.8	3128.	27.0	3100.
(Zone 5)	6.2	3216.	6.0	3346.	6.4	3128.	6.0	3346.
error:	4054.				error:	2736.		

In rounding the number of "model" dwellings per zone to the nearest integer number the total number of "model" dwellings may vary from the "required". In this case the program will stop and must be rerun specifying the number of "model" dwellings per zone on Card 7 using an I3 format. The program will then automatically force the required distribution.

A1.446 "Model" Dwellings

Individual "model" dwellings are identified by their level of initial "housing" services and the zone in which they are located. They are formed from census data on rent and value distributions, aggregated by zone. These data are distributed in terms of one dollar rent intervals over the range of 1 to 250 for each zone, then the ratio of actual dwellings to model dwellings for the respective zone is used to split the continuum of actual dwellings into "model" dwellings. Rent data are assigned directly while the owner-occupier values are assigned by deflating the distribution boundaries by R/V (calc.) values at the census tract level. Note that each interval class is uniformly distributed across the corresponding range. The lower bound on the bottom intervals has been set to 1 for rents, and $15,000 for values, with the upper bound on the highest interval is constrained to a maximum "rent" or "effective" rent of 250. Those units which report "no cash rent" are simply distributed uniformly within the range of 30 to 130.

For each "model" dwelling, representing a section of the rent continuum, the mean rent is computed along with the corresponding standard deviation. This mean rent is interpreted as the "residential" services associated with the "model" dwelling. The final step is to obtain the decade-start quantity of "housing"

services. This simply involves multiplying the mean rent by the respective zone's weighted ADJUSTOR. Following is the rent continuum for a single zone. There are 40,598 actual dwellings in this zone to be allocated to 12 "model" dwellings. "Q" represents the quantity of "residential" services, equivalent to a dollar of monthly rent, with the #UNITs being the number of actual units at each interval. The "*" indicates the sections of the continuum corresponding to each "model" dwelling.

*** MODEL DWELLINGS: DISTRIBUTION of SERVICES: Vancouver 05

(Zone 1)

Number Actual Dwellings: 40598.
Number MODEL Dwellings: 12.
Ratio of ACTUAL to MODEL: 3383.

"Q"	#units	"Q"	#units	"Q"	#units	"Q"	#units	"Q"	#units	"Q"	#unit
*1	4.4	43	69.0	85	530.5	127	311.4	169	101.0	211	46.3
2	4.4	44	69.0	86	530.5	128	311.4	170	95.2	212	46.3
3	4.4	45	71.4	87	530.5	129	307.9	171	93.5	213	46.9
4	4.4	46	82.1	88	530.5	130	261.8	172	93.5	214	46.9
5	4.4	47	82.1	89	530.5	131	257.8	173	84.0	215	46.0
6	4.4	48	100.5	* 90	490.2	132	258.4	174	84.8	216	51.1
7	4.4	49	115.3	91	490.2	133	249.8	175	64.6	217	51.1
8	5.0	50	143.6	92	490.2	*134	251.5	176	64.6	218	51.1
9	5.0	51	143.6	93	490.2	135	251.5	177	64.6	219	53.2
10	5.0	52	158.8	94	490.2	136	251.5	178	64.6	220	57.0
11	5.0	53	158.8	95	490.2	137	240.3	179	64.6	221	57.0
12	5.0	54	158.8	96	490.2	138	213.8	180	64.6	222	56.4
13	5.0	55	158.8	* 97	490.2	139	213.8	181	62.7	223	56.4
14	5.0	56	158.8	98	490.2	140	200.4	182	62.2	224	56.4
15	5.0	57	158.8	99	490.2	141	193.5	183	62.2	225	55.8
16	5.0	58	158.8	100	470.4	142	179.1	184	62.2	226	55.8
17	4.8	59	158.8	101	471.4	143	179.1	185	60.4	227	55.8
18	7.6	60	203.6	102	474.0	144	170.1	186	60.4	228	55.8
19	8.4	* 61	203.6	103	476.9	145	170.1	187	58.5	229	55.8
20	8.6	62	203.6	*104	486.3	146	170.1	188	55.2	230	55.8
21	8.6	63	203.6	105	486.5	147	170.1	189	55.2	231	55.8
22	8.6	64	203.6	106	486.5	148	170.1	190	53.8	232	55.8
23	8.6	65	203.6	107	473.4	149	161.3	191	53.8	233	56.1
24	8.6	66	203.6	108	461.2	150	120.1	*192	52.8	234	56.1
25	8.6	67	203.6	109	461.2	151	120.1	193	52.8	235	57.6
26	8.6	68	203.6	110	347.3	152	120.1	194	52.8	236	57.6
27	9.3	69	203.6	111	348.4	*153	120.1	195	52.8	237	57.5
28	9.3	70	259.1	*112	338.6	154	120.1	196	51.4	238	57.5
29	9.3	71	259.1	113	338.6	155	120.1	197	50.9	239	57.5
30	45.0	72	258.7	114	338.6	156	120.1	198	50.6	240	57.5
31	45.0	73	263.9	115	338.6	157	118.2	199	50.6	241	52.9
32	45.0	74	272.4	116	341.5	158	118.2	200	48.3	242	52.9
33	45.0	75	280.3	117	335.4	159	113.5	201	48.3	243	52.9
34	45.0	* 76	280.6	118	335.4	160	113.5	202	47.8	244	39.8
35	45.0	77	299.9	119	335.4	161	103.9	203	47.8	245	58.1
36	45.0	78	334.1	120	307.5	162	104.2	204	47.4	246	58.1
37	45.0	79	349.2	121	307.5	163	105.9	205	47.4	247	69.0
38	45.0	80	489.1	*122	310.0	164	105.9	206	46.4	248	63.6
39	45.0	81	519.2	123	310.0	165	105.9	207	46.3	249	57.2
40	69.0	82	519.2	124	310.0	166	103.4	208	46.3	*250	356.6
41	69.0	83	519.2	125	310.0	167	103.4	209	46.3		
42	69.0	* 84	521.6	126	311.4	168	100.3	210	46.3		

The characteristics of the derived "model" dwellings (the residential and housing services associated with each), are output after each zone's continuum. In addition, a corresponding data record for each "model" dwelling is written to file for input to the program "SIM01.FORT". The output of these characteristics for the sample zone are as follows:

*** MODEL DWELLINGS: DISTRIBUTION of SERVICES: Vancouver 05

(Zone 1)

Model No.	Residential SERVICEs Mean	S.D.	Housing SERVICEs
1	48.	93.	38.
2	69.	63.	55.
3	80.	39.	64.
4	87.	36.	69.
5	94.	41.	75.
6	101.	42.	80.
7	108.	42.	86.
8	117.	50.	93.
9	128.	54.	102.
10	142.	68.	113.
11	169.	95.	135.
12	225.	190.	179.

A partial listing of the output data file is as follows:

```
   Vancouver 05
3  1    38     1
3  2    55     1
3  3    64     1
3  4    69     1
3  5    75     1
  ....
  ....
3 64    86     5
3 65   101     5
3 66   123     5
3 67   196     5
```

1961 "model" dwellings

Details of the generated 1961 "model" dwellings are reported in Figures A3:04.

A1.45 ORIGINAL MODEL: Calibration Data: "D71.FORT"

This section outlines the program "D71.FORT" used to generate the data required for the "calibration" simulation runs. Two forms of calibration runs are required; those estimating the GAMMA and those the BETA parameters. The basic difference is that in calibration runs for the demand parameters - GAMMAs - a short run market situation is approximated by assuming a fixed supply, while the supply parameters - BETAs - are estimated in a long run market situation using the estimated GAMMA parameters. The GAMMA estimates are made using 1971 "model" households and dwellings; the BETA estimates using 1971 "model" dwellings and 1961 "model" dwellings.

1. GAMMAs - these parameters are estimated by fitting 1971 "model" households to 1971 "model" dwellings. This is achieved by setting BETA1 and BETA2 exogenously at values of 1.0 and 0.0 respectively. That is, the supply functions of the existing dwellings are completely inelastic, with each individual dwelling supplying a fixed quantity of housing services. This requires the creation of 1971 "model" dwellings.
2. BETAs - these parameters are estimated by fitting the 1971 "model" households to the 1961 "model" dwellings generated by the program "D61.FORT", plus new construction.

In order to measure the goodness-of-fit of the MODEL, under various parameter values, against the actual metropolitan area to which it is being fitted comparative statistics on selected criteria are calculated by the solution algorithm. These calculations are based on an input data set which contains, by

zone, the actual price and quantity of housing services, the distribution by type of households, the average income and a utilization factor. The solution algorithm program, in "calibration" mode, calculates equivalent numbers from the solution allocation and calculates statistics that reflect the difference between the input characteristics and the solution characteristics. The input data set will differ between the two "calibration" modes in as much as the relative prices and the utilization factors will reflect the shift from the short run to the long run formulation.

A1.451 General Outline

The input to this program is drawn from both the 1961 and 1971 data sets. The input files are:

1. hedonic coefficients and neighbourhood means for both the 1961 and 1971 equations from the control deck
2. 1961 and 1971 census data from the files CMA61.INPUT and CMA71.INPUT
3. zonal distribution of census tracts from CMA61.ZN and CMA71.ZN
4. cross-tabs between 1961 and 1971 from file CMA71.TAB

The output is grouped into three sections; the first is equivalent to that of "D61.FORT" but produces data on the 1971 "model" dwellings, the second includes information on the calculation of the calibration data, while the third consists of the two alternative sets of calibration data required as input to "SIM01.FORT" for the calibration calculations. The program is, in fact, used twice to generate the two alternative calibration data sets. This is necessary because with the GAMMA calibration, dwellings constructed during the 1961-71 decade are treated as existing at decade-end and thus the "model" representations are generated for only the number of zones. With BETA calibrations,

the decade-end characterisation must differentiate between new and existing dwellings. Consequently, the additional "zone of new construction" is created and the decade's new dwellings added to it. Allocations to the other zones are correspondingly reduced, resulting in a decade-end "model" representation with the artificial new consruction zone included.

The following description employs a set of computations based on Vancouver data as an example.

A1.452 Input Data

The required control card deck for both runs consists of seventeen cards; one the control, four the 1971 hedonic coefficients, four the 1961 hedonic coefficients, four sets of mean neighbourhood values, and four for the auxiliary data: mean income adjustors, the annexed zone, fhe required number of "model" dwellings and the actual "prices" of new construction.

1. control and title card (2I1,I2,5A4)
2. 1971 rental model: structural coefficients (8F10.0)
3. 1971 rental model: neighbourhood coefficients (8F10.0)
4. 1971 owner model: structural coefficients (8F10.0)
5. 1971 owner model: neighbourhood coefficients (8F10.0)
6. 1961 rental model: structural coefficients (8F10.0)
7. 1961 rental model: neighbourhood coefficients (8F10.0)
8. 1961 owner model: structural coefficients (8F10.0)
9. 1961 owner model: neighbourhood coefficients (8F10.0)
10. 1971 data means for 1971 neighbourhood variables (8F10.0)
11. 1971 data means for 1961 neighbourhood variables (8F10.0)
12. 1961 data means for 1971 neighbourhood variables (8F10.0)
13. 1961 data means for 1961 neighbourhood variables (8F10.0)
14. the 1971 mean income adjustor (F5.4)
15. zone for annexed census tracts (I2)
16. the number of 1971 "model" dwellings required (I3) or, the required number of "model" dwellings per zone (10I3)
17. the actual "prices" of new construction (F5.3) :PN.

An example set of program control cards for Vancouver's "GAMMA" run with five zones is as follows. Individual cards are described in the subsequent sections.

```
0105  VANCOUVER:05
5.7846                .2211      -.1161     -.1727     -.2696     .2738
.1325      -.1019
8.4802                .1287      -.1866     -.2222     -.3126     .5031
.0968      0.1549
4.1219     .2025                 -.3471     -.1608     .5513
0.2361     .2620      -.0023
6.6700     .1438                 -.4124     -.1540     1.3975
.0666      .6275      -.00080
9.0414     .2080
9.0414     .2080       65.
8.1423     .2251
8.1423     .2251       53.4
.967247
04
018026004043009
1.4401.980
```

note: on card 16 the distribution of "model" dwellings is specified

The control and data card has three data fields; the first (column 1) indicates whether or not the program forces the fitting of the required number of "model" dwellings (see "DWELL161" for details). The second, (column 2) indicates the type of calibration data set to be created (1 for the GAMMA set plus 1971 "model" dwellings, 2 for the BETA set). Field two (columns 3-4) contains the number of zones and field three (columns 5-24) the title. On loading the title card, the program checks to ensure that the number of zones corresponds to that specified on both CMA61.ZN and CMA71.ZN. An error stops execution. The program then loads the 1961 and 1971 census tract numbers from CMA61.INPUT and CMA71.INPUT respectively, along with the zonal organisation from CMA71.TAB. The coefficients and means for the hedonic equations are then loaded along with the income deflator and the zone for annexed tracts from the control deck. A summary of this input data is output as follows.

*** 1971 ZONAL ORGANISATION

:ZONE	:C.T. COUNT
1	28
2	37
3	9
4	80
5	18
6	6

*** REVIEW of INPUT DATA

*** ANNEXED ZONE - the annexed zone 6 included in zone 4

*** 1971 INCOME ADJUSTOR - 0.9672

*** INPUT COEFFICIENTS: 1971 HEDONIC EQUATION

RENTAL MODEL Structural		Neighbourhood		OWNER-OCCUPIER MODEL Structural		Neighbourhood	
CONSTANT	5.785	LN INCME	0.132	CONSTANT	8.480	LN INCME	0.09
	0.0	%APT.	-.102		0.0	%APT.	0.15
%BATH	0.221		0.0	%BATH	0.129		0.0
%10-20YR	-.116		0.0	%10-20YR	-.187		0.0
%20-25YR	-.173		0.0	%20-25	-.222		0.0
%OVER 25	-.270		0.0	%OVER 25	-.313		0.0
LN RMS	0.274		0.0	LN RMS	0.503		0.0

*** INPUT COEFFICIENTS: 1961 HEDONIC EQUATION

RENTAL MODEL Structural		Neighbourhood		OWNER-OCCUPIER MODEL Structural		Neighbourhood	
CONSTANT	4.122	LN INCME	0.236	CONSTANT	6.670	LN INCME	0.06
%G.COND.	0.202	%APT.	0.262	%G.COND.	0.144	%APT.	0.62
%BATH	0.0	ACCESS	-.002	%BATH	0.0	ACCESS	-.00
%15-40YR	-.347		0.0	%15-40YR	-.412		0.0
%OVER40	-.161		0.0	%0VER40	-.154		0.0
LN RMS	0.551		0.0	LN RMS	1.398		0.0

*INPUT MEANS of NEIGHBOURHOOD variables

1971 data	1971 equation	LN INCME	%APT.		
		9.041	0.208	0.0	
	1961 equation	LN INCME	%APT.	ACCESS	
		9.041	0.208	65.000	
1961 data	1971 equation	LN INCME	%APT.		
		8.142	0.225	0.0	
	1961 equation	LN INCME	%APT.	ACCESS	
		8.142	0.225	53.400	

A1.453 1971 "Model" Dwellings

The technique used for creating the 1971 "model" dwellings generally follows that outlined in the Section A1.44: "1961" Distribution of Housing Services, subsections A1.443 to A1.446. The major differences are that the 1971 Hedonic equations are used, the required number of "model" dwellings must correspond to the number of "model" households, and the base price employed must reflect relative price changes over the decade. In addition, the 1971 census data provides a data break-down by renters and owners which eliminates the need, as in 1961, to substitute the same values for some of the independent variables into both models.

Since all 1971 dwellings are treated as existing during GAMMA calibration, the BETA calibration process will differentiate between existing and new dwellings giving the two alternative sets of 1971 "model" dwellings which must be generated. For the GAMMA calibration, the allocation of dwellings to zone matches that used in "D61.FORT". In generating the BETA calibration data only those 1971 dwellings in existence prior to 1961 are allocated to the existing zones; all new dwellings are allocated to the zone of new construction and thus the number of "model" dwellings in the existing zones will be reduced accordingly. The resulting "model" dwelling distribution will correspond to the expected solution set generated by a BETA calibration run. The two alternative distributions of 100 "model" dwellings, by zone, generated for Vancouver are presented in Figure A3:04.

zone	GAMMA mode distribution	BETA mode distribution
1	18	11
2	26	20
3	4	3
4	43	26
5	9	6
99	na	34
	100	100

note: zone "99" is the artificial zone of new construction

Figure A1:04 VANCOUVER: Distribution of "Model" Dwellings.

In deriving the RHS's by tract, the input data is adjusted to correspond to whether or not the new dwellings are isolated. That is, for the BETA calibration data runs, the age and condition data are adjusted to generate separate data for new and existing dwellings.

The 1971 Hedonic models used in calculating the average RHSs are:

RENTAL MODEL

LOG(RHS-rent) =

CONSTANT

+ %BATH * proportion rental dwellings with bath

+ %10-20YR * proportion rental dwellings built 1951-1960

+ %20-25YR * proportion rental dwellings built 1946-1950

+ LN RMS * LOG (average number rooms - rental dwellings)

+ LN INCME * the input value (card 10) for the log of the average income for all households in the urban area.

+ %APT * the input value (card 10) for the proportion of apartment dwellings in the urban area.

OWNER MODEL

LOG(RHS-own) =

CONSTANT

+ %BATH * proportion o-o dwellings with bath

+ %10-20YR * proportion o-o dwellings built 1951-1960

+ %20-25YR * proportion o-o dwellings built 1946-1950

+ LN RMS * LOG (average number rooms - o-o dwellings)

+ LN INCME * the input value (card 10) for the log of the average income for all households in the urban area.

+ %APT * the input value (card 10) for the proportion of apartment dwellings in the urban area.

In creating the "model" dwellings any annexed tracts are assigned to the zone specified on card "15". In default, incorrect or missing zone number, these annexed tracts are assigned to the zone with the highest access value.

In generating the 1961 "model" dwellings (Section A1.444), it was noted that "housing" services prices were calculated assuming a mean price per unit of "housing" service of 1.00: the "actual" quantity ADJUSTORs being weighted to provide this mean price. At decade-end this price must be adjusted upwards to reflect the nominal price increases over the decade. To generate the GAMMA set, one must assume that the market is in equilibrium at decade-end, and that the relative equilibrium zonal prices are a function of the price of "new housing" services. That is, at decade-end one must adjust by zone for both relative quality levels and differentials in "housing" services price increases over the decade. The latter differentials have been derived utilizing estimated hedonic price indices: this process is outlined in the following Section. The calculated price indices indicate by zone

(including the zone of new construction), the relative prices over the decade from the base price of 1.00 per unit of "housing" service. As would be anticipated, the derived value for the zone of new construction is significantly different from the value derived in Section A1.21. For this reason the actual calculated values for PN are input so that the distribution of the hedonically derived prices can be adjusted to these values. That is, the price per unit of "new housing" service is set to the input PN values, and values for the other zones are redistributed accordingly. Because of the redistribution of the stock, the calculated hedonic price indices for the existing stock will vary between the GAMMA and the BETA runs; the same value being calculated for the zone of new construction in both runs.

As a result of this need for price adjustments, the program calculates two "weighted" ADJUSTORs; one corresponding to a price of 1.00, and the second to the input weighted PN. These ADJUSTORs are as follows for Vancouver's GAMMA data set run, with the PN values in brackets.

*** "Residential" to "Relative Housing" SERVICES quantity ADJUSTOR RATIOs: "RHS"/ACTUAL ADJUSTORS

	rental	owner	"actual"	"weighted"	
(Zone 1)	0.9565	0.7457	0.8778	0.8338	0.6044
(Zone 2)	1.1503	1.0609	1.1054	1.0499	0.7081
(Zone 3)	0.7071	0.7059	0.7061	0.6706	0.5726
(Zone 4)	1.1238	1.0571	1.0792	1.0250	0.7101
(Zone 5)	1.2330	1.0706	1.1085	1.0528	0.6996
			------		
	city ADJUSTOR		1.0529		

Corresponding to the technique used in "D61.FORT", the decade-end quantities of "housing" services for the respective PNs are calculated from the derived mean rent ("residential" services) for

each "model" dwelling by multiplying by the respective ADJUSTOR. The derived "model" dwelling characteristics for Vancouver's Zone 1 under the two models are as follows:

*** MODEL DWELLINGS: VANCOUVER:05 ["GAMMA" calibration set]

(Zone 1) quantity adjustors 0.8338 0.6044 0.4396

Model	Residential SERVICEs		Housing SERVICEs	
No.	Mean	S.D.	1.000	1.440
1	77.	117.	64.	46.
2	107.	74.	89.	65.
3	123.	58.	102.	74.
4	134.	50.	112.	81.
5	143.	43.	119.	86.
6	151.	36.	126.	91.
7	156.	30.	130.	95.
8	162.	34.	135.	98.
9	167.	29.	140.	101.
10	173.	38.	145.	105.
11	180.	33.	150.	109.
12	186.	38.	155.	113.
13	195.	45.	162.	118.
14	204.	43.	170.	123.
15	216.	56.	180.	130.
16	234.	87.	195.	141.
17	271.	115.	226.	164.
18	344.	490.	287.	208.

*** MODEL DWELLINGS: VANCOUVER:05 ["BETA" calibration set]

(Zone 1) quantity adjustors 0.8556 0.6415 0.4665

Model	Residential SERVICEs		Housing SERVICEs	
1	76.	108.	65.	49.
2	112.	86.	96.	72.
3	131.	61.	112.	84.
4	144.	57.	123.	92.
5	156.	57.	134.	100.
6	167.	49.	143.	107.
7	179.	56.	153.	115.
8	193.	65.	165.	124.
9	211.	78.	181.	135.
10	241.	109.	206.	155.
11	314.	275.	269.	

As with "D61.FORT" the characteristics of the derived "model" dwellings (the residential and housing services associated with each) are output after each zone's continuum but with "housing"

services reflecting the two alternative mean prices: 1.00, and the weighted PN. In addition, with the GAMMA option, a corresponding data record for each model dwelling is written to the GAMMA calibration data file.

A1.454 Hedonic Price Indices

The 1971 price of "housing" services must reflect the increase over the decade - from an intial price of 1.00 - of an initial unit of "relative housing" service. This requires the calculation of quality adjusted price indices. The technique used involves substituting the independent variable values for 1961 and 1971 - structural and neighbourhood - into both the 1971 and 1961 HEDONIC equations and estimating the corresponding "hedonic" values. That is, for each zone eight hedonic values are calculated; four for the RENTAL, four for the OWNER model.

1. R7171 rental: 1971 data in 1971 HEDONIC equation
2. R7161 rental: 1971 data in 1961 HEDONIC equation

gives R71 = R7171/R7161

3. O7171 owner: 1971 data in 1971 HEDONIC equation
4. O7161 owner: 1971 data in 1961 HEDONIC equation

gives O71 = O7171/O7161

5. R6171 rental: 1961 data in 1971 HEDONIC equation
6. R6161 rental: 1961 data in 1961 HEDONIC equation

gives R61 = R6171/R6161

7. O6171 owner: 1961 data in 1971 HEDONIC equation
8. O6161 owner: 1961 data in 1961 HEDONIC equation

gives O61 = O6171/O6161

Each of R71, O71, R61 and O61 represent constant quality indices for the decade. The zonal indices, PI, are calculated as the geometric mean of these values.

PI = SQRT{(R71**WR71)*(O71**WO71)*(R61**WR61)*(O61**WO61)}

where

WR71, WO71 are respectively proportions of the zone's 1971 stock that are rental and owner-occupier, and

WR61, WO61 are the corresponding 1961 values.

For checking purposes, the program outputs the detailed calculations of the Hedonic values for the total CMA and the mean values of the independent structural variables for each zone. Following is the sample output for the substitution of the 1971 data into the 1971 HEDONIC equations

*** HEDONICALLY derived PRICE INDEX (1961-1971)

CALCULATIONs: 1971 data - 1971 equations (Total CMA)

Rental:Structural

	CONSTANT		%BATH	%10-20YR	%20-25YR	%OVER 25	LN RM
mean	0.0	0.5570	0.9366	0.1734	0.0787	0.2882	3.802
coef	5.7846	0.0	0.2211	-0.1161	-0.1727	-0.2696	0.273
value	5.7846	0.0	0.2071	-0.0201	-0.0136	-0.0777	0.365

Rental:Neighbourhood

	LN INCME	%APT.	
mean	9.0414	0.2080	0.0
coef	0.1325	-0.1019	0.0
value	1.1980	-0.0212	0.0

Owner: Structural

	CONSTANT		%BATH	%10-20YR	%20-25	%OVER 25	LN RM
mean	0.0	0.1707	0.9909	0.2860	0.1401	0.3221	6.224
coef	8.4802	0.0	0.1287	-0.1866	-0.2222	-0.3126	0.503
value	8.4802	0.0	0.1275	-0.0534	-0.0311	-0.1007	0.919

Owner: Neighbourhood

	LN INCME	%APT.	
mean	9.0414	0.2080	0.0
coef	0.0968	0.1549	0.0
value	0.8752	0.0322	0.0

Actual Rent	Hedonic	Actual Value	Hedonic
129.	139.	28744.	28279.

*** HEDONICALLY derived PRICE INDEX (1961-1971)

ZONAL DATA: 1971 data - 1971 equations

RENTAL: structural

Zone	CONSTANT		%BATH	%10-20YR	%20-25YR	%OVER 25	LN RMS
1	0.0	0.8232	0.9381	0.1919	0.0576	0.2612	3.3854
2	0.0	0.5891	0.8957	0.1331	0.0880	0.4538	3.7320
3	0.0	0.1809	0.9668	0.1763	0.0481	0.1263	4.8208
4	0.0	0.4024	0.9665	0.1912	0.0788	0.1707	4.0495
5	0.0	0.1232	0.9652	0.1998	0.1404	0.2664	4.4616
99	0.0	1.0000	1.0000	0.0000	0.0000	0.0000	3.7363

OWNER: structural

Zone	CONSTANT		%BATH	%10-20YR	%20-25YR	%OVER 25	LN RMS
1	0.0	0.2169	0.9930	0.1497	0.1419	0.6079	6.9305
2	0.0	0.2523	0.9865	0.1553	0.1841	0.5683	5.7679
3	0.0	0.0851	0.9976	0.4904	0.1098	0.1786	7.7773
4	0.0	0.1531	0.9927	0.3498	0.1275	0.1950	6.1749
5	0.0	0.0852	0.9867	0.3039	0.1218	0.1847	5.9393
99	0.0	1.0000	1.0000	0.0000	0.0000	0.0000	6.2786

zone	Actual Rent	Hedonic	Actual Value	Hedonic
1	142.	136.	37541.	27999.
2	115.	132.	24081.	25556.
3	222.	157.	45437.	32089.
4	131.	147.	27519.	29048.
5	118.	145.	26989.	28837.
99	160.	143.	32690.	29841.

Because the quality of the hedonic models suffers from a lack of suitable independent variables, these derived price indices are treated as relative values and, as noted earlier, are adjusted according to the new construction price, PN.

A1.455 Calibration Data

Under the two alternative program options, calibration data sets are generated from the census data with data values equivalent to "values" calculated by the solution algorithm program. Both sets reflect actual period-end conditions, the difference is in the value for the relative price of "housing" services, the utilization factor and more importantly, in terms of the redistribution of the actual dwellings to the zone of new construction. In each set, for each zone including the "zone of new construction", twelve data values are calculated.

1. the actual 1971 price of a unit of "housing" service (field 1)
2. the actual 1971 distribution of housing types in the zone output as eight data fields (fields 2-9) each being the proportion of the respective household type in the zone
3. the average 1971 household income in the zone (field 10)
4. the existing stock utilization factor (field 11); the proportion of the period-start stock occupied at period-end
5. the average quantity of "housing" services consumed in 1971 (field 12)

Three components of these data are derived by common means for both calibrations data sets. They are the 1971 distribution of household TYPEs, their average income and the 1971 average quantities of "housing" services consumed. The variation in values lies in the distribution, by zone, of the housing stock. The distribution of household types by zone is calculated as the weighted average of the corresponding census tract distributions. For the assumptions used in calculating the census distributions see Section A1.11: Raw Data. The income value is similarly calculated as the weighted mean of the tracts' average household income. The zonal average quantity of "housing" services are derived on a zonal basis from the quantities of "housing" services

assigned the individual "model" dwellings. The calibration value is simply the mean of the quantities assigned. With the "GAMMA" data set this value reflects the average quantity of "relative housing" services consumed in the zone in 1971 without adjustment for new construction; with the "BETA" set the adjustment for new construction is made.

In calibrating the MODELs for the GAMMA's, short run market situation, the aim is to adjust the value of the GAMMA parameters until the 1971 "model" households consume all the input 1971 "model" dwellings: the number of each nominally set at 100. Since in forming the "model" dwellings the quantity of "housing" services is adjusted so that the 1971 price per unit of new "housing" service is the new construction price, PN, the expected solution price for each "model" dwelling, correspondingly the zone's average, is a function of the value of PN employed. The prices output in the calibration data sets are derived via the hedonic price indice and adjusted to the input "weighted" PN value. Similarly, the utilization factor (field 11) will be 1.00 representing one hundred percent usage of the 1971 stock. Since the short run market situation assumes that no new dwellings are constructed, the corresponding data for the "zone of new construction" is set to zero.

In calibrating for the BETA's, long run market situation, the price and the utilization factors must represent actual changes over the 1961-1971 decade. The utilization factor is simply calculated as the ratio of the 1971 dwellings designated as being built in or prior to 1961, from CMA71.INPUT, and the total number of dwellings in 1961, from CMA61.INPUT.

The prices are those derived via the hedonic price indices and

adjusted to the "weighted" PN.

These calibration data are output to the respective data files. Corresponding records are written to hardcopy as follows:

```
*** CALIBRATION DATA WRITTEN to FILE :  VANCOUVER:05
     ["GAMMA" calibration set]

70 1 1.438 .032 .241 .041 .141 .106 .098 .202 .139 10570 1.000 103.
70 2 1.546 .064 .348 .050 .115 .104 .069 .146 .103  8220 1.000  92.
70 3 1.221 .058 .591 .032 .134 .086 .011 .050 .039 18876 1.000 122.
70 4 1.505 .095 .491 .058 .115 .078 .031 .072 .060 10058 1.000 100.
70 5 1.569 .088 .483 .048 .104 .126 .017 .056 .078  9409 1.000  92.
7099  .0   .0   .0   .0   .0   .0   .0   .0   .0        0  .0      .

*** CALIBRATION DATA WRITTEN to FILE :  VANCOUVER:05
     ["BETA" calibration set]

70 1 1.410 .036 .283 .039 .138 .112 .082 .178 .132 11223 0.989 102.
70 2 1.546 .065 .362 .047 .113 .107 .063 .140 .102  8347 0.945  89.
70 3 1.356 .058 .600 .031 .129 .085 .012 .047 .038 19221 1.000 104.
70 4 1.588 .091 .494 .054 .116 .084 .028 .071 .062 10086 1.000  90.
70 5 1.634 .086 .475 .047 .102 .133 .017 .058 .082  9131 0.955  86.
70 6 1.440 .080 .401 .057 .121 .084 .058 .117 .083  9756 1.000 123.
```

These data are reported on a CMA basis in Figures A3:13

A1.456 Minimum Quantity of New Services

When simulations provide "model" households with an option to consume new "model" dwellings a constraint is imposed on the minimum level of services in recognition of structural and other regulations typically imposed on new units by local government. The UI calculated this minimum quantity value from the average rent (including imputed rent on owner-occupied units) of the lowest rent "model" dwelling constructed over the decade; that is, of the lowest "n" actual dwellings where "n" is the number of actual dwellings per model dwelling (de Leeuw and Struyk (1975, p74)). This average rent figure is then deflated by the average price of new construction over the decade, PN, to obtain the minimum

quantity of services, QM.

The equivalent process is performed in "D71.FORT" by generating the "model" dwellings for the zone of new construction. The values for QM can thus be taken directly from the assigned quantities for these "model" dwellings. Because of "noise" in the value distribution and to allow for depreciation of stock constructed in the earlier stage of the decade, the values for QM are taken as the "housing" service associated with the second lowest new "model" dwelling generated. These values represent the effective decade-end quantity under the alternative PN assumptions. This then assumes that this constraint represents a constant real quantity over the decade. The estimated values for the eight selected CMAs under the two alternative PNs are presented in Figure A1:05

	Calculated QM's	
CMA	weighted PN	1971 PN
Calgary	50.3	39.3
Kitchener	62.2	47.9
Quebec City	44.6	36.3
St. John's	34.1	27.9
Saskatoon	47.2	37.5
Sudbury	27.3	23.0
Vancouver	56.7	41.2
Winnipeg	54.6	45.7

Figure A1:05 Minimum Quantities of New Services.

The majority of the variance in these measurements results from the variation in housing costs by CMA These estimates of QM are based on the quantity of "housing" services a dollar would buy at decade-start. Thus, where housing costs are low, a unit of QM represents more "housing" services than where housing costs are

high. Factors such as building code standards and zoning requirements will also affect the relative values.

A1.5 ORIGINAL MODEL: SOLUTION ALGORITHM :"SIM01.FORT"

This section describes the computer program, "SIM01.FORT", developed for solving the ORIGINAL HOUSING MARKET MODEL; a mathematical formulation of the changes over a ten year period in the price and quantity of housing in an urban area. Given the supply and demand formulations of the ORIGINAL MODEL, and corresponding zonal specifications, a relatively simple algorithm is employed to generate solution conditions. The algorithm used in this program follows that specified in MacRae (1978) and assigns "model" households to "model" dwellings, new if desired, so that households have no motivation to change their level of consumption.

The solution conditions are:

1. allocate "model" households to "model" dwellings in such a manner that they pay the maximum amount they are willing to; given income and preferences. That is, no household selects a dwelling at an equilibrium price less than that which they are willing to pay, and
2. obtain calculated zonal characteristics equal to the initial characteristics on which the dwelling selections were based.

This computer program has been written in MTS:FORTRAN utilizing only general library functions, making it suitable for IBM system usage in batch mode.

The following sections have been ordered to correspond to program logic; from initialization through data input to the calculations and output. The general structure of the program is outlined in the following flow chart (Figure A1:06).

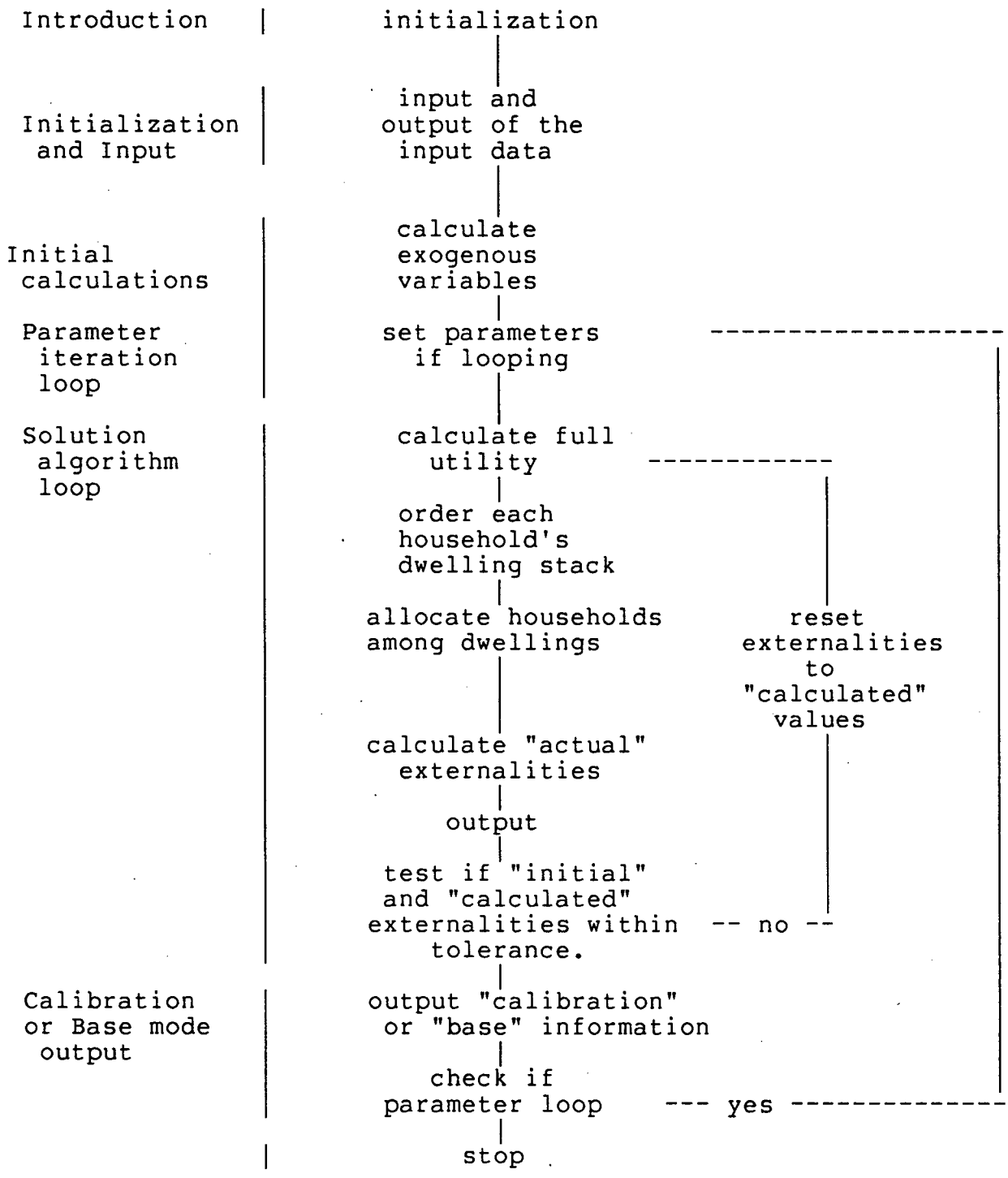


Figure A1:06 Flow Chart of Program Structure: "SIM01.FORT"

A1.51 General Outline.

This program consists of five general "subroutines" and a "control" section with multiple entry points in the calculating and output "subroutines". To enable the reader to relate to the actual input and output of the program this description is based on an example simulation. For simplicity, the example used has the input restricted to seven "model" existing dwellings located in two "zones", with the third "zone" being that for new construction. "Model" households have correspondingly been restricted to ten, with the "TYPE" option restricted to two. In normal usage the number of existing "model" dwellings ranges from approximately 65 to 100, with five to ten "zones". The corresponding number of "model" households will be in the region of 100, with eight "TYPE" specifications the standard.

The program may be used in one of three modes

1. in "calibration" mode to estimate, via simulation, the GAMMA and the BETA parameters,
2. in "base" mode to generate a base case for the urban area under consideration, and
3. in "policy" mode wherein policy parameters can be entered allowing the simulation of the affects of alternative market interventions.

The basic description incorporates the features of the two alternative standard "calibration" runs with the example being for a BETA "calibration" run. Details on the alternative "base" and "policy" runs are outlined in the subsequent sections: A1.58: "Base" Mode and A1.59: Policy Mode. The only significant difference between "calibration" mode and the two alternative modes is that with the former the behavioural parameter values are varied, with special restrictions on the allocation algorithm. The

latter involves the additional input of policy parameters using a fixed set of behavioural parameters.

A1.52 Initialization and Input.

The program initializes by setting all storage array elements to zero and then inputs the required data. Each input record is identified by a four-character code, corresponding to the first four columns of the input record, with data being spaced in five column fields across the remainder of the record. The standard input format for all input records is (2I2,12F5.0). This basic input to the solution algorithm is created by the utility programs "D61.FORT", "HH1.FORT" and "CZONE.FORT", with additional input from the input control deck. Additional data necessary for calibration is created by the utility program "D71.FORT".

Input is classified into nine groups, each group being identified by the number code in column 1:

"1___" data for "model" households
"2___" data on each household "TYPE"
"3___" data on "model" dwellings
"4___" data on each "zone"
"5___" behavioural parameters
"6___" construction and operating data
"7___" calibration data
"8___" policy data
"9___" system control parameters

In the following section each of these groups is detailed.

"1___" "Model" households.

Each "model" household is loaded with two basic data sets; actual annual income and type. "Model" household data records are identified with a "1" in column 1, with the "model" household being identified in columns 2 to 4 by a number not exceeding 120. Input need not be in sequential order but the numbering of the households must be continuous. For an outline of the calculation of these input data see the description of "HH1.FORT" in Section A1.43. The corresponding data input for the example is as follows, with blanks identified by a "_".

```
100118140____2
100230140____1
1003_3140____2
1004_3140____1
100558100____1
100648100____1
100721468____1
1008_6468____2
100911468____2
101021468____2
```

The first data field (columns 5-9) is the annual actual or measured income for the "model" household. The second field (columns 10-14) is the household TYPE group and in general use will take a value of 1 through 8.

"2___" Household TYPEs.

The household "TYPE" group data input has been separated into two records per household TYPE as the "average income" by household TYPE is calculated by "HH1.FORT", while the "ALPHA's" are generated externally. The household TYPE "average income" records are identified by a "20" in columns 1-2. A "21" denotes "ALPHA" records, with the household TYPE group identified in column 4 on both records. The combined data input for the example is as follows:

```
200134000
200214600
2101.1450
2102.2450
```

"3___" Model dwellings.

Model dwellings are initialized with two data fields; the original level of "housing" services and the zone in which it is located. This input is generated by the program "D61.FORT", (see description, Section A1.44 for details of calculations). Alternatively, when the program is being used to calibrate the GAMMAs, the input "model" dwellings are as for the decade-end. In these instances this input set is generated by the utility program "D71.FORT". The basic record structure consists of a "3" in column 1, the "model" dwelling number not exceeding 120 in columns 2-4, and normally two data fields. The required data input for the example is as follows.

```
3001__385____1
3002__195____2
3003__271____1
3004__251____1
3005__481____2
3006__249____2
3007__391____1
```

"4___" Zonal characteristics.

Data records for zonal characteristics consist of those for zones associated with existing dwellings and one for the zone of new construction. The program assumes that the zone with the highest number is the zone of new construction. The input data required for all runs, generated by the utility program "CZONE.FORT", consists of an initializing value for the zone's "end of the decade relative wealth"; the zone's average decade-end household income, and a relative access variable. The record

structure consists of a "40" in columns 1-2 the zone number, up to 20, in columns 3-4, and two data fields. The standard zonal input for the example, with "4003" being the zone of new construction is:

```
400120000___31
400237090___50
400329110___47
```

"5___" Behavioural parameters.

The program uses five behavioural parameters in addition to the "TYPE" specific ALPHA parameters. They are loaded under the basic code "50" and are identified by the numbers in columns 3-4 with each input record containing two data fields. Three of these parameters relate to household utility; GAMMA1, GAMMA2, GAMMA3, and two to the "supply of housing services from the existing stock" function; BETA1, BETA2. The respective number codings are:

"5001" GAMMA1: the parameter measuring the responsiveness of households to price differences within the housing market. This parameter may vary between 0 and 1, with 0 indicating maximum responsiveness.

"5002" GAMMA2: the parameter indicating the value households place, other things equal, on being located in a wealthy zone. This parameter has a lower limit of zero and no natural upper limit, but normally operates in the range 0.0 to 1.0.

"5003" GAMMA3: the parameter indicating the strength of the households' preference for leisure. A value of zero indicates that access is not valued, a value >0 through <1 indicates a declining marginal utility, 1 indicates a linear preference function, and values >1 generate an increasing marginal utility for access. Normally operates in the range 0.0 to 1.0.

"5004" BETA1: this parameter indicates the percentage of the initial level of services an existing dwelling will provide at the end of the decade <u>if</u> the price per unit of housing service obtained covers only operating costs. i.e., a value of 0.66 indicates that 66% of the initial level will still be supplied under these pessimistic price conditions.

"5005" BETA2: correspondingly, this parameter refers to the additional services that will be provided in response to an increase in the price received per unit of housing <u>over</u> the operating cost.

When the program is in "calibration" mode it will accept two input values for two of the five parameters, i.e., will read a second vaue in field two (column 10-14). These values will indicate to the program that a multiple set of runs is required in which the values of the two respective parameters are varied between the two supplied values. One pair of parameters will generate four runs, two pairs sixteen runs.

The five parameter values input for the example are:

```
50010.450
50020.20
50030.20
50040.560
50050.335
```

"6___" Construction and Operating data.

The basic supply function for new construction is assumed elastic at a price, PN, above a minimum quantity of services, QM, dictated by building codes. QM is input directly while PN may be input directly or calculated as the sum of the two inputs; PO and PC. The separate inputs of PO and PC are necessary since both values independently enter the supply function of an existing dwelling. These values are measured on a flow basis, in terms of dollars per month per unit of housing services, and are calculated as a weighted average for the decade under consideration.

"6001" PO : OPERATING COST; is the cash cost of monthly operation per unit of housing service, exclusive of financing. Given that the average initial price of housing service is 1.0, the range of this parameter is 0.2 through 1.5.

"6002" PC : FINANCING COST; is the monthly cost of financing one unit of housing service.

"6003" QM : MIN. QUANTITY; indicates the minimum number of units of housing service each new dwelling must provide. This minimum quantity corresponds to government-imposed restrictions on size and quality for new construction.

The three values input for this example are;

```
6001_0.43
6002_0.77
6003_140.
```

"7___" Calibration data.

The MODELs are calibrated to a given urban area, in terms of the BETA and GAMMA behavioural parameters, by simulating the model under different sets of parameter values and determining which set gives the "best fit". Best fit is calculated in terms of the difference between the actual market results and the simulated results. The actual results required for such error testing are generated by the utility program "D71.FORT", and input with a record structure of "70" in columns 1-2, the zone number in columns 3-4, and twelve data fields. These fields are; field one (columns 5-9) the average price, fields two through nine (columns 10-49) representing the distribution of households by type within the zone as a decimal percent, field ten (columns 50-54) the average income, and field eleven (columns 55-59) the utilization factor, which is the percentage of the starting stock occupied at the end of the period. Field twelve is the average quantity of "housing" services consumed. (See the description of "D71.FORT", in Section A1.45, for full details.) The calibration input for the example is:

```
70011.100.3333.6666                                12000  .75  210.
70021.300.25  .75                                    7230  .85  170.
70031.200.30  .70                                   28140 1.00  300.
```

"8___" "Policy" data.

These data are required when the program is in "policy" mode, simulating the effects of alternative forms of market intervention. Details of these input records are included in the Section A1.59: Policy Mode.

"9___" System control parameters.

These parameters are used to control input to and output from the program, in addition to controlling the operation of the algorithm. Options are provided to control the volume of printed output, control graphical output and to indicate the program mode.

It should be noted that in actual use most of the data records are contained in input data files. Three alternative files are used for each CMA corresponding to the different solution modes of the solution algorithm.

1. CMA.G5B : input for calibrating the GAMMA parameters
2. CMA.B5B : input for calibrating the BETA parameters
3. CMA.P5B : output from BASE mode runs for POLICY mode runs

These files contain records as follows;

1. CMA.G5B - GAMMA calibration

    1. 1971 "model" households
    2. 1971 household type characteristics
       - average income and ALPHA values
    3. 1971 "model" dwellings
    4. 1971 zonal characteristics
    5. GAMMA calibration set

2. CMA.B5B - Beta calibration

    1. 1971 "model" households
    2. 1971 household type characteristics
       - average income and ALPHA values
    3. 1961 "model" dwellings
    4. 1961 zonal characteristics
    5. BETA calibration set

2. CMA.P5B - Policy analysis

1. 1971 "model" households
2. 1971 household type characteristics
   - average income and ALPHA values
3. 1961 "model" dwellings
4. 1961 zonal characteristics

The remaining records; those for the behavioural parameters, the construction and operating data, the policy data and the system control parameters, are input from the control deck.

While loading the data, the program checks for errors, counts the number of "model" dwellings and "model" households, and ensures that the numbering is continuous and that zone and type specifications are correct. Errors are indicated. After loading, a review of the input is output as follows;

```
 *** INPUT DATA   Example Solution

 *** "1___" MODEL HOUSEHOLDs:            number households  10

household   1      2      3      4      5      6      7      8      9     10

income   18140  30140   3140   3140  58100  48100  21468   6468  11468  21468
type         2.     1.     2.     1.     1.     1.     1.     2.     2.     2.

*** "2___" HOUSEHOLD TYPE GROUPs:      number groups   2

TYPE group          1      2

 income          34000  14600
 ALPHA           .1450  .2450

*** "3___" MODEL DWELLINGS:             number dwellings   7

dwelling          1      2      3      4      5      6      7

 services       385.   195.   271.   251.   481.   249.   391.
 zone             1.     2.     1.     1.     2.     2.     1.

*** "4___" ZONAL CHARACTERISTICS:       number zones  3

ZONE number       1      2      3

"wealth"      20000  37090  29110
 distance        31.    50.    47.

*** "5___" BEHAVIOURAL PARAMETERS

  GAMMA1     GAMMA2     GAMMA3      BETA1      BETA2
 (price )   (wealth)   (access)   (depre.)   (elast)

 0.4500     0.2000     0.2000     0.5600     0.3350
 0.0        0.0        0.0        0.0        0.0


*** "6___" CONSTRUCTION CHARACTERISTICS

   PO         PC         PN         QM

   0.43       0.77       1.20     140.00

*** "7___" CALIBRATION DATA:

                        ********  household type  ********
zone  price  1     2     3     4     5     6     7     8     "Y"     usage  "Q"

  1   1.10  0.33  0.67  0.0   0.0   0.0   0.0   0.0   0.0   12000.   .75  210.
  2   1.30  0.25  0.75  0.0   0.0   0.0   0.0   0.0   0.0   14230.   .85  170.
  3   1.20  0.30  0.70  0.0   0.0   0.0   0.0   0.0   0.0   28140.   .0   300.
```

A1.53 Initial Calculations.

The solution algorithm is a repetitive simulation process whereby values calculated in one "execution" of the allocation algorithm are used as input for a subsequent "execution". The solution process is repeated until the input and output values of selected parameters converge. During the initial calculation stage, the program calculates those variable values that are constant throughout a complete run and initializes those endogenous variables whose values vary with each execution. In general only the zonal wealth externality variable varies during program iteration and all solution conditions including the price-quantity intercepts between household's demand functions and the respective supply functions are calculated exogenous to the solution process. These calculations are detailed in Section A1.54 that follows. The initial calculations, common to all simulations consist of; calculating "permanent" or "model" income, sorting the "model" households in descending "model" income order and the initialization of the zonal externalities.

A1.531 Monthly "Permanent" Income

While the program takes as input a mixture of annual and monthly values, all calculations are based on monthly values. "Permanent" or "model" income is calculated as the weighted product of the household's "actual" annual (input) income and the average income for the household type divided by 12. It is this "model" income that enters into the household's demand function and actually determines what dwelling it selects and what quantity of "housing" services it consumes. These "model" incomes are calculated under the assumption that the "permanent" income

elasticity of demand as outlined in Equation A1:5 is 0.6. The "actual" and the "model" incomes can be output for each household along with the relevant ALPHA value in the following form:

*** HOUSEHOLD CHARACTERISTICS: test simulation program

household	1	2	3	4	5	6	7	8	9	10
ALPHA	0.245	0.145	0.245	0.145	0.145	0.145	0.145	0.245	0.245	0.245
"Y"act'l	18140	30140	3140	3140	58100	48100	21468	6468	11468	21468
"Y"model	1386	2636	484	679	3908	3489	2150	746	1053	1533

note: "Y":act'l is the input annual amount;
"Y":model is a monthly amount.

A1.532 Ordering the "Model" Households.

After calculating the "model" incomes the program creates an ordered array of the "model" households. This array, termed the stack of "unassigned" households, contains all "model" households ordered by their "model" income. This ordering allows the solution algorithm to allocate the "model" households by declining consumption levels, thus minimizing the subsequent need for "reassignments", increasing the solution algorithm's efficiency. Since incomes are exogenously determined, this ordering of the stack is retained throughout the run. The ordered stack for the example is;

*** ORDERED HOUSEHOLD STACK

5 6 2 7 10 1 9 8 4 3

A1.533 Initialize "Relative" Wealth Externality Parameter.

The endogenously derived component of the utility function is associated with the preference for living in a wealthy zone. The

relative "wealth" of a zone is measured as the ratio of the average household income in the zone, to the average household income for the urban area at large.

$$Wz = (MY)zone / (MY)city$$

where,
(MY) is the average household income for the respective groupings.

The values for Wz are initialized as the ratio of the respective actual average decade-end values of (MY), where (MY)city is set to the value for the zone of new construction. By initializing Wz at these values, in preference to setting them to one, a faster convergence of the solution algorithm is achieved. During each "execution", the Wz's are recalculated from the relevant data for input into the next "execution". In multiple calibration runs, the previously calculated set is used at initialization for subsequent iterations.

A1.54 Price-Quantity Intercepts

With the MacRae allocation algorithm all valid intercepts between a household's demand curve and the supply curves associated with new and existing dwellings are calculated and the solutions "ordered" by "model" household, in terms of a declining total utility derived from housing and other goods and services.

Given the different nature of the supply curves for the new and existing services, the program utilizes two separate routines for solving for the relevant quantity of new services and the price and quantity associated with existing dwellings.

In addition, since "policies" are introduced by modifying the respective supply and demand curves; a separate solution equation

must be derived for each combination of supply function and subsidy policy. The result is a multiplicity of solution equations being included in this section of the program. Details of "policy" implementations are included in Section A1.59.

A1.541 Quantity and Partial Utility: New Services

With the ORIGINAL MODEL specification the supply function for new "model" dwellings is a horizontal function at PN. With this formulation the program can calculate the relevant intersections of the "new dwelling" supply function with each household's demand function by the direct substitution of PN into the demand function. If the calculated quantity of new construction for a "model" household, QN, is less than the specified minimum allowable quantity, QM, QN is set to zero for the "model" household.

For valid QN's the partial utilities associated with "housing services", "other goods and services", and "access" are calculated; a "partial" utility value, being the sum of these three values, is obtained. This partial utility value will be constant throughout the solution loops as it is derived completely from exogenous data. The price, quantity and partial utility data are then stored for subsequent use. If an invalid intercept occurs, the relevant price, quantity and partial utility values are set to zero.

A1.542 Quantity, Price and Partial Utility: Existing Services.

The approach used to derive price-quantity intercepts involves solving for price in a reduced equation. Given that the basic form of the existing stock supply functions is a linear function in "Pj", the unit price, and the household's demand function is a quadratic in "Pj", "Pj" can be calculated as the positive root of

the quadratic of the form;

```
A*Pj**2 + B*Pj + C
```

Since the reduced form equation with subsidy payments incorporated may be a cubic or higher power the derivation of Pj has been based completely on a numerical solution process, in preferrence to the more efficient analytical methods. The advantage of a completely numerical procedure is firstly consistency when considering policy applications and secondly simplicity of programming when incorporating alternative functions. The numerical procedure used is a combination of the bisection and secant rules solving for FN(Pj) = 0. Convergence is normally achieved within ten passes with the exit tolerance set at a price change of 0.0001.

Once calculated the value for Pj is then substituted into the existing dwelling supply function to obtain the value for Qj. Invalid intercepts are considered to occur if one of the following conditions is violated;

1. if the required level of consumption of housing services forces a negative utility to be associated with other goods and services. i.e.,

```
(Yi-Qj*Pj) - GAMMA1*(1.-ALPHAi*Yi) < 0.0
```

where,

ALPHAi is the household's "ALPHA".

2. Pj is less than PO, the operating cost, and
3. Qj is less than the household's QN; zero if the household is ineligible to consume a new dwelling or during calibration.

For valid intercepts, the "partial" utilities are calculated as for new construction but employing the relevant values for Pj and Qj: the calculated values for Pj and Qj and the "partial"

utility, zero if an invalid intercept, are then stored.

These stored price, quantity and "partial" utility data can then be output as follows; (note that dwelling "8" is the "new" dwelling)

*** PRICE, QUANTITY and "partial" UTILITY: test simulation prog

(Household 1)

DWELLING	1	2	3	4	5	6	7	8
price	1.132	2.092	1.555	1.666	0.925	1.678	1.116	1.200
quantity	294.0	203.2	240.2	230.5	338.4	229.6	296.8	282.8
partial"U"	431.	310.	371.	358.	465.	354.	434.	418.

(Household 2)

DWELLING	1	2	3	4	5	6	7	8
price	1.263	2.398	1.758	1.890	1.024	1.905	1.245	1.200
quantity	308.6	220.5	256.2	246.9	352.2	245.9	311.4	318.4
partial"U"	926.	744.	839.	819.	971.	812.	930.	934.

(Household 3)

DWELLING	1	2	3	4	5	6	7	8
price	0.0	0.806	0.595	0.639	0.0	0.644	0.0	0.0
quantity	0.0	130.5	164.8	155.8	0.0	154.9	0.0	0.0
partial"U"	0.	171.	192.	187.	0.	185.	0.	0.

(Household 4)

DWELLING	1	2	3	4	5	6	7	8
price	0.0	0.665	0.485	0.522	0.0	0.526	0.0	0.0
quantity	0.0	122.5	156.1	147.3	0.0	146.4	0.0	0.0
partial"U"	0.	275.	295.	291.	0.	289.	0.	0.

(Household 5)

DWELLING	1	2	3	4	5	6	7	8
price	1.831	3.481	2.549	2.741	1.484	2.762	1.804	1.200
quantity	372.0	281.8	318.4	308.8	416.5	307.8	374.8	472.1
partial"U"	1228.	918.	1082.	1047.	1304.	1037.	1234.	1385.

(Household 6)

DWELLING	1	2	3	4	5	6	7	8
price	1.645	3.126	2.291	2.462	1.334	2.481	1.621	1.200
quantity	351.3	261.7	298.0	288.5	395.5	287.6	354.1	421.5
partial"U"	1135.	870.	1010.	980.	1200.	971.	1140.	1236.

(Household 7)

DWELLING	1	2	3	4	5	6	7	8
price	1.042	1.980	1.452	1.561	0.844	1.572	1.027	1.200
quantity	284.0	196.8	232.1	222.9	327.1	221.9	286.7	259.8
partial"U"	794.	653.	727.	711.	829.	705.	797.	762.

(Household 8)

DWELLING	1	2	3	4	5	6	7	8
price	0.643	1.197	0.887	0.952	0.523	0.959	0.634	1.200
quantity	239.4	152.6	187.7	178.5	282.4	177.6	242.1	152.3
partial"U"	288.	225.	256.	249.	307.	247.	290.	225.

(Household 9)

DWELLING	1	2	3	4	5	6	7	8
price	0.882	1.633	1.213	1.300	0.719	1.309	0.869	1.200
quantity	266.0	177.2	213.3	203.9	309.7	202.9	268.8	214.8
partial"U"	362.	273.	318.	308.	388.	305.	364.	317.

(Household 10)

DWELLING	1	2	3	4	5	6	7	8
price	1.241	2.292	1.704	1.826	1.014	1.839	1.224	1.200
quantity	306.2	214.5	251.9	242.2	350.9	241.2	309.0	313.0
partial"U"	458.	322.	391.	376.	496.	372.	461.	463.

From a review of this example output it can be seen that households "3" and "4" are ineligible for a new dwelling, values for dwelling "8" zero, and that households "5" and "6" will select only a new dwelling; quantity values for all existing dwellings less than the values for dwelling "8". Only those dwellings yielding a price lower than the operating cost, 0.43 in this case, have zero values.

A1.55 Parameter Iteration Loop.

When the program is in "calibration" mode and multiple values have been entered for the behavioural parameters, a parameter iteration loop is created. This loop then controls entry to and exit from the solution algorithm loop. The parameters are initialized to the first input values and then increased by one-third the range in subsequent runs. For example, if the input parameter values are;

5004__0.2__0.5
5005__0.6__0.9

the parameter iteration combinations will be;

BETA1	0.2	0.3	0.4	0.5	0.2	0.3	0.4	0.5
BETA2	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7

BETA1	0.2	0.3	0.4	0.5	0.2	0.3	0.4	0.5
BETA2	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9

After the first iteration the relative wealth externality - Wz - is initialized to the previously calculated value. i.e., not re-initialized to the input conditions.

A1.56 Solution Algorithm Loop.

The solution algorithm loop consists of four separate sections, each executed in order, then repeated until the convergence tolerance criterion is met. The first step involves calculating the "externality" utility and the creation of the "ordered dwelling" stacks. The second step involves allocating the households among the existing and potentially new dwellings. Given the final allocations, the zones' "actual" wealth externality are then calculated and compared to the initial externality values. If

the difference is within the specified tolerance control is transferred out of the loop, otherwise the steps are repeated up to a maximum of ten times.

A1.561 Relative Wealth Utility

The partial utility associated with the relative wealth is calculated for each element in the "model" household-"model" dwelling array, with the full utility being calculated as the product of this partial value and the initially stored "partial" value. The final value of the utility is zero if the stored "partial" value is zero. The calculated values for the individual dwellings can be output by household, as follows;

*** "total" UTILITY: test simulation prog

(Household 1)

DWELLING	1	2	3	4	5	6	7	8
utility	428.	312.	368.	355.	468.	356.	430.	418.

(Household 2)

DWELLING	1	2	3	4	5	6	7	8
utility	919.	748.	833.	813.	976.	816.	923.	934.

(Household 3)

DWELLING	1	2	3	4	5	6	7	8
utility	0.	172.	190.	186.	0.	186.	0.	0.

(Household 4)

DWELLING	1	2	3	4	5	6	7	8
utility	0.	277.	293.	289.	0.	290.	0.	0.

(Household 5)

DWELLING	1	2	3	4	5	6	7	8
utility	1219.	923.	1074.	1039.	1310.	1042.	1225.	1385.

(Household 6)

DWELLING	1	2	3	4	5	6	7	8
utility	1127.	874.	1002.	973.	1206.	976.	1132.	1236.

(Household 7)

DWELLING	1	2	3	4	5	6	7	8
utility	788.	657.	721.	706.	833.	709.	791.	762.

(Household 8)

DWELLING	1	2	3	4	5	6	7	8
utility	286.	226.	254.	248.	308.	248.	287.	225.

(Household 9)

DWELLING	1	2	3	4	5	6	7	8
utility	360.	274.	315.	305.	390.	306.	362.	317.

(Household 10)

DWELLING	1	2	3	4	5	6	7	8
utility	455.	324.	388.	373.	499.	374.	458.	463.

A1.562 Households' "Ordered Dwelling" Stacks.

Input to the allocation algorithm consists of the "ordered unassigned" household stack, created during initialization, and the "ordered dwelling" stacks. The latter stacks, one for each household, are formed from all dwellings (including the new dwelling) that yield valid intersections with the corresponding household's demand curve, i.e., have been assigned a positive "utility" value. Each individual stack is ordered in terms of descending utility, with the lowest member being the new dwelling; zero if the household is unable to consume a new dwelling. The new dwelling occupies the bottom position in the stack as it is assumed that there is no competition for this dwelling. The exception is that during GAMMA calibration runs, when no new "model" dwellings are allocated, all existing "model" dwellings yielding a price greater than the operating cost will be included in the stacks. The household is free to select the quantity of new housing services it desires to consume and the building industry will supply that quantity. While some dwellings may yield a valid intersection, externalities may be such that the total utility derived from occupying the dwelling may be less than that derived from consuming a new dwelling. In these instances, the existing dwelling is discarded during creation of the stacks. These ordered stacks can be output as follows;

```
*** HOUSEHOLD's "ordered" dwelling STACKs
household   1
   5   7   1   8   0   0   0   0
household   2
   5   8   0   0   0   0   0   0
household   3
   3   6   4   2   0   0   0   0
household   4
   3   6   4   2   0   0   0   0
household   5
   8   0   0   0   0   0   0   0
household   6
   8   0   0   0   0   0   0   0
household   7
   5   7   1   8   0   0   0   0
household   8
   5   7   1   3   6   4   2   8
household   9
   5   7   1   8   0   0   0   0
household  10
   5   8   0   0   0   0   0   0
```

Note that the stacks of households "3" and "4", who cannot consume new dwellings, end with a 0 not an 8 that corresponds to a new dwelling.

A1.563 "Allocation" Algorithm.

The basic objective of the allocation algorithm is to assign the ordered households, one by one, to their preferred dwelling, if they can outbid the current occupant, and re-assign them only when another household is willing to pay a higher price for the dwelling. The algorithm uses as input the "ordered assigned" household stack and the housholds' "ordered dwelling" stacks. The output is a dwelling occupancy array that indicates which household, if any, occupies each dwelling and the price; the value of the latter being initialized at zero. In addition, an array indicating the status of each household's potential new dwelling is generated. The respective element of this array is set equal to PN if a household occupies a new dwelling; to -1.0 if the household is unassigned (forced out of the market).

The solution process begins with the selection of the household at the top of the "ordered unassigned" household stack: this selected household is termed the "unassigned" household. The simplified logic of the algorithm is;

1. select the dwelling number at the top of the household's "ordered dwelling" stack and in so doing delete it from the stack.
2. a check is made to see if the dwelling number is;
    a. for an existing dwelling: take option 1.
    b. for a new dwelling: take option 2.
    c. a zero: take option 3.
3. the respective options involve:

**option 1: existing dwelling.

a. check to see if occupied.

b.1 if not occupied the repective elements of the "occupancy" array are set to the household number and the price that the household will pay. The algorithm then returns to select the next household from the "ordered unassigned" household stack ands starts repeating the steps.

b.2 if occupied a comparision is made between the current price bid and the price that the unassigned household is offering to pay

: if the offer is less than, or equal to, the current price the current occupant remains and the unassigned household selects the next dwelling number at the top of its "ordered dwelling" stack - step "1" - and the process continues.

: if the offer is greater than the current price, the unassigned household occupies the dwelling and the displaced household then selects the next dwelling number at the top of its "ordered dwelling" stack - step "1" - and the process continues.

**option 2: new dwelling.

the respective element in the "new dwelling" array is set to PN. The algorithm then returns to select the next household from the "ordered unassigned" household stack and continues through the steps.

**option 3: unassigned.

The presence of a zero indicates that the household cannot consume the minimum quantity of "new dwelling" services. The household is treated as unassignable, with the program setting the respective element of the new dwelling array to -1., for future reference. The algorithm then continues as in option 2.

The end condition occurs when all households in the ordered unassigned household stack have been processed.

The number of iterations of the allocation algorithm has a finite upper bound, being the sum of the elements in the "ordered dwelling" stacks. This bound results because on each iteration a new element must be selected and once selected is discarded. A tracing of each iteration of the allocation algorithm can be output as follows; the trace being sequentially row-wise.

*** tracing HOUSEHOLD ASSIGMENTs

hhold	dwell	price	hhold	dwell	price	hhold	dwell	price
5	8	1.2000	6	8	1.2000	2	5	1.0238
7	5	0.8443	7	7	1.0273	10	5	1.0144
10	8	1.2000	1	5	0.9252	1	7	1.1169
7	1	1.0424	9	5	0.7193	9	7	0.8696
9	1	0.8820	9	8	1.2000	8	5	0.5236
8	7	0.6344	8	1	0.6435	8	3	0.8880
4	3	0.4858	4	6	0.5269	3	3	0.5963
3	6	0.6448	4	4	0.5228			

A1.564 Solution Output

With this MODEL only one conditional externality factor (relative wealth Wz) is used. This factor is calculated as:

$$Wz = (MY)zone / (MY)city$$

where,

(MY) is the average household income for the respective groupings.

On each iteration the "actual" and "expected" externalities are output as follows;

*** "ACTUAL" and "EXPECTED" EXTERNALITIES

zone	"ACTUAL" relative wealth	"ACTUAL" "#" units	"EXPECTED" relative wealth	"EXPECTED" "#" units
1	0.5552	4.	0.6870	4.
2	0.7508	2.	1.2741	3.
3	1.5694	4.	1.0000	0.

Root-Mean-Squared-Error: 0.1308

The root-mean-squared error (R.M.S.E.) statistic is employed as the indicator of convergence between the "expected" and the "actual" externalities. The error term is calculated by summing the square of the difference between the "actual" and "expected" values over the zones and dividing the total by twice the number of

zones.

$$R.M.S.E. = \frac{\text{zones } (Wz.actual - Wz.expected)^{**2}}{2 * \text{number zones}}$$

The convergence tolerance level is set to a R.M.S.E. of 0.01, but may be reset via an input parameter. The program will exit from the "solution algorithm" loop if the R.M.S.E. is less than the tolerance level, otherwise the program will loop ten times before exiting. On exiting from the "solution" algorithm loop the program transfers to output the final allocation of "model" households to both existing and new "model" dwellings. Unassigned households are similarly reported.

*** ALLOCATION of HOUSEHOLDS

existing dwellings

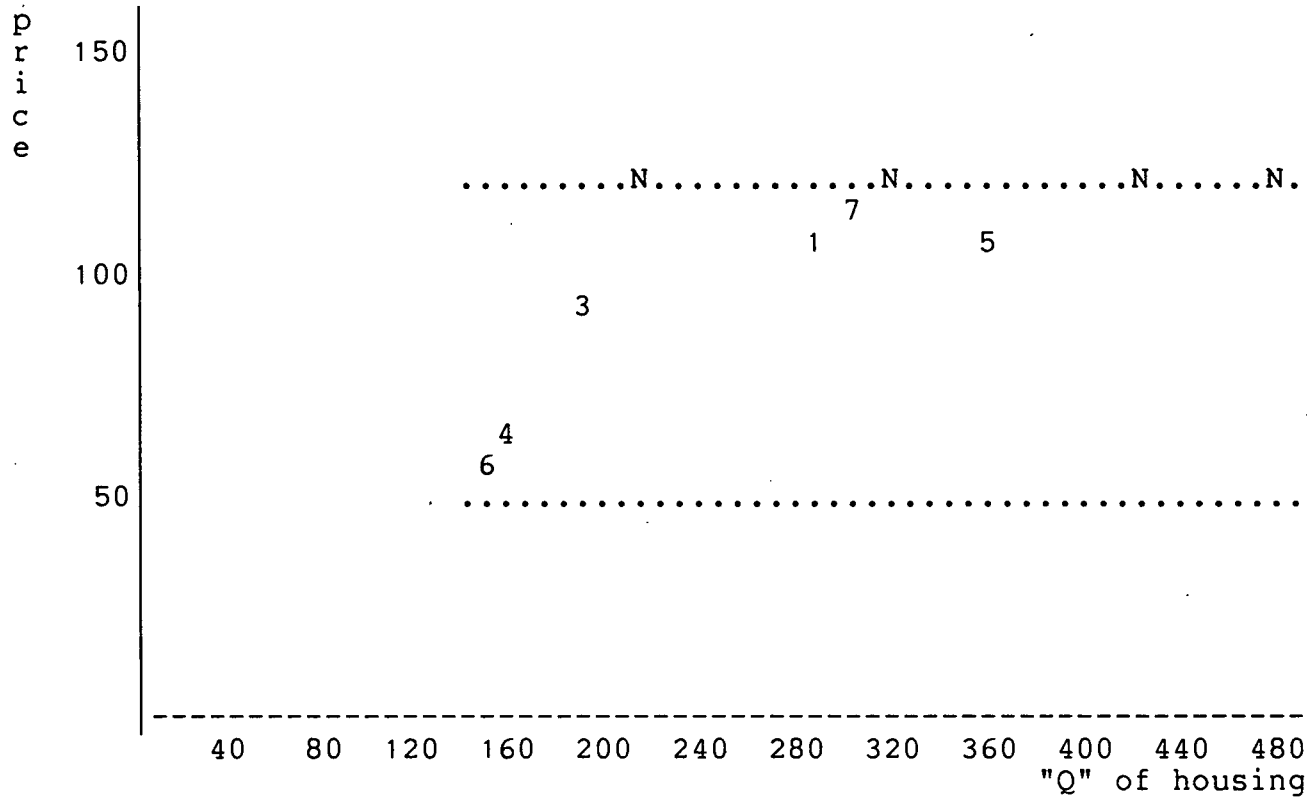
DWELLING	1	2	3	4	5	6	7
zone	1.	0.	1.	1.	2.	2.	1.
household	7	0	8	4	2	3	1
type	1.	0.	2.	1.	1.	2.	2.
price	1.042	0.0	0.887	0.639	1.024	0.526	1.116
quantity	284.0	0.0	187.7	155.8	352.2	146.4	296.8
"P"*"Q"	296.0	0.0	166.6	99.5	360.5	77.1	331.3

*** ALLOCATION of HOUSEHOLDS

new dwellings

household	5	6	9	10
type	1.	1.	2.	2.
price	1.200	1.200	1.200	1.200
quantity	472.1	421.5	214.8	313.0
"P"*"Q"	566.5	505.8	257.7	375.6

Additional graphical presentation of the solution conditions can also be output. In the following example the two horizontal rows of dots corresponds to PN, the price of new construction and PO, the operating costs respectively. They commence at QM, the minimum quantity of new construction.



PRICE-QUANTITY curves: Example Solution

After these outputs the program, when in "calibration" mode, transfers to calculate and output the calibration error before returning for additional input (Section A1.57 Calibration Mode). In the alternative "base" and "policy" modes the transfer is described in the corresponding Sections A1.58 and A1.59.

A1.57 ORIGINAL MODEL: Calibration Mode.

Calibration involves testing "solution" conditions generated under different behavioural parameters with "actual" market conditions. In the ORIGINAL MODEL five criterion sets based on zonal values are used.

1. average price per unit of "housing" services
2. the distribution of households by type
3. average household income
4. the utilization of the existing stock
5. the average quantity of "housing" services

The summary statistic used to indicate the "goodness-of-fit" of the model is termed the "mean error". Two mean error statistics are derived for each "solution" condition by:

1. calculating on a zonal basis the difference between the "actual" and "solution" means for price, quantity, income, utilization and the distribution of households by TYPE group (normally eight).

2. calculating the root-mean-square errors for each of these groups by summing the squares of the difference and dividing the sum by twice the number of zones.

3. weighting each of the groups R.M.S.E. by the unweighted average of the zonal means for that group, and

4. then these weighted R.M.S.E.'s are averaged to obtain the final summary measures. The first "mean error" value output corresponds1 to the average of the weighted R.M.S.E.s for prices, quantities, incomes and utilization: the second for the distribution by household TYPE.

The calibration output which includes the average zonal characteristics and the calibration errors is as follows:

```
*** CALIBRATION output:  test simulation prog

*** AVERAGE "actual" and "solution" ZONAL CHARACTERISTICS

 parameter values   GAMMA1  GAMMA2  GAMMA3  BETA1   BETA2
                    0.4500  0.2000  0.2000  0.5600  0.3350

                  ********  household type  ********

      price  1    2    3    4    5    6    7    8  income  usage "Q"

(zone  1)

actual  1.10 0.33 0.67 0.0  0.0  0.0  0.0  0.0  0.0 12000. 0.75 210.
calc.   0.97 0.25 0.75 0.0  0.0  0.0  0.0  0.0  0.0 12304. 1.00 231.

(zone  2)

actual  1.30 0.25 0.75 0.0  0.0  0.0  0.0  0.0  0.0 14230. 0.85 170.
calc.   0.88 1.00 0.0  0.0  0.0  0.0  0.0  0.0  0.0 16640. 0.67 249.

(zone  3)

actual  1.20 0.30 0.70 0.0  0.0  0.0  0.0  0.0  0.0 28140. 0.0  300.
calc.   1.20 0.50 0.50 0.0  0.0  0.0  0.0  0.0  0.0 34784. 0.0  355.

 *** CALIBRATION ERRORS

                  ********  household type  ********

        price   1   2   3    4    5    6    7    8  "Y"    usage  "Q"

R.M.S.E.  .21 .13 .13  .0   .0   .0   .0   .0   .0  1920.5 .052 16.5

R.M.S.E. .987 .72 .72  .0   .0   .0   .0   .0   .0  .0020  .27 .014
(weighted)    ------------- averaged ------------

          MEAN ERRORS     0.3170     0.7214
```

This output is provided at the end of each parameter iteration loop; the status of the iterated parameters being indicated in the output table. At termination of the parameter iteration loop transfers control to input additional data. An "end-of-file" terminates program execution.

A1.58 ORIGINAL MODEL: Base Mode

"Base" mode runs are used to generate a data set for input during "policy" runs that allows the internal calculation of comparative statistics that highlight the effects of the market intervention under study. In "base" mode the BETA calibration data set is employed as input along with the finally selected set of the five calibration parameters. The program outputs to file or cards a title record card and the data records for the household TYPEs, ALPHAs and average incomes, the zonal characteristics and records for each 1961 "model" existing dwelling and 1971 "model" household. The latter set of records contains additional data on the solution conditions. Output for each "model" household is the input "actual" income and household TYPE, together with the additional data; number of the dwelling occupied, price paid per unit of "housing" service, the quantity consumed and the utility. A new "model" dwelling is indicated by a "model" dwelling number of 999: a household forced to double-up is indicated by a zero. The "model" household component of the "policy" data set generated for the example data is as follows;

```
100118140____2____71.116296.8
100230140____1____51.024352.2
1003_3140____2____40.639155.8
1004_3140____1____60.526146.4
100558100____1__9991.200472.1
100648100____1__9991.200421.5
100721468____1____11.042284.0
1008_6468____2____30.887187.7
100911468____2__9991.200214.8
101021468____2__9991.200313.0
```

A1.59 ORIGINAL MODEL: Policy Mode

The aim in calibrating the MODELs is to evaluate the alternative policy options. The version of the solution algorithm program used in this study contains "policy" options capable of analysing the following policy types; income subsidy, in-kind subsidy, price subsidy, direct subsidy and public housing. With the first four options, the policies can be directed to either new or existing dwellings, or a combination of both, with household eligibility being regulated by "actual" income, TYPE and earmarking.

The specification of the subsidy amount to the program is based on a set of equations; the option available varying with the subsidy mode. In addition to incorporating different parameter values with each of the different equation types, up to four equations can be "stacked" to create relatively complex "conditional" programs such as a Rent Triangle or a Conditional Housing Allowance Program. The policy mode options, with the available equations, are:

1. income subsidy

1.2 SUB = POL1 * [POL3 - POL4 * AY]

2. in-kind subsidy

2.1 SUB = POL1 * [POL2 * Pj * Qj - POL4 * AY]

2.2 SUB = POL1 * [POL3 - POL4 * AY]

2.3 SUB = POL1 * [POL2 * Pj * Qj - POL5 * Pj * Qj]

2.4 SUB = POL1 * [POL3 - POL5 * Pj * Qj]

2.5 SUB = POL1 * [POL2 * Pj * Qj - POL5 * AY * Pj * Qj]

2.6 SUB = POL1 * [POL3 - POL5 * AY * Pj * Qj]

3. price subsidy

3.1 SUB = Qj * [(PO - POL1) + (PC - POL2)] ... for new

SUB = Qj * [(PO - POL3) + (PC - POL4)] ... for existing

4. direct demand subsidy

4.1 SUB = POL1 * [POL2 * Pj * Qj - POL4 * AY]

4.2 SUB = POL1 * [POL3 - POL4 * AY]

5. direct supply subsidy

5.1 SUB = POL1 * [POL2 * Pj * Qj - POL4 * AY]

5.2 SUB = POL1 * [POL3 - POL4 * AY]

20. constrained MINIMUM quantity subsidy

20.1 income subsidy to consume MINIMUM quantity (POL1)

20.2 in-kind subsidy to consume MINIMUM quantity (POL1)

20.3 direct constrained subsidy at MINIMUM quantity (POL1)

20.4 direct quantity subsidy at MINIMUM quantity (POL1)

20.5 direct expenditure subsidy at MINIMUM quantity (POL1)

20.6 direct price subsidy at MINIMUM quantity (POL1)

These are the options utilized in generating the policy simulations reported in Chapter 10.

In addition, eligibility may be specified via AILIM(POL6) and a minimum consumption level (earmarking requirement) via QMIN.

With the in-kind policy option the equation used may be directly specified, or selected by the program in accordance with the following logic:

if POL4 and POL5 both non-zero	select 5 or 6
if POL4 zero	select 3 or 4
if POL5 zero	select 1 or 2
if POL5 non-zero	select 1, 3 or 5

That is, if POL2 non-zero, POL3 is disregarded.

The additional input dat records available for "policy" simulations are:

"810 " General Policy parameters

"8201" Eligible Households by TYPE

"8301" Public Housing Recipients

At least one "810 " card is required for all "policy" runs; the "8200" and "8300" cards are optional. Details of these input records are:

"810 " General Policy Parameters

This input record contains eleven (11) data fields and may be used for up to four different equations in one policy run. (the equation number being identified in column 4). Fields correspond to OPTION, POL1, POL2, POL3, POL4, POL5, AILIM, QMIN, QMAX, RMIN and RMAX with the first six as detailed in the individual policy equations. The other parameters are used for special applications as detailed following.

field .

1 . OPTION
. data values:
. 1. income subsidy (new and existing)
. 2. income subsidy (existing only)
. 3. income subsidy (new only)
. 4. in-kind subsidy (new and existing)
. 5. in-kind subsidy (existing only)
. 6. in-kind subsidy (new only)
. 7. price subsidy (new and existing)
. 8. price subsidy (existing only)
. 9. price subsidy (new only)
. 10. direct demand subsidy (new and existing)
. 11. direct demand subsidy (existing only)
. 12. direct demand subsidy (new only)
. 13. direct supply subsidy (new and existing)
. 14. direct supply subsidy (existing only)
. 15. direct supply subsidy (new only)

. 20. constrained MINIMUM (new and existing)
. 21. constrained MINIMUM (existing only)
. 22. constrained MINIMUM (new only)

note: if only one equation is used ("8101") there is no limit on the subsidy amount other than that dictated by AILIM (the eligible income limit) and QMIN (the earmarking constraint). If more than one equation is used ("8102" - "8104") then the additional equations act as constraints on the subsidy amount such that at the solution (Pj, Qj) the subsidy given by an equation must be less than or equal to that provided by the next equation to be acceptable.

fields

(2-6) these fields correspond to POL1 through POL5 as detailed above.

field .

7 .AILIM, actual annual income eligibility limit, i.e. "model"
. household's actual income, must be less than or equal to
. this amount to be eligible for a subsidy. If zero, all
. households are eligible.

field

8 QMIN, the earmarking requirement. A household must consume a quantity greater than or equal to this

field .

9 .QMAX

. designated for use as a maximum quantity constraint

field .

10 .RMIN

. designated for use as a minimum rental/expenditure
. constraint

field .

11 .RMAX

. maximum rent constraint

amount to be eligible for a subsidy.

"8200" ELIGIBLE HOUSEHOLDS by TYPE

This input record contains eight fields corresponding to the eight household types.

default value: all households eligible for a subsidy

data options: 1. 0 for ineligible household types
2. 1 for eligible household types

"8300" PUBLIC HOUSING RECIPIENTS

This input record contains nine fields; the first being a control switch while the remaining eight are for the numbers of households forced to take new construction, and therefore non-competitive. Such households are indicated by a subsidy type code "99" in the output data.

default value: option off

field	
1	.control switch . data options: 1. 0 if data not to be considered . 2. 1 if require option
(8-9)	.public housing recipients . data options: valid household number in the range of; . 1 through 100

An income subsidy to both new and existing "model" dwellings (policy option 1) is taken as an example in this following description. The subsidy is to be 0.75 of the income "gap" where income is 25% of actual income. No restriction is to be placed on household eligibility, but "model" household "6" is treated as a public housing recipient. The required "policy" input records are:

```
8101____1_0.75____1_____0.25
8200____1____1
8300____1____6
```

After the basic data review these additional records are output as follows:

*** "8___" POLICY PARAMETERS

option	POL1	POL2	POL3	POL4	POL5	POL6	POL7
1.1	0.75	1.00	0.0	0.25	0.0	0.0	0.0

ELIGIBILITY by TYPE

1	2
1.	1.

PUBLIC HOUSING: option 1

6	0

A1.591 Simulation of Subsidy Options

In evaluating subsidy options, the program firstly calculates the intercept between the unsubsidized demand and supply curves and calculates the partial utility. It then attempts (for eligible households) to solve for each of the four potential subsidy equations in turn. For a new dwelling this is done simply by solving for the reduced equation in Q, assuming that PN, the price of new construction, is given (as sum of PO + PC or input price subsidy parameters). With existing dwellings the numerical solution technique must be utilized, wherein the alternative subsidy equations are incorporated into the demand and/or supply equations. After a check on earmarking requirements the amount of the subsidy is calculated by substituting the respective equations as outlined in the previous Section. This then allows the calculation of total "model" income and the corresponding partial utilities.

If only a single subsidy equation is used the total partial utilities with and without the subsidy are compared; the option

with the highest partial utility is selected.

If more than one subsidy equation is used the subsequent equations act as upper bounds on the maximum subsidy amount. This is achieved by firstly calculating the subsidy amount under the new equation for the solution price and quantity associated with the previous equation (e.g. price and quantity from equation 1 are substituted into subsidy equation 2) if this amount is greater than or equal to the previously calculated amount the household's subsidy amount is taken as for the previous equation. Otherwise, if the new equation is not the last equation in the set a new solution price and quantity is calculated and the process repeated. If the new equation is the last, the household's subsidy amount is simply set to zero.

For "model" households designated as new public housing recipients, all array elements associated with the existing "model" dwellings are set to zero. If the "model" household is not eligible for a new dwelling, QN is less than QM, it is assigned a QN value equal to QM. In this manner, its dwelling stack contains only a new "model" dwelling for which there is no competition.

A special option has been incorporated to aid in the efficient computation of the subsidy costs when comparing alternative policy forms supporting a constant minimum standard of housing reflected as a minimum quantity. The required subsidy amount under the designated form of subsidy is computed without the use of the special parametered equations. The alternative graphical representation of these six forms of intervention is detailed in Figure 9.02 with the mathematical formulation included as Section 9.31. The subsidy amount is computed as the additional cash required to shift the household from its unsubsidized level of

consumption to consume the required minimum quantity of housing in accord with the selected policy mode.

A1.592 Subsidy Calculation

After the calculation of the price-quantity intercepts and the associated partial utilities, the program transfers into the standard solution algorithm loop. Since the amounts in the majority of policies are a function of the solution conditions, on exiting from the allocation algorithm the program calculates the subsidy TYPE and amount associated with each household. The exception is that under the constrained MINIMUM quantity option the subsidy amount is computed directly. This additional information is output as a part of the ALLOCATION of HOUSEHOLDS data. In addition this data is output in conjunction with the income data ordered by "model" household income, with the form of the subsidy indicated by a code number. These two outputs for the example data set are as follows;

```
*** ALLOCATION of HOUSEHOLDS
existing dwellings

DWELLING          1      2      3      4      5      6      7
 zone             1.     0.     1.     1.     2.     2.     1.

household         7      0      8      3      2      4      1
 type             1.     0.     2.     2.     1.     1.     2.

 price        1.042  0.0    0.922  0.679  1.024  0.534  1.116
 quantity     284.0    0.0  190.5  158.7  352.2  146.9  296.8
 "P"*"Q"      296.0    0.0  175.7  107.7  360.5   78.5  331.3
 SUBSIDY
  :type           0      0     12     12      0     12      0
  :amount         0.     0.    31.    32.     0.    10.     0.

*** ALLOCATION of HOUSEHOLDS
new dwellings

household         5      6      9     10
 type             1.     1.     2.     2.

 price        1.200  1.200  1.200  1.200
 quantity     472.1  421.6  218.3  313.0
 "P"*"Q"      566.5  505.9  262.0  375.6
 SUBSIDY
  :type           0     99     12      0
  :amount         0.     0.    17.     0.

*** SUBSIDY AMOUNT: example data set

SUB=0.7500*(  1.00*P*Q-0.25*AY)  :Y LIMIT=9999./month  :MINQ=   0.
```

HHOLD #	HHOLD TYPE	INCOME ACTUAL	INCOME MODEL	DWELLING #	DWELLING PRICE	DWELLING QUANTITY	DWELLING P*Q	SUBSIDY TYPE	SUBSIDY AMOUNT
5	1.	4842.	3908.	999	1.200	472.1	566.5	0	0.0
6	1.	4008.	3489.	999	1.200	421.6	505.9	99	0.0
2	1.	2512.	2636.	5	1.024	352.2	360.5	0	0.0
7	1.	1789.	2150.	1	1.042	284.0	296.0	0	0.0
10	2.	1789.	1533.	999	1.200	313.0	375.6	0	0.0
1	2.	1512.	1386.	7	1.116	296.8	331.3	0	0.0
9	2.	956.	1053.	999	1.200	218.3	262.0	12	17.3
8	2.	539.	746.	3	0.922	190.5	175.7	12	30.7
4	1.	262.	679.	6	0.534	146.9	78.5	12	9.8
3	2.	262.	484.	4	0.679	158.7	107.7	12	31.7
		18469.				2854.0	3059.6		89.5

The subsidy type code numbers indicate firstly the subsidy equation by which it was derived and secondly the form of the subsidy. The six subsidy forms used are:

"1" income subsidy
"2" in-kind subsidy
"3" price subsidy
"4" direct demand subsidy
"5" direct supply subsidy

"20" constrained MINIMUM

with

"9" public housing

A1.593 Calculation of Subsidy Impact

To aid in evaluating the market effects of the input policy the program calculates data indicating changes from the market state generated in the "base" mode run, and input as elements of the "model" household records. In addition to general results for the CMA at large, selected statistics are calculated for all recipients, groupings of the recipients and the lowest income non-recipients. The size of the special groups is taken as the smaller of either half of the recipient group (recipient or non-recipient), or ten. The nature of the output is indicated in the following example;

*** SUBSIDY IMPACT: example data set

Participants:		4.	Subsidy: Mean	22.4
	: percent	40.00%	: Median	24.0

New Construction:	Base	4.
	: Subsidized	4.
	: % change	0.0 %

	CMA	RECIPIENTS			NON-RECIPIENT
		all	low "Y"	high "Y"	
Number	10.	4.	2.	2.	6.
Changes					
Prices	0.83%	2.57%	4.12%	1.70%	0.00%
Quality	0.34%	1.38%	1.14%	1.56%	-0.01%
Expenditure	0.76%	3.84%	5.47%	3.17%	-0.01%
Incomes					
Lowest	262.	262.	262.	539.	1512.
Highest	4842.	956.	262.	956.	4842.
Changes in Purchasing Power	0.48%	4.44%	7.94%	3.21%	0.0 %
Efficiency Ratio	0.038	0.062	0.055	0.065	
Earmarking Ratio		25.78	23.24	27.98	
%Subsidy obtained		100.00%	46.38%	53.62%	
participation rate	40.00%				

note: [1] NON-RECIPIENTS are lowest-income group
[2] Efficiency Ratio is the percentage increase in housing consumption divided by the average net dollar amount transferred to the corresponding group.
[3] Earmarking Ratio is the ratio of the change in housing expenditure to subsidy received.

After this output, the program transfers control to input additional data for the next run.

SECTION A2:

THE MODIFIED HOUSING MARKET MODEL

In implementing the MODIFIED model, the majority of the data sets and hedonic estimations resulting from the ORIGINAL model are utilized while with the computerized applications the software used for "model" generation has simply been modified to serve both models. The exception is with the creation of the "model" households, where a new SHU data set was created and a new program written to calculate household taxes and generate the resulting "model" households under the respecified TYPE groupings that reflect tenure. Additional data sets are also required in order to directly estimate the demand functions under a translog utility function.

The general set of manipulations required to generate the data for a C.M.A. for the MODIFIED model are:

1. delineate the C.M.A. geographically into a specific number of zones. While the model has the capability of handling up to ten zones, five zones have been employed throughout this study for the sake of consistency through the range of C.M.A. sizes. [See Section A1.42 for details on this procedure.]

2. calculate by zone the average income and average access for use in determining zonal externalities. [See Section A1.42 for details.]

3. derive the demand system for the model in a series of four steps. The first involves the creation of a dataset (from the 1974 Survey of Housing Units data) for input to a regression package. Hedonic equations suitable for reducing expenditures to "housing" services are then derived via O.L.S. regressions; estimating separate hedonic equations for owner-occupied and rental dwellings. The resulting coefficients are then used to convert actual 1971 rents and prices from "residential" services to "housing" services, while creating the input file for the translog expenditure estimates. [See Section A2.31.] The final step involves the estimation of the translog functions.

4. create the 1971 "model" households utilizing after-tax incomes. In addition to income information, data on equity holdings are also required for the owner-occupier "model" households. As with the ORIGINAL model, income data from the 1974 Survey of Housing Units deflated to 1971 means are used. [See Section A2.51.]

The demand function parameter sets (A1,B11,B12,BM1,BM2) are then estimated utilizing the 1974 SHU data by differentiating households firstly by TYPE and then by income into four quartiles to reflect additional variations with income and to enable the generation of relative smooth demand functions. Details of this procedure are outlined in Section 8.51. These operations provide the data required to estimate the two zonal externality parameters: EXT1 and EXT2 via a calibration process similiar to that used for the ORIGINAL model.

The next step involves the generation of the supply system. This involves the generation of the 1961 "model" dwelling representations and the calibration of the supply function parameters.

5. again the "model" dwellings are derived in a manner similiar to that outlined in Section 8.23 with independent "model" rental and owner-occupier dwellings created.

As with the ORIGINAL model, calibration data representing the change in market conditions over the decade are derived. These data are differentiated by tenure to allow the independent calculation of goodness-of-fit statistics for the rental and owner-occupier components. This calibration process is briefly outlined in Section 8.54.

In final preparation for policy analysis a data set incorporating data on the "base" solution is generated. This data set is generated by the solution algorithm program "SIM02.FORT" when in "base" mode. For details of this procedure, see Section

A2.69

For the purpose of the linear and non-linear regression analysis and the creation of the tenured "model" representations, several files, in addition to those for the ORIGINAL model, are required. These additional files are detailed in the following Section. The subsequent Sections detail the additional analytical calculations and regression analysis required in deriving the new behavioural parameters. A further Section outlines the changes made in creating the tenured "model" representations, with the final Section detailing the structure of the simulation process incorporating the MODIFIED model.

A2.1 MODIFIED model: Data Files

The MODIFIED model framework utilizes the majority of the data files associated with the ORIGINAL model. An additional raw data file is created from the 1974 Survey of Housing Units file, incorporating detailed data on household's housing expenditures and other income data required for the calculation of after tax incomes. Two intermediate files are required when estimating the demand side translog functions. The first is required as input for estimating the hedonic equations; the second provides the input for the actual functional estimates. Similarly, in estimating the supply system one additional file is required.

A2.11 Additional Data Files

The following additional data files are required in calibrating the MODIFIED model for each C.M.A.:

1. CMA.SHU.T contains selected records from the 1974 Survey of Housing Units master tape files. In creating this file, several variables are either aggregated or recalculated. This file replaces CMA.SHU used for the ORIGINAL model and provides input for the demand function parameter estimates and the creation of the 1971 "model" households.

2. CMA.REG02 This file, creatd by the program "WORK00.FORT" contains data drawn from CMA.SHU and CMA.SHU.T and is used for hedonic equation estimations.

3. CMA.REG03 Also created by the program "WORK00.FORT", drawing data from CMA.SHU and CMA.SHU.T. It contains the input

variables for the demand translog function estimates.

4. CMA.REG04 Also created by the program "WORK00.FORT", drawing data from CMA.SHU and CMA.SHU.T. It contains the 1974 SHU input variables for testing the supply side translog function estimates.

5. CMA.REG05 Also created by the program "WORK00.FORT", drawing data from CMA.SHU.T to be used in the estimation of the relationship between the owner-occupier's user costs and property value.

6. CMA.T.DATA this file contains data transferred from CMA.REG03 and the regression output print files by the utility programs "WORK04.FORT" and "WORK07.FORT". The first section contains data on the distribution of incomes and mean statistics on household characteristics differentiated into the seven different groupings used for estimating. The second section contains the coefficients from the demand regression along with the associated mean values of the dependent variables. The third section contains the log likelihood values for the unconstrained and constrained estimates utilized in deriving the test statistics for the unity income elasticity.

CMA.SHU.T 1974 SURVEY OF HOUSING UNITS (MODIFIED model)

variable number	field number	field	name	
1	1	01-03	survey area	001
2	2	04-10	household weight	017
3	3	11-12	type of dwelling	018
4	4	13-14	year dwelling constructed	022
5	5	15-16	toilet facilities	026
6	6	17-18	tenure	029
7	7	19-25	74 selling price	#01
8	8	26-32	74 O.S.B. mortgages	#02
9	9	33-37	74 monthly interest payments	#03
10	10	38-42	74 monthly total mortgage payments	#04
11	11	43-47	74 monthly additional taxes	#05
12	12	48-52	74 monthly repair expenditure	#06
13	13	53-57	74 monthly rent payment	088
14	14	58-62	74 monthly payments for all basic utilities and services	092
15	15	63-65	number of living rooms	069
16	16	66-68	number of work rooms	070
17	17	69-71	number of bedrooms	071
18	18	72-73	exterior condition	093
19	19	74-81	household income	083
20	20	82-84	household size	084
21	21	85-87	number of children	094
22	22	88-90	age of head	097
23	23	88-90	marital status of head	099
24	24	93-99	73 head's income	100
25	25	100-106	73 spouse's income	102
26	26	107-108	presence of spouse	101
27	27	109-110	1 if mortgage payment includes taxes	153
28	28	111-113	number of defects	016
29	29	114-118	area of living space	072
30	30	119-123	area of work space	073
31	31	124-128	area of bedroom space	074
32	32	129-131	land use 1	076
33	33	132-134	land use 2	077
34	34	135-137	land use 3	078
35	35	138-139	basic facilities	087
36	36	140-141	condition of exterior	093
37	37	142-143	reason for selecting 1	127
38	38	144-145	reason for selecting 2	128

note: Variables 7 through 12 have been computed from the raw data.

The computations involved are (SHU variable prefixed by "S");

1. V07 = S32/S33 if S33 non-zero.

2. V08 = (S35+S36+S37)/S33 if S33 non-zero.

3. V09 = (S35*S41/100)+(S36*S42/100)+(S37*S43/100)
   all divided by (S33*12) if S33 non-zero.

4. V10 = (S89+S90+S91)/S91 if S33 non-zero.

5. V11 = S44/(S33*12) if S33 non-zero.

6. V12 = S67/(S68*12) if S68 non-zero and S66 = 1.

CMA.REG02. SHU data for Hedonic Estimates

variable number	field number	field	name
1	1	1- 5	monthly expenditure on housing
2	2	6- 10	tenure
3	3	11- 15	full water supply
4	4	16- 20	full bathroom facilities
5	5	21- 25	toilet
6	6	26- 30	subsidised?
7	7	31- 35	LOG(number of living rooms)*10000.
8	8	36- 40	LOG(after tax income)*10000.
9	9	41- 45	structure TYPE
10	10	46- 50	LOG(distance from work)*10000.
11	11	51- 55	age: built 66 to 71
12	12	56- 60	built 61 to 65
13	13	61- 65	built 51 to 60
14	14	66- 70	built 46 to 50
15	15	71- 75	built 21 to 45
16	16	76- 80	built pre 1921
17	17	81- 90	household weight
18	18	91- 95	number defects (not used)
19	19	96-100	LOG(living room size)*10000.
20	20	101-105	LOG(workspace size)*10000.
21	21	106-110	LOG(bedroom size)*10000.
22	22	111-115	open space
23	23	116-120	high density neighbourhood
24	24	121-125	commercial neighbourhood
25	25	126-130	presence of basic facilities
26	26	131-135	poor exterior
27	27	136-140	fair exterior
28	28	141-145	choose because of neighbourhood
29	29	146-150	choose because of finance
30	30	151-155	average cost of finance (O-Oers only)

note: the computations of these variables are detailed in the program "WORK00.FORT".

CMA.REG03 file: SHU data for Translog Regressions: Demand

variable number	field number	field	name
1	1	1- 5	household TYPE
2	2	6-15	monthly housing expenditure
3	3	16-25	monthly after tax income
4	4	26-35	price per unit of housing service
5	5	36-45	price per unit of other goods
6	6	46-55	household weight

note: this file is generatd by the program "WORK00.FORT"
with data drawn from CMA.SHU.T and CMA.SHU

CMA.REG04 file: SHU data for Translog Regressions: Supply

variable number	field number	field	name
1	1	1- 5	household TYPE
2	2	6-15	housing expenditure
3	3	16-25	profit
4	4	26-35	wealth (PROFIT function)
5	5	36-45	cost
6	6	46-55	wealth (COST function)
7	7	56-65	price per unit of housing service

note: this file is generatd by the program "WORK00.FORT"
with data drawn from CMA.SHU.T and CMA.SHU

CMA.REG05 file: SHU data for User Cost/Value Ratio Regressions

variable number	field number	field	name
1	1	1- 5	household TYPE
2	2	6-15	expenditure/value RATIO
3	3	16-25	value of dwelling
4	4	26-35	annual expenditure

note: this file is generatd by the program "WORK00.FORT"
with data drawn from CMA.SHU.T.
: contains only owner-occupier data points

A2.2 MODIFIED model: Analytical Calculations

A2.21 New Construction Costs

The approach used by the U.I. in calculating the cost per unit of new housing services involves the weighting of actual costs for the duration of the decade. In the MODIFIED model the functional specifications are based on a decade-end cost of construction. The calculation of these costs on a C.M.A. basis under the same approach are included in Section A1.21, with the derived results reported in Table A3:10. These costs are based on the changes in costs associated with the construction of a minimum quality (quantity) owner-occupier dwelling. Their shortcomings are that, firstly, they do not represent cost changes associated with higher quality housing, in particular the impact of the cost of available sites for construction. Secondly, they may not represent long run equilibrium costs, as is assumed in the estimation of the demand and supply functions. This disequilibrium may result from a short run upswing in the price of existing dwellings at the end of the decade. Finally, independent costs for rental and owner-occupied dwellings are required in order to reflect the relative changes in rental and owner-occupier production costs arising from different structure types and the differential taxation treatment.

By necessity, the price of new construction has been derived from the change in rents associated with rental dwellings and the market value of owner-occupier dwellings constructed in 1960-1961 and 1970-1971, as reported in the respective census. The computation procedure involves the calculation of the ratios of the rents to derive the cost per unit of rental housing; the ratio of

user costs based on market values, current mortgage rates and estimated operating costs for owners. The 1971 owner-occupiers' user costs were derived from the SHU data set and divided by the market value (MV) to obtain the "total factor". The monthly mortgage factor (MR) of 0.007883 was based on the reported mean Canadian rate of 9.46%. "Other", representing monthly costs other than interest, is the difference between the "total" and the mortgage factor. This "other" factor is assumed to be constant across the decade, while the monthly mortgage factor in 1961 reflects an interest rate of 7.00%. The resulting "total" factor is then multiplied by the 1961 market value to yield the user cost.

These calculations are detailed in Table A2:01 with the separate PN values for rented and owner-occupied dwellings reported. In all cases the PN for owner-occupied is higher than the corresponding rental value, reflecting typically a lower growth rate in market rents than increases in ownership costs, in particular financing costs.

	Calgary	Kitchener	Quebec City	St. John's
Rental:				
1961 rent	83.	72.	65.	78.
1971 rent	137.	120.	100.	101.
PN	1.65	1.67	1.54	1.30
Owners:				
1971 MV	23184.	25173.	18881.	18809.
user cost	215.42	246.63	210.91	206.43
Factors:				
Total	.0092918	.0097974	.0111705	.0109751
MR	.0078833	.0078833	.0078833	.0078833
other	.0014085	.0019141	.0032872	.0030918
1961 MV	15898.	13510.	14340.	13584.
Factors:				
MR	.0058333	.0058333	.0058333	.0058333
other	.0014085	.0019141	.0032872	.0030918
Total	.0072418	.0077474	.0091205	.0089251
user cost	115.13	104.67	130.79	121.24
PN	1.87	2.36	1.61	1.70

	Saskatoon	Sudbury	Vancouver	Winnipeg
Rental:				
1961 rent	83.	78.	85.	79.
1971 rent	101.	122.	135.	113.
PN	1.22	1.56	1.59	1.43
Owners:				
1971 MV	17480.	21958.	27279.	17679.
user cost	173.34	242.83	276.96	184.75
Factors:				
Total	.0099165	.0110588	.0101529	.0104503
MR	.0078833	.0078833	.0078833	.0078833
other	.0020332	.0031755	.0022696	.0025670
1961 MV	13515.	14089.	15339.	13221.
Factors:				
MR	.0058333	.0058333	.0058333	.0058333
other	.0020332	.0031755	.0022696	.0025670
Total	.0078665	.0090089	.0081029	.0084003
user cost	106.32	126.93	124.29	111.06
PN	1.63	1.91	2.23	1.66

Table A2:01 Calculation of Effective Decade End Construction Costs

A2.22 Computation of Ownership Costs

The supply function formulation incorporated in the MODIFIED model is of a discontinuous linear form. The break point is assumed to occur at a price equal to the ownership costs net of repairs and maintenance. Ownership costs are defined to include normal operating costs and financing costs. These costs are calculated as a percentage of the mean price on a C.M.A. and tenure basis as follows:

	% operating [1]	% capital [1]	repairs as %		finance as %capital [3]	owner cost %
C.M.A.						
Calgary	.33	.67	.30	rent	.75	.73
				o-oers	.59	.63
Kitchener	.36	.64	.26	rent	.75	.75
				o-oers	.44	.55
Quebec	.40	.60	.29	rent	.75	.74
				o-oers	.51	.59
St. John's	.30	.70	.29	rent	.75	.74
				o-oers	.53	.58
Saskatoon	.39	.61	.23	rent	.75	.76
				o-oers	.56	.64
Sudbury	.34	.66	.26	rent	.75	.75
				o-oers	.44	.54
Vancouver	.29	.71	.26	rent	.75	.75
				o-oers	.41	.50
Winnipeg	.34	.66	.22	rent	.75	.76
				o-oers	.49	.59

source: [1] Tables A3:10 split for 1971
[2] 1969 Survey of Family Expenditures
[3] the owner-occupier percent financed is derived from the 1974 SHU; the rental percent has simply been set to a market norm.

Table A2:02 Ownership Costs as % of Mean Price

A2.3 MODIFIED model : Demand Function Estimation

The derivation of the demand side behavioural parameters is based on the direct estimation of the demand functions on a household TYPE basis. The preparation of the input data set for the estimation procedure involves the estimation of Hedonic coefficients for the 1974 Survey of Housing Units data. In the following Section the data preparation for the Hedonics, the Hedonic estimates and the Translog estimations of the expenditure share equations from which the demand functions are derived, are described.

A2.31 Preparation for Estimation of the Demand Functions

The estimation of the expenditure share functions under a direct utility specification requires the calculation of both the quantity of "housing" services consumed and the houshold's after tax income (being the assumed approximation for expenditure), as neither is recorded. The derivation of the quantity of "housing" services by necessity follows an approach similar to that used in generating "model" dwellings; the calculation of the after tax incomes involves calculating the tax liability of the household, considering all sources of income, and personal and non-personal deductions.

The program "WORK00.FORT" has been written to convert the 1974 Survey of Housing Units data firstly into a data file including calculated housing expenditure, after tax income and other attributes applicable to the derivation of the Hedonic coefficients, and then secondly reprocess the SHU data utilizing the Hedonic coefficients to convert the calculated housing

expenditure to a quantity of "housing" services, for output to the translog regression input file.

The SHU dataset contains 1974 price/rent data which must be deflated to 1971 values. This is achieved by using "WORK00.FORT" to derive the mean rent and value for the SHU dataset. A deflator, corresponding to the ratio of the computed values from the 1971 Census data and these means are used as input to "WORK00.FORT" when deriving the alternative datasets. The calculations of the deflators are included as Table A2:03.

	CAL	KIT	QUE	JHN	SAS	SUB	VAN	WIN
Rents								
1971	127	119	98	103	100	120	129	108
1974	152	145	122	149	128	139	165	131
deflator	.83553	.82069	.80328	.69128	.78125	.86331	.78182	.82443
Values								
1971	23742	25532	20588	21364	17965	23471	28744	19016
1974	38081	42266	28261	32720	27877	30990	52392	25925
deflator	.62346	.60408	.72850	.65293	.64444	.75737	.54863	.73350

note: derived from Tables A3:6 for 1971 and "WORK00.FORT" (option 0) for 1974

Table A2:03 Rent and Value Deflators for 1974 SHU

The SHU data reports 1973 total household incomes, the head's income and the spouse's income. By assuming that any additional income over and above that reported for the head and the spouse is associated with a third person only, a maximum of three income sources can be differentiated. Firstly, the 1973 incomes are deflated to equivalent 1971 value using provincial indices, by

household TYPE and by head or spouse, drawn from the 1972 and 1974 HIFE survey data prepared for Canada Mortgage and Housing by Statistics Canada. Then in calculating the tax liabilty for each of the three sources, exemptions were made in accordance with the 1971 Tax Schedule. The exemptions considered were:

1. a married person allowance if spouse present and income less than $1250.
2. personal exemption of $1000 per income source.
3. age exemption to all persons over 65 years of age.
4. $300 per child allocated to the highest income source.
5. other non-personal deductions are assigned as 7.5% of gross income. This percentage was estimated on a national basis via simple regression for data reported in Taxation Statistics (1973 Edition - 1971 Taxation Year) with an R2 of 0.99.

The tax on incomes in excess of exemptions is calculated in accordance with the following table:

In calculating the taxes it is assumed that all government transfers are treated as taxable income. For a renting household, after tax income is simply the gross minus taxes; for owners, opportunity income associated with their equity holding in their property is added to their net income.

taxable income	tax
500 or less	nil
500	nil + 16%
2000	240 + 18%
3000	420 + 19%
4000	610 + 22%
6000	1050 + 26%
8000	1570 + 30%
10000	2170 + 35%
12000	2870 + 40%
15000	4070 + 45%
25000	8750 + 50%
40000	16070 + 55%
60000	27070 + 60%

The monthly expenditure on housing for renters is taken as the monthly rent plus other reported expenditures on utilities. With owner-occupiers, the monthly expenditure is considered to include interest payments (not the full mortgage payment), utilities payments, repairs, maintenance and the opportunity cost of equity. It has been assumed that the equity holding (expected net sale price minus the mortgage balance) is an additional mortgage to the owner earning tax free interest at the current market rate of 0.9475% per month. This monthly expenditure was the dependent variable for the Hedonic estimates. The independent variables used in addition to after tax income are detailed in the description of the file CMA.REG02 in Section A2.11.

The approach taken in deriving suitable common Hedonic equations across the eight C.M.A.s was to simply run a stepwise regression on each C.M.A. and then select the most consistent variables. The two Hedonic models are as follows:

RENTAL MODEL

LOG(EXPEND) =

CONSTANT

+ BATH : 1. if full service, 0. otherwise

+ TOILET : 1. if full service, 0. otherwise

+ SUBSIDIS: 1. if subsidised unit.

+ LGLIVING: LOG of number of living rooms

+ LGINCOM : LOG of the household's monthly after tax income

+ TYPE : 1. if multiple unit structure, 0. otherwise

+ LGDIST : LOG of the reported distance to work

+ B5160 : 1. if built 1961 through 1960, 0. otherwise

+ B4650 : 1. if built 1946 through 1950, 0. otherwise

+ B2145 : 1. if built 1921 through 1945, 0. otherwise

+ BPRE20 : 1. if built prior to 1920, 0. otherwise

+ LGLVSIZE: LOG of the size of the living areas

+ LGBDSIZE: LOG of the size of the bedroom areas

+ OPENSP : 1. if property adjacent to open space, 0. otherwise

+ HIGHDEN : 1. if adjacent property apartments, 0. otherwise

+ COMMERC : 1. if adjacent property commercial, 0. otherwise

+ NEIGHBD : 1. if rented due to neighbourhood, 0. otherwise

+ FINANCE : 1. if rented due to low rent, 0. otherwise

OWNER-OCCUPIER MODEL

LOG(EXPEND) =

CONSTANT

+ BATH : 1. if full service, 0. otherwise

+ TOILET : 1. if full service, 0. otherwise

+ SUBSIDIS: 1. if subsidised unit.

+ LGLIVING: LOG of number of living rooms

+ LGINCOM : LOG of the household monthly after tax income

+ TYPE : 1. if multiple unit structure, 0. otherwise

+ LGDIST : LOG of the reported distance to work

+ B5160 : 1. if built 1961 through 1960, 0. otherwise

+ B4650 : 1. if built 1946 through 1950, 0. otherwise

+ B2145 : 1. if built 1921 through 1945, 0. otherwise

+ BPRE20 : 1. if built prior to 1920, 0. otherwise

+ LGLVSIZE: LOG of the size of the living areas

+ LGBDSIZE: LOG of the size of the bedroom areas

+ OPENSP : 1. if property adjacent to open space, 0. otherwise

+ HIGHDEN : 1. if adjacent property apartments, 0. otherwise

+ FINANCE : 1. if brought due to finance, 0. otherwise

+ AMRATE : average rate of interest paid on mortgages

Given the large sample of individual observations, the general goodness-of-fit still exceeds that associated with the Hedonic models derived from the 1961 and 1971 aggregated Census data. The additional information of importance available from the SHU file includes the living and bedrom areas (entered into the equation in a logarithmic form), information on financing for owner-occupiers (entered into equations as a cost of financing) and whether or not the dwelling unit was subsidised.

Complete results for both the rental and owner-occupier equations are reported on a C.M.A. basis in Figures A3:14. An example set for Vancouver is included as Table A2:04.

	Rental	Owner-Occupied
CONSTANT	2.5335	1.4999
	(21.9)	(5.50)
BATH	0.6068	na
	(3.41)	
TOILET	-.4338	0.1913
	(2.41)	(0.98)
SUBSIDIS	-.2940	-.0251
	(10.1)	(0.50)
LGLIVING	0.2176	0.1254
	(7.21)	(3.31)
LGINCOM	0.1546	0.2032
	(11.9)	(9.62)
TYPE	-.1354	-.3077
	(8.51)	(9.34)
LGDIST	-.0062	-.0041
	(0.86)	(0.50)
B5160	-.0892	-.1106
	(4.19)	(4.55)
B4650	-.0986	-.0904
	(3.33)	(3.47)
B2145	-.0558	-.1183
	(2.56)	(5.51)
BPRE20	-.1466	-.1183
	(4.90)	(5.51)
LGLVSIZE	0.1644	0.2455
	(8.53)	(8.53)
LGBDSIZE	0.0640	0.0295
	(13.2)	(2.50)
OPENSP	0.0310	0.0332
	(1.65)	(1.09)
HIGHDEN	0.0301	-.1426
	(1.78)	(1.09)
COMMERC	-.0413	na
	(2.40)	
NEIGHBD	0.0589	na
	(2.78)	
FINANCE	-.0382	-.0655
	(2.37)	(2.72)
AMRATE	na	0.0891
		(16.9)
R2	0.58	0.51
Observations	1345	1228

note: "t" statistics in brackets
: data source: VAN.REG02

Table A2:04 1971 Hedonics for Translog Estimates (Vancouver)

On the second pass through the program "WORK00.FORT", these estimated coefficients are included as input from the control deck. To estimate the translog expenditure share function for a direct utility system, data on total expenditures and housing expenditures, together with the quantities of housing and other goods and services are required. Total expenditure is equated to after-tax income on the assunption that net savings are included in other goods and services. Expenditures on housing are calculated in the same manner as those for the hedonic file. The quantities of housing and other goods and services are not reported and must be calculated. An additional complication arises inasmuch as the model operates in terms of 1961 units, requiring the deflation of 1971 expenditures. The approach taken has been to obtain the respective 1971 prices assuming a 1961 price of 1.00 per unit. For other goods and services this simply involved calculating the Consumer Price Index (Statistics Canada Bulletin (62-002 monthly)) for 1971, assuming 1961 = 1.00. While the C.P.I. includes a large component of housing, insufficient data exist on a C.M.A. basis to isolate a non-housing index. The 1971 price unit values of other goods and services used for the eight C.M.A.s are:

	1971 price/unit other goods and services
Calgary	1.282
Kitchener	1.300
Quebec City	1.270
St. John's	1.241
Saskatoon	1.237
Sudbury	1.350
Vancouver	1.270
Winnipeg	1.289

source: Statistics Canada Bulletin (62-002 monthly)

Table A2:05 Price per Unit of Other Goods and Services

In deriving the price per unit of "housing" services three factors must be considered. Firstly, housing price inflation in general over the decade. Secondly the relative changes of rental housing and owner-occupier housing prices arising from different structure types and the differential taxation treatment. Finally, in deriving "housing" services from expenditures adjustments must be made to the price to compensate for neighbourhood attributes. This adjustment is made in terms of the ratio of "residential" services to "housing" services.

To derive an inflation index (price per unit) for actual expenditures ("residential" housing services) a ratio of mean monthly expenditure in 1971 over 1961 was calculated on a household TYPE basis. The only source of such data is the 1974 Survey of Housing Units, which enabled the calculation of mean expenditures for each of the ten TYPE groups as of 1971. The 1961 data available consists of aggregated rents only and values incorporated in the 1961 Census. The approach thus taken follows that outlined in Section A2.21, wherein the price per rental unit of "residential" service was simply calculated as the ratio of the rents; the owner-occupier price as the ratio of user costs based on market values, current mortgage rates and estimated operating costs. The resulting prices across the eight C.M.A.s are:

	HOUSEHOLD TYPE									
	1	2	3	4	5	6	7	8	9	10
Calgary	1.65	1.65	1.65	1.65	1.65	1.81	1.85	1.87	1.86	1.89
Kitchener	1.67	1.67	1.67	1.67	1.67	2.28	2.34	2.35	2.39	2.38
Quebec City	1.54	1.54	1.54	1.54	1.54	1.56	1.57	1.61	1.64	1.62
St. John's	1.29	1.29	1.29	1.29	1.29	1.68	1.71	1.69	1.73	1.70
Saskatoon	1.22	1.22	1.22	1.22	1.22	1.56	1.61	1.63	1.66	1.65
Sudbury	1.56	1.56	1.56	1.56	1.56	1.87	1.88	1.90	1.92	1.93
Vancouver	1.58	1.58	1.58	1.58	1.58	2.35	2.39	2.41	2.13	2.43
Winnipeg	1.43	1.43	1.43	1.43	1.43	1.61	1.65	1.65	1.71	1.67

Table A2:06 Price per Unit of "Residential" Service

These prices are taken as input to the program and are adjusted for each individual household to reflect neighbourhood conditions: this procedure utilizes the Hedonic equations. With each of the two equations, six variables were designated as representing neighbourhood attributes: TYPE, LGDIST, OPENSP, HIGHDEN, COMMERC and NEIGHBHD. A household's "ORHS" (own relative "housing" services) and the corresponding "RHS" (relative "housing" services) are calculated respectively, by substituting the household's own neighbourhood variable values and alternatively the C.M.A. wide average neighbourhood values in addition to the relevant structural variable values, into the appropriate Hedonic equation. If the calculated value for ORHS is greater than the RHS value, the household is located in an above-average neighbourhood and thus pays an above-average price per unit of "housing" service; the converse also holds true. For each household, the corresponding household TYPE input price per unit of "residential" service is multiplied by the ratio of ORHS to RHS in deriving the price per unit of "housing" service.

The calculated total expenditure (after tax income), housing

expenditure, price per unit of "housing" service and the price per unit of other goods and services are then written to file.

A2.32 Estimating the Expenditure Share Function

The expenditure share functions, under a direct translog utility function, were estimated utilizing the non-linear option of U.B.C.:*SHAZAM (Version 3.0). This software package uses an algorithm based on the Quasi-Newton method.

Because of the volume of equations to be estimated, the sensitivity of solutions to initial conditions was tested on one C.M.A. only. From these tests the following set of initial parameter values (A1=0.5, B11=-0.1, B12=0.1, BM1=0.1, BM2=-0.1) was selected for use in estimating the functions for all eight C.M.A.s.

Equations for a total of seven separate groupings of households were estimated for each C.M.A. One set simply involved differentiating each C.M.A. by household TYPE. The second set involved two equations for each household TYPE; one group for the above-mean income, one for the below-mean while the third set involved differentiating each TYPE group into income quartiles to provide four independent sets of estimates subsequently utilized in the simulation model.

The *SHAZAM control cards for these estimates are generated by the program WORK4 utilizing data from CMA.REG03 to derive the interval constraints and the mean values for normalising the variables. Output from the regression package is held on file to be scanned by the program WORK7 which transfers the derived coefficients, "T" statistics and log likelihood values to the file CMA.T.DATA. The necessary control cards for the constrained

estimates are created and the results processed in a similiar manner.

Complete results from the regressions, on a C.M.A. basis are presented in APPENDIX Tables A3:16 through A3:22. These tables are derived from the data stored on file CMA.T.DATA by the program WORK2. This program is also used to generate the input dataset for the elasticity calculations and data for the simulation program.

The elasticities are calculated using the program "ELAST.FORT" with the unity income test statistics being generated by the program "WORK05.FORT"; the programs generating Tables A3:23 and A3:24 respectively.

A2.4 MODIFIED model: Supply System Estimation

In an attempt to derive a supply system for the MODIFIED model for which the parameters could be estimated directly in preference to being derived via the calibration technique used in the ORIGINAL model, two alternative theoretical formulations have been tested empirically using available data. These two alternative formulations are detailed in Section 5.11 and follow the approach utilized for the demand system being based on translog representations.

The first formulation is based on the derivation of a household's profit share function representing the "profit" an owner-occupier derives from the production of housing services. The second is a cost share function representing the "cost" of such production. The attempted estimates are based on the data available in the Survey of Housing Units (SHU) data, with a single data set created for input for the estimation procedures. The creation of this data set is detailed in the following Section with the two subsequent sections reporting the estimated parameters.

A2.41 Preparation for Estimation of the Supply Functions

This procedure follows that reported in Section A2.31 for the preparation of the data for the estimation of the occupant's expenditure share functions. The data preparation involves a second pass through the program "WORK00.FORT". The required variables for the estimates include the household TYPE, the household's expenditure on housing, the household's worth, and alternatively the profit and cost and price per unit of housing service.

Firstly, while the ORIGINAL model's supply system formulation assumes that all dwellings are controlled by landlords with owner-occupiers renting to themselves, these formulations assume that the occupant controls the dwelling and are responsible for the production of "housing" services. As such, these formulations are applicable only to owner-occupiers.

The expenditure on housing is as for the demand estimates (see Section A2.31) with a monthly expenditure taken to include interest payments, utilities, repairs, maintenance and the opportunity cost of equity.

The SHU data set has no data on household assets, consequently alternative proxies for the household's wealth have been used for the two functions. For the profit share estimates the "wealth" is based on the quantity of "housing" services the household controls. This is an hedonically derived quantity obtained via substitution of mean neighbourhood attributes. For the cost share estimates the wealth proxy has been constructed considering both the household's housing wealth and its human wealth. The value is constructed by calculating the present value at 10% per annum of the "housing" services stream through until the head's age reaches seventy-three; the income stream until an age of sixty-five. (Full details are available from the program "WORK00.FORT".)

The household's profit is taken as that derived from the production of both human and "housing" services. It is calculated as the monthly after tax income plus a monthly "return on" the "housing" services controlled minus actual monthly cash expenses. The monthly "return on" is based on 0.1471% of the dwelling's value.

The household's cost is taken as the monthly income opportunity cost plus the cost of controlling the "housing" services. The utilized price per unit of "housing" service is as detailed in Section A2.31.

The calculated expenditure on housing, the alternative wealth parameters, the profit and cost and the price per unit of "housing" service are written to the file CMA.REG04.

A2.42 Estimating the Profit Share Function

The profit share translog functions were estimated utilizing the OLS option of U.B.C:*SHAZAM(Version 3.0). The *SHAZAM contol cards for these estimates are generated by the program "WORK06.FORT", which uses data derived from CMA.REG04 to derive the necessary interval constraints and the mean values for normalizing the variables. Three different scenarios are considered. The first is based on all the owner-occupiers; the other two representing households with alternatively wealth below or above the mean. The estimated parameters for the selected eight CMAs are detailed following in Table A2:07.

	INTERCEPT	LGPRICE	LGCAP	R2
CALGARY				
all	0.2522	-0.8847	0.0185	0.07
	(83.8)	(10.5)	(1.66)	
below	0.2521	-0.9728	0.0188	0.09
	(58.5)	(8.95)	(0.75)	
above	0.2515	-0.6728	0.0342	0.04
	(62.7)	(4.87)	(1.36)	
KITCHENER				
all	0.2615	-0.8337	0.0174	0.07
	(88.2)	(10.2)	(1.50)	
below	0.2682	-0.9791	0.0949	0.10
	(60.1)	(8.64)	(3.73)	
above	0.2539	-0.5251	0.0192	0.03
	(71.0)	(4.64)	(0.83)	
QUEBEC CITY				
all	0.2578	0.0732	-0.0140	0.01
	(61.5)	(2.37)	(1.05)	
below	0.2555	0.0654	-0.0936	0.02
	(45.2)	(1.63)	(3.11)	
above	0.2613	0.1018	0.0195	0.01
	(43.5)	(2.11)	(0.66)	
ST. JOHN'S				
all	0.2991	0.1822	-0.0643	0.03
	(77.0)	(4.32)	(5.13)	
below	0.3131	0.1722	-0.1011	0.03
	(56.2)	(2.85)	(-3.71)	
above	0.2840	0.1812	-0.0003	0.02
	(57.2)	(3.29)	(0.01)	

Table A2:07 Supply Profit Share Function Estimates

	INTERCEPT	LGPRICE	LGCAP	R2
SASKATOON				
all	0.2376	-0.1719	-0.0290	0.01
	(88.7)	(3.82)	(3.01)	
below	0.2436	-0.2400	-0.0603	0.02
	(63.9)	(3.72)	(2.78)	
above	0.2312	-0.0741	0.0259	0.00
	(65.3)	(1.24)	1.20)	
SUDBURY				
all	0.2885	0.1243	-0.0773	0.02
	(70.9)	(3.14)	(5.05)	
below	0.3014	0.1268	-0.1677	0.04
	(50.8)	(2.36)	(4.86)	
above	0.2757	0.1185	0.0538	0.02
	(54.3)	(2.10)	(1.69)	
VANCOUVER				
all	0.2808	0.0513	-0.0023	0.00
	(92.4)	(1.80)	(0.19)	
below	0.2816	0.0827	0.0408	0.01
	(64.7)	(2.15)	(1.44)	
above	0.2799	0.0050	-0.0542	0.01
	(68.3)	(0.12)	(1.96)	
WINNIPEG				
all	0.2822	0.1054	-0.0591	0.02
	(68.2)	(1.24)	(4.20)	
below	0.2972	-0.0493	-0.0800	0.01
	(47.7)	(0.40)	(2.56)	
above	0.2683	0.3234	0.0214	0.02
	(53.5)	(2.97)	(0.71)	

Table A2:07(cont) Supply Profit Share Function Estimates

A2.43 Estimating the Cost Share Function

The method used to estimate the cost share function is identical to that for the Profit Share function with the *SHAZAM control cards generated by the program "WORK06.FORT".

Again three alternative scenarios are considered representing the same differentiation utilized for the Profit Share estimates. The estimated parameters for the selected eight CMAs are detailed following in Table A2:08.

	INTERCEPT	LGPRICE	LGCAP	R2
CALGARY				
all	0.2070	0.0113	-0.0261	0.21
	(106.)	(0.20)	(17.1)	
below	0.2437	-0.1011	-0.0166	0.09
	(65.8)	(1.15)	(6.57)	
above	0.1903	0.1936	-0.0362	0.03
	(101.)	(2.72)	(4.39)	
KITCHENER				
all	0.2097	0.2104	-0.0330	0.31
	(115.)	(3.87)	(23.2)	
below	0.2484	0.1563	-0.0266	0.16
	(65.7)	(1.77)	(10.1)	
above	0.1963	0.2877	-0.5636	0.09
	(120.)	(4.46)	(8.12)	
QUEBEC CITY				
	0.1930	0.1499	-0.0214	0.14
	(84.4)	(9.02)	(12.7)	
below	0.2205	0.1666	-0.0121	0.09
	(54.4)	(6.74)	(4.44)	
above	0.1801	0.1455	-0.0365	0.10
	(81.5)	(6.87)	(4.30)	
ST. JOHN'S				
all	0.2314	0.1500	-0.0256	0.16
	(106.)	(6.56)	(14.7)	
below	0.2656	0.1451	-0.0141	0.06
	(74.8)	(3.88)	(5.34)	
above	0.2100	0.1464	-0.0369	0.06
	(87.1)	(5.69)	(3.95)	

Table A2:08 Supply Cost Share Function Estimates

	INTERCEPT	LGPRICE	LGCAP	R2
SASKATOON				
all	0.1942	0.1698	-0.0243	0.17
	(114.)	(5.76)	(18.5)	
below	0.2322	0.1799	-0.0164	0.08
	(74.1)	(4.06)	(8.01)	
above	0.1784	0.1218	-0.0522	0.07
	(104.)	(3.31)	(7.25)	
SUDBURY				
all	0.2104	0.1336	-0.0237	0.17
	(99.3)	(6.84)	(15.6)	
below	0.2404	0.1390	-0.0153	0.08
	(63.7)	(4.61)	(6.15)	
above	0.1955	0.1490	-0.0505	0.10
	(91.6)	(6.30)	(6.22)	
VANCOUVER				
all	0.2427	0.0950	-0.0254	0.17
	(110.)	(4.86)	(15.5)	
below	0.2772	0.1709	-0.0155	0.10
	(73.6)	(6.01)	(5.87)	
above	0.2251	0.0016	-0.0727	0.08
	(96.5)	(0.06)	(7.54)	
WINNIPEG				
all	0.2097	0.2128	-0.0272	0.24
	(98.2)	(5.14)	(18.8)	
below	0.2436	0.1988	-0.0207	0.12
	(59.3)	(2.76)	(8.10)	
above	0.1944	0.2416	-0.0396	0.08
	(97.3)	(5.56)	(4.70)	

Table A2:08(cont) Supply Cost Share Function Estimates

A2.5 MODIFIED model: "Model" Households and Dwellings

The approach taken in deriving the model representations follows that for the ORIGINAL model except that significant changes have been required to incorporate the after tax incomes of the households and the use of actual user costs, not "rent equivalence" in the derivation of the owner-occupied "model" dwellings. In deriving the 1971 representations the number of rental households and dwellings have to be matched: the actual split between the tenures is based on the 1971 Census data. The 1961 tenure split for the model dwellings is based on the 1961 Census data.

In deriving the 1961 and 1971 "model" dwelling representations use is made of the 1961 and 1971 hedonic coefficients estimated for the ORIGINAL model. These regression studies are reported in Sections A1.311 and A1.312 respectively.

A2.51 Tenured "Model" Households: "HH2.FORT"

In a manner similiar to that outlined in Section A1.43 the characteristics of the "model" households for each of the ten TYPEs are derived from the 1974 Survey of Housing Units data. For each C.M.A. a total of 100 "model" households are formed each being represented by the actual 1971 after tax income, taxes and TYPE group. In addition for each owner-occupier their percent equity holding in their actual dwellings is included. Each of these characteristics is derived from separate distributions of the actual characteristics by dividing the continuums by the ratio of actual to "model" households. As with the ORIGINAL model each "model" household is grouped regardless of its location in the C.M.A.

The required after tax income (and taxes) and the equity holding are not directly available on the SHU data sets. This has required their calculation from reported household and household members gross incomes with deductions based on the household's characteristics. The method by which taxes are calculated follows that detailed in APPENDIX A2.31.

In calculating the after tax income it is assumed that for owner-occupiers a tax free return on their equity holding is included as after tax income. Based on the assumption that the current mortgage rate applicable to their property represents their marginal opportunity return this additional income is calculated as the owner's equity times the marginal opportunity rate of return. The output data record for each household includes data on the after tax income, the TYPE group, the taxable income and taxes paid.

The control cards required and the operation of the program follows "HH1.FORT", the program used for generating the "model" households for the ORIGINAL model.

A2.52 Tenured "Model" Dwellings: "D71.FORT"

The complete implementation of the MODIFIED model requires the creation of two sets of "model" dwellings; a 1971 set to be employed for calibrating for neighbourhood externalities and a 1961 set for use in "base" calibrations and "policy" simulations.

The methods used follow those described for the ORIGINAL model's "model" dwellings, with the exception that dwellings within a geographical zone are separated into either a rental or owner-occupier sub-zone. That is, in place of five zones, ten effective

zones are created. With the ORIGINAL model, the technique used in adjusting owner-occupied dwelling values to a rent equivalence is based on the assumption that average rental and owner-ocupier dwellings within a census tract provide equivalent quantity of "residential" services. For the MODIFIED model the "user" costs calculated for estimating the demand and supply function are derived independent of such a constraint, resulting in the average user cost for owners being greatly in excess of average rents. Thus in deriving the "model" dwelling the quantities must reflect the relationship between actual user costs and value, not the corresponding rent and value. Since the "model" dwelling representations are derived from Census data which does not include data on user costs a relationship between user cost and value was estimated using the functional relationship

$$\frac{EXPEND}{VALUE} = A1 + B1 * LOG(VALUE)$$

with the expectation that the ratio will decline with an increasing value. By normalising the independent variable VALUE by dividing by the mean, the Intercept will correspond to the mean value for the expenditure to value ratio given that the logarithm of one is zero.

The only available data from which this function can be estimated is the 1974 SHU dataset. Accordingly a dataset CMA.REG05 is created by the program "WORK00.FORT" which involves only owner-occupier data points. The necessary *SHAZAM control cards required for estimating the function are created by the program "WORK04.FORT" and includes the necessary parameters for

normalisation.

The estimated parameters are used as an additional input data record to "D71.FORT". To derive the distribution of monthly "user costs" from the corresponding values simply involves the substitution of the respective value range parameters into the estimated equation to derive an interval in terms of the "user cost".

In deflating the resulting decade-end quantities of "relative housing" services (1971 "model" dwellings), expressed in terms of a 1971 price per unit of "housing" service of 1.00, to equivalent 1961 quantities, the relative zonal price indicies must adjust not only for the zonal differences but also for the difference in price inflation for owner-occupied dwellings relative to rental dwellings. Both the derived PN's for the rental and owner-occupied are taken as input to provide normalisation of the hedonically derived price indices.

While creating the 1971 "model" dwellings , "D71.FORT" generates a calibration dataset to test the solution conditions during the EXT's calibration. This dataset is as for the "GAMMA" calibration process execept no data on the household TYPE distribution is generated.

In addition, "D71.FORT" is re-run under option 2 generating two new construction zones (rental and owner-occupied) to firstly obtain the QM's, the minimum quantity of "new" construction and secondly a calibration dataset for calibrating the "BETA" parameters for the supply functions.

A2.53 1961 Tenured "Model" Dwellings :"D61.FORT"

The 1961 "model" dwellings are derived in a similiar manner, as for the ORIGINAL model with changes similiar to those applied to "D71.FORT". But lacking suitable data from which to derive a comparable expenditure to value function use is made of the function estimates from the 1974 SHU data outlined in Table 8:16 and the computed values and user costs detailed in Table A2:42 The average user costs and values are used to adjust the mean ratio (intercept) of the 1974 estimates with the assumption that the rate of change remains constant. This adjustment is computed as follows for the selected C.M.A.s.

C.M.A.	1971	Ratio	Expend/VALUE
Calgary	0.1161	.0072418/.0092918	0.0905
Kitchener	0.1206	.0077474/.0097974	0.0954
Quebec	0.1401	.0091205/.0111705	0.1144
St.John's	0.1337	.0089251/.0109751	0.1087
Saskatoon	0.1211	.0078665/.0099165	0.0961
Sudbury	0.1379	.0090089/.0110588	0.1123
Vancouver	0.1219	.0081029/.0101529	0.0973
Winnipeg	0.1301	.0084003/.0104503	0.1046

Table A2:07 Calculation of 1961 Expend/VALUE Ratio.

A2.6 MODIFIED model: SOLUTION ALGORITHM :"SIM02.FORT"

This section describes the computer program, "SIM02.FORT", developed for solving the MODIFIED HOUSING MARKET model; a mathematical formulations of the changes over a ten year period in the price and quantity of housing in an urban area. This model incorporates non-linear demand functions and discontinuous supply functions leading to a more complex solution process. The general and computational requirements are similiar to those for the ORIGINAL model although the nature of the demand system has required the incorporation of a more complex solution algorithm. Generally solution times are comparable to those for the ORIGINAL model.

This computer program has been written in FORTRAN IV G1 utilizing only general library functions, making it suitable for IBM system usage in batch mode. The following sections have been ordered to correspond to program logic; from initialization through data input to the calculations and output. The general structure of the program is outlined in the following flow chart (Figure A2:01).

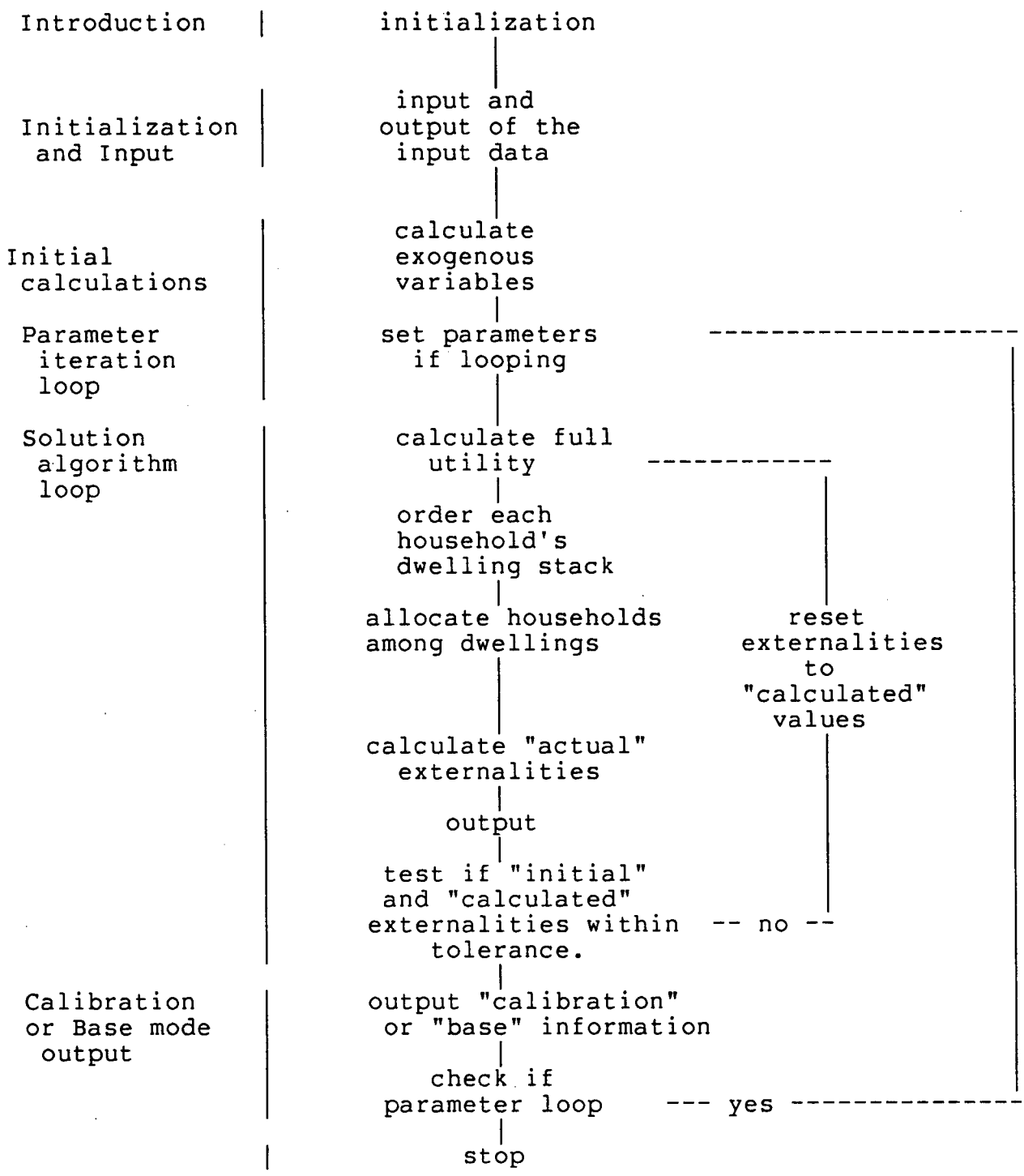


Figure A2:01 Flow Chart of Program Structure: "SIM02.FORT"

A2.61 General Outline.

This program consists of five general "subroutines" and a "control" section with multiple entry points in the calculating and output "subroutines". To enable the reader to relate to the actual input and output of the program this description is based on an example simulation. For simplicity, the example used has the input restricted to ten "model" existing dwellings located in two "zones", with the third "zone" being that for new construction. "Model" households have correspondingly been restricted to ten, with the TYPE option restricted to two; one rental and one owner-occupier. In normal usage the number of existing "model" dwellings ranges from approximately 65 to 100, with five to ten "zones". The corresponding number of "model" households will be in the region of 100, with the ten "TYPE" specifications the standard.

The program may be used in one of three modes

1. in "calibration" mode to estimate, via simulation, the EXT and the BETA parameters,
2. in "base" mode to generate a base case for the urban area under consideration, and
3. in "policy" mode wherein policy parameters can be entered allowing the simulation of the affects of alternative market interventions.

The basic description incorporates the features of the two alternative standard "calibration" runs with the example being for an EXT "calibration" run. Details on the alternative "base" and "policy" runs are outlined in the subsequent sections: A2.68: "Base" Mode and A2.69: Policy Mode. The only significant difference between "calibration" mode and the two alternative modes is that with the former the behavioural parameter values are varied, with special restrictions on the allocation algorithm. The

latter involves the additional input of policy parameters using a fixed set of behavioural parameters.

A2.62 Initialization and Input.

The program initializes by setting all storage array elements to zero and then inputs the required data. Each input record is identified by a four-character code, corresponding to the first four columns of the input record, with data being spaced in five column fields across the remainder of the record. The standard input format for all input records is (2I2,12F5.0). This basic input to the solution algorithm is created by the utility programs "HH2.FORT", "D61.FORT" and "CZONE.FORT", with additional input from the input control deck. Additional data necessary for calibration is created by the utility program "D71.FORT"

Input is classified into nine groups, each group being identified by the number code in column 1:

"1___" data for "model" households
"2___" data on each household "TYPE"
"3___" data on "model" dwellings
"4___" data on each "zone"
"5___" behavioural parameters
"7___" calibration data
"8___" policy data
"9___" system control parameters

In the following section each of these groups is detailed.

"1___" "Model" households.

Each "model" household is loaded with four basic data values; annual after tax income, type, taxable income and taxes. The third field is not utilized by this VERSION of the program. These "model" household data records are identified with a "1" in column 1, with the "model" household being identified in columns 2 to 4 by a number not exceeding 120. Input need not be in sequential order but the numbering of the households must be continuous. For an outline of the calculation of these input data see the description of "HH2.FORT" in Section A2.51. The corresponding data input for the example is as follows, with blanks as identified.

```
1001 1527    1 -217    0
1002 2235    1  102   60
1003 3938    1  900  191
1004 5616    1 3309  731
100523829    14494027846
1006 2235    2 2814  628
1007 9779    2 6334 1556
100811275    2 8173 1983
100913986    211724 2991
101016827    214648 4236
```

The first data field (columns 5-9) is the annual after tax income for the "model" household. The second field (columns 10-14) is the household TYPE group and in general use will take a value of 1 through 10. Field three is the taxable income (after all deductions) and field four is the taxes.

"2___" Household TYPEs.

The household "TYPE" group data input involves five separate records per household TYPE. They involve one record to indicate the boundaries of the four income quartiles; the other four contain the parameters for the expenditure share function for each of the four quartiles.

The respective records for the two example household groups

are as follows:

```
2001353.9638.4870.21289.
2101    0-.398-.144.2962.1716.120684.01169
2201    0-.233-.118.0970.2324-.31290.13382
2301    0-.190-.089.1357.2873-.17698.32550
2401    0-.151-.081.0938.3138-.176116.1854
2002671.3925.81166.1613.
2102    0-.250-.095.1632.3408-.08690.35392
2202    0-.216-.101.1737.2964.0491105.9566
2302    0-.189-.088.1361.3370-.121117.1737
2402    0-.168-.093.0774.2491-.297143.0104
```

"3___" Model dwellings.

Model dwellings are initialized with three data fields; the original level of "housing" services, the zone in which it is located and its tenure type. This input is generated alternatively for decade start by the program "D61.FORT", (see description, Section A2.53 for details of calculations) or, when the program is being used to calibrate the EXT parameters the input "model" dwellings are as for the decade-end. In this instance the input data set is generated by the utility program "D71.FORT". The basic record structure consists of a "3" in column 1, the "model" dwelling number not exceeding 120 in columns 2-4, and the three data fields. The required data input for the example is as follows.

```
3001   50    1    1
3002  101    2    1
3003  129    1    1
3004  161    2    1
3005  234    2    1
3006   50    2    2
3007  101    1    2
3008  129    2    2
3009  161    1    2
3010  234    1    2
```

"4___" Zonal characteristics.

Data records for zonal characteristics consist of those for zones associated with existing dwellings and one for the zone of

new construction. The program assumes that the zone with the highest number is the zone of new construction. The input data required for all runs, generated by the utility program "CZONE.FORT", consists of an initializing value for the zone's "end of the decade relative wealth"; the zone's average decade-end household income, and a relative access variable. The record structure consists of a "40" in columns 1-2 the zone number, up to 20, in columns 3-4, and two data fields. The standard zonal input for the example, with "4003" being the zone of new construction is:

```
400120000___31
400237090___50
400329110___47
```

"5___" Behavioural parameters.

The program uses fifteen behavioural parameters in addition to the "TYPE" specific parameters entered for the expenditure share function. They are loaded under the basic code "50" and are identified by the numbers in columns 3-4. Two parameters relate to the zonal externalities, one to input the consumer price index with the remainder used to formulate alternatively the owner-occupier and rental supply functions. The respective number codings are:

"5001" EXT1: this parameter determines zonal allocations. It is equivalent to the "GAMMA2" parameter in the ORIGINAL model, indicating the value households place, other things equal, on being located in a wealthy zone. This parameter has a lower limit of zero and no natural upper limit, but normally operates in the range 0.0 to 1.0.

"5002" EXT2: this parameter determines zonal allocations. It is equivalent to the "GAMMA3" parameter in the ORIGINAL model, indicating the strength of the households' preference for leisure. A value of zero indicates that access is not valued, a value >0 through <1 indicates a declining marginal utility, 1 indicates a linear preference function, and values >1 generate an increasing marginal utility for access. Normally operates in the range 0.0 t0 1.0.

"5003" BETA1:RENTAL: this parameter indicates the percentage of the initial level of services an existing dwelling will provide at the end of the decade if the price per unit of housing service obtained covers only operating costs. i.e., a value of 0.66 indicates that 66% of the initial level will still be supplied under these pessimistic price conditions.

"5004" BETA2:RENTAL correspondingly, this parameter refers to the additional services that will be provided in response to an increase in the price received per unit of housing over the operating cost.

"5005" BETA1:OWNERS: this parameter indicates the percentage of the initial level of services an existing dwelling will provide at the end of the decade if the price per unit of housing service obtained covers only operating costs. i.e., a value of 0.66 indicates that 66% of the initial level will still be supplied under these pessimistic price conditions.

"5006" BETA2:OWNERS correspondingly, this parameter refers to the additional services that will be provided in response to an increase in the price received per unit of housing over the operating cost.

"5007" OC:RENTAL: determines the break point in the supply function. At prices below this level the dwelling supplies the fully depreciated quantity.

"5008" OC:OWNERS: determines the break point in the supply function. At prices below this level the dwelling supplies the fully depreciated quantity.

The parameters "5011", "5012", "5013" correspond to "6001", "6002" and "6003" from the ORIGINAL model but apply only to the rental dwellings. Correspondingly "5016", "5017" and "5018" apply to owner dwellings.

The basic supply function for new construction is assumed elastic at a price, PN, above a minimum quantity of services, QM, dictated by building codes. QM is input directly while PN may be input directly or calculated as the sum of the two inputs; PO and PC. The separate inputs of PO and PC are necessary since both values independently enter the supply function of an existing dwelling. These values are measured on a flow basis, in terms of dollars per month per unit of housing services, and are calculated

as the value at the end of the decade.

"5011" RPO : OPERATING COST:RENTAL is the cash cost of monthly operation per unit of housing service, exclusive of financing. Given that the average initial price of housing service is 1.0, the range of this parameter is 0.2 through 1.5.

"5012" RPC : FINANCING COST:RENTAL is the monthly cost of financing one unit of housing service.

"5013" OQM : MINIMUM QUANTITY:RENTAL; indicates the minimum number of units of housing service each new dwelling must provide. This minimum quantity corresponds to government-imposed restrictions on size and quality for new construction.

"5016" OPO : OPERATING COST:OWNERS is the cash cost of monthly operation per unit of housing service, exclusive of financing. Given that the average initial price of housing service is 1.0, the range of this parameter is 0.2 through 1.5.

"5017" OPC : FINANCING COST:OWNERS: is the monthly cost of financing one unit of housing service.

"5018" OQM : MINIMUM QUANTITY:OWNERS; indicates the minimum number of units of housing service each new dwelling must provide. This minimum quantity corresponds to government-imposed restrictions on size and quality for new construction.

When the program is in "calibration" mode it will accept two input values for any two pairs of the first six parameters, i.e., will read a second vaue in field two (column 10-14). These values will indicate to the program that a multiple set of runs is required in which the values of the two respective parameters are varied between the two supplied values. One pair of parameters will generate four runs, two pairs sixteen runs.

The respective parameter values input for the example are:

```
50010.200
50020.100
50030.750
50040.500
50050.750
50060.500
50071.205
50081.178
50110.450
50121.200
501337.00
50160.450
50171.420
501839.00
50201.282
```

"7___" Calibration data.

The models are calibrated to a given urban area, in terms of the EXT and BETA behavioural parameters, by simulating the model under different sets of parameter values and determining which set gives the "best fit". Best fit is calculated in terms of the difference between the actual market results and the simulated results. The actual results required for such error testing are generated by the utility program "D71.FORT", and input with a record structure of "70" in columns 1-2, the zone number in columns 3-4, and twelve data fields. These fields are; field one (columns 5-9) the average price, fields two through nine (columns 10-49) are blank, field ten (columns 50-54) the average income, and field eleven (columns 55-59) the utilization factor, which is the percentage of the starting stock occupied at the end of the period. Field twelve is the average quantity of "housing" services consumed. (See the description of "D71.FORT", in Section A2.52, for full details.) The calibration input for the example is:

```
70011.100                                    12000  .75  210.
70021.300                                     7230  .85  170.
70031.200                                    28140 1.00  300.
```

"8___" "Policy" data.

This data is required when the program is in "policy" mode, simulating the effects of alternative market intervention. Details of these input records are included in the Section A2.69: Policy Mode.

"9___" System control parameters.

These parameters are used to control input to and output from the program, in addition to controlling the operation of the algorithm. Options are provided to control the volume of printed output, control graphical output and to indicate the program mode.

It should be noted that in actual use most of the data records are contained in input data files. Three alternative files are used for each C.M.A. corresponding to the different solution modes of the solution algorithm.

1. CMA.D5T : input for calibrating the EXT parameters
2. CMA.S5T : input for calibrating the BETA parameters
3. CMA.P5T : output from BASE mode runs for POLICY mode runs

These files contain records as follows;

1. CMA.D5T - BETA calibration

    1. 1971 "model" households
    2. 1971 household type characteristics
       - expenditure share parameters
    3. 1971 "model" dwellings
    4. 1971 zonal characteristics
    5. EXT calibration set

2. CMA.D5T - BETA calibration

    1. 1971 "model" households
    2. 1971 household type characteristics
       - expenditure share parameters
    3. 1961 "model" dwellings
    4. 1961 zonal characteristics
    5. BETA calibration set

2. CMA.P5T - Policy analysis

1. 1971 "model" households
2. 1971 household type characteristics
   - expenditure share parameters
3. 1961 "model" dwellings
4. 1961 zonal characteristics

The remaining records; those for the behavioural parameters, the construction and operating data, the policy data and the system control parameters, are input from the control deck.

While loading the data, the program checks for errors, counts the number of "model" dwellings and "model" households, and ensures that the numbering is continuous and that zone and type specifications are correct. Errors are indicated. After loading, a review of the input is output as follows;

*** INPUT DATA Example Solution

*** "1___" model HOUSEHOLDs: number households 10

household	1	2	3	4	5	6	7	8	9	10
income	1527	2235	3938	5616	23829	2235	9779	11275	13986	16827
type	1.	1.	1.	1.	1.	2.	2.	2.	2.	2.

*** "2___" HOUSEHOLD TYPE GROUPs: number groups 2

TYPE group	1	2
income	354.	671.
income	638.	926.
income	870.	1166.
income	1289.	1613.

*** "21__" DEMAND PARAMETERs Q01

TYPE	1	2
A0	0.0	0.0
A1	-0.3980	-0.2500
A2	-0.6020	-0.7500
B11	-0.1440	-0.0950
B12	0.2962	0.1632
B21	0.2962	0.1632
B22	-0.1756	-0.2492
BM1	0.1716	0.3408
BM2	0.1206	-0.0860
MXH	84.0	90.4
MXG	169.4	392.5
MEX	353.9	671.3
MPH	1.6300	1.8550
esP	-.21230	-.18020
esY	-.21230	-.18020

*** "22__" DEMAND PARAMETERs Q02

TYPE	1	2
A0	0.0	0.0
A1	-0.2330	-0.2160
A2	-0.7670	-0.7840
B11	-0.1180	-0.1010
B12	0.0970	0.1737
B21	0.0970	0.1737
B22	-0.4090	-0.1246
BM1	0.2324	0.2964
BM2	-0.3120	0.0491
MXH	90.1	105.9
MXG	382.0	566.9
MEX	638.4	925.8
MPH	1.6500	1.8810
esP	-.17215	-.16502
esY	-.17215	-.16502

*** "23__" DEMAND PARAMETERs Q03

TYPE	1	2
A0	0.0	0.0
A1	-0.1900	-0.1890
A2	-0.8100	-0.8110
B11	-0.0890	-0.0880
B12	0.1357	0.1361
B21	0.1357	0.1361
B22	-0.3117	-0.2571
BM1	0.2873	0.3370
BM2	-0.1760	-0.1210
MXH	98.3	117.1
MXG	550.3	737.6
MEX	870.2	1166.0
MPH	1.6760	1.8780
esP	-.14359	-.15169
esY	-.14359	-.15169

*** "24__" DEMAND PARAMETERs Q04

TYPE	1	2
A0	0.0	0.0
A1	-0.1510	-0.1680
A2	-0.8490	-0.8320
B11	-0.0810	-0.0930
B12	0.0938	0.0774
B21	0.0938	0.0774
B22	-0.2698	-0.3744
BM1	0.3138	0.2491
BM2	-0.1760	-0.2970
MXH	116.1	143.0
MXG	854.8	1049.0
MEX	1289.0	1613.0
MPH	1.6630	1.8690
esP	-.12838	-.13485
esY	-.12838	-.13485

*** "3___" model DWELLINGS: number dwellings 10

dwelling	1	2	3	4	5	6	7	8	9	10
services	50	101	129	161	234	50	101	129	161	234
zone	1	2	1	2	2	2	1	2	1	1
tenure	1	1	1	1	1	2	2	2	2	2

*** "40__" ZONAL CHARACTERISTICS: number zones 3

ZONE number	1	2	3
"wealth"	20000.	37090.	29110.
distance	31.	50.	47.

*** "50__" EXTERNALITIES PARAMETERs

EXT1 (wealth)	EXT2 (access)
0.50	0.50
0.0	0.0

*** "50__" SUPPLY PARAMETERS

rental			owners		
BETA1	BETA2	%EXP	BETA1	BETA2	%EXP
0.0	0.0	0.0	0.0	0.0	0.0

*** "501_" PRICE and MINQ PARAMETERs

rental			owners		
RPO	RPC	RQM	OPO	OPC	OQM
0.45	1.20	70.00	0.45	1.42	90.00

CPI = 1.28200

*** "70__" CALIBRATION DATA:

zone	price									income	usage	"Q"
1	1.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12000.	0.75	210.0
2	1.65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7230.	0.85	170.0
3	1.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28140.	0.0	300.0

A2.63 Initial Calculations.

The solution algorithm is a repetitive simulation process whereby values calculated in one "execution" of the allocation algorithm are used as input for a subsequent "execution". The solution process is repeated until the input and output values of selected parameters converge. During the initial calculation stage, the program calculates those variable values that are constant throughout a complete run and initializes those endogenous variables whose values vary with each execution. In general only the zonal wealth externality variable varies during program iteration and all solution conditions including the price-quantity intercepts between household's demand functions and the respective supply functions are calculated exogenous to the solution process. These calculations are detailed in Section A2.64 that follows. The initial calculations, common to all simulations consist of; calculating "permanent" or "model" income, sorting the "model" households in descending "model" income order and the initialization of the zonal externalities.

A2.631 Monthly Income

While the program takes as input a mixture of annual and monthly values, all calculations are based on monthly values. The "actual" income, used in all computations, is simply the input annual after tax income divided by 12. Based on the household's income level,the corresponding expenditure share is calculated based on the respective quartile values for the TYPE: calculated as a linear interpolation of the means for the bounding quartile means. If the household's income is greater than the mean for quartile 4 or less than the mean for quartile 1 the value is

extrapolated using the respective share elasticity. The "input" and the "actual" incomes can be output for each household along with the relevant expenditure shares in the following form:

*** HOUSEHOLD CHARACTERISTICS: test simulation prog

household	1	2	3	4	5	6	7	8	9	10
"Y"input	1527	2235	3938	5616	23829	2235	9779	11275	13986	16827
Share	.3986	.3984	.3980	.3318	.1510	.2503	.2308	.2145	.1891	.1779
"Y"actual	127	186	328	468	1986	186	815	940	1166	1402

A2.632 Ordering the "Model" Households.

After calculating the "actual" incomes the program creates an ordered array of the "model" households. This array, termed the stack of "unassigned" households, contains all "model" households ordered by their "actual" income. This ordering allows the solution algorithm to allocate the "model" households by declining consumption levels, thus minimising the subsequent need for "reassignments", increasing the solution algorithm's efficiency. Since incomes are exogenously determined, this ordering of the stack is retained throughout the run. The ordered stack for the example is;

*** ORDERED HOUSEHOLD STACK

5 10 9 8 7 4 3 2 6 1

A2.633 Initialize "Relative" Wealth Externality Parameter.

The endogenously derived component of the utility function is associated with the preference for living in a wealthy zone. The relative "wealth" of a zone is measured as the ratio of the average household income in the zone, to the average household income for the urban area at large.

$$W(iz) = (MY)zone / (MY)city$$

where,
(MY) is the average household income for the respective groupings.

The values for W(iz) are initialized as the ratio of the respective actual average decade-end values of (MY), where (MY)city is set to the value for the zone of new construction. By initializing W(iz) at these values, in preference to setting them to one, a faster convergence of the solution algorithm is achieved. During each "execution", the W(iz)'s are recalculated from the relevant data for input into the next "execution". In multiple calibration runs, the previously calculated set is used at initialization for subsequent iterations.

A2.64 Price-Quantity Intercepts

With the MacRae allocation algorithm all valid intercepts between a household's demand curve and the supply curves associated with new and existing dwellings are calculated and the solutions "ordered" by "model" household, in terms of a declining total utility derived from housing and other goods and services.

Given the different nature of the supply curves for the new and existing services, the program utilizes two separate routines for solving for the relevant quantity of new services and the price and quantity associated with existing dwellings.

In addition, since "policies" are introduced by modifying the respective supply and demand curves; a separate solution equation must be derived for each combination of supply function and subsidy policy. The result is a multiplicity of solution equations being included in this section of the program. Details of "policy"

implementations are included in Section A2.69.

A2.641 Quantity and Partial Utility: New Dwellings

The supply function for new "model" dwellings involves horizontal functions at respectively RPN and OPN for the rental and owned dwellings. The quantity is calculated directly utilizing the household's "actual" income and expenditure share. Firstly the expenditure share is recomputed to reflect the difference between PN and the "mean prce" for the household utilizing the "share elasticity with respect to price" (See Section 8.52 for theoretical basis). Based on the income and the expenditure share, the expenditure on housing and consequently the quantity, at the given price, can be calculated.

Based on the computed quantity and the residual quantity of other goods and services, the utility is calculated using the log linear formulation and combined with the partial utility associated with "access". This partial utility value will be constant throughout the solution loops as it is derived completely from exogenous data. The price, quantity and partial utility data are then stored for subsequent use. If an invalid intercept occurs, the relevant price, quantity and partial utility values are set to zero.

A2.642 Quantity, Price and Partial Utility: Existing Dwellings

The computation of the intercept between the household's demand function and the supply function associated with an existing dwelling is complicated further by the household's expenditure share being dependant on the unknown price. Thus, while the solution process is similiar to that used with new dwellings the

expenditure share must be recalculated for each computed price during the solution iterations. The general procedure thus involves calculating the difference between the quantity demand and the quantity supplied over a price range with iterations proceeding until the two quantities converge.

Based on the computed price and quantity and the residual quantity of other goods and services, the utility is calculated as for new dwellings for valid intercepts.

These stored prices, quantities and "partial" utility data can then be output as follows:

*** PRICE, QUANTITY and "partial" UTILITY: test simulation prog

(Household 1)

dwelling	1	2	3	4	5	6	7	8	9	10
price	0.734	0.551	0.483	0.0	0.0	0.0	0.0	0.0	0.0	0.0
quantity	50.0	101.0	129.0	0.0	0.0	0.0	0.0	0.0	0.0	0.
part "U"	0.465	0.654	0.782	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(Household 2)

dwelling	1	2	3	4	5	6	7	8	9	10
price	1.074	0.807	0.707	0.621	0.490	0.0	0.0	0.0	0.0	0.0
quantity	50.0	101.0	129.0	161.0	234.0	0.0	0.0	0.0	0.0	0.
part "U"	0.592	0.758	0.876	0.986	1.296	0.0	0.0	0.0	0.0	0.0

(Household 3)

dwelling	1	2	3	4	5	6	7	8	9	10
price	1.889	1.420	1.244	1.093	0.863	0.0	0.0	0.0	0.0	0.0
quantity	50.0	101.0	129.0	161.0	234.0	0.0	0.0	0.0	0.0	0.
part "U"	0.891	0.989	1.086	1.167	1.414	0.0	0.0	0.0	0.0	0.0

(Household 4)

dwelling	1	2	3	4	5	6	7	8	9	10
price	2.100	1.679	1.489	1.319	1.054	0.0	0.0	0.0	0.0	0.0
quantity	50.0	101.0	129.0	161.0	234.0	0.0	0.0	0.0	0.0	0.
part "U"	0.941	0.997	1.067	1.115	1.272	0.0	0.0	0.0	0.0	0.0

(Household 5)

dwelling	1	2	3	4	5	6	7	8	9	10
price	1.700	2.616	2.532	2.380	2.045	0.0	0.0	0.0	0.0	0.0
quantity	50.0	101.0	129.0	161.0	234.0	0.0	0.0	0.0	0.0	0.
part "U"	1.599	1.486	1.497	1.468	1.475	0.0	0.0	0.0	0.0	0.0

(Household 6)

dwelling	1	2	3	4	5	6	7	8	9	10
price	0.0	0.0	0.0	0.0	0.0	0.535	0.499	0.454	0.0	0.0
quantity	0.0	0.0	0.0	0.0	0.0	50.0	101.0	129.0	0.0	0.
part "U"	0.0	0.0	0.0	0.0	0.0	0.390	0.496	0.538	0.0	0.0

(Household 7)

dwelling	1	2	3	4	5	6	7	8	9	10
price	0.0	0.0	0.0	0.0	0.0	1.847	1.888	1.744	1.590	1.31
quantity	0.0	0.0	0.0	0.0	0.0	50.0	101.0	129.0	161.0	234.
part "U"	0.0	0.0	0.0	0.0	0.0	0.989	1.014	1.017	1.06	101.127

(Household 8)

dwelling	1	2	3	4	5	6	7	8	9	10
price	0.0	0.0	0.0	0.0	0.0	1.695	1.913	1.791	1.647	1.38
quantity	0.0	0.0	0.0	0.0	0.0	50.0	101.0	129.0	161.0	234.
part "U"	0.0	0.0	0.0	0.0	0.0	1.000	1.012	1.01	101.049	1.105

(Household 9)

dwelling	1	2	3	4	5	6	7	8	9	10
price	0.0	0.0	0.0	0.0	0.0	1.398	1.923	1.841	1.719	1.46
quantity	0.0	0.0	0.0	0.0	0.0	50.0	101.0	129.0	161.0	234.
part "U"	0.0	0.0	0.0	0.0	0.0	1.010	1.011	101.004	1.034	1.073

(Household 10)

dwelling	1	2	3	4	5	6	7	8	9	10
price	0.0	0.0	0.0	0.0	0.0	1.139	1.958	1.912	1.808	1.56
quantity	0.0	0.0	0.0	0.0	0.0	50.0	101.0	129.0	161.0	234.
part "U"	0.0	0.0	0.0	0.0	0.0	1.014	1.007	0.996	1.023	1.054

As indicated in this example renters consider only rental dwellings; owner-occupiers only owner occupier dwellings. That is, there is no potential for tenure switching. In EXT calibration mode only existing dwellings are considered: reflecting decade-end quantities. Without the upper bound imposed by the availability of an optional new dwellings there is no ceiling on the unit prices for the existing stock. Only those dwellings yielding a price lower than the operating cost, 0.45 for both rental and owened in this case, have zero values.

A2.65 Parameter Iterations Loop.

When the program is in "calibration" mode and multiple values have been entered for the behavioural parameters, a parameter iteration loop is created. This loop then controls entry to and exit from the solution algorithm loop. The parameters are initialized to the first input values and then increased by one-third the range in subsequent runs. For example, if the input parameter values are;

5001__0.2__0.5
5002__0.6__0.9

the parameter iteration combinations will be;

EXT1	0.2	0.3	0.4	0.5	0.2	0.3	0.4	0.5
EXT2	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7

EXT1	0.2	0.3	0.4	0.5	0.2	0.3	0.4	0.5
EXT2	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9

After the first iteration the relative wealth externality - Wz - is initialized to the previously calculated value. i.e., not re-initialized to the input conditions.

A2.66 Solution Algorithm Loop.

The solution algorithm loop consists of four separate sections, each executed in order, then repeated until the convergence tolerance criterion is met. The first step involves calculating the "externality" utility and the creation of the "ordered dwelling" stacks. The second step involves allocating the households among the existing and potentially new dwellings. Given the final allocations, the zones' "actual" wealth externalities are then calculated and compared to the initial externality values. If the difference is within the specified tolerance control is transferred out of the loop, otherwise the steps are repeated up to a maximum of ten times.

A2.661 Relative Wealth Utility

The partial utility associated with the relative wealth is calculated for each element in the "model" household-"model" dwelling array, with the full utility being calculated as the product of this partial value and the initially stored "partial" value. The final value of the utility is zero if the stored "partial" value is zero. The calculated values for the individual dwellings can be output by household, as follows;

*** "total" UTILITY: test simulation prog

(Household 1)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	46.	66.	77.	0.	0.	0.	0.	0.	0.	0.

(Household 2)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	58.	77.	86.	100.	131.	0.	0.	0.	0.	0.

(Household 3)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	88.	100.	107.	118.	143.	0.	0.	0.	0.	0.

(Household 4)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	92.	101.	105.	113.	129.	0.	0.	0.	0.	0.

(Household 5)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	157.	151.	147.	149.	149.	0.	0.	0.	0.	0.

(Household 6)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	0.	0.	0.	0.	0.	40.	49.	55.	0.	0.

(Household 7)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	0.	0.	0.	0.	0.	100.	100.	103.	104.	111.

(Household 8)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	0.	0.	0.	0.	0.	101.	99.	102.	103.	109.

(Household 9)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	0.	0.	0.	0.	0.	102.	99.	102.	102.	105.

(Household 10)

dwelling	1	2	3	4	5	6	7	8	9	10
utility	0.	0.	0.	0.	0.	103.	99.	101.	100.	104.

A2.662 Households' "Ordered Dwelling" Stacks.

Input to the allocation algorithm consists of the "ordered unassigned" household stack, created during initialization, and the "ordered dwelling" stacks. The latter stacks, one for each household, are formed from all dwellings (including the new dwelling) that yield valid intersections with the corresponding household's demand curve, i.e., have been assigned a positive "utility" value. Each individual stack is ordered in terms of descending utility, with the lowest member being the new dwelling; zero if the household is unable to consume a new dwelling. The new dwelling occupies the bottom position in the stack as it is assumed that there is no competition for this dwelling. The exception is that during EXT calibration runs, when no new "model" dwellings are allocated, all existing "model" dwellings yielding a price greater than the operating cost will be included in the stacks. The household is free to select the quantity of new housing services it desires to consume and the building industry will supply that quantity. While some dwellings may yield a valid intersection, externalities may be such that the total utility derived from occupying the dwelling may be less than that derived from consuming a new dwelling. In these instances, the existing dwelling is discarded during creation of the stacks. These ordered stacks can be output as follows;

```
*** HOUSEHOLD's "ordered" dwelling STACKs
household   1
   3   2   1   0   0   0   0   0   0   0   0
household   2
   5   4   3   2   1   0   0   0   0   0   0
household   3
   5   4   3   2   1   0   0   0   0   0   0
household   4
   5   4   3   2   1   0   0   0   0   0   0
household   5
   1   2   5   4   3   0   0   0   0   0   0
household   6
   8   7   6   0   0   0   0   0   0   0   0
household   7
  10   9   8   6   7   0   0   0   0   0   0
household   8
  10   9   8   6   7   0   0   0   0   0   0
household   9
  10   6   8   9   7   0   0   0   0   0   0
household  10
  10   6   8   9   7   0   0   0   0   0   0
```

A2.663 "Allocation" Algorithm.

The basic objective of the allocation algorithm is to assign the ordered households, one by one, to their preferred dwelling, if they can outbid the current occupant, and re-assign them only when another household is willing to pay a higher price for the dwelling. The algorithm uses as input the "ordered assigned"

household stack and the housholds' "ordered dwelling" stacks. The output is a dwelling occupancy array that indicates which household, if any, occupies each dwelling and the price; the value of the latter being initialized at zero. In addition, an array indicating the status of each household's potential new dwelling is generated. The respective element of this array is set equal to PN if a household occupies a new dwelling; to -1.0 if the household is unassigned (forced out of the market).

The solution process begins with the selection of the household at the top of the "ordered unassigned" household stack: this selected household is termed the "unassigned" household. The simplified logic of the algorithm is;

1. select the dwelling number at the top of the household's "ordered dwelling" stack and in so doing delete it from the stack.
2. a check is made to see if the dwelling number is;
    a. for an existing dwelling: take option 1.
    b. for a new dwelling: take option 2.
    c. a zero: take option 3.
3. the respective options involve:

**option 1: existing dwelling.

a. check to see if occupied.

b.1 <u>if not occupied</u> the repective elements of the "occupancy" array are set to the household number and the price that the household will pay. The algorithm then returns to select the next household from the "ordered unassigned" household stack ands starts repeating the steps.

b.2 <u>if occupied</u> a comparision is made between the current price bid and the price that the unassigned household is offering to pay

: if the offer is less than, or equal to, the current price the current occupant remains and the unassigned household selects the next dwelling number at the top of its "ordered

dwelling" stack - step "1" - and the process continues.

: if the offer is greater than the current price, the unassigned household occupies the dwelling and the displaced household then selects the next dwelling number at the top of its "ordered dwelling" stack - step "1" - and the process continues.

**option 2: new dwelling.

the respective element in the "new dwelling" array is set to PN. The algorithm then returns to select the next household from the "ordered unassigned" household stack and continues through the steps.

**option 3: unassigned.

The presence of a zero indicates that the household cannot consume the minimum quantity of "new dwelling" services. The household is treated as unassignable, with the program setting the respective element of the new dwelling array to -1., for future reference. The algorithm then continues as in option 2.

The end condition occurs when all households in the ordered unassigned household stack have been processed.

The number of iterations of the allocation algorithm has a finite upper bound, being the sum of the elements in the "ordered dwelling" stacks. This bound results because on each iteration a new element must be selected and once selected is discarded. A tracing of each iteration of the allocation algorithm can be output as follows; the trace being sequentially row-wise.

*** tracing HOUSEHOLD ASSIGMENTs

hhold	dwell	price	hhold	dwell	price	hhold	dwell	price
5	1	1700.000	10	10	1564.000	9	10	1465.000
9	6	1398.000	8	10	1380.000	8	9	1647.000
7	10	1317.000	7	9	1590.000	7	8	1744.000
4	5	1054.000	3	5	863.000	3	4	1093.000
2	5	490.000	2	4	621.000	2	3	707.000
6	8	454.000	6	7	499.000	1	3	483.000
1	2	551.000						

A2.664 "Actual" and "Expected" Externalities.

With this model only one conditional externality factor (relative wealth W(iz)) is used. This factor is calculated as:

$$W(iz) = (MY)zone \; / \; (MY)city$$

where,

(MY) is the average household income for the respective groupings.

On each iteration the "actual" and "expected" externalities are output as follows;

*** "ACTUAL" and "EXPECTED" EXTERNALITIES

zone	"ACTUAL" relative wealth	"ACTUAL" "#" units	"EXPECTED" relative wealth	"EXPECTED" "#" units
1	1.3867	5.	0.7006	5.
2	0.6133	5.	1.2994	5.
3	1.0000	0.	1.0198	0.

Root-Mean-Squared-Error: 0.1617

The root-mean-squared error (R.M.S.E.) statistic is employed as the indicator of convergence between the "expected" and the "actual" externalities. The error term is calculated by summing the square of the difference between the "actual" and "expected" values over the zones and dividing the total by twice the number of zones.

$$R.M.S.E. = \frac{\text{zones } (W(iz)actual - W(iz)expected)^{**}2}{2 * \text{number zones}}$$

The convergence tolerance level is set to a R.M.S.E. of 0.01, but may be reset via an input parameter. The program will exit from the "solution algorithm" loop if the R.M.S.E. is less than the

tolerance level, otherwise the program will loop ten times before exiting. On exiting from the "solution" algorithm loop the program transfers to output the final allocation of "model" households to both existing and new "model" dwellings. Unassigned households are similarly reported.

*** ALLOCATION of HOUSEHOLDS

existing dwellings

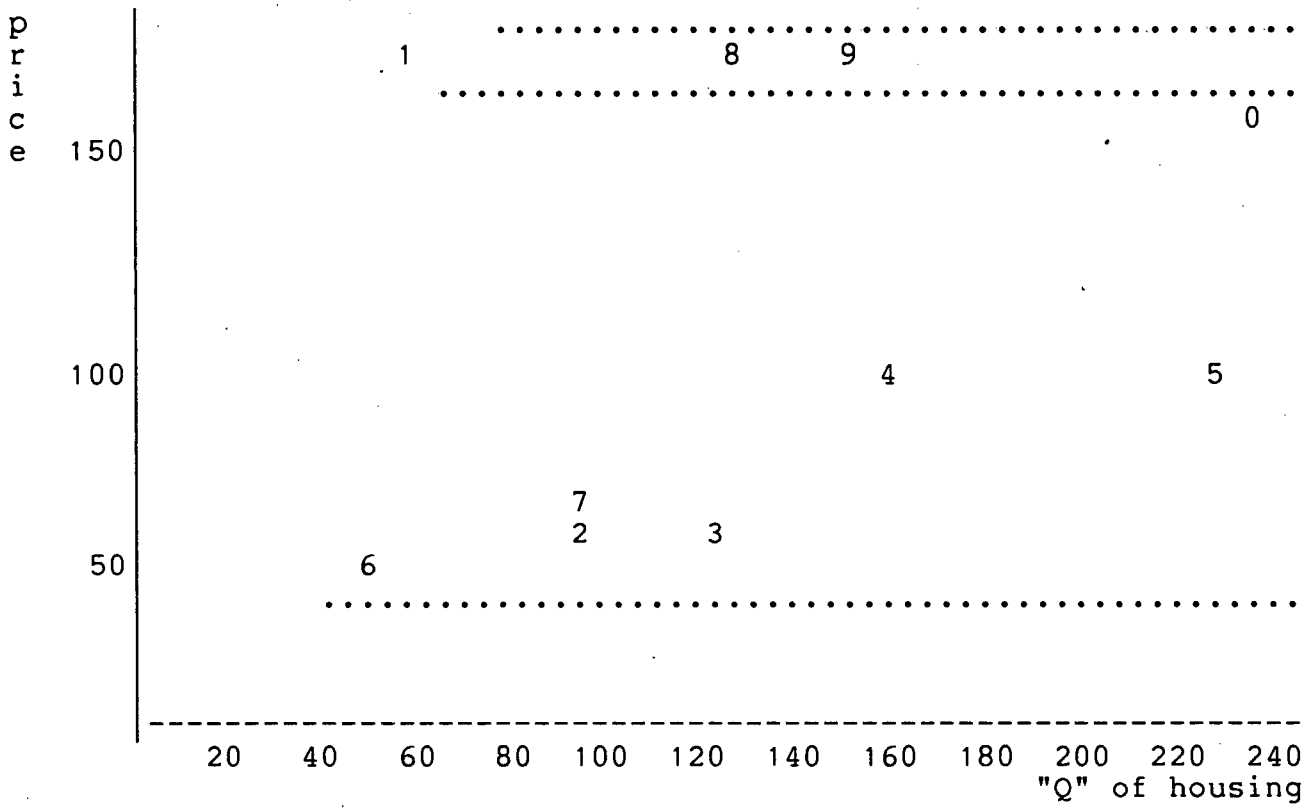
DWELLING	1	2	3	4	5	6	7	8	9	10
zone	1.	2.	1.	2.	2.	2.	1.	2.	1.	1.
household	5	1	2	3	4	9	6	7	8	10
type	1.	1.	1.	1.	1.	2.	2.	2.	2.	2.
utility	157.	66.	86.	118.	129.	102.	49.	103.	103.	104.
price	1.700	0.551	0.707	1.093	1.054	1.398	0.499	1.744	1.647	1.564
quantity	50.	101.	129.	161.	234.	50.	101.	129.	161.	234.
"P"*"Q"	85.0	55.7	91.2	176.0	246.6	69.9	50.4	225.0	265.2	366.0

*** ALLOCATION OF HOUSEHOLDS

new dwellings

NO NEW DWELLINGS CREATED

Additional graphical presentation of the solution conditions can also be output. In the following example the three horizontal rows of dots correspond respectively to PN, the price of new services for alternatively the owners and the renters and PO, the operating costs. They commence at QM, the respective minimum quantity of new construction.



PRICE-QUANTITY curves: Example Solution

After these outputs the program, when in "calibration" mode, transfers to calculate and output the calibration error before returning for additional input (Section A2.67 Calibration Mode). In the alternative "base" and "policy" modes the transfer is described in the corresponding Sections A2.68 and A2.69.

A2.67 MODIFIED model: Calibration Mode.

The program is placed in "calibration mode" via the two alternative control parametrs "9901" for EXT calibration and "9902" for BETA calibrations. Calibration involves testing "solution" conditions generated under different behavioural parameters with "actual" market conditions. In the ORIGINAL model five criterion sets based on zonal values are used.

1. average price per unit of "housing" services
2. the distribution of households by type
3. average household income
4. the utilization of the existing stock
5. the average quantity of "housing" services

The summary statistic used to indicate the "goodness-of-fit" of the model is termed the "mean error". Two mean error statistics are derived for each "solution" condition by:

1. calculating on a zonal basis the difference between the "actual" and "solution" means for price, quantity, income, utilization and the distribution of households by TYPE group (normally eight).

2. calculating the root-mean-aquare errors for each of these groups by summing the squares of the difference and dividing the sum by twice the number of zones.

3. weighting each of the groups R.M.S.E. by the unweighted average of the zonal means for that group, and

4. then these weighted R.M.S.E.'s are averaged to obtain the final summary measures. The first "mean error" value output corresponds to the average of the weighted R.M.S.E.s for prices, quantities, incomes and utilization: the second for the distribution by household TYPE.

The calibration output which includes the average zonal characteristics and the calibration errors is as follows:

```
 *** CALIBRATION output:  test simulation prog

 *** AVERAGE "actual" and "solution" ZONAL CHARACTERISTICS

  parameter values:

EXT1  0.50 :EXT2  0.50 :B1R  0.0  :B2R  0.0  :B1O  0.0  :B2O  0.0

          price                                income  usage  "Q"
 (zone  1)
  actual  1.10                                12000.  0.75  210.
  calc.   1.27                                18231.  1.00  135.
 (zone  2)
  actual  1.65                                 7230.  0.85  170.
  calc.   1.15                                 8063.  1.00  135.
 (zone  3)
  actual  1.81                                28140.  0.0   300.
  calc.   0.0                                     0.  0.0     0.

 *** CALIBRATION ERRORS

           price                                 income  usage  "Q"
  R.M.S.E. .3145                                4805.6 0.049  51.9

  R.M.S.E. .2603                               0.3655 0.049 0.384
 (weighted)

          MEAN ERRORS     0.2647
```

This output is provided automatically at the end of each parameter iteration loop; the status of the iterated parameters being indicated in the output table. On termination of the parameter iteration loop controlis transferred either to input additional data or an "end-of-file" or control parameter "9999" terminates program execution.

A2.68 MODIFIED model: Base Mode

"Base" mode runs are used to generate a data set for input during "policy" runs that allows the internal calculation of comparative statistics that highlight the effects of the market intervention under study. A "base" mode run is indicated to the program by the control parameter "9903". In "base" mode the BETA calibration dataset is employed as input along with the finally

selected set of the calibration parameters. The program outputs to file or cards a title record card and the data records for the household TYPEs, ALPHAs and average incomes, the zonal characteristics and records for each 1961 "model" existing dwelling and 1971 "model" household. The latter set of records contains additional data on the solution conditions. Output for each "model" household is the input "actual" income and household TYPE, together with the additional data; number of the dwelling occupied, price paid per unit of "housing" service, the quantity consumed and the utility. A new "model" dwelling is indicated by a "model" dwelling number of 999: a household forced to double-up is indicated by a zero. The "model" household component of the "policy" data set generated for the example data could be as follows;

```
 1001 1527     1 -217    0          00.0    0.0  0.0
 1002 2235     1  102   60          11.466 53.4 52.8
 1003 3938     1  900  191          21.404100.4 99.6
 1004 5616     1 3309  731          31.379124.1107.6
 100523829     14494027846          51.426237.7160.3
 1006 2235     2 2814  628          00.0    0.0  0.0
 1007 9779     2 6334 1556          71.641125.7103.3
 100811275     2 8173 1983          81.555148.4105.0
 100913986     211724 2991          91.493174.7105.0
 101016827     214648 4236         101.378225.5106.8
```

A2.69 MODIFIED model: Policy Mode

The aim in calibrating the models is to evaluate the alternative policy options. This VERSION of the MODIFIED model has policy capabilities directly comparable to the ORIGINAL model and contains "policy" options capable of analysing the following policy types; income subsidy, in-kind subsidy, price subsidy, direct subsidy and public housing. With the first four options, the

policies can be directed to either new or existing dwellings, or a combination of both, with household eligibility being regulated by "actual" income, TYPE and earmarking. No provision has been made to differentiate on a tenure basis.

The specification of the subsidy amount to the program is based on a set of equations; the option available varying with the subsidy mode. In addition to incorporating different parameter values with each of the different equation types, up to four equations can be "stacked" to create relatively complex "conditional" programs such as a Rent Triangle or a Conditional Housing Allowance Program. The policy mode options, with the available equations, are:

1. income subsidy

 1.2 SUB = POL1 * [POL3 - POL4 * AY]

2. in-kind subsidy

 2.1 SUB = POL1 * [POL2 * Pj * Qj - POL4 * AY]

 2.2 SUB = POL1 * [POL3 - POL4 * AY]

 2.3 SUB = POL1 * [POL2 * Pj * Qj - POL5 * Pj * Qj]

 2.4 SUB = POL1 * [POL3 - POL5 * Pj * Qj]

 2.5 SUB = POL1 * [POL2 * Pj * Qj - POL5 * AY * Pj * Qj]

 2.6 SUB = POL1 * [POL3 - POL5 * AY * Pj * Qj]

3. price subsidy

 3.1 SUB = Qj * [(PO - POL1) + (PC - POL2)] ... for new

 SUB = Qj * [(PO - POL3) + (PC - POL4)] ... for existing

4. direct demand subsidy

 4.1 SUB = POL1 * [POL2 * Pj * Qj - POL4 * AY]

 4.2 SUB = POL1 * [POL3 - POL4 * AY]

5. direct supply subsidy

5.1 SUB = POL1 * [POL2 * Pj * Qj - POL4 * AY]

5.2 SUB = POL1 * [POL3 - POL4 * AY]

20. constrained MINIMUM quantity subsidy

20.1 income subsidy to consume MINIMUM quantity (POl1,POL2)

20.2 in-kind subsidy to consume MINIMUM quantity (POl1,POL2)

20.3 direct constrained subsidy at MINIMUM quantity (POl1,POL2)

20.4 direct quantity subsidy at MINIMUM quantity (POl1,POL2)

20.5 direct expenditure subsidy at MINIMUM quantity (POl1,POL2)

20.6 direct price subsidy at MINIMUM quantity (POl1,POL2)

These are the options utilized in generating the policy simulations reported in Chapter 10 as for the MODIFIED model. POL1 is used to indicate the minimum quantity for the rental sector; POL2 the minimum quantity for the owner-occupiers.

In addition, eligibility may be specified via AILIM(POL6) and a minimum consumption level (earmarking requirement) via QMIN.

With the in-kind policy option the equation used may be directly specified, or selected by the program in accordance with the following logic:

```
if POL4 and POL5 both non-zero  select 5 or 6
if POL4 zero                    select 3 or 4
if POL5 zero                    select 1 or 2

if POL5 non-zero                select 1, 3 or 5
```

That is, if POL2 non-zero, POL3 is disregarded.

The additional input data records available for "policy" simulations are:

"810 _" General Policy parameters

"8201" Eligible Households by TYPE

"8301" Public Housing Recipients

At least one "810 _" card is required for all "policy" runs; the "8200" and "8300" cards are optional. Details of these input records are:

"810 _" General Policy Parameters

This input record contains eleven (11) data fields and may be used for up to four different equations in one policy run. The equation number is identified in column 4. Fields correspond to OPTION, POL1, POL2, POL3, POL4, POL5, AILIM, QMIN, QMAX, RMIN and RMAX with the first six as detailed in the individual policy equations. The other parameters are used for special applications as detailed following.

field .

1 . OPTION
. data values: 1. income subsidy (new and existing)
. 2. income subsidy (existing only)
. 3. income subsidy (new only)
. 4. in-kind subsidy (new and existing)
. 5. in-kind subsidy (existing only)
. 6. in-kind subsidy (new only)
. 7. price subsidy (new and existing)
. 8. price subsidy (existing only)
. 9. price subsidy (new only)
. 10. direct demand subsidy (new and existing)
. 11. direct demand subsidy (existing only)
. 12. direct demand subsidy (new only)
. 13. direct supply subsidy (new and existing)
. 14. direct supply subsidy (existing only)
. 15. direct supply subsidy (new only)

. 20. constrained MINIMUM (new and existing)
. 21. constrained MINIMUM (existing only)
. 22. constrained MINIMUM (new only)

note: if only one equation is used ("8101") there is no limit on the subsidy amount other than that dictated by AILIM (the eligible income limit) and QMIN (the earmarking constraint). If more than one equation is used ("8102" - "8104") then the additional equations act as constraints on the subsidy amount such that at the solution (Pj, Qj) the subsidy given by an equation must be less than or equal to that provided by the next equation to be acceptable.

fields

(2-6) these fields correspond to POL1 through POL5 as detailed above.

field .

7 .AILIM, actual annual income eligibility limit, i.e. "model" household's actual income, must be less than or equal to this amount to be eligible for a subsidy. If zero, all households are eligible.

field

8 QMIN, the earmarking requirement. A household must consume a quantity greater than or equal to this

field .

9 .QMAX

. designated for use as a maximum quantity constraint

field .

10 .RMIN

. designated for use as a minimum rental/expenditure constraint

field .

11 .RMAX

. maximum rent constraint

amount to be eligible for a subsidy.

"8200" ELIGIBLE HOUSEHOLDS by TYPE

This input record contains ten fields corresponding to the ten household TYPEs.

default value: all households eligible for a subsidy

data options: 1. 0 for ineligible household types
2. 1 for eligible household types

"8300" PUBLIC HOUSING RECIPIENTS

This input record contains nine fields; the first being a control switch while the remaining eight are for the numbers of households forced to take new construction, and therefore non-competitive. Such households are indicated by a subsidy type code "99" in the output data.

default value: option off

fieid	
1	.control switch . data options: 1. 0 if data not to be considered . 2. 1 if require option
(8-9)	.public housing recipients . data options: valid household number in the range of; . 1 through 100

An income subsidy to both new and existing "model" dwellings (policy option 1) is shown in this following example. The subsidy is to be 0.75 of the income "gap" where income is 25% of actual income. No restriction is to be placed on household eligibility, but "model" household "6" is treated as a public housing recipient. The required "policy" input records are:

```
8101____1_0.75____1______0.25
8200____1____1
8300____1____6
```

After the basic data review these additional records are output as follows:

```
*** "8___" POLICY PARAMETERS

option  POL1     POL2     POL3     POL4     POL5     POL6     POL7
 1.1    0.75     1.00     0.0      0.25     0.0      0.0      0.0

 ELIGIBILITY by TYPE
     1     2
     1.    1.

 PUBLIC HOUSING: option    1

     6     0
```

A2.691 Simulation of Subsidy Options

With the MODIFIED model the income constraint and eligibility is based on the household's total gross income: annual after tax income plus taxes divided by 12. The overall approach to computing subsidies follows that for the ORIGINAL model.

In evaluating subsidy options, the program firstly calculates the intercept between the unsubsidised demand and supply curves and calculates the partial utility. It then attempts (for eligible households) to solve for each of the four potential subsidy equations in turn. For both new and existing dwellings the solution conditions are generated using a numerical solution technique. An additional iteration loop must be included to allow the consideration of the dependance of the expenditure share on the income. Consequently, with each computed subsidy amount the expenditure share must be recomputed to reflect the alternative income level (the form of the recomputation is conditional on the subsidy type). After a check on earmarking requirements the amount of the subsidy is calculated by substituting the respective equations as outlined in the previous Section. This then allows the calculation of total incomes and the corresponding partial

utilities.

If only a single subsidy equation is used the total partial utilities with and without the subsidy are compared; the option with the highest partial utility is selected.

If more than one subsidy equation is used the subsequent equations act as upper bounds on the maximum subsidy amount. This is achieved by firstly calculating the subsidy amount under the new equation for the solution price and quantity associated with the previous equation (e.g. price and quantity from equation 1 are substituted into subsidy equation 2). If this amount is greater than or equal to the previously calculated amount the household's subsidy amount is taken as for the previous equation. Otherwise, if the new equation is not the last equation in the set a new solution price and quantity is calculated and the process repeated. If the new equation is the last, the household's subsidy amount is simply set to zero.

For "model" households designated as new public housing recipients, all array elements associated with the existing "model" dwellings are set to zero. If the "model" household is not eligible for a new dwelling, QN is less than QM, it is assigned a QN value equal to QM. In this manner, its dwelling stack contains only a new "model" dwelling for which there is no competition.

A special option has been incorporated to aid in the efficient computation of the subsidy costs when comparing alternative policy forms supporting a constant minimum standard of housing reflected as a minimum quantity. The required subsidy amount under the designated form of subsidy is computed without the use of the special parametered equations. The alternative graphical representation of these six forms of intervention are detailed in

Figure 9.02 with the mathematical formulation included as Section 9.31. The subsidy amount is computed as the additional cash required to shift the household from its unsubsidised level of consumption to consume by choice the required minimum quantity of housing in a manner comparable to that used for the ORIGINAL model.

A2.692 Subsidy Calculation

After the calculation of the price-quantity intercepts and the associated partial utilities, the program transfers into the standard solution algorithm loop. Since the amounts in the majority of policies are a function of the solution conditions, on exiting from the allocation algorithm the program calculates the subsidy TYPE and amount associated with each household. The exception is that under the constrained MINIMUM quantity option the subsidy amount is computed directly. This additional information is output as a part of the ALLOCATION of HOUSEHOLDS data. In addition this data is output in conjunction with the income data ordered by "actual" household income, with the form of the subsidy indicated by a code number as for the ORIGINAL model.

A2.693 Calculation of Subsidy Impact

To aid in evaluating the market effects of the input policy the program calculates data indicating changes from the market state generated in the "base" mode run, and input as elements of the "model" household records. In addition to general results for the C.M.A. at large, selected statistics are calculated for all recipients, groupings of the recipients and the lowest income non-recipients. The size of the special groups is taken as the smaller of either half of the recipient group (recipient or non-recipient),

or ten. The nature of the output is as for the ORIGINAL model.

SECTION A3: MODEL IMPLEMENTATION DATA and RESULTs

In the following SECTION the statistics and selected results derived during the initialization of the two MODELs, for the eight selected CMAs, are presented. The eight CMAs are:

1. CALGARY
2. KITCHENER
3. QUEBEC CITY
4. ST. JOHN'S
5. SASKATOON
6. SUDBURY
7. VANCOUVER
8. WINNIPEG

The individual Figures presented for each CMA. are detailed on the following pages.

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-1 CALGARY

A3:01-1 Zonal Characteristics (5 Zones)
A3:02-1 Clustering (5 Zones)
A3:03-1 ORIGINAL MODEL:Household Characteristics
A3:04-1 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-1 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-1 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-1 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-1 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-1 ORIGINAL MODEL:Household ALPHAs
A3:10-1 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-1 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-1 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-1 ORIGINAL MODEL:Policy Dataset
A3:14-1 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-1 TENURE MODEL:Translog Input Variables Statistics

A3:16-1 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-1 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-1 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-1 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-1 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-1 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-1 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-1 TENURE MODEL:Income and Price Elasticities
A3:24-1 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-1 TENURE MODEL:"Demand" Calibration Data
A3:26-1 TENURE MODEL:"Supply" Calibration Data
A3:27-1 TENURE MODEL:Policy Dataset

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-2 KITCHENER

A3:01-2 Zonal Characteristics (5 Zones)
A3:02-2 Clustering (5 Zones)
A3:03-2 ORIGINAL MODEL:Household Characteristics
A3:04-2 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-2 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-2 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-2 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-2 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-2 ORIGINAL MODEL:Household ALPHAs
A3:10-2 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-2 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-2 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-2 ORIGINAL MODEL:Policy Dataset
A3:14-2 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-2 TENURE MODEL:Translog Input Variables Statistics

A3:16-2 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-2 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-2 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-2 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-2 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-2 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-2 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-2 TENURE MODEL:Income and Price Elasticities
A3:24-2 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-2 TENURE MODEL:"Demand" Calibration Data
A3:26-2 TENURE MODEL:"Supply" Calibration Data
A3:27-2 TENURE MODEL:Policy Dataset

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-3 QUEBEC CITY

A3:01-3 Zonal Characteristics (5 Zones)
A3:02-3 Clustering (5 Zones)
A3:03-3 ORIGINAL MODEL:Household Characteristics
A3:04-3 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-3 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-3 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-3 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-3 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-3 ORIGINAL MODEL:Household ALPHAs
A3:10-3 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-3 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-3 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-3 ORIGINAL MODEL:Policy Dataset
A3:14-3 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-3 TENURE MODEL:Translog Input Variables Statistics

A3:16-3 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-3 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-3 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-3 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-3 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-3 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-3 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-3 TENURE MODEL:Income and Price Elasticities
A3:24-3 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-3 TENURE MODEL:"Demand" Calibration Data
A3:26-3 TENURE MODEL:"Supply" Calibration Data
A3:27-3 TENURE MODEL:Policy Dataset

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-4 ST. JOHN'S

A3:01-4 Zonal Characteristics (5 Zones)
A3:02-4 Clustering (5 Zones)
A3:03-4 ORIGINAL MODEL:Household Characteristics
A3:04-4 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-4 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-4 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-4 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-4 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-4 ORIGINAL MODEL:Household ALPHAs
A3:10-4 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-4 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-4 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-4 ORIGINAL MODEL:Policy Dataset
A3:14-4 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-4 TENURE MODEL:Translog Input Variables Statistics

A3:16-4 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-4 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-4 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-4 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-4 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-4 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-4 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-4 TENURE MODEL:Income and Price Elasticities
A3:24-4 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-4 TENURE MODEL:"Demand" Calibration Data
A3:26-4 TENURE MODEL:"Supply" Calibration Data
A3:27-4 TENURE MODEL:Policy Dataset

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-5 SASKATOON

A3:01-5 Zonal Characteristics (5 Zones)
A3:02-5 Clustering (5 Zones)
A3:03-5 ORIGINAL MODEL:Household Characteristics
A3:04-5 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-5 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-5 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-5 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-5 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-5 ORIGINAL MODEL:Household ALPHAs
A3:10-5 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-5 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-5 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-5 ORIGINAL MODEL:Policy Dataset
A3:14-5 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-5 TENURE MODEL:Translog Input Variables Statistics

A3:16-5 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-5 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-5 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-5 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-5 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-5 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-5 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-5 TENURE MODEL:Income and Price Elasticities
A3:24-5 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-5 TENURE MODEL:"Demand" Calibration Data
A3:26-5 TENURE MODEL:"Supply" Calibration Data
A3:27-5 TENURE MODEL:Policy Dataset

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-6 SUDBURY

A3:01-6 Zonal Characteristics (5 Zones)
A3:02-6 Clustering (5 Zones)
A3:03-6 ORIGINAL MODEL:Household Characteristics
A3:04-6 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-6 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-6 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-6 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-6 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-6 ORIGINAL MODEL:Household ALPHAs
A3:10-6 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-6 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-6 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-6 ORIGINAL MODEL:Policy Dataset
A3:14-6 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-6 TENURE MODEL:Translog Input Variables Statistics

A3:16-6 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-6 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-6 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-6 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-6 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-6 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-6 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-6 TENURE MODEL:Income and Price Elasticities
A3:24-6 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-6 TENURE MODEL:"Demand" Calibration Data
A3:26-6 TENURE MODEL:"Supply" Calibration Data
A3:27-6 TENURE MODEL:Policy Dataset

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-7 VANCOUVER

A3:01-7 Zonal Characteristics (5 Zones)
A3:02-7 Clustering (5 Zones)
A3:03-7 ORIGINAL MODEL:Household Characteristics
A3:04-7 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-7 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-7 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-7 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-7 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-7 ORIGINAL MODEL:Household ALPHAs
A3:10-7 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-7 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-7 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-7 ORIGINAL MODEL:Policy Dataset
A3:14-7 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-7 TENURE MODEL:Translog Input Variables Statistics

A3:16-7 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-7 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-7 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-7 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-7 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-7 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-7 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-7 TENURE MODEL:Income and Price Elasticities
A3:24-7 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-7 TENURE MODEL:"Demand" Calibration Data
A3:26-7 TENURE MODEL:"Supply" Calibration Data
A3:27-7 TENURE MODEL:Policy Dataset

SECTION A3: DERIVED CMA DATA and RESULTs.

A3:**-8 WINNIPEG

A3:01-8 Zonal Characteristics (5 Zones)
A3:02-8 Clustering (5 Zones)
A3:03-8 ORIGINAL MODEL:Household Characteristics
A3:04-8 ORIGINAL MODEL:1961 Dwelling Characteristics
A3:05-8 ORIGINAL MODEL:1961 Hedonic Estimates

A3:06-8 ORIGINAL MODEL:1971 Dwelling Characteristics
[GAMMA calibration set]
A3:07-8 ORIGINAL MODEL:1971 Dwelling Characteristics
[BETA calibration set]
A3:08-8 ORIGINAL MODEL:1971 Hedonic Estimates
A3:09-8 ORIGINAL MODEL:Household ALPHAs
A3:10-8 ORIGINAL MODEL:Prices, Costs and Quantities

A3:11-8 ORIGINAL MODEL:"GAMMA" Calibration Data
A3:12-8 ORIGINAL MODEL:"BETA" Calibration Data
A3:13-8 ORIGINAL MODEL:Policy Dataset
A3:14-8 TENURE MODEL:1971 Hedonic Estimates for Translog
A3:15-8 TENURE MODEL:Translog Input Variables Statistics

A3:16-8 TENURE MODEL:Expenditure Share Estimates
[all income groups]
A3:17-8 TENURE MODEL:Expenditure Share Estimates
[below mean incomes]
A3:18-8 TENURE MODEL:Expenditure Share Estimates
[above mean incomes]
A3:19-8 TENURE MODEL:Expenditure Share Estimates
[quartile 1]
A3:20-8 TENURE MODEL:Expenditure Share Estimates
[quartile 2]
A3:21-8 TENURE MODEL:Expenditure Share Estimates
[quartile 3]
A3:22-8 TENURE MODEL:Expenditure Share Estimates
[quartile 4]

A3:23-8 TENURE MODEL:Income and Price Elasticities
A3:24-8 TENURE MODEL:Log Likelihood Values
[Test of unity income elasticity]
A3:25-8 TENURE MODEL:"Demand" Calibration Data
A3:26-8 TENURE MODEL:"Supply" Calibration Data
A3:27-8 TENURE MODEL:Policy Dataset

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	9	16
2	2	4
3	8	39
4	4	5
5	4	4
A	-	9
Total	27	77

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 1

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	76.	115.	13,756.	18,968.	3,270.	8,028.	38.
2	116.	155.	20,453.	28,947.	5,038.	14,289.	65.
3	87.	149.	16,380.	24,222.	4,836.	11,519.	75.
4	73.	115.	18,943.	26,661.	3,121.	7,810.	20.
5	70.	129.	11,872.	18,724.	3,718.	9,525.	116.
A		157.		24,181.		10,942.	116.
CMA	83.	137.	15,898.	23,201.	4,139.	10,291.	66.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	24,052.	29,580.	24.4	8,114.	27.4	16.9
2	5,521.	6,360.	5.2	1,296.	20.4	2.7
3	33,387.	54,825.	45.3	22,517.	41.1	46.8
4	8,627.	12,255.	10.1	4,639.	37.9	9.6
5	6,297.	5,075.	4.2	1,813.	35.7	3.8
A		13,070.	10.8	9,705.	74.3	20.2
	77,884.	121,165.	100.0	48,084.	39.7	100.0

source: program "CZONE.FORT": files CAL61.INPUT and CAL71.INPUT.

Figure A3:01-1 CALGARY: Zonal Characteristics (5 zones)

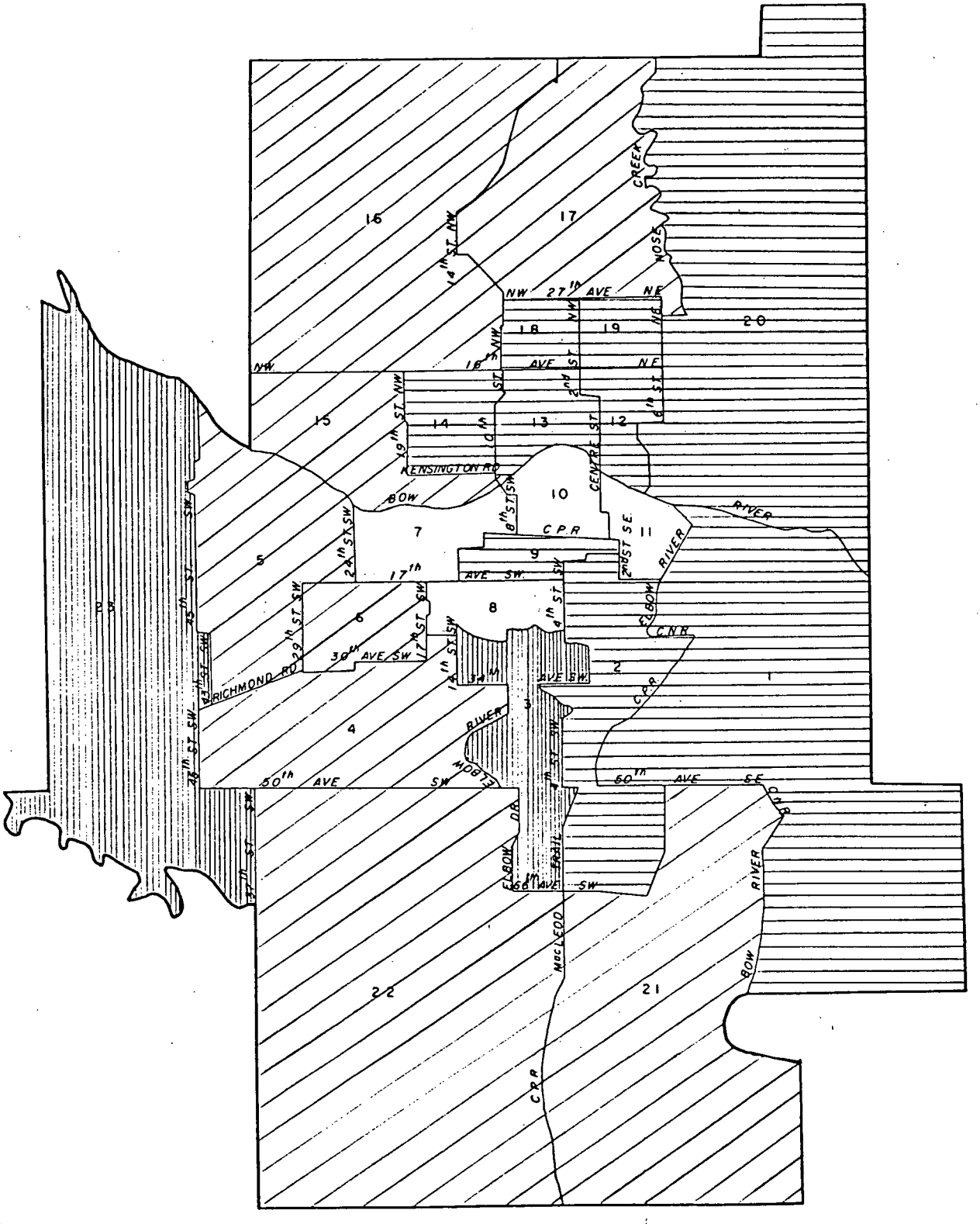


Figure A3:02-1 CALGARY: Clustering (5 zones)

Demographic Characteristics:

Population [1] 1961: 279,062.
[2] 1971: 403,320.

Households [1] 1961: 78,396.
[2] 1971: 121,290.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 10,291.
1974 SHU data [4] : 11,966.

deflator : 0.8600

SHU deflated : 10,506.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file CAL.SHU

SHU dataset:

Sample size : 2879.
Sum of the WEIGHTs : 149,736.

RATIO of SHU weights
to actual households : 1.2345

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	9,637.	15,488.	10.	1549.	1255.
2	12,261.	57,955.	39.	1486.	1204.
3	11,754.	10,883.	7.	1555.	1260.
4	13,300.	20,834.	15.	1389.	1125.
5	5,465.	9,297.	6.	1549.	1255.
6	7,605.	13,772.	9.	1530.	1239.
7	8,103.	13,833.	9.	1537.	1245.
8	3,874.	7,674.	5.	1535.	1243.

source: program "HH1.FORT" :file CAL.SHU

Figure A3:03-1 CALGARY: HOUSEHOLD Characteristics.

Total 1961 dwellings : 77,885.

Rental	:	28,663.
Owner-occupier	:	49,222.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	75.	11,401.	13,225.	12,651.	0.0684
2	118.	864.	20,344.	4,657.	0.0696
3	87.	9,397.	16,186.	23,990.	0.0648
4	72.	5,595.	18,936.	3,032.	0.0456
5	78.	1,406.	11,359.	4,891.	0.0828
CMA	80.	28,663.	15,508.	49,222.	0.0696

source: program "D61.FORT" : dataset CAL61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings : TOTAL 77,885.
: RATIO of EXISTING unannexed/TOTAL 89.5%
: TOTAL 1961 Dwellings EXISTING in 1971 73,081.
: TOTAL 1961 Dwellings ADJUSTED for ANNEXED 81,643.
: 1971 "model" Dwellings 100.
: 1971 RATIO ACTUAL/"model" 1212.
: 1961 "model" Dwellings 67.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	"RHS"/actual SERVICES weighted
1	24,052.	21.	1145.	1.0956	1.0348
2	5,521.	5.	1104.	0.8955	0.8458
3	33,387.	29.	1151.	1.0307	0.9735
4	8,627.	7.	1233.	0.9905	0.9356
5	6,297.	5.	1260.	1.1871	1.1213

error of fit 0.02478

source: program "D61.FORT" : dataset CAL61.INPUT.

Figure A3:04-1 CALGARY: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	4.0305	4.0066	2.7454	3.0537
	(6.60)	(7.91)	(3.77)	(5.28)
MULTIPLE	0.2996	0.3211	0.1903	0.1436
	(4.03)	(5.14)	(2.15)	(2.39)
CONSTRUCTED PRE 20	0.2639	0.2344	-.1499	-.1788
	(3.77)	(3.83)	(1.83)	(3.18)
20-45	0.0555	0.0151	-.1927	-.0750
	(0.74)	(0.25)	(2.18)	(1.08)
CONDITION	0.2090	0.2661	0.1555	0.1103
	(2.68)	(4.06)	(1.70)	(1.73)
LN ROOMS	0.7622	1.0059	0.7046	0.5837
	(7.05)	(10.2)	(5.50)	(6.87)
LN INCOME	0.4958	0.4431	0.3746	0.3643
	(6.33)	(6.56)	(4.06)	(5.11)
ACCESS	-.00141	.00128	-.0025	-.0024
	(2.83)	(3.39)	(4.18)	(4.59)
R2	0.41	0.99	0.42	0.99
OBSERVATIONS	368	368	356	356

note : "t" statistis in brackets
: data source: CAL61.EA

MEANS:

LN INCOME	8.2580
MULTIPLE	0.3146
ACCESS	58.1

Figure A3:05-1 CALGARY: 1961 Hedonic Estimates

Total 1971 dwellings : 121,165.

Rental	:	52,330.
Owner-occupier	:	68,835.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	120.	20,230.	21,095.	22,415.	0.0684
2	153.	1,830.	28,828.	4,530.	0.0636
3	139.	18,755.	24,961.	36,085.	0.0672
4	114.	10,155.	27,905.	2,095.	0.0492
5	123.	1,360.	19,321.	3,710.	0.0768
CMA	127.	52,330.	23,742.	68,835.	0.0636

source: program "D71.FORT" : dataset CAL71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	42,645.	35.	1218.	1.0349	1.0223
2	6,360.	5.	1272.	0.8235	0.8134
3	54,840.	46.	1192.	0.9590	0.9473
4	12,250.	10.	1225.	0.9869	0.9748
5	5,070.	4.	1268.	1.0963	1.0830
			1211.		

error of fit 0.01483

source: program "D71.FORT" : dataset CAL71.INPUT.

Figure A3:06-1 CALGARY: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 121,165.

Built prior 1961 : 73,047.
Built 1961-1971 : 48,118.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	103.	11,921.	18,408.	12,891.	0.0672
2	137.	1,002.	28,896.	4,062.	0.0564
3	115.	10,057.	22,349.	22,248.	0.0612
4	98.	5,576.	27,753.	2,031.	0.0420
5	99.	794.	15,751.	2,465.	0.0756
99	151.	22,979.	27,737.	25,139.	0.0660
CMA	127.	52,330.	23,888.	68,835.	0.0636

source: program "D71.FORT" : dataset CAL71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	24,812.	20.	1241.	1.1217	1.1034
2	5,064.	4.	1266.	0.8277	0.8142
3	32,305.	27.	1196.	1.0400	1.0230
4	7,607.	6.	1268.	1.0593	1.0420
5	3,259.	3.	1087.	1.2818	1.2609
99	48,118.	40.	1203.	0.8951	0.8804
			1211.		

error of fit 0.01848

source: program "D71.FORT" : dataset CAL71.INPUT.

Figure A3:07-1 CALGARY : 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	8.4919	8.1684	5.8402	6.0649
	(54.2)	(52.7)	(45.6)	(53.4)
MULTIPLE	0.0522	0.0803	-.0436	-.0779
	(1.66)	(2.27)	(1.64)	(2.95)
CONSTRUCTION 51-60	-.1227	-.1498	-.2076	-.2227
	(5.31)	(7.03)	(8.45)	(8.91)
46-50	-.2373	-.2374	-.2382	-.2349
	(7.16)	(7.06)	(6.25)	(6.24)
20-45	-.2995	-.3264	-.2919	-.2693
	(8.45)	(8.45)	(8.41)	(7.96)
PRE 20	-.3456	-.3089	-.4054	-.3741
	(8.55)	(7.31)	(11.2)	(10.2)
FACILITIES	-.0500	0.0814	0.2349	0.2613
	(0.55)	(0.94)	(5.11)	(5.92)
LN INCOME	-.0545	0.0868	0.1196	0.0891
	(3.90)	(5.84)	(8.97)	(7.61)
LN ROOMS	0.5747	0.5851	0.2508	0.2812
	(14.7)	(14.7)	(10.1)	(11.5)
R2	0.31	0.99	0.32	0.98
OBSERVATIONS	1105	1105	1071	1071
WEIGHTED 20-45/PRE 20	-.3188	-.3190	-.3538	-.3268

note : "t" statistis in brackets
: data source: CAL.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	8.9898
MULTIPLE	0.3100
ACCESS	49.0

Figure A3:08-1 CALGARY: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	23,201.	40,394.	0.57437
RENT	137.	154.	0.88961
INCOME	10,291.	11,966.	0.8600

R/V ratio: 0.0636 P(j)/PN ratio: 0.86681

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.8066 (110.)	0.1655	2.8294 (106.)	0.1694	0.1835
DUMMY (TYPE 2)	-.1090 (3.49)	0.1484	-.1725 (5.53)	0.1425	0.1547
DUMMY (TYPE 3)	-.1760 (4.28)	0.1388	-.2124 (4.97)	0.1369	0.1487
DUMMY (TYPE 4)	-.2761 (7.08)	0.1256	-.3320 (8.80)	0.1215	0.1322
DUMMY (TYPE 5)	0.4251 (10.2)	0.2532	0.3978 (8.32)	0.2521	0.2709
DUMMY (TYPE 6)	0.3311 (8.35)	0.2305	0.2873 (7.08)	0.2257	0.2432
DUMMY (TYPE 7)	0.1923 (4.81)	0.2006	0.1633 (3.89)	0.1994	0.2154
DUMMY (TYPE 8)	0.7345 (16.1)	0.3451	0.6566 (13.1)	0.3265	0.3485
R2	0.23		0.78		
OBSERVATIONS	2773		2773		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-1 CALGARY: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	10.343 (71.7)	10.253 (70.7)	0.1580	0.1024	0.3130
DUMMY (TYPE 2)	0.0440 (1.98)	0.0058 (0.26)	0.1306	0.0712	0.7098
DUMMY (TYPE 3)	-.0080 (0.27)	-.0283 (0.92)	0.1306	0.0973	0.2155
DUMMY (TYPE 4)	-.0397 (1.42)	-.0729 (2.66)	0.1129	0.0734	0.2413
DUMMY (TYPE 5)	-.0372 (1.21)	-.0970 (2.74)	0.2279	0.1506	0.3710
DUMMY (TYPE 6)	0.0895 (3.15)	-.0581 (1.98)	0.2030	0.1340	0.4588
DUMMY (TYPE 7)	-.0308 (1.08)	-.0752 (2.48)	0.1689	0.1094	0.4330
DUMMY (TYPE 8)	-.0478 (1.35)	-.1704 (4.35)	0.2805	0.1796	0.4929
LN INCOME	-.8296 (52.7)	-.8161 (51.6)			
R2	0.61	0.89			
OBSERVATIONS	2773	2773			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Figure A3:09-1(b) CALGARY: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	657.0	950.	4,414	-	-	-
1962	666.0	953.	5,136	0.091	60.6	86.7
1963	676.0	958.	3,672	0.065	43.9	62.3
1964	691.0	965.	3,887	0.069	47.7	66.6
1965	711.0	1009.	4,178	0.074	52.6	74.7
1966	736.0	1193.	3,304	0.058	42.6	69.2
1967	771.0	1311.	3,833	0.068	52.4	89.1
1968	817.0	1574.	7,403	0.131	106.9	206.2
1969	862.0	1909.	9,737	0.172	148.3	328.3
1970	923.0	2084.	6,740	0.119	109.8	248.0
1971	977.0	1979.	8,801	0.155	151.5	306.7

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	657.0	950.0	1607.0	0.409	0.591	1.000	--
decade weighted	816.3	1538.8	2355.1	0.506	0.954	1.460	50.3
1971	977.4	1979.0	2956.4	0.608	1.232	1.840	39.3

Figure A3:10-1 CALGARY: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 1 9636
20 212260
20 311753
20 413300
20 5 5464
20 6 7604
20 7 8102
20 8 3874

0000 ALPHA by TYPE
21 1.1694
21 2.1425
21 3.1369
21 4.1215
21 5.2521
21 6.2257
21 7.1994
21 8.3265

0000 "MODEL" HOUSEHOLDS
10 1 2385    1
10 2 4523    1
10 3 5844    1
10 4 7114    1
10 5 8470    1
10 6 9575    1
10 710573    1
10 811886    1
10 913504    1
101023338    1
1011  387    2
1012 1967    2
1013 3142    2
1014 3881    2
1015 4843    2
1016 5543    2
1017 6359    2
1018 6943    2
1019 7366    2
1020 7791    2
1021 8268    2
1022 8633    2
1023 8858    2
1024 9265    2
1025 9564    2
1026 9901    2
102710336    2
102810494    2
102910799    2
103011192    2
103111652    2
103212084    2
103312314    2
103412632    2
103512909    2
103613133    2
103713497    2
103813915    2
103914236    2
104014967    2
104115815    2
104216560    2
104317309    2
104418458    2
104519225    2
104620945    2
104723412    2
104830199    2
104942147    2
1050 4228    3
1051 7561    3
1052 9531    3
105311254    3
105413005    3
105515594    3
105621426    3
1057 2820    4
1058 5920    4
1059 7316    4
1060 8257    4
1061 9221    4
106210208    4
106311117    4
106412324    4
106513364    4
106614287    4
106715443    4
106816923    4
106918774    4
107021740    4
107131958    4
1072 2020    5
1073 2798    5
1074 3598    5
1075 4614    5
1076 7076    5
107712716    5
1078 1441    6
1079 3006    6
1080 4391    6
1081 5364    6
1082 7025    6
1083 8200    6
1084 9498    6
108511622    6
108617763    6
1087 1185    7
1088 2557    7
1089 4444    7
1090 5745    7
1091 7151    7
1092 8599    7
109310428    7
109412671    7
109519640    7
1096 1226    8
1097 1918    8
1098 2432    8
1099 4008    8
11 0 9619    8
```

Figure A3:11-1 CALGARY: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1   32   25    1 | 3035  226  179    1 | 3069  124   98    3
30 2   50   40    1 | 3036   70   55    2 | 3070  125  100    3
30 3   60   47    1 | 3037   99   79    2 | 3071  127  101    3
30 4   66   52    1 | 3038  116   92    2 | 3072  129  103    3
30 5   70   56    1 | 3039  137  109    2 | 3073  131  104    3
30 6   74   59    1 | 3040  186  148    2 | 3074  134  106    3
30 7   78   62    1 | 3041   36   28    3 | 3075  136  108    3
30 8   82   65    1 | 3042   58   46    3 | 3076  139  110    3
30 9   86   68    1 | 3043   65   52    3 | 3077  142  112    3
3010   89   71    1 | 3044   70   56    3 | 3078  145  115    3
3011   93   73    1 | 3045   75   59    3 | 3079  149  118    3
3012   96   76    1 | 3046   79   62    3 | 3080  153  121    3
3013   99   78    1 | 3047   82   65    3 | 3081  157  125    3
3014  102   81    1 | 3048   85   67    3 | 3082  162  129    3
3015  104   83    1 | 3049   87   69    3 | 3083  169  134    3
3016  107   85    1 | 3050   89   71    3 | 3084  178  141    3
3017  110   87    1 | 3051   91   72    3 | 3085  199  158    3
3018  113   90    1 | 3052   93   74    3 | 3086  252  200    3
3019  116   92    1 | 3053   95   75    3 | 3087   24   19    4
3020  119   95    1 | 3054   97   77    3 | 3088   56   44    4
3021  122   97    1 | 3055   99   78    3 | 3089   70   56    4
3022  125   99    1 | 3056  101   80    3 | 3090   85   67    4
3023  128  101    1 | 3057  102   81    3 | 3091   98   78    4
3024  131  104    1 | 3058  104   83    3 | 3092  108   86    4
3025  134  106    1 | 3059  106   84    3 | 3093  116   92    4
3026  137  108    1 | 3060  108   85    3 | 3094  125   99    4
3027  140  111    1 | 3061  110   87    3 | 3095  136  108    4
3028  143  114    1 | 3062  112   88    3 | 3096  159  126    4
3029  147  116    1 | 3063  113   90    3 | 3097   57   45    5
3030  151  120    1 | 3064  115   91    3 | 3098   92   73    5
3031  156  124    1 | 3065  117   93    3 | 3099  120   96    5
3032  162  128    1 | 3066  118   94    3 | 31 0  160  127    5
3033  168  133    1 | 3067  120   95    3
3034  178  141    1 | 3068  122   97    3

0000 ZONAL DATA
40 1 8921   62
40 214289   65
40 311519   75
40 4 7810   20
40 5 9525  116
40 610290   66

0000 Calibration Data
70 11.2770.1060.3990.0660.0970.0730.0740.1120.073 89201.000114.0
70 21.1160.0830.5180.0470.1240.0930.0230.0600.052142871.000121.8
70 31.2610.1160.5470.0600.0980.0580.0340.0560.030115171.000117.4
70 41.3960.0600.1560.0710.1090.0610.1700.2410.132 78081.000 97.8
70 51.3000.1360.6020.0560.0620.0560.0160.0470.026 95291.000107.3
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0      00.0    0.0
```

Figure A3:11-1A CALGARY: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 1 9636
20 212260
20 311753
20 413300
20 5 5464
20 6 7604
20 7 8102
20 8 3874

0000 ALPHA by TYPE
21 1.1694
21 2.1425
21 3.1369
21 4.1215
21 5.2521
21 6.2257
21 7.1994
21 8.3265
```

```
0000 "MODEL" HOUSEHOLDS
10 1 2385     1
10 2 4523     1
10 3 5844     1
10 4 7114     1
10 5 8470     1
10 6 9575     1
10 710573     1
10 811886     1
10 913504     1
101023338     1
1011  387     2
1012 1967     2
1013 3142     2
1014 3881     2
1015 4843     2
1016 5543     2
1017 6359     2
1018 6943     2
1019 7366     2
1020 7791     2
1021 8268     2
1022 8633     2
1023 8858     2
1024 9265     2
1025 9564     2
1026 9901     2
102710336     2
102810494     2
102910799     2
103011192     2
103111652     2
103212084     2
103312314     2
103412632     2
103512909     2
103613133     2
103713497     2
103813915     2
103914236     2
104014967     2
104115815     2
104216560     2
104317309     2
104418458     2
104519225     2
104620945     2
104723412     2
104830199     2
104942147     2
1050 4228     3
1051 7561     3
1052 9531     3
105311254     3
105413005     3
105515594     3
105621426     3
1057 2820     4
1058 5920     4
1059 7316     4
1060 8257     4
1061 9221     4
106210208     4
106311117     4
106412324     4
106513364     4
106614287     4
106715443     4
106816923     4
106918774     4
107021740     4
107131958     4
1072 2020     5
1073 2798     5
1074 3598     5
1075 4614     5
1076 7076     5
107712716     5
1078 1441     6
1079 3006     6
1080 4391     6
1081 5364     6
1082 7025     6
1083 8200     6
1084 9498     6
108511622     6
108617763     6
1087 1185     7
1088 2557     7
1089 4444     7
1090 5745     7
1091 7151     7
1092 8599     7
109310428     7
109412671     7
109519640     7
1096 1226     8
1097 1918     8
1098 2432     8
1099 4008     8
11 0 9619     8
```

Figure A3:12-1 CALGARY: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1    22     1        3035    92     3
30 2    41     1        3036    94     3
30 3    52     1        3037    97     3
30 4    58     1        3038    99     3
30 5    63     1        3039   101     3
30 6    67     1        3040   104     3
30 7    71     1        3041   106     3
30 8    74     1        3042   108     3
30 9    78     1        3043   111     3
3010    81     1        3044   113     3
3011    85     1        3045   115     3
3012    89     1        3046   118     3
3013    93     1        3047   120     3
3014    98     1        3048   123     3
3015   102     1        3049   127     3
3016   107     1        3050   133     3
3017   113     1        3051   139     3
3018   119     1        3052   145     3
3019   126     1        3053   152     3
3020   141     1        3054   166     3
3021   207     1        3055   261     3
3022    65     2        3056    26     4
3023    88     2        3057    53     4
3024   103     2        3058    67     4
3025   123     2        3059    77     4
3026   174     2        3060    92     4
3027    39     3        3061   117     4
3028    58     3        3062   187     4
3029    65     3        3063    54     5
3030    70     3        3064    81     5
3031    75     3        3065    96     5
3032    81     3        3066   112     5
3033    86     3        3067   150     5
3034    90     3

0000 ZONAL DATA
40 1 8921   62
40 214289   65
40 311519   75
40 4 7810   20
40 5 9525  116
40 610290   66

0000 Calibration Data
70 11.1850.0910.3410.0650.1080.0940.0820.1290.090 81761.000119.3
70 20.9680.0790.5090.0460.1260.0980.0230.0630.056144750.917136.9
70 31.0890.1070.5030.0610.1100.0740.0400.0660.039106750.968129.7
70 41.2300.0590.1550.0670.1020.0610.1600.2470.148 74590.882116.2
70 51.1710.1330.5740.0570.0690.0640.0180.0540.031 88050.518114.5
70 61.4600.1220.5190.0630.0850.0420.0540.0770.038112301.000117.4
```

Figure A3:12-1A CALGARY: "BETA" Calibration Data

0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA

10 1 2385	1	61.134	53.4	1051 7561	3	9991.460	84.5
10 2 4523	1	331.323	73.6	1052 9531	3	661.398	98.6
10 3 5844	1	9991.460	82.8	105311254	3	471.450	107.6
10 4 7114	1	401.453	93.3	105413005	3	9991.460	117.1
10 5 8470	1	461.417	104.6	105515594	3	9991.460	130.5
10 6 9575	1	9991.460	111.3	105621426	3	9991.460	158.0
10 710573	1	9991.460	118.2	1057 2820	4	51.062	48.8
10 811886	1	201.459	126.8	1058 5920	4	101.344	69.9
10 913504	1	9991.460	136.9	1059 7316	4	341.380	78.7
101023338	1	9991.460	190.0	1060 8257	4	131.448	83.3
1011 387	2	20.506	24.6	1061 9221	4	381.455	88.9
1012 1967	2	41.062	44.9	106210208	4	9991.460	94.4
1013 3142	2	581.250	55.8	106311117	4	441.420	100.2
1014 3881	2	591.231	63.7	106412324	4	181.438	106.2
1015 4843	2	111.282	71.7	106513364	4	9991.460	111.0
1016 5543	2	121.336	76.6	106614287	4	9991.460	115.5
1017 6359	2	601.416	81.5	106715443	4	9991.460	121.0
1018 6943	2	651.434	85.6	106816923	4	9991.460	127.8
1019 7366	2	141.459	88.1	106918774	4	531.451	136.3
1020 7791	2	241.431	91.7	107021740	4	541.451	148.9
1021 8268	2	411.443	94.8	107131958	4	9991.460	187.2
1022 8633	2	421.456	97.0	1072 2020	5	301.192	57.1
1023 8858	2	431.435	99.0	1073 2798	5	91.306	66.4
1024 9265	2	171.451	101.3	1074 3598	5	231.348	76.1
1025 9564	2	451.453	103.2	1075 4614	5	371.424	86.2
1026 9901	2	611.459	105.2	1076 7076	5	251.453	110.4
102710336	2	9991.460	108.0	107712716	5	9991.460	156.6
102810494	2	481.434	109.6	1078 1441	6	291.056	50.2
102910799	2	9991.460	110.8	1079 3006	6	321.341	69.8
103011192	2	491.445	113.6	1080 4391	6	361.459	84.5
103111652	2	9991.460	116.0	1081 5364	6	161.444	95.7
103212084	2	501.445	119.0	1082 7025	6	191.442	112.6
103312314	2	9991.460	119.9	1083 8200	6	9991.460	122.9
103412632	2	9991.460	121.8	1084 9498	6	9991.460	134.3
103512909	2	9991.460	123.4	108511622	6	9991.460	151.6
103613133	2	511.455	124.8	108617763	6	9991.460	195.5
103713497	2	9991.460	126.7	1087 1185	7	280.934	42.6
103813915	2	521.442	129.6	1088 2557	7	71.246	59.1
103914236	2	671.408	132.5	1089 4444	7	351.350	79.6
104014967	2	9991.460	134.8	1090 5745	7	151.429	90.8
104115815	2	9991.460	139.4	1091 7151	7	9991.460	102.6
104216560	2	9991.460	143.3	1092 8599	7	9991.460	114.6
104317309	2	9991.460	147.1	109310428	7	9991.460	128.7
104418458	2	261.420	154.4	109412671	7	9991.460	144.7
104519225	2	9991.460	156.7	109519640	7	9991.460	188.2
104620945	2	621.426	166.3	1096 1226	8	221.092	50.9
104723412	2	211.369	180.3	1097 1918	8	81.250	61.7
104830199	2	551.246	217.3	1098 2432	8	641.315	69.2
104942147	2	9991.460	251.0	1099 4008	8	391.421	89.6
1050 4228	3	311.261	62.8	1100 9619	8	9991.460	149.5

Figure A3:13-1 CALGARY: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1    22     1        3035    92     3
30 2    41     1        3036    94     3
30 3    52     1        3037    97     3
30 4    58     1        3038    99     3
30 5    63     1        3039   101     3
30 6    67     1        3040   104     3
30 7    71     1        3041   106     3
30 8    74     1        3042   108     3
30 9    78     1        3043   111     3
3010    81     1        3044   113     3
3011    85     1        3045   115     3
3012    89     1        3046   118     3
3013    93     1        3047   120     3
3014    98     1        3048   123     3
3015   102     1        3049   127     3
3016   107     1        3050   133     3
3017   113     1        3051   139     3
3018   119     1        3052   145     3
3019   126     1        3053   152     3
3020   141     1        3054   166     3
3021   207     1        3055   261     3
3022    65     2        3056    26     4
3023    88     2        3057    53     4
3024   103     2        3058    67     4
3025   123     2        3059    77     4
3026   174     2        3060    92     4
3027    39     3        3061   117     4
3028    58     3        3062   187     4
3029    65     3        3063    54     5
3030    70     3        3064    81     5
3031    75     3        3065    96     5
3032    81     3        3066   112     5
3033    86     3        3067   150     5
3034    90     3

0000 INCOME by TYPE     0000 ALPHA by TYPE      0000 ZONAL DATA
20 1 9636               21 1.1694               40 1 6085   62
20 212260               21 2.1425               40 2 7244   65
20 311753               21 3.1369               40 3 8654   75
20 413300               21 4.1215               40 4 8398   20
20 5 5464               21 5.2521               40 5 7867  116
20 6 7604               21 6.2257               40 613650   66
20 7 8102               21 7.1994
20 8 3874               21 8.3265
```

Figure A3:13-1(cont) CALGARY: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	2.6115	1.6919
	(23.5)	(5.02)
BATH	0.2223	na
	(1.90)	
TOILET	0.0179	0.0499
	(0.15)	(0.17)
SUBSIDIS	-.4871	-.1626
	(13.8)	(2.67)
LNLIVING	0.2778	0.3384
	(8.57)	(9.60)
LNINCOM	0.1402	0.2428
	(9.97)	(12.4)
TYPE	-.0708	-.0950
	(4.45)	(3.11)
LNDIST	-.0022	-.0015
	(0.26)	(0.18)
B5160	-.0611	-.0888
	(3.00)	(4.75)
B4650	-.2116	-.0990
	(6.76)	(3.32)
B2145	-.1466	-.1615
	(5.19)	(5.15)
BPRE20	-.2601	-.2428
	(8.79)	(6.42)
LGLVSIZE	0.1096	0.1095
	(6.88)	(5.08)
LGBDSIZE	0.0738	0.0192
	(9.14)	(1.85)
OPENSP	0.0359	0.0184
	(1.91)	(0.73)
HIGHDEN	0.0095	-.0760
	(0.61)	(1.87)
COMMERC	-.0296	na
	(1.68)	
NEIGHBD	0.0619	na
	(3.18)	
FINANCE	-.0590	-.0381
	(3.67)	(1.91)
AMRATE	na	0.0964
		(22.2)
R2	0.58	0.49
Observations	1270	1415

note: "t" statistics in brackets
: data source: CAL.REG02

Figure A3:14-1 CALGARY: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	323.5	109.3	1.606	1.282	0.4193
min	75.7	25.1	1.524	1.282	0.0635
max	1797.3	247.3	1.794	1.282	0.9932
TYPE 2					
mean	519.8	124.5	1.627	1.282	0.2901
min	103.4	18.4	1.517	1.282	0.0340
max	2754.8	609.9	1.877	1.282	0.9992
TYPE 3					
mean	750.7	148.5	1.657	1.282	0.2352
min	148.6	30.9	1.516	1.282	0.0485
max	2845.3	398.5	1.870	1.282	0.8720
TYPE 4					
mean	568.6	152.2	1.689	1.282	0.3267
min	98.0	53.5	1.524	1.282	0.0888
max	2175.4	442.8	1.859	1.282	0.9798
TYPE 5					
mean	730.7	153.9	1.679	1.282	0.2388
min	153.3	46.0	1.520	1.282	0.0824
max	1753.9	283.2	1.859	1.282	0.8173
TYPE 6					
mean	652.1	228.5	1.798	1.282	0.4058
min	140.5	46.8	1.541	1.282	0.0837
max	2638.3	1013.6	1.863	1.282	0.9544
TYPE 7					
mean	726.8	215.6	1.835	1.282	0.3462
min	138.5	37.6	1.568	1.282	0.0408
max	2071.2	643.1	1.904	1.282	0.9368
TYPE 8					
mean	1038.1	224.9	1.871	1.282	0.2288
min	314.5	37.9	1.589	1.282	0.0481
max	2974.9	812.2	1.925	1.282	0.7507
TYPE 9					
mean	882.7	237.6	1.867	1.282	0.2879
min	168.3	44.9	1.580	1.282	0.0337
max	2186.8	699.3	1.914	1.282	0.9721
TYPE 10					
mean	986.3	240.2	1.899	1.282	0.2583
min	192.1	28.5	1.609	1.282	0.0434
max	2819.9	985.0	1.945	1.282	0.9891

Figure A3:15-1 CALGARY : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3628	-.1776	0.2299	0.1113	0.0644	68.2	167.0	323.5	148
	(97.1)	(13.4)	(36.4)	(2.95)	(7.68)				
2	-.2591	-.1508	0.2201	0.1301	0.0711	76.4	308.4	519.8	363
	(123.)	(17.5)	(54.1)	(6.78)	(12.5)				
3	-.2050	-.1378	0.1548	0.1121	-.0769	89.6	469.7	750.7	317
	(228.)	(24.9)	(58.9)	(4.91)	(17.9)				
4	-.2847	-.1839	0.2204	0.0767	0.0346	89.9	324.8	568.6	248
	(150.)	(16.8)	(50.4)	(2.23)	(5.29)				
5	-.2161	-.1158	0.1546	0.2500	-.0874	91.5	450.0	730.7	194
	(225.)	(15.6)	(50.5)	(8.09)	(15.0)				
6	-.3637	-.1799	0.2176	0.0905	0.0132	126.9	330.4	652.1	249
	(231.)	(22.4)	(53.6)	(4.62)	(1.97)				
7	-.3080	-.1464	0.2116	0.1457	0.0076	117.4	398.8	726.8	151
	(154.)	(17.5)	(36.9)	(6.00)	(0.92)				
8	-.2197	-.1164	0.1344	0.2154	-.1326	120.0	634.3	1038.1	257
	(389.)	(41.8)	(59.8)	(24.0)	(29.1)				
9	-.2742	-.1244	0.2014	0.2345	0.0062	127.3	503.1	882.7	335
	(262.)	(21.2)	(60.3)	(14.5)	(1.25)				
10	-.2507	-.1243	0.1996	0.2067	0.0334	126.5	582.0	986.3	423
	(242.)	(26.3)	(62.8)	(14.7)	(7.37)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-1 CALGARY: Direct Translog-Expenditure Share
[all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4949	-.1900	0.3060	0.0887	0.1712	59.9	79.9	198.9	96
	(142.)	(14.1)	(28.1)	(2.81)	(12.5)				
2	-.3510	-.1450	0.3044	0.1754	0.1765	68.7	173.2	333.2	192
	(151.)	(13.1)	(40.3)	(7.01)	(16.1)				
3	-.2658	-.1301	0.2007	0.1774	-.0202	82.3	303.0	523.6	171
	(218.)	(15.2)	(37.6)	(5.90)	(2.39)				
4	-.3982	-.1567	0.2813	0.1702	0.1188	83.4	174.9	364.8	133
	(169.)	(8.76)	(34.4)	(4.00)	(10.1)				
5	-.2744	-.1117	0.1953	0.2654	-.0352	85.8	302.7	531.9	107
	(213.)	(12.2)	(31.4)	(8.20)	(3.41)				
6	-.4718	-.1985	0.2813	0.0759	0.1061	113.9	181.2	435.9	157
	(294.)	(20.0)	(37.0)	(3.52)	(9.16)				
7	-.3953	-.2245	0.2705	-.0008	0.0847	105.4	241.4	502.3	90
	(175.)	(13.8)	(31.0)	(0.02)	(6.78)				
8	-.2475	-.1256	0.1568	0.2053	-.1007	106.5	477.3	811.3	145
	(310.)	(31.1)	(31.8)	(18.0)	(11.4)				
9	-.2996	-.1406	0.2524	0.2051	0.0747	109.3	382.0	693.8	196
	(296.)	(17.8)	(52.3)	(10.3)	(11.2)				
10	-.2740	-.1085	0.2584	0.2593	0.1073	107.7	434.2	760.9	250
	(249.)	(18.6)	(49.1)	(15.2)	(14.7)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-1 CALGARY: Direct Translog-Expenditure Share
[below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2431	-.1120	0.1164	0.2238	-.2228	83.5	328.0	553.5	52
	(170.)	(20.7)	(19.1)	(8.59)	(11.2)				
2	-.1953	-.1199	0.1248	0.1300	-.1096	85.0	460.1	729.2	171
	(186.)	(28.1)	(23.1)	(6.08)	(4.48)				
3	-.1618	-.0870	0.0838	0.2732	-.3191	98.1	664.9	1016.6	146
	(267.)	(18.9)	(11.9)	(11.7)	(7.83)				
4	-.2069	-.1121	0.1115	0.2439	-.2412	97.4	498.2	804.3	115
	(251.)	(15.5)	(17.1)	(7.60)	(8.87)				
5	-.1699	-.0829	0.0866	0.3693	-.2999	98.5	631.1	975.2	87
	(230.)	(9.59)	(8.49)	(7.77)	(5.54)				
6	-.2717	-.1378	0.1900	0.1795	-.0058	149.1	585.2	1021.1	92
	(199.)	(17.6)	(29.0)	(6.71)	(0.39)				
7	-.2347	-.1032	0.1118	0.3022	-.2623	135.1	631.0	1058.1	61
	(199.)	(22.1)	(9.23)	(15.7)	(5.89)				
8	-.1950	-.1065	0.0866	0.2335	-.3268	137.3	837.6	1331.9	112
	(433.)	(49.5)	(20.1)	(28.6)	(16.9)				
9	-.2494	-.1150	0.1391	0.2402	-.1414	152.6	674.0	1149.0	139
	(341.)	(27.7)	(22.9)	(16.0)	(7.15)				
10	-.2261	-.1235	0.1188	0.1838	-.1820	153.7	795.5	1312.1	173
	(408.)	(49.6)	(27.2)	(21.0)	(12.0)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-1 CALGARY: Direct Translog-Expenditure Share
[above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.5435	-.1484	0.4101	0.1414	0.3060	50.9	55.5	153.2	52
	(126.)	(9.58)	(19.6)	(4.15)	(12.4)				
2	-.4777	-.1458	0.3631	0.2178	0.2641	62.3	89.7	216.1	81
	(133.)	(6.69)	(26.6)	(4.09)	(14.6)				
3	-.3726	-.1422	0.2662	0.1756	0.0704	78.9	175.8	353.9	69
	(181.)	(13.4)	(28.5)	(5.47)	(4.66)				
4	-.5213	-.1921	0.3644	0.0861	0.2284	81.5	100.5	264.7	68
	(170.)	(7.82)	(22.3)	(1.55)	(10.8)				
5	-.3495	-.1096	0.2447	0.2747	0.0248	87.1	211.9	415.9	47
	(159.)	(5.92)	(19.4)	(5.28)	(1.28)				
6	-.5264	-.1897	0.3284	0.1033	0.1852	99.9	125.6	339.3	80
	(225.)	(12.6)	(21.3)	(3.32)	(8.38)				
7	-.5208	-.2678	0.3005	-.0821	0.1388	99.2	135.7	354.3	41
	(166.)	(15.5)	(24.9)	(2.28)	(7.99)				
8	-.2692	-.1011	0.1766	0.3246	-.0625	97.7	384.0	674.3	67
	(203.)	(13.4)	(20.4)	(13.4)	(4.26)				
9	-.3661	-.1591	0.2866	0.1513	0.1222	101.3	264.3	526.9	73
	(161.)	(10.2)	(31.3)	(4.90)	(10.3)				
10	-.3078	-.0710	0.3204	0.3439	0.1840	98.2	335.0	615.0	109
	(175.)	(7.64)	(33.8)	(11.9)	(15.0)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-1 CALGARY: Direct Translog-Expenditure Share
[quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4534	-.1402	0.3187	0.1631	0.1640	70.5	108.6	252.9	44
	(145.)	(4.96)	(9.76)	(2.16)	(2.71)				
2	-.2867	-.1439	0.2348	0.1234	0.0483	73.4	234.2	418.7	111
	(208.)	(13.4)	(13.2)	(2.74)	(1.02)				
3	-.2187	-.1107	0.0883	0.2504	-.3334	84.6	389.0	638.4	102
	(232.)	(9.73)	(3.63)	(4.49)	(3.62)				
4	-.3113	-.1425	0.2064	0.2083	-.0235	85.5	252.8	469.5	65
	(194.)	(8.91)	(9.97)	(4.29)	(0.47)				
5	-.2314	-.1039	0.1686	0.2915	-.0738	84.9	373.8	622.8	60
	(184.)	(8.84)	(4.23)	(4.81)	(0.46)				
6	-.4313	-.1822	0.2595	0.0922	0.0485	128.6	238.9	536.3	77
	(309.)	(14.9)	(15.1)	(2.85)	(1.46)				
7	-.3243	-.1705	0.1448	0.1025	-.2168	110.6	329.8	626.1	49
	(231.)	(9.79)	(4.95)	(2.10)	(2.82)				
8	-.2317	-.1029	0.1901	0.3067	0.0906	114.1	557.5	928.9	78
	(479.)	(11.3)	(12.2)	(7.70)	(1.51)				
9	-.2699	-.1380	0.1591	0.2094	-.1351	114.1	451.9	792.8	123
	(744.)	(21.9)	(13.2)	(8.91)	(3.52)				
10	-.2519	-.1174	0.1942	0.2499	0.0142	115.1	510.9	873.7	141
	(581.)	(28.2)	(25.4)	(14.8)	(0.67)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-1 CALGARY: Direct Translog-Expenditure Share
[quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2916	-.0927	0.1910	0.3354	-.0640	76.9	230.8	417.7	36
	(159.)	(6.11)	(5.46)	(5.83)	(0.70)				
2	-.2111	-.0884	0.1640	0.3337	-.0524	77.4	369.6	600.6	101
	(262.)	(13.1)	(12.6)	(10.0)	(1.15)				
3	-.1783	-.0845	0.1297	0.2978	-.1756	92.3	558.1	870.2	95
	(241.)	(10.7)	(4.18)	(5.99)	(1.08)				
4	-.2216	-.1155	0.1245	0.2480	-.1949	86.3	405.3	666.8	71
	(196.)	(6.54)	(3.61)	(2.99)	(1.43)				
5	-.1860	-.0719	0.1257	0.4535	-.1200	92.8	530.2	836.1	47
	(171.)	(4.67)	(2.93)	(5.19)	(0.54)				
6	-.3041	-.0953	0.2574	0.3433	0.1454	137.2	449.7	825.6	60
	(199.)	(6.53)	(17.5)	(7.45)	(4.69)				
7	-.2349	-.0957	0.1146	0.3311	-.2520	110.3	511.6	858.4	39
	(133.)	(10.2)	(3.64)	(7.93)	(2.21)				
8	-.2051	-.0946	0.1465	0.3237	-.1100	127.6	726.8	1171.7	72
	(438.)	(20.4)	(8.67)	(13.3)	(1.51)				
9	-.2726	-.1550	0.1400	0.1153	-.2029	144.7	567.3	997.3	95
	(462.)	(23.1)	(9.61)	(4.65)	(4.53)				
10	-.2299	-.1074	0.1912	0.2588	0.0562	136.2	686.0	1137.7	117
	(375.)	(19.7)	(12.1)	(10.5)	(0.93)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-1 CALGARY: Direct Translog-Expenditure Share
[quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1873	-.1123	0.1009	0.1616	-.2343	98.2	546.6	858.8	16
	(95.5)	(6.98)	(7.62)	(1.54)	(3.47)				
2	-.1763	-.0998	0.1131	0.2272	-.0507	95.9	590.6	914.9	70
	(139.)	(20.0)	(20.5)	(9.05)	(2.26)				
3	-.1415	-.0766	0.0901	0.3228	-.1707	108.9	863.9	1289.2	51
	(187.)	(9.71)	(7.29)	(6.99)	(1.80)				
4	-.1905	-.0997	0.0950	0.2899	-.3023	115.2	648.1	1026.1	44
	(154.)	(9.07)	(8.77)	(6.22)	(5.36)				
5	-.1546	-.0877	0.0243	0.3027	-.6961	105.1	749.6	1138.7	40
	(129.)	(6.89)	(0.93)	(3.88)	(3.97)				
6	-.2247	-.1057	0.1187	0.2673	-.2171	171.4	839.3	1387.7	32
	(208.)	(20.5)	(12.1)	(14.6)	(7.18)				
7	-.2359	-.1252	0.1289	0.2266	-.2131	178.9	842.6	1412.2	22
	(223.)	(19.8)	(7.24)	(9.05)	(2.99)				
8	-.1817	-.1003	0.0830	0.2362	-.2880	154.9	1037.1	1620.3	40
	(250.)	(32.4)	(13.6)	(17.4)	(11.5)				
9	-.2142	-.0910	0.1051	0.3125	-.2536	169.8	904.3	1476.6	44
	(168.)	(18.4)	(6.91)	(15.6)	(3.83)				
10	-.2205	-.1216	0.0989	0.1836	-.2353	190.3	1024.3	1676.3	56
	(260.)	(27.6)	(12.4)	(10.8)	(8.42)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-1 CALGARY: Direct Translog-Expenditure Share
[quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.7841	0.7802	0.8216	-1.0199	-1.5197	-0.7935
Q02	0.6849	0.7051	0.7061	-1.0326	-1.2603	-0.8745
Q03	0.5299	0.5713	0.5732	-1.0214	-1.2301	-0.8576
Q04	0.3751	0.3545	0.3530	-1.0086	-1.3834	-0.6165
TYPE 2						
Q01	0.7482	0.7654	0.8286	-0.9921	-1.6264	-0.6545
Q02	0.4908	0.4878	0.4873	-1.0494	-1.2264	-0.8828
Q03	0.4171	0.4445	0.4457	-1.0166	-1.1313	-0.9156
Q04	0.3198	0.3554	0.3562	-0.9899	-1.1549	-0.6999
TYPE 3						
Q01	0.6109	0.6197	0.6209	-1.0407	-1.7383	-0.7452
Q02	0.4414	0.4351	0.4347	-0.9955	-1.1268	-0.8899
Q03	0.3701	0.3701	0.3702	-1.0272	-1.1437	-0.9185
Q04	0.2910	0.3144	0.3270	-0.9934	-1.2275	-0.6944
TYPE 4						
Q01	0.7631	0.7736	0.7816	-1.0069	-1.5586	-0.7469
Q02	0.5500	0.5698	0.5680	-0.9983	-1.1577	-0.8842
Q03	0.4357	0.4440	0.4443	-0.9909	-1.1098	-0.8908
Q04	0.4043	0.4041	0.4039	-0.9972	-1.2903	-0.6052
TYPE 5						
Q01	0.6129	0.6283	0.6273	-1.0352	-1.4776	-0.8487
Q02	0.4570	0.4657	0.4731	-1.0156	-1.1534	-0.8704
Q03	0.4098	0.4644	0.4669	-0.9890	-1.0692	-0.9041
Q04	0.4171	0.3426	0.3418	-0.9934	-1.0924	-0.8537
TYPE 6						
Q01	0.7772	0.7781	0.8091	-0.9837	-1.4668	-0.7469
Q02	0.6662	0.6704	0.6732	-1.0209	-1.2594	-0.8642
Q03	0.5278	0.6102	0.5947	-1.0164	-1.1580	-0.8965
Q04	0.4362	0.4448	0.4487	-1.0017	-1.3276	-0.6788
TYPE 7						
Q01	0.7235	0.7247	0.7271	-1.0088	-2.1462	-0.6474
Q02	0.5616	0.5498	0.5444	-1.0121	-1.1805	-0.8624
Q03	0.4774	0.4860	0.4909	-0.9975	-1.2214	-0.8527
Q04	0.4602	0.4619	0.4634	-0.9994	-1.3548	-0.7007
TYPE 8						
Q01	0.5222	0.5344	0.5478	-1.0021	-1.4312	-0.8470
Q02	0.4525	0.4721	0.4849	-0.9975	-1.1135	-0.9124
Q03	0.4217	0.4340	0.4430	-1.0090	-1.1468	-0.8924
Q04	0.3666	0.3657	0.3651	-0.9827	-1.2046	-0.6912
TYPE 9						
Q01	0.6046	0.6118	0.6183	-1.0367	-1.5747	-0.7775
Q02	0.5068	0.5110	0.5121	-1.0014	-1.1044	-0.9170
Q03	0.4885	0.4803	0.4780	-1.0120	-1.1199	-0.8976
Q04	0.4299	0.4356	0.4433	-0.9994	-1.3697	-0.6912
TYPE 10						
Q01	0.5588	0.5758	0.5705	-1.1097	-1.4433	-0.9815
Q02	0.4732	0.4894	0.4876	-1.0126	-1.0850	-0.9560
Q03	0.4295	0.4462	0.4588	-1.0173	-1.1669	-0.8817
Q04	0.4146	0.4153	0.4159	-0.9960	-1.3239	-0.6883

Figure A3:23-1 CALGARY : Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	270.50	215.03	176.86	134.04	123.38	120.20	61.44
BM1=BM2=0	238.47	153.32	130.39	81.90	19.27	88.53	51.70
statistic	64.06	123.41	92.95	104.29	208.21	63.34	19.48
TYPE 2							
normal	683.13	409.37	506.19	183.08	320.04	353.80	226.57
BM1=BM2=0	579.04	262.37	388.90	98.20	308.11	279.09	143.42
statistic	208.17	294.00	234.58	169.76	23.85	149.42	166.28
TYPE 3							
normal	882.68	482.51	538.20	200.25	350.93	347.32	199.96
BM1=BM2=0	777.78	456.00	474.18	182.60	313.90	312.72	171.70
statistic	209.81	53.04	128.05	35.30	74.05	69.19	56.52
TYPE 4							
normal	550.57	314.90	399.19	171.02	206.85	239.29	163.05
BM1=BM2=0	534.57	265.76	356.27	122.06	185.04	218.10	145.62
statistic	32.00	98.29	85.84	97.91	43.62	42.38	34.85
TYPE 5							
normal	585.53	325.30	325.33	139.94	206.41	174.75	154.39
BM1=BM2=0	510.74	294.59	285.33	127.75	190.76	153.75	139.83
statistic	149.57	61.42	80.01	24.38	31.30	41.99	29.12
TYPE 6							
normal	609.37	418.75	279.35	210.50	248.45	194.29	125.01
BM1=BM2=0	597.70	376.67	246.66	177.42	243.52	170.10	90.83
statistic	23.32	84.15	65.38	66.17	9.86	48.37	68.37
TYPE 7							
normal	359.86	239.04	214.04	113.26	165.70	131.87	91.76
BM1=BM2=0	341.36	214.07	156.77	87.03	150.26	96.47	71.31
statistic	37.00	49.93	114.55	52.46	30.86	70.80	40.90
TYPE 8							
normal	873.27	482.41	471.58	217.90	328.80	313.59	169.51
BM1=BM2=0	640.22	372.46	324.57	155.48	241.65	244.83	103.27
statistic	466.10	219.90	294.03	124.84	174.30	137.52	132.48
TYPE 9							
normal	906.98	581.02	481.67	201.12	526.74	373.49	156.21
BM1=BM2=0	811.29	486.26	343.14	154.21	448.88	299.76	103.55
statistic	191.37	189.51	277.07	93.81	155.73	147.45	105.32
TYPE10							
normal	1072.33	685.29	638.66	298.00	574.39	437.10	220.40
BM1=BM2=0	970.50	537.49	458.90	199.87	441.16	326.75	142.12
statistic	203.65	295.61	359.51	196.25	266.45	220.68	156.57

Figure A3:24-1 CALGARY: Log Likelihood Values
[test of unity income elasticity]

0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1163	1	-511	0	1051	7193	7	4905	1084
10	2	1834	1	123	7	1052	8346	7	5597	1319
10	3	2359	1	-25	79	1053	9596	7	6990	1758
10	4	3239	1	608	137	105412069		711422		3591
10	5	5812	1	3685	930	105517786		718930		7889
10	6	1063	2	-139	27	1056	6383	8	3514	747
10	7	1977	2	946	202	1057	8747	8	5645	1272
10	8	2871	2	1755	319	1058	9556	8	7396	1652
10	9	3820	2	2850	543	105910547		8	8144	1847
1010		4501	2	3799	766	106011397		8	9629	2298
1011		5032	2	4545	971	106112072		810363		2660
1012		5667	2	4995	1104	106212827		810209		2402
1013		6428	2	5944	1394	106313816		811690		2840
1014		7211	2	7060	1768	106415093		813810		3682
1015		7987	2	8083	2135	106516328		814741		4004
1016		9253	2	9707	2785	106621560		822538		7936
101712611			216461		6623	1067	2678	9	-340	92
1018		2809	3	630	186	1068	5620	9	2483	455
1019		4928	3	3085	634	1069	7283	9	3873	807
1020		6572	3	4889	999	1070	8339	9	5051	1124
1021		7421	3	5984	1211	1071	8893	9	5905	1380
1022		8199	3	6713	1403	1072	9579	9	6419	1549
1023		9039	3	7935	1774	1073	9931	9	6541	1639
1024		9850	3	8904	2004	107410392		9	7317	1863
102510978			310339		2422	107510973		9	8256	2206
102612480			312494		3216	107611536		9	8811	2422
102716906			318981		5926	107712330		9	9751	2809
1028		1740	4	40	87	107813154		910803		3313
1029		3266	4	1430	293	107914808		914706		5321
1030		4109	4	2163	404	108022594		92939		14604
1031		5249	4	3068	595	1081	3645	10	-277	194
1032		6188	4	4258	898	1082	6805	10	2939	619
1033		7145	4	4829	1061	1083	7669	10	4325	940
1034		8424	4	6245	1492	1084	8393	10	4958	1158
1035		9672	4	8621	2363	1085	9119	10	5614	1281
103613933			415679		6162	1086	9760	10	6042	1457
1037		4202	5	1615	394	108710133		10	6669	1535
1038		6254	5	3974	802	108810511		10	6996	1713
1039		7084	5	4506	1022	108910825		10	7657	1859
1040		8137	5	5896	1286	109011138		10	7676	1814
1041		9557	5	7665	1726	109111618		10	8370	2044
104211266			5	9766	2258	109212124		10	8574	2129
104314198			513912		4069	109312706		10	9286	2128
1044		3301	6	-121	44	109413405		1010627		2712
1045		4584	6	181	83	109514060		1010887		2858
1046		5979	6	998	207	109614915		1012911		3533
1047		8189	6	3456	802	109715857		1013372		3465
104812924			6	9402	2769	109816727		1013910		3982
1049		2969	7	515	113	109919245		1017157		5542
1050		5618	7	3251	666	11	025420	103036		14034

Figure A3:25-1 CALGARY: Demand Calibration Data

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0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1153.2252.9417.7858.8          |  20 6339.3536.3825.61388.
20 2216.1418.7600.6914.9          |  20 7354.3626.1858.41412.
20 3353.9638.4870.21289.          |  20 8674.3928.91172.1620.
20 4264.7469.5666.81026.          |  20 9526.9792.8997.31477.
20 5415.9622.8836.11139.          |  2010615.0873.71138.1676.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.543-.148.4101.1414.306050.9255.53153.21.613
21 2    0-.478-.146.3631.2178.264162.2589.71216.11.629
21 3    0-.373-.142.2662.1756.070478.86175.8353.91.631
21 4    0-.521-.192.3644.0861.228481.46100.5264.71.667
21 5    0-.350-.110.2447.2747.024887.06211.9415.91.659
21 6    0-.526-.190.3284.1033.185299.86125.6339.31.780
21 7    0-.521-.268.3005-.082.138899.23135.7354.31.827
21 8    0-.269-.101.1766.3246-.06397.66384.0674.31.857
21 9    0-.366-.159.2866.1513.1222101.3264.3526.91.862
2110    0-.308-.071.3204.3439.184098.16335.0615.01.892
0000  (quartile 02)
22 1    0-.453-.140.3187.1631.164070.53108.6252.91.612
22 2    0-.287-.144.2348.1234.048373.42234.2418.71.613
22 3    0-.219-.111.0883.2504-.33384.60389.0638.41.651
22 4    0-.311-.142.2064.2083-.02385.54252.8469.51.694
22 5    0-.231-.104.1686.2915-.07484.88373.8622.81.691
22 6    0-.431-.182.2595.0922.0485128.6238.9536.31.795
22 7    0-.324-.170.1448.1025-.217110.6329.8626.11.840
22 8    0-.232-.103.1901.3067.0906114.1557.5928.91.879
22 9    0-.270-.138.1591.2094-.135114.1451.9792.81.871
2210    0-.252-.117.1942.2499.0142115.1510.9873.71.899
0000  (quartile 03)
23 1    0-.292-.093.1910.3354-.06476.90230.8417.71.587
23 2    0-.211-.088.1640.3337-.05277.42369.6600.61.634
23 3    0-.178-.084.1297.2978-.17692.30558.1870.21.677
23 4    0-.222-.116.1245.2480-.19586.29405.3666.81.704
23 5    0-.186-.072.1257.4535-.12092.84530.2836.11.680
23 6    0-.304-.095.2574.3433.1454137.2449.7825.61.815
23 7    0-.235-.096.1146.3311-.252110.3511.6858.41.831
23 8    0-.205-.095.1465.3237-.110127.6726.81172.1.878
23 9    0-.273-.155.1400.1153-.203144.7567.3997.31.868
2310    0-.230-.107.1912.2588.0562136.2686.01138.1.900
0000  (quartile 04)
24 1    0-.187-.112.1009.1616-.23498.20546.6858.81.609
24 2    0-.176-.100.1131.2272-.05195.92590.6914.91.636
24 3    0-.141-.077.0901.3228-.171108.9863.91289.1.665
24 4    0-.191-.100.0950.2899-.302115.2648.11026.1.691
24 5    0-.155-.088.0243.3027-.696105.1749.61139.1.684
24 6    0-.225-.106.1187.2673-.217171.4839.31388.1.818
24 7    0-.236-.125.1289.2266-.213178.9842.61412.1.847
24 8    0-.182-.100.0830.2362-.288154.91037.1620.1.869
24 9    0-.214-.091.1051.3125-.254169.8904.31477.1.866
2410    0-.221-.122.0989.1836-.235190.31024.1676.1.909
```

Figure A3:25-1(cont) CALGARY: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1   40     1     1  | 3035   31     4     1  | 3069   93     3     2
30 2   57     1     1  | 3036   57     4     1  | 3070   99     3     2
30 3   64     1     1  | 3037   73     4     1  | 3071  102     3     2
30 4   70     1     1  | 3038   88     4     1  | 3072  104     3     2
30 5   76     1     1  | 3039   98     4     1  | 3073  107     3     2
30 6   82     1     1  | 3040  107     4     1  | 3074  109     3     2
30 7   87     1     1  | 3041  117     4     1  | 3075  111     3     2
30 8   93     1     1  | 3042  136     4     1  | 3076  114     3     2
30 9   97     1     1  | 3043   98     5     1  | 3077  116     3     2
3010  101     1     1  | 3044   39     1     2  | 3078  118     3     2
3011  105     1     1  | 3045   54     1     2  | 3079  121     3     2
3012  109     1     1  | 3046   63     1     2  | 3080  123     3     2
3013  114     1     1  | 3047   68     1     2  | 3081  126     3     2
3014  119     1     1  | 3048   74     1     2  | 3082  128     3     2
3015  125     1     1  | 3049   79     1     2  | 3083  131     3     2
3016  131     1     1  | 3050   83     1     2  | 3084  133     3     2
3017  148     1     1  | 3051   87     1     2  | 3085  136     3     2
3018   85     2     1  | 3052   90     1     2  | 3086  139     3     2
3019  123     2     1  | 3053   94     1     2  | 3087  141     3     2
3020   50     3     1  | 3054   97     1     2  | 3088  144     3     2
3021   66     3     1  | 3055  101     1     2  | 3089  149     3     2
3022   76     3     1  | 3056  106     1     2  | 3090  155     3     2
3023   83     3     1  | 3057  111     1     2  | 3091  161     3     2
3024   89     3     1  | 3058  115     1     2  | 3092  171     3     2
3025   93     3     1  | 3059  122     1     2  | 3093  186     3     2
3026   96     3     1  | 3060  132     1     2  | 3094  211     3     2
3027  100     3     1  | 3061  166     1     2  | 3095  263     3     2
3028  104     3     1  | 3062   71     2     2  | 3096   82     4     2
3029  108     3     1  | 3063   88     2     2  | 3097  161     4     2
3030  112     3     1  | 3064  103     2     2  | 3098   76     5     2
3031  117     3     1  | 3065  149     2     2  | 3099  112     5     2
3032  122     3     1  | 3066   58     3     2  | 31 0  172     5     2
3033  129     3     1  | 3067   79     3     2
3034  151     3     1  | 3068   86     3     2

0000 ZONAL Data
40 1 6085   62         | 40 2 7244   65         | 40 3 8654   75
40 4 8398   20         | 40 5 7867  116         | 40 613650   66
0000  Parameters
5011 .45               | 50121.20               | 5013 0.0
5016 .45               | 50171.42               | 5018 0.0
50201.282              |

0000 Calibration Data
70 11.5950.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   89201.000 94.2
70 21.4270.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  142881.000103.1
70 31.6020.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  115181.000120.2
70 41.6670.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   78081.000 94.9
70 51.6660.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   95301.000114.2
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0      00.0    0.0
```

Figure A3:25-1(cont) CALGARY: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1163	1	-511	0	1051	7193	7	4905	1084
10	2	1834	1	123	7	1052	8346	7	5597	1319
10	3	2359	1	-25	79	1053	9596	7	6990	1758
10	4	3239	1	608	137	105412069		711422		3591
10	5	5812	1	3685	930	105517786		718930		7889
10	6	1063	2	-139	27	1056	6383	8	3514	747
10	7	1977	2	946	202	1057	8747	8	5645	1272
10	8	2871	2	1755	319	1058	9556	8	7396	1652
10	9	3820	2	2850	543	105910547		8	8144	1847
1010		4501	2	3799	766	106011397		8	9629	2298
1011		5032	2	4545	971	106112072		810363		2660
1012		5667	2	4995	1104	106212827		810209		2402
1013		6428	2	5944	1394	106313816		811690		2840
1014		7211	2	7060	1768	106415093		813810		3682
1015		7987	2	8083	2135	106516328		814741		4004
1016		9253	2	9707	2785	106621560		822538		7936
101712611			216461		6623	1067	2678	9	-340	92
1018		2809	3	630	186	1068	5620	9	2483	455
1019		4928	3	3085	634	1069	7283	9	3873	807
1020		6572	3	4889	999	1070	8339	9	5051	1124
1021		7421	3	5984	1211	1071	8893	9	5905	1380
1022		8199	3	6713	1403	1072	9579	9	6419	1549
1023		9039	3	7935	1774	1073	9931	9	6541	1639
1024		9850	3	8904	2004	107410392		9	7317	1863
102510978			310339		2422	107510973		9	8256	2206
102612480			312494		3216	107611536		9	8811	2422
102716906			318981		5926	107712330		9	9751	2809
1028		1740	4	40	87	107813154		910803		3313
1029		3266	4	1430	293	107914808		914706		5321
1030		4109	4	2163	404	108022594		92939814604		
1031		5249	4	3068	595	1081	3645	10	-277	194
1032		6188	4	4258	898	1082	6805	10	2939	619
1033		7145	4	4829	1061	1083	7669	10	4325	940
1034		8424	4	6245	1492	1084	8393	10	4958	1158
1035		9672	4	8621	2363	1085	9119	10	5614	1281
103613933			415679		6162	1086	9760	10	6042	1457
1037		4202	5	1615	394	108710133		10	6669	1535
1038		6254	5	3974	802	108810511		10	6996	1713
1039		7084	5	4506	1022	108910825		10	7657	1859
1040		8137	5	5896	1286	109011138		10	7676	1814
1041		9557	5	7665	1726	109111618		10	8370	2044
104211266			5	9766	2258	109212124		10	8574	2129
104314198			513912		4069	109312706		10	9286	2128
1044		3301	6	-121	44	109413405		1010627		2712
1045		4584	6	181	83	109514060		1010887		2858
1046		5979	6	998	207	109614915		1012911		3533
1047		8189	6	3456	802	109715857		1013372		3465
104812924			6	9402	2769	109816727		1013910		3982
1049		2969	7	515	113	109919245		1017157		5542
1050		5618	7	3251	666	11	025420	103036614034		

Figure A3:26-1 CALGARY: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1153.2252.9417.7858.8          | 20 6339.3536.3825.61388.
20 2216.1418.7600.6914.9          | 20 7354.3626.1858.41412.
20 3353.9638.4870.21289.          | 20 8674.3928.91172.1620.
20 4264.7469.5666.81026.          | 20 9526.9792.8997.31477.
20 5415.9622.8836.11139.          | 2010615.0873.71138.1676.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.543-.148.4101.1414.306050.9255.53153.21.613
21 2    0-.478-.146.3631.2178.264162.2589.71216.11.629
21 3    0-.373-.142.2662.1756.070478.86175.8353.91.631
21 4    0-.521-.192.3644.0861.228481.46100.5264.71.667
21 5    0-.350-.110.2447.2747.024887.06211.9415.91.659
21 6    0-.526-.190.3284.1033.185299.86125.6339.31.780
21 7    0-.521-.268.3005-.082.138899.23135.7354.31.827
21 8    0-.269-.101.1766.3246-.06397.66384.0674.31.857
21 9    0-.366-.159.2866.1513.1222101.3264.3526.91.862
2110    0-.308-.071.3204.3439.184098.16335.0615.01.892
0000  (quartile 02)
22 1    0-.453-.140.3187.1631.164070.53108.6252.91.612
22 2    0-.287-.144.2348.1234.048373.42234.2418.71.613
22 3    0-.219-.111.0883.2504-.33384.60389.0638.41.651
22 4    0-.311-.142.2064.2083-.02385.54252.8469.51.694
22 5    0-.231-.104.1686.2915-.07484.88373.8622.81.691
22 6    0-.431-.182.2595.0922.0485128.6238.9536.31.795
22 7    0-.324-.170.1448.1025-.217110.6329.8626.11.840
22 8    0-.232-.103.1901.3067.0906114.1557.5928.91.879
22 9    0-.270-.138.1591.2094-.135114.1451.9792.81.871
2210    0-.252-.117.1942.2499.0142115.1510.9873.71.899
0000  (quartile 03)
23 1    0-.292-.093.1910.3354-.06476.90230.8417.71.587
23 2    0-.211-.088.1640.3337-.05277.42369.6600.61.634
23 3    0-.178-.084.1297.2978-.17692.30558.1870.21.677
23 4    0-.222-.116.1245.2480-.19586.29405.3666.81.704
23 5    0-.186-.072.1257.4535-.12092.84530.2836.11.680
23 6    0-.304-.095.2574.3433.1454137.2449.7825.61.815
23 7    0-.235-.096.1146.3311-.252110.3511.6858.41.831
23 8    0-.205-.095.1465.3237-.110127.6726.81172.1.878
23 9    0-.273-.155.1400.1153-.203144.7567.3997.31.868
2310    0-.230-.107.1912.2588.0562136.2686.01138.1.900
0000  (quartile 04)
24 1    0-.187-.112.1009.1616-.23498.20546.6858.81.609
24 2    0-.176-.100.1131.2272-.05195.92590.6914.91.636
24 3    0-.141-.077.0901.3228-.171108.9863.91289.1.665
24 4    0-.191-.100.0950.2899-.302115.2648.11026.1.691
24 5    0-.155-.088.0243.3027-.696105.1749.61139.1.684
24 6    0-.225-.106.1187.2673-.217171.4839.31388.1.818
24 7    0-.236-.125.1289.2266-.213178.9842.61412.1.847
24 8    0-.182-.100.0830.2362-.288154.91037.1620.1.869
24 9    0-.214-.091.1051.3125-.254169.8904.31477.1.866
2410    0-.221-.122.0989.1836-.235190.31024.1676.1.909
```

Figure A3:26-1(cont) CALGARY: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1    28     1     1  | 3024   135     4     1  | 3047    99     3     2
30 2    52     1     1  | 3025   101     5     1  | 3048   102     3     2
30 3    65     1     1  | 3026    52     1     2  | 3049   104     3     2
30 4    74     1     1  | 3027    73     1     2  | 3050   106     3     2
30 5    81     1     1  | 3028    79     1     2  | 3051   109     3     2
30 6    88     1     1  | 3029    86     1     2  | 3052   111     3     2
30 7    97     1     1  | 3030    93     1     2  | 3053   113     3     2
30 8   106     1     1  | 3031   100     1     2  | 3054   115     3     2
30 9   118     1     1  | 3032   106     1     2  | 3055   119     3     2
3010   152     1     1  | 3033   113     1     2  | 3056   124     3     2
3011   112     2     1  | 3034   119     1     2  | 3057   130     3     2
3012    59     3     1  | 3035   128     1     2  | 3058   135     3     2
3013    82     3     1  | 3036   162     1     2  | 3059   143     3     2
3014    94     3     1  | 3037    86     2     2  | 3060   176     3     2
3015   106     3     1  | 3038   104     2     2  | 3061    51     4     2
3016   117     3     1  | 3039   121     2     2  | 3062    77     4     2
3017   130     3     1  | 3040   165     2     2  | 3063   115     4     2
3018   143     3     1  | 3041    57     3     2  | 3064    68     5     2
3019   175     3     1  | 3042    74     3     2  | 3065    94     5     2
3020    31     4     1  | 3043    84     3     2  | 3066   110     5     2
3021    63     4     1  | 3044    92     3     2  | 3067   138     5     2
3022    82     4     1  | 3045    95     3     2
3023    97     4     1  | 3046    97     3     2  |

0000 ZONAL Data
40 1 6085   62          | 40 2 7244   65          | 40 3 8654   75
40 4 8398   20          | 40 5 7867  116          | 40 613650   66
0000  Parameters
50 1 .2                 | 50 2 .1                 |
5011 .45                | 50121.20                | 5013 37.
5016 .45                | 50171.42                | 5018 39.
50201.282               |                         |

0000 Calibration Data
70 11.5900.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   79241.000104.8
70 21.4770.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  146261.000115.0
70 31.5920.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   99691.000109.3
70 41.5400.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   71750.997100.2
70 51.7170.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   88060.565107.4
70 61.7390.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   98351.000120.8
70 71.6740.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   84091.000111.5
70 81.4870.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  144390.873133.3
70 91.6030.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  109960.928128.0
70101.4990.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   82390.670117.7
70111.7800.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   88050.504109.2
70122.3070.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  125061.000 99.5
```

Figure A3:26-1(cont) CALGARY: Supply Calibration Data

0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data

10	1	1163	1	-510	0	21.448 38.0
10	2	1834	1	123	7	31.571 53.4
10	3	2359	1	-24	79	51.547 65.1
10	4	3239	1	608	137	9991.815 61.1
10	5	5812	1	3685	930	9991.815 67.2
10	6	1063	2	-138	27	201.615 26.4
10	7	1977	2	946	202	211.566 51.3
10	8	2871	2	1755	319	221.599 68.9
10	9	3820	2	2850	543	9991.815 62.6
1010		4501	2	3799	766	9991.815 63.1
1011		5032	2	4545	971	9991.815 61.3
1012		5667	2	4995	1104	9991.815 63.7
1013		6428	2	5944	1394	61.645 76.9
1014		7211	2	7060	1768	9991.815 64.3
1015		7987	2	8083	2135	9991.815 68.7
1016		9253	2	9707	2785	9991.815 74.9
101	712611		216461		6623	171.638112.7
1018		2809	3	630	186	41.537 58.7
1019		4928	3	3085	634	9991.815 72.7
1020		6572	3	4889	999	9991.815 75.5
1021		7421	3	5984	1211	141.675 83.8
1022		8199	3	6713	1403	9991.815 73.9
1023		9039	3	7935	1774	9991.815 76.9
1024		9850	3	8904	2004	9991.815 79.1
102	510978		310339		2422	91.625100.3
102	612480		312494		3216	111.684100.1
102	716906		318981		5926	101.606127.5
1028		1740	4	40	87	121.587 48.6
1029		3266	4	1430	293	231.655 84.7
1030		4109	4	2163	404	9991.815 79.9
1031		5249	4	3068	595	251.682 89.7
1032		6188	4	4258	898	9991.815 78.6
1033		7145	4	4829	1061	71.711 88.0
1034		8424	4	6245	1492	151.672 93.2
1035		9672	4	8621	2363	241.595111.4
103	613933		415679		6162	191.598145.1
1037		4202	5	1615	394	131.673 72.8
1038		6254	5	3974	802	9991.815 78.7
1039		7084	5	4506	1022	9991.815 76.9
1040		8137	5	5896	1286	9991.815 77.4
1041		9557	5	7665	1726	81.669 93.3
104	211266		5	9766	2258	161.650101.4
104	314198		513912		4069	181.603119.2
1044		3301	6	-120	44	271.760 82.6
1045		4584	6	181	83	9992.057 87.5
1046		5979	6	998	207	9992.057101.2
1047		8189	6	3456	802	9992.057112.5
104	812924		6	9402	2769	9992.057128.6
1049		2969	7	515	113	641.744 75.4
1050		5618	7	3251	666	9992.057 94.1

Figure A3:27-1 CALGARY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
1051 7193     7 4905 1084        9992.057 93.3
1052 8346     7 5597 1319        9992.057 93.1
1053 9596     7 6990 1758        9992.057 91.9
105412069     711422 3591        9992.057105.2
105517786     718930 7889         401.829192.7
1056 6383     8 3514  747         421.774 83.2
1057 8747     8 5645 1272         431.877100.8
1058 9556     8 7396 1652         371.896104.3
105910547     8 8144 1847        9992.057 95.2
106011397     8 9629 2298         451.892114.6
106112072     810363 2660         481.866121.1
106212827     810209 2402         321.860125.3
106313816     811690 2840         381.891125.5
106415093     813810 3682         521.884133.4
106516328     814741 4004         551.872142.0
106621560     822538 7936         361.807185.7
1067 2678     9 -339   92         261.644 53.3
1068 5620     9 2483  455         621.866 91.7
1069 7283     9 3873  807        9992.057 93.4
1070 8339     9 5051 1124        9992.057 96.5
1071 8893     9 5905 1380        9992.057 97.1
1072 9579     9 6419 1549        9992.057 97.6
1073 9931     9 6541 1639         311.872119.4
107410392     9 7317 1863         501.865126.0
107510973     9 8256 2206         331.860134.0
107611536     9 8811 2422         541.883138.3
107712330     9 9751 2809         391.885145.8
107813154     910803 3313         351.870152.7
107914808     914706 5321         571.893157.4
108022594     92939814604        9992.057181.7
1081 3645    10 -276  194         411.679 59.5
1082 6805    10 2939  619         281.872 93.8
1083 7669    10 4325  940         291.884102.9
1084 8393    10 4958 1158         651.856110.5
1085 9119    10 5614 1281         301.889111.5
1086 9760    10 6042 1457         441.913112.0
108710133    10 6669 1535         461.886116.1
108810511    10 6996 1713         471.881118.1
108910825    10 7657 1859         661.826126.7
109011138    10 7676 1814         491.875123.6
109111618    10 8370 2044         511.863128.6
109212124    10 8574 2129         631.847134.3
109312706    10 9286 2128         531.878134.5
109413405    1010627 2712         341.865140.6
109514060    1010887 2858         561.864146.3
109614915    1012911 3533         671.830159.3
109715857    1013372 3465         581.880160.8
109816727    1013910 3982         591.875169.7
109919245    1017157 5542         601.823202.0
11 025420    103036614034        9992.057215.0
```

Figure A3:27-1 CALGARY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1153.2252.9417.7858.8          | 20 6339.3536.3825.61388.
20 2216.1418.7600.6914.9          | 20 7354.3626.1858.41412.
20 3353.9638.4870.21289.          | 20 8674.3928.91172.1620.
20 4264.7469.5666.81026.          | 20 9526.9792.8997.31477.
20 5415.9622.8836.11139.          | 2010615.0873.71138.1676.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.543-.148.4101.1414.306050.9255.53153.21.613
21 2    0-.478-.146.3631.2178.264162.2589.71216.11.629
21 3    0-.373-.142.2662.1756.070478.86175.8353.91.631
21 4    0-.521-.192.3644.0861.228481.46100.5264.71.667
21 5    0-.350-.110.2447.2747.024887.06211.9415.91.659
21 6    0-.526-.190.3284.1033.185299.86125.6339.31.780
21 7    0-.521-.268.3005-.082.138899.23135.7354.31.827
21 8    0-.269-.101.1766.3246-.06397.66384.0674.31.857
21 9    0-.366-.159.2866.1513.1222101.3264.3526.91.862
2110    0-.308-.071.3204.3439.184098.16335.0615.01.892
0000  (quartile 02)
22 1    0-.453-.140.3187.1631.164070.53108.6252.91.612
22 2    0-.287-.144.2348.1234.048373.42234.2418.71.613
22 3    0-.219-.111.0883.2504-.33384.60389.0638.41.651
22 4    0-.311-.142.2064.2083-.02385.54252.8469.51.694
22 5    0-.231-.104.1686.2915-.07484.88373.8622.81.691
22 6    0-.431-.182.2595.0922.0485128.6238.9536.31.795
22 7    0-.324-.170.1448.1025-.217110.6329.8626.11.840
22 8    0-.232-.103.1901.3067.0906114.1557.5928.91.879
22 9    0-.270-.138.1591.2094-.135114.1451.9792.81.871
2210    0-.252-.117.1942.2499.0142115.1510.9873.71.899
0000  (quartile 03)
23 1    0-.292-.093.1910.3354-.06476.90230.8417.71.587
23 2    0-.211-.088.1640.3337-.05277.42369.6600.61.634
23 3    0-.178-.084.1297.2978-.17692.30558.1870.21.677
23 4    0-.222-.116.1245.2480-.19586.29405.3666.81.704
23 5    0-.186-.072.1257.4535-.12092.84530.2836.11.680
23 6    0-.304-.095.2574.3433.1454137.2449.7825.61.815
23 7    0-.235-.096.1146.3311-.252110.3511.6858.41.831
23 8    0-.205-.095.1465.3237-.110127.6726.81172.1.878
23 9    0-.273-.155.1400.1153-.203144.7567.3997.31.868
2310    0-.230-.107.1912.2588.0562136.2686.01138.1.900
0000  (quartile 04)
24 1    0-.187-.112.1009.1616-.23498.20546.6858.81.609
24 2    0-.176-.100.1131.2272-.05195.92590.6914.91.636
24 3    0-.141-.077.0901.3228-.171108.9863.91289.1.665
24 4    0-.191-.100.0950.2899-.302115.2648.11026.1.691
24 5    0-.155-.088.0243.3027-.696105.1749.61139.1.684
24 6    0-.225-.106.1187.2673-.217171.4839.31388.1.818
24 7    0-.236-.125.1289.2266-.213178.9842.61412.1.847
24 8    0-.182-.100.0830.2362-.288154.91037.1620.1.869
24 9    0-.214-.091.1051.3125-.254169.8904.31477.1.866
2410    0-.221-.122.0989.1836-.235190.31024.1676.1.909
```

Figure A3:27-1(cont) CALGARY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1    28     1     1  | 3024   135     4     1  | 3047    99     3     2
30 2    52     1     1  | 3025   101     5     1  | 3048   102     3     2
30 3    65     1     1  | 3026    52     1     2  | 3049   104     3     2
30 4    74     1     1  | 3027    73     1     2  | 3050   106     3     2
30 5    81     1     1  | 3028    79     1     2  | 3051   109     3     2
30 6    88     1     1  | 3029    86     1     2  | 3052   111     3     2
30 7    97     1     1  | 3030    93     1     2  | 3053   113     3     2
30 8   106     1     1  | 3031   100     1     2  | 3054   115     3     2
30 9   118     1     1  | 3032   106     1     2  | 3055   119     3     2
3010   152     1     1  | 3033   113     1     2  | 3056   124     3     2
3011   112     2     1  | 3034   119     1     2  | 3057   130     3     2
3012    59     3     1  | 3035   128     1     2  | 3058   135     3     2
3013    82     3     1  | 3036   162     1     2  | 3059   143     3     2
3014    94     3     1  | 3037    86     2     2  | 3060   176     3     2
3015   106     3     1  | 3038   104     2     2  | 3061    51     4     2
3016   117     3     1  | 3039   121     2     2  | 3062    77     4     2
3017   130     3     1  | 3040   165     2     2  | 3063   115     4     2
3018   143     3     1  | 3041    57     3     2  | 3064    68     5     2
3019   175     3     1  | 3042    74     3     2  | 3065    94     5     2
3020    31     4     1  | 3043    84     3     2  | 3066   110     5     2
3021    63     4     1  | 3044    92     3     2  | 3067   138     5     2
3022    82     4     1  | 3045    95     3     2
3023    97     4     1  | 3046    97     3     2

0000 ZONAL Data
40 1 6085   62         | 40 2 7244   65         | 40 3 8654   75
40 4 8398   20         | 40 5 7867  116         | 40 613650   66

0000  Parameters
50 10.200              | 50 20.100              |
50 30.550              | 50 40.300              | 50 71.205
50 50.675              | 50 60.350              | 50 81.178
50110.450              | 50121.200              | 5013 50.0
50160.450              | 50171.420              | 5018 55.0
50201.282              |
```

Figure A3:27-1(cont) CALGARY: MODIFIED Policy Dataset

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	10	11
2	10	15
3	3	3
4	5	12
5	2	2
A	-	2
Total	30	45

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 5

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	70.	117.	12,225.	21,449.	3,884.	9,096.	21.
2	80.	130.	14,393.	27,313.	4,537.	11,058.	56.
3	72.	144.	18,840.	32,700.	6,216.	13,354.	52.
4	67.	110.	12,211.	22,412.	3,863.	9,653.	91.
5	41.	81.	11,514.	26,065.	2,812.	9,483.	93.
A		94.		31,904.		11,945.	93.
total	72.	120.	13,510.	25,048.	4,277.	10,362.	60.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	12,880.	15,930.	23.9	2,829.	17.8	11.4
2	11,555.	20,945.	31.5	9,821.	46.9	39.6
3	914.	5,820.	8.7	4,591.	78.9	18.5
4	13,569.	20,070.	30.2	6,701.	33.4	27.0
5	1,152.	1,456.	2.2	1,158.	21.0	1.2
A		2,325.	3.5	572.	24.6	2.3
	40,070.	66,555.	100.0	24,821.	37.3	100.0

source: program "CZONE.FORT": files KIT61.INPUT and KIT71.INPUT.

Figure A3:01-2 KITCHENER: Zonal Characteristics (5 zones)

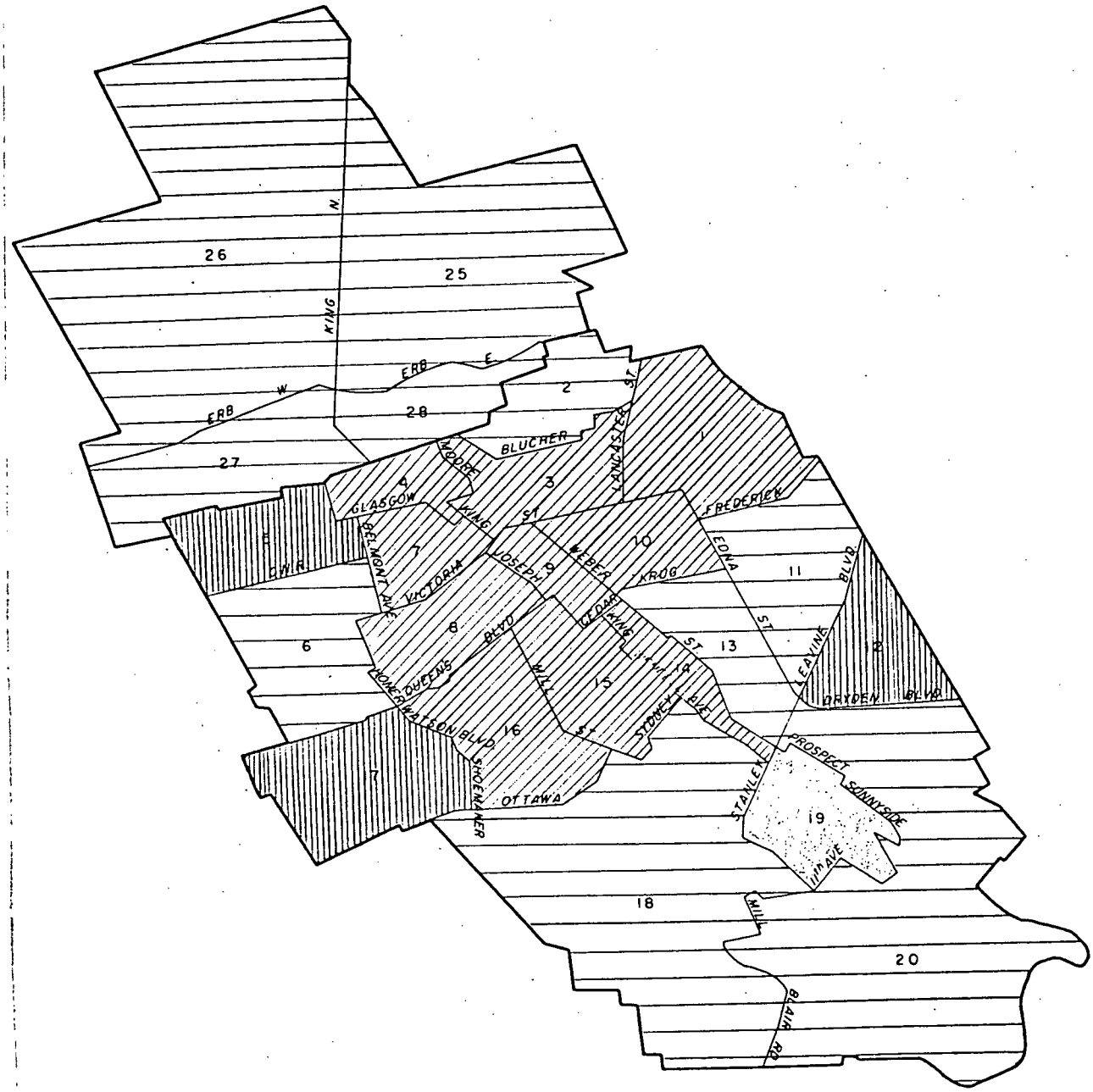

Figure A3:02-2 KITCHENER: Clustering (5 zones)

Demographic Characteristics:

Population [1] 1961: 154,864.
[2] 1971: 226,850.

Households [1] 1961: 42,174.
[2] 1971: 66,580.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 10,362.
1974 SHU data [4] : 11,773.

deflator : 0.8801

SHU deflated : 10,633.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file KIT.SHU

SHU dataset:

Sample size : 2954.
Sum of the WEIGHTs : 75,941.

RATIO of SHU weights
to actual households : 1.1406

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	9,122.	8,959.	12.	747.	655.
2	12,738.	27,584.	36.	766.	672.
3	10,801.	6,624.	9.	736.	645.
4	12,758.	11,821.	15.	788.	691.
5	6,928.	5,729.	8.	716.	628.
6	7,402.	4,803.	6.	801.	702.
7	8,177.	5,110.	7.	730.	640.
8	4,721.	5,311.	7.	759.	665.

source: program "HH1.FORT" :file KIT.SHU

Figure A3:03-2 KITCHENER: HOUSEHOLD Characteristics.

Total 1961 dwellings : 40,070.

Rental	:	11,384.
Owner-occupier	:	28,686.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	67.	4,656.	12,290.	8,224.	0.0660
2	80.	2,352.	14,564.	9,203.	0.0660
3	78.	54.	20,634.	860.	0.0456
4	67.	4,096.	12,181.	9,473.	0.0660
5	41.	226.	11,455.	926.	0.0432
total	69.	11,384.	13,206.	28,686.	0.0636

source: program "D61.FORT" : dataset KIT61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings : TOTAL 40,070.
: RATIO of EXISTING unannexed/TOTAL 99.8%
: TOTAL 1961 Dwellings EXISTING in 1971 41,734.
: TOTAL 1961 Dwellings ADJUSTED for ANNEXED 41,827.
: 1971 "model" Dwellings 100.
: 1971 RATIO ACTUAL/"model" 666.
: 1961 "model" Dwellings 63.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	12,880.	20.	644.	0.9774	0.9833
2	11,555.	18.	642.	0.9584	0.9642
3	914.	1.	914.	0.9117	0.9172
4	13,569.	22.	617.	0.9914	0.9974
5	1,152.	2.	576.	1.4590	1.4678

error of fit 0.02715

source: program "D61.FORT" : dataset KIT61.INPUT.

Figure A3:04-2 KITCHENER: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	7.1628	4.1184	2.2229	1.4981
	(11.1)	(6.56)	(2.72)	(2.14)
MULTIPLE	0.5660	0.6255	0.1382	0.2444
	(5.61)	(6.26)	(1.21)	(2.84)
CONSTRUCTED PRE 20	-.3588	-.3199	-.1556	-.1832
	(4.85)	(4.84)	(1.99)	(3.13)
20-45	-.3287	-.2985	-.0221	-.0455
	(4.74)	(5.36)	(0.31)	(0.72)
CONDITION	0.2073	0.2277	0.1514	0.0855
	(3.23)	(4.43)	(2.26)	(1.80)
LN ROOMS	1.0025	1.3762	0.2247	0.4385
	(7.87)	(11.3)	(1.46)	(3.74)
LN INCOME	0.0553	0.3395	0.4908	0.5370
	(0.72)	(4.76)	(5.33)	(6.53)
ACCESS	0.00034	.00011	-.0003	.00001
	(0.78)	(0.29)	(0.59)	(0.03)
R2	0.32	0.99	0.34	0.99
OBSERVATIONS	279	279	261	261

note : "t" statistis in brackets
: data source: KIT61.EA

MEANS:

LN INCOME	8.2678
MULTIPLE	0.2927
ACCESS	52.9

Figure A3:05-2 KITCHENER: 1961 Hedonic Estimates

Total 1971 dwellings : 66,550.

Rental : 26,640.
Owner-occupier : 39,910.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	116.	7,995.	21,461.	7,930.	0.0648
2	131.	8,025.	27,336.	12,915.	0.0576
3	142.	1,470.	32,521.	4,350.	0.0528
4	110.	8,340.	22,674.	11,735.	0.0576
5	89.	810.	29,603.	2,980.	0.0360
total	119.	26,640.	25,532.	39,910.	0.0564

source: program "D71.FORT" : dataset KIT71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	15,925.	24.	664.	0.9517	1.0026
2	20,940.	31.	676.	0.9154	0.9643
3	5,820.	9.	647.	0.8719	0.9185
4	20,075.	30.	669.	0.9975	1.0508
5	3,790.	6.	632.	0.8791	0.9261
			665.		

error of fit 0.01277

source: program "D71.FORT" : dataset KIT71.INPUT.

Figure A3:06-2 KITCHENER: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 66,550.

Built prior 1961 : 41,712.
Built 1961-1971 : 24,838.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	111.	5,464.	22,027.	7,628.	0.0600
2	113.	2,903.	24,981.	8,201.	0.0540
3	133.	141.	33,255.	1,088.	0.0480
4	99.	4,397.	21,792.	8,980.	0.0552
5	78.	731.	27,331.	2,178.	0.0348
99	133.	13,004.	30,554.	11,834.	0.0528
CMA	119.	26,640.	25,705.	39,910.	0.0552

source: program "D71.FORT" : dataset KIT71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual calculated	SERVICES weighted
1	13,092.	20.	655.	0.9500	1.0078
2	11,104.	17.	653.	0.9799	1.0394
3	1,229.	2.	615.	0.8452	0.8966
4	13,337.	20.	669.	1.0457	1.1093
5	2,909.	4.	727.	0.9867	1.0467
99	24,838.	37.	671.	0.8695	0.9223
			665.		

error of fit 0.01608

source: program "D71.FORT" : dataset KIT71.INPUT.

Figure A3:07-2 KITCHENER: 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	8.7091	8.4373	5.8651	5.9102
	(56.3)	(54.1)	(41.9)	(43.8)
MULTIPLE	0.0302	-.0019	0.0353	0.0351
	(1.27)	(0.08)	(1.26)	(1.21)
CONSTRUCTION 51-60	-.0610	-.0987	-.1319	-.1152
	(2.50)	(4.72)	(4.88)	(4.12)
46-50	-.1655	-.1985	-.2879	-.2593
	(5.05)	(6.27)	(6.52)	(5.73)
20-45	-.2802	-.3096	-.3184	-.3076
	(10.4)	(11.8)	(10.2)	(9.50)
PRE 20	-.3157	-.3477	-.3799	-.3485
	(12.0)	(13.5)	(14.7)	(13.2)
FACILITIES	0.1114	0.1186	0.0988	0.1151
	(1.30)	(1.27)	(1.62)	(1.84)
LN INCOME	0.0452	0.0615	0.1128	0.1028
	(3.46)	(4.74)	(7.91)	(7.52)
LN ROOMS	0.5178	0.5940	0.2701	0.2785
	(13.6)	(16.3)	(9.41)	(9.55)
R2	0.29	0.99	0.33	0.97
OBSERVATIONS	1147	1147	1140	1140
WEIGHTED 20-45/PRE 20	-.2989	-.3297	-.3560	-.3326

note : "t" statistis in brackets
: data source: KIT.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	8.98268
MULTIPLE	0.5107
ACCESS	60.0

Figure A3:08-2 KITCHENER: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	25,048.	43,589.	0.57464
RENT	120.	147.	0.81633
INCOME	10,362.	11,773.	0.8801

R/V ratio: 0.0564 P(j)/PN ratio: 0.97969

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.7982 (126.)	0.1642	2.7938 (120.)	0.1634	0.1655
DUMMY (TYPE 2)	-.2503 (9.08)	0.1278	-.2616 (9.53)	0.1258	0.1275
DUMMY (TYPE 3)	-.1520 (4.37)	0.1410	-.1586 (4.39)	0.1395	0.1413
DUMMY (TYPE 4)	-.2848 (8.82)	0.1235	-.3188 (9.93)	0.1188	0.1204
DUMMY (TYPE 5)	0.1937 (5.61)	0.1992	0.2285 (5.84)	0.2054	0.2079
DUMMY (TYPE 6)	0.2493 (6.55)	0.2106	0.2284 (5.63)	0.2054	0.2079
DUMMY (TYPE 7)	0.0378 (0.98)	0.1705	0.0001 (0.00)	0.1634	0.1655
DUMMY (TYPE 8)	0.5632 (14.6)	0.2883	0.5451 (13.5)	0.2819	0.2850
R2	0.23		0.73		
OBSERVATIONS	2857		2857		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-2 KITCHENER: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	10.212 (76.2)	10.089 (73.1)	0.1542	0.1118	0.4990
DUMMY (TYPE 2)	-.0058 (0.30)	0.0091 (0.45)	0.1188	0.0678	0.3743
DUMMY (TYPE 3)	-.0168 (0.69)	-.0311 (1.21)	0.1304	0.0887	0.4227
DUMMY (TYPE 4)	-.0439 (1.93)	-.0498 (2.14)	0.1119	0.0754	0.2203
DUMMY (TYPE 5)	-.0471 (1.94)	-.0535 (1.90)	0.1825	0.1149	0.3432
DUMMY (TYPE 6)	0.0229 (0.86)	0.0272 (0.94)	0.1876	0.1319	0.3529
DUMMY (TYPE 7)	-.1132 (4.21)	-.1275 (4.38)	0.1483	0.1062	0.2759
DUMMY (TYPE 8)	-.0649 (2.25)	-.0959 (3.10)	0.2385	0.1397	0.4806
LN INCOME	-.8200 (55.7)	-.8074 (53.3)			
R2	0.63	0.87			
OBSERVATIONS	2857	2857			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Figure A3:09-2(b) KITCHENER: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	797.0	972.	-	-	-	-
1962	809.0	950.	1,377	0.046	37.2	43.7
1963	819.0	965.	2,634	0.088	72.0	84.9
1964	838.0	1013.	3,173	0.106	88.7	107.4
1965	862.0	1052.	2,820	0.094	80.9	98.9
1966	890.0	1271.	2,432	0.081	72.0	103.0
1967	930.0	1415.	3,198	0.107	99.5	151.4
1968	985.0	1732.	3,503	0.117	115.2	202.6
1969	1040.0	1959.	3,841	0.128	133.1	250.8
1970	1112.0	2205.	3,075	0.103	114.5	227.1
1971	1179.0	2078.	3,905	0.130	153.2	270.1

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	797.0	972.0	1769.0	0.451	0.549	1.000	--
decade weighted	966.0	1540.0	2506.0	0.547	0.873	1.420	62.2
1971	1178.5	2078.0	3256.5	0.667	1.175	1.842	47.9

Figure A3:10-2 KITCHENER: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 1 9121
20 212737
20 310800
20 412758
20 5 6927
20 6 7401
20 7 8176
20 8 4721

0000 ALPHA by TYPE
21 1.1634
21 2.1258
21 3.1395
21 4.1188
21 5.2054
21 6.2054
21 7.1634
21 8.2819

0000 "MODEL" HOUSEHOLDS
10 1  808    1
10 2 3424    1
10 3 5478    1
10 4 7258    1
10 5 8381    1
10 6 9013    1
10 7 9612    1
10 810322    1
10 911311    1
101012575    1
101113826    1
101217733    1
1013 1193    2
1014 3663    2
1015 5025    2
1016 5873    2
1017 6735    2
1018 7303    2
1019 7775    2
1020 8141    2
1021 8796    2
1022 8915    2
1023 9312    2
1024 9678    2
102510029    2
102610445    2
102710606    2
102810955    2
102911280    2
103011541    2
103112041    2
103212348    2
103312610    2
103413007    2
103513350    2
103613823    2
103714276    2
103814787    2
103915317    2
104015917    2
104116601    2
104217174    2
104317759    2
104418578    2
104519833    2
104621803    2
104725365    2
104840558    2
1049 2999    3
1050 5581    3
1051 7236    3
1052 9263    3
105310456    3
105411518    3
105512817    3
105614915    3
105723966    3
1058 3151    4
1059 5860    4
1060 7497    4
1061 8620    4
1062 9414    4
106310213    4
106410906    4
106511973    4
106612711    4
106713777    4
106815087    4
106916275    4
107017949    4
107120337    4
107228843    4
1073 1880    5
1074 3132    5
1075 3809    5
1076 4745    5
1077 6060    5
1078 7614    5
107910435    5
108017967    5
1081 2008    6
1082 4490    6
1083 5913    6
1084 7222    6
1085 9448    6
108615314    6
1087 2273    7
1088 4663    7
1089 5804    7
1090 7465    7
1091 9409    7
109211418    7
109316315    7
1094 1111    8
1095 1576    8
1096 2187    8
1097 3065    8
1098 4311    8
1099 6196    8
11 014232    8
```

Figure A3:11-2 KITCHENER: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1   37   29    1 | 3035   85   66    2 | 3069   63   49    4
30 2   53   41    1 | 3036   87   67    2 | 3070   67   52    4
30 3   60   46    1 | 3037   90   69    2 | 3071   70   54    4
30 4   65   50    1 | 3038   92   71    2 | 3072   73   56    4
30 5   68   53    1 | 3039   94   72    2 | 3073   75   58    4
30 6   71   55    1 | 3040   96   74    2 | 3074   78   60    4
30 7   74   57    1 | 3041   99   76    2 | 3075   80   62    4
30 8   77   59    1 | 3042  101   78    2 | 3076   83   64    4
30 9   79   61    1 | 3043  104   80    2 | 3077   85   65    4
3010   82   63    1 | 3044  106   82    2 | 3078   87   67    4
3011   84   65    1 | 3045  109   84    2 | 3079   90   69    4
3012   87   67    1 | 3046  112   86    2 | 3080   92   71    4
3013   90   69    1 | 3047  115   88    2 | 3081   95   73    4
3014   93   72    1 | 3048  118   91    2 | 3082   98   75    4
3015   96   74    1 | 3049  121   93    2 | 3083  100   77    4
3016  100   77    1 | 3050  124   96    2 | 3084  103   80    4
3017  104   80    1 | 3051  128   99    2 | 3085  106   82    4
3018  108   83    1 | 3052  133  103    2 | 3086  110   84    4
3019  112   87    1 | 3053  140  108    2 | 3087  113   87    4
3020  117   90    1 | 3054  152  117    2 | 3088  116   90    4
3021  122   94    1 | 3055  195  150    2 | 3089  119   92    4
3022  131  101    1 | 3056   69   53    3 | 3090  123   95    4
3023  142  110    1 | 3057   89   69    3 | 3091  127   98    4
3024  170  131    1 | 3058   99   76    3 | 3092  134  104    4
3025   41   31    2 | 3059  106   82    3 | 3093  145  112    4
3026   57   44    2 | 3060  113   87    3 | 3094  194  150    4
3027   63   48    2 | 3061  121   93    3 | 3095   45   35    5
3028   66   51    2 | 3062  129   99    3 | 3096   71   55    5
3029   70   54    2 | 3063  140  108    3 | 3097   86   66    5
3030   73   56    2 | 3064  177  137    3 | 3098  101   78    5
3031   76   58    2 | 3065   32   24    4 | 3099  120   93    5
3032   78   60    2 | 3066   48   37    4 | 31 0  183  141    5
3033   81   62    2 | 3067   54   42    4
3034   83   64    2 | 3068   59   45    4

0000 ZONAL DATA
40 1 9096   21
40 211058   56
40 313354   52
40 4 9653   91
40 510993   93
40 610361   59

0000 Calibration Data
70 11.4050.0850.3490.0610.1220.1120.0600.1170.094 90951.000 92.6
70 21.4070.1200.4830.0710.1230.0650.0400.0580.040110571.000 99.6
70 31.2620.1330.6200.0620.0860.0360.0150.0280.019133491.000115.8
70 41.4170.1100.4710.0640.1100.0880.0220.0640.070 96511.000 94.0
70 51.2440.0880.5480.0490.1190.0970.0060.0420.050109941.000101.0
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:11-2A KITCHENER: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 1 9121
20 212737
20 310800
20 412758
20 5 6927
20 6 7401
20 7 8176
20 8 4721

0000 ALPHA by TYPE
21 1.1634
21 2.1258
21 3.1395
21 4.1188
21 5.2054
21 6.2054
21 7.1634
21 8.2819
```

```
0000 "MODEL" HOUSEHOLDS
10 1  808     1
10 2 3424     1
10 3 5478     1
10 4 7258     1
10 5 8381     1
10 6 9013     1
10 7 9612     1
10 810322     1
10 911311     1
101012575     1
101113826     1
101217733     1
1013 1193     2
1014 3663     2
1015 5025     2
1016 5873     2
1017 6735     2
1018 7303     2
1019 7775     2
1020 8141     2
1021 8796     2
1022 8915     2
1023 9312     2
1024 9678     2
102510029     2
102610445     2
102710606     2
102810955     2
102911280     2
103011541     2
103112041     2
103212348     2
103312610     2
103413007     2
103513350     2
103613823     2
103714276     2
103814787     2
103915317     2
104015917     2
104116601     2
104217174     2
104317759     2
104418578     2
104519833     2
104621803     2
104725365     2
104840558     2
1049 2999     3
1050 5581     3
```

```
1051 7236     3
1052 9263     3
105310456     3
105411518     3
105512817     3
105614915     3
105723966     3
1058 3151     4
1059 5860     4
1060 7497     4
1061 8620     4
1062 9414     4
106310213     4
106410906     4
106511973     4
106612711     4
106713777     4
106815087     4
106916275     4
107017949     4
107120337     4
107228843     4
1073 1880     5
1074 3132     5
1075 3809     5
1076 4745     5
1077 6060     5
1078 7614     5
107910435     5
108017967     5
1081 2008     6
1082 4490     6
1083 5913     6
1084 7222     6
1085 9448     6
108615314     6
1087 2273     7
1088 4663     7
1089 5804     7
1090 7465     7
1091 9409     7
109211418     7
109316315     7
1094 1111     8
1095 1576     8
1096 2187     8
1097 3065     8
1098 4311     8
1099 6196     8
11 014232     8
```

Figure A3:12-2 KITCHENER: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1   29    1        3035   90    2
30 2   46    1        3036   97    2
30 3   50    1        3037  108    2
30 4   52    1        3038  144    2
30 5   55    1        3039   83    3
30 6   58    1        3040   25    4
30 7   60    1        3041   40    4
30 8   62    1        3042   47    4
30 9   64    1        3043   51    4
3010   67    1        3044   53    4
3011   69    1        3045   56    4
3012   72    1        3046   59    4
3013   75    1        3047   61    4
3014   78    1        3048   63    4
3015   83    1        3049   66    4
3016   87    1        3050   68    4
3017   92    1        3051   70    4
3018   98    1        3052   73    4
3019  106    1        3053   75    4
3020  144    1        3054   78    4
3021   38    2        3055   82    4
3022   46    2        3056   86    4
3023   51    2        3057   91    4
3024   56    2        3058   96    4
3025   60    2        3059  102    4
3026   64    2        3060  114    4
3027   68    2        3061  169    4
3028   70    2        3062   58    5
3029   73    2        3063  139    5
3030   76    2
3031   79    2
3032   81    2
3033   84    2
3034   87    2

0000 ZONAL DATA
40 1 9096   21
40 211058   56
40 313354   52
40 4 9653   91
40 510993   93
40 610361   59

0000 Calibration Data
70 11.4010.0820.3440.0600.1210.1140.0600.1200.098 90361.000 89.6
70 21.4890.1020.4630.0640.1300.0840.0390.0660.053110060.962 87.5
70 31.4410.1240.5870.0640.1030.0510.0200.0320.019150001.000 95.8
70 41.4330.1090.4700.0630.1100.0900.0220.0660.071 96400.986 89.3
70 51.2380.0880.5460.0490.1190.0980.0060.0420.052109611.000101.6
70 61.4200.1250.5070.0700.1100.0620.0310.0540.042108581.000111.6
```

Figure A3:12-2A KITCHENER: "BETA" Calibration Data

0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA

10 1 808	1	20.611	33.5	1051 7236	3	291.380	78.9
10 2 3424	1	461.182	58.4	1052 9263	3	561.356	92.1
10 3 5478	1	511.331	74.1	105310456	3	9991.420	97.5
10 4 7258	1	141.420	85.7	105411518	3	9991.420	103.3
10 5 8381	1	9991.420	93.5	105512817	3	9991.420	110.2
10 6 9013	1	571.384	98.5	105614915	3	9991.420	120.7
10 7 9612	1	9991.420	101.5	105723966	3	9991.420	160.4
10 810322	1	361.410	106.2	1058 3151	4	31.085	47.3
10 911311	1	9991.420	111.9	1059 5860	4	71.342	63.8
101012575	1	9991.420	119.3	1060 7497	4	101.399	73.0
101113826	1	9991.420	126.2	1061 8620	4	121.418	79.1
101217733	1	381.308	151.0	1062 9414	4	301.416	83.4
1013 1193	2	430.592	36.7	106310213	4	9991.420	87.5
1014 3663	2	51.152	53.7	106410906	4	151.416	91.1
1015 5025	2	251.291	62.4	106511973	4	9991.420	96.3
1016 5873	2	261.333	67.8	106612711	4	171.399	100.3
1017 6735	2	271.365	73.0	106713777	4	9991.420	104.7
1018 7303	2	521.332	77.3	106815087	4	9991.420	110.6
1019 7775	2	531.347	80.0	106916275	4	9991.420	115.8
1020 8141	2	131.389	81.4	107017949	4	9991.420	122.8
1021 8796	2	9991.420	84.7	107120337	4	9991.420	132.3
1022 8915	2	9991.420	85.4	107228843	4	9991.420	163.2
1023 9312	2	551.376	88.5	1073 1880	5	41.059	48.5
1024 9678	2	391.393	90.2	1074 3132	5	471.230	61.8
102510029	2	331.407	91.9	1075 3809	5	81.365	66.6
102610445	2	341.391	94.5	1076 4745	5	281.380	75.7
102710606	2	161.405	95.1	1077 6060	5	311.417	86.7
102810955	2	9991.420	96.6	1078 7614	5	9991.420	99.4
102911280	2	9991.420	98.3	107910435	5	9991.420	120.1
103011541	2	9991.420	99.7	108017967	5	9991.420	166.4
103112041	2	9991.420	102.2	1081 2008	6	241.050	52.1
103212348	2	9991.420	103.8	1082 4490	6	111.391	74.9
103312610	2	9991.420	105.1	1083 5913	6	321.397	88.2
103413007	2	9991.420	107.1	1084 7222	6	351.419	98.9
103513350	2	591.373	109.9	1085 9448	6	191.415	116.3
103613823	2	9991.420	111.1	108615314	6	201.391	156.5
103714276	2	9991.420	113.2	1087 2273	7	440.973	47.4
103814787	2	9991.420	115.7	1088 4663	7	481.282	65.3
103915317	2	371.412	118.3	1089 5804	7	501.360	72.9
104015917	2	601.364	122.4	1090 7465	7	541.380	84.3
104116601	2	9991.420	124.0	1091 9409	7	9991.420	95.9
104217174	2	9991.420	126.5	109211418	7	181.420	107.7
104317759	2	9991.420	129.1	109316315	7	9991.420	133.5
104418578	2	9991.420	132.6	1094 1111	8	230.951	45.1
104519833	2	9991.420	137.9	1095 1576	8	621.028	53.3
104621803	2	631.350	148.4	1096 2187	8	61.240	59.0
104725365	2	9991.420	159.9	1097 3065	8	491.330	69.8
104840558	2	9991.420	211.9	1098 4311	8	9991.420	83.2
1049 2999	3	451.034	51.7	1099 6196	8	581.392	104.3
1050 5581	3	91.344	68.1	110014232	8	611.306	177.0

Figure A3:13-2 KITCHENER: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   29    1
30 2   46    1
30 3   50    1
30 4   52    1
30 5   55    1
30 6   58    1
30 7   60    1
30 8   62    1
30 9   64    1
3010   67    1
3011   69    1
3012   72    1
3013   75    1
3014   78    1
3015   83    1
3016   87    1
3017   92    1
3018   98    1
3019  106    1
3020  144    1
3021   38    2
3022   46    2
3023   51    2
3024   56    2
3025   60    2
3026   64    2
3027   68    2
3028   70    2
3029   73    2
3030   76    2
3031   79    2
3032   81    2
3033   84    2
3034   87    2
3035   90    2
3036   97    2
3037  108    2
3038  144    2
3039   83    3
3040   25    4
3041   40    4
3042   47    4
3043   51    4
3044   53    4
3045   56    4
3046   59    4
3047   61    4
3048   63    4
3049   66    4
3050   68    4
3051   70    4
3052   73    4
3053   75    4
3054   78    4
3055   82    4
3056   86    4
3057   91    4
3058   96    4
3059  102    4
3060  114    4
3061  169    4
3062   58    5
3063  139    5

0000 INCOME by TYPE
20 1 9121
20 212737
20 310800
20 412758
20 5 6927
20 6 7401
20 7 8176
20 8 4721

0000 ALPHA by TYPE
21 1.1634
21 2.1258
21 3.1395
21 4.1188
21 5.2054
21 6.2054
21 7.1634
21 8.2819

0000 ZONAL DATA
40 1 6661   21
40 2 7426   56
40 3 9185   52
40 4 6586   91
40 511095   93
40 613908   59
```

Figure A3:13-2(cont) KITCHENER: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	2.7303	1.3861
	(21.0)	(7.06)
BATH	0.1551	na
	(1.84)	
TOILET	-.0521	0.0292
	(0.49)	(0.27)
SUBSIDIS	-.4835	-.0281
	(13.9)	(0.29)
LNLIVING	0.2237	0.1843
	(7.13)	(5.43)
LNINCOM	0.1323	0.2097
	(10.3)	(12.5)
TYPE	-.0502	-.0950
	(3.57)	(4.19)
LNDIST	0.0122	0.0004
	(1.75)	(0.06)
B5160	-.0636	-.0705
	(3.08)	(3.91)
B4650	-.1237	-.1233
	(3.40)	(4.86)
B2145	-.1325	-.1375
	(5.53)	(6.48)
BPRE20	-.2455	-.1532
	(12.6)	(7.44)
LGLVSIZE	0.0888	0.1491
	(4.73)	(5.58)
LGBDSIZE	0.1025	0.1287
	(13.4)	(7.47)
OPENSP	0.0244	0.0081
	(1.39)	(0.33)
HIGHDEN	0.0164	-.0321
	(1.23)	(1.31)
COMMERC	-.0209	na
	(1.41)	
NEIGHBD	0.0421	na
	(1.40)	
FINANCE	-.0160	-.0567
	(1.16)	(3.27)
AMRATE	na	0.0875
		(24.9)
R2	0.54	0.54
Observations	1353	1425

note: "t" statistics in brackets
: data source: KIT.REG02

Figure A3:14-2 KITCHENER: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	461.5	113.5	1.646	1.300	0.3209
min	60.8	29.5	1.565	1.300	0.0516
max	1947.9	287.2	1.786	1.300	0.9377
TYPE 2					
mean	455.2	115.3	1.657	1.300	0.2964
min	56.7	6.6	1.565	1.300	0.0719
max	1816.1	242.1	1.850	1.300	0.9881
TYPE 3					
mean	788.1	132.3	1.672	1.300	0.2025
min	54.7	30.4	1.565	1.300	0.0609
max	2077.2	282.3	1.890	1.300	0.8430
TYPE 4					
mean	523.3	135.3	1.690	1.300	0.2956
min	126.4	41.0	1.565	1.300	0.0663
max	1380.3	276.6	1.878	1.300	0.8964
TYPE 5					
mean	719.7	139.7	1.690	1.300	0.2186
min	173.5	63.2	1.565	1.300	0.0704
max	2127.8	254.4	1.852	1.300	0.8277
TYPE 6					
mean	666.7	255.4	2.267	1.300	0.4456
min	170.1	55.7	2.027	1.300	0.0584
max	3107.1	944.1	2.325	1.300	0.9892
TYPE 7					
mean	760.2	245.0	2.338	1.300	0.3469
min	252.0	88.7	2.082	1.300	0.1004
max	1587.8	762.6	2.387	1.300	0.8543
TYPE 8					
mean	1139.8	252.9	2.356	1.300	0.2371
min	359.3	45.9	2.085	1.300	0.0448
max	3195.2	691.4	2.397	1.300	0.5455
TYPE 9					
mean	892.1	253.3	2.395	1.300	0.2995
min	162.1	95.1	2.126	1.300	0.1026
max	3807.7	651.7	2.438	1.300	0.9087
TYPE 10					
mean	1050.6	256.9	2.386	1.300	0.2561
min	262.1	77.3	2.115	1.300	0.0833
max	3726.6	849.8	2.427	1.300	0.8153

Figure A3:15-2 KITCHENER : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2626	-.1389	0.1768	0.1537	-.0292	69.0	267.7	461.5	193
	(134.)	(15.4)	(46.6)	(5.29)	(5.29)				
2	-.2678	-.1727	0.2172	0.0653	0.0409	69.5	261.4	455.2	307
	(163.)	(23.5)	(53.6)	(2.56)	(7.23)				
3	-.1746	-.1219	0.1363	0.1158	-.1055	79.0	504.5	788.1	396
	(251.)	(26.8)	(69.5)	(6.87)	(31.1)				
4	-.2658	-.1170	0.1841	0.2658	-.0355	79.9	298.5	523.3	181
	(245.)	(12.9)	(53.3)	(8.49)	(6.39)				
5	-.1991	-.1112	0.1450	0.2412	-.0986	82.5	446.2	719.7	276
	(253.)	(14.0)	(59.4)	(7.42)	(21.7)				
6	-.3999	-.2285	0.2390	-.0651	0.0579	112.6	316.4	666.7	307
	(210.)	(23.3)	(51.1)	(2.67)	(8.61)				
7	-.3279	-.1581	0.1976	0.1397	-.0223	104.7	396.3	760.2	112
	(221.)	(22.5)	(37.5)	(8.12)	(2.63)				
8	-.2234	-.1092	0.1192	0.2450	-.2031	107.3	682.2	1139.8	271
	(566.)	(42.6)	(50.8)	(24.0)	(36.3)				
9	-.2879	-.1592	0.1918	0.1440	-.0324	105.7	491.4	892.1	245
	(401.)	(30.4)	(65.5)	(9.24)	(6.51)				
10	-.2479	-.1266	0.1625	0.2141	-.0842	107.6	610.5	1050.6	490
	(598.)	(47.0)	(94.9)	(23.6)	(23.7)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-2 KITCHENER : Direct Translog-Expenditure Share
[all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3742	-.1492	0.2451	0.1850	0.0585	61.2	132.8	273.0	118
	(201.)	(15.2)	(38.5)	(6.72)	(6.43)				
2	-.3393	-.1634	0.2823	0.1090	0.1210	63.3	167.2	321.8	177
	(178.)	(17.8)	(41.7)	(3.99)	(13.0)				
3	-.2380	-.1110	0.1824	0.1949	-.0525	75.1	320.8	542.5	199
	(252.)	(16.2)	(46.9)	(8.78)	(7.99)				
4	-.3417	-.1386	0.2360	0.2164	0.0360	71.4	181.2	354.9	93
	(269.)	(9.75)	(41.1)	(5.47)	(4.13)				
5	-.2534	-.1081	0.1939	0.2864	-.0350	79.2	309.1	535.5	143
	(273.)	(10.8)	(44.5)	(8.30)	(4.58)				
6	-.5143	-.1888	0.3359	0.0477	0.1944	100.5	171.8	451.7	194
	(287.)	(14.9)	(34.8)	(1.69)	(14.5)				
7	-.3780	-.1647	0.2483	0.1569	0.0529	90.5	270.6	562.2	63
	(211.)	(13.0)	(24.8)	(5.01)	(3.61)				
8	-.2558	-.1147	0.1346	0.2612	-.1822	96.4	508.8	888.5	151
	(434.)	(29.4)	(23.3)	(17.6)	(13.5)				
9	-.3096	-.1506	0.2241	0.1851	0.0088	90.0	374.4	702.2	150
	(382.)	(17.4)	(47.2)	(7.10)	(1.25)				
10	-.2722	-.1241	0.1970	0.2332	-.0315	95.8	475.1	845.9	298
	(573.)	(31.7)	(63.7)	(19.1)	(5.71)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-2 KITCHENER : Direct Translog-Expenditure Share
[below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1783	-.0793	0.0895	0.3383	-.2792	81.3	479.9	758.2	75
	(243.)	(19.8)	(22.6)	(14.3)	(15.8)				
2	-.2042	-.0993	0.0959	0.3027	-.2883	77.9	389.8	636.9	130
	(334.)	(20.7)	(14.0)	(13.8)	(9.05)				
3	-.1350	-.0799	0.0759	0.2793	-.2952	82.9	690.0	1036.2	197
	(345.)	(20.1)	(14.6)	(10.9)	(8.30)				
4	-.2164	-.0896	0.1130	0.3917	-.2358	88.9	422.4	701.3	88
	(255.)	(11.7)	(10.9)	(10.0)	(5.34)				
5	-.1596	-.0854	0.0824	0.3235	-.2861	86.0	593.6	917.7	133
	(304.)	(14.0)	(13.3)	(9.63)	(6.97)				
6	-.2985	-.1776	0.1729	0.0590	-.0456	133.2	564.7	1035.9	113
	(182.)	(17.5)	(21.6)	(1.92)	(2.32)				
7	-.2889	-.1456	0.1643	0.1361	-.0856	122.9	557.8	1014.8	49
	(251.)	(18.8)	(12.7)	(3.96)	(2.20)				
8	-.1973	-.1029	0.1002	0.2410	-.2576	121.1	900.5	1456.0	120
	(387.)	(31.4)	(17.3)	(16.5)	(9.41)				
9	-.2650	-.1415	0.1505	0.1666	-.1189	130.7	676.0	1192.0	95
	(378.)	(21.4)	(27.6)	(6.61)	(6.08)				
10	-.2220	-.1140	0.1345	0.2356	-.1420	125.9	820.7	1368.3	192
	(583.)	(56.7)	(45.0)	(31.8)	(14.5)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-2 KITCHENER : Direct Translog-Expenditure Share
[above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4751	-.1674	0.2796	0.1407	0.1212	51.8	72.5	179.0	57
	(187.)	(14.5)	(30.8)	(5.12)	(9.47)				
2	-.4463	-.1827	0.3309	0.0515	0.1877	61.4	102.6	234.4	80
	(159.)	(19.1)	(31.1)	(1.88)	(13.4)				
3	-.3320	-.1567	0.2303	0.1244	0.0083	74.8	199.1	383.3	87
	(225.)	(8.04)	(29.3)	(2.67)	(0.65)				
4	-.4092	-.1104	0.2846	0.2518	0.1078	65.0	121.6	265.6	47
	(287.)	(10.1)	(36.0)	(9.65)	(9.72)				
5	-.3211	-.1366	0.2219	0.2318	0.0017	77.1	216.2	411.7	60
	(192.)	(6.23)	(26.0)	(3.64)	(0.12)				
6	-.5901	-.1345	0.3794	0.1317	0.2463	87.9	106.9	337.6	94
	(295.)	(8.76)	(21.8)	(4.77)	(10.4)				
7	-.4340	-.1601	0.3263	0.1354	0.1542	85.3	200.8	457.6	29
	(160.)	(7.60)	(15.8)	(2.99)	(5.49)				
8	-.3091	-.1471	0.1362	0.1900	-.2041	91.8	368.0	693.2	57
	(245.)	(18.9)	(11.4)	(7.84)	(7.41)				
9	-.3436	-.1401	0.2428	0.2081	0.0357	79.1	281.8	555.3	57
	(203.)	(9.12)	(29.9)	(4.95)	(3.22)				
10	-.2977	-.1219	0.2237	0.2389	0.0088	88.3	386.0	712.0	133
	(399.)	(16.6)	(40.8)	(11.1)	(0.98)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-2 KITCHENER : Direct Translog-Expenditure Share
[quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3195	-.1226	0.2010	0.2734	0.0023	69.9	189.1	360.8	61
	(262.)	(9.29)	(8.10)	(5.69)	(0.03)				
2	-.2724	-.1238	0.1564	0.2481	-.1311	64.9	220.4	393.9	97
	(318.)	(14.6)	(10.8)	(6.68)	(3.21)				
3	-.1895	-.0795	0.1353	0.3679	-.1032	75.4	415.4	666.1	112
	(300.)	(12.6)	(7.07)	(10.6)	(1.11)				
4	-.2941	-.1426	0.1258	0.2034	-.2295	78.0	242.2	446.2	46
	(221.)	(6.62)	(3.16)	(3.03)	(1.81)				
5	-.2178	-.1090	0.1343	0.2611	-.2091	80.7	376.2	625.0	83
	(270.)	(10.3)	(5.77)	(5.42)	(2.16)				
6	-.4611	-.0978	0.3935	0.2961	0.3104	112.4	232.8	559.0	100
	(364.)	(8.08)	(35.8)	(10.3)	(22.1)				
7	-.3426	-.1442	0.2338	0.2262	0.0431	94.9	330.1	651.4	34
	(244.)	(9.87)	(11.2)	(4.37)	(0.85)				
8	-.2321	-.0937	0.0976	0.3417	-.3566	99.2	594.1	1007.0	94
	(519.)	(17.7)	(3.59)	(14.0)	(3.27)				
9	-.2931	-.1552	0.1568	0.1739	-.1424	96.6	431.2	792.2	93
	(473.)	(11.8)	(6.17)	(3.83)	(1.75)				
10	-.2555	-.1205	0.1775	0.2396	-.0829	101.9	546.9	953.9	165
	(555.)	(25.1)	(15.9)	(12.7)	(2.29)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-2 KITCHENER : Direct Translog-Expenditure Share [quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2212	-.0827	0.1160	0.3846	-.2250	78.3	348.8	582.5	51
	(232.)	(12.4)	(6.64)	(10.3)	(3.22)				
2	-.2259	-.0970	0.1221	0.3465	-.1652	73.2	320.6	538.8	78
	(325.)	(11.9)	(4.48)	(10.2)	(1.43)				
3	-.1505	-.0782	0.1141	0.3299	-.1311	80.2	586.7	897.3	120
	(272.)	(11.8)	(7.78)	(8.77)	(1.62)				
4	-.2369	-.0676	0.1922	0.4989	0.0217	85.7	360.1	614.6	61
	(218.)	(4.39)	(4.84)	(7.05)	(0.15)				
5	-.1771	-.0785	0.1428	0.4085	0.0292	84.3	509.9	805.6	89
	(287.)	(7.01)	(4.90)	(6.89)	(0.18)				
6	-.3299	-.1245	0.2938	0.2678	0.2211	119.1	428.0	825.5	68
	(208.)	(7.03)	(14.2)	(4.42)	(4.07)				
7	-.3096	-.0978	0.2547	0.3839	0.1918	116.7	470.7	886.5	31
	(232.)	(5.27)	(6.94)	(5.06)	(1.99)				
8	-.2125	-.1075	0.0966	0.2175	-.3548	114.9	773.9	1276.5	83
	(336.)	(17.8)	(3.82)	(8.44)	(3.22)				
9	-.2808	-.1026	0.2371	0.3343	0.1363	117.5	555.9	1004.5	58
	(333.)	(7.77)	(11.9)	(6.81)	(2.29)				
10	-.2259	-.0942	0.1934	0.3309	0.0604	112.7	715.2	1199.6	133
	(627.)	(26.1)	(23.0)	(20.7)	(2.11)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-2 KITCHENER : Direct Translog-Expenditure Share
[quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1292	-.0683	0.0661	0.3281	-.3290	87.8	758.5	1131.5	24
	(196.)	(19.9)	(10.7)	(14.8)	(8.70)				
2	-.1817	-.1042	0.0754	0.2410	-.3646	84.9	493.7	784.0	52
	(179.)	(10.5)	(6.20)	(4.00)	(5.45)				
3	-.1172	-.0615	0.0720	0.3610	-.2363	87.2	851.0	1252.8	77
	(269.)	(10.3)	(8.42)	(8.08)	(3.36)				
4	-.1842	-.0934	0.0976	0.3483	-.2612	96.1	563.0	897.2	27
	(171.)	(4.62)	(5.48)	(3.49)	(2.87)				
5	-.1336	-.0740	0.0671	0.3198	-.3689	89.5	762.9	1144.5	44
	(157.)	(7.83)	(6.68)	(5.05)	(4.78)				
6	-.2607	-.1417	0.0954	0.1547	-.3148	154.7	771.4	1353.9	45
	(217.)	(23.4)	(11.1)	(8.69)	(10.4)				
7	-.2576	-.1185	0.1852	0.2442	0.0087	133.6	707.8	1235.7	18
	(232.)	(15.2)	(15.6)	(6.27)	(0.25)				
8	-.1715	-.0823	0.0825	0.3266	-.3123	134.9	1184.5	1858.7	37
	(241.)	(17.5)	(10.5)	(15.3)	(7.96)				
9	-.2446	-.1187	0.1182	0.2313	-.2389	151.2	864.2	1486.1	37
	(287.)	(11.6)	(12.1)	(4.76)	(5.10)				
10	-.2136	-.1064	0.1061	0.2602	-.2558	155.6	1058.7	1748.8	59
	(327.)	(30.0)	(14.3)	(16.3)	(9.84)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-2 KITCHENER : Direct Translog-Expenditure Share
[quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.7151	0.7212	0.7608	-0.9912	-1.8868	-0.6608
Q02	0.5540	0.5966	0.6128	-0.9917	-1.1820	-0.8139
Q03	0.4515	0.4864	0.4893	-0.9976	-1.2188	-0.8240
Q04	0.2875	0.2898	0.2908	-0.9989	-1.3772	-0.7254
TYPE 2						
Q01	0.6570	0.6589	0.6610	-1.0500	-1.9856	-0.7284
Q02	0.5114	0.5228	0.5219	-0.9994	-1.1125	-0.8958
Q03	0.4554	0.4821	0.4960	-0.9830	-1.1345	-0.8568
Q04	0.3874	0.3730	0.3715	-0.9936	-1.1580	-0.7753
TYPE 3						
Q01	0.5542	0.5542	0.5542	-1.0363	-1.9227	-0.7437
Q02	0.3958	0.4196	0.4224	-1.0060	-1.1299	-0.8968
Q03	0.3216	0.3369	0.3386	-1.0068	-1.1037	-0.9090
Q04	0.2581	0.2743	0.2803	-0.9969	-1.1439	-0.7614
TYPE 4						
Q01	0.6694	0.6892	0.6884	-1.0359	-1.5276	-0.8468
Q02	0.5423	0.5435	0.5435	-0.9912	-1.1284	-0.8815
Q03	0.4968	0.6167	0.5803	-0.9978	-1.0503	-0.9495
Q04	0.3932	0.4178	0.4246	-0.9875	-1.2161	-0.8107
TYPE 5						
Q01	0.5751	0.5887	0.5934	-1.0129	-1.5227	-0.7843
Q02	0.4386	0.4379	0.4376	-1.0145	-1.1336	-0.9074
Q03	0.3736	0.4226	0.4350	-0.9861	-1.0749	-0.9000
Q04	0.3075	0.3016	0.3009	-0.9995	-1.1891	-0.7911
TYPE 6						
Q01	0.8168	0.8237	0.8374	-1.0213	-1.6002	-0.7476
Q02	0.7217	0.7838	0.7957	-1.0173	-1.2214	-0.8684
Q03	0.5493	0.6097	0.6304	-1.0098	-1.1970	-0.8237
Q04	0.5035	0.4768	0.4611	-0.9962	-1.2897	-0.5613
TYPE 7						
Q01	0.6770	0.6817	0.6842	-1.0452	-1.4359	-0.8701
Q02	0.6037	0.6271	0.6211	-0.9978	-1.0801	-0.8954
Q03	0.5592	0.6497	0.6640	-0.9793	-1.0603	-0.8943
Q04	0.4589	0.4876	0.5072	-1.0044	-1.1985	-0.7371
TYPE 8						
Q01	0.5579	0.5584	0.5587	-0.9916	-1.3476	-0.7938
Q02	0.4925	0.4901	0.4875	-1.0060	-1.1228	-0.9037
Q03	0.4227	0.4066	0.4023	-1.0219	-1.1220	-0.9155
Q04	0.3683	0.3716	0.3738	-0.9973	-1.2443	-0.6758
TYPE 9						
Q01	0.5939	0.6012	0.6102	-1.0220	-1.5454	-0.8126
Q02	0.5345	0.5374	0.5394	-0.9927	-1.1168	-0.8909
Q03	0.5215	0.5698	0.5732	-1.0032	-1.0723	-0.8994
Q04	0.4705	0.4684	0.4678	-1.0025	-1.2025	-0.6379
TYPE 10						
Q01	0.5393	0.5451	0.5480	-1.0323	-1.3765	-0.8931
Q02	0.4853	0.4896	0.4907	-1.0182	-1.1146	-0.9388
Q03	0.4437	0.4744	0.4745	-1.0123	-1.0913	-0.9408
Q04	0.4266	0.4279	0.4289	-0.9993	-1.2788	-0.6684

Figure A3:23-2 KITCHENER : Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	444.67	313.46	293.78	163.99	207.93	193.83	109.60
BM1=BM2=0	416.34	285.76	213.93	133.31	168.79	148.84	79.19
statistic	56.65	55.41	159.69	61.37	78.29	89.98	60.83
TYPE 2							
normal	674.51	419.50	484.86	193.45	338.69	299.35	190.19
BM1=BM2=0	644.25	336.17	387.98	130.37	277.08	234.22	159.05
statistic	60.51	166.65	193.76	126.16	123.23	130.26	62.29
TYPE 3							
normal	1158.34	592.82	767.28	263.37	418.44	455.15	327.01
BM1=BM2=0	962.07	528.92	657.68	259.41	345.15	399.55	282.37
statistic	392.53	127.80	219.20	7.93	146.59	111.20	89.27
TYPE 4							
normal	519.58	291.03	315.30	162.09	161.88	214.20	106.86
BM1=BM2=0	470.20	271.62	250.19	128.74	151.36	171.04	93.68
statistic	98.75	38.81	130.22	66.71	21.02	86.31	26.34
TYPE 5							
normal	832.23	459.27	513.85	185.80	305.58	343.53	175.41
BM1=BM2=0	706.48	416.46	436.00	179.12	275.29	301.97	148.06
statistic	251.51	85.62	155.70	13.34	60.59	83.12	54.69
TYPE 6							
normal	647.45	465.72	309.49	254.45	309.10	206.72	163.21
BM1=BM2=0	586.89	346.04	290.76	197.03	201.99	198.10	113.83
statistic	121.12	239.36	37.45	114.83	214.22	17.23	98.76
TYPE 7							
normal	321.01	191.06	172.19	89.44	122.79	114.23	75.63
BM1=BM2=0	290.96	178.44	127.86	77.54	110.34	88.21	50.22
statistic	60.11	25.23	88.66	23.80	24.89	52.05	50.82
TYPE 8							
normal	1007.67	549.24	474.40	199.01	391.46	330.02	159.83
BM1=BM2=0	724.91	408.57	369.95	158.96	279.22	259.17	117.25
statistic	565.53	281.34	208.91	80.09	224.47	141.69	85.16
TYPE 9							
normal	771.18	501.57	345.75	178.58	360.71	218.12	149.52
BM1=BM2=0	739.91	472.87	280.79	162.38	331.11	180.65	115.14
statistic	62.53	57.39	129.90	32.40	59.20	74.95	68.76
TYPE10							
normal	1657.83	1046.11	760.10	458.87	634.96	553.59	245.29
BM1=BM2=0	1394.40	909.38	554.39	411.90	526.05	401.28	174.73
statistic	526.85	273.46	411.41	93.95	217.84	304.62	141.13

Figure A3:24-2 KITCHENER : Log Likelihood Values:
[test of unity income elasticity]

0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1601	1	-230	17	1051	4826	7	1800	384
10	2	3061	1	753	157	1052	7017	7	3975	802
10	3	4737	1	2499	476	1053	9043	7	6350	1488
10	4	9376	1	7807	2149	105410954		7	7348	1804
10	5	1143	2	-99	35	105514904		714205		4900
10	6	2722	2	1607	298	1056	6568	8	3047	595
10	7	3764	2	2674	484	1057	9322	8	6164	1296
10	8	4458	2	3496	660	105810728		8	8030	1802
10	9	5011	2	4388	889	105911375		8	8564	1950
1010		5582	2	4559	941	106012070		8	9534	2163
1011		6511	2	5984	1350	106112799		810029		2218
1012		7502	2	7134	1725	106213568		811240		2653
1013		9899	210474		3114	106314387		812432		3049
1014		2822	3	576	162	106415418		813005		3245
1015		5064	3	3096	562	106516575		814162		3742
1016		6160	3	4350	828	106618867		817212		4907
1017		7094	3	5471	1090	106727160		83023911550		
1018		8068	3	6588	1321	1068	3730	9	308	190
1019		8876	3	7666	1611	1069	7325	9	3642	713
1020		9620	3	8439	1798	1070	8465	9	4923	1038
102110330			3	9497	2117	1071	8996	9	5245	1140
102211269			310470		2372	1072	9716	9	5883	1323
102312299			311827		2770	107310325		9	6719	1583
102413538			313444		3361	107411177		9	7646	1903
102517055			318660		5558	107511961		9	8818	2318
1026		972	4	-303	43	107613243		910288		2950
1027		3399	4	1614	293	107715529		913261		4330
1028		5025	4	2808	521	107823248		92769213269		
1029		6565	4	4079	813	1079	5765	10	2003	498
1030		7610	4	5428	1189	1080	8211	10	4263	923
103110560			4	9390	2681	1081	8871	10	5323	1140
1032		3243	5	475	193	1082	9455	10	5951	1366
1033		5628	5	2486	536	1083	9837	10	6395	1411
1034		6593	5	3829	777	108410291		10	6445	1472
1035		7448	5	5127	1065	108510608		10	6948	1494
1036		8305	5	6274	1281	108610968		10	7811	1787
1037		9051	5	6921	1467	108711342		10	7971	1799
1038		9876	5	7986	1756	108811704		10	7492	1686
103910928			5	9413	2181	108912026		10	7787	1753
104014029			512757		3389	109012299		10	9081	2098
1041		2791	6	-502	0	109112844		10	8731	2058
1042		3565	6	-295	22	109213354		1010248		2489
1043		4252	6	367	124	109313736		1010438		2543
1044		5042	6	-37	74	109414251		1011149		2927
1045		5891	6	530	111	109514683		1011393		2744
1046		6772	6	1777	339	109615449		1011918		2952
1047		7554	6	2054	409	109716162		1012992		3357
1048		8832	6	3519	735	109817412		1014423		4005
104911784			6	6564	1559	109919541		1017182		5254
105016841			612563		3954	11	027655	102844310430		

Figure A3:25-2 KITCHENER: Demand Calibration Data

```
0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1179.0360.8582.51132.          |  20 6337.6559.0825.51354.
20 2234.4393.9538.8784.0          |  20 7457.6651.4886.51236.
20 3383.3666.1897.31253.          |  20 8693.21007.1277.1859.
20 4265.6446.2614.6897.2          |  20 9555.3792.21005.1486.
20 5411.7625.0805.61145.          |  2010712.0953.91200.1749.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.475-.167.2796.1407.121251.7672.49179.01.643
21 2    0-.446-.183.3309.0515.187761.36102.6234.41.649
21 3    0-.332-.157.2303.1244.008374.82199.1383.31.663
21 4    0-.409-.110.2846.2518.107864.99121.6265.61.665
21 5    0-.321-.137.2219.2318.001777.09216.2411.71.693
21 6    0-.590-.134.3794.1317.246387.88106.9337.62.259
21 7    0-.434-.160.3263.1354.154285.25200.8457.62.308
21 8    0-.309-.147.1362.1900-.20491.78368.0693.22.336
21 9    0-.344-.140.2428.2081.035779.14281.8555.32.387
2110    0-.298-.122.2237.2389.008888.29386.0712.02.380
0000  (quartile 02)
22 1    0-.319-.123.2010.2734.002369.95189.1360.81.643
22 2    0-.272-.124.1564.2481-.13164.88220.4393.91.653
22 3    0-.190-.080.1353.3679-.10375.40415.4666.11.673
22 4    0-.294-.143.1258.2034-.22977.96242.2446.21.686
22 5    0-.218-.109.1343.2611-.20980.66376.2625.01.683
22 6    0-.461-.098.3935.2961.3104112.4232.8559.02.282
22 7    0-.343-.144.2338.2262.043194.90330.1651.42.340
22 8    0-.232-.094.0976.3417-.35799.21594.11007.2.364
22 9    0-.293-.155.1568.1739-.14296.59431.2792.22.397
2210    0-.255-.121.1775.2396-.083101.9546.9953.92.383
0000  (quartile 03)
23 1    0-.221-.083.1160.3846-.22578.25348.8582.51.650
23 2    0-.226-.097.1221.3465-.16573.18320.6538.81.664
23 3    0-.150-.078.1141.3299-.13180.18586.7897.31.676
23 4    0-.237-.068.1922.4989.021785.74360.1614.61.703
23 5    0-.177-.078.1428.4085.029284.32509.9805.61.688
23 6    0-.330-.125.2938.2678.2211119.1428.0825.52.256
23 7    0-.310-.098.2547.3839.1918116.7470.7886.52.351
23 8    0-.212-.107.0966.2175-.355114.9773.91277.2.358
23 9    0-.281-.103.2371.3343.1363117.5555.91005.2.399
2310    0-.226-.094.1934.3309.0604112.7715.21200.2.394
0000  (quartile 04)
24 1    0-.129-.068.0661.3281-.32987.78758.51132.1.652
24 2    0-.182-.104.0754.2410-.36584.95493.7784.01.669
24 3    0-.117-.061.0720.3610-.23687.18851.01253.1.678
24 4    0-.184-.093.0976.3483-.26196.14563.0897.21.712
24 5    0-.134-.074.0671.3198-.36989.48762.91145.1.703
24 6    0-.261-.142.0954.1547-.315154.7771.41354.2.266
24 7    0-.258-.119.1852.2442.0087133.6707.81236.2.361
24 8    0-.171-.082.0825.3266-.312134.91185.1859.2.362
24 9    0-.245-.119.1182.2313-.239151.2864.21486.2.399
2410    0-.214-.106.1061.2602-.256155.61059.1749.2.392
```

Figure A3:25-2(cont) KITCHENER: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1   48     1     1  | 3035  104     4     1  | 3069  141     2     2
30 2   61     1     1  | 3036  107     4     1  | 3070  159     2     2
30 3   68     1     1  | 3037  111     4     1  | 3071  208     2     2
30 4   74     1     1  | 3038  119     4     1  | 3072   81     3     2
30 5   79     1     1  | 3039  141     4     1  | 3073   93     3     2
30 6   85     1     1  | 3040  102     5     1  | 3074  101     3     2
30 7   90     1     1  | 3041   51     1     2  | 3075  107     3     2
30 8   95     1     1  | 3042   67     1     2  | 3076  113     3     2
30 9   99     1     1  | 3043   76     1     2  | 3077  122     3     2
3010  106     1     1  | 3044   81     1     2  | 3078  153     3     2
3011  116     1     1  | 3045   84     1     2  | 3079   49     4     2
3012  134     1     1  | 3046   87     1     2  | 3080   64     4     2
3013   52     2     1  | 3047   91     1     2  | 3081   69     4     2
3014   71     2     1  | 3048   94     1     2  | 3082   75     4     2
3015   79     2     1  | 3049   99     1     2  | 3083   80     4     2
3016   85     2     1  | 3050  105     1     2  | 3084   83     4     2
3017   89     2     1  | 3051  112     1     2  | 3085   86     4     2
3018   93     2     1  | 3052  141     1     2  | 3086   89     4     2
3019   96     2     1  | 3053   62     2     2  | 3087   92     4     2
3020  100     2     1  | 3054   80     2     2  | 3088   95     4     2
3021  104     2     1  | 3055   85     2     2  | 3089   98     4     2
3022  108     2     1  | 3056   89     2     2  | 3090  102     4     2
3023  114     2     1  | 3057   93     2     2  | 3091  106     4     2
3024  128     2     1  | 3058   97     2     2  | 3092  111     4     2
3025   81     3     1  | 3059  100     2     2  | 3093  115     4     2
3026  115     3     1  | 3060  103     2     2  | 3094  123     4     2
3027   40     4     1  | 3061  105     2     2  | 3095  135     4     2
3028   62     4     1  | 3062  108     2     2  | 3096  179     4     2
3029   71     4     1  | 3063  111     2     2  | 3097   63     5     2
3030   78     4     1  | 3064  113     2     2  | 3098   93     5     2
3031   84     4     1  | 3065  116     2     2  | 3099  115     5     2
3032   89     4     1  | 3066  121     2     2  | 31 0  166     5     2
3033   95     4     1  | 3067  126     2     2
3034  100     4     1  | 3068  132     2     2  |

0000 ZONAL Data
40 1 6661   21        | 40 2 7426   56        | 40 3 9185   52
40 4 6586   91        | 40 511095   93        | 40 613908   59
0000  Parameters
5011 .45              | 50121.22              | 5013 0.0
5016 .45              | 50171.91              | 5018 0.0
50201.300             |

0000 Calibration Data
70 12.1420.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   90961.000 89.3
70 22.2320.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  110581.000105.5
70 32.0880.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  133501.000107.4
70 42.2240.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   96521.000 95.3
70 52.0840.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  109951.000108.0
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:25-2(cont) KITCHENER: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1601	1	-230	17	1051	4826	7	1800	384
10	2	3061	1	753	157	1052	7017	7	3975	802
10	3	4737	1	2499	476	1053	9043	7	6350	1488
10	4	9376	1	7807	2149	105410954		7	7348	1804
10	5	1143	2	-99	35	105514904		714205		4900
10	6	2722	2	1607	298	1056	6568	8	3047	595
10	7	3764	2	2674	484	1057	9322	8	6164	1296
10	8	4458	2	3496	660	105810728		8	8030	1802
10	9	5011	2	4388	889	105911375		8	8564	1950
1010		5582	2	4559	941	106012070		8	9534	2163
1011		6511	2	5984	1350	106112799		810029		2218
1012		7502	2	7134	1725	106213568		811240		2653
1013		9899	210474		3114	106314387		812432		3049
1014		2822	3	576	162	106415418		813005		3245
1015		5064	3	3096	562	106516575		814162		3742
1016		6160	3	4350	828	106618867		817212		4907
1017		7094	3	5471	1090	106727160		83023911550		
1018		8068	3	6588	1321	1068	3730	9	308	190
1019		8876	3	7666	1611	1069	7325	9	3642	713
1020		9620	3	8439	1798	1070	8465	9	4923	1038
102110330			3	9497	2117	1071	8996	9	5245	1140
102211269			310470		2372	1072	9716	9	5883	1323
102312299			311827		2770	107310325		9	6719	1583
102413538			313444		3361	107411177		9	7646	1903
102517055			318660		5558	107511961		9	8818	2318
1026		972	4	-303	43	107613243		910288		2950
1027		3399	4	1614	293	107715529		913261		4330
1028		5025	4	2808	521	107823248		92769213269		
1029		6565	4	4079	813	1079	5765	10	2003	498
1030		7610	4	5428	1189	1080	8211	10	4263	923
103110560			4	9390	2681	1081	8871	10	5323	1140
1032		3243	5	475	193	1082	9455	10	5951	1366
1033		5628	5	2486	536	1083	9837	10	6395	1411
1034		6593	5	3829	777	108410291		10	6445	1472
1035		7448	5	5127	1065	108510608		10	6948	1494
1036		8305	5	6274	1281	108610968		10	7811	1787
1037		9051	5	6921	1467	108711342		10	7971	1799
1038		9876	5	7986	1756	108811704		10	7492	1686
103910928			5	9413	2181	108912026		10	7787	1753
104014029			512757		3389	109012299		10	9081	2098
1041		2791	6	-502	0	109112844		10	8731	2058
1042		3565	6	-295	22	109213354		1010248		2489
1043		4252	6	367	124	109313736		1010438		2543
1044		5042	6	-37	74	109414251		1011149		2927
1045		5891	6	530	111	109514683		1011393		2744
1046		6772	6	1777	339	109615449		1011918		2952
1047		7554	6	2054	409	109716162		1012992		3357
1048		8832	6	3519	735	109817412		1014423		4005
104911784			6	6564	1559	109919541		1017182		5254
105016841			612563		3954	11	027655	102844310430		

Figure A3:26-2 KITCHENER: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1179.0360.8582.51132.          |  20 6337.6559.0825.51354.
20 2234.4393.9538.8784.0          |  20 7457.6651.4886.51236.
20 3383.3666.1897.31253.          |  20 8693.21007.1277.1859.
20 4265.6446.2614.6897.2          |  20 9555.3792.21005.1486.
20 5411.7625.0805.61145.          |  2010712.0953.91200.1749.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.475-.167.2796.1407.121251.7672.49179.01.643
21 2    0-.446-.183.3309.0515.187761.36102.6234.41.649
21 3    0-.332-.157.2303.1244.008374.82199.1383.31.663
21 4    0-.409-.110.2846.2518.107864.99121.6265.61.665
21 5    0-.321-.137.2219.2318.001777.09216.2411.71.693
21 6    0-.590-.134.3794.1317.246387.88106.9337.62.259
21 7    0-.434-.160.3263.1354.154285.25200.8457.62.308
21 8    0-.309-.147.1362.1900-.20491.78368.0693.22.336
21 9    0-.344-.140.2428.2081.035779.14281.8555.32.387
2110    0-.298-.122.2237.2389.008888.29386.0712.02.380
0000  (quartile 02)
22 1    0-.319-.123.2010.2734.002369.95189.1360.81.643
22 2    0-.272-.124.1564.2481-.13164.88220.4393.91.653
22 3    0-.190-.080.1353.3679-.10375.40415.4666.11.673
22 4    0-.294-.143.1258.2034-.22977.96242.2446.21.686
22 5    0-.218-.109.1343.2611-.20980.66376.2625.01.683
22 6    0-.461-.098.3935.2961.3104112.4232.8559.02.282
22 7    0-.343-.144.2338.2262.043194.90330.1651.42.340
22 8    0-.232-.094.0976.3417-.35799.21594.11007.2.364
22 9    0-.293-.155.1568.1739-.14296.59431.2792.22.397
2210    0-.255-.121.1775.2396-.083101.9546.9953.92.383
0000  (quartile 03)
23 1    0-.221-.083.1160.3846-.22578.25348.8582.51.650
23 2    0-.226-.097.1221.3465-.16573.18320.6538.81.664
23 3    0-.150-.078.1141.3299-.13180.18586.7897.31.676
23 4    0-.237-.068.1922.4989.021785.74360.1614.61.703
23 5    0-.177-.078.1428.4085.029284.32509.9805.61.688
23 6    0-.330-.125.2938.2678.2211119.1428.0825.52.256
23 7    0-.310-.098.2547.3839.1918116.7470.7886.52.351
23 8    0-.212-.107.0966.2175-.355114.9773.91277.2.358
23 9    0-.281-.103.2371.3343.1363117.5555.91005.2.399
2310    0-.226-.094.1934.3309.0604112.7715.21200.2.394
0000  (quartile 04)
24 1    0-.129-.068.0661.3281-.32987.78758.51132.1.652
24 2    0-.182-.104.0754.2410-.36584.95493.7784.01.669
24 3    0-.117-.061.0720.3610-.23687.18851.01253.1.678
24 4    0-.184-.093.0976.3483-.26196.14563.0897.21.712
24 5    0-.134-.074.0671.3198-.36989.48762.91145.1.703
24 6    0-.261-.142.0954.1547-.315154.7771.41354.2.266
24 7    0-.258-.119.1852.2442.0087133.6707.81236.2.361
24 8    0-.171-.082.0825.3266-.312134.91185.1859.2.362
24 9    0-.245-.119.1182.2313-.239151.2864.21486.2.399
2410    0-.214-.106.1061.2602-.256155.61059.1749.2.392
```

Figure A3:26-2(cont) KITCHENER: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1    38     1     1  | 3022    81     1     2  | 3043   124     2     2
30 2    56     1     1  | 3023    85     1     2  | 3044   129     2     2
30 3    64     1     1  | 3024    89     1     2  | 3045   142     2     2
30 4    68     1     1  | 3025    93     1     2  | 3046   175     2     2
30 5    75     1     1  | 3026    97     1     2  | 3047   132     3     2
30 6    85     1     1  | 3027   103     1     2  | 3048    44     4     2
30 7   107     1     1  | 3028   109     1     2  | 3049    68     4     2
30 8    53     2     1  | 3029   116     1     2  | 3050    74     4     2
30 9    68     2     1  | 3030   122     1     2  | 3051    77     4     2
3010    79     2     1  | 3031   149     1     2  | 3052    81     4     2
3011   102     2     1  | 3032    67     2     2  | 3053    85     4     2
3012    43     4     1  | 3033    78     2     2  | 3054    89     4     2
3013    59     4     1  | 3034    84     2     2  | 3055    93     4     2
3014    68     4     1  | 3035    91     2     2  | 3056    96     4     2
3015    76     4     1  | 3036    97     2     2  | 3057   100     4     2
3016    87     4     1  | 3037   102     2     2  | 3058   107     4     2
3017   112     4     1  | 3038   106     2     2  | 3059   113     4     2
3018   186     5     1  | 3039   110     2     2  | 3060   120     4     2
3019    61     1     2  | 3040   113     2     2  | 3061   128     4     2
3020    73     1     2  | 3041   117     2     2  | 3062   169     4     2
3021    77     1     2  | 3042   120     2     2  | 3063   127     5     2

0000 ZONAL Data
40 1 6661   21          | 40 2 7426   56          | 40 3 9185   52
40 4 6586   91          | 40 511095   93          | 40 610908   59
0000  Parameters
50 1 .1                 | 50 2 .3                 |
5011 .45                | 50121.22                | 5013 38.
5016 .45                | 50171.91                | 5018 74.
50201.300               |

0000 Calibration Data
70 11.5540.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   88851.000 93.2
70 21.6200.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  107411.000 97.3
70 31.6160.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  150571.000103.2
70 41.5540.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   92271.000 98.0
70 51.4670.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  110871.000110.2
70 61.7810.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  103621.000 99.5
70 72.4130.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   91460.928 90.7
70 82.5100.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  111020.892 97.8
70 92.3710.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  149941.000112.0
70102.4570.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   98430.948 93.8
70112.0320.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  109201.000112.7
70122.2080.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  114041.000122.7
```

Figure A3:26-2(cont) KITCHENER: Supply Calibration Data

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
10 1 1601    1 -229   17        141.450 46.4
10 2 3061    1  753  157       9991.837 53.4
10 3 4737    1 2499  476       9991.837 60.4
10 4 9376    1 7807 2149       9991.837 73.1
10 5 1143    2  -98   35         21.366 33.8
10 6 2722    2 1607  298       9991.837 52.3
10 7 3764    2 2674  484       9991.837 57.7
10 8 4458    2 3496  660       9991.837 55.8
10 9 5011    2 4388  889       9991.837 55.6
1010 5582    2 4559  941       9991.837 58.3
1011 6511    2 5984 1350       9991.837 61.4
1012 7502    2 7134 1725       9991.837 66.1
1013 9899    210474 3114         91.875 72.5
1014 2822    3  576  162         81.670 46.6
1015 5064    3 3096  562       9991.837 67.4
1016 6160    3 4350  828       9991.837 69.7
1017 7094    3 5471 1090       9991.837 68.2
1018 8068    3 6588 1321       9991.837 64.0
1019 8876    3 7666 1611       9991.837 66.0
1020 9620    3 8439 1798       9991.837 67.1
102110330    3 9497 2117       9991.837 67.6
102211269    310470 2372         31.860 67.2
102312299    311827 2770       9991.837 71.0
102413538    313444 3361         41.857 71.2
102517055    318660 5558        111.722 94.3
1026  972    4 -302   43         11.429 25.0
1027 3399    4 1614  293        161.606 71.5
1028 5025    4 2808  521       9991.837 66.9
1029 6565    4 4079  813       9991.837 72.8
1030 7610    4 5428 1189        101.804 78.3
103110560    4 9390 2681        181.463127.6
1032 3243    5  475  193        151.558 58.7
1033 5628    5 2486  536        171.591 90.0
1034 6593    5 3829  777       9991.837 71.4
1035 7448    5 5127 1065       9991.837 69.4
1036 8305    5 6274 1281       9991.837 71.1
1037 9051    5 6921 1467       9991.837 72.0
1038 9876    5 7986 1756         51.808 74.9
103910928    5 9413 2181         61.764 81.5
104014029    512757 3389         71.680 94.3
1041 2791    6 -501    0        521.999 71.6
1042 3565    6 -294   22        542.119 84.6
1043 4252    6  367  124       9992.596 75.1
1044 5042    6  -36   74       9992.596 82.8
1045 5891    6  530  111       9992.596 89.0
1046 6772    6 1777  339       9992.596 93.0
1047 7554    6 2054  409       9992.596 96.0
1048 8832    6 3519  735       9992.596 97.5
104911784    6 6564 1559        632.283132.1
105016841    612563 3954        442.424143.9
```

Figure A3:27-2 KITCHENER: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
1051 4826     7 1800  384          552.105 86.8
1052 7017     7 3975  802         9992.596 78.9
1053 9043     7 6350 1488         9992.596 88.9
105410954     7 7348 1804          282.378116.5
105514904     714205 4900          412.437128.5
1056 6568     8 3047  595          322.359 71.2
1057 9322     8 6164 1296         9992.596 80.2
105810728     8 8030 1802         9992.596 83.2
105911375     8 8564 1950         9992.596 83.7
106012070     8 9534 2163         9992.596 83.7
106112799     810029 2218         9992.596 86.9
106213568     811240 2653          232.503 96.3
106314387     812432 3049          242.494100.4
106415418     813005 3245          272.404111.4
106516575     814162 3742          382.413115.1
106618867     817212 4907          392.434120.6
106727160     83023911550          452.431155.4
1068 3730     9  308  190          511.918 63.2
1069 7325     9 3642  713          562.234 94.6
1070 8465     9 4923 1038          572.269100.3
1071 8996     9 5245 1140         9992.596 82.4
1072 9716     9 5883 1323         9992.596 85.9
107310325     9 6719 1583          602.226117.5
107411177     9 7646 1903          352.509102.4
107511961     9 8818 2318          292.350121.0
107613243     910288 2950          622.113155.6
107715529     913261 4330          432.444135.4
107823248     92769213269          472.696161.3
1079 5765    10 2003  498          532.058 76.1
1080 8211    10 4263  923          202.465 80.8
1081 8871    10 5323 1140         9992.596 78.7
1082 9455    10 5951 1366          212.500 86.7
1083 9837    10 6395 1411          582.242106.1
108410291    10 6445 1472         9992.596 84.5
108510608    10 6948 1494         9992.596 85.6
108610968    10 7811 1787          592.238111.7
108711342    10 7971 1799          222.524 92.1
108811704    10 7492 1686         9992.596 89.0
108912026    10 7787 1753          332.584 91.1
109012299    10 9081 2098          612.185123.0
109112844    10 8731 2058          252.461102.6
109213354    1010248 2489          342.565 97.2
109313736    1010438 2543          262.452106.5
109414251    1011149 2927          362.465107.1
109514683    1011393 2744          372.441111.3
109615449    1011918 2952          302.331126.2
109716162    1012992 3357          402.425122.5
109817412    1014423 4005          422.429130.3
109919541    1017182 5254          312.331154.2
11 027655    102844310430          462.474194.2
```

Figure A3:27-2 KITCHENER: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1179.0360.8582.51132.          |  20 6337.6559.0825.51354.
20 2234.4393.9538.8784.0          |  20 7457.6651.4886.51236.
20 3383.3666.1897.31253.          |  20 8693.21007.1277.1859.
20 4265.6446.2614.6897.2          |  20 9555.3792.21005.1486.
20 5411.7625.0805.61145.          |  2010712.0953.91200.1749.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.475-.167.2796.1407.121251.7672.49179.01.643
21 2    0-.446-.183.3309.0515.187761.36102.6234.41.649
21 3    0-.332-.157.2303.1244.008374.82199.1383.31.663
21 4    0-.409-.110.2846.2518.107864.99121.6265.61.665
21 5    0-.321-.137.2219.2318.001777.09216.2411.71.693
21 6    0-.590-.134.3794.1317.246387.88106.9337.62.259
21 7    0-.434-.160.3263.1354.154285.25200.8457.62.308
21 8    0-.309-.147.1362.1900-.20491.78368.0693.22.336
21 9    0-.344-.140.2428.2081.035779.14281.8555.32.387
2110    0-.298-.122.2237.2389.008888.29386.0712.02.380
0000  (quartile 02)
22 1    0-.319-.123.2010.2734.002369.95189.1360.81.643
22 2    0-.272-.124.1564.2481-.13164.88220.4393.91.653
22 3    0-.190-.080.1353.3679-.10375.40415.4666.11.673
22 4    0-.294-.143.1258.2034-.22977.96242.2446.21.686
22 5    0-.218-.109.1343.2611-.20980.66376.2625.01.683
22 6    0-.461-.098.3935.2961.3104112.4232.8559.02.282
22 7    0-.343-.144.2338.2262.043194.90330.1651.42.340
22 8    0-.232-.094.0976.3417-.35799.21594.11007.2.364
22 9    0-.293-.155.1568.1739-.14296.59431.2792.22.397
2210    0-.255-.121.1775.2396-.083101.9546.9953.92.383
0000  (quartile 03)
23 1    0-.221-.083.1160.3846-.22578.25348.8582.51.650
23 2    0-.226-.097.1221.3465-.16573.18320.6538.81.664
23 3    0-.150-.078.1141.3299-.13180.18586.7897.31.676
23 4    0-.237-.068.1922.4989.021785.74360.1614.61.703
23 5    0-.177-.078.1428.4085.029284.32509.9805.61.688
23 6    0-.330-.125.2938.2678.2211119.1428.0825.52.256
23 7    0-.310-.098.2547.3839.1918116.7470.7886.52.351
23 8    0-.212-.107.0966.2175-.355114.9773.91277.2.358
23 9    0-.281-.103.2371.3343.1363117.5555.91005.2.399
2310    0-.226-.094.1934.3309.0604112.7715.21200.2.394
0000  (quartile 04)
24 1    0-.129-.068.0661.3281-.32987.78758.51132.1.652
24 2    0-.182-.104.0754.2410-.36584.95493.7784.01.669
24 3    0-.117-.061.0720.3610-.23687.18851.01253.1.678
24 4    0-.184-.093.0976.3483-.26196.14563.0897.21.712
24 5    0-.134-.074.0671.3198-.36989.48762.91145.1.703
24 6    0-.261-.142.0954.1547-.315154.7771.41354.2.266
24 7    0-.258-.119.1852.2442.0087133.6707.81236.2.361
24 8    0-.171-.082.0825.3266-.312134.91185.1859.2.362
24 9    0-.245-.119.1182.2313-.239151.2864.21486.2.399
2410    0-.214-.106.1061.2602-.256155.61059.1749.2.392
```

Figure A3:27-2(cont) KITCHENER: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1    38     1     1  | 3022    81     1     2  | 3043   124     2     2
30 2    56     1     1  | 3023    85     1     2  | 3044   129     2     2
30 3    64     1     1  | 3024    89     1     2  | 3045   142     2     2
30 4    68     1     1  | 3025    93     1     2  | 3046   175     2     2
30 5    75     1     1  | 3026    97     1     2  | 3047   132     3     2
30 6    85     1     1  | 3027   103     1     2  | 3048    44     4     2
30 7   107     1     1  | 3028   109     1     2  | 3049    68     4     2
30 8    53     2     1  | 3029   116     1     2  | 3050    74     4     2
30 9    68     2     1  | 3030   122     1     2  | 3051    77     4     2
3010    79     2     1  | 3031   149     1     2  | 3052    81     4     2
3011   102     2     1  | 3032    67     2     2  | 3053    85     4     2
3012    43     4     1  | 3033    78     2     2  | 3054    89     4     2
3013    59     4     1  | 3034    84     2     2  | 3055    93     4     2
3014    68     4     1  | 3035    91     2     2  | 3056    96     4     2
3015    76     4     1  | 3036    97     2     2  | 3057   100     4     2
3016    87     4     1  | 3037   102     2     2  | 3058   107     4     2
3017   112     4     1  | 3038   106     2     2  | 3059   113     4     2
3018   186     5     1  | 3039   110     2     2  | 3060   120     4     2
3019    61     1     2  | 3040   113     2     2  | 3061   128     4     2
3020    73     1     2  | 3041   117     2     2  | 3062   169     4     2
3021    77     1     2  | 3042   120     2     2  | 3063   127     5     2

0000 ZONAL Data
40 1 6661   21         | 40 2 7426   56         | 40 3 9185   52
40 4 6586   91         | 40 511095   93         | 40 610908   59

0000  Parameters
50 10.100              | 50 20.300              |
50 30.500              | 50 40.380              | 50 71.253
50 50.500              | 50 60.310              | 50 81.298
50110.450              | 50121.220              | 5013 51.0
50160.450              | 50171.910              | 5018 74.0
50201.300              |
```

Figure A3:27-2(cont) KITCHENER: MODIFIED Policy Dataset

QUEBEC CITY

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	27	27
2	18	19
3	23	22
4	7	10
5	7	8
A	-	11
Total	82	97

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 5

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	54.	72.	10,914.	17,606.	2,810.	7,624.	29.
2	77.	103.	17,184.	24,438.	3,620.	9,718.	51.
3	52.	88.	11,651.	17,567.	2,995.	9,362.	100.
4	82.	139.	18,504.	27,334.	4,958.	13,273.	99.
5	63.	106.	15,014.	20,198.	4,104.	10,287.	101.
A		106.		19,402.		9,834.	101.
total	65.	100.	14,340.	21,214.	3,548.	9,800.	73.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	24,449.	25,370.	19.9	2,053.	8.1	4.6
2	23,687.	32,865.	25.8	8,368.	25.5	18.6
3	14,738.	19,645.	15.5	7,676.	39.1	17.1
4	6,661.	17,215.	13.5	9,640.	56.0	21.5
5	9,366.	12,450.	9.8	5,971.	52.0	14.4
A		19,590.	15.4	10,677.	54.5	23.8
	78,901.	127,135.	100.0	44,894.	35.3	100.0

source: program "CZONE.FORT": files QUE61.INPUT and QUE71.INPUT.

Figure A3:01-3 QUEBEC CITY: Zonal Characteristics (5 zones)

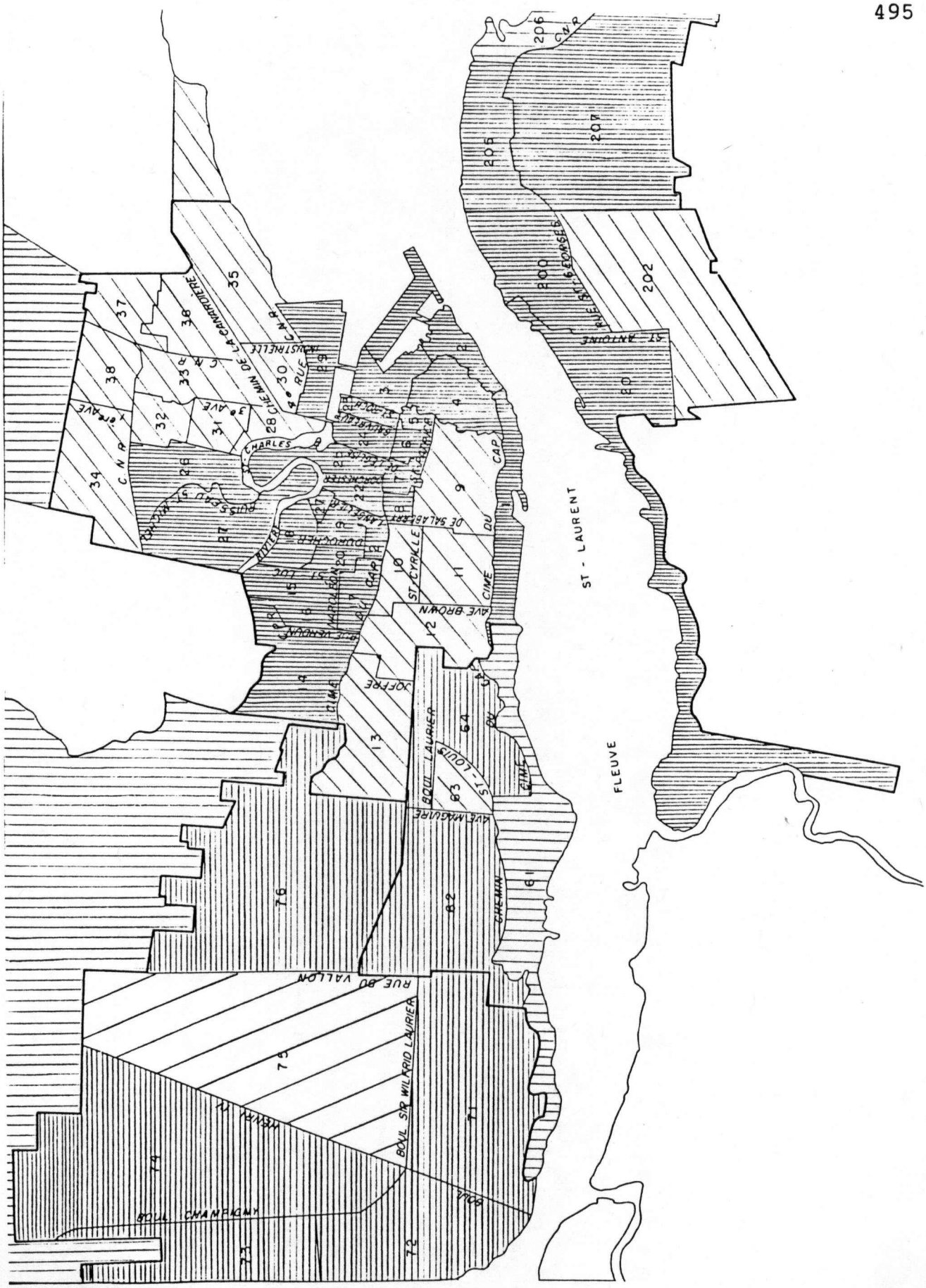

Figure A3:02-3 QUEBEC CITY: Clustering (5 zones)

Demographic Characteristics:

Population [1] 1961: 357,568.
[2] 1971: 480,505.

Households [1] 1961: 79,139.
[2] 1971: 127,510.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 9,800.
1974 SHU data [4] : 10,879.

deflator : 0.9001

SHU deflated : 9,992.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file QUE.SHU

SHU dataset:

Sample size : 2843.
Sum of the WEIGHTs : 99,885.

RATIO of SHU weights
to actual households : 0.78335

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	9,852.	5,874.	6.	979.	1250.
2	11,807.	38,230.	38.	1006.	1284.
3	10,006.	7,038.	7.	1005.	1283.
4	12,859.	13,422.	13.	1032.	1317.
5	8,222.	7,159.	7.	1023.	1306.
6	5,946.	9,555.	10.	956.	1220.
7	7,042.	12,581.	13.	968.	1236.
8	4,850.	6,026.	6.	1004.	1282.

source: program "HH1.FORT" :file QUE.SHU

Figure A3:03-3 QUEBEC CITY: HOUSEHOLD Characteristics.

Total 1961 dwellings : 78,901.

Rental	:	45,631.
Owner-occupier	:	33,270.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	54.	17,923.	10,575.	6,526.	0.0648
2	74.	16,398.	17,920.	7,289.	0.0600
3	50.	5,876.	11,334.	8,862.	0.0564
4	87.	1,746.	20,136.	4,915.	0.0444
5	64.	3,691.	14,634.	5,675.	0.0564
total	63.	45,634.	14,490.	33,270.	0.0528

source: program "D61.FORT" : dataset QUE61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings : TOTAL		78,901.
: RATIO of EXISTING unannexed/TOTAL		92.9%
: TOTAL 1961 Dwellings EXISTING in 1971		82,241.
: TOTAL 1961 Dwellings ADJUSTED for ANNEXED		88,491.
: 1971 "model" Dwellings		100.
: 1971 RATIO ACTUAL/"model"		1271.
: 1961 "model" Dwellings		70.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	24,449.	22.	1111.	1.1502	1.0316
2	23,687.	21.	1128.	0.8880	0.7964
3	14,378.	13.	1134.	1.3382	1.2002
4	6,661.	6.	1110.	0.9998	0.8967
5	9,366.	8.	1171.	1.1156	1.0005

error of fit 0.01162

source: program "D61.FORT" : dataset QUE61.INPUT.

Figure A3:04-3 QUEBEC CITY: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	2.1774	3.1012	2.0541	1.7145
	(2.58)	(5.22)	(5.26)	(4.46)
MULTIPLE	0.5896	0.5023	0.1462	0.1818
	(4.07)	(6.10)	(2.83)	(3.49)
CONSTRUCTED PRE 20	-.2355	-.4226	-.3230	-.3048
	(2.33)	(4.94)	(7.00)	(7.75)
20-45	-.2250	-.3030	-.1336	-.1806
	(2.17)	(3.43)	(2.81)	(4.27)
CONDITION	0.0311	0.0278	0.1135	0.1244
	(0.23)	(0.27)	(1.91)	(2.40)
LN ROOMS	1.2845	1.4322	0.4942	0.3564
	(7.27)	(10.0)	(6.03)	(4.93)
LN INCOME	0.6290	0.4880	0.4718	0.5380
	(5.78)	(6.31)	(9.32)	(10.8)
ACCESS	-.0022	0.0022	-.0025	-.0024
	(2.45)	(3.07)	(5.97)	(6.88)
R2	0.39	0.99	0.62	0.99
OBSERVATIONS	343	343	338	338

note : "t" statistis in brackets
: data source: QUE61.EA

MEANS:

LN INCOME	8.1284
MULTIPLE	0.6456
ACCESS	66.5

Figure A3:05-3 QUEBEC CITY: 1961 Hedonic Estimates

Total 1971 dwellings : 127,125.

Rental	:	73,580.
Owner-occupier	:	53,545.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	71.	19,080.	16,387.	6,280.	0.0528
2	103.	24,930.	23,269.	7,920.	0.0529
3	98.	15,870.	18,515.	23,385.	0.0636
4	138.	8,490.	27,963.	8,720.	0.0588
5	111.	5,210.	19,111.	7,240.	0.0696
total	98.	73,580.	20,588.	53,545.	0.0576

source: program "D71.FORT" : dataset QUE71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	25,360.	20.	1268.	1.1078	1.0600
2	32,850.	26.	1263.	0.9404	0.8998
3	39,255.	32.	1227.	1.0896	1.0425
4	17,210.	13.	1324.	0.8626	0.8254
5	12,450.	9.	1383.	1.0485	1.0033
			1271.		

error of fit 0.02652

source: program "D71.FORT" : dataset QUE71.INPUT.

Figure A3:06-3 QUEBEC CITY: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 127,125.

Built prior 1961 : 82,264.
Built 1961-1971 : 44,861.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	77.	17,667.	17,698.	5,646.	0.0528
2	95.	17,636.	24,511.	6,874.	0.0468
3	82.	8,610.	17,132.	12,291.	0.0576
4	115.	2,318.	27,312.	5,260.	0.0504
5	90.	2,426.	17,890.	3,536.	0.0600
99	120.	24,923.	22,403.	19,938.	0.0648
CMA	98.	73,580.	21,152.	53,545.	0.0648

source: program "D71.FORT" : dataset QUE71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	23,313.	18.	1295.	1.0160	0.9890
2	24,510.	19.	1290.	0.9568	0.9314
3	20,902.	16.	1306.	1.2008	1.1689
4	7,578.	6.	1263.	0.9113	0.8871
5	5,962.	5.	1192.	1.1683	1.1373
99	44,861.	36.	1246.	0.9342	0.9094
			1271.		

error of fit 0.02122

source: program "D71.FORT" : dataset QUE71.INPUT.

Figure A3:07-3 QUEBEC CITY: 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	7.630	7.463	5.8029	5.988
	(41.3)	(43.1)	(45.7)	(54.1)
MULTIPLE	0.2244	0.2332	-.0184	-.0212
	(6.96)	(7.51)	(0.40)	(0.49)
CONSTRUCTION 51-60	0.0183	-.020	-.2280	-.2236
	(0.49)	(0.60)	(8.42)	(8.46)
46-50	-.1429	-.1776	-.3753	-.3902
	(2.70)	(3.55)	(11.7)	(12.5)
20-45	-.1568	-.2246	-.3919	-.4265
	(3.49)	(5.01)	(15.7)	(17.4)
PRE 20	-.3436	-.4239	-.4521	-.4555
	(7.58)	(9.75)	(17.4)	(18.4)
FACILITIES	0.2328	0.1576	0.4287	0.3996
	(2.93)	(2.03)	(10.9)	(11.5)
LN INCOME	0.1129	0.1239	0.0975	0.0812
	(6.06)	(6.97)	(7.21)	(6.90)
LN ROOMS	0.5543	0.6470	0.1825	0.1685
	(10.6)	(13.1)	(7.11)	(6.87)
R2	0.23	0.98	0.43	0.98
OBSERVATIONS	1002	1002	1226	1226
WEIGHTED 20-45/PRE 20	-.2527	-.3269	-.4215	-.4408

note : "t" statistis in brackets
: data source: QUE.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	9.1149
MULTIPLE	0.3902
ACCESS	70.0

Figure A3:08-3 QUEBEC CITY: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	21,214.	32,570.	0.65134
RENT	100.	129.	0.77519
INCOME	9,800.	10,879.	0.9001

R/V ratio: 0.0576 P(j)/PN ratio: 0.99185

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.4936 (73.9)	0.1210	2.5135 (70.6)	0.1235	0.1242
DUMMY (TYPE 2)	-.0875 (2.30)	0.1109	-.1197 (3.05)	0.1096	0.1102
DUMMY (TYPE 3)	-.0270 (0.54)	0.1178	-.0186 (0.36)	0.1212	0.1289
DUMMY (TYPE 4)	-.2100 (4.69)	0.0981	-.2290 (5.07)	0.0982	0.0987
DUMMY (TYPE 5)	0.2027 (4.38)	0.1482	0.1496 (2.88)	0.1434	0.1442
DUMMY (TYPE 6)	0.6199 (13.0)	0.2250	0.5966 (12.5)	0.2242	0.2252
DUMMY (TYPE 7)	0.2962 (6.41)	0.1628	0.2903 (6.33)	0.1651	0.1659
DUMMY (TYPE 8)	0.6457 (12.1)	0.2308	0.6038 (11.1)	0.2259	0.2270
R2	0.20		0.72		
OBSERVATIONS	2788		2788		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-3 QUEBEC CITY: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	9.6765 (65.1)	9.4023 (63.2)	0.1155	0.0851	0.1977
DUMMY (TYPE 2)	0.0116 (0.41)	-.0163 (0.55)	0.0991	0.0555	0.5398
DUMMY (TYPE 3)	0.0285 (0.78)	0.0193 (0.51)	0.1165	0.0908	0.1804
DUMMY (TYPE 4)	-.0255 (0.77)	-.0534 (1.57)	0.0895	0.0595	0.1973
DUMMY (TYPE 5)	0.0390 (1.15)	-.0459 (1.18)	0.1265	0.0809	0.2401
DUMMY (TYPE 6)	0.1725 (4.80)	0.1577 (4.30)	0.1982	0.1278	0.5370
DUMMY (TYPE 7)	0.0127 (0.37)	-.0263 (0.75)	0.1451	0.0906	0.3230
DUMMY (TYPE 8)	0.0739 (1.81)	-.0122 (0.29)	0.1951	0.1233	0.3625
LN INCOME	-.7881 (49.1)	-.7564 (47.0)			
R2	0.57	0.85			
OBSERVATIONS	2788	2788			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Figure A3:09-3(b) QUEBEC CITY: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	753.0	848.	3,247	-	-	-
1962	765.0	858.	3,946	0.081	62.0	69.5
1963	775.0	922.	4,535	0.093	72.1	85.7
1964	795.0	958.	4,257	0.087	69.2	83.3
1965	819.0	977.	4,228	0.086	70.4	84.0
1966	846.0	1144.	3,373	0.069	58.4	79.0
1967	887.0	1174.	2,841	0.058	51.5	68.1
1968	990.0	1439.	4,903	0.100	97.1	143.9
1969	993.0	1681.	6,184	0.125	124.3	210.1
1970	1063.0	1786.	6,421	0.131	139.3	234.0
1971	1133.0	1662.	8,074	0.169	191.6	280.9

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	753.0	848.0	1601.0	0.470	0.530	1.000	--
decade weighted	936.0	1339.0	2275.0	0.584	0.836	1.420	44.6
1971	1133.7	1662.0	2795.7	0.708	1.038	1.746	36.3

Figure A3:10-3 QUEBEC CITY: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 1 9852
20 211806
20 310005
20 412859
20 5 8221
20 6 5946
20 7 7042
20 8 4849

0000 ALPHA by TYPE
21 1.1235
21 2.1096
21 3.1212
21 4.0982
21 5.1434
21 6.2242
21 7.1651
21 8.2259

0000 "MODEL" HOUSEHOLDS
10 1 3015     1
10 2 6416     1
10 3 8137     1
10 4 9745     1
10 512372     1
10 619300     1
10 7  282     2
10 8 1775     2
10 9 2985     2
1010 3868     2
1011 4826     2
1012 5496     2
1013 5950     2
1014 6302     2
1015 6666     2
1016 6946     2
1017 7253     2
1018 7667     2
1019 7965     2
1020 8455     2
1021 8817     2
1022 9088     2
1023 9293     2
1024 9568     2
1025 9952     2
102610262     2
102710717     2
102810973     2
102911269     2
103011695     2
103112165     2
103212832     2
103313491     2
103414121     2
103514825     2
103615697     2
103716628     2
103817788     2
103918595     2
104019756     2
104121614     2
104224783     2
104330694     2
104442379     2
1045 3816     3
1046 6855     3
1047 8255     3
1048 9704     3
104911148     3
105012833     3
105117329     3
1052 2255     4
1053 4614     4
1054 6854     4
1055 8264     4
1056 9322     4
105710330     4
105811526     4
105913116     4
106014506     4
106116105     4
106218094     4
106321683     4
106431597     4
1065 2003     5
1066 3158     5
1067 4661     5
1068 6235     5
1069 8141     5
107011853     5
107122034     5
1072  661     6
1073 1659     6
1074 2762     6
1075 3531     6
1076 4549     6
1077 5647     6
1078 6774     6
1079 8320     6
108010102     6
108115624     6
1082 1207     7
1083 1805     7
1084 2478     7
1085 3354     7
1086 4518     7
1087 5290     7
1088 6223     7
1089 6985     7
1090 7702     7
1091 8801     7
109210658     7
109312629     7
109419847     7
1095 1238     8
1096 1996     8
1097 2732     8
1098 3918     8
1099 6250     8
11 013325     8
```

Figure A3:11-3 QUEBEC CITY: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1   20   17    1 | 3035   78   64    2 | 3069   98   80    3
30 2   37   30    1 | 3036   81   66    2 | 3070  102   83    3
30 3   48   39    1 | 3037   83   67    2 | 3071  106   86    3
30 4   55   45    1 | 3038   85   69    2 | 3072  110   89    3
30 5   58   47    1 | 3039   87   71    2 | 3073  115   93    3
30 6   61   49    1 | 3040   90   73    2 | 3074  119   97    3
30 7   64   52    1 | 3041   93   75    2 | 3075  124  101    3
30 8   66   54    1 | 3042   96   78    2 | 3076  129  105    3
30 9   69   56    1 | 3043   99   80    2 | 3077  141  114    3
3010   72   58    1 | 3044  106   86    2 | 3078  187  152    3
3011   75   61    1 | 3045  118   96    2 | 3079   40   33    4
3012   77   63    1 | 3046  169  137    2 | 3080   59   48    4
3013   80   65    1 | 3047   17   14    3 | 3081   67   54    4
3014   83   67    1 | 3048   32   26    3 | 3082   74   60    4
3015   86   70    1 | 3049   39   32    3 | 3083   81   66    4
3016   91   74    1 | 3050   46   37    3 | 3084   86   70    4
3017   96   78    1 | 3051   52   42    3 | 3085   92   75    4
3018  104   84    1 | 3052   55   45    3 | 3086   98   79    4
3019  118   96    1 | 3053   58   47    3 | 3087  103   84    4
3020  162  132    1 | 3054   61   49    3 | 3088  109   88    4
3021   33   27    2 | 3055   64   52    3 | 3089  115   94    4
3022   45   37    2 | 3056   66   54    3 | 3090  126  102    4
3023   51   41    2 | 3057   69   56    3 | 3091  155  126    4
3024   54   44    2 | 3058   71   58    3 | 3092   32   26    5
3025   56   46    2 | 3059   73   60    3 | 3093   53   43    5
3026   59   48    2 | 3060   75   61    3 | 3094   64   52    5
3027   61   50    2 | 3061   78   63    3 | 3095   72   59    5
3028   63   51    2 | 3062   80   65    3 | 3096   80   65    5
3029   65   53    2 | 3063   82   67    3 | 3097   90   73    5
3030   68   55    2 | 3064   84   69    3 | 3098  103   84    5
3031   70   57    2 | 3065   87   70    3 | 3099  115   94    5
3032   72   58    2 | 3066   89   72    3 | 31 0  143  116    5
3033   74   60    2 | 3067   92   75    3
3034   76   62    2 | 3068   95   77    3

0000 ZONAL DATA
40 1 7624   29
40 2 9718   51
40 3 9362  108
40 413273  107
40 510010  110
40 6 9799   77

0000 Calibration Data
70 11.3650.0580.3950.0360.1040.1050.0670.1620.072 75771.000 76.0
70 21.5330.0680.3970.0460.1310.1140.0600.1240.060 97161.000 78.1
70 31.3760.1190.5990.0530.0820.0620.0190.0460.020 96241.000 84.2
70 41.3420.1010.5370.0560.1020.0470.0570.0860.014132731.000 92.6
70 51.4160.1170.5750.0560.0910.0520.0360.0560.016102861.000 83.5
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:11-3A QUEBEC CITY: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 1 9852
20 211806
20 310005
20 412859
20 5 8221
20 6 5946
20 7 7042
20 8 4849

0000 ALPHA by TYPE
21 1.1235
21 2.1096
21 3.1212
21 4.0982
21 5.1434
21 6.2242
21 7.1651
21 8.2259
```

```
0000 "MODEL" HOUSEHOLDS
10 1 3015     1
10 2 6416     1
10 3 8137     1
10 4 9745     1
10 512372     1
10 619300     1
10 7  282     2
10 8 1775     2
10 9 2985     2
1010 3868     2
1011 4826     2
1012 5496     2
1013 5950     2
1014 6302     2
1015 6666     2
1016 6946     2
1017 7253     2
1018 7667     2
1019 7965     2
1020 8455     2
1021 8817     2
1022 9088     2
1023 9293     2
1024 9568     2
1025 9952     2
102610262     2
102710717     2
102810973     2
102911269     2
103011695     2
103112165     2
103212832     2
103313491     2
103414121     2
103514825     2
103615697     2
103716628     2
103817788     2
103918595     2
104019756     2
104121614     2
104224783     2
104330694     2
104442379     2
1045 3816     3
1046 6855     3
1047 8255     3
1048 9704     3
104911148     3
105012833     3
```

```
105117329     3
1052 2255     4
1053 4614     4
1054 6854     4
1055 8264     4
1056 9322     4
105710330     4
105811526     4
105913116     4
106014506     4
106116105     4
106218094     4
106321683     4
106431597     4
1065 2003     5
1066 3158     5
1067 4661     5
1068 6235     5
1069 8141     5
107011853     5
107122034     5
1072  661     6
1073 1659     6
1074 2762     6
1075 3531     6
1076 4549     6
1077 5647     6
1078 6774     6
1079 8320     6
108010102     6
108115624     6
1082 1207     7
1083 1805     7
1084 2478     7
1085 3354     7
1086 4518     7
1087 5290     7
1088 6223     7
1089 6985     7
1090 7702     7
1091 8801     7
109210658     7
109312629     7
109419847     7
1095 1238     8
1096 1996     8
1097 2732     8
1098 3918     8
1099 6250     8
11 013325     8
```

Figure A3:12-3 QUEBEC CITY: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1    18     1        | 3035    66     2        | 3069    92     5
30 2    31     1        | 3036    68     2        | 3070   125     5
30 3    35     1        | 3037    71     2
30 4    39     1        | 3038    75     2
30 5    42     1        | 3039    78     2
30 6    44     1        | 3040    84     2
30 7    46     1        | 3041    93     2
30 8    48     1        | 3042   111     2
30 9    50     1        | 3043   160     2
3010    53     1        | 3044    22     3
3011    55     1        | 3045    39     3
3012    57     1        | 3046    47     3
3013    59     1        | 3047    53     3
3014    61     1        | 3048    58     3
3015    64     1        | 3049    62     3
3016    67     1        | 3050    66     3
3017    70     1        | 3051    71     3
3018    74     1        | 3052    76     3
3019    79     1        | 3053    81     3
3020    85     1        | 3054    90     3
3021    97     1        | 3055   104     3
3022   175     1        | 3056   150     3
3023    25     2        | 3057    46     4
3024    37     2        | 3058    60     4
3025    41     2        | 3059    70     4
3026    45     2        | 3060    79     4
3027    48     2        | 3061    92     4
3028    50     2        | 3062   127     4
3029    52     2        | 3063    38     5
3030    54     2        | 3064    52     5
3031    56     2        | 3065    61     5
3032    59     2        | 3066    68     5
3033    61     2        | 3067    75     5
3034    64     2        | 3068    83     5

0000 ZONAL DATA
40 1 7624    29 |
40 2 9718    51 |
40 3 9362   108 |
40 413273   107 |
40 510010   110 |
40 6 9799    77 |

0000 Calibration Data
70 11.3660.0560.3880.0350.1050.1060.0690.1670.074 74880.955 78.7
70 21.5380.0620.3840.0430.1290.1230.0610.1310.067 97311.000 77.2
70 31.4250.1140.5920.0520.0840.0690.0180.0480.023 94701.000 80.3
70 41.6800.0890.5500.0480.0970.0650.0510.0820.018145761.000 68.4
70 51.4770.1130.5700.0540.0940.0570.0350.0580.018101970.637 78.6
70 61.4200.1110.5480.0560.0980.0570.0390.0690.022103281.000100.5
```

Figure A3:12-3A QUEBEC CITY: "BETA" Calibration Data

0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA

10 1 3015	1	61.199	45.9	105117329	3	9991.420	118.7
10 2 6416	1	321.374	67.3	1052 2255	4	241.074	36.0
10 3 8137	1	511.325	79.0	1053 4614	4	281.201	52.2
10 4 9745	1	181.403	85.6	1054 6854	4	111.358	62.2
10 512372	1	541.341	101.0	1055 8264	4	9991.420	68.2
10 619300	1	9991.420	128.2	1056 9322	4	151.398	73.8
10 7 282	2	440.615	15.7	105710330	4	591.364	79.4
10 8 1775	2	630.992	35.2	105811526	4	9991.420	83.2
10 9 2985	2	51.190	43.6	105913116	4	9991.420	89.9
1010 3868	2	71.258	49.5	106014506	4	9991.420	95.5
1011 4826	2	91.313	55.3	106116105	4	9991.420	101.7
1012 5496	2	291.358	58.8	106218094	4	9991.420	109.1
1013 5950	2	481.288	63.3	106321683	4	9991.420	121.6
1014 6302	2	311.367	63.6	106431597	4	9991.420	152.5
1015 6666	2	651.307	67.3	1065 2003	5	41.154	39.7
1016 6946	2	581.355	67.8	1066 3158	5	271.220	50.6
1017 7253	2	131.406	68.3	1067 4661	5	101.366	60.2
1018 7667	2	501.313	73.0	1068 6235	5	341.350	72.1
1019 7965	2	661.305	74.9	1069 8141	5	521.337	85.1
1020 8455	2	351.381	75.5	107011853	5	611.376	105.0
1021 8817	2	161.394	77.1	107122034	5	9991.420	150.0
1022 9088	2	9991.420	77.8	1072 661	6	21.059	29.9
1023 9293	2	9991.420	78.9	1073 1659	6	571.202	48.0
1024 9568	2	171.400	80.8	1074 2762	6	301.352	60.9
1025 9952	2	9991.420	82.2	1075 3531	6	331.380	69.8
102610262	2	9991.420	83.7	1076 4549	6	371.380	81.2
102710717	2	9991.420	85.9	1077 5647	6	681.351	93.6
102810973	2	601.354	89.2	1078 6774	6	691.358	104.1
102911269	2	391.388	89.6	1079 8320	6	551.359	117.7
103011695	2	9991.420	90.6	108010102	6	9991.420	129.0
103112165	2	9991.420	92.7	108115624	6	431.302	176.1
103212832	2	201.378	97.1	1082 1207	7	31.050	33.6
103313491	2	9991.420	98.7	1083 1805	7	251.125	41.0
103414121	2	9991.420	101.4	1084 2478	7	261.220	47.4
103514825	2	9991.420	104.4	1085 3354	7	641.258	55.9
103615697	2	9991.420	108.1	1086 4518	7	121.353	64.3
103716628	2	211.406	112.4	1087 5290	7	141.383	69.9
103817788	2	9991.420	116.5	1088 6223	7	9991.420	76.0
103918595	2	9991.420	119.6	1089 6985	7	671.338	84.0
104019756	2	421.369	126.3	1090 7702	7	9991.420	86.4
104121614	2	701.294	137.0	1091 8801	7	401.367	95.4
104224783	2	621.370	144.6	109210658	7	411.382	106.5
104330694	2	561.326	167.1	109312629	7	9991.420	116.2
104442379	2	221.372	199.4	109419847	7	9991.420	152.4
1045 3816	3	81.242	51.2	1095 1238	8	451.124	39.0
1046 6855	3	9991.420	68.0	1096 1996	8	461.218	49.5
1047 8255	3	361.370	77.4	1097 2732	8	471.286	57.8
1048 9704	3	381.369	85.3	1098 3918	8	491.349	69.8
104911148	3	191.406	91.5	1099 6250	8	531.363	91.9
105012833	3	9991.420	99.1	110013325	8	9991.420	141.4

Figure A3:13-3 QUEBEC CITY: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   18    1 | 3035   66    2 | 3069   92    5
30 2   31    1 | 3036   68    2 | 3070  125    5
30 3   35    1 | 3037   71    2 |
30 4   39    1 | 3038   75    2 |
30 5   42    1 | 3039   78    2 |
30 6   44    1 | 3040   84    2 |
30 7   46    1 | 3041   93    2 |
30 8   48    1 | 3042  111    2 |
30 9   50    1 | 3043  160    2 |
3010   53    1 | 3044   22    3 |
3011   55    1 | 3045   39    3 |
3012   57    1 | 3046   47    3 |
3013   59    1 | 3047   53    3 |
3014   61    1 | 3048   58    3 |
3015   64    1 | 3049   62    3 |
3016   67    1 | 3050   66    3 |
3017   70    1 | 3051   71    3 |
3018   74    1 | 3052   76    3 |
3019   79    1 | 3053   81    3 |
3020   85    1 | 3054   90    3 |
3021   97    1 | 3055  104    3 |
3022  175    1 | 3056  150    3 |
3023   25    2 | 3057   46    4 |
3024   37    2 | 3058   60    4 |
3025   41    2 | 3059   70    4 |
3026   45    2 | 3060   79    4 |
3027   48    2 | 3061   92    4 |
3028   50    2 | 3062  127    4 |
3029   52    2 | 3063   38    5 |
3030   54    2 | 3064   52    5 |
3031   56    2 | 3065   61    5 |
3032   59    2 | 3066   68    5 |
3033   61    2 | 3067   75    5 |
3034   64    2 | 3068   83    5 |

0000 INCOME by TYPE   | 0000 ALPHA by TYPE    | 0000 ZONAL DATA
20 1 9852             | 21 1.1235             | 40 1 8249   29
20 211806             | 21 2.1096             | 40 2 7183   51
20 310005             | 21 3.1212             | 40 3 7596  108
20 412859             | 21 4.0982             | 40 411210  107
20 5 8221             | 21 5.1434             | 40 5 7679  110
20 6 5946             | 21 6.2242             | 40 614238   77
20 7 7042             | 21 7.1651             |
20 8 4849             | 21 8.2259             |
```

Figure A3:13-3(cont) QUEBEC CITY: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	3.3695	1.2008
	(35.0)	(3.07)
BATH	0.3419	na
	(8.40)	
TOILET	-.2321	0.0049
	(3.44)	(0.02)
SUBSIDIS	-.3018	-.0899
	(5.06)	(1.85)
LNLIVING	0.4095	0.1866
	(6.81)	(9.42)
LNINCOM	0.0991	0.3116
	(8.20)	(13.2)
TYPE	-.0209	-.2397
	(1.58)	(7.91)
LNDIST	-.0219	-.0265
	(2.86)	(2.38)
B5160	-.1557	-.0212
	(7.37)	(0.77)
B4650	-.2565	-.0517
	(10.4)	(1.21)
B2145	-.2626	-.2488
	(13.7)	(6.88)
BPRE20	-.3053	-.3331
	(17.3)	(8.15)
LGLVSIZE	0.0621	0.0076
	(4.09)	(0.21)
LGBDSIZE	0.0400	0.1551
	(7.64)	(5.61)
OPENSP	0.0289	0.0233
	(1.80)	(0.87)
HIGHDEN	0.0300	-.1853
	(1.94)	(6.73)
COMMERC	-.0346	na
	(2.16)	
NEIGHBD	0.0155	na
	(0.64)	
FINANCE	-.0486	-.0110
	(2.98)	(0.35)
AMRATE	na	0.0846
		(15.3)
R2	0.43	0.54
Observations	1558	1150

note: "t" statistics in brackets
: data source: QUE.REG02

Figure A3:14-3 QUEBEC CITY: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	499.2	109.0	1.563	1.270	0.3062
min	91.9	38.6	1.453	1.270	0.0555
max	2239.2	300.4	1.671	1.270	0.9914
TYPE 2					
mean	442.2	104.8	1.545	1.270	0.3047
min	68.3	30.5	1.404	1.270	0.0768
max	1554.6	284.4	1.671	1.270	0.9978
TYPE 3					
mean	713.9	116.8	1.536	1.270	0.2111
min	127.8	45.0	1.367	1.270	0.0481
max	2454.9	331.8	1.671	1.270	0.9160
TYPE 4					
mean	547.8	115.4	1.531	1.270	0.2533
min	121.8	20.9	1.404	1.270	0.0183
max	2049.8	333.4	1.648	1.270	0.8746
TYPE 5					
mean	757.8	119.8	1.529	1.270	0.1780
min	173.2	56.2	1.382	1.270	0.0635
max	1562.4	379.1	1.645	1.270	0.8395
TYPE 6					
mean	828.3	231.8	1.516	1.270	0.3236
min	145.1	40.2	1.071	1.270	0.0495
max	3318.4	783.1	1.763	1.270	0.9432
TYPE 7					
mean	734.3	214.0	1.529	1.270	0.3411
min	61.8	50.7	1.053	1.270	0.0898
max	1710.5	468.6	1.774	1.270	0.8395
TYPE 8					
mean	1108.1	227.9	1.594	1.270	0.2213
min	217.6	23.9	1.095	1.270	0.0235
max	3518.7	961.3	1.820	1.270	0.8447
TYPE 9					
mean	873.6	226.8	1.700	1.270	0.2782
min	158.5	59.2	1.115	1.270	0.0577
max	2822.0	768.1	1.853	1.270	0.9900
TYPE 10					
mean	1075.3	231.0	1.652	1.270	0.2255
min	264.1	71.3	1.096	1.270	0.0592
max	3098.0	967.9	1.831	1.270	0.7917

Figure A3:15-3 QUEBEC CITY : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2444	-.2021	0.1946	-.0870	0.0297	69.6	307.2	499.2	241
	(89.7)	(18.2)	(41.0)	(2.83)	(4.65)				
2	-.2590	-.1866	0.2280	-.0061	0.0695	67.9	265.7	442.2	392
	(136.)	(17.9)	(57.6)	(0.19)	(13.6)				
3	-.1739	-.1127	0.1515	0.1602	-.0672	76.1	470.1	713.9	432
	(184.)	(21.9)	(69.9)	(9.15)	(18.4)				
4	-.2186	-.1071	0.1657	0.2141	-.0688	75.5	340.4	547.8	278
	(207.)	(20.7)	(57.7)	(14.8)	(14.9)				
5	-.1636	-.1034	0.1308	0.1908	-.0949	78.6	502.4	757.8	215
	(205.)	(21.3)	(55.9)	(10.8)	(22.0)				
6	-.2944	-.1825	0.1883	0.0538	-.0132	150.5	469.7	828.3	216
	(103.)	(20.7)	(26.3)	(2.03)	(1.02)				
7	-.3000	-.1827	0.2024	0.0462	-.0233	139.6	409.7	734.3	81
	(79.6)	(12.6)	(17.2)	(1.30)	(1.32)				
8	-.2090	-.1151	0.1346	0.1900	-.1119	141.4	693.1	1108.1	182
	(103.)	(18.7)	(21.1)	(12.1)	(10.7)				
9	-.2672	-.1590	0.2152	0.1347	0.0511	133.0	509.3	873.6	355
	(173.)	(21.3)	(44.6)	(5.87)	(7.86)				
10	-.2183	-.1165	0.1371	0.2055	-.1154	139.8	664.8	1075.3	316
	(172.)	(20.2)	(29.9)	(11.5)	(12.1)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-3 QUEBEC CITY : Direct Translog-Expenditure Share
[all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3629	-.2136	0.2704	-.0374	0.1202	61.4	145.1	280.6	145
	(121.)	(14.6)	(30.8)	(0.99)	(9.77)				
2	-.3572	-.1309	0.3044	0.1662	0.1614	61.1	147.1	281.3	221
	(160.)	(9.86)	(45.4)	(5.22)	(18.3)				
3	-.2488	-.1185	0.2002	0.1866	-.0083	72.9	285.2	474.6	227
	(224.)	(17.7)	(58.6)	(10.7)	(1.43)				
4	-.2920	-.1340	0.2157	0.1672	-.0046	70.5	216.2	383.2	151
	(278.)	(29.6)	(55.8)	(19.5)	(0.74)				
5	-.2057	-.1158	0.1663	0.1866	-.0537	73.0	349.4	555.3	117
	(212.)	(17.9)	(41.5)	(9.80)	(8.03)				
6	-.3594	-.1672	0.2452	0.1128	0.0747	121.1	265.3	518.3	138
	(92.0)	(9.15)	(14.1)	(2.42)	(2.43)				
7	-.3621	-.1539	0.2477	0.0841	0.0304	115.7	251.3	492.2	42
	(61.1)	(6.35)	(11.6)	(1.79)	(1.00)				
8	-.2184	-.1053	0.1488	0.2621	-.0885	106.6	486.7	787.4	97
	(69.7)	(6.74)	(13.4)	(4.33)	(5.07)				
9	-.2886	-.1337	0.2845	0.1683	0.1331	113.1	382.5	675.5	225
	(148.)	(12.6)	(30.3)	(6.36)	(11.0)				
10	-.2382	-.1306	0.1501	0.1628	-.0960	114.9	484.8	803.9	192
	(143.)	(13.9)	(17.0)	(5.73)	(5.90)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-3 QUEBEC CITY : Direct Translog-Expenditure Share [below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1564	-.0862	0.0894	0.2783	-.2367	82.1	551.9	829.4	96
	(260.)	(26.1)	(27.0)	(16.5)	(14.6)				
2	-.1830	-.1007	0.0972	0.2342	-.2747	76.8	418.9	650.2	171
	(440.)	(34.0)	(24.8)	(16.5)	(14.4)				
3	-.1248	-.0646	0.0619	0.3227	-.3449	79.7	674.9	978.8	205
	(395.)	(27.7)	(15.8)	(21.4)	(11.5)				
4	-.1663	-.0725	0.0709	0.3247	-.3529	81.5	488.2	743.5	127
	(308.)	(19.1)	(11.2)	(15.2)	(10.6)				
5	-.1308	-.0788	0.0628	0.2201	-.3532	85.2	685.0	999.6	98
	(326.)	(23.2)	(10.0)	(10.1)	(8.05)				
6	-.2404	-.1395	0.1681	0.1643	-.0404	202.4	831.5	1376.8	78
	(73.6)	(12.1)	(14.5)	(3.16)	(1.36)				
7	-.2634	-.1547	0.2050	0.1717	0.0004	165.4	580.2	995.0	39
	(50.1)	(5.24)	(4.18)	(1.39)	(0.00)				
8	-.1992	-.0876	0.1584	0.3297	0.0064	181.1	928.7	1474.1	85
	(79.6)	(9.03)	(11.0)	(7.58)	(0.15)				
9	-.2398	-.1217	0.1080	0.2226	-.2917	167.6	728.7	1216.6	130
	(261.)	(21.5)	(12.7)	(10.1)	(9.65)				
10	-.1997	-.1057	0.1079	0.2273	-.2434	178.5	943.5	1495.4	124
	(107.)	(13.4)	(5.69)	(7.49)	(3.04)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-3 QUEBEC CITY : Direct Translog-Expenditure Share [above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4861	-.1593	0.3559	0.0859	0.2319	55.2	75.6	182.6	75
	(126.)	(5.75)	(19.0)	(1.52)	(9.63)				
2	-.4839	-.0773	0.3539	0.2486	0.2387	52.9	74.1	176.1	102
	(137.)	(2.45)	(29.9)	(4.16)	(15.5)				
3	-.3798	-.1508	0.2443	0.1494	0.0501	72.1	149.8	302.2	101
	(232.)	(13.6)	(39.1)	(5.78)	(5.06)				
4	-.4107	-.1512	0.2652	0.1779	0.0646	67.0	120.2	256.6	65
	(293.)	(6.90)	(43.1)	(3.84)	(6.81)				
5	-.2546	-.1216	0.2035	0.2335	-.0014	67.7	246.8	418.0	49
	(178.)	(7.16)	(26.1)	(3.76)	(0.10)				
6	-.4059	-.2025	0.2478	0.0509	0.0573	104.2	182.6	386.8	67
	(72.1)	(5.79)	(8.89)	(0.60)	(1.16)				
7	-.5976	-.3581	0.3435	-.2037	0.1893	104.1	91.6	280.9	16
	(100.)	(7.12)	(14.7)	(2.79)	(5.59)				
8	-.2660	-.1218	0.1932	0.2452	-.0382	98.9	331.3	570.7	44
	(44.2)	(2.78)	(7.88)	(1.79)	(0.97)				
9	-.3413	-.0963	0.3373	0.2786	0.2001	107.3	285.3	543.5	93
	(98.5)	(5.39)	(20.4)	(6.36)	(9.96)				
10	-.2722	-.1249	0.1885	0.1580	-.0554	110.6	375.1	651.5	87
	(86.6)	(6.66)	(10.1)	(3.18)	(1.80)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-3 QUEBEC CITY : Direct Translog-Expenditure Share
[quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2787	-.0835	0.2642	0.4225	0.2146	68.1	219.7	385.6	70
	(227.)	(8.61)	(38.2)	(12.6)	(18.6)				
2	-.2850	-.1072	0.2368	0.2967	0.1075	68.0	209.8	371.5	119
	(375.)	(17.7)	(32.7)	(15.0)	(6.97)				
3	-.1860	-.0827	0.1677	0.3290	0.0707	73.4	393.8	612.9	126
	(379.)	(11.4)	(12.9)	(7.67)	(1.17)				
4	-.2371	-.1049	0.2402	0.3112	0.2240	73.1	288.7	478.8	86
	(298.)	(9.84)	(11.6)	(6.64)	(2.68)				
5	-.1798	-.0784	0.1912	0.3542	0.2515	76.8	423.3	654.2	68
	(232.)	(7.62)	(7.58)	(6.91)	(1.96)				
6	-.3254	-.1119	0.3227	0.2489	0.1990	137.1	343.3	642.5	71
	(66.3)	(5.28)	(9.72)	(4.20)	(4.41)				
7	-.2980	-.2054	0.1513	-.1605	-.2133	122.9	349.6	622.3	26
	(50.3)	(4.38)	(1.35)	(0.76)	(0.59)				
8	-.1930	-.0928	0.1288	0.2306	-.2738	113.0	615.7	967.4	53
	(81.2)	(7.95)	(3.14)	(4.02)	(1.73)				
9	-.2563	-.1062	0.2928	0.2105	0.1609	117.1	451.0	768.5	132
	(124.)	(5.30)	(12.8)	(3.16)	(3.75)				
10	-.2151	-.0911	0.2158	0.3292	0.0835	118.4	575.7	930.3	105
	(136.)	(5.38)	(7.86)	(3.85)	(0.77)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-3 QUEBEC CITY : Direct Translog-Expenditure Share
[quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1928	-.0967	0.1150	0.2929	-.1779	79.8	413.4	650.1	58
	(219.)	(19.0)	(12.4)	(14.0)	(5.11)				
2	-.2046	-.1050	0.1226	0.2429	-.2214	70.6	335.5	535.2	107
	(413.)	(23.5)	(9.98)	(11.3)	(3.64)				
3	-.1367	-.0633	0.0601	0.3605	-.3770	75.3	571.6	840.8	130
	(338.)	(16.3)	(4.17)	(14.6)	(3.81)				
4	-.1798	-.0874	0.0979	0.2947	-.2607	75.8	413.2	639.6	83
	(286.)	(11.9)	(4.20)	(6.87)	(2.18)				
5	-.1434	-.0955	0.0167	0.1134	-.8032	80.3	577.2	855.1	56
	(260.)	(15.8)	(0.64)	(2.64)	(4.64)				
6	-.2657	-.1247	0.2283	0.1598	0.0197	177.5	618.2	1061.5	48
	(52.3)	(7.43)	(8.32)	(2.72)	(0.42)				
7	-.2703	-.0637	0.4137	0.4056	0.4629	142.7	466.9	811.8	23
	(39.5)	(0.98)	(3.24)	(1.69)	(1.21)				
8	-.1958	-.0535	0.2592	0.3779	0.1713	157.4	807.7	1280.4	53
	(58.2)	(2.56)	(6.26)	(3.96)	(1.47)				
9	-.2480	-.0953	0.2053	0.3388	0.0025	143.7	596.3	1007.6	86
	(215.)	(6.48)	(6.37)	(6.05)	(0.02)				
10	-.1805	-.0865	0.1211	0.3119	-.1444	135.4	812.0	1257.7	74
	(81.3)	(3.29)	(2.27)	(2.24)	(0.58)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-3 QUEBEC CITY : Direct Translog-Expenditure Share
[quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1215	-.0577	0.0742	0.4031	-.2209	85.6	763.5	1102.9	38
	(216.)	(16.0)	(12.1)	(16.2)	(4.30)				
2	-.1587	-.0763	0.0820	0.3310	-.3143	87.2	558.3	842.6	64
	(232.)	(14.4)	(10.6)	(11.6)	(7.17)				
3	-.1105	-.0681	0.0531	0.2626	-.3725	87.4	854.0	1218.1	75
	(266.)	(18.9)	(9.01)	(8.78)	(6.97)				
4	-.1495	-.0576	0.0732	0.3745	-.2852	92.5	629.7	939.5	44
	(166.)	(11.7)	(6.21)	(11.8)	(3.56)				
5	-.1176	-.0576	0.0622	0.3461	-.3365	91.6	828.8	1192.4	42
	(234.)	(12.4)	(2.39)	(11.2)	(1.57)				
6	-.2103	-.1347	0.1158	0.1639	-.2886	242.3	1172.7	1881.3	30
	(61.6)	(10.4)	(3.50)	(2.08)	(1.99)				
7	-.2567	-.1968	0.2685	-.0987	0.0813	198.1	743.1	1258.4	16
	(28.4)	(3.18)	(2.41)	(0.39)	(0.20)				
8	-.2008	-.0857	0.1593	0.3693	-.0033	220.2	1129.2	1795.1	32
	(60.6)	(6.42)	(2.03)	(3.98)	(0.01)				
9	-.2295	-.1172	0.0823	0.2053	-.3849	214.2	987.6	1625.0	44
	(175.)	(21.9)	(4.19)	(8.92)	(4.98)				
10	-.2176	-.1074	0.1211	0.2340	-.2238	242.4	1138.2	1847.3	50
	(59.4)	(6.10)	(2.79)	(2.43)	(1.29)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-3 QUEBEC CITY : Direct Translog-Expenditure Share
[quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.6974	0.7009	0.7054	-1.0433	-1.6021	-0.7614
Q02	0.4925	0.6176	0.6251	-1.0050	-1.2331	-0.8478
Q03	0.3811	0.4047	0.4065	-0.9947	-1.1724	-0.8517
Q04	0.2519	0.2931	0.3043	-0.9966	-1.1998	-0.7080
TYPE 2						
Q01	0.7152	0.7383	0.7476	-1.0457	-2.0060	-0.6967
Q02	0.5045	0.5529	0.5537	-1.0184	-1.1851	-0.9085
Q03	0.4103	0.4052	0.4040	-1.0151	-1.1662	-0.8724
Q04	0.3469	0.3470	0.3470	-1.0038	-1.2585	-0.7109
TYPE 3						
Q01	0.6118	0.6203	0.6197	-1.0238	-1.5770	-0.7188
Q02	0.3583	0.3995	0.3949	-1.0163	-1.1354	-0.9289
Q03	0.3099	0.3087	0.3085	-0.9997	-1.1262	-0.8950
Q04	0.2494	0.2399	0.2383	-1.0004	-1.1881	-0.7891
TYPE 4						
Q01	0.6662	0.6780	0.6808	-1.0172	-1.5317	-0.6883
Q02	0.4403	0.4833	0.5072	-1.0134	-1.1610	-0.8816
Q03	0.3735	0.3747	0.3749	-1.0055	-1.1225	-0.9091
Q04	0.3151	0.3253	0.3301	-1.0054	-1.2086	-0.7377
TYPE 5						
Q01	0.4766	0.4841	0.4889	-1.0302	-1.5548	-0.8021
Q02	0.3520	0.3822	0.4115	-1.0088	-1.1916	-0.8866
Q03	0.3236	0.2730	0.2593	-1.0257	-1.1488	-0.9056
Q04	0.2662	0.2647	0.2643	-1.0058	-1.1362	-0.8970
TYPE 6						
Q01	0.6323	0.6359	0.6389	-1.0018	-1.6072	-0.7813
Q02	0.5591	0.5831	0.5735	-1.0660	-1.1681	-0.9597
Q03	0.4724	0.4613	0.4596	-1.0731	-1.3015	-0.8750
Q04	0.4465	0.4087	0.4017	-0.9983	-1.3247	-0.6026
TYPE 7						
Q01	0.7905	0.7907	0.7925	-0.9857	-2.5836	-0.5039
Q02	0.4896	0.4313	0.4276	-1.0886	-1.3195	-0.9382
Q03	0.5103	0.5579	0.5635	-1.1369	-1.2502	-1.0166
Q04	0.4489	0.4096	0.4074	-1.1031	-1.3200	-0.8446
TYPE 8						
Q01	0.4962	0.5095	0.5096	-1.0166	-1.6363	-0.7835
Q02	0.3836	0.3710	0.3635	-1.0545	-1.2431	-0.9371
Q03	0.3905	0.3985	0.3933	-1.1224	-1.1142	-1.1757
Q04	0.3905	0.4314	0.4905	-0.9949	-1.2806	-0.6776
TYPE 9						
Q01	0.5881	0.6039	0.6010	-1.0915	-1.6048	-0.9220
Q02	0.4595	0.4549	0.4556	-1.1193	-1.2169	-1.0191
Q03	0.4891	0.5089	0.5195	-1.0263	-1.1753	-0.8938
Q04	0.4721	0.4443	0.4213	-1.0082	-1.4038	-0.7437
TYPE 10						
Q01	0.4718	0.4690	0.4676	-1.0544	-1.4518	-0.8779
Q02	0.4366	0.4547	0.4503	-1.0407	-1.1107	-0.9691
Q03	0.3696	0.3830	0.3855	-1.0052	-1.1080	-0.8972
Q04	0.4277	0.4210	0.4182	-1.0086	-1.2176	-0.7150

Figure A3:23-3 QUEBEC CITY : Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	445.02	294.75	370.32	162.62	232.32	222.22	177.81
BM1=BM2=0	422.47	225.79	244.77	108.07	164.98	155.55	138.55
statistic	45.11	137.92	251.09	109.08	134.67	133.36	78.53
TYPE 2							
normal	755.83	465.36	673.61	215.60	420.81	427.93	258.27
BM1=BM2=0	654.75	314.23	527.48	121.22	345.77	342.30	211.11
statistic	202.17	302.25	292.25	188.76	150.08	171.25	94.33
TYPE 3							
normal	1112.95	631.37	858.81	292.70	483.08	538.96	324.64
BM1=BM2=0	962.07	576.94	720.09	275.84	362.25	465.13	257.56
statistic	301.77	108.86	277.44	33.71	241.66	147.66	134.17
TYPE 4							
normal	748.91	459.87	481.33	212.44	310.91	321.46	168.24
BM1=BM2=0	620.34	424.20	343.00	191.97	254.14	270.96	119.16
statistic	257.13	71.33	276.65	40.95	113.54	100.99	98.15
TYPE 5							
normal	663.22	376.50	409.40	161.44	254.42	234.48	190.41
BM1=BM2=0	539.67	320.43	312.08	149.04	194.69	181.44	161.95
statistic	247.10	112.15	194.63	24.81	119.47	106.09	56.92
TYPE 6							
normal	407.76	254.59	178.10	125.10	141.44	104.84	85.82
BM1=BM2=0	403.16	251.20	163.83	124.37	130.05	100.66	77.18
statistic	9.21	6.77	28.55	1.47	22.79	8.37	17.28
TYPE 7							
normal	170.38	87.48	88.92	42.25	58.91	54.40	38.70
BM1=BM2=0	169.25	85.20	87.89	32.51	58.46	52.83	38.63
statistic	2.27	4.55	2.06	19.48	0.89	3.13	0.14
TYPE 8							
normal	411.43	210.45	211.99	86.48	146.52	131.35	87.87
BM1=BM2=0	342.63	186.01	166.26	82.78	130.41	111.93	71.85
statistic	137.59	48.87	91.46	7.41	32.22	38.84	32.04
TYPE 9							
normal	781.92	501.38	435.77	204.70	332.81	286.58	157.41
BM1=BM2=0	735.72	426.28	374.95	152.10	326.11	260.31	130.04
statistic	92.39	150.20	121.66	105.19	13.40	52.54	54.75
TYPE10							
normal	793.16	475.10	326.90	200.23	303.91	206.46	123.82
BM1=BM2=0	710.38	443.72	282.13	193.01	283.83	193.95	104.82
statistic	165.57	62.76	89.55	14.43	40.16	25.03	38.00

Figure A3:24-3 QUEBEC CITY : Log Likelihood Values:
[test of unity income elasticity]

```
0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs
10 1 1339     1 -588     0
10 2 2057     1  230    21
10 3 2401     1  -32    93
10 4 3341     1  603   146
10 5 4377     1 1388   271
10 6 5788     1 3277   753
10 7 7721     1 5082  1194
10 812408     110567 3190
10 9  646     2 -464     0
1010 1370     2  186    18
1011 1645     2  534   128
1012 2126     2 1041   244
1013 2795     2 1729   347
1014 3606     2 2377   470
1015 4079     2 3015   627
1016 4567     2 3786   800
1017 4920     2 4062   886
1018 5407     2 4913  1137
1019 5859     2 5436  1297
1020 6381     2 5769  1413
1021 7234     2 6397  1628
1022 8434     2 8655  2492
102311718     214551 5666
1024 2259     3  125    69
1025 3147     3 1004   207
1026 4169     3 2156   443
1027 5575     3 3833   787
1028 6416     3 4861  1071
1029 6991     3 5365  1188
1030 7613     3 6214  1391
1031 8114     3 6681  1477
1032 8529     3 7211  1653
1033 9081     3 7697  1687
1034 9770     3 8602  2006
103510555     3 9748  2404
103611436     310797 2681
103712428     312044 3161
103816825     319089 6368
1039 1173     4 -307    23
1040 2669     4  563   142
1041 3654     4  921   214
1042 4713     4 2489   515
1043 5388     4 3026   615
1044 5833     4 3182   654
1045 6376     4 3933   840
1046 6994     4 4912  1144
1047 7697     4 5570  1340
1048 8241     4 6193  1550
1049 9442     4 8063  2248
105012987     414497 5735
1051 4145     5 1274   359
1052 6021     5 3528   746
1053 6997     5 4245   913
1054 8008     5 5355  1199
1055 8933     5 6499  1536
105610198     5 8245  1989
105712277     511336 3117
105815037     515297 4766
1059 3281     6  222   104
1060 5200     6  917   266
1061 6782     6 2357   536
1062 8285     6 4625  1113
106311993     6 7430  2079
106420648     622314 9839
1065 4314     7 1801   405
1066 8536     7 6489  1682
106714213     714510 5739
1068 5502     8 2362   549
1069 9232     8 6660  1631
107011682     8 9741  2362
107113176     811800 3288
107215277     813260 3674
107317665     816736 5189
107423524     82636210712
1075 1735     9-1644     5
1076 5285     9 1780   360
1077 6884     9 3382   724
1078 7688     9 4256   939
1079 8286     9 5312  1262
1080 8679     9 5930  1464
1081 9215     9 6195  1565
1082 9895     9 7201  1913
108310467     9 7500  2041
108411180     9 8588  2458
108512319     910337 3238
108613645     912460 4296
108716533     917890 7539
108822712     93092516426
1089 6025    10 2042   521
1090 8261    10 4411  1066
1091 9206    10 5642  1365
109210143    10 6808  1630
109310900    10 7763  1932
109411517    10 8738  2300
109512786    10 9806  2701
109614194    1012538 3821
109715281    1013276 4024
109817514    1016351 4986
109920116    1020076 7476
11 026169    103124415557
```

Figure A3:25-3 QUEBEC CITY: Demand Calibration Data

```
0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1182.6385.6650.11103.          |  20 6386.8642.51062.1881.
20 2176.1371.5535.2842.6          |  20 7280.9622.3811.81258.
20 3302.2612.9840.81218.          |  20 8570.7967.41280.1795.
20 4256.6478.8639.6939.5          |  20 9543.5768.51008.1625.
20 5418.0654.2855.11192.          |  2010651.5930.31258.1847.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.486-.159.3559.0859.231955.1775.56182.61.567
21 2    0-.484-.077.3539.2486.238752.9574.06176.11.550
21 3    0-.380-.151.2443.1494.050172.14149.8302.21.552
21 4    0-.411-.151.2652.1779.064667.03120.2256.61.551
21 5    0-.255-.122.2035.2335-.00167.67246.8418.01.545
21 6    0-.406-.203.2478.0509.0573104.2182.6386.81.484
21 7    0-.598-.358.3435-.204.1893104.191.55280.91.577
21 8    0-.266-.122.1932.2452-.03898.87331.3570.71.508
21 9    0-.341-.096.3373.2786.2001107.3285.3543.51.682
2110    0-.272-.125.1885.1580-.055110.6375.1651.51.605
0000  (quartile 02)
22 1    0-.279-.084.2642.4225.214668.11219.7385.61.563
22 2    0-.285-.107.2368.2967.107568.01209.8371.51.547
22 3    0-.186-.083.1677.3290.070773.44393.8612.91.538
22 4    0-.237-.105.2402.3112.224073.12288.7478.81.536
22 5    0-.180-.078.1912.3542.251576.83423.3654.21.521
22 6    0-.325-.112.3227.2489.1990137.1343.3642.51.490
22 7    0-.298-.205.1513-.161-.213122.9349.6622.31.468
22 8    0-.193-.093.1288.2306-.274113.0615.7967.41.638
22 9    0-.256-.106.2928.2105.1609117.1451.0768.51.676
2210    0-.215-.091.2158.3292.0835118.4575.7930.31.679
0000  (quartile 03)
23 1    0-.193-.097.1150.2929-.17879.79413.4650.11.562
23 2    0-.205-.105.1226.2429-.22170.58335.5535.21.546
23 3    0-.137-.063.0601.3605-.37775.25571.6840.81.529
23 4    0-.180-.087.0979.2947-.26175.75413.2639.61.518
23 5    0-.143-.095.0167.1134-.80380.33577.2855.11.524
23 6    0-.266-.125.2283.1598.0197177.5618.21062.1.560
23 7    0-.270-.064.4137.4056.4629142.7466.9811.81.519
23 8    0-.196-.053.2592.3779.1713157.4807.71280.1.602
23 9    0-.248-.095.2053.3388.0025143.7596.31008.1.742
2310    0-.181-.087.1211.3119-.144135.4812.01258.1.672
0000  (quartile 04)
24 1    0-.122-.058.0742.4031-.22185.61763.51103.1.556
24 2    0-.159-.076.0820.3310-.31487.23558.3842.61.534
24 3    0-.110-.068.0531.2626-.37387.41854.01218.1.525
24 4    0-.149-.058.0732.3745-.28592.47629.7939.51.516
24 5    0-.118-.058.0622.3461-.33791.65828.81192.1.530
24 6    0-.210-.135.1158.1639-.289242.31173.1881.1.579
24 7    0-.257-.197.2685-.099.0813198.1743.11258.1.594
24 8    0-.201-.086.1593.3693-.003220.21129.1795.1.625
24 9    0-.229-.117.0823.2053-.385214.2987.61625.1.730
2410    0-.218-.107.1211.2340-.224242.41138.1847.1.647
```

Figure A3:25-3(cont) QUEBEC CITY: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1   36    1    1 | 3035   43    3    1 | 3069  166    2    2
30 2   56    1    1 | 3036   58    3    1 | 3070   57    3    2
30 3   60    1    1 | 3037   65    3    1 | 3071   89    3    2
30 4   63    1    1 | 3038   70    3    1 | 3072  103    3    2
30 5   67    1    1 | 3039   75    3    1 | 3073  116    3    2
30 6   70    1    1 | 3040   81    3    1 | 3074  123    3    2
30 7   73    1    1 | 3041   86    3    1 | 3075  128    3    2
30 8   76    1    1 | 3042   93    3    1 | 3076  134    3    2
30 9   79    1    1 | 3043   99    3    1 | 3077  139    3    2
3010   82    1    1 | 3044  105    3    1 | 3078  145    3    2
3011   85    1    1 | 3045  110    3    1 | 3079  149    3    2
3012   91    1    1 | 3046  116    3    1 | 3080  154    3    2
3013   98    1    1 | 3047  141    3    1 | 3081  158    3    2
3014  110    1    1 | 3048   58    4    1 | 3082  162    3    2
3015  144    1    1 | 3049   74    4    1 | 3083  166    3    2
3016   43    2    1 | 3050   81    4    1 | 3084  173    3    2
3017   53    2    1 | 3051   86    4    1 | 3085  181    3    2
3018   56    2    1 | 3052   92    4    1 | 3086  191    3    2
3019   59    2    1 | 3053  100    4    1 | 3087  224    3    2
3020   62    2    1 | 3054  119    4    1 | 3088   90    4    2
3021   65    2    1 | 3055   54    5    1 | 3089  116    4    2
3022   68    2    1 | 3056   77    5    1 | 3090  127    4    2
3023   71    2    1 | 3057   93    5    1 | 3091  135    4    2
3024   73    2    1 | 3058  114    5    1 | 3092  144    4    2
3025   76    2    1 | 3059   58    1    2 | 3093  159    4    2
3026   79    2    1 | 3060   85    1    2 | 3094  183    4    2
3027   81    2    1 | 3061  102    1    2 | 3095   90    5    2
3028   84    2    1 | 3062  119    1    2 | 3096  133    5    2
3029   87    2    1 | 3063  157    1    2 | 3097  151    5    2
3030   90    2    1 | 3064   79    2    2 | 3098  166    5    2
3031   94    2    1 | 3065  100    2    2 | 3099  182    5    2
3032   97    2    1 | 3066  112    2    2 | 31 0  218    5    2
3033  105    2    1 | 3067  123    2    2
3034  134    2    1 | 3068  136    2    2 |

0000 ZONAL Data
40 1 8249   29      | 40 2 7183   51      | 40 3 7596  108
40 411210  107      | 40 5 7679  110      | 40 614238   77
0000  Parameters
5011 .41            | 50121.13            | 5013 0.0
5016 .41            | 50171.20            | 5018 0.0
50201.270           |

0000 Calibration Data
70 11.4280.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   75781.000 85.5
70 21.6040.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   97611.000 87.8
70 31.4620.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   96251.000120.4
70 41.4200.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  132731.000111.6
70 51.5030.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  102861.000127.5
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0      00.0    0.0
```

Figure A3:25-3(cont) QUEBEC CITY: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1339	1	-588	0	1051	4145	5	1274	359
10	2	2057	1	230	21	1052	6021	5	3528	746
10	3	2401	1	-32	93	1053	6997	5	4245	913
10	4	3341	1	603	146	1054	8008	5	5355	1199
10	5	4377	1	1388	271	1055	8933	5	6499	1536
10	6	5788	1	3277	753	105610198		5	8245	1989
10	7	7721	1	5082	1194	105712277		511336		3117
10	812408		110567		3190	105815037		515297		4766
10	9	646	2	-464	0	1059	3281	6	222	104
1010		1370	2	186	18	1060	5200	6	917	266
1011		1645	2	534	128	1061	6782	6	2357	536
1012		2126	2	1041	244	1062	8285	6	4625	1113
1013		2795	2	1729	347	106311993		6	7430	2079
1014		3606	2	2377	470	106420648		622314		9839
1015		4079	2	3015	627	1065	4314	7	1801	405
1016		4567	2	3786	800	1066	8536	7	6489	1682
1017		4920	2	4062	886	106714213		714510		5739
1018		5407	2	4913	1137	1068	5502	8	2362	549
1019		5859	2	5436	1297	1069	9232	8	6660	1631
1020		6381	2	5769	1413	107011682		8	9741	2362
1021		7234	2	6397	1628	107113176		811800		3288
1022		8434	2	8655	2492	107215277		813260		3674
102311718			214551		5666	107317665		816736		5189
1024		2259	3	125	69	107423524		82636210712		
1025		3147	3	1004	207	1075	1735	9	-1644	5
1026		4169	3	2156	443	1076	5285	9	1780	360
1027		5575	3	3833	787	1077	6884	9	3382	724
1028		6416	3	4861	1071	1078	7688	9	4256	939
1029		6991	3	5365	1188	1079	8286	9	5312	1262
1030		7613	3	6214	1391	1080	8679	9	5930	1464
1031		8114	3	6681	1477	1081	9215	9	6195	1565
1032		8529	3	7211	1653	1082	9895	9	7201	1913
1033		9081	3	7697	1687	108310467		9	7500	2041
1034		9770	3	8602	2006	108411180		9	8588	2458
103510555			3	9748	2404	108512319		910337		3238
103611436			310797		2681	108613645		912460		4296
103712428			312044		3161	108716533		917890		7539
103816825			319089		6368	108822712		93092516426		
1039		1173	4	-307	23	1089	6025	10	2042	521
1040		2669	4	563	142	1090	8261	10	4411	1066
1041		3654	4	921	214	1091	9206	10	5642	1365
1042		4713	4	2489	515	109210143		10	6808	1630
1043		5388	4	3026	615	109310900		10	7763	1932
1044		5833	4	3182	654	109411517		10	8738	2300
1045		6376	4	3933	840	109512786		10	9806	2701
1046		6994	4	4912	1144	109614194		1012538		3821
1047		7697	4	5570	1340	109715281		1013276		4024
1048		8241	4	6193	1550	109817514		1016351		4986
1049		9442	4	8063	2248	109920116		1020076		7476
105012987			414497		5735	11	026169	103124415557		

Figure A3:26-3 QUEBEC CITY: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1182.6385.6650.11103.          | 20 6386.8642.51062.1881.
20 2176.1371.5535.2842.6          | 20 7280.9622.3811.81258.
20 3302.2612.9840.81218.          | 20 8570.7967.41280.1795.
20 4256.6478.8639.6939.5          | 20 9543.5768.51008.1625.
20 5418.0654.2855.11192.          | 2010651.5930.31258.1847.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.486-.159.3559.0859.231955.1775.56182.61.567
21 2    0-.484-.077.3539.2486.238752.9574.06176.11.550
21 3    0-.380-.151.2443.1494.050172.14149.8302.21.552
21 4    0-.411-.151.2652.1779.064667.03120.2256.61.551
21 5    0-.255-.122.2035.2335-.00167.67246.8418.01.545
21 6    0-.406-.203.2478.0509.0573104.2182.6386.81.484
21 7    0-.598-.358.3435-.204.1893104.191.55280.91.577
21 8    0-.266-.122.1932.2452-.03898.87331.3570.71.508
21 9    0-.341-.096.3373.2786.2001107.3285.3543.51.682
2110    0-.272-.125.1885.1580-.055110.6375.1651.51.605
0000  (quartile 02)
22 1    0-.279-.084.2642.4225.214668.11219.7385.61.563
22 2    0-.285-.107.2368.2967.107568.01209.8371.51.547
22 3    0-.186-.083.1677.3290.070773.44393.8612.91.538
22 4    0-.237-.105.2402.3112.224073.12288.7478.81.536
22 5    0-.180-.078.1912.3542.251576.83423.3654.21.521
22 6    0-.325-.112.3227.2489.1990137.1343.3642.51.490
22 7    0-.298-.205.1513-.161-.213122.9349.6622.31.468
22 8    0-.193-.093.1288.2306-.274113.0615.7967.41.638
22 9    0-.256-.106.2928.2105.1609117.1451.0768.51.676
2210    0-.215-.091.2158.3292.0835118.4575.7930.31.679
0000  (quartile 03)
23 1    0-.193-.097.1150.2929-.17879.79413.4650.11.562
23 2    0-.205-.105.1226.2429-.22170.58335.5535.21.546
23 3    0-.137-.063.0601.3605-.37775.25571.6840.81.529
23 4    0-.180-.087.0979.2947-.26175.75413.2639.61.518
23 5    0-.143-.095.0167.1134-.80380.33577.2855.11.524
23 6    0-.266-.125.2283.1598.0197177.5618.21062.1.560
23 7    0-.270-.064.4137.4056.4629142.7466.9811.81.519
23 8    0-.196-.053.2592.3779.1713157.4807.71280.1.602
23 9    0-.248-.095.2053.3388.0025143.7596.31008.1.742
2310    0-.181-.087.1211.3119-.144135.4812.01258.1.672
0000  (quartile 04)
24 1    0-.122-.058.0742.4031-.22185.61763.51103.1.556
24 2    0-.159-.076.0820.3310-.31487.23558.3842.61.534
24 3    0-.110-.068.0531.2626-.37387.41854.01218.1.525
24 4    0-.149-.058.0732.3745-.28592.47629.7939.51.516
24 5    0-.118-.058.0622.3461-.33791.65828.81192.1.530
24 6    0-.210-.135.1158.1639-.289242.31173.1881.1.579
24 7    0-.257-.197.2685-.099.0813198.1743.11258.1.594
24 8    0-.201-.086.1593.3693-.003220.21129.1795.1.625
24 9    0-.229-.117.0823.2053-.385214.2987.61625.1.730
2410    0-.218-.107.1211.2340-.224242.41138.1847.1.647
```

Figure A3:26-3(cont) QUEBEC CITY: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1   25    1    1 | 3025   65    2    1 | 3049   84    2    2
30 2   37    1    1 | 3026   68    2    1 | 3050   92    2    2
30 3   41    1    1 | 3027   72    2    1 | 3051   99    2    2
30 4   45    1    1 | 3028   75    2    1 | 3052  108    2    2
30 5   47    1    1 | 3029   79    2    1 | 3053  139    2    2
30 6   50    1    1 | 3030   86    2    1 | 3054   72    3    2
30 7   53    1    1 | 3031  117    2    1 | 3055  109    3    2
30 8   56    1    1 | 3032   39    3    1 | 3056  122    3    2
30 9   58    1    1 | 3033   57    3    1 | 3057  130    3    2
3010   61    1    1 | 3034   68    3    1 | 3058  139    3    2
3011   64    1    1 | 3035   79    3    1 | 3059  149    3    2
3012   67    1    1 | 3036  108    3    1 | 3060  162    3    2
3013   71    1    1 | 3037   62    4    1 | 3061  192    3    2
3014   76    1    1 | 3038   94    4    1 | 3062  113    4    2
3015   83    1    1 | 3039   53    5    1 | 3063  133    4    2
3016  109    1    1 | 3040   74    5    1 | 3064  147    4    2
3017   33    2    1 | 3041  103    5    1 | 3065  187    4    2
3018   44    2    1 | 3042   55    1    2 | 3066   94    5    2
3019   48    2    1 | 3043   81    1    2 | 3067  117    5    2
3020   52    2    1 | 3044   99    1    2 | 3068  129    5    2
3021   54    2    1 | 3045  110    1    2 | 3069  137    5    2
3022   57    2    1 | 3046  124    1    2 | 3070  160    5    2
3023   59    2    1 | 3047  157    1    2
3024   62    2    1 | 3048   61    2    2

0000 ZONAL Data
40 1 8249   29       | 40 2 7183   51       | 40 3 7596  108
40 411210  107       | 40 5 7679  110       | 40 614238   77
0000  Parameters
50 1 .1               | 50 2 .1              |
5011 .41              | 50121.13             | 5013 46.
5016 .41              | 50171.20             | 5018 80.
50201.270             |

0000 Calibration Data
70 11.3570.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   72890.987 86.2
70 21.5480.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   97521.000 83.4
70 31.4720.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   95071.000 94.7
70 41.5180.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  128551.000 93.7
70 51.5400.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  109880.658 92.0
70 61.6890.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  101931.000100.7
70 71.6320.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   81100.865112.0
70 81.7840.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   97180.924105.3
70 91.6150.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   94441.000138.2
70102.0510.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  153351.000108.9
70111.6660.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   96540.623136.2
70121.4160.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  104391.000161.7
```

Figure A3:26-3(cont) QUEBEC CITY: Supply Calibration Data

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
10  1 1339     1 -587     0          31.384 41.2
10  2 2057     1  230    21         191.518 55.6
10  3 2401     1  -31    93         391.527 62.0
10  4 3341     1  603   146         231.546 70.3
10  5 4377     1 1388   271          91.561 70.2
10  6 5788     1 3277   753         271.500 82.0
10  7 7721     1 5082  1194         141.499 86.5
10  812408     110567 3190         411.406106.3
10  9  646     2 -463     0          11.276 22.0
1010  1370     2  186    18         181.357 42.9
1011  1645     2  534   128          41.432 47.8
1012  2126     2 1041   244          61.506 57.4
1013  2795     2 1729   347         211.543 64.4
1014  3606     2 2377   470         221.555 68.8
1015  4079     2 3015   627         331.557 68.9
1016  4567     2 3786   800        9991.694 59.1
1017  4920     2 4062   886        9991.694 60.4
1018  5407     2 4913  1137        9991.694 61.3
1019  5859     2 5436  1297         241.531 73.1
1020  6381     2 5769  1413        9991.694 60.4
1021  7234     2 6397  1628         111.541 76.3
1022  8434     2 8655  2492         401.506 85.3
102311718     214551 5666         311.395119.8
1024  2259     3  125    69          51.452 51.0
1025  3147     3 1004   207          81.528 65.8
1026  4169     3 2156   443         131.511 82.0
1027  5575     3 3833   787         301.447 93.1
1028  6416     3 4861  1071         281.497 85.6
1029  6991     3 5365  1188         261.519 79.4
1030  7613     3 6214  1391        9991.694 62.7
1031  8114     3 6681  1477        9991.694 63.5
1032  8529     3 7211  1653        9991.694 63.7
1033  9081     3 7697  1687        9991.694 63.7
1034  9770     3 8602  2006        9991.694 62.9
103510555     3 9748  2404        9991.694 63.7
103611436     310797  2681         341.528 80.4
103712428     312044  3161         291.477 88.6
103816825     319089  6368         161.421115.2
1039  1173     4 -306    23         321.281 34.6
1040  2669     4  563   142          71.512 61.3
1041  3654     4  921   214         101.550 73.3
1042  4713     4 2489   515         121.527 78.8
1043  5388     4 3026   615         251.529 76.7
1044  5833     4 3182   654        9991.694 62.2
1045  6376     4 3933   840        9991.694 63.1
1046  6994     4 4912  1144        9991.694 63.2
1047  7697     4 5570  1340        9991.694 62.2
1048  8241     4 6193  1550        9991.694 64.9
1049  9442     4 8063  2248         351.481 89.2
105012987     414497  5735         361.439116.5
```

Figure A3:27-3 QUEBEC CITY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
1051 4145     5 1274  359          201.504 59.7
1052 6021     5 3528  746         9991.694 62.8
1053 6997     5 4245  913         9991.694 64.2
1054 8008     5 5355 1199         9991.694 64.0
1055 8933     5 6499 1536          371.565 76.0
105610198     5 8245 1989         9991.694 66.2
105712277     511336 3117          151.476 93.0
105815037     515297 4766          381.467104.3
1059 3281     6  222  104          481.495 73.9
1060 5200     6  917  266         9991.771 86.3
1061 6782     6 2357  536         9991.771100.3
1062 8285     6 4625 1113         9991.771111.6
106311993     6 7430 2079         9991.771142.1
106420648     622314 9839         9991.771195.4
1065 4314     7 1801  405         9991.771101.5
1066 8536     7 6489 1682         9991.771103.0
106714213     714510 5739          641.605189.3
1068 5502     8 2362  549          541.469 84.6
1069 9232     8 6660 1631         9991.771 91.3
107011682     8 9741 2362         9991.771100.2
107113176     811800 3288          671.549142.1
107215277     813260 3674          571.568161.4
107317665     816736 5189          581.619179.2
107423524     82636210712          611.614245.4
1075 1735     9-1643     5         421.213 48.1
1076 5285     9 1780  360          491.555100.8
1077 6884     9 3382  724          501.635117.4
1078 7688     9 4256  939          661.640120.5
1079 8286     9 5312 1262          441.616124.7
1080 8679     9 5930 1464          521.568131.1
1081 9215     9 6195 1565          511.615124.6
1082 9895     9 7201 1913          621.582138.1
108310467     9 7500 2041          461.564148.9
108411180     9 8588 2458          691.548161.8
108512319     910337 3238          631.620164.9
108613645     912460 4296          471.576188.5
108716533     917890 7539          701.654203.8
108822712     93092516426          651.727251.2
1089 6025    10 2042  521          431.499 94.9
1090 8261    10 4411 1066         9991.771 96.8
1091 9206    10 5642 1365         9991.771101.8
109210143    10 6808 1630         9991.771105.6
109310900    10 7763 1932          451.566133.5
109411517    10 8738 2300          551.584134.0
109512786    10 9806 2701          561.551146.2
109614194    1012538 3821          681.544153.8
109715281    1013276 4024          531.524163.2
109817514    1016351 4986          591.587184.4
109920116    1020076 7476          601.650210.9
11 026169    103124415557         9991.771254.3
```

Figure A3:27-3 QUEBEC CITY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1182.6385.6650.11103.          |  20 6386.8642.51062.1881.
20 2176.1371.5535.2842.6          |  20 7280.9622.3811.81258.
20 3302.2612.9840.81218.          |  20 8570.7967.41280.1795.
20 4256.6478.8639.6939.5          |  20 9543.5768.51008.1625.
20 5418.0654.2855.11192.          |  2010651.5930.31258.1847.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.486-.159.3559.0859.231955.1775.56182.61.567
21 2    0-.484-.077.3539.2486.238752.9574.06176.11.550
21 3    0-.380-.151.2443.1494.050172.14149.8302.21.552
21 4    0-.411-.151.2652.1779.064667.03120.2256.61.551
21 5    0-.255-.122.2035.2335-.00167.67246.8418.01.545
21 6    0-.406-.203.2478.0509.0573104.2182.6386.81.484
21 7    0-.598-.358.3435-.204.1893104.191.55280.91.577
21 8    0-.266-.122.1932.2452-.03898.87331.3570.71.508
21 9    0-.341-.096.3373.2786.2001107.3285.3543.51.682
2110    0-.272-.125.1885.1580-.055110.6375.1651.51.605
0000  (quartile 02)
22 1    0-.279-.084.2642.4225.214668.11219.7385.61.563
22 2    0-.285-.107.2368.2967.107568.01209.8371.51.547
22 3    0-.186-.083.1677.3290.070773.44393.8612.91.538
22 4    0-.237-.105.2402.3112.224073.12288.7478.81.536
22 5    0-.180-.078.1912.3542.251576.83423.3654.21.521
22 6    0-.325-.112.3227.2489.1990137.1343.3642.51.490
22 7    0-.298-.205.1513-.161-.213122.9349.6622.31.468
22 8    0-.193-.093.1288.2306-.274113.0615.7967.41.638
22 9    0-.256-.106.2928.2105.1609117.1451.0768.51.676
2210    0-.215-.091.2158.3292.0835118.4575.7930.31.679
0000  (quartile 03)
23 1    0-.193-.097.1150.2929-.17879.79413.4650.11.562
23 2    0-.205-.105.1226.2429-.22170.58335.5535.21.546
23 3    0-.137-.063.0601.3605-.37775.25571.6840.81.529
23 4    0-.180-.087.0979.2947-.26175.75413.2639.61.518
23 5    0-.143-.095.0167.1134-.80380.33577.2855.11.524
23 6    0-.266-.125.2283.1598.0197177.5618.21062.1.560
23 7    0-.270-.064.4137.4056.4629142.7466.9811.81.519
23 8    0-.196-.053.2592.3779.1713157.4807.71280.1.602
23 9    0-.248-.095.2053.3388.0025143.7596.31008.1.742
2310    0-.181-.087.1211.3119-.144135.4812.01258.1.672
0000  (quartile 04)
24 1    0-.122-.058.0742.4031-.22185.61763.51103.1.556
24 2    0-.159-.076.0820.3310-.31487.23558.3842.61.534
24 3    0-.110-.068.0531.2626-.37387.41854.01218.1.525
24 4    0-.149-.058.0732.3745-.28592.47629.7939.51.516
24 5    0-.118-.058.0622.3461-.33791.65828.81192.1.530
24 6    0-.210-.135.1158.1639-.289242.31173.1881.1.579
24 7    0-.257-.197.2685-.099.0813198.1743.11258.1.594
24 8    0-.201-.086.1593.3693-.003220.21129.1795.1.625
24 9    0-.229-.117.0823.2053-.385214.2987.61625.1.730
2410    0-.218-.107.1211.2340-.224242.41138.1847.1.647
```

Figure A3:27-3(cont) QUEBEC CITY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   25    1    1 | 3025   65    2    1 | 3049   84    2    2
30 2   37    1    1 | 3026   68    2    1 | 3050   92    2    2
30 3   41    1    1 | 3027   72    2    1 | 3051   99    2    2
30 4   45    1    1 | 3028   75    2    1 | 3052  108    2    2
30 5   47    1    1 | 3029   79    2    1 | 3053  139    2    2
30 6   50    1    1 | 3030   86    2    1 | 3054   72    3    2
30 7   53    1    1 | 3031  117    2    1 | 3055  109    3    2
30 8   56    1    1 | 3032   39    3    1 | 3056  122    3    2
30 9   58    1    1 | 3033   57    3    1 | 3057  130    3    2
3010   61    1    1 | 3034   68    3    1 | 3058  139    3    2
3011   64    1    1 | 3035   79    3    1 | 3059  149    3    2
3012   67    1    1 | 3036  108    3    1 | 3060  162    3    2
3013   71    1    1 | 3037   62    4    1 | 3061  192    3    2
3014   76    1    1 | 3038   94    4    1 | 3062  113    4    2
3015   83    1    1 | 3039   53    5    1 | 3063  133    4    2
3016  109    1    1 | 3040   74    5    1 | 3064  147    4    2
3017   33    2    1 | 3041  103    5    1 | 3065  187    4    2
3018   44    2    1 | 3042   55    1    2 | 3066   94    5    2
3019   48    2    1 | 3043   81    1    2 | 3067  117    5    2
3020   52    2    1 | 3044   99    1    2 | 3068  129    5    2
3021   54    2    1 | 3045  110    1    2 | 3069  137    5    2
3022   57    2    1 | 3046  124    1    2 | 3070  160    5    2
3023   59    2    1 | 3047  157    1    2
3024   62    2    1 | 3048   61    2    2

0000 ZONAL Data
40 1 8249   29       | 40 2 7183   51       | 40 3 7596  108
40 411210  107       | 40 5 7679  110       | 40 614238   77

0000  Parameters
50 10.100            | 50 20.100            |
50 30.725            | 50 40.450            | 50 71.140
50 50.625            | 50 60.400            | 50 80.950
50110.410            | 50121.130            | 5013 52.0
50160.410            | 50171.200            | 5018 80.0
50201.270            |
```

Figure A3:27-3(cont) QUEBEC CITY: MODIFIED Policy Dataset

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	5	5
2	2	2
3	2	2
4	7	8
5	4	4
A	-	6
Total	20	27

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 5

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	74.	79.	12,629.	17,822.	2,602.	7,708.	34.
2	124.	141.	21,509.	34,366.	4,603.	15,244.	52.
3	88.	109.	19,537.	28,459.	4,495.	11,067.	71.
4	80.	105.	13,566.	21,706.	3,284.	9,154.	99.
5	48.	85.	7,724.	16,647.	2,284.	7,327.	103.
A		110.		22,813.		9,156.	105.
total	78.	101.	13,584.	21,769.	3,184.	9,094.	83.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	5,922.	5,950.	20.7	423.	7.1	4.6
2	1,004.	1,030.	3.6	56.	5.4	0.6
3	2,145.	2,560.	8.9	480.	18.7	5.2
4	6,759.	10,935.	38.1	4,080.	37.3	44.4
5	2,011.	2,355.	8.2	800.	33.9	8.7
A		5,875.	20.5	3,351.	57.0	36.5
	17,841.	28,705.	100.0	9,189.	32.0	100.0

source: program "CZONE.FORT": files JHN61.INPUT and JHN71.INPUT.

Figure A3:01-4 ST. JOHN'S: Zonal Characteristics (5 zones)

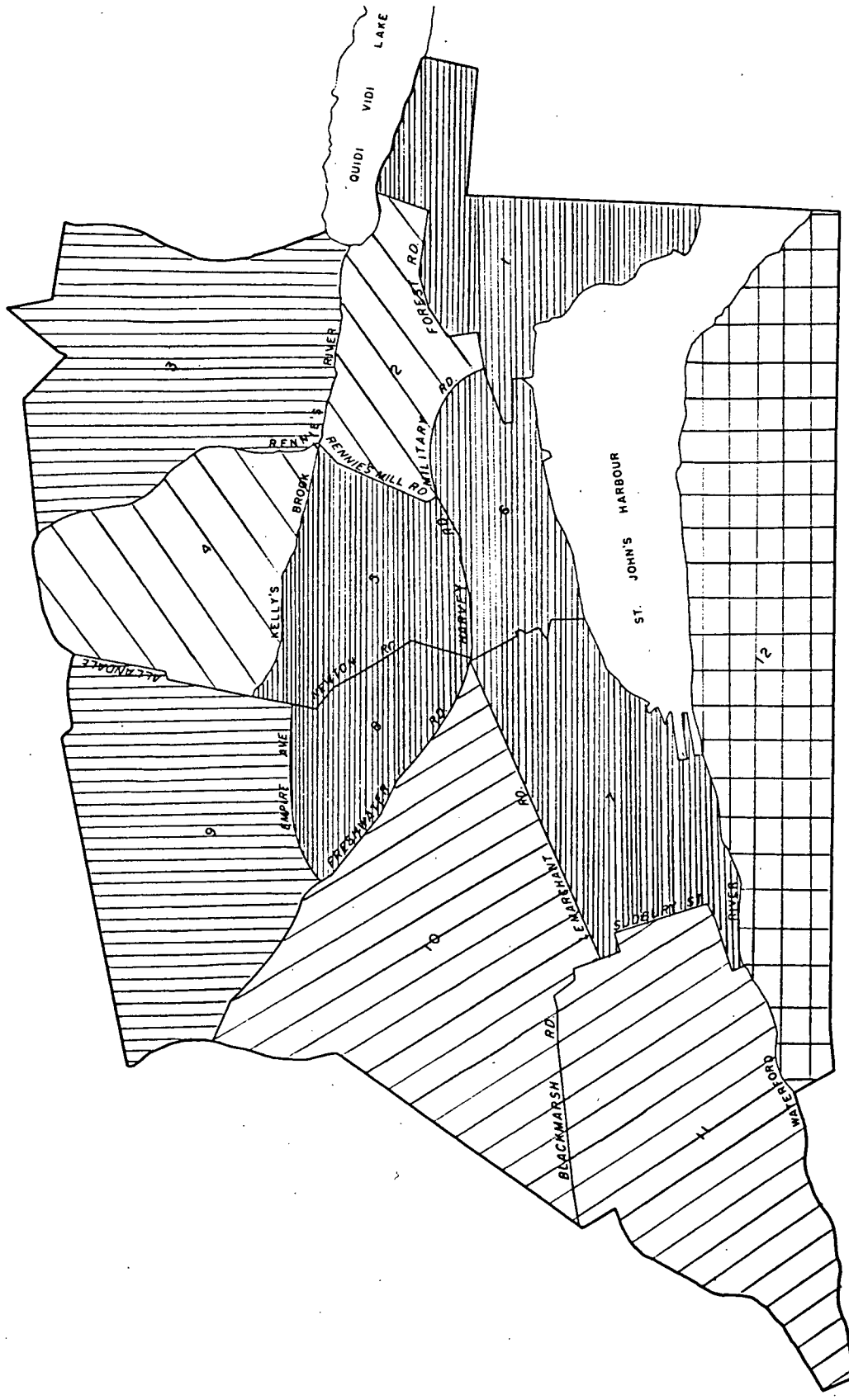

Figure A3:02-4 ST. JOHN'S: Clustering (5 zones)

Demographic Characteristics:

Population [1] 1961: 90,838.
[2] 1971: 131,810.

Households [1] 1961: 17,917.
[2] 1971: 29,755.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 9,094.
1974 SHU data [4] : 11,791.

deflator : 0.7712

SHU deflated : 9,093.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file JHN.SHU

SHU dataset:

Sample size : 2764.
Sum of the WEIGHTs : 21,369.

RATIO of SHU weights
to actual households : 0.718165

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	7,985.	2,292.	11.	208.	290.
2	10,127.	9,081.	42.	216.	301.
3	9,498.	965.	5.	193.	269.
4	10,581.	3,573.	17.	210.	292.
5	6,429.	1,600.	7.	229.	319.
6	8,126.	902.	4.	225.	313.
7	7,563.	1,519.	7.	217.	302.
8	4,607.	1,437.	7.	205.	286.

source: program "HH1.FORT" :file JHN.SHU

Figure A3:03-4 ST. JOHN'S: HOUSEHOLD Characteristics.

Total 1961 dwellings : 17,841.

Rental	:	5,458.
Owner-occupier	:	12,385.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	72.	2,339.	12,420.	3,583.	0.0696
2	123.	323.	21,542.	681.	0.0684
3	87.	750.	19,518.	1,395.	0.0540
4	77.	1,698.	13,281.	5,061.	0.0696
5	50.	348.	7,255.	1,663.	0.0828
total	77.	5,458.	13,777.	12,385.	0.0696

source: program "D61.FORT" : dataset JHN61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings	: TOTAL	17,841.
	: RATIO of EXISTING unannexed/TOTAL	95.2%
	: TOTAL 1961 Dwellings EXISTING in 1971	19,516.
	: TOTAL 1961 Dwellings ADJUSTED for ANNEXED	20,419.
: 1971 "model" Dwellings		100.
: 1971 RATIO ACTUAL/"model"		287.
: 1961 "model" Dwellings		71.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	"RHS"/actual SERVICES weighted
1	5,922.	23.	258.	0.9331	0.9507
2	1,004.	4.	251.	0.7415	0.7558
3	2,145.	9.	238.	0.8341	0.8498
4	6,759.	27.	250.	0.9644	0.9826
5	2,011.	8.	251.	1.2772	1.3013

error of fit 0.01592

source: program "D61.FORT" : dataset JHN61.INPUT.

Figure A3:04-4 ST. JOHN'S: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	1.8478	-.2287	0.4635	0.02758
	(1.99)	(0.24)	(0.51)	(0.04)
MULTIPLE	0.3444	0.2178	0.2848	0.1682
	(2.44)	(1.37)	(2.03)	(1.63)
CONSTRUCTED PRE 20	-.2980	-.1129	-.2354	-.1336
	(2.00)	(0.63)	(1.63)	(1.53)
20-45	-.4594	-.3232	-.1807	-.1438
	(3.64)	(2.61)	(1.46)	(1.41)
CONDITION	0.5378	0.3904	0.4592	0.1766
	(3.57)	(2.76)	(0.30)	(1.61)
LN ROOMS	1.3379	1.4009	0.6483	0.5488
	(6.37)	(6.49)	(3.27)	(3.29)
LN INCOME	0.60105	0.8482	0.6483	0.7245
	(4.78)	(6.52)	(5.27)	(8.38)
ACCESS	0.0006	.0012	-.0015	-.0017
	(0.46)	(0.95)	(1.22)	(1.62)
R2	0.66	0.98	0.48	0.99
OBSERVATIONS	141	141	135	135

note : "t" statistis in brackets
: data source: JHN61.EA

MEANS:

LN INCOME	8.0038
MULTIPLE	0.4402
ACCESS	72.8

Figure A3:05-4 ST. JOHN'S: 1961 Hedonic Estimates

Total 1971 dwellings : 28,710.

Rental : 9,945.
Owner-occupier : 18,765.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	77.	2,520.	17,938.	3,435.	0.0516
2	141.	375.	34,257.	655.	0.0492
3	104.	1,025.	28,851.	1,535.	0.0432
4	106.	3,645.	21,571.	7,290.	0.0588
5	118.	2,380.	19,708.	5,850.	0.0720
total	103.	9,945.	21,364.	18,765.	0.0576

source: program "D71.FORT" : dataset JHN71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual calculated	"RHS"/actual weighted	SERVICES
1	5,955.	21.	284.	0.9522	1.0012	
2	1,030.	4.	258.	0.6436	0.6767	
3	2,560.	9.	285.	0.8553	0.8993	
4	10,935.	37.	296.	0.9463	0.9950	
5	8,230.	29.	284.	0.9368	0.9851	
			287.			

error of fit 0.02652

source: program "D71.FORT" : dataset JHN71.INPUT.

Figure A3:06-4 ST. JOHN'S: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 28,710.

Built prior 1961 : 19,516.
Built 1961-1971 : 9,194.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	61.	2,202.	14,618.	3,336.	0.0504
2	135.	348.	32,911.	627.	0.0492
3	96.	778.	27,939.	1,301.	0.0408
4	94.	1,903.	19,753.	4,950.	0.0576
5	89.	900.	14,366.	3,172.	0.0744
99	133.	3,814.	26,196.	5,379.	0.0612
CMA	103.	9,945.	20,783.	18,765.	0.0588

source: program "D71.FORT" : dataset JHN71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	5,538.	19.	291.	1.1733	1.1793
2	975.	4.	244.	0.6714	0.6748
3	2,079.	7.	297.	0.8912	0.8957
4	6,853.	24.	286.	1.0009	1.0060
5	4,072.	14.	291.	1.1369	1.1426
99	9,194.	32.	287.	0.8148	0.8190
			287.		

error of fit 0.01487

source: program "D71.FORT" : dataset JHN71.INPUT.

Figure A3:07-4 ST. JOHN'S: 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	7.289	7.461	5.199	5.264
	(44.5)	(47.2)	(28.3)	(30.2)
MULTIPLE	-.1391	-.1619	0.0166	0.0352
	(5.50)	(6.43)	(0.38)	(0.77)
CONSTRUCTION 51-60	-.1211	-.1316	-.2917	-.3056
	(3.55)	(3.90)	(7.26)	(7.35)
46-50	-.2526	-.2425	-.2679	-.2920
	(6.10)	(5.89)	(5.40)	(5.70)
20-45	-.4070	-.4215	-.1837	-.2139
	(12.1)	(12.4)	(4.26)	(4.82)
PRE 20	-.5686	-.5783	-.3653	-.3478
	(15.5)	(15.9)	(8.95)	(8.47)
FACILITIES	0.4414	0.4212	0.4988	0.4887
	(9.20)	(8.89)	(10.9)	(11.0)
LN INCOME	0.1584	0.1441	0.1716	0.1646
	(8.89)	(8.41)	(8.57)	(8.74)
LN ROOMS	0.5766	0.5721	0.0447	0.0346
	(12.3)	(12.1)	(1.36)	(1.02)
R2	0.49	0.95	0.35	0.87
OBSERVATIONS	1200	1200	965	965
WEIGHTED 20-45/PRE 20	-.4822	-.4943	-.2907	-.2928

note : "t" statistis in brackets
: data source: JHN.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	9.0112
MULTIPLE	0.610
ACCESS	82.0

Figure A3:08-4 ST. JOHN'S: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	21,769.	42,880.	0.50767
RENT	101.	166.	0.60843
INCOME	9,094.	11,791.	0.77120

R/V ratio: 0.0576 P(j)/PN ratio: 0.84140

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.7505 (91.7)	0.1565	2.7346 (79.1)	0.1540	0.1695
DUMMY (TYPE 2)	-.1814 (5.06)	0.1305	-.2055 (5.15)	0.1254	0.1385
DUMMY (TYPE 3)	-.1737 (3.08)	0.1315	-.1813 (2.70)	0.1285	0.1418
DUMMY (TYPE 4)	-.3280 (7.45)	0.1127	-.3200 (6.87)	0.1118	0.1236
DUMMY (TYPE 5)	0.0518 (0.95)	0.1648	0.0428 (0.72)	0.1608	0.1769
DUMMY (TYPE 6)	0.2196 (3.63)	0.1949	0.1932 (2.83)	0.1869	0.2050
DUMMY (TYPE 7)	0.0794 (1.35)	0.1694	0.0524 (0.86)	0.1623	0.1785
DUMMY (TYPE 8)	0.3152 (4.96)	0.2145	0.3270 (5.05)	0.2136	0.2336
R2	0.07		0.52		
OBSERVATIONS	2518		2518		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-4 ST. JOHN'S: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	9.4776 (60.5)	9.4441 (59.7)	0.1344	0.0864	0.3969
DUMMY (TYPE 2)	-.0409 (1.50)	-.0235 (0.77)	0.1096	0.0586	0.9092*
DUMMY (TYPE 3)	0.0035 (0.08)	0.0347 (0.68)	0.1219	0.0983	0.1810
DUMMY (TYPE 4)	-.0990 (2.94)	-.0492 (1.37)	0.1033	0.0642	0.2174
DUMMY (TYPE 5)	-.1317 (3.17)	-.1147 (2.55)	0.1413	0.0878	0.2593
DUMMY (TYPE 6)	0.1707 (3.74)	0.2195 (4.24)	0.1652	0.1207	0.2954
DUMMY (TYPE 7)	-.0077 (0.17)	-.0027 (0.06)	0.1396	0.0918	0.3608
DUMMY (TYPE 8)	-.1123 (2.29)	-.0938 (1.87)	0.1860	0.1104	0.3860
LN INCOME	-.7586 (43.4)	-.7619 (43.0)			
R2	0.47	0.73			
OBSERVATIONS	2518	2518			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

[*] values truncated.

Figure A3:09-4(b) ST. JOHN'S: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	628.0	1044.	252	-	-	-
1962	630.0	1096.	373	0.048	36.3	52.6
1963	633.0	1081.	521	0.067	42.4	72.4
1964	641.0	1039.	449	0.058	37.2	60.3
1965	653.0	1157.	556	0.071	46.4	81.7
1966	667.0	1349.	1,023	0.131	87.4	176.7
1967	696.0	1458.	1,213	0.156	108.6	227.4
1968	733.0	1770.	977	0.126	92.3	223.0
1969	765.0	1916.	771	0.099	75.7	189.7
1970	813.0	2203.	679	0.087	70.7	191.7
1971	867.0	1956.	1,222	0.157	136.2	307.1

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	628.0	1044.0	1672.0	0.376	0.624	1.000	--
decade weighted	727.0	1583.0	2310.0	0.434	0.946	1.380	34.1
1971	867.5	1956.0	2823.5	0.519	1.170	1.689	27.9

Figure A3:10-4 ST. JOHN'S: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 1 7985
20 210127
20 3 9497
20 410581
20 5 6429
20 6 8125
20 7 7562
20 8 4606

0000 ALPHA by TYPE
21 1.1540
21 2.1254
21 3.1285
21 4.1118
21 5.1608
21 6.1869
21 7.1623
21 8.2136
```

0000 "MODEL" HOUSEHOLDS			
10 1 747	1	105122329	2
10 2 2491	1	105228422	2
10 3 3997	1	105339773	2
10 4 5142	1	1054 4001	3
10 5 6167	1	1055 7509	3
10 6 7201	1	1056 9408	3
10 7 8239	1	105711136	3
10 8 9532	1	105815228	3
10 911160	1	1059 2076	4
101012866	1	1060 3421	4
101120912	1	1061 4371	4
1012 99	2	1062 5064	4
1013 291	2	1063 5979	4
1014 962	2	1064 6697	4
1015 2032	2	1065 7579	4
1016 2712	2	1066 8266	4
1017 3310	2	1067 9075	4
1018 3792	2	1068 9828	4
1019 4148	2	106910905	4
1020 4524	2	107012062	4
1021 4801	2	107113566	4
1022 5183	2	107215185	4
1023 5531	2	107316731	4
1024 5904	2	107420095	4
1025 6243	2	107529910	4
1026 6613	2	1076 1704	5
1027 7031	2	1077 2700	5
1028 7378	2	1078 3493	5
1029 7677	2	1079 4315	5
1030 7891	2	1080 6023	5
1031 8233	2	1081 8398	5
1032 8638	2	108218207	5
1033 9012	2	1083 2280	6
1034 9371	2	1084 5366	6
1035 9700	2	1085 8823	6
103610076	2	108616156	6
103710441	2	1087 948	7
103810830	2	1088 2612	7
103911138	2	1089 4751	7
104011559	2	1090 6302	7
104111817	2	1091 8174	7
104212486	2	109211066	7
104313114	2	109318950	7
104413766	2	1094 933	8
104514379	2	1095 1649	8
104615282	2	1096 2102	8
104716014	2	1097 2916	8
104817124	2	1098 4371	8
104918449	2	1099 6052	8
105019886	2	11 014425	8

Figure A3:11-4 ST. JOHN'S: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1   18   14    1 | 3035   16   13    4 | 3069  156  128    4
30 2   35   29    1 | 3036   32   26    4 | 3070  169  138    4
30 3   46   37    1 | 3037   41   33    4 | 3071  220  180    4
30 4   55   45    1 | 3038   48   40    4 | 3072    8    7    5
30 5   63   52    1 | 3039   54   44    4 | 3073   16   13    5
30 6   68   56    1 | 3040   59   48    4 | 3074   22   18    5
30 7   72   59    1 | 3041   62   51    4 | 3075   29   24    5
30 8   76   62    1 | 3042   65   53    4 | 3076   35   28    5
30 9   80   65    1 | 3043   68   56    4 | 3077   40   33    5
3010   84   69    1 | 3044   71   58    4 | 3078   46   37    5
3011   89   72    1 | 3045   74   61    4 | 3079   51   42    5
3012   93   76    1 | 3046   77   63    4 | 3080   57   47    5
3013   98   80    1 | 3047   79   65    4 | 3081   62   51    5
3014  104   85    1 | 3048   82   67    4 | 3082   67   55    5
3015  110   90    1 | 3049   84   69    4 | 3083   73   60    5
3016  118   96    1 | 3050   87   71    4 | 3084   79   64    5
3017  127  104    1 | 3051   89   73    4 | 3085   83   68    5
3018  137  112    1 | 3052   92   75    4 | 3086   88   72    5
3019  149  122    1 | 3053   95   77    4 | 3087   92   75    5
3020  166  136    1 | 3054   97   79    4 | 3088   97   79    5
3021  238  194    1 | 3055  100   81    4 | 3089  103   84    5
3022   51   41    2 | 3056  102   84    4 | 3090  109   89    5
3023   81   66    2 | 3057  105   86    4 | 3091  114   94    5
3024  103   84    2 | 3058  108   88    4 | 3092  120   98    5
3025  137  112    2 | 3059  110   90    4 | 3093  125  102    5
3026   50   41    3 | 3060  114   93    4 | 3094  130  106    5
3027   69   56    3 | 3061  118   96    4 | 3095  136  111    5
3028   77   63    3 | 3062  122   99    4 | 3096  140  115    5
3029   82   67    3 | 3063  125  102    4 | 3097  145  119    5
3030   88   72    3 | 3064  129  105    4 | 3098  151  123    5
3031   96   78    3 | 3065  133  108    4 | 3099  165  135    5
3032  109   89    3 | 3066  137  112    4 | 31 0  217  177    5
3033  127  103    3 | 3067  143  117    4
3034  171  139    3 | 3068  149  122    4

0000 ZONAL DATA
40 1 7708   34
40 215244   52
40 311067   71
40 4 9154   99
40 5 8633  105
40 6 9093   82

0000 Calibration Data
70 11.0460.0890.5120.0370.0590.1320.0280.0760.068 77091.000 96.5
70 21.1100.0480.4570.0300.1170.1220.0150.0980.113152421.000 93.1
70 31.2120.0850.6290.0400.0950.0740.0110.0410.026110661.000 96.5
70 41.2030.1230.5700.0580.0860.0890.0140.0350.026 91521.000 97.6
70 51.2350.1300.6080.0530.0590.0780.0150.0340.023 86361.000 89.8
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0      00.0    0.0
```

Figure A3:11-4A ST. JOHN'S: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 1 7985
20 210127
20 3 9497
20 410581
20 5 6429
20 6 8125
20 7 7562
20 8 4606

0000 ALPHA by TYPE
21 1.1540
21 2.1254
21 3.1285
21 4.1118
21 5.1608
21 6.1869
21 7.1623
21 8.2136
```

```
0000 "MODEL" HOUSEHOLDS
10 1  747    1
10 2 2491    1
10 3 3997    1
10 4 5142    1
10 5 6167    1
10 6 7201    1
10 7 8239    1
10 8 9532    1
10 911160    1
101012866    1
101120912    1
1012   99    2
1013  291    2
1014  962    2
1015 2032    2
1016 2712    2
1017 3310    2
1018 3792    2
1019 4148    2
1020 4524    2
1021 4801    2
1022 5183    2
1023 5531    2
1024 5904    2
1025 6243    2
1026 6613    2
1027 7031    2
1028 7378    2
1029 7677    2
1030 7891    2
1031 8233    2
1032 8638    2
1033 9012    2
1034 9371    2
1035 9700    2
103610076    2
103710441    2
103810830    2
103911138    2
104011559    2
104111817    2
104212486    2
104313114    2
104413766    2
104514379    2
104615282    2
104716014    2
104817124    2
104918449    2
105019886    2
```

```
105122329    2
105228422    2
105339773    2
1054 4001    3
1055 7509    3
1056 9408    3
105711136    3
105815228    3
1059 2076    4
1060 3421    4
1061 4371    4
1062 5064    4
1063 5979    4
1064 6697    4
1065 7579    4
1066 8266    4
1067 9075    4
1068 9828    4
106910905    4
107012062    4
107113566    4
107215185    4
107316731    4
107420095    4
107529910    4
1076 1704    5
1077 2700    5
1078 3493    5
1079 4315    5
1080 6023    5
1081 8398    5
108218207    5
1083 2280    6
1084 5366    6
1085 8823    6
108616156    6
1087  948    7
1088 2612    7
1089 4751    7
1090 6302    7
1091 8174    7
109211066    7
109318950    7
1094  933    8
1095 1649    8
1096 2102    8
1097 2916    8
1098 4371    8
1099 6052    8
11 014425    8
```

Figure A3:12-4 ST. JOHN'S: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1    18     1        3035  127     3        3069  103     5
30 2    31     1        3036  180     3        3070  138     5
30 3    37     1        3037   18     4        3071  210     5
30 4    43     1        3038   31     4
30 5    49     1        3039   41     4
30 6    55     1        3040   48     4
30 7    59     1        3041   54     4
30 8    63     1        3042   59     4
30 9    66     1        3043   63     4
3010    70     1        3044   66     4
3011    73     1        3045   70     4
3012    76     1        3046   73     4
3013    79     1        3047   77     4
3014    83     1        3048   81     4
3015    86     1        3049   84     4
3016    90     1        3050   87     4
3017    94     1        3051   90     4
3018   100     1        3052   93     4
3019   109     1        3053   97     4
3020   119     1        3054  101     4
3021   136     1        3055  105     4
3022   175     1        3056  110     4
3023   231     1        3057  115     4
3024    63     2        3058  120     4
3025    88     2        3059  127     4
3026   105     2        3060  136     4
3027   142     2        3061  146     4
3028    45     3        3062  164     4
3029    67     3        3063  211     4
3030    80     3        3064   19     5
3031    90     3        3065   28     5
3032   100     3        3066   42     5
3033   109     3        3067   60     5
3034   117     3        3068   78     5

0000 ZONAL DATA
40 1 7708    34
40 215244    52
40 311067    71
40 4 9154    99
40 5 8633   105
40 6 9093    82

0000 Calibration Data
70 11.0230.0890.5120.0370.0580.1320.0280.0760.069 77080.936 88.2
70 21.1050.0480.4580.0300.1170.1220.0150.0980.113152230.973 84.7
70 31.1910.0850.6350.0390.0930.0720.0110.0400.025108310.970 87.7
70 41.1450.1150.5660.0530.0830.1010.0160.0380.029 89131.000 88.9
70 51.1670.1230.6170.0460.0440.0960.0110.0360.027 74961.000 73.3
70 61.3800.1310.5850.0600.0830.0680.0150.0340.023 97291.000 94.9
```

Figure A3:12-4A ST. JOHN'S: "BETA" Calibration Data

0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA

10 1 2106	1	41.197	45.3	1051 7159	3	131.229	84.1
10 2 3882	1	411.239	64.2	1052 8516	3	311.258	92.3
10 3 4919	1	101.245	73.8	1053 9604	3	321.261	99.1
10 4 5877	1	121.255	81.8	105411111	3	9991.300	106.5
10 5 6696	1	141.246	88.8	105513084	3	9991.300	117.5
10 6 7539	1	581.285	93.8	105617252	3	9991.300	138.7
10 7 8555	1	491.246	102.8	1057 3002	4	391.226	47.1
10 8 9557	1	9991.300	107.5	1058 5209	4	9991.300	63.6
10 910639	1	621.281	115.6	1059 6327	4	9991.300	71.5
101012028	1	9991.300	123.4	1060 7501	4	551.276	80.0
101116186	1	9991.300	147.5	1061 8392	4	9991.300	84.7
1012 503	2	650.956	20.6	1062 9321	4	9991.300	90.3
1013 2492	2	221.228	47.1	106310885	4	9991.300	99.1
1014 3616	2	61.240	58.7	106411820	4	611.270	105.3
1015 4389	2	261.237	66.0	106513009	4	341.249	112.4
1016 5149	2	431.239	72.6	106614557	4	9991.300	117.9
1017 5626	2	281.242	76.4	106717173	4	9991.300	130.2
1018 6018	2	9991.300	77.8	106825971	4	641.237	171.1
1019 6525	2	9991.300	81.6	1069 1886	5	31.325	41.2
1020 6814	2	561.274	84.6	1070 2775	5	401.190	55.0
1021 7261	2	571.268	88.1	1071 3306	5	71.200	60.8
1022 7545	2	471.240	91.2	1072 3703	5	251.264	63.3
1023 7864	2	151.244	93.4	1073 4377	5	271.239	70.7
1024 8189	2	9991.300	93.6	1074 5723	5	291.264	82.2
1025 8428	2	9991.300	95.2	1075 7535	5	591.270	96.7
1026 8791	2	161.252	99.5	107616672	5	201.237	158.0
1027 9090	2	9991.300	99.6	1077 789	6	211.336	30.6
1028 9377	2	601.281	102.2	1078 1778	6	51.222	52.5
1029 9759	2	331.260	105.6	1079 2599	6	81.230	65.7
103010006	2	171.249	107.7	1080 3473	6	441.246	77.6
103110408	2	9991.300	108.1	1081 4262	6	461.254	87.4
103210775	2	501.235	113.2	1082 5080	6	481.248	97.3
103311166	2	9991.300	112.7	1083 6007	6	671.256	107.2
103411511	2	181.249	117.1	1084 8145	6	351.262	128.4
103511829	2	9991.300	116.7	108513476	6	521.200	178.9
103612199	2	9991.300	118.9	1086 1497	7	21.368	34.2
103712583	2	9991.300	121.1	1087 3094	7	531.236	55.7
103813217	2	191.248	127.3	1088 4430	7	421.241	69.0
103913747	2	511.250	130.2	1089 5459	7	111.251	77.8
104014159	2	631.282	130.9	1090 6541	7	301.257	86.6
104114703	2	9991.300	133.0	1091 8211	7	9991.300	97.5
104215371	2	9991.300	136.5	109210649	7	9991.300	114.0
104316208	2	9991.300	141.0	109316316	7	9991.300	147.2
104416839	2	9991.300	144.2	1094 1035	8	381.253	37.5
104518257	2	9991.300	151.4	1095 1511	8	661.222	47.8
104620400	2	9991.300	161.8	1096 1786	8	231.214	53.1
104724523	2	361.134	193.9	1097 2068	8	241.232	57.4
104837327	2	9991.300	232.6	1098 2847	8	91.234	69.6
1049 3143	3	9991.300	49.9	1099 3898	8	451.259	82.9
1050 5861	3	541.262	73.6	1100 9725	8	9991.300	140.8

Figure A3:13-4 ST. JOHN'S: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   22    1        3035  136    2
30 2   34    1        3036  223    2
30 3   42    1        3037   26    3
30 4   50    1        3038   40    3
30 5   57    1        3039   51    3
30 6   63    1        3040   61    3
30 7   67    1        3041   69    3
30 8   71    1        3042   74    3
30 9   75    1        3043   78    3
3010   79    1        3044   83    3
3011   83    1        3045   88    3
3012   87    1        3046   93    3
3013   91    1        3047   98    3
3014   95    1        3048  104    3
3015  100    1        3049  110    3
3016  106    1        3050  122    3
3017  115    1        3051  139    3
3018  125    1        3052  197    3
3019  136    1        3053   60    4
3020  170    1        3054   78    4
3021   31    2        3055   84    4
3022   51    2        3056   89    4
3023   58    2        3057   93    4
3024   62    2        3058   98    4
3025   67    2        3059  102    4
3026   71    2        3060  107    4
3027   76    2        3061  111    4
3028   82    2        3062  121    4
3029   87    2        3063  137    4
3030   92    2        3064  184    4
3031   98    2        3065   27    5
3032  105    2        3066   52    5
3033  112    2        3067  114    5
3034  120    2

0000 INCOME by TYPE    0000 ALPHA by TYPE    0000 ZONAL DATA
20 1 7977              21 1.1510             40 1 7044   25
20 211084              21 2.1264             40 2 7885   29
20 3 9424              21 3.1278             40 3 6898   54
20 411038              21 4.1130             40 411131   62
20 5 5689              21 5.1771             40 5 3037    5
20 6 5024              21 6.2347             40 614109   43
20 7 7013              21 7.1579
20 8 3249              21 8.2802
```

Figure A3:13-4(cont) ST. JOHN'S: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	2.8963	0.7998
	(16.6)	(4.02)
BATH	0.1639	na
	(3.37)	
TOILET	-.0493	0.3355
	(0.75)	(3.90)
SUBSIDIS	-.2268	-.0786
	(6.94)	(0.87)
LNLIVING	0.2047	0.2494
	(4.64)	(5.59)
LNINCOM	0.1647	0.2485
	(9.35)	(11.9)
TYPE	-.0252	-.2770
	(1.30)	(10.3)
LNDIST	0.0057	0.0027
	(0.44)	(0.22)
B5160	-.1543	-.0006
	(5.41)	(0.03)
B4650	-.0796	0.0321
	(5.52)	(0.97)
B2145	-.0796	-.0287
	(2.38)	(1.08)
BPRE20	-.1399	-.1918
	(4.79)	(6.53)
LGLVSIZE	0.0988	0.1859
	(3.42)	(6.30)
LGBDSIZE	0.0185	0.1026
	(3.42)	(6.30)
OPENSP	-.0493	-.0171
	(2.02)	(0.70)
HIGHDEN	-.0037	-.0178
	(0.15)	(0.39)
COMMERC	0.0166	na
	(0.62)	
NEIGHBD	0.0964	na
	(2.88)	
FINANCE	-.0213	-.0440
	(0.90)	(1.46)
AMRATE	na	0.0723
		(15.0)
R2	0.38	0.51
Observations	1077	1332

note: "t" statistics in brackets
: data source: JHN.REG02

Figure A3:14-4 ST. JOHN'S: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	403.4	108.4	1.275	1.241	0.3503
min	42.5	24.9	1.202	1.241	0.0579
max	2058.6	691.3	1.426	1.241	0.9353
TYPE 2					
mean	425.6	118.9	1.287	1.241	0.3670
min	57.8	40.8	1.202	1.241	0.0905
max	1689.8	256.5	1.467	1.241	0.9460
TYPE 3					
mean	664.3	128.4	1.292	1.241	0.2292
min	140.7	31.1	1.202	1.241	0.0389
max	2037.9	299.3	1.464	1.241	0.9041
TYPE 4					
mean	470.3	121.7	1.294	1.241	0.3092
min	81.6	42.9	1.202	1.241	0.0971
max	1284.1	326.3	1.448	1.241	0.9965
TYPE 5					
mean	676.3	130.4	1.294	1.241	0.2303
min	105.3	35.9	1.202	1.241	0.0258
max	2681.6	324.9	1.445	1.241	0.9444
TYPE 6					
mean	679.3	239.6	1.691	1.241	0.4283
min	130.5	51.4	1.295	1.241	0.0533
max	3682.8	724.5	1.755	1.241	0.9675
TYPE 7					
mean	764.9	277.7	1.698	1.241	0.3992
min	105.3	63.9	1.318	1.241	0.1192
max	2487.2	743.5	1.780	1.241	0.9971
TYPE 8					
mean	1050.7	273.1	1.699	1.241	0.2811
min	200.1	46.5	1.304	1.241	0.0474
max	3007.2	989.1	1.768	1.241	0.8870
TYPE 9					
mean	794.8	268.2	1.740	1.241	0.3627
min	181.7	63.1	1.335	1.241	0.1042
max	2228.2	1010.0	1.809	1.241	0.9909
TYPE 10					
mean	1047.5	281.6	1.706	1.241	0.2879
min	174.2	23.7	1.311	1.241	0.0662
max	3189.6	1012.6	1.781	1.241	0.9919

Figure A3:15-4 ST. JOHN'S : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2893	-.1687	0.1897	0.0746	-.0112	85.0	237.7	403.4	94
	(91.3)	(11.6)	(33.6)	(1.85)	(1.37)				
2	-.2938	-.1937	0.2021	-.0062	-.0021	92.3	247.2	425.6	149
	(134.)	(20.4)	(41.1)	(0.28)	(0.31)				
3	-.2022	-.1093	0.1591	0.1998	-.0577	99.5	431.8	664.3	291
	(196.)	(20.8)	(58.7)	(10.2)	(12.7)				
4	-.2774	-.2131	0.2268	-.0548	0.0648	94.0	280.9	470.3	265
	(132.)	(19.8)	(44.2)	(1.56)	(9.23)				
5	-.2014	-.1024	0.1611	0.2522	-.0481	100.7	439.9	676.3	278
	(153.)	(14.8)	(51.4)	(9.13)	(10.7)				
6	-.3713	-.1853	0.2310	0.0491	0.0459	141.9	354.3	679.3	201
	(141.)	(18.9)	(40.4)	(2.11)	(5.31)				
7	-.3787	-.1791	0.2787	0.1420	0.1448	162.7	392.6	764.9	126
	(109.)	(10.4)	(32.4)	(3.54)	(11.2)				
8	-.2670	-.1556	0.1703	0.0872	-.0611	160.8	626.5	1050.7	222
	(175.)	(23.5)	(30.5)	(3.95)	(6.44)				
9	-.3489	-.2115	0.2542	0.0056	0.0876	153.8	424.3	794.8	299
	(189.)	(25.7)	(43.1)	(0.25)	(10.4)				
10	-.2772	-.1414	0.2153	0.1801	0.0468	165.3	617.1	1047.5	484
	(215.)	(26.1)	(58.8)	(11.4)	(8.86)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-4 ST. JOHN'S: Direct Translog-Expenditure Share [all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4043	-.1700	0.2603	0.1137	0.0855	72.2	114.6	234.3	61
	(169.)	(17.2)	(34.0)	(4.66)	(7.58)				
2	-.4229	-.2303	0.2737	-.0347	0.0865	82.0	121.3	256.3	88
	(186.)	(19.4)	(34.6)	(1.39)	(8.21)				
3	-.2680	-.1208	0.2034	0.1977	-.0035	93.9	278.1	466.3	156
	(209.)	(16.1)	(43.1)	(8.78)	(0.47)				
4	-.3646	-.1926	0.3028	0.0532	0.1585	82.9	162.2	308.6	148
	(139.)	(12.4)	(32.2)	(1.26)	(12.5)				
5	-.2592	-.1145	0.2159	0.2319	0.0186	90.2	280.5	464.7	152
	(170.)	(14.4)	(40.1)	(8.57)	(2.45)				
6	-.4961	-.2191	0.2988	-.0027	0.1409	124.8	178.0	431.3	129
	(179.)	(12.2)	(25.9)	(0.07)	(8.43)				
7	-.4393	-.1132	0.3650	0.2506	0.2650	136.9	246.9	538.4	72
	(109.)	(4.51)	(22.0)	(5.23)	(11.4)				
8	-.3038	-.1518	0.2091	0.0965	-.0094	132.1	423.6	748.0	120
	(139.)	(14.5)	(15.9)	(2.86)	(0.43)				
9	-.3936	-.1679	0.3262	0.0876	0.1782	131.2	292.7	589.7	173
	(159.)	(11.5)	(25.9)	(2.38)	(10.4)				
10	-.3088	-.1286	0.2634	0.2137	0.1094	137.0	433.1	770.2	280
	(187.)	(15.9)	(38.8)	(9.81)	(12.4)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-4 ST. JOHN'S: Direct Translog-Expenditure Share [below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1942	-.0877	0.0966	0.2983	-.2648	108.7	465.4	716.1	33
	(159.)	(13.7)	(18.9)	(13.7)	(14.9)				
2	-.2050	-.0990	0.0943	0.2898	-.3264	107.0	428.7	670.0	61
	(205.)	(16.9)	(11.9)	(11.1)	(10.2)				
3	-.1534	-.0708	0.0745	0.3463	-.3224	106.0	609.3	893.1	135
	(295.)	(18.8)	(11.8)	(14.8)	(8.99)				
4	-.2083	-.1052	0.1137	0.2639	-.2317	108.1	431.0	674.9	117
	(286.)	(19.0)	(16.5)	(10.5)	(7.94)				
5	-.1574	-.0787	0.0640	0.3065	-.4171	113.3	632.2	931.6	126
	(249.)	(18.5)	(13.4)	(13.5)	(15.6)				
6	-.2630	-.1219	0.1590	0.2277	-.1161	172.6	670.1	1123.6	72
	(123.)	(13.5)	(15.3)	(6.05)	(4.15)				
7	-.3159	-.1849	0.1355	0.0224	-.2191	197.1	586.8	1067.0	54
	(93.9)	(10.1)	(5.49)	(0.32)	(3.22)				
8	-.2387	-.1275	0.1189	0.1739	-.2122	194.7	865.3	1406.8	102
	(149.)	(12.0)	(9.00)	(4.47)	(4.82)				
9	-.3069	-.1737	0.2048	0.1199	0.0038	184.9	605.0	1076.4	126
	(200.)	(19.9)	(22.3)	(4.64)	(0.16)				
10	-.2474	-.1346	0.1397	0.1604	-.1573	204.1	869.7	1428.1	204
	(193.)	(20.7)	(18.2)	(6.98)	(7.04)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-4 ST. JOHN'S: Direct Translog-Expenditure Share [above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4917	-.1237	0.3129	0.1813	0.1609	66.2	69.5	170.0	37
	(166.)	(7.98)	(15.7)	(6.10)	(6.44)				
2	-.5827	-.2456	0.2886	-.0714	0.1273	72.1	55.0	162.3	42
	(178.)	(12.6)	(22.0)	(2.19)	(7.35)				
3	-.3715	-.1732	0.2479	0.0996	0.0517	92.9	167.8	327.6	67
	(188.)	(14.4)	(29.9)	(3.22)	(4.12)				
4	-.4583	-.1663	0.3655	0.0924	0.2403	79.0	103.5	230.3	74
	(114.)	(6.35)	(20.2)	(1.60)	(10.6)				
5	-.3230	-.1053	0.2622	0.2369	0.0799	82.3	188.2	339.7	70
	(142.)	(9.38)	(28.0)	(7.36)	(6.22)				
6	-.5544	-.2275	0.3221	-.0259	0.1738	108.3	119.9	329.6	71
	(146.)	(7.14)	(16.6)	(0.45)	(6.65)				
7	-.5372	-.1090	0.4027	0.2534	0.3274	130.5	154.6	413.3	31
	(72.5)	(1.43)	(12.4)	(1.82)	(7.93)				
8	-.3654	-.1375	0.2944	0.1526	0.1148	121.1	291.7	564.1	51
	(94.4)	(7.04)	(10.6)	(2.82)	(2.46)				
9	-.4581	-.1800	0.3125	0.0559	0.1495	113.9	194.6	440.7	72
	(146.)	(10.4)	(17.8)	(1.40)	(6.92)				
10	-.3535	-.1308	0.3171	0.2025	0.1771	123.4	318.7	603.7	125
	(139.)	(10.9)	(27.9)	(6.42)	(12.7)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-4 ST. JOHN'S: Direct Translog-Expenditure Share [quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3146	-.1473	0.1834	0.2023	-.0845	81.5	184.0	333.4	24
	(117.)	(6.07)	(4.67)	(2.74)	(0.69)				
2	-.3397	-.1330	0.2133	0.2757	-.0221	91.1	181.9	342.1	46
	(247.)	(6.79)	(9.09)	(4.51)	(0.38)				
3	-.2147	-.0971	0.1092	0.3061	-.2425	94.6	361.2	570.8	89
	(261.)	(12.9)	(5.08)	(8.68)	(2.85)				
4	-.2934	-.1452	0.1893	0.1757	-.0471	86.8	220.9	386.8	74
	(263.)	(12.3)	(12.3)	(3.91)	(1.11)				
5	-.2198	-.0906	0.1293	0.3288	-.1735	96.9	359.2	571.4	82
	(233.)	(8.79)	(5.28)	(6.62)	(1.81)				
6	-.4474	-.1225	0.3760	0.2103	0.2586	145.0	249.3	555.8	58
	(137.)	(4.98)	(16.1)	(3.74)	(8.05)				
7	-.3800	-.1156	0.3605	0.2337	0.2305	141.7	316.8	632.9	41
	(77.1)	(3.08)	(5.86)	(1.60)	(1.38)				
8	-.2708	-.1474	0.1219	0.0851	-.3343	140.2	521.1	883.9	69
	(115.)	(7.31)	(1.74)	(1.14)	(1.49)				
9	-.3500	-.0304	0.4398	0.4722	0.3900	143.5	362.7	695.9	101
	(140.)	(1.57)	(18.6)	(9.20)	(13.3)				
10	-.2812	-.1352	0.2007	0.1390	-.1020	148.0	525.4	904.4	155
	(178.)	(10.7)	(7.55)	(3.37)	(1.48)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-4 ST. JOHN'S: Direct Translog-Expenditure Share [quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2348	-.0987	0.1343	0.2775	-.2183	97.7	325.1	527.3	23
	(194.)	(8.86)	(5.67)	(5.40)	(2.33)				
2	-.2321	-.1030	0.0963	0.2817	-.4061	95.8	326.5	528.7	39
	(207.)	(11.8)	(4.28)	(6.43)	(4.84)				
3	-.1677	-.0807	0.0706	0.2904	-.4240	99.2	510.3	760.9	80
	(247.)	(11.3)	(2.92)	(6.34)	(3.34)				
4	-.2355	-.1100	0.1284	0.2634	-.2015	103.1	351.9	570.8	72
	(254.)	(13.1)	(6.76)	(8.16)	(2.90)				
5	-.1813	-.1066	0.0649	0.2175	-.4644	109.0	518.6	785.8	79
	(225.)	(11.1)	(2.76)	(4.26)	(3.94)				
6	-.3164	-.0934	0.2484	0.2985	0.0385	158.9	469.2	851.4	45
	(123.)	(6.13)	(8.94)	(5.24)	(0.55)				
7	-.3735	-.1667	0.2451	0.0996	-.0394	192.8	443.6	881.4	37
	(90.2)	(1.69)	(1.85)	(0.33)	(0.10)				
8	-.2546	-.1206	0.1973	0.1810	-.1036	179.7	725.0	1206.2	64
	(132.)	(6.73)	(5.32)	(2.85)	(0.91)				
9	-.3183	-.1340	0.2953	0.2395	0.1865	164.0	502.0	910.9	80
	(149.)	(5.55)	(9.39)	(2.97)	(2.47)				
10	-.2451	-.0750	0.2734	0.3958	0.1896	174.3	736.6	1212.2	129
	(158.)	(5.43)	(12.5)	(7.43)	(3.12)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-4 ST. JOHN'S: Direct Translog-Expenditure Share [quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1460	-.0611	0.0640	0.3712	-.4011	134.0	788.0	1150.3	10
	(361.)	(44.0)	(32.5)	(51.6)	(21.3)				
2	-.1786	-.1036	0.0989	0.2476	-.2661	126.7	609.9	920.5	22
	(124.)	(7.29)	(6.00)	(2.78)	(2.99)				
3	-.1385	-.0578	0.0779	0.4141	-.2467	116.0	753.4	1085.3	55
	(195.)	(9.44)	(6.08)	(9.86)	(2.84)				
4	-.1767	-.0614	0.0976	0.4810	-.2120	116.2	557.5	841.4	45
	(182.)	(5.06)	(8.58)	(8.50)	(3.70)				
5	-.1321	-.0653	0.0519	0.3195	-.4219	120.5	823.2	1176.8	47
	(178.)	(14.4)	(7.18)	(10.3)	(8.60)				
6	-.2064	-.0853	0.0875	0.3725	-.3811	195.5	1004.8	1577.5	27
	(59.7)	(4.24)	(2.43)	(4.62)	(2.45)				
7	-.2398	-.1043	0.0098	0.2820	-.5875	206.4	898.6	1471.1	17
	(49.2)	(2.36)	(0.12)	(1.33)	(2.28)				
8	-.2176	-.0978	0.1116	0.2754	-.2038	219.9	1101.5	1744.7	38
	(78.9)	(7.29)	(4.73)	(5.45)	(2.00)				
9	-.2901	-.1400	0.2142	0.2332	0.0731	221.1	784.0	1364.2	46
	(138.)	(10.6)	(13.8)	(5.26)	(1.36)				
10	-.2457	-.1424	0.0676	0.0653	-.4027	255.4	1098.5	1799.4	75
	(146.)	(14.6)	(2.69)	(1.46)	(4.87)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-4 ST. JOHN'S: Direct Translog-Expenditure Share [quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.7313	0.7315	0.7622	-1.0230	-1.5662	-0.7312
Q02	0.5566	0.5705	0.5790	-0.9978	-1.2207	-0.8071
Q03	0.4634	0.4566	0.4572	-1.0243	-1.2241	-0.9000
Q04	0.3490	0.3327	0.3098	-0.9966	-1.5148	-0.3743
TYPE 2						
Q01	0.7705	0.7705	0.7705	-1.0063	-2.0547	-0.6159
Q02	0.5952	0.6392	0.6560	-0.9926	-1.2376	-0.8035
Q03	0.5040	0.4640	0.4577	-1.0216	-1.1842	-0.8442
Q04	0.3737	0.3714	0.3707	-0.9991	-1.3214	-0.6698
TYPE 3						
Q01	0.5962	0.5994	0.6030	-1.0264	-1.7493	-0.7136
Q02	0.4370	0.4446	0.4444	-0.9985	-1.1240	-0.9001
Q03	0.3665	0.3455	0.3461	-1.0136	-1.1033	-0.9232
Q04	0.3016	0.3283	0.3339	-0.9967	-1.1485	-0.8122
TYPE 4						
Q01	0.6787	0.6839	0.6866	-1.0522	-1.6441	-0.7880
Q02	0.5190	0.5267	0.5297	-1.0090	-1.1979	-0.8332
Q03	0.4580	0.4646	0.4646	-1.0047	-1.1164	-0.9038
Q04	0.3704	0.4426	0.4717	-0.9861	-1.1487	-0.7350
TYPE 5						
Q01	0.5501	0.5589	0.5557	-1.0700	-1.7022	-0.8665
Q02	0.4430	0.4588	0.4558	-1.0048	-1.1165	-0.9183
Q03	0.3917	0.3641	0.3624	-1.0034	-1.1115	-0.8936
Q04	0.3030	0.2869	0.2853	-1.0008	-1.1861	-0.7954
TYPE 6						
Q01	0.7551	0.7564	0.7614	-1.0195	-1.7451	-0.7211
Q02	0.6882	0.7182	0.7165	-1.0495	-1.2954	-0.9026
Q03	0.5537	0.5792	0.5783	-1.0540	-1.2539	-0.8990
Q04	0.4681	0.4606	0.4559	-0.9979	-1.3412	-0.6195
TYPE 7						
Q01	0.8254	0.8299	0.8870	-0.9735	-1.4353	-0.7772
Q02	0.6232	0.6413	0.6437	-1.0731	-1.2593	-0.9238
Q03	0.6145	0.6016	0.5896	-1.0565	-1.2846	-0.8637
Q04	0.5483	0.4895	0.4530	-0.9768	-1.2392	-0.5902
TYPE 8						
Q01	0.5892	0.5894	0.5896	-1.0751	-1.8252	-0.8174
Q02	0.4803	0.4591	0.4444	-1.0501	-1.2176	-0.8787
Q03	0.4726	0.4571	0.4501	-1.0684	-1.2360	-0.8974
Q04	0.4184	0.4296	0.4332	-1.0023	-1.2200	-0.7275
TYPE 9						
Q01	0.6711	0.6717	0.6732	-1.0470	-1.7623	-0.7664
Q02	0.6309	0.7088	0.7119	-1.1217	-1.2572	-1.0281
Q03	0.5585	0.5837	0.6018	-1.0256	-1.1884	-0.8764
Q04	0.4998	0.5392	0.5922	-0.9872	-1.3067	-0.6646
TYPE 10						
Q01	0.5919	0.6026	0.6041	-1.0641	-1.5547	-0.8714
Q02	0.4928	0.4827	0.4760	-1.0671	-1.2447	-0.9195
Q03	0.4749	0.5209	0.5271	-1.0613	-1.1973	-0.9534
Q04	0.4642	0.4167	0.4033	-1.0176	-1.2605	-0.7106

Figure A3:23-4 ST. JOHN'S: Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	207.48	167.95	125.24	104.44	79.59	90.21	61.95
BM1=BM2=0	204.78	141.88	87.31	85.25	72.33	68.97	32.42
statistic	5.40	52.13	75.86	38.37	14.52	42.49	59.06
TYPE 2							
normal	346.99	231.89	222.96	114.59	158.00	144.92	82.66
BM1=BM2=0	346.88	201.33	177.06	86.98	141.30	116.42	67.42
statistic	0.21	61.12	91.80	55.21	33.41	56.99	30.48
TYPE 3							
normal	781.62	438.01	520.36	191.62	323.88	306.21	219.70
BM1=BM2=0	684.08	404.10	410.45	181.17	270.75	247.27	168.77
statistic	195.08	67.83	219.80	20.90	106.27	117.88	101.85
TYPE 4							
normal	540.32	318.40	425.92	159.01	250.18	264.85	173.71
BM1=BM2=0	478.12	231.30	352.95	98.26	224.18	216.40	149.77
statistic	124.41	174.20	145.95	121.50	52.00	96.90	47.89
TYPE 5							
normal	687.72	406.57	475.48	190.39	285.30	296.81	188.95
BM1=BM2=0	614.28	373.67	343.08	162.51	228.72	258.89	121.62
statistic	146.88	65.80	264.80	55.75	113.15	75.85	134.66
TYPE 6							
normal	406.92	287.36	196.71	162.80	143.31	126.12	79.75
BM1=BM2=0	392.40	241.09	162.00	132.12	114.25	103.79	71.74
statistic	29.03	92.53	69.41	61.35	58.13	44.66	16.01
TYPE 7							
normal	244.12	152.03	139.15	65.98	95.54	95.80	47.20
BM1=BM2=0	177.11	93.32	126.31	38.62	94.02	92.95	44.14
statistic	134.01	117.41	25.67	54.72	3.05	5.70	6.12
TYPE 8							
normal	543.53	287.61	290.68	119.84	186.00	185.28	114.09
BM1=BM2=0	510.40	278.96	247.97	115.73	174.52	167.10	102.34
statistic	66.26	17.29	85.43	8.22	22.96	36.36	23.51
TYPE 9							
normal	636.65	365.56	347.73	170.61	250.91	222.08	136.81
BM1=BM2=0	572.42	297.10	333.10	146.18	182.17	217.61	119.98
statistic	128.47	136.94	29.26	48.85	137.48	8.94	33.65
TYPE10							
normal	1097.35	649.68	559.92	290.72	415.30	368.47	220.29
BM1=BM2=0	996.96	538.44	494.93	210.91	386.57	333.94	181.56
statistic	200.77	222.48	129.98	159.61	57.46	69.05	77.46

Figure A3:24-4 ST. JOHN'S: Log Likelihood Values:
[test of unity income elasticity]

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0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs
10 1 1704     1 -293    23
10 2 3619     1  709   177
10 3 8537     1 6567  2095
10 4 1187     2 -253    18
10 5 2417     2  738   161
10 6 3911     2 2590   492
10 7 5653     2 4798  1052
10 8 9325     2 9841  3079
10 9 2575     3  281   116
1010 4673     3 2799   553
1011 6017     3 4122   800
1012 6994     3 5451  1101
1013 7943     3 6340  1312
1014 9053     3 7771  1669
101510693     3 9812  2293
101614044     314587  4245
1017  458     4-1410     0
1018 1976     4 -355    32
1019 2848     4 -139    64
1020 3555     4  310    84
1021 4097     4 1339   279
1022 4670     4 1510   286
1023 5640     4 2654   511
1024 6534     4 3826   780
1025 7680     4 5120  1150
102610407     4 9337  2778
1027 1931     5-1140    43
1028 4412     5 1160   300
1029 5413     5 2332   480
1030 6248     5 3501   716
1031 7288     5 4208   833
1032 8274     5 5852  1236
1033 9462     5 6788  1553
103410976     5 8849  2093
103515062     515779  5250
1036 2332     6 -479     0
1037 3531     6 -304    54
1038 4031     6 -282    14
1039 4716     6  -48    52
1040 5321     6  566   185
1041 6320     6 1364   278
1042 7405     6 2417   514
1043 8765     6 3245   696
104411512     6 6410  1564
104518291     616433  5899
1046 3530     7  572   139
1047 5303     7 1858   377
1048 6483     7 3068   625
1049 7415     7 3523   744
1050 8818     7 5607  1316
1051 9775     7 6611  1684
105211639     7 8212  2249
105317568     718811  7963
1054 4701     8 1028   233
1055 6918     8 3026   556
1056 8275     8 4605   946
1057 9330     8 5863  1187
105810068     8 6923  1513
105910890     8 7466  1646
106012102     8 9092  2142
106113064     810585  2651
106214347     811282  2882
106316161     813609  3826
106417832     815863  4400
106523603     823230  8206
1066 1107     9-1663     0
1067 3051     9 -977    33
1068 4465     9  220   101
1069 5535     9 1079   240
1070 6509     9 1989   387
1071 7332     9 2809   573
1072 7934     9 3914   809
1073 8618     9 4050   885
1074 9092     9 5444  1251
1075 9803     9 5929  1401
107610638     9 7269  1843
107711893     9 8188  2202
107813898     911389  3583
107919386     921086  9413
1080 3183    10 -554   106
1081 5497    10 1075   296
1082 6851    10 2529   541
1083 7674    10 3188   664
1084 8323    10 4207   906
1085 8978    10 4851  1057
1086 9509    10 5605  1182
108710054    10 6631  1494
108810423    10 6443  1506
108910932    10 5921  1340
109011526    10 7467  1738
109112150    10 8619  1954
109212759    10 8919  2217
109313473    10 9375  2158
109414281    1010971  2739
109515038    1011324  2888
109615959    1013032  3511
109717046    1014121  4090
109818670    1015292  4712
109921205    1019081  6603
11 029174    103284814901
```

Figure A3:25-4 ST. JOHN'S: Demand Calibration Data

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0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1170.0333.4527.31150.          |  20 6329.6555.8851.41578.
20 2162.3342.1528.7920.5          |  20 7413.3632.9881.41471.
20 3327.6570.8760.91085.          |  20 8564.1883.91206.1745.
20 4230.3386.8570.8841.4          |  20 9440.7695.9910.91364.
20 5339.7571.4785.81177.          |  2010603.7904.41212.1799.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.492-.124.3129.1813.160966.1669.47170.01.268
21 2    0-.583-.246.2886-.071.127372.1354.97162.31.301
21 3    0-.371-.173.2479.0996.051792.91167.8327.61.289
21 4    0-.458-.166.3655.0924.240378.99103.5230.31.288
21 5    0-.323-.105.2622.2369.079982.31188.2339.71.289
21 6    0-.554-.228.3221-.026.1738108.3119.9329.61.681
21 7    0-.537-.109.4027.2534.3274130.5154.6413.31.684
21 8    0-.365-.138.2944.1526.1148121.1291.7564.11.678
21 9    0-.458-.180.3125.0559.1495113.9194.6440.71.759
2110    0-.354-.131.3171.2025.1771123.4318.7603.71.690
0000  (quartile 02)
22 1    0-.315-.147.1834.2023-.08581.54184.0333.41.285
22 2    0-.340-.133.2133.2757-.02291.09181.9342.11.275
22 3    0-.215-.097.1092.3061-.24394.65361.2570.81.294
22 4    0-.293-.145.1893.1757-.04786.78220.9386.81.300
22 5    0-.220-.091.1293.3288-.17496.94359.2571.41.297
22 6    0-.447-.122.3760.2103.2586145.0249.3555.81.703
22 7    0-.380-.116.3605.2337.2305141.7316.8632.91.687
22 8    0-.271-.147.1219.0851-.334140.2521.1883.91.692
22 9    0-.350-.030.4398.4722.3900143.5362.7695.91.709
2210    0-.281-.135.2007.1390-.102148.0525.4904.41.710
0000  (quartile 03)
23 1    0-.235-.099.1343.2775-.21897.69325.1527.31.270
23 2    0-.232-.103.0963.2817-.40695.84326.5528.71.288
23 3    0-.168-.081.0706.2904-.42499.17510.3760.91.287
23 4    0-.236-.110.1284.2634-.201103.1351.9570.81.301
23 5    0-.181-.107.0649.2175-.464109.0518.6785.81.301
23 6    0-.316-.093.2484.2985.0385158.9469.2851.41.694
23 7    0-.374-.167.2451.0996-.039192.8443.6881.41.710
23 8    0-.255-.121.1973.1810-.104179.7725.01206.1.708
23 9    0-.318-.134.2953.2395.1865164.0502.0910.91.749
2310    0-.245-.075.2734.3958.1896174.3736.61212.1.707
0000  (quartile 04)
24 1    0-.146-.061.0640.3712-.401134.0788.01150.1.284
24 2    0-.179-.104.0989.2476-.266126.7609.9920.51.287
24 3    0-.138-.058.0779.4141-.247116.0753.41085.1.298
24 4    0-.177-.061.0976.4810-.212116.2557.5841.41.284
24 5    0-.132-.065.0519.3195-.422120.5823.21177.1.287
24 6    0-.206-.085.0875.3725-.381195.51005.1578.1.687
24 7    0-.240-.104.0098.2820-.588206.4898.61471.1.722
24 8    0-.218-.098.1116.2754-.204219.91101.1745.1.726
24 9    0-.290-.140.2142.2332.0731221.1784.01364.1.764
2410    0-.246-.142.0676.0653-.403255.41098.1799.1.722
```

Figure A3:25-4(cont) ST. JOHN'S: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1    35     1     1 | 3035   158     5     1 | 3069   148     4     2
30 2    70     1     1 | 3036    36     1     2 | 3070   152     4     2
30 3    79     1     1 | 3037    58     1     2 | 3071   156     4     2
30 4    88     1     1 | 3038    70     1     2 | 3072   159     4     2
30 5    97     1     1 | 3039    80     1     2 | 3073   163     4     2
30 6   108     1     1 | 3040    86     1     2 | 3074   167     4     2
30 7   123     1     1 | 3041    92     1     2 | 3075   170     4     2
30 8   139     1     1 | 3042    97     1     2 | 3076   176     4     2
30 9   174     1     1 | 3043   104     1     2 | 3077   184     4     2
3010    91     2     1 | 3044   113     1     2 | 3078   192     4     2
3011    55     3     1 | 3045   123     1     2 | 3079   208     4     2
3012    81     3     1 | 3046   141     1     2 | 3080   257     4     2
3013   104     3     1 | 3047   180     1     2 | 3081    25     5     2
3014   147     3     1 | 3048   107     2     2 | 3082    39     5     2
3015    45     4     1 | 3049   161     2     2 | 3083    52     5     2
3016    66     4     1 | 3050   120     3     2 | 3084    64     5     2
3017    74     4     1 | 3051   140     3     2 | 3085    72     5     2
3018    82     4     1 | 3052   148     3     2 | 3086    81     5     2
3019    92     4     1 | 3053   163     3     2 | 3087    89     5     2
3020   101     4     1 | 3054   201     3     2 | 3088    98     5     2
3021   107     4     1 | 3055    45     4     2 | 3089   107     5     2
3022   114     4     1 | 3056    72     4     2 | 3090   116     5     2
3023   120     4     1 | 3057    85     4     2 | 3091   126     5     2
3024   125     4     1 | 3058    98     4     2 | 3092   136     5     2
3025   132     4     1 | 3059   104     4     2 | 3093   143     5     2
3026   141     4     1 | 3060   109     4     2 | 3094   149     5     2
3027   158     4     1 | 3061   115     4     2 | 3095   155     5     2
3028    47     5     1 | 3062   120     4     2 | 3096   161     5     2
3029    77     5     1 | 3063   125     4     2 | 3097   169     5     2
3030   102     5     1 | 3064   129     4     2 | 3098   178     5     2
3031   113     5     1 | 3065   133     4     2 | 3099   195     5     2
3032   120     5     1 | 3066   137     4     2 | 31 0   234     5     2
3033   127     5     1 | 3067   141     4     2
3034   133     5     1 | 3068   144     4     2

0000 ZONAL Data
40 1 7557   34        | 40 211300   52        | 40 311075   71
40 4 9264   99        | 40 5 8835  105        | 40 612429   82
0000  Parameters
5011 .35              | 5012 .95              | 5013 0.0
5016 .35              | 50171.35              | 5018 0.0
50201.241             |

0000 Calibration Data
70 11.4710.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   77101.000 99.7
70 21.5850.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  152431.000119.3
70 31.7150.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  110661.000128.8
70 41.7320.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   91531.000129.3
70 51.7980.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   86371.000116.7
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0      00.0    0.0
```

Figure A3:25-4(cont) ST. JOHN'S: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1704	1	-293	23	1051	9775	7	6611	1684
10	2	3619	1	709	177	105211639		7	8212	2249
10	3	8537	1	6567	2095	105317568		718811		7963
10	4	1187	2	-253	18	1054	4701	8	1028	233
10	5	2417	2	738	161	1055	6918	8	3026	556
10	6	3911	2	2590	492	1056	8275	8	4605	946
10	7	5653	2	4798	1052	1057	9330	8	5863	1187
10	8	9325	2	9841	3079	105810068		8	6923	1513
10	9	2575	3	281	116	105910890		8	7466	1646
1010		4673	3	2799	553	106012102		8	9092	2142
1011		6017	3	4122	800	106113064		810585		2651
1012		6994	3	5451	1101	106214347		811282		2882
1013		7943	3	6340	1312	106316161		813609		3826
1014		9053	3	7771	1669	106417832		815863		4400
101510693			3	9812	2293	106523603		823230		8206
101614044			314587		4245	1066	1107	9	-1663	0
1017		458	4	-1410	0	1067	3051	9	-977	33
1018		1976	4	-355	32	1068	4465	9	220	101
1019		2848	4	-139	64	1069	5535	9	1079	240
1020		3555	4	310	84	1070	6509	9	1989	387
1021		4097	4	1339	279	1071	7332	9	2809	573
1022		4670	4	1510	286	1072	7934	9	3914	809
1023		5640	4	2654	511	1073	8618	9	4050	885
1024		6534	4	3826	780	1074	9092	9	5444	1251
1025		7680	4	5120	1150	1075	9803	9	5929	1401
102610407			4	9337	2778	107610638		9	7269	1843
1027		1931	5	-1140	43	107711893		9	8188	2202
1028		4412	5	1160	300	107813898		911389		3583
1029		5413	5	2332	480	107919386		921086		9413
1030		6248	5	3501	716	1080	3183	10	-554	106
1031		7288	5	4208	833	1081	5497	10	1075	296
1032		8274	5	5852	1236	1082	6851	10	2529	541
1033		9462	5	6788	1553	1083	7674	10	3188	664
103410976			5	8849	2093	1084	8323	10	4207	906
103515062			515779		5250	1085	8978	10	4851	1057
1036		2332	6	-479	0	1086	9509	10	5605	1182
1037		3531	6	-304	54	108710054		10	6631	1494
1038		4031	6	-282	14	108810423		10	6443	1506
1039		4716	6	-48	52	108910932		10	5921	1340
1040		5321	6	566	185	109011526		10	7467	1738
1041		6320	6	1364	278	109112150		10	8619	1954
1042		7405	6	2417	514	109212759		10	8919	2217
1043		8765	6	3245	696	109313473		10	9375	2158
104411512			6	6410	1564	109414281		1010971		2739
104518291			616433		5899	109515038		1011324		2888
1046		3530	7	572	139	109615959		1013032		3511
1047		5303	7	1858	377	109717046		1014121		4090
1048		6483	7	3068	625	109818670		1015292		4712
1049		7415	7	3523	744	109921205		1019081		6603
1050		8818	7	5607	1316	11	029174	10328	4814	901

Figure A3:26-4 ST. JOHN'S: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1170.0333.4527.31150.          |  20 6329.6555.8851.41578.
20 2162.3342.1528.7920.5          |  20 7413.3632.9881.41471.
20 3327.6570.8760.91085.          |  20 8564.1883.91206.1745.
20 4230.3386.8570.8841.4          |  20 9440.7695.9910.91364.
20 5339.7571.4785.81177.          |  2010603.7904.41212.1799.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.492-.124.3129.1813.160966.1669.47170.01.268
21 2    0-.583-.246.2886-.071.127372.1354.97162.31.301
21 3    0-.371-.173.2479.0996.051792.91167.8327.61.289
21 4    0-.458-.166.3655.0924.240378.99103.5230.31.288
21 5    0-.323-.105.2622.2369.079982.31188.2339.71.289
21 6    0-.554-.228.3221-.026.1738108.3119.9329.61.681
21 7    0-.537-.109.4027.2534.3274130.5154.6413.31.684
21 8    0-.365-.138.2944.1526.1148121.1291.7564.11.678
21 9    0-.458-.180.3125.0559.1495113.9194.6440.71.759
2110    0-.354-.131.3171.2025.1771123.4318.7603.71.690
0000  (quartile 02)
22 1    0-.315-.147.1834.2023-.08581.54184.0333.41.285
22 2    0-.340-.133.2133.2757-.02291.09181.9342.11.275
22 3    0-.215-.097.1092.3061-.24394.65361.2570.81.294
22 4    0-.293-.145.1893.1757-.04786.78220.9386.81.300
22 5    0-.220-.091.1293.3288-.17496.94359.2571.41.297
22 6    0-.447-.122.3760.2103.2586145.0249.3555.81.703
22 7    0-.380-.116.3605.2337.2305141.7316.8632.91.687
22 8    0-.271-.147.1219.0851-.334140.2521.1883.91.692
22 9    0-.350-.030.4398.4722.3900143.5362.7695.91.709
2210    0-.281-.135.2007.1390-.102148.0525.4904.41.710
0000  (quartile 03)
23 1    0-.235-.099.1343.2775-.21897.69325.1527.31.270
23 2    0-.232-.103.0963.2817-.40695.84326.5528.71.288
23 3    0-.168-.081.0706.2904-.42499.17510.3760.91.287
23 4    0-.236-.110.1284.2634-.201103.1351.9570.81.301
23 5    0-.181-.107.0649.2175-.464109.0518.6785.81.301
23 6    0-.316-.093.2484.2985.0385158.9469.2851.41.694
23 7    0-.374-.167.2451.0996-.039192.8443.6881.41.710
23 8    0-.255-.121.1973.1810-.104179.7725.01206.1.708
23 9    0-.318-.134.2953.2395.1865164.0502.0910.91.749
2310    0-.245-.075.2734.3958.1896174.3736.61212.1.707
0000  (quartile 04)
24 1    0-.146-.061.0640.3712-.401134.0788.01150.1.284
24 2    0-.179-.104.0989.2476-.266126.7609.9920.51.287
24 3    0-.138-.058.0779.4141-.247116.0753.41085.1.298
24 4    0-.177-.061.0976.4810-.212116.2557.5841.41.284
24 5    0-.132-.065.0519.3195-.422120.5823.21177.1.287
24 6    0-.206-.085.0875.3725-.381195.51005.1578.1.687
24 7    0-.240-.104.0098.2820-.588206.4898.61471.1.722
24 8    0-.218-.098.1116.2754-.204219.91101.1745.1.726
24 9    0-.290-.140.2142.2332.0731221.1784.01364.1.764
2410    0-.246-.142.0676.0653-.403255.41098.1799.1.722
```

Figure A3:26-4(cont) ST. JOHN'S: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1   34     1     1  | 3025   76     1     2  | 3049   87     4     2
30 2   50     1     1  | 3026   80     1     2  | 3050   92     4     2
30 3   62     1     1  | 3027   84     1     2  | 3051   96     4     2
30 4   72     1     1  | 3028   88     1     2  | 3052  100     4     2
30 5   82     1     1  | 3029   92     1     2  | 3053  104     4     2
30 6   92     1     1  | 3030   96     1     2  | 3054  109     4     2
30 7  101     1     1  | 3031  100     1     2  | 3055  113     4     2
30 8  117     1     1  | 3032  109     1     2  | 3056  117     4     2
30 9  154     1     1  | 3033  118     1     2  | 3057  121     4     2
3010  100     2     1  | 3034  138     1     2  | 3058  125     4     2
3011   64     3     1  | 3035  164     1     2  | 3059  129     4     2
3012   96     3     1  | 3036   96     2     2  | 3060  133     4     2
3013  139     3     1  | 3037  114     2     2  | 3061  139     4     2
3014   42     4     1  | 3038  135     2     2  | 3062  145     4     2
3015   64     4     1  | 3039   82     3     2  | 3063  153     4     2
3016   80     4     1  | 3040  100     3     2  | 3064  174     4     2
3017   94     4     1  | 3041  108     3     2  | 3065   37     5     2
3018  108     4     1  | 3042  112     3     2  | 3066   49     5     2
3019  125     4     1  | 3043  117     3     2  | 3067   68     5     2
3020  162     4     1  | 3044  131     3     2  | 3068   92     5     2
3021   94     5     1  | 3045   38     4     2  | 3069  117     5     2
3022   35     1     2  | 3046   56     4     2  | 3070  143     5     2
3023   52     1     2  | 3047   71     4     2  | 3071  181     5     2
3024   67     1     2  | 3048   83     4     2  |

0000 ZONAL Data
40 1 7557   34         | 40 211300   52         | 40 311075   71
40 4 9264   99         | 40 5 8835  105         | 40 612429   82
0000  Parameters
50 1 .0                | 50 2 .1                |
5011 .35               | 5012 .95               | 5013 42.
5016 .35               | 50171.35               | 5018 41.
50201.241              |

0000 Calibration Data
70 11.1190.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   75900.943 96.2
70 21.2120.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  153551.000 86.3
70 31.2800.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  102171.000 92.5
70 41.2440.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   88891.000100.0
70 51.1250.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   85341.000109.5
70 61.4860.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   98381.000101.1
70 71.4670.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   77870.932120.3
70 81.5650.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  151510.921120.4
70 91.7140.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  111990.933125.2
70101.6240.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   89230.978123.1
70111.6940.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   72031.000105.1
70121.9300.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   96521.000126.4
```

Figure A3:26-4(cont) ST. JOHN'S: Supply Calibration Data

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
10  1 1704    1 -292   23          21.235 57.2
10  2 3619    1  709  177        9991.430 68.8
10  3 8537    1 6567 2095         181.233123.1
10  4 1187    2 -252   18          141.234 47.6
10  5 2417    2  738  161          111.325 79.8
10  6 3911    2 2590  492        9991.430 76.6
10  7 5653    2 4798 1052        9991.430 80.8
10  8 9325    2 9841 3079         131.156144.6
10  9 2575    3  281  116          151.194 69.6
1010 4673    3 2799  553          161.306 98.1
1011 6017    3 4122  800           51.299 99.8
1012 6994    3 5451 1101        9991.430 79.8
1013 7943    3 6340 1312        9991.430 82.1
1014 9053    3 7771 1669        9991.430 82.2
101510693    3 9812 2293         121.261112.3
101614044    314587 4245          91.140157.0
1017  458    4-1409    0           00.0    0.0
1018 1976    4 -354   32           31.181 66.4
1019 2848    4 -138   64         9991.430 71.1
1020 3555    4  310   84         9991.430 76.2
1021 4097    4 1339  279           41.309 88.4
1022 4670    4 1510  286        9991.430 74.4
1023 5640    4 2654  511        9991.430 82.0
1024 6534    4 3826  780         171.253108.8
1025 7680    4 5120 1150          71.248116.4
102610407    4 9337 2778         191.194136.2
1027 1931    5-1139   43          11.282 40.7
1028 4412    5 1160  300        9991.430 75.1
1029 5413    5 2332  480        9991.430 80.7
1030 6248    5 3501  716        9991.430 82.2
1031 7288    5 4208  833           61.251106.4
1032 8274    5 5852 1236         211.266110.3
1033 9462    5 6788 1553         101.258116.3
103410976    5 8849 2093          81.216130.3
103515062    515779 5250         201.127162.8
1036 2332    6 -478    0         231.581 69.7
1037 3531    6 -303   54         471.650 99.5
1038 4031    6 -281   14         481.630114.9
1039 4716    6  -47   52         271.697121.1
1040 5321    6  566  185         501.687131.6
1041 6320    6 1364  278        9991.870123.9
1042 7405    6 2417  514        9991.870131.9
1043 8765    6 3245  696         321.707157.7
104411512    6 6410 1564         371.716166.1
104518291    616433 5899         601.696191.6
1046 3530    7  572  139         671.659 95.8
1047 5303    7 1858  377        9991.870116.1
1048 6483    7 3068  625        9991.870122.2
1049 7415    7 3523  744        9991.870122.0
1050 8818    7 5607 1316         421.706162.0
```

Figure A3:27-4 ST. JOHN'S: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
1051 9775     7 6611 1684        9991.870155.3
105211639     7 8212 2249         381.730197.3
105317568     718811 7963         701.716206.7
1054 4701     8 1028  233         241.604 91.2
1055 6918     8 3026  556         491.677124.2
1056 8275     8 4605  946         681.697132.7
1057 9330     8 5863 1187        9991.870118.0
105810068     8 6923 1513        9991.870119.6
105910890     8 7466 1646        9991.870122.7
106012102     8 9092 2142         541.700157.0
106113064     810585 2651         691.695167.9
106214347     811282 2882        9991.870153.6
106316161     813609 3826         611.687197.9
106417832     815863 4400         621.699207.7
106523603     823230 8206        9991.870215.9
1066 1107     9-1662    0         451.246 39.2
1067 3051     9 -976   33         461.611 75.1
1068 4465     9  220  101         261.626108.4
1069 5535     9 1079  240         281.693124.4
1070 6509     9 1989  387         291.714132.2
1071 7332     9 2809  573         511.712138.3
1072 7934     9 3914  809         301.723139.6
1073 8618     9 4050  885        9991.870126.5
1074 9092     9 5444 1251         531.717150.5
1075 9803     9 5929 1401         551.700161.3
107610638     9 7269 1843         571.693171.6
107711893     9 8188 2202         591.710184.4
107813898     911389 3583         631.682214.7
107919386     921086 9413         711.762266.0
1080 3183    10 -553  106         661.544 63.9
1081 5497    10 1075  296         251.609103.6
1082 6851    10 2529  541         391.701118.4
1083 7674    10 3188  664        9991.870111.2
1084 8323    10 4207  906        9991.870116.1
1085 8978    10 4851 1057        9991.870120.3
1086 9509    10 5605 1182         361.726140.3
108710054    10 6631 1494         521.713144.9
108810423    10 6443 1506         311.721145.5
108910932    10 5921 1340         401.731146.3
109011526    10 7467 1738        9991.870132.9
109112150    10 8619 1954         411.721157.1
109212759    10 8919 2217         561.687166.7
109313473    10 9375 2158         331.699169.4
109414281    1010971 2739         431.721170.2
109515038    1011324 2888         581.706180.2
109615959    1013032 3511         441.715189.8
109717046    1014121 4090         341.725201.0
109818670    1015292 4712         351.675231.6
109921205    1019081 6603         641.721252.4
11 029174    10328481 4901       9991.870302.8
```

Figure A3:27-4 ST. JOHN'S: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1170.0333.4527.31150.          |  20 6329.6555.8851.41578.
20 2162.3342.1528.7920.5          |  20 7413.3632.9881.41471.
20 3327.6570.8760.91085.          |  20 8564.1883.91206.1745.
20 4230.3386.8570.8841.4          |  20 9440.7695.9910.91364.
20 5339.7571.4785.81177.          |  2010603.7904.41212.1799.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.492-.124.3129.1813.160966.1669.47170.01.268
21 2    0-.583-.246.2886-.071.127372.1354.97162.31.301
21 3    0-.371-.173.2479.0996.051792.91167.8327.61.289
21 4    0-.458-.166.3655.0924.240378.99103.5230.31.288
21 5    0-.323-.105.2622.2369.079982.31188.2339.71.289
21 6    0-.554-.228.3221-.026.1738108.3119.9329.61.681
21 7    0-.537-.109.4027.2534.3274130.5154.6413.31.684
21 8    0-.365-.138.2944.1526.1148121.1291.7564.11.678
21 9    0-.458-.180.3125.0559.1495113.9194.6440.71.759
2110    0-.354-.131.3171.2025.1771123.4318.7603.71.690
0000  (quartile 02)
22 1    0-.315-.147.1834.2023-.08581.54184.0333.41.285
22 2    0-.340-.133.2133.2757-.02291.09181.9342.11.275
22 3    0-.215-.097.1092.3061-.24394.65361.2570.81.294
22 4    0-.293-.145.1893.1757-.04786.78220.9386.81.300
22 5    0-.220-.091.1293.3288-.17496.94359.2571.41.297
22 6    0-.447-.122.3760.2103.2586145.0249.3555.81.703
22 7    0-.380-.116.3605.2337.2305141.7316.8632.91.687
22 8    0-.271-.147.1219.0851-.334140.2521.1883.91.692
22 9    0-.350-.030.4398.4722.3900143.5362.7695.91.709
2210    0-.281-.135.2007.1390-.102148.0525.4904.41.710
0000  (quartile 03)
23 1    0-.235-.099.1343.2775-.21897.69325.1527.31.270
23 2    0-.232-.103.0963.2817-.40695.84326.5528.71.288
23 3    0-.168-.081.0706.2904-.42499.17510.3760.91.287
23 4    0-.236-.110.1284.2634-.201103.1351.9570.81.301
23 5    0-.181-.107.0649.2175-.464109.0518.6785.81.301
23 6    0-.316-.093.2484.2985.0385158.9469.2851.41.694
23 7    0-.374-.167.2451.0996-.039192.8443.6881.41.710
23 8    0-.255-.121.1973.1810-.104179.7725.01206.1.708
23 9    0-.318-.134.2953.2395.1865164.0502.0910.91.749
2310    0-.245-.075.2734.3958.1896174.3736.61212.1.707
0000  (quartile 04)
24 1    0-.146-.061.0640.3712-.401134.0788.01150.1.284
24 2    0-.179-.104.0989.2476-.266126.7609.9920.51.287
24 3    0-.138-.058.0779.4141-.247116.0753.41085.1.298
24 4    0-.177-.061.0976.4810-.212116.2557.5841.41.284
24 5    0-.132-.065.0519.3195-.422120.5823.21177.1.287
24 6    0-.206-.085.0875.3725-.381195.51005.1578.1.687
24 7    0-.240-.104.0098.2820-.588206.4898.61471.1.722
24 8    0-.218-.098.1116.2754-.204219.91101.1745.1.726
24 9    0-.290-.140.2142.2332.0731221.1784.01364.1.764
2410    0-.246-.142.0676.0653-.403255.41098.1799.1.722
```

Figure A3:27-4(cont) ST. JOHN'S: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1    34     1     1  | 3025    76     1     2  | 3049    87     4     2
30 2    50     1     1  | 3026    80     1     2  | 3050    92     4     2
30 3    62     1     1  | 3027    84     1     2  | 3051    96     4     2
30 4    72     1     1  | 3028    88     1     2  | 3052   100     4     2
30 5    82     1     1  | 3029    92     1     2  | 3053   104     4     2
30 6    92     1     1  | 3030    96     1     2  | 3054   109     4     2
30 7   101     1     1  | 3031   100     1     2  | 3055   113     4     2
30 8   117     1     1  | 3032   109     1     2  | 3056   117     4     2
30 9   154     1     1  | 3033   118     1     2  | 3057   121     4     2
3010   100     2     1  | 3034   138     1     2  | 3058   125     4     2
3011    64     3     1  | 3035   164     1     2  | 3059   129     4     2
3012    96     3     1  | 3036    96     2     2  | 3060   133     4     2
3013   139     3     1  | 3037   114     2     2  | 3061   139     4     2
3014    42     4     1  | 3038   135     2     2  | 3062   145     4     2
3015    64     4     1  | 3039    82     3     2  | 3063   153     4     2
3016    80     4     1  | 3040   100     3     2  | 3064   174     4     2
3017    94     4     1  | 3041   108     3     2  | 3065    37     5     2
3018   108     4     1  | 3042   112     3     2  | 3066    49     5     2
3019   125     4     1  | 3043   117     3     2  | 3067    68     5     2
3020   162     4     1  | 3044   131     3     2  | 3068    92     5     2
3021    94     5     1  | 3045    38     4     2  | 3069   117     5     2
3022    35     1     2  | 3046    56     4     2  | 3070   143     5     2
3023    52     1     2  | 3047    71     4     2  | 3071   181     5     2
3024    67     1     2  | 3048    83     4     2  |

0000 ZONAL Data
40 1 7557   34          | 40 211300   52          | 40 311075   71
40 4 9264   99          | 40 5 8835  105          | 40 612429   82

0000  Parameters
50 10.0                 | 50 20.100               |
50 30.800               | 50 40.400               | 50 70.962
50 50.810               | 50 60.375               | 50 80.986
50110.350               | 50120.950               | 5013 67.0
50160.350               | 50171.350               | 5018 77.0
50201.241               |
```

Figure A3:27-4(cont) ST. JOHN'S: MODIFIED Policy Dataset

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	6	7
2	3	3
3	4	4
4	2	2
5	1	1
A	-	1
Total	16	21

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 4

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	71.	86.	10,769.	14,629.	2,914.	7,103.	25.
2	84.	105.	14,010.	18,347.	3,510.	8,441.	29.
3	79.	99.	10,170.	16,166.	3,491.	8,459.	54.
4	100.	113.	17,567.	22,878.	4,809.	10,837.	65.
5	57.	110.	20,119.	23,500.	2,590.	7,015.	5.
A		100.		15,221.		7,696.	73.
total	83.	101.	13,515.	18,177.	3,676.	8,675.	43.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	7,344.	10,145.	26.3	2,904.	28.6	20.1
2	5,862.	6,135.	15.9	803.	13.1	5.6
3	5,700.	7,540.	19.5	2,466.	32.7	17.1
4	4,261.	10,925.	28.3	6,647.	60.8	46.0
5	951.	1,225.	3.2	534.	43.6	3.7
A		2,625.	6.8	1,086.	41.4	7.5
total	24,118.	38,595.	100.0	14,440.	37.4	100.0

source: program "CZONE.FORT": files SAS61.INPUT and SAS71.INPUT.

Figure A3:01-5 SASKATOON: Zonal Characteristics (5 zones)

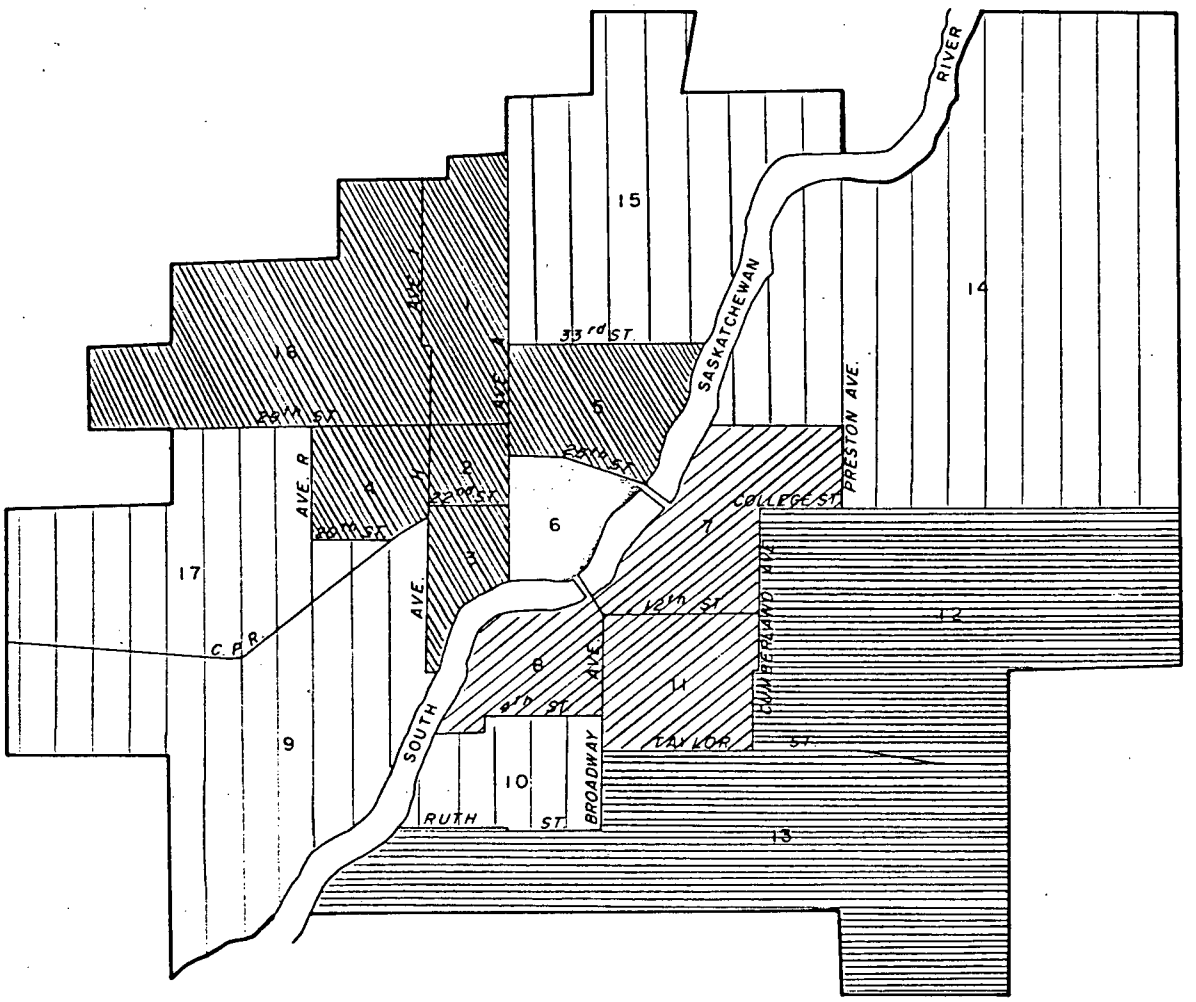

Figure A3:02-5 SASKATOON: Clustering (5 zones)

Demographic Characteristics:

Population [1] 1961: 95,526.
[2] 1971: 126,450.

Households [1] 1961: 25,912.
[2] 1971: 38,635.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 8,675.
1974 SHU data [4] : 10,619.

deflator : 0.8169

SHU deflated : 8,800.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file SAS.SHU

SHU dataset:

Sample size : 3925.
Sum of the WEIGHTs : 42,930.

RATIO of SHU weights
to actual households : 1.11117

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	7,978.	4,533.	11.	412.	370.
2	11,085.	15,922.	37.	430.	387.
3	9,425.	3,432.	8.	429.	386.
4	11,039.	5,024.	12.	419.	377.
5	5,690.	3,624.	8.	453.	408
6	5,024.	3,761.	9.	418.	376.
7	7,014.	3,491.	8.	436.	392.
8	3,250.	3,143.	7.	449.	404.

source: program "HH1.FORT" :file SAS.SHU

Figure A3:03-5 SASKATOON: HOUSEHOLD Characteristics.

Total 1961 dwellings : 24,811.

Rental	:	7,192.
Owner-occupier	:	16,928.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	72.	2,372.	10,521.	4,972.	0.0816
2	84.	1,835.	13,954.	4,027.	0.0720
3	80.	1,198.	10,200.	4,502.	0.0936
4	100.	904.	16,616.	3,357.	0.0720
5	57.	883.	20,119.	68.	0.0336
total	78.	7,192.	12,499.	16,928.	0.0756

source: program "D61.FORT" : dataset SAS61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings	: TOTAL	24,118.
	: RATIO of EXISTING unannexed/TOTAL	93.8%
	: TOTAL 1961 Dwellings EXISTING in 1971	24,155.
	: TOTAL 1961 Dwellings ADJUSTED for ANNEXED	25,759.
: 1971 "model" Dwellings		100.
: 1971 RATIO ACTUAL/"model"		386.
: 1961 "model" Dwellings		67.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	7,344.	20.	367.	1.0372	1.0268
2	5,862.	16.	366.	0.9405	0.9311
3	5,700.	16.	356.	1.0616	1.0510
4	4,261.	12.	355.	0.9628	0.9532
5	951.	3.	317.	0.9303	0.9209

error of fit 0.02069

source: program "D61.FORT" : dataset SAS61.INPUT.

Figure A3:04-5 SASKATOON: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	7.1313	5.5278	5.4186	5.7893
	(17.8)	(14.2)	(13.4)	(17.5)
MULTIPLE	0.5483	0.5491	-.0717	-.0180
	(5.42)	(5.90)	(0.68)	(0.25)
CONSTRUCTED PRE 20	-.2168	-.2699	-.2866	-.2826
	(2.03)	(2.90)	(2.65)	(3.32)
20-45	-.2969	-.2621	-.2311	-.2530
	(3.31)	(3.47)	(2.45)	(3.14)
CONDITION	0.3587	0.3033	0.0269	0.0317
	(3.59)	(3.66)	(0.27)	(0.36)
LN ROOMS	0.6543	1.4367	0.6609	0.5075
	(5.64)	(12.4)	(5.26)	(5.96)
LN INCOME	0.1284	0.1671	0.0699	0.0569
	(2.84)	(3.69)	(1.61)	(1.51)
ACCESS	-.0036	-.0019	-.0006	-.0015
	(2.60)	(1.79)	(0.46)	(1.22)
R2	0.52	0.99	0.42	0.99
OBSERVATIONS	154	154	147	147

note : "t" statistis in brackets
: data source: SAS61.EA

MEANS:

LN INCOME	8.0705
MULTIPLE	0.2400
ACCESS	36.8

Figure A3:05-5 SASKATOON: 1961 Hedonic Estimates

Total 1971 dwellings : 38,595.

Rental : 15,715.
Owner-occupier : 22,880.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	84.	4,495.	14,721.	5,655.	0.0684
2	105.	2,755.	18,178.	3,385.	0.0696
3	100.	2,205.	16,132.	5,320.	0.0744
4	110.	5,065.	21,172.	8,495.	0.0624
5	110.	1,195.	23,500.	25.	0.0564
total	100.	15,715.	17,965.	22,880.	0.0672

source: program "D71.FORT" : dataset SAS71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	10,150.	27.	376.	1.0805	1.0984
2	6,140.	16.	384.	0.8716	0.8861
3	7,525.	14.	538.	0.9839	1.0058
4	13,560.	40.	339.	0.9449	0.9606
5	1,220.	3.	407.	0.8169	0.8305
			385.		

error of fit 0.111543

source: program "D71.FORT" : dataset SAS71.INPUT.

Figure A3:06-5 SASKATOON: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 38,595.

Built prior 1961 : 24,145.
Built 1961-1971 : 14,450.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	70.	3,159.	13,596.	4,089.	0.0612
2	88.	2,022.	17,967.	3,310.	0.0588
3	75.	1,305.	14,268.	3,754.	0.0636
4	89.	1,630.	19,189.	4,189.	0.0552
5	90.	669.	22,500.	18.	0.0480
99	126.	6,930.	21,922.	7,520.	0.0684
CMA	100.	15,715.	18,106.	22,880.	0.0660

source: program "D71.FORT" : dataset SAS71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual calculated	"RHS"/actual weighted	SERVICES
1	7,248.	19.	382.	1.1738	1.1730	
2	5,332.	14.	381.	0.9369	0.9363	
3	5,059.	13.	389.	1.1503	1.1495	
4	5,819.	15.	388.	1.0334	1.0326	
5	687.	2.	344.	0.9941	0.9934	
99	14,450.	37.	391.	0.8466	0.8460	
			385.			

error of fit 0.01321

source: program "D71.FORT" : dataset SAS71.INPUT.

Figure A3:07-5 SASKATOON: 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	7.930	7.798	5.007	5.099
	(50.1)	(54.4)	(32.0)	(35.6)
MULTIPLE	0.1357	0.1196	0.0367	0.0131
	(3.96)	(3.47)	(1.27)	(0.45)
CONSTRUCTION 51-60	-.1359	-.1565	-.2128	-.1940
	(5.10)	(6.20)	(6.67)	(5.83)
46-50	-.3855	-.3721	-.2052	-.1772
	(9.94)	(9.29)	(4.19)	(3.68)
20-45	-.3873	-.4089	-.2848	-.2464
	(12.7)	(13.1)	(7.97)	(6.92)
PRE 20	-.4831	-.5201	-.3441	-.2929
	(11.9)	(12.7)	(7.69)	(6.61)
FACILITIES	0.0447	0.1294	0.2411	0.2082
	(0.49)	(1.58)	(4.57)	(4.15)
LN INCOME	0.0998	0.1006	0.1808	0.1745
	(6.26)	(6.80)	(10.5)	(10.8)
LN ROOMS	0.5559	0.5866	0.2741	0.2652
	(14.1)	(14.3)	(9.58)	(9.59)
R2	0.39	0.98	0.37	0.95
OBSERVATIONS	1133	1133	1056	1056
WEIGHTED 20-45/PRE 20	-.4161	-.4424	-.3054	-.2625

note : "t" statistis in brackets
: data source: SAS.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	8.9699
MULTIPLE	0.1050
ACCESS	35.0

Figure A3:08-5 SASKATOON: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	18,177.	30,374.	0.59844
RENT	101.	136.	0.74265
INCOME	8,675.	10,619.	0.81690

R/V ratio: 0.0672 P(j)/PN ratio: 0.97268

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.7077 (121.)	0.1449	2.7145 (102.)	0.1510	0.1536
DUMMY (TYPE 2)	-.1515 (5.51)	0.1289	-.1779 (5.78)	0.1264	0.1287
DUMMY (TYPE 3)	-.1247 (3.36)	0.1324	-.1663 (4.06)	0.1278	0.1301
DUMMY (TYPE 4)	-.2470 (6.86)	0.1171	-.2895 (7.51)	0.1130	0.1151
DUMMY (TYPE 5)	0.1527 (4.09)	0.1747	0.1594 (3.82)	0.1771	0.1801
DUMMY (TYPE 6)	0.4403 (11.8)	0.2329	0.4414 (10.9)	0.2247	0.2384
DUMMY (TYPE 7)	0.1006 (2.57)	0.1658	0.0449 (1.05)	0.1579	0.1606
DUMMY (TYPE 8)	0.6611 (16.0)	0.2904	0.6183 (14.2)	0.2802	0.2843
R2	0.22		0.74		
OBSERVATIONS	2844		2844		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-5 SASKATOON: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	9.0849 (55.6)	9.1456 (54.6)	0.1439	0.1059	0.2561
DUMMY (TYPE 2)	0.0303 (1.34)	0.0365 (1.43)	0.1177	0.0696	0.4486
DUMMY (TYPE 3)	-.0087 (0.29)	-.0433 (1.28)	0.1221	0.0940	0.1964
DUMMY (TYPE 4)	-.0553 (1.88)	-.0665 (2.10)	0.1065	0.0735	0.1870
DUMMY (TYPE 5)	-.0595 (1.95)	-.1275 (3.69)	0.1616	0.1015	0.2605
DUMMY (TYPE 6)	0.0749 (2.39)	0.0468 (1.36)	0.2103	0.1372	0.4685
DUMMY (TYPE 7)	-.0364 (1.15)	-.1043 (3.00)	0.1422	0.0986	0.2773
DUMMY (TYPE 8)	-.0063 (0.17)	-.1001 (2.52)	0.2488	0.1549	0.4883
LN INCOME	-.7141 (39.3)	-.7212 (38.7)			
R2	0.49	0.83			
OBSERVATIONS	2844	2844			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Figure A3:09-5(B) SASKATOON: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	700.0	922.	-	-	-	-
1962	710.0	913.	1,001	0.072	51.1	65.7
1963	719.0	927.	1,153	0.083	59.7	76.9
1964	735.0	978.	1,526	0.110	80.8	107.6
1965	757.0	1032.	1,784	0.129	97.7	133.1
1966	777.0	1213.	1,275	0.092	71.5	111.6
1967	811.0	1320.	2,153	0.155	125.7	204.6
1968	859.0	1524.	2,278	0.164	140.9	249.9
1969	908.0	1815.	1,935	0.139	126.2	252.3
1970	970.0	1777.	259	0.019	18.4	33.8
1971	1025.0	1633.	498	0.036	36.9	58.8

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	700.0	922.0	1622.0	0.432	0.568	1.000	--
decade weighted	809.0	1294.0	2103.0	0.500	0.800	1.300	47.2
1971	1025.0	1633.0	2658.0	0.632	1.007	1.639	37.5

Figure A3:10-5 SASKATOON: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 1 7977
20 211084
20 3 9424
20 411038
20 5 5689
20 6 5024
20 7 7013
20 8 3249

0000 ALPHA by TYPE
21 1.1510
21 2.1264
21 3.1278
21 4.1130
21 5.1771
21 6.2347
21 7.1579
21 8.2802

0000 "MODEL" HOUSEHOLDS
10 1 2106    1
10 2 3882    1
10 3 4919    1
10 4 5877    1
10 5 6696    1
10 6 7539    1
10 7 8555    1
10 8 9557    1
10 910639    1
101012028    1
101116186    1
1012  503    2
1013 2492    2
1014 3616    2
1015 4389    2
1016 5149    2
1017 5626    2
1018 6018    2
1019 6525    2
1020 6814    2
1021 7261    2
1022 7545    2
1023 7864    2
1024 8189    2
1025 8428    2
1026 8791    2
1027 9090    2
1028 9377    2
1029 9759    2
103010006    2
103110408    2
103210775    2
103311166    2
103411511    2
103511829    2
103612199    2
103712583    2
103813217    2
103913747    2
104014159    2
104114703    2
104215371    2
104316208    2
104416839    2
104518257    2
104620400    2
104724523    2
104837327    2
1049 3143    3
1050 5861    3
1051 7159    3
1052 8516    3
1053 9604    3
105411111    3
105513084    3
105617252    3
1057 3002    4
1058 5209    4
1059 6327    4
1060 7501    4
1061 8392    4
1062 9321    4
106310885    4
106411820    4
106513009    4
106614557    4
106717173    4
106825971    4
1069 1886    5
1070 2775    5
1071 3306    5
1072 3703    5
1073 4377    5
1074 5723    5
1075 7535    5
107616672    5
1077  789    6
1078 1778    6
1079 2599    6
1080 3473    6
1081 4262    6
1082 5080    6
1083 6007    6
1084 8145    6
108513476    6
1086 1497    7
1087 3094    7
1088 4430    7
1089 5459    7
1090 6541    7
1091 8211    7
109210649    7
109316316    7
1094 1035    8
1095 1511    8
1096 1786    8
1097 2068    8
1098 2847    8
1099 3898    8
11 0 9725    8
```

Figure A3:11-5 SASKATOON: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1    15    12     1 | 3035    83    66     2 | 3069    83    66     4
30 2    30    24     1 | 3036    88    70     2 | 3070    85    68     4
30 3    42    33     1 | 3037    94    74     2 | 3071    87    69     4
30 4    49    39     1 | 3038   100    79     2 | 3072    88    70     4
30 5    55    44     1 | 3039   106    84     2 | 3073    90    71     4
30 6    60    48     1 | 3040   114    91     2 | 3074    92    73     4
30 7    65    51     1 | 3041   123    98     2 | 3075    93    74     4
30 8    69    55     1 | 3042   137   109     2 | 3076    95    75     4
30 9    72    57     1 | 3043   195   154     2 | 3077    97    77     4
3010    76    60     1 | 3044    25    20     3 | 3078    98    78     4
3011    79    63     1 | 3045    43    34     3 | 3079   100    80     4
3012    83    66     1 | 3046    51    41     3 | 3080   102    81     4
3013    86    68     1 | 3047    59    47     3 | 3081   104    82     4
3014    89    71     1 | 3048    67    53     3 | 3082   106    84     4
3015    93    74     1 | 3049    74    59     3 | 3083   109    86     4
3016    96    76     1 | 3050    81    64     3 | 3084   111    88     4
3017   100    79     1 | 3051    88    70     3 | 3085   113    90     4
3018   103    82     1 | 3052    94    75     3 | 3086   116    92     4
3019   107    85     1 | 3053   101    80     3 | 3087   118    94     4
3020   110    87     1 | 3054   108    86     3 | 3088   121    96     4
3021   114    91     1 | 3055   116    92     3 | 3089   123    98     4
3022   118    94     1 | 3056   126   100     3 | 3090   126   100     4
3023   123    98     1 | 3057   158   126     3 | 3091   128   102     4
3024   129   102     1 | 3058    26    21     4 | 3092   132   104     4
3025   137   108     1 | 3059    50    40     4 | 3093   136   108     4
3026   146   116     1 | 3060    58    46     4 | 3094   141   112     4
3027   184   146     1 | 3061    62    49     4 | 3095   147   117     4
3028    32    26     2 | 3062    66    52     4 | 3096   158   126     4
3029    48    38     2 | 3063    70    55     4 | 3097   195   155     4
3030    57    45     2 | 3064    73    58     4 | 3098    38    30     5
3031    63    50     2 | 3065    75    60     4 | 3099    74    59     5
3032    69    54     2 | 3066    78    62     4 | 31 0   123    98     5
3033    74    58     2 | 3067    80    63     4
3034    79    62     2 | 3068    82    65     4

0000 ZONAL DATA
40 1 7103   25
40 2 8441   29
40 3 8459   54
40 410228   62
40 5 7015    5
40 6 8675   43

0000 Calibration Data
70 11.2840.0980.3690.0540.0800.1170.0750.1100.098 71021.000 90.0
70 21.2180.0660.2760.0560.1220.1410.1230.1120.104 84411.000 91.4
70 31.3180.1100.4610.0620.1020.1000.0380.0700.057 84591.000 85.2
70 41.2310.1260.5290.0620.0890.0550.0480.0520.039102271.000100.4
70 51.4640.0090.0460.0320.1190.1050.1040.2820.303 70151.000 78.5
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:11-5A SASKATOON: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 1 7977
20 211084
20 3 9424
20 411038
20 5 5689
20 6 5024
20 7 7013
20 8 3249

0000 ALPHA by TYPE
21 1.1510
21 2.1264
21 3.1278
21 4.1130
21 5.1771
21 6.2347
21 7.1579
21 8.2802
```

0000 "MODEL" HOUSEHOLDS				
10 1 2106	1	1051 7159	3
10 2 3882	1	1052 8516	3
10 3 4919	1	1053 9604	3
10 4 5877	1	105411111	3
10 5 6696	1	105513084	3
10 6 7539	1	105617252	3
10 7 8555	1	1057 3002	4
10 8 9557	1	1058 5209	4
10 910639	1	1059 6327	4
101012028	1	1060 7501	4
101116186	1	1061 8392	4
1012 503	2	1062 9321	4
1013 2492	2	106310885	4
1014 3616	2	106411820	4
1015 4389	2	106513009	4
1016 5149	2	106614557	4
1017 5626	2	106717173	4
1018 6018	2	106825971	4
1019 6525	2	1069 1886	5
1020 6814	2	1070 2775	5
1021 7261	2	1071 3306	5
1022 7545	2	1072 3703	5
1023 7864	2	1073 4377	5
1024 8189	2	1074 5723	5
1025 8428	2	1075 7535	5
1026 8791	2	107616672	5
1027 9090	2	1077 789	6
1028 9377	2	1078 1778	6
1029 9759	2	1079 2599	6
103010006	2	1080 3473	6
103110408	2	1081 4262	6
103210775	2	1082 5080	6
103311166	2	1083 6007	6
103411511	2	1084 8145	6
103511829	2	108513476	6
103612199	2	1086 1497	7
103712583	2	1087 3094	7
103813217	2	1088 4430	7
103913747	2	1089 5459	7
104014159	2	1090 6541	7
104114703	2	1091 8211	7
104215371	2	109210649	7
104316208	2	109316316	7
104416839	2	1094 1035	8
104518257	2	1095 1511	8
104620400	2	1096 1786	8
104724523	2	1097 2068	8
104837327	2	1098 2847	8
1049 3143	3	1099 3898	8
1050 5861	3	11 0 9725	8

Figure A3:12-5 SASKATOON: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1    22     1          3035  136     2
30 2    34     1          3036  223     2
30 3    42     1          3037   26     3
30 4    50     1          3038   40     3
30 5    57     1          3039   51     3
30 6    63     1          3040   61     3
30 7    67     1          3041   69     3
30 8    71     1          3042   74     3
30 9    75     1          3043   78     3
3010    79     1          3044   83     3
3011    83     1          3045   88     3
3012    87     1          3046   93     3
3013    91     1          3047   98     3
3014    95     1          3048  104     3
3015   100     1          3049  110     3
3016   106     1          3050  122     3
3017   115     1          3051  139     3
3018   125     1          3052  197     3
3019   136     1          3053   60     4
3020   170     1          3054   78     4
3021    31     2          3055   84     4
3022    51     2          3056   89     4
3023    58     2          3057   93     4
3024    62     2          3058   98     4
3025    67     2          3059  102     4
3026    71     2          3060  107     4
3027    76     2          3061  111     4
3028    82     2          3062  121     4
3029    87     2          3063  137     4
3030    92     2          3064  184     4
3031    98     2          3065   27     5
3032   105     2          3066   52     5
3033   112     2          3067  114     5
3034   120     2

0000 ZONAL DATA
40 1 7103    25
40 2 8441    29
40 3 8459    54
40 410228    62
40 5 7015     5
40 6 8675    43

0000 Calibration Data
70 11.2650.0820.3270.0500.0830.1300.0840.1280.116 66440.988 89.3
70 21.1850.0660.2770.0560.1220.1410.1240.1110.104 84680.910 93.2
70 31.3050.1050.4590.0590.1010.1060.0370.0720.062 82880.888 83.1
70 41.2460.1180.5330.0590.0910.0660.0470.0540.033 99691.000 93.9
70 51.4590.0090.0460.0320.1190.1050.1040.2820.303 70150.723 87.4
70 61.3000.1230.4730.0630.0900.0690.0540.0680.059 94631.000107.2
```

Figure A3:12-5A SASKATOON: "BETA" Calibration Data

```
0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA
10 1 2106     1     41.197 45.3  |  1051 7159     3    131.229 84.1
10 2 3882     1    411.239 64.2  |  1052 8516     3    311.258 92.3
10 3 4919     1    101.245 73.8  |  1053 9604     3    321.261 99.1
10 4 5877     1    121.255 81.8  |  105411111     3   9991.300106.5
10 5 6696     1    141.246 88.8  |  105513084     3   9991.300117.5
10 6 7539     1    581.285 93.8  |  105617252     3   9991.300138.7
10 7 8555     1    491.246102.8  |  1057 3002     4    391.226 47.1
10 8 9557     1   9991.300107.5  |  1058 5209     4   9991.300 63.6
10 910639     1    621.281115.6  |  1059 6327     4   9991.300 71.5
101012028     1   9991.300123.4  |  1060 7501     4    551.276 80.0
101116186     1   9991.300147.5  |  1061 8392     4   9991.300 84.7
1012  503     2    650.956 20.6  |  1062 9321     4   9991.300 90.3
1013 2492     2    221.228 47.1  |  106310885     4   9991.300 99.1
1014 3616     2     61.240 58.7  |  106411820     4    611.270105.3
1015 4389     2    261.237 66.0  |  106513009     4    341.249112.4
1016 5149     2    431.239 72.6  |  106614557     4   9991.300117.9
1017 5626     2    281.242 76.4  |  106717173     4   9991.300130.2
1018 6018     2   9991.300 77.8  |  106825971     4    641.237171.1
1019 6525     2   9991.300 81.6  |  1069 1886     5     31.325 41.2
1020 6814     2    561.274 84.6  |  1070 2775     5    401.190 55.0
1021 7261     2    571.268 88.1  |  1071 3306     5     71.200 60.8
1022 7545     2    471.240 91.2  |  1072 3703     5    251.264 63.3
1023 7864     2    151.244 93.4  |  1073 4377     5    271.239 70.7
1024 8189     2   9991.300 93.6  |  1074 5723     5    291.264 82.2
1025 8428     2   9991.300 95.2  |  1075 7535     5    591.270 96.7
1026 8791     2    161.252 99.5  |  107616672     5    201.237158.0
1027 9090     2   9991.300 99.6  |  1077  789     6    211.336 30.6
1028 9377     2    601.281102.2  |  1078 1778     6     51.222 52.5
1029 9759     2    331.260105.6  |  1079 2599     6     81.230 65.7
103010006     2    171.249107.7  |  1080 3473     6    441.246 77.6
103110408     2   9991.300108.1  |  1081 4262     6    461.254 87.4
103210775     2    501.235113.2  |  1082 5080     6    481.248 97.3
103311166     2   9991.300112.7  |  1083 6007     6    671.256107.2
103411511     2    181.249117.1  |  1084 8145     6    351.262128.4
103511829     2   9991.300116.7  |  108513476     6    521.200178.9
103612199     2   9991.300118.9  |  1086 1497     7     21.368 34.2
103712583     2   9991.300121.1  |  1087 3094     7    531.236 55.7
103813217     2    191.248127.3  |  1088 4430     7    421.241 69.0
103913747     2    511.250130.2  |  1089 5459     7    111.251 77.8
104014159     2    631.282130.9  |  1090 6541     7    301.257 86.6
104114703     2   9991.300133.0  |  1091 8211     7   9991.300 97.5
104215371     2   9991.300136.5  |  109210649     7   9991.300114.0
104316208     2   9991.300141.0  |  109316316     7   9991.300147.2
104416839     2   9991.300144.2  |  1094 1035     8    381.253 37.5
104518257     2   9991.300151.4  |  1095 1511     8    661.222 47.8
104620400     2   9991.300161.8  |  1096 1786     8    231.214 53.1
104724523     2    361.134193.9  |  1097 2068     8    241.232 57.4
104837327     2   9991.300232.6  |  1098 2847     8     91.234 69.6
1049 3143     3   9991.300 49.9  |  1099 3898     8    451.259 82.9
1050 5861     3    541.262 73.6  |  1100 9725     8   9991.300140.8
```

Figure A3:13-5 SASKATOON: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1    22     1        3035  136     2
30 2    34     1        3036  223     2
30 3    42     1        3037   26     3
30 4    50     1        3038   40     3
30 5    57     1        3039   51     3
30 6    63     1        3040   61     3
30 7    67     1        3041   69     3
30 8    71     1        3042   74     3
30 9    75     1        3043   78     3
3010    79     1        3044   83     3
3011    83     1        3045   88     3
3012    87     1        3046   93     3
3013    91     1        3047   98     3
3014    95     1        3048  104     3
3015   100     1        3049  110     3
3016   106     1        3050  122     3
3017   115     1        3051  139     3
3018   125     1        3052  197     3
3019   136     1        3053   60     4
3020   170     1        3054   78     4
3021    31     2        3055   84     4
3022    51     2        3056   89     4
3023    58     2        3057   93     4
3024    62     2        3058   98     4
3025    67     2        3059  102     4
3026    71     2        3060  107     4
3027    76     2        3061  111     4
3028    82     2        3062  121     4
3029    87     2        3063  137     4
3030    92     2        3064  184     4
3031    98     2        3065   27     5
3032   105     2        3066   52     5
3033   112     2        3067  114     5
3034   120     2

0000 INCOME by TYPE      0000 ALPHA by TYPE      0000 ZONAL DATA
20 1 7977                21 1.1510               40 1 7044   25
20 211084                21 2.1264               40 2 7885   29
20 3 9424                21 3.1278               40 3 6898   54
20 411038                21 4.1130               40 411131   62
20 5 5689                21 5.1771               40 5 3037    5
20 6 5024                21 6.2347               40 614109   43
20 7 7013                21 7.1579
20 8 3249                21 8.2802
```

Figure A3:13-5(cont) SASKATOON: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	2.5720	1.8915
	(22.1)	(5.84)
BATH	0.4014	na
	(4.21)	
TOILET	-.0629	-.3053
	(0.65)	(1.06)
SUBSIDIS	-.5116	0.0213
	(12.1)	(0.92)
LNLIVING	0.2764	0.3396
	(8.36)	(10.7)
LNINCOM	0.1682	0.2407
	(11.8)	(13.7)
TYPE	-.0070	-.2140
	(0.40)	(7.33)
LNDIST	0.0013	-.0050
	(0.14)	(0.59)
B5160	-.1457	-.1014
	(6.46)	(5.41)
B4650	-.2478	-.2468
	(7.29)	(8.18)
B2145	-.1693	-.2506
	(7.36)	(10.7)
BPRE20	-.2358	-.2932
	(7.52)	(9.24)
LGLVSIZE	0.0637	0.0525
	(3.67)	(2.53)
LGBDSIZE	0.0563	0.1128
	(7.94)	(7.14)
OPENSP	0.0383	0.0370
	(1.87)	(1.44)
HIGHDEN	0.0010	-.0092
	(0.05)	(0.21)
COMMERC	0.0156	na
	(0.79)	
NEIGHBD	0.0155	na
	(0.52)	
FINANCE	-.0659	-.0315
	(3.74)	(1.83)
AMRATE	na	0.0846
		(21.8)
R2	0.61	0.49
Observations	1075	1703

note: "t" statistics in brackets
: data source: SAS.REG02

Figure A3:14-5 SASKATOON: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	384.8	102.8	1.224	1.237	0.3389
min	86.0	21.9	1.201	1.237	0.0711
max	2125.1	256.3	1.277	1.237	0.9918
TYPE 2					
mean	395.3	104.9	1.220	1.237	0.3236
min	54.6	27.3	1.201	1.237	0.0519
max	1256.0	235.9	1.279	1.237	0.9423
TYPE 3					
mean	642.4	121.3	1.220	1.237	0.2313
min	110.5	27.3	1.201	1.237	0.0370
max	2107.8	260.9	1.300	1.237	0.9678
TYPE 4					
mean	463.3	123.6	1.219	1.237	0.3174
min	68.4	49.2	1.201	1.237	0.1078
max	1345.0	324.2	1.280	1.237	0.9525
TYPE 5					
mean	665.1	130.6	1.217	1.237	0.2278
min	183.8	46.1	1.201	1.237	0.0762
max	1570.5	267.2	1.279	1.237	0.6860
TYPE 6					
mean	585.7	172.8	1.547	1.237	0.3546
min	110.0	43.1	1.255	1.237	0.0351
max	3871.7	711.8	1.643	1.237	0.8797
TYPE 7					
mean	601.4	157.6	1.595	1.237	0.3027
min	146.1	43.2	1.308	1.237	0.0575
max	2555.1	426.3	1.696	1.237	0.9415
TYPE 8					
mean	896.5	186.6	1.634	1.237	0.2247
min	256.9	20.6	1.311	1.237	0.0300
max	1882.3	558.7	1.717	1.237	0.7345
TYPE 9					
mean	730.3	192.3	1.669	1.237	0.2799
min	225.7	36.6	1.332	1.237	0.0572
max	2639.6	715.9	1.749	1.237	0.8739
TYPE 10					
mean	898.4	194.0	1.658	1.237	0.2338
min	140.1	35.3	1.328	1.237	0.0593
max	3021.4	852.4	1.738	1.237	0.9802

Figure A3:15-5 SASKATOON : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2924	-.2331	0.2234	-.0645	0.0620	83.9	228.0	384.8	162
	(105.)	(21.1)	(41.4)	(1.85)	(7.50)				
2	-.2791	-.1611	0.2071	0.0917	0.0081	85.9	234.8	395.3	272
	(187.)	(22.8)	(53.4)	(4.06)	(1.52)				
3	-.2011	-.1153	0.1756	0.2136	-.0131	99.4	421.2	642.4	316
	(152.)	(16.4)	(58.7)	(6.68)	(2.75)				
4	-.2792	-.1519	0.2047	0.1463	0.0017	101.4	274.6	463.3	143
	(177.)	(15.3)	(50.3)	(6.12)	(0.27)				
5	-.2010	-.1298	0.1285	0.1254	-.1520	107.3	432.1	665.1	182
	(337.)	(35.5)	(58.4)	(9.47)	(29.8)				
6	-.3065	-.1779	0.1771	0.0415	-.0644	111.9	333.7	585.7	274
	(208.)	(30.4)	(47.7)	(2.57)	(10.3)				
7	-.2783	-.1658	0.1890	0.0406	-.0059	99.2	358.8	601.4	136
	(109.)	(18.1)	(27.9)	(1.55)	(0.52)				
8	-.2125	-.1089	0.1364	0.2178	-.1194	114.2	573.8	896.5	283
	(316.)	(35.2)	(53.1)	(19.2)	(22.6)				
9	-.2692	-.1578	0.1784	0.1042	-.0445	115.3	434.9	730.3	460
	(420.)	(43.1)	(71.5)	(9.54)	(8.94)				
10	-.2239	-.1297	0.1782	0.1653	-.0015	117.3	569.4	898.4	550
	(290.)	(38.3)	(76.2)	(17.5)	(0.43)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-5 SASKATOON : Direct Translog-Expenditure Share
[all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3888	-.1554	0.2894	0.1749	0.1714	68.2	111.1	220.8	111
	(131.)	(10.3)	(32.0)	(4.56)	(12.7)				
2	-.3799	-.1517	0.2723	0.1531	0.0950	75.6	127.6	250.0	150
	(232.)	(13.3)	(43.4)	(5.29)	(10.5)				
3	-.2766	-.0997	0.2396	0.2928	0.0654	92.6	251.7	424.3	170
	(189.)	(8.94)	(49.2)	(7.41)	(8.68)				
4	-.3839	-.1677	0.2605	0.1185	0.0737	93.2	152.3	301.9	76
	(234.)	(14.6)	(42.1)	(5.19)	(8.45)				
5	-.2675	-.1555	0.1665	0.1175	-.1039	100.7	276.6	464.6	99
	(417.)	(35.1)	(46.2)	(8.55)	(12.8)				
6	-.3962	-.2027	0.2336	0.0195	0.0103	94.1	184.2	373.0	174
	(258.)	(24.4)	(32.5)	(0.98)	(0.84)				
7	-.3452	-.1541	0.2651	0.1046	0.1025	91.6	237.1	439.6	84
	(119.)	(9.74)	(17.3)	(2.72)	(4.20)				
8	-.2470	-.1087	0.1650	0.2275	-.0780	100.2	408.9	668.8	153
	(243.)	(21.9)	(28.1)	(14.7)	(7.25)				
9	-.2972	-.1216	0.2368	0.2353	0.0525	97.7	316.8	554.5	278
	(444.)	(20.9)	(54.8)	(13.5)	(6.48)				
10	-.2569	-.1076	0.2232	0.2734	0.0551	101.7	404.1	668.6	300
	(292.)	(20.6)	(55.9)	(18.4)	(9.84)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-5 SASKATOON : Direct Translog-Expenditure Share
[below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1958	-.1005	0.0981	0.2780	-.2706	118.1	482.5	741.8	51
	(371.)	(24.1)	(37.3)	(14.0)	(30.3)				
2	-.2104	-.0924	0.1105	0.3374	-.2267	98.5	366.5	573.9	122
	(596.)	(37.3)	(31.0)	(26.6)	(15.7)				
3	-.1467	-.0662	0.0794	0.3654	-.2847	107.4	618.6	896.3	146
	(562.)	(43.8)	(23.1)	(35.2)	(12.9)				
4	-.2093	-.1066	0.1083	0.2579	-.2552	110.7	413.5	646.4	67
	(533.)	(31.4)	(29.0)	(18.1)	(15.3)				
5	-.1551	-.0756	0.0727	0.3348	-.3645	115.3	617.5	904.2	83
	(639.)	(39.1)	(21.7)	(30.6)	(17.4)				
6	-.2347	-.1249	0.1202	0.1650	-.2030	143.0	593.9	955.6	100
	(136.)	(19.8)	(12.8)	(5.96)	(6.36)				
7	-.2071	-.1229	0.0843	0.1063	-.3496	111.4	555.3	862.9	52
	(113.)	(18.8)	(7.00)	(3.21)	(6.73)				
8	-.1867	-.1035	0.1048	0.2169	-.2032	130.8	768.0	1164.4	130
	(271.)	(23.8)	(13.2)	(9.97)	(6.14)				
9	-.2420	-.1320	0.1592	0.1837	-.0339	142.3	615.3	998.8	182
	(313.)	(23.4)	(36.7)	(9.13)	(2.40)				
10	-.1963	-.1192	0.1368	0.1544	-.0683	136.0	767.8	1174.2	250
	(315.)	(34.8)	(25.3)	(9.75)	(2.90)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-5 SASKATOON : Direct Translog-Expenditure Share
[above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4405	-.1181	0.3543	0.2808	0.2894	56.9	72.9	159.9	60
	(152.)	(7.07)	(27.7)	(7.44)	(16.0)				
2	-.4857	-.1285	0.3213	0.1855	0.1747	66.3	71.0	168.3	74
	(215.)	(7.32)	(32.2)	(5.24)	(12.3)				
3	-.3724	-.1066	0.2966	0.2735	0.1400	90.4	156.4	303.8	79
	(195.)	(6.14)	(36.0)	(5.65)	(11.8)				
4	-.4624	-.1949	0.3017	0.0731	0.1302	84.6	98.8	225.5	40
	(221.)	(6.89)	(27.1)	(1.29)	(9.76)				
5	-.3408	-.1687	0.1851	0.1126	-.0834	99.1	190.7	356.5	49
	(316.)	(25.1)	(24.7)	(6.23)	(5.36)				
6	-.4774	-.2163	0.2468	0.0046	0.0383	82.4	116.3	273.6	88
	(244.)	(16.7)	(18.0)	(0.16)	(1.67)				
7	-.4393	-.2886	0.2901	-.1619	0.1202	88.7	152.7	328.4	36
	(137.)	(14.5)	(17.1)	(4.03)	(4.85)				
8	-.2908	-.1311	0.1859	0.1663	-.0584	95.9	312.0	541.8	72
	(185.)	(12.2)	(14.6)	(4.46)	(2.54)				
9	-.3386	-.1005	0.2848	0.3167	0.1412	89.9	241.7	449.5	123
	(479.)	(13.4)	(47.2)	(14.0)	(12.8)				
10	-.2983	-.1028	0.2595	0.2690	0.1010	95.5	308.6	540.2	139
	(208.)	(11.7)	(34.8)	(13.0)	(10.5)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-5 SASKATOON : Direct Translog-Expenditure Share [quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3399	-.1429	0.1911	0.2093	-.0633	81.5	156.0	292.5	51
	(357.)	(29.0)	(23.6)	(13.7)	(3.90)				
2	-.3137	-.1414	0.1670	0.1990	-.1376	84.7	182.8	329.5	76
	(614.)	(28.5)	(14.7)	(12.5)	(4.48)				
3	-.2184	-.1032	0.1240	0.2784	-.2062	94.5	334.4	529.0	91
	(560.)	(24.9)	(12.9)	(14.1)	(5.45)				
4	-.3260	-.1464	0.2476	0.1753	0.0800	102.7	211.6	386.8	36
	(395.)	(15.9)	(15.2)	(5.16)	(1.76)				
5	-.2180	-.1117	0.1097	0.2514	-.2736	102.1	360.7	570.5	50
	(588.)	(19.1)	(10.2)	(9.56)	(6.43)				
6	-.3449	-.1640	0.2533	0.1244	0.0838	106.0	253.8	474.8	86
	(149.)	(9.03)	(7.37)	(2.41)	(0.93)				
7	-.2886	-.1047	0.2064	0.3493	0.0841	93.9	300.4	523.0	48
	(144.)	(8.98)	(8.90)	(9.19)	(2.33)				
8	-.2181	-.0953	0.1644	0.2748	-.0343	104.0	495.0	781.6	81
	(188.)	(14.0)	(7.08)	(8.55)	(0.43)				
9	-.2701	-.1179	0.1791	0.2309	-.1119	103.9	376.4	637.9	155
	(284.)	(12.7)	(8.12)	(7.17)	(1.62)				
10	-.2287	-.1121	0.1536	0.2655	-.0855	107.0	486.5	779.5	161
	(332.)	(15.5)	(8.63)	(8.68)	(1.25)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-5 SASKATOON : Direct Translog-Expenditure Share
[quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2403	-.1095	0.1255	0.3057	-.2269	108.0	337.1	549.6	34
	(379.)	(21.1)	(17.8)	(14.9)	(10.7)				
2	-.2323	-.0949	0.1228	0.3495	-.1891	90.2	292.4	471.5	73
	(483.)	(22.9)	(9.48)	(17.3)	(4.01)				
3	-.1623	-.0666	0.0839	0.3845	-.2903	101.4	516.0	762.0	93
	(531.)	(30.8)	(7.66)	(27.6)	(4.82)				
4	-.2301	-.1101	0.1204	0.2710	-.2100	102.1	338.0	542.9	43
	(420.)	(19.6)	(6.58)	(13.2)	(2.85)				
5	-.1705	-.0791	0.0659	0.3491	-.4338	108.9	520.9	777.1	54
	(543.)	(29.8)	(5.10)	(24.3)	(6.15)				
6	-.2795	-.1428	0.1220	0.1121	-.2820	130.4	419.4	718.7	67
	(128.)	(11.8)	(4.43)	(2.67)	(3.52)				
7	-.2447	-.1422	0.0831	0.0799	-.4193	111.6	446.9	727.6	34
	(103.)	(12.5)	(2.22)	(1.85)	(3.93)				
8	-.2022	-.1019	0.1383	0.2491	-.1038	123.4	651.9	1008.8	78
	(251.)	(10.4)	(5.47)	(4.69)	(0.95)				
9	-.2524	-.0969	0.2399	0.3272	0.1704	126.6	507.4	838.6	117
	(275.)	(9.49)	(18.1)	(8.13)	(4.46)				
10	-.2008	-.0951	0.1683	0.2867	0.0661	121.9	660.7	1019.8	163
	(355.)	(16.1)	(11.1)	(10.6)	(1.06)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-5 SASKATOON : Direct Translog-Expenditure Share
[quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1518	-.0781	0.0798	0.3205	-.2870	138.2	773.1	1126.2	17
	(208.)	(8.46)	(13.2)	(4.86)	(7.78)				
2	-.1881	-.0819	0.1017	0.3651	-.2631	110.9	476.8	726.6	49
	(385.)	(19.4)	(12.8)	(16.9)	(6.15)				
3	-.1279	-.0737	0.0827	0.3097	-.2262	117.9	798.7	1132.0	53
	(393.)	(14.3)	(13.6)	(8.32)	(4.86)				
4	-.1845	-.0992	0.0941	0.2651	-.2966	126.1	548.6	831.8	24
	(400.)	(19.5)	(15.6)	(12.0)	(8.31)				
5	-.1357	-.0661	0.0785	0.3620	-.2573	127.2	797.5	1141.0	29
	(617.)	(19.2)	(18.0)	(16.1)	(8.66)				
6	-.1840	-.0864	0.1227	0.3494	-.1689	168.8	948.1	1436.8	33
	(145.)	(16.6)	(9.25)	(9.80)	(3.32)				
7	-.1588	-.0654	0.0712	0.4100	-.3462	110.8	760.0	1118.4	18
	(64.7)	(5.22)	(3.86)	(4.32)	(2.64)				
8	-.1681	-.0882	0.1003	0.2829	-.1592	141.8	942.3	1397.9	52
	(129.)	(11.7)	(4.53)	(6.61)	(1.37)				
9	-.2236	-.1174	0.1158	0.2239	-.2211	170.4	809.6	1287.1	65
	(433.)	(33.5)	(26.7)	(15.7)	(12.6)				
10	-.1878	-.1196	0.1298	0.1333	-.0829	162.4	968.6	1463.5	87
	(162.)	(18.9)	(14.8)	(3.92)	(2.26)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-5 SASKATOON : Direct Translog-Expenditure Share
[quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.7359	0.7347	0.8302	-0.9872	-1.3358	-0.7194
Q02	0.5850	0.6024	0.6103	-0.9985	-1.2428	-0.7910
Q03	0.4753	0.4978	0.4994	-0.9946	-1.2055	-0.8088
Q04	0.3186	0.3330	0.3367	-0.9987	-1.4097	-0.6152
TYPE 2						
Q01	0.7274	0.7432	0.7567	-1.0192	-1.7956	-0.7022
Q02	0.5587	0.5628	0.5643	-1.0063	-1.2099	-0.8583
Q03	0.4643	0.4925	0.5027	-0.9898	-1.1470	-0.8547
Q04	0.3978	0.4166	0.4243	-1.0002	-1.2387	-0.7933
TYPE 3						
Q01	0.6317	0.6518	0.6586	-1.0438	-1.5693	-0.7901
Q02	0.4358	0.4405	0.4420	-1.0060	-1.1616	-0.8683
Q03	0.3552	0.3661	0.3683	-1.0025	-1.1322	-0.8886
Q04	0.2755	0.2876	0.2913	-1.0001	-1.2145	-0.7237
TYPE 4						
Q01	0.6968	0.7001	0.7100	-1.0134	-1.6340	-0.7618
Q02	0.5505	0.5660	0.5720	-1.0204	-1.2621	-0.8606
Q03	0.4513	0.4602	0.4641	-0.9966	-1.1635	-0.8588
Q04	0.3883	0.3821	0.3815	-1.0017	-1.1670	-0.7736
TYPE 5						
Q01	0.5702	0.5703	0.5703	-1.0091	-1.3901	-0.7917
Q02	0.4392	0.4367	0.4354	-1.0032	-1.1958	-0.8747
Q03	0.3911	0.3803	0.3767	-1.0002	-1.1395	-0.8997
Q04	0.2950	0.3124	0.3124	-0.9993	-1.1439	-0.8033
TYPE 6						
Q01	0.6937	0.6937	0.6935	-1.0110	-1.6342	-0.7184
Q02	0.5648	0.5768	0.5792	-1.0245	-1.2400	-0.8588
Q03	0.5103	0.4745	0.4688	-1.0336	-1.2388	-0.8474
Q04	0.3670	0.4053	0.4245	-0.9993	-1.3265	-0.6305
TYPE 7						
Q01	0.6301	0.6272	0.6210	-1.0399	-1.8058	-0.7360
Q02	0.5423	0.6073	0.5921	-0.9768	-1.0600	-0.9238
Q03	0.4587	0.4302	0.4064	-1.0315	-1.2934	-0.8921
Q04	0.3544	0.3729	0.3801	-0.9941	-1.2255	-0.5643
TYPE 8						
Q01	0.5023	0.5022	0.5022	-1.0314	-1.3403	-0.8750
Q02	0.4176	0.4257	0.4310	-1.0211	-1.1554	-0.9070
Q03	0.3929	0.4007	0.4025	-1.0100	-1.1011	-0.9085
Q04	0.3336	0.3513	0.3587	-0.9950	-1.1790	-0.8088
TYPE 9						
Q01	0.6111	0.6362	0.6387	-1.0343	-1.3786	-0.8923
Q02	0.5005	0.5001	0.4999	-1.0321	-1.1587	-0.9108
Q03	0.4692	0.5030	0.5289	-1.0201	-1.1816	-0.8800
Q04	0.4331	0.4350	0.4361	-0.9999	-1.2570	-0.6508
TYPE 10						
Q01	0.5331	0.5479	0.5416	-1.0565	-1.3760	-0.9250
Q02	0.4473	0.4553	0.4652	-1.0009	-1.1576	-0.8625
Q03	0.3830	0.4110	0.4134	-1.0069	-1.1002	-0.9236
Q04	0.3474	0.3515	0.3531	-1.0186	-1.2541	-0.7369

Figure A3:23-5 SASKATOON : Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	330.85	258.46	221.81	164.77	202.48	152.14	79.81
BM1=BM2=0	293.22	190.38	141.02	100.41	148.98	105.96	63.36
statistic	75.26	136.16	161.58	128.72	107.00	92.35	32.91
TYPE 2							
normal	651.52	394.83	523.24	203.69	318.86	309.74	218.42
BM1=BM2=0	642.84	345.88	368.25	152.77	231.59	211.96	167.11
statistic	17.35	97.91	309.98	101.85	174.54	195.57	102.62
TYPE 3							
normal	757.36	455.28	667.37	221.40	396.27	424.69	248.46
BM1=BM2=0	728.97	408.33	480.35	169.26	298.10	294.36	208.59
statistic	56.78	93.90	374.04	104.29	196.34	260.66	79.75
TYPE 4							
normal	377.39	224.10	305.40	123.63	145.43	191.05	122.39
BM1=BM2=0	358.50	183.10	224.14	95.64	118.28	142.52	95.32
statistic	37.77	82.01	162.52	55.99	54.29	97.06	54.15
TYPE 5							
normal	635.60	374.96	410.56	180.24	235.75	261.80	158.66
BM1=BM2=0	454.43	294.49	293.64	146.11	192.59	189.48	107.92
statistic	362.36	160.94	233.84	68.25	86.34	144.64	101.48
TYPE 6							
normal	670.46	461.08	287.11	245.23	226.35	190.11	118.96
BM1=BM2=0	621.82	460.51	230.20	242.27	222.00	163.28	81.66
statistic	97.28	1.13	113.83	5.93	8.71	53.67	74.61
TYPE 7							
normal	298.83	196.50	160.75	99.37	148.74	104.62	63.58
BM1=BM2=0	296.36	186.44	124.41	74.91	122.39	86.81	51.56
statistic	4.93	20.12	72.68	48.93	52.69	35.63	24.02
TYPE 8							
normal	893.40	472.01	461.82	218.58	266.04	285.75	181.75
BM1=BM2=0	683.77	371.69	359.61	195.49	203.13	221.47	155.03
statistic	419.28	200.66	204.43	46.18	125.82	128.56	53.45
TYPE 9							
normal	1351.49	880.73	592.27	435.51	504.15	392.75	279.23
BM1=BM2=0	1263.80	806.80	503.17	365.69	447.62	349.10	182.79
statistic	175.38	147.86	178.19	139.64	113.08	87.32	192.87
TYPE10							
normal	1461.81	856.96	820.78	383.54	560.00	591.61	283.61
BM1=BM2=0	1364.66	726.43	683.15	301.48	475.30	458.01	232.00
statistic	194.29	261.06	275.27	164.12	169.39	267.20	103.22

Figure A3:24-5 SASKATOON : Log Likelihood Values:
[test of unity income elasticity]

0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1354	1	-468	0	1051	3124	7	915	189
10	2	1825	1	-4	0	1052	5043	7	2803	543
10	3	2344	1	321	85	1053	6227	7	4011	841
10	4	3058	1	762	191	1054	7321	7	4917	1095
10	5	3879	1	1244	252	1055	9060	7	7248	1876
10	6	8045	1	6627	2006	105612967		713232		5044
10	7	744	2	-396	0	1057	5277	8	2022	423
10	8	1585	2	554	96	1058	7051	8	4193	883
10	9	2080	2	1064	231	1059	8281	8	5745	1258
1010		2750	2	1738	328	1060	9254	8	6845	1488
1011		3504	2	2502	459	106110019		8	7406	1679
1012		4099	2	3301	649	106211131		8	8657	2010
1013		4701	2	3949	813	106312015		8	9991	2452
1014		5422	2	4646	1013	106413278		811558		2988
1015		6604	2	6081	1454	106514931		813934		3906
1016		9084	2	9742	2897	106618592		819031		6637
1017		1997	3	-196	55	1067	3249	9	448	185
1018		3410	3	1333	286	1068	5256	9	1987	387
1019		4429	3	2421	477	1069	6045	9	2313	437
1020		5428	3	3514	674	1070	6704	9	3508	701
1021		6154	3	4346	874	1071	7198	9	3424	681
1022		6973	3	5392	1127	1072	7674	9	4201	885
1023		7818	3	6508	1407	1073	8224	9	4993	1111
1024		8648	3	7404	1639	1074	8814	9	5694	1333
1025		9803	3	8959	2169	1075	9359	9	6298	1518
102610913			310309		2461	107610152		9	7056	1784
102715046			316814		5403	107710705		9	7340	1888
1028		1140	4	-356	33	107811986		9	9708	2820
1029		2710	4	1060	225	107913345		911045		3423
1030		3709	4	1800	329	108019839		92315510827		
1031		4916	4	2286	435	1081	3742	10	440	204
1032		5856	4	3401	680	1082	6125	10	2100	460
1033		7014	4	4814	1063	1083	7134	10	3728	757
103410044			4	8872	2648	1084	7780	10	4059	873
1035		3322	5	452	172	1085	8276	10	4848	1117
1036		5248	5	2318	475	1086	8731	10	5566	1253
1037		6845	5	4246	912	1087	9207	10	5563	1339
1038		8093	5	5569	1243	1088	9741	10	6358	1500
1039		9563	5	7663	1794	108910397		10	7191	1679
104013427			513003		3806	109010744		10	7414	1849
1041		2084	6	-257	0	109111151		10	8082	2004
1042		2751	6	-310	2	109211628		10	8840	2211
1043		3418	6	-354	16	109312191		10	9361	2283
1044		4051	6	29	79	109412691		10	9920	2323
1045		4568	6	486	161	109513166		1010229		2613
1046		5153	6	847	217	109613745		1010404		2655
1047		5923	6	1532	331	109714391		1012442		3551
1048		6825	6	2559	530	109815444		1013328		4081
1049		8499	6	3591	787	109917363		1015434		4764
105015708			613509		4744	11	022784	102551810848		

Figure A3:25-5 SASKATOON: Demand Calibration Data

```
0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1159.9292.5549.61126.          |  20 6273.6474.8718.71437.
20 2168.3329.5471.5726.6          |  20 7328.4523.0727.61118.
20 3303.8529.0762.01132.          |  20 8541.8781.61009.1398.
20 4225.5386.8542.9831.8          |  20 9449.5637.9838.61287.
20 5356.5570.5777.11141.          |  2010540.2779.51020.1464.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.440-.118.3543.2808.289456.8972.87159.91.227
21 2    0-.486-.128.3213.1855.174766.3070.96168.31.215
21 3    0-.372-.107.2966.2735.140090.44156.4303.81.220
21 4    0-.462-.195.3017.0731.130284.5798.82225.51.220
21 5    0-.341-.169.1851.1126-.08399.15190.7356.51.217
21 6    0-.477-.216.2468.0046.038382.40116.3273.61.576
21 7    0-.439-.289.2901-.162.120288.69152.7328.41.594
21 8    0-.291-.131.1859.1663-.05895.86312.0541.81.633
21 9    0-.339-.101.2848.3167.141289.85241.7449.51.676
2110    0-.298-.103.2595.2690.101095.47308.6540.21.661
0000  (quartile 02)
22 1    0-.340-.143.1911.2093-.06381.48156.0292.51.221
22 2    0-.314-.141.1670.1990-.13884.66182.8329.51.220
22 3    0-.218-.103.1240.2784-.20694.53334.4529.01.219
22 4    0-.326-.146.2476.1753.0800102.7211.6386.81.217
22 5    0-.218-.112.1097.2514-.274102.1360.7570.51.217
22 6    0-.345-.164.2533.1244.0838106.0253.8474.81.522
22 7    0-.289-.105.2064.3493.084193.85300.4523.01.612
22 8    0-.218-.095.1644.2748-.034104.0495.0781.61.630
22 9    0-.270-.118.1791.2309-.112103.9376.4637.91.661
2210    0-.229-.112.1536.2655-.086107.0486.5779.51.658
0000  (quartile 03)
23 1    0-.240-.109.1255.3057-.227108.0337.1549.61.224
23 2    0-.232-.095.1228.3495-.18990.16292.4471.51.217
23 3    0-.162-.067.0839.3845-.290101.4516.0762.01.220
23 4    0-.230-.110.1204.2710-.210102.1338.0542.91.222
23 5    0-.170-.079.0659.3491-.434108.9520.9777.11.219
23 6    0-.279-.143.1220.1121-.282130.4419.4718.71.541
23 7    0-.245-.142.0831.0799-.419111.6446.9727.61.563
23 8    0-.202-.102.1383.2491-.104123.4651.91009.1.640
23 9    0-.252-.097.2399.3272.1704126.6507.4838.61.668
2310    0-.201-.095.1683.2867.0661121.9660.71020.1.662
0000  (quartile 04)
24 1    0-.152-.078.0798.3205-.287138.2773.11126.1.227
24 2    0-.188-.082.1017.3651-.263110.9476.8726.61.233
24 3    0-.128-.074.0827.3097-.226117.9798.71132.1.222
24 4    0-.185-.099.0941.2651-.297126.1548.6831.81.215
24 5    0-.136-.066.0785.3620-.257127.2797.51141.1.214
24 6    0-.184-.086.1227.3494-.169168.8948.11437.1.549
24 7    0-.159-.065.0712.4100-.346110.8760.01118.1.609
24 8    0-.168-.088.1003.2829-.159141.8942.31398.1.634
24 9    0-.224-.117.1158.2239-.221170.4809.61287.1.674
2410    0-.188-.120.1298.1333-.083162.4968.61464.1.644
```

Figure A3:25-5(cont) SASKATOON: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1   21     1     1 | 3035   150     4     1 | 3069    84     3     2
30 2   60     1     1 | 3036   160     4     1 | 3070    90     3     2
30 3   80     1     1 | 3037   185     4     1 | 3071    97     3     2
30 4   91     1     1 | 3038    41     5     1 | 3072   103     3     2
30 5  101     1     1 | 3039    80     5     1 | 3073   109     3     2
30 6  110     1     1 | 3040   133     5     1 | 3074   116     3     2
30 7  120     1     1 | 3041    41     1     2 | 3075   122     3     2
30 8  130     1     1 | 3042    62     1     2 | 3076   133     3     2
30 9  139     1     1 | 3043    69     1     2 | 3077   163     3     2
3010  152     1     1 | 3044    76     1     2 | 3078    53     4     2
3011  179     1     1 | 3045    82     1     2 | 3079    79     4     2
3012   55     2     1 | 3046    89     1     2 | 3080    87     4     2
3013   81     2     1 | 3047    94     1     2 | 3081    92     4     2
3014   95     2     1 | 3048    99     1     2 | 3082    98     4     2
3015  107     2     1 | 3049   104     1     2 | 3083   103     4     2
3016  119     2     1 | 3050   109     1     2 | 3084   106     4     2
3017  132     2     1 | 3051   115     1     2 | 3085   109     4     2
3018  161     2     1 | 3052   122     1     2 | 3086   111     4     2
3019   67     3     1 | 3053   128     1     2 | 3087   113     4     2
3020   92     3     1 | 3054   150     1     2 | 3088   115     4     2
3021  106     3     1 | 3055    49     2     2 | 3089   117     4     2
3022  119     3     1 | 3056    63     2     2 | 3090   119     4     2
3023  131     3     1 | 3057    72     2     2 | 3091   121     4     2
3024  155     3     1 | 3058    78     2     2 | 3092   123     4     2
3025   61     4     1 | 3059    84     2     2 | 3093   127     4     2
3026   84     4     1 | 3060    90     2     2 | 3094   131     4     2
3027   96     4     1 | 3061    98     2     2 | 3095   135     4     2
3028  104     4     1 | 3062   109     2     2 | 3096   139     4     2
3029  112     4     1 | 3063   150     2     2 | 3097   146     4     2
3030  119     4     1 | 3064    40     3     2 | 3098   157     4     2
3031  126     4     1 | 3065    59     3     2 | 3099   186     4     2
3032  132     4     1 | 3066    65     3     2 | 31 0    85     5     2
3033  138     4     1 | 3067    72     3     2
3034  144     4     1 | 3068    78     3     2

0000 ZONAL Data
40 1 7044    25       | 40 2 7885    29       | 40 3 6898    54
40 411131    62       | 40 5 3037     5       | 40 614109    43
0000  Parameters
5011 .33              | 5012 .89              | 5013 0.0
5016 .33              | 50171.30              | 5018 0.0
50201.237             |

0000 Calibration Data
70 11.4750.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   71021.000100.9
70 21.3960.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   84411.000 96.4
70 31.5770.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   84591.000100.0
70 41.4410.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  102281.000119.3
70 51.4260.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   70151.000 84.8
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0      00.0    0.0
```

Figure A3:25-5(cont) SASKATOON: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1354	1	-468	0	1051	3124	7	915	189
10	2	1825	1	-4	0	1052	5043	7	2803	543
10	3	2344	1	321	85	1053	6227	7	4011	841
10	4	3058	1	762	191	1054	7321	7	4917	1095
10	5	3879	1	1244	252	1055	9060	7	7248	1876
10	6	8045	1	6627	2006	105612967		713232		5044
10	7	744	2	-396	0	1057	5277	8	2022	423
10	8	1585	2	554	96	1058	7051	8	4193	883
10	9	2080	2	1064	231	1059	8281	8	5745	1258
1010		2750	2	1738	328	1060	9254	8	6845	1488
1011		3504	2	2502	459	106110019		8	7406	1679
1012		4099	2	3301	649	106211131		8	8657	2010
1013		4701	2	3949	813	106312015		8	9991	2452
1014		5422	2	4646	1013	106413278		811558		2988
1015		6604	2	6081	1454	106514931		813934		3906
1016		9084	2	9742	2897	106618592		819031		6637
1017		1997	3	-196	55	1067	3249	9	448	185
1018		3410	3	1333	286	1068	5256	9	1987	387
1019		4429	3	2421	477	1069	6045	9	2313	437
1020		5428	3	3514	674	1070	6704	9	3508	701
1021		6154	3	4346	874	1071	7198	9	3424	681
1022		6973	3	5392	1127	1072	7674	9	4201	885
1023		7818	3	6508	1407	1073	8224	9	4993	1111
1024		8648	3	7404	1639	1074	8814	9	5694	1333
1025		9803	3	8959	2169	1075	9359	9	6298	1518
102610913			310309		2461	107610152		9	7056	1784
102715046			316814		5403	107710705		9	7340	1888
1028		1140	4	-356	33	107811986		9	9708	2820
1029		2710	4	1060	225	107913345		911045		3423
1030		3709	4	1800	329	108019839		92315510827		
1031		4916	4	2286	435	1081	3742	10	440	204
1032		5856	4	3401	680	1082	6125	10	2100	460
1033		7014	4	4814	1063	1083	7134	10	3728	757
103410044			4	8872	2648	1084	7780	10	4059	873
1035		3322	5	452	172	1085	8276	10	4848	1117
1036		5248	5	2318	475	1086	8731	10	5566	1253
1037		6845	5	4246	912	1087	9207	10	5563	1339
1038		8093	5	5569	1243	1088	9741	10	6358	1500
1039		9563	5	7663	1794	108910397		10	7191	1679
104013427			513003		3806	109010744		10	7414	1849
1041		2084	6	-257	0	109111151		10	8082	2004
1042		2751	6	-310	2	109211628		10	8840	2211
1043		3418	6	-354	16	109312191		10	9361	2283
1044		4051	6	29	79	109412691		10	9920	2323
1045		4568	6	486	161	109513166		1010229		2613
1046		5153	6	847	217	109613745		1010404		2655
1047		5923	6	1532	331	109714391		1012442		3551
1048		6825	6	2559	530	109815444		1013328		4081
1049		8499	6	3591	787	109917363		1015434		4764
105015708			613509		4744	11	022784	102551810848		

Figure A3:26-5 SASKATOON: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1159.9292.5549.61126.          |  20 6273.6474.8718.71437.
20 2168.3329.5471.5726.6          |  20 7328.4523.0727.61118.
20 3303.8529.0762.01132.          |  20 8541.8781.61009.1398.
20 4225.5386.8542.9831.8          |  20 9449.5637.9838.61287.
20 5356.5570.5777.11141.          |  2010540.2779.51020.1464.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.440-.118.3543.2808.289456.8972.87159.91.227
21 2    0-.486-.128.3213.1855.174766.3070.96168.31.215
21 3    0-.372-.107.2966.2735.140090.44156.4303.81.220
21 4    0-.462-.195.3017.0731.130284.5798.82225.51.220
21 5    0-.341-.169.1851.1126-.08399.15190.7356.51.217
21 6    0-.477-.216.2468.0046.038382.40116.3273.61.576
21 7    0-.439-.289.2901-.162.120288.69152.7328.41.594
21 8    0-.291-.131.1859.1663-.05895.86312.0541.81.633
21 9    0-.339-.101.2848.3167.141289.85241.7449.51.676
2110    0-.298-.103.2595.2690.101095.47308.6540.21.661
0000  (quartile 02)
22 1    0-.340-.143.1911.2093-.06381.48156.0292.51.221
22 2    0-.314-.141.1670.1990-.13884.66182.8329.51.220
22 3    0-.218-.103.1240.2784-.20694.53334.4529.01.219
22 4    0-.326-.146.2476.1753.0800102.7211.6386.81.217
22 5    0-.218-.112.1097.2514-.274102.1360.7570.51.217
22 6    0-.345-.164.2533.1244.0838106.0253.8474.81.522
22 7    0-.289-.105.2064.3493.084193.85300.4523.01.612
22 8    0-.218-.095.1644.2748-.034104.0495.0781.61.630
22 9    0-.270-.118.1791.2309-.112103.9376.4637.91.661
2210    0-.229-.112.1536.2655-.086107.0486.5779.51.658
0000  (quartile 03)
23 1    0-.240-.109.1255.3057-.227108.0337.1549.61.224
23 2    0-.232-.095.1228.3495-.18990.16292.4471.51.217
23 3    0-.162-.067.0839.3845-.290101.4516.0762.01.220
23 4    0-.230-.110.1204.2710-.210102.1338.0542.91.222
23 5    0-.170-.079.0659.3491-.434108.9520.9777.11.219
23 6    0-.279-.143.1220.1121-.282130.4419.4718.71.541
23 7    0-.245-.142.0831.0799-.419111.6446.9727.61.563
23 8    0-.202-.102.1383.2491-.104123.4651.91009.1.640
23 9    0-.252-.097.2399.3272.1704126.6507.4838.61.668
2310    0-.201-.095.1683.2867.0661121.9660.71020.1.662
0000  (quartile 04)
24 1    0-.152-.078.0798.3205-.287138.2773.11126.1.227
24 2    0-.188-.082.1017.3651-.263110.9476.8726.61.233
24 3    0-.128-.074.0827.3097-.226117.9798.71132.1.222
24 4    0-.185-.099.0941.2651-.297126.1548.6831.81.215
24 5    0-.136-.066.0785.3620-.257127.2797.51141.1.214
24 6    0-.184-.086.1227.3494-.169168.8948.11437.1.549
24 7    0-.159-.065.0712.4100-.346110.8760.01118.1.609
24 8    0-.168-.088.1003.2829-.159141.8942.31398.1.634
24 9    0-.224-.117.1158.2239-.221170.4809.61287.1.674
2410    0-.188-.120.1298.1333-.083162.4968.61464.1.644
```

Figure A3:26-5(cont) SASKATOON: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1    30     1     1 | 3024    75     1     2 | 3047    54     3     2
30 2    53     1     1 | 3025    80     1     2 | 3048    66     3     2
30 3    68     1     1 | 3026    83     1     2 | 3049    78     3     2
30 4    80     1     1 | 3027    87     1     2 | 3050    83     3     2
30 5    90     1     1 | 3028    91     1     2 | 3051    88     3     2
30 6   105     1     1 | 3029    95     1     2 | 3052    92     3     2
30 7   142     1     1 | 3030    99     1     2 | 3053    96     3     2
30 8    48     2     1 | 3031   104     1     2 | 3054   101     3     2
30 9    70     2     1 | 3032   110     1     2 | 3055   105     3     2
3010    84     2     1 | 3033   117     1     2 | 3056   112     3     2
3011   104     2     1 | 3034   130     1     2 | 3057   122     3     2
3012   141     2     1 | 3035    52     2     2 | 3058   141     3     2
3013    61     3     1 | 3036    70     2     2 | 3059    84     4     2
3014    86     3     1 | 3037    76     2     2 | 3060    98     4     2
3015   120     3     1 | 3038    81     2     2 | 3061   101     4     2
3016    76     4     1 | 3039    87     2     2 | 3062   104     4     2
3017    98     4     1 | 3040    92     2     2 | 3063   108     4     2
3018   146     4     1 | 3041    97     2     2 | 3064   111     4     2
3019    34     5     1 | 3042   102     2     2 | 3065   114     4     2
3020    78     5     1 | 3043   107     2     2 | 3066   122     4     2
3021    41     1     2 | 3044   116     2     2 | 3067   141     4     2
3022    54     1     2 | 3045   135     2     2
3023    66     1     2 | 3046    41     3     2 |

0000 ZONAL Data
40 1 7044    25        | 40 2 7885    29        | 40 3 6898    54
40 411131    62        | 40 5 3037     5        | 40 614109    43
0000  Parameters
50 1 .1                | 50 2 .0                |
5011 .33               | 5012 .89               | 5013 37.
5016 .33               | 50171.30               | 5018 54.
50201.237              |

0000 Calibration Data
70 11.2210.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   65241.000114.7
70 21.1840.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   85821.000119.3
70 31.2460.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   83021.000119.0
70 41.1830.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   98361.000132.2
70 51.3730.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   70150.758 93.8
70 61.2190.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   91181.000132.3
70 71.6150.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   67380.823 89.9
70 81.5010.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   83980.822 94.0
70 91.6970.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   82840.834 91.3
70101.6230.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  100211.000106.0
70112.2090.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   70150.267 64.5
70121.6640.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   97811.000110.0
```

Figure A3:26-5(cont) SASKATOON: Supply Calibration Data

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
10  1 1354     1 -467     0          131.104 47.6
10  2 1825     1   -3     0          161.130 61.9
10  3 2344     1  321    85          201.186 69.3
10  4 3058     1  762   191          101.214 77.7
10  5 3879     1 1244   252         9991.342 74.2
10  6 8045     1 6627  2006         9991.342102.8
10  7  744     2 -395     0           81.017 32.0
10  8 1585     2  554    96           91.139 58.0
10  9 2080     2 1064   231           41.185 71.1
1010 2750     2 1738   328          141.213 79.6
1011 3504     2 2502   459         9991.342 72.6
1012 4099     2 3301   649         9991.342 73.2
1013 4701     2 3949   813         9991.342 75.7
1014 5422     2 4646  1013          171.214 90.8
1015 6604     2 6081  1454         9991.342 83.1
1016 9084     2 9742  2897          151.238114.5
1017 1997     3 -195    55           31.140 56.4
1018 3410     3 1333   286           51.231 85.4
1019 4429     3 2421   477         9991.342 84.8
1020 5428     3 3514   674         9991.342 85.3
1021 6154     3 4346   874         9991.342 81.4
1022 6973     3 5392  1127         9991.342 82.4
1023 7818     3 6508  1407          111.232 98.8
1024 8648     3 7404  1639           61.232 99.7
1025 9803     3 8959  2169         9991.342 88.2
102610913    310309  2461         9991.342 92.7
102715046    316814  5403          181.208134.1
1028 1140     4 -355    33           21.107 41.6
1029 2710     4 1060   225         9991.342 74.0
1030 3709     4 1800   329         9991.342 85.3
1031 4916     4 2286   435         9991.342 89.3
1032 5856     4 3401   680         9991.342 89.5
1033 7014     4 4814  1063         9991.342 90.4
103410044     4 8872  2648           71.203129.7
1035 3322     5  452   172         9991.342 66.1
1036 5248     5 2318   475         9991.342 89.8
1037 6845     5 4246   912         9991.342 85.7
1038 8093     5 5569  1243         9991.342 89.9
1039 9563     5 7663  1794         9991.342 92.0
104013427    513003  3806          121.205129.1
1041 2084     6 -256     0          461.565 53.1
1042 2751     6 -309     2          471.566 70.0
1043 3418     6 -353    16         9991.793 70.0
1044 4051     6   29    79         9991.793 76.2
1045 4568     6  486   161         9991.793 79.7
1046 5153     6  847   217         9991.793 81.9
1047 5923     6 1532   331         9991.793 84.4
1048 6825     6 2559   530         9991.793 91.5
1049 8499     6 3591   787         9991.793100.7
105015708    613509  4744          661.583163.2
```

Figure A3:27-5 SASKATOON: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
1051 3124     7  915  189         221.593 71.7
1052 5043     7 2803  543        9991.793 80.7
1053 6227     7 4011  841        9991.793 78.1
1054 7321     7 4917 1095        9991.793 84.3
1055 9060     7 7248 1876        9991.793 91.5
105612967     713232 5044         391.589114.5
1057 5277     8 2022  423         481.567 83.7
1058 7051     8 4193  883         241.619101.0
1059 8281     8 5745 1258         491.620105.2
1060 9254     8 6845 1488         251.610106.8
106110019     8 7406 1679         271.595114.0
106211131     8 8657 2010         411.581125.0
106312015     8 9991 2452         421.583131.5
106413278     811558 2988         431.585138.4
106514931     813934 3906         561.588145.5
106618592     819031 6637         451.568171.5
1067 3249     9  448  185         211.651 56.1
1068 5256     9 1987  387         231.653 90.6
1069 6045     9 2313  437         371.621101.0
1070 6704     9 3508  701         381.608106.3
1071 7198     9 3424  681         261.604108.7
1072 7674     9 4201  885         591.604110.1
1073 8224     9 4993 1111         291.573120.1
1074 8814     9 5694 1333         301.579125.9
1075 9359     9 6298 1518         551.573132.6
107610152     9 7056 1784         641.576140.5
107710705     9 7340 1888         651.583145.4
107811986     9 9708 2820         571.592157.1
107913345     911045 3423         671.562175.5
108019839     92315510827        9991.793195.9
1081 3742    10  440  204         351.539 63.2
1082 6125    10 2100  460         361.630 94.3
1083 7134    10 3728  757         501.596107.8
1084 7780    10 4059  873         511.583112.7
1085 8276    10 4848 1117         521.570116.2
1086 8731    10 5566 1253         281.580116.2
1087 9207    10 5563 1339         401.578117.2
1088 9741    10 6358 1500         531.570121.2
108910397    10 7191 1679         601.578124.7
109010744    10 7414 1849         611.572127.7
109111151    10 8082 2004         541.581129.0
109211628    10 8840 2211         621.577132.2
109312191    10 9361 2283         311.586133.6
109412691    10 9920 2323         631.583138.3
109513166    1010229 2613         321.588141.8
109613745    1010404 2655         441.580148.2
109714391    1012442 3551         331.592151.7
109815444    1013328 4081         341.570164.5
109917363    1015434 4764         581.573179.4
11 022784    102551810848        9991.793185.7
```

Figure A3:27-5 SASKATOON: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1159.9292.5549.61126.          |  20 6273.6474.8718.71437.
20 2168.3329.5471.5726.6          |  20 7328.4523.0727.61118.
20 3303.8529.0762.01132.          |  20 8541.8781.61009.1398.
20 4225.5386.8542.9831.8          |  20 9449.5637.9838.61287.
20 5356.5570.5777.11141.          |  2010540.2779.51020.1464.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.440-.118.3543.2808.289456.8972.87159.91.227
21 2    0-.486-.128.3213.1855.174766.3070.96168.31.215
21 3    0-.372-.107.2966.2735.140090.44156.4303.81.220
21 4    0-.462-.195.3017.0731.130284.5798.82225.51.220
21 5    0-.341-.169.1851.1126-.08399.15190.7356.51.217
21 6    0-.477-.216.2468.0046.038382.40116.3273.61.576
21 7    0-.439-.289.2901-.162.120288.69152.7328.41.594
21 8    0-.291-.131.1859.1663-.05895.86312.0541.81.633
21 9    0-.339-.101.2848.3167.141289.85241.7449.51.676
2110    0-.298-.103.2595.2690.101095.47308.6540.21.661
0000  (quartile 02)
22 1    0-.340-.143.1911.2093-.06381.48156.0292.51.221
22 2    0-.314-.141.1670.1990-.13884.66182.8329.51.220
22 3    0-.218-.103.1240.2784-.20694.53334.4529.01.219
22 4    0-.326-.146.2476.1753.0800102.7211.6386.81.217
22 5    0-.218-.112.1097.2514-.274102.1360.7570.51.217
22 6    0-.345-.164.2533.1244.0838106.0253.8474.81.522
22 7    0-.289-.105.2064.3493.084193.85300.4523.01.612
22 8    0-.218-.095.1644.2748-.034104.0495.0781.61.630
22 9    0-.270-.118.1791.2309-.112103.9376.4637.91.661
2210    0-.229-.112.1536.2655-.086107.0486.5779.51.658
0000  (quartile 03)
23 1    0-.240-.109.1255.3057-.227108.0337.1549.61.224
23 2    0-.232-.095.1228.3495-.18990.16292.4471.51.217
23 3    0-.162-.067.0839.3845-.290101.4516.0762.01.220
23 4    0-.230-.110.1204.2710-.210102.1338.0542.91.222
23 5    0-.170-.079.0659.3491-.434108.9520.9777.11.219
23 6    0-.279-.143.1220.1121-.282130.4419.4718.71.541
23 7    0-.245-.142.0831.0799-.419111.6446.9727.61.563
23 8    0-.202-.102.1383.2491-.104123.4651.91009.1.640
23 9    0-.252-.097.2399.3272.1704126.6507.4838.61.668
2310    0-.201-.095.1683.2867.0661121.9660.71020.1.662
0000  (quartile 04)
24 1    0-.152-.078.0798.3205-.287138.2773.11126.1.227
24 2    0-.188-.082.1017.3651-.263110.9476.8726.61.233
24 3    0-.128-.074.0827.3097-.226117.9798.71132.1.222
24 4    0-.185-.099.0941.2651-.297126.1548.6831.81.215
24 5    0-.136-.066.0785.3620-.257127.2797.51141.1.214
24 6    0-.184-.086.1227.3494-.169168.8948.11437.1.549
24 7    0-.159-.065.0712.4100-.346110.8760.01118.1.609
24 8    0-.168-.088.1003.2829-.159141.8942.31398.1.634
24 9    0-.224-.117.1158.2239-.221170.4809.61287.1.674
2410    0-.188-.120.1298.1333-.083162.4968.61464.1.644
```

Figure A3:27-5(cont) SASKATOON: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1    30     1     1 | 3024    75     1     2 | 3047    54     3     2
30 2    53     1     1 | 3025    80     1     2 | 3048    66     3     2
30 3    68     1     1 | 3026    83     1     2 | 3049    78     3     2
30 4    80     1     1 | 3027    87     1     2 | 3050    83     3     2
30 5    90     1     1 | 3028    91     1     2 | 3051    88     3     2
30 6   105     1     1 | 3029    95     1     2 | 3052    92     3     2
30 7   142     1     1 | 3030    99     1     2 | 3053    96     3     2
30 8    48     2     1 | 3031   104     1     2 | 3054   101     3     2
30 9    70     2     1 | 3032   110     1     2 | 3055   105     3     2
3010    84     2     1 | 3033   117     1     2 | 3056   112     3     2
3011   104     2     1 | 3034   130     1     2 | 3057   122     3     2
3012   141     2     1 | 3035    52     2     2 | 3058   141     3     2
3013    61     3     1 | 3036    70     2     2 | 3059    84     4     2
3014    86     3     1 | 3037    76     2     2 | 3060    98     4     2
3015   120     3     1 | 3038    81     2     2 | 3061   101     4     2
3016    76     4     1 | 3039    87     2     2 | 3062   104     4     2
3017    98     4     1 | 3040    92     2     2 | 3063   108     4     2
3018   146     4     1 | 3041    97     2     2 | 3064   111     4     2
3019    34     5     1 | 3042   102     2     2 | 3065   114     4     2
3020    78     5     1 | 3043   107     2     2 | 3066   122     4     2
3021    41     1     2 | 3044   116     2     2 | 3067   141     4     2
3022    54     1     2 | 3045   135     2     2
3023    66     1     2 | 3046    41     3     2

0000 ZONAL Data
40 1 7044    25        | 40 2 7885    29        | 40 3 6898    54
40 411131    62        | 40 5 3037     5        | 40 614109    43

0000  Parameters
50 10.100              | 50 20.0                |
50 30.550              | 50 40.400              | 50 70.927
50 50.500              | 50 60.600              | 50 81.043
50110.330              | 50120.890              | 5013 57.0
50160.330              | 50171.300              | 5018 70.0
50201.237              |
```

Figure A3:27-5(cont) SASKATOON: MODIFIED Policy Dataset

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	4	6
2	7	8
3	5	5
4	3	3
5	2	2
A	-	4
Total	21	28

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 5

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	87.	147.	14,726.	26,957.	4,879.	13,503.	79.
2	68.	105.	10,647.	20,497.	4,291.	11,621.	96.
3	87.	127.	18,149.	28,088.	4,400.	12,064.	25.
4	70.	108.	13,300.	20,721.	3,841.	9,733.	18.
5	62.	96.	12,572.	19,802.	6,032.	13,426.	97.
A		120.		20,311.		11,356.	97.
total	78.	122.	14,089.	23,565.	4,525.	11,990.	69.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	5,414.	9,375.	23.8	3,915.	41.8	35.5
2	6,744.	8,645.	21.9	2,349.	27.2	21.3
3	8,069.	8,175.	20.8	677.	8.3	6.1
4	3,978.	4,375.	11.1	708.	16.2	6.4
5	1,643.	1,870.	4.7	322.	17.2	2.9
A		6,950.	17.6	3,046.	43.8	27.6
total	25,848.	39,390.	100.0	11,016.	28.0	100.0

source: program "CZONE.FORT": files SUB61.INPUT and SUB71.INPUT.

Figure A3:01-6 SUDBURY: Zonal Characteristics (5 zones)

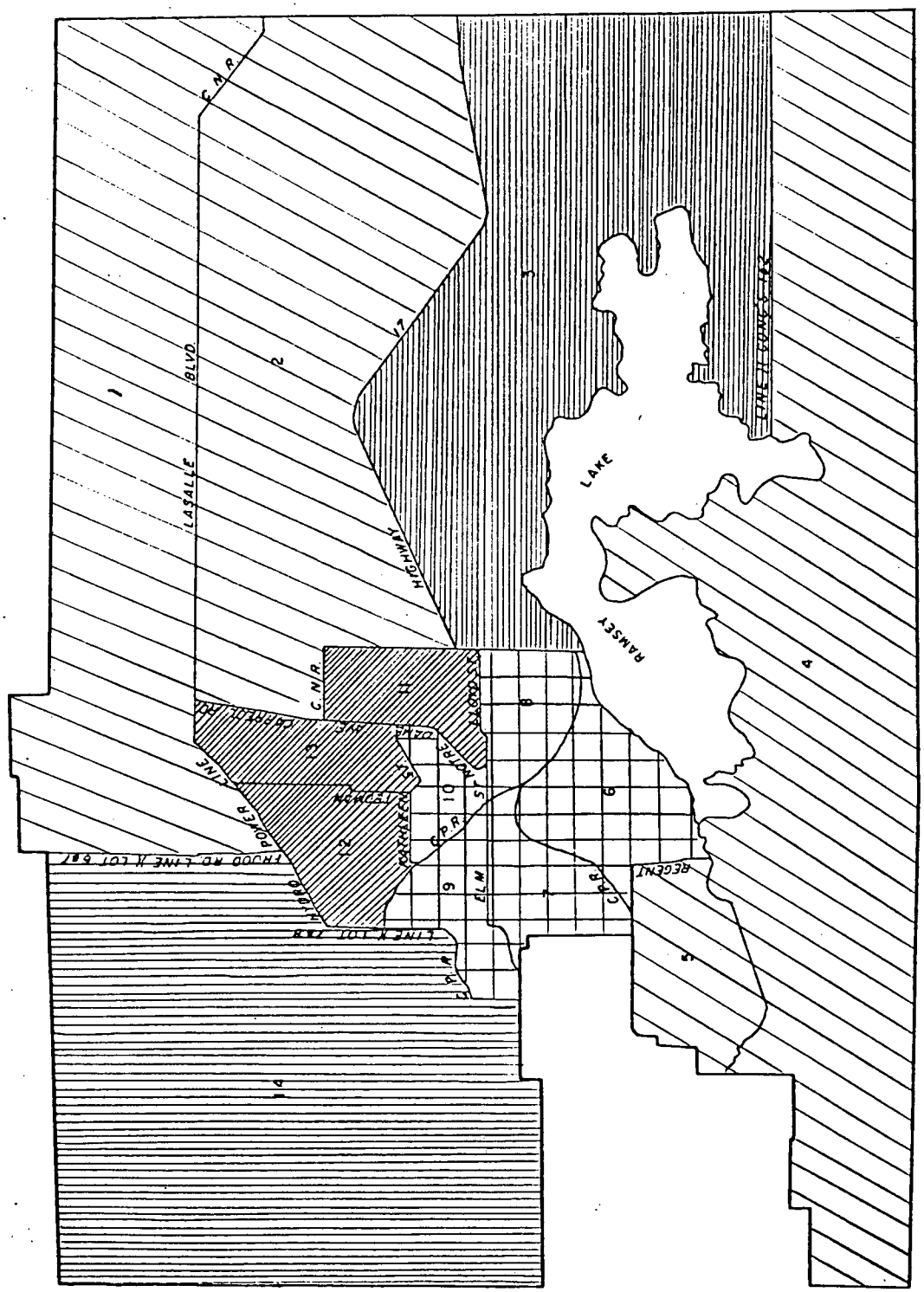

Figure A3:02-6 SUDBURY: Clustering (5 zones)

Demographic Characteristics:

Population [1] 1961: 119,694.
[2] 1971: 155,425.

Households [1] 1961: 26,155.
[2] 1971: 39,435.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 11,990.
1974 SHU data [4] : 12,283.

deflator : 0.9725

SHU deflated : 11,989.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file SUB.SHU

SHU dataset:

Sample size : 2747.
Sum of the WEIGHTs : 30,051.

RATIO of SHU weights
to actual households : 0.76204

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	11,204.	3,388.	11.	308.	404.
2	13,612.	12,447.	42.	296.	388.
3	13,388.	1,949.	6.	325.	426.
4	13,715.	4,757.	16.	297.	390.
5	7,597.	2,015.	7.	288.	378.
6	7,434.	1,442.	5.	288.	378.
7	8,770.	2,422.	8.	303.	398.
8	4,634.	1,631.	5.	326.	428.

source: program "HH1.FORT" :file SUB.SHU

Figure A3:03-6 SUDBURY: HOUSEHOLD Characteristics.

Total 1961 dwellings : 25,848.

Rental : 11,087.
Owner-occupier : 14,761.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	84.	1,416.	14,616.	3,998.	0.0696
2	67.	1,862.	10,458.	4,882.	0.0768
3	87.	4,164.	18,158.	3,905.	0.0576
4	69.	2,268.	13,267.	1,710.	0.0624
5	63.	1,377.	12,058.	266.	0.0636
total	77.	11,087.	13,974.	14,761.	0.0660

source: program "D61.FORT" : dataset SUB61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings : TOTAL 25,848.
: RATIO of EXISTING unannexed/TOTAL 94.7%

: TOTAL 1961 Dwellings EXISTING in 1971 28,374.
: TOTAL 1961 Dwellings ADJUSTED for ANNEXED 29,972.

: 1971 "model" Dwellings 100.

: 1971 RATIO ACTUAL/"model" 394.

: 1961 "model" Dwellings 76.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	5,414.	16.	338.	1.0746	0.9681
2	6,744.	20.	337.	1.3916	1.2538
3	8,069.	23.	351.	0.8575	0.7725
4	3,978.	12.	332.	0.9456	0.8519
5	1,643.	5.	329.	1.6199	1.4594

error of fit 0.01895

source: program "D61.FORT" : dataset SUB61.INPUT.

Figure A3:04-6 SUDBURY: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	8.0494	5.2694	6.7374	7.1240
	(6.76)	(4.38)	(7.88)	(10.9)
MULTIPLE	0.4937	0.3714	-.1081	-.0418
	(2.86)	(2.48)	(0.87)	(0.43)
CONSTRUCTED PRE 20	-.3968	-.3126	-.5104	-.4880
	(3.08)	(2.25)	(5.51)	(7.79)
20-45	-.3899	-.3099	-.2274	-.2101
	(3.48)	(3.31)	(2.82)	(3.28)
CONDITION	0.1975	0.1343	0.2429	0.2081
	(1.81)	(1.40)	(3.10)	(3.31)
LN ROOMS	0.7925	1.0041	0.5176	0.5544
	(3.61)	(5.12)	(3.28)	(4.60)
LN INCOME	0.0496	0.3489	0.0549	-.1104
	(0.34)	(2.43)	(0.52)	(1.40)
ACCESS	-.0054	-.0054	-.0036	-.0038
	(5.31)	(6.40)	(4.96)	(6.27)
R2	0.47	0.99	0.45	0.99
OBSERVATIONS	150	150	149	149

note : "t" statistis in brackets
: data source: SUB61.EA

MEANS:

LN INCOME	8.3909
MULTIPLE	0.4156
ACCESS	57.0

Figure A3:05-6 SUDBURY: 1961 Hedonic Estimates

Total 1971 dwellings : 39,405.

Rental : 16,540.
Owner-occupier : 22,865.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	148.	3,295.	26,949.	6,085	0.0660
2	103.	2,540.	20,631.	6,105.	0.0600
3	126.	4,500.	28,343.	3,680.	0.0540
4	108.	2,635.	20,842.	1,745.	0.0624
5	108.	3,570.	20,201.	5,250.	0.0636
total	120.	16,540.	23,471.	22,865.	0.0612

source: program "D71.FORT" : dataset SUB71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	9,380.	25.	375.	0.9164	0.8946
2	8,645.	23.	376.	1.1389	1.1118
3	8,180.	22.	372.	0.8136	0.7942
4	4,380.	12.	365.	0.9900	0.9664
5	8,820.	23.	384.	1.1900	1.1617
			394.		

error of fit 0.01363

source: program "D71.FORT" : dataset SUB71.INPUT.

Figure A3:06-6 SUDBURY: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 39,405.

Built prior 1961 : 28,379.
Built 1961-1971 : 11,026.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	125.	1,672.	25,153.	3,789.	0.0600
2	95.	1,959.	20,226.	4,334.	0.0564
3	124.	4,129.	29,108.	3,374.	0.0516
4	110.	2,138.	22,587.	1,533.	0.0588
5	87.	2,511.	18,844.	2,939.	0.0552
99	151.	4,129.	27,073.	6,897.	0.0672
CMA	120.	16,540.	24,399.	22,865.	0.0588

source: program "D71.FORT" : dataset SUB71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	5,461.	14.	390.	0.9894	0.9321
2	6,293.	16.	393.	1.1760	1.1078
3	7,503.	19.	395.	0.8096	0.7627
4	3,671.	9.	408.	0.9454	0.8906
5	5,450.	14.	389.	1.3300	1.2530
99	11,026.	28.	394.	1.0253	0.9659
			394.		

error of fit 0.00711

source: program "D71.FORT" : dataset SUB71.INPUT.

Figure A3:07-6 SUDBURY: 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	8.950	8.645	6.012	6.049
	(58.2)	(52.6)	(39.3)	(38.7)
MULTIPLE	0.2491	0.2520	0.1689	0.1588
	(8.99)	(9.02)	(5.46)	(5.17)
CONSTRUCTION 51-60	-.1789	-.1489	-.1719	-.1692
	(5.70)	(5.33)	(4.54)	(4.43)
46-50	-.3249	-.2974	-.2365	-.2676
	(8.53)	(8.16)	(5.95)	(6.80)
20-45	-.3353	-.3262	-.2862	-.2929
	(10.3)	(10.5)	(8.79)	(8.96)
PRE 20	-.4027	-.3954	-.4837	-.5066
	(8.34)	(8.13)	(11.9)	(12.4)
FACILITIES	0.1539	0.1966	0.2042	0.2215
	(2.73)	(3.11)	(4.94)	(4.93)
LN INCOME	0.0678	0.0867	0.0941	0.0931
	(4.41)	(5.22)	(5.69)	(5.54)
LN ROOMS	0.3022	0.3515	0.1967	0.1681
	(7.89)	(8.87)	(6.17)	(5.02)
R2	0.25	0.98	0.24	0.93
OBSERVATIONS	1070	1070	1144	1144
WEIGHTED 20-45/PRE 20	-.3493	-.3406	-.3500	-.3620

note : "t" statistis in brackets
: data source: SUB.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	9.1291
MULTIPLE	0.2262
ACCESS	73.0

Figure A3:08-6 SUDBURY: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	23,565.	35,866.	0.65703
RENT	122.	139.	0.87769
INCOME	11,990.	12,283.	0.9725

R/V ratio: 0.0612 P(j)/PN ratio: 1.03320

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.6876 (99.5)	0.1470	2.6641 (99.5)	0.1436	0.1423
DUMMY (TYPE 2)	-.1978 (6.20)	0.1206	-.1902 (6.16)	0.1178	0.1176
DUMMY (TYPE 3)	-.1316 (2.89)	0.1288	-.1086 (2.37)	0.1288	0.1276
DUMMY (TYPE 4)	-.2837 (7.44)	0.1107	-.2742 (7.54)	0.1091	0.1081
DUMMY (TYPE 5)	0.1973 (4.47)	0.1790	0.2439 (5.23)	0.1837	0.1821
DUMMY (TYPE 6)	0.3283 (6.81)	0.2041	0.3600 (7.22)	0.2058	0.2041
DUMMY (TYPE 7)	0.1052 (2.41)	0.1633	0.1224 (2.77)	0.1622	0.1608
DUMMY (TYPE 8)	0.5179 (11.0)	0.2460	0.4947 (9.76)	0.2354	0.2335
R2	0.17		0.58		
OBSERVATIONS	2614		2614		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-6 SUDBURY: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	9.5233 (58.0)	9.4224 (56.7)	0.1314	0.0868	0.2943
DUMMY (TYPE 2)	-.0214 (0.85)	-.0248 (1.02)	0.1112	0.0656	0.4063
DUMMY (TYPE 3)	0.0523 (1.47)	0.0537 (1.50)	0.1217	0.0911	0.1849
DUMMY (TYPE 4)	-.0943 (3.16)	-.1001 (3.49)	0.1025	0.0670	0.1910
DUMMY (TYPE 5)	-.0620 (1.79)	-.0454 (1.23)	0.1670	0.1098	0.2767
DUMMY (TYPE 6)	0.0711 (1.88)	0.0635 (1.60)	0.1893	0.1392	0.3398
DUMMY (TYPE 7)	-.1233 (3.62)	-.1181 (3.38)	0.1398	0.0960	0.3356
DUMMY (TYPE 8)	-.1306 (3.30)	-.1829 (4.27)	0.2094	0.1426	0.3417
LN INCOME	-.7469 (42.0)	-.7343 (41.0)			
R2	0.50	0.75			
OBSERVATIONS	2614	2614			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Figure A3:09-6(b) SUDBURY: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	797.0	992.	838	-	-	-
1962	808.0	982.	1,232	0.104	84.0	102.1
1963	819.0	995.	484	0.041	33.6	40.8
1964	838.0	1009.	271	0.023	19.3	23.2
1965	862.0	1079.	309	0.026	22.4	28.1
1966	890.0	1280.	394	0.033	29.3	42.2
1967	930.0	1327.	884	0.075	69.7	99.5
1968	985.0	1625.	743	0.063	62.0	102.4
1969	1040.0	2107.	1,779	0.151	157.0	318.2
1970	1112.0	2430.	1,961	0.166	184.6	403.4
1971	1178.0	2298.	3,761	0.318	374.7	730.8

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	797.0	992.0	1789.0	0.446	0.554	1.000	--
decade weighted	1037.0	1891.0	2928.0	0.581	1.059	1.640	33.4
1971	1178.0	2298.3	3476.3	0.658	1.285	1.943	28.2

Figure A3:10-6 SUDBURY: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 111204
20 213612
20 313387
20 413715
20 5 7597
20 6 7433
20 7 8769
20 8 4633

0000 ALPHA by TYPE
21 1.1436
21 2.1187
21 3.1288
21 4.1091
21 5.1837
21 6.2058
21 7.1622
21 8.2354

0000 "MODEL" HOUSEHOLDS
10 1 1796     1
10 2 4301     1
10 3 6532     1
10 4 7949     1
10 5 9244     1
10 610214     1
10 711523     1
10 813361     1
10 915125     1
101017034     1
101128650     1
1012  718     2
1013 2388     2
1014 3637     2
1015 5260     2
1016 6328     2
1017 7245     2
1018 7920     2
1019 8348     2
1020 8788     2
1021 9048     2
1022 9537     2
1023 9840     2
102410043     2
102510233     2
102610571     2
102710851     2
102811058     2
102911389     2
103011622     2
103111750     2
103212015     2
103312320     2
103412681     2
103512965     2
103613548     2
103713891     2
103814313     2
103914680     2
104014905     2
104115510     2
104215927     2
104316336     2
104416773     2
104517576     2
104618579     2
104719566     2
104820794     2
104922430     2
105024581     2
105127128     2
105230990     2
105345110     2
1054 5180     3
1055 8837     3
105610831     3
105713883     3
105816909     3
105925825     3
1060 3338     4
1061 5501     4
1062 7139     4
1063 8131     4
1064 9043     4
1065 9810     4
106610621     4
106711653     4
106812768     4
106914390     4
107015652     4
107117022     4
107218324     4
107319812     4
107422594     4
107535935     4
1076 2416     5
1077 3880     5
1078 4679     5
1079 5644     5
1080 7100     5
1081 9813     5
108219700     5
1083 1970     6
1084 4387     6
1085 7122     6
1086 9044     6
108714938     6
1088 1201     7
1089 3090     7
1090 5282     7
1091 7352     7
1092 9036     7
109310388     7
109413331     7
109520563     7
1096 1525     8
1097 2219     8
1098 3341     8
1099 5251     8
110011094     8
```

Figure A3:11-6 SUDBURY: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1   26   22    1 | 3035   62   52    2 | 3069   39   33    4
30 2   37   32    1 | 3036   65   55    2 | 3070   46   39    4
30 3   43   36    1 | 3037   68   57    2 | 3071   53   44    4
30 4   47   40    1 | 3038   71   60    2 | 3072   59   50    4
30 5   51   43    1 | 3039   75   63    2 | 3073   64   54    4
30 6   54   46    1 | 3040   80   67    2 | 3074   70   59    4
30 7   57   48    1 | 3041   85   72    2 | 3075   76   64    4
30 8   60   50    1 | 3042   92   77    2 | 3076   83   70    4
30 9   62   52    1 | 3043   99   84    2 | 3077   93   79    4
3010   65   55    1 | 3044  109   92    2 | 3078  115   97    4
3011   67   57    1 | 3045  122  103    2 | 3079   21   18    5
3012   70   59    1 | 3046  151  128    2 | 3080   37   31    5
3013   72   61    1 | 3047   25   21    3 | 3081   44   37    5
3014   75   63    1 | 3048   33   28    3 | 3082   49   42    5
3015   78   66    1 | 3049   37   32    3 | 3083   54   46    5
3016   81   69    1 | 3050   42   35    3 | 3084   58   49    5
3017   86   72    1 | 3051   45   38    3 | 3085   61   51    5
3018   91   77    1 | 3052   48   41    3 | 3086   64   54    5
3019   97   81    1 | 3053   51   43    3 | 3087   67   57    5
3020  102   86    1 | 3054   54   45    3 | 3088   70   59    5
3021  108   91    1 | 3055   57   48    3 | 3089   73   61    5
3022  113   95    1 | 3056   60   51    3 | 3090   76   64    5
3023  119  100    1 | 3057   63   53    3 | 3091   80   67    5
3024  137  116    1 | 3058   66   56    3 | 3092   83   70    5
3025   10    9    2 | 3059   70   59    3 | 3093   87   74    5
3026   24   20    2 | 3060   73   61    3 | 3094   92   78    5
3027   33   28    2 | 3061   76   64    3 | 3095   98   82    5
3028   39   33    2 | 3062   79   67    3 | 3096  105   89    5
3029   43   36    2 | 3063   83   70    3 | 3097  114   96    5
3030   47   39    2 | 3064   87   74    3 | 3098  125  106    5
3031   50   42    2 | 3065   92   78    3 | 3099  142  120    5
3032   53   45    2 | 3066   98   83    3 | 3100  167  141    5
3033   56   47    2 | 3067  119  101    3
3034   59   50    2 | 3068   26   22    4 |

0000 ZONAL DATA
40 113503   79 |
40 211621   96 |
40 312064   25 |
40 4 9733   18 |
40 511795   97 |
40 611990   68 |

0000 Calibration Data
70 11.6760.1230.5980.0590.0900.0410.0260.0480.015135021.000 74.9
70 21.6730.1380.6160.0570.0660.0490.0110.0430.020116211.000 67.9
70 31.7240.0930.4080.0690.1480.0790.0430.1020.058120641.000 64.7
70 41.7840.1280.4480.0680.0890.0880.0450.0870.047 97321.000 65.8
70 51.5670.1540.6360.0580.0580.0420.0100.0260.016117931.000 80.3
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:11-6A SUDBURY: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 111204
20 213612
20 313387
20 413715
20 5 7597
20 6 7433
20 7 8769
20 8 4633

0000 ALPHA by TYPE
21 1.1436
21 2.1187
21 3.1288
21 4.1091
21 5.1837
21 6.2058
21 7.1622
21 8.2354
```

```
0000 "MODEL" HOUSEHOLDS
10 1 1796     1
10 2 4301     1
10 3 6532     1
10 4 7949     1
10 5 9244     1
10 610214     1
10 711523     1
10 813361     1
10 915125     1
101017034     1
101128650     1
1012  718     2
1013 2388     2
1014 3637     2
1015 5260     2
1016 6328     2
1017 7245     2
1018 7920     2
1019 8348     2
1020 8788     2
1021 9048     2
1022 9537     2
1023 9840     2
102410043     2
102510233     2
102610571     2
102710851     2
102811058     2
102911389     2
103011622     2
103111750     2
103212015     2
103312320     2
103412681     2
103512965     2
103613548     2
103713891     2
103814313     2
103914680     2
104014905     2
104115510     2
104215927     2
104316336     2
104416773     2
104517576     2
104618579     2
104719566     2
104820794     2
104922430     2
105024581     2
```

```
105127128     2
105230990     2
105345110     2
1054 5180     3
1055 8837     3
105610831     3
105713883     3
105816909     3
105925825     3
1060 3338     4
1061 5501     4
1062 7139     4
1063 8131     4
1064 9043     4
1065 9810     4
106610621     4
106711653     4
106812768     4
106914390     4
107015652     4
107117022     4
107218324     4
107319812     4
107422594     4
107535935     4
1076 2416     5
1077 3880     5
1078 4679     5
1079 5644     5
1080 7100     5
1081 9813     5
108219700     5
1083 1970     6
1084 4387     6
1085 7122     6
1086 9044     6
108714938     6
1088 1201     7
1089 3090     7
1090 5282     7
1091 7352     7
1092 9036     7
109310388     7
109413331     7
109520563     7
1096 1525     8
1097 2219     8
1098 3341     8
1099 5251     8
110011094     8
```

Figure A3:12-6 SUDBURY: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1    40     1        3035   140     2        3069    84     4
30 2    56     1        3036   192     2        3070    93     4
30 3    64     1        3037    30     3        3071   123     4
30 4    69     1        3038    43     3        3072    51     5
30 5    74     1        3039    48     3        3073    83     5
30 6    79     1        3040    52     3        3074    97     5
30 7    85     1        3041    55     3        3075   111     5
30 8    89     1        3042    57     3        3076   151     5
30 9    93     1        3043    60     3
3010    97     1        3044    62     3
3011   102     1        3045    65     3
3012   107     1        3046    67     3
3013   112     1        3047    70     3
3014   119     1        3048    72     3
3015   132     1        3049    75     3
3016   161     1        3050    79     3
3017    23     2        3051    82     3
3018    38     2        3052    86     3
3019    48     2        3053    90     3
3020    58     2        3054    95     3
3021    66     2        3055   102     3
3022    70     2        3056   109     3
3023    74     2        3057   119     3
3024    78     2        3058   138     3
3025    82     2        3059   181     3
3026    86     2        3060    26     4
3027    90     2        3061    42     4
3028    94     2        3062    48     4
3029    98     2        3063    53     4
3030   102     2        3064    57     4
3031   106     2        3065    61     4
3032   112     2        3066    65     4
3033   120     2        3067    70     4
3034   130     2        3068    77     4

0000 ZONAL DATA
40 113503   79
40 211621   96
40 312064   25
40 4 9733   18
40 511795   97
40 611990   68

0000 Calibration Data
70 11.7240.1230.5850.0600.0920.0460.0270.0500.017131181.000 69.3
70 21.6940.1380.6160.0570.0660.0490.0110.0430.020116010.934 65.9
70 31.7300.0930.4090.0690.1480.0790.0430.1020.058120380.930 64.0
70 41.7800.1280.4470.0680.0890.0880.0440.0870.047 96700.924 65.1
70 51.6800.1430.6340.0560.0690.0450.0090.0270.017120431.000 73.7
70 61.6400.1400.6000.0590.0720.0440.0200.0460.020123641.000 86.5
```

Figure A3:12-6A SUDBURY: "BETA" Calibration Data

0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA

10 1 1796	1	391.201	30.4	105127128	2	9991.640	117.9
10 2 4301	1	31.447	46.5	105230990	2	9991.640	127.7
10 3 6532	1	9991.640	56.1	105345110	2	9991.640	160.0
10 4 7949	1	251.592	64.1	1054 5180	3	441.573	48.0
10 5 9244	1	9991.640	69.2	1055 8837	3	9991.640	64.8
10 610214	1	741.570	75.0	105610831	3	9991.640	73.3
10 711523	1	111.598	79.9	105713883	3	9991.640	85.0
10 813361	1	321.592	87.5	105816909	3	9991.640	95.7
10 915125	1	141.610	93.8	105925825	3	161.585	125.4
101017034	1	151.569	102.0	1060 3338	4	401.293	34.7
101128650	1	591.564	139.6	1061 5501	4	641.527	43.1
1012 718	2	380.774	20.3	1062 7139	4	451.558	50.0
1013 2388	2	621.254	31.4	1063 8131	4	461.620	53.0
1014 3637	2	411.376	38.5	1064 9043	4	9991.640	56.2
1015 5260	2	651.512	45.8	1065 9810	4	241.569	60.3
1016 6328	2	661.570	50.2	106610621	4	61.614	62.4
1017 7245	2	471.579	54.3	106711653	4	511.638	65.5
1018 7920	2	9991.640	56.3	106812768	4	9991.640	69.2
1019 8348	2	51.617	58.5	106914390	4	701.639	74.3
1020 8788	2	491.640	59.9	107015652	4	9991.640	78.1
1021 9048	2	681.628	61.2	107117022	4	9991.640	82.2
1022 9537	2	501.636	63.0	107218324	4	9991.640	85.9
1023 9840	2	9991.640	64.2	107319812	4	9991.640	90.0
102410043	2	261.567	66.4	107422594	4	711.627	97.8
102510233	2	71.596	66.5	107535935	4	361.423	137.8
102610571	2	691.636	67.0	1076 2416	5	21.320	38.0
102710851	2	521.626	68.3	1077 3880	5	211.448	48.0
102811058	2	9991.640	68.8	1078 4679	5	221.510	52.5
102911389	2	81.619	70.5	1079 5644	5	231.578	57.4
103011622	2	9991.640	70.9	1080 7100	5	731.607	65.3
103111750	2	9991.640	71.4	1081 9813	5	301.592	79.7
103212015	2	281.590	73.4	108219700	5	9991.640	119.3
103312320	2	91.623	73.8	1083 1970	6	631.361	36.8
103412681	2	291.578	76.1	1084 4387	6	671.590	54.6
103512965	2	541.636	75.8	1085 7122	6	531.640	71.9
103613548	2	9991.640	77.7	1086 9044	6	311.614	83.7
103713891	2	9991.640	78.9	108714938	6	9991.640	112.2
103814313	2	551.620	80.8	1088 1201	7	191.017	27.1
103914680	2	9991.640	81.6	1089 3090	7	421.383	40.0
104014905	2	9991.640	82.3	1090 5282	7	41.533	52.4
104115510	2	121.621	84.8	1091 7352	7	9991.640	61.7
104215927	2	751.594	86.8	1092 9036	7	271.602	70.7
104316336	2	561.637	87.0	109310388	7	101.613	76.6
104416773	2	9991.640	88.4	109413331	7	9991.640	88.2
104517576	2	331.570	92.8	109520563	7	761.572	116.9
104618579	2	571.623	94.4	1096 1525	8	721.200	32.3
104719566	2	341.550	99.5	1097 2219	8	201.291	38.7
104820794	2	351.504	104.8	1098 3341	8	431.515	45.1
104922430	2	581.578	107.1	1099 5251	8	481.622	57.1
105024581	2	9991.640	111.1	110011094	8	131.630	89.1

Figure A3:13-6 SUDBURY: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1    40     1        3035   140     2        3069    84     4
30 2    56     1        3036   192     2        3070    93     4
30 3    64     1        3037    30     3        3071   123     4
30 4    69     1        3038    43     3        3072    51     5
30 5    74     1        3039    48     3        3073    83     5
30 6    79     1        3040    52     3        3074    97     5
30 7    85     1        3041    55     3        3075   111     5
30 8    89     1        3042    57     3        3076   151     5
30 9    93     1        3043    60     3
3010    97     1        3044    62     3
3011   102     1        3045    65     3
3012   107     1        3046    67     3
3013   112     1        3047    70     3
3014   119     1        3048    72     3
3015   132     1        3049    75     3
3016   161     1        3050    79     3
3017    23     2        3051    82     3
3018    38     2        3052    86     3
3019    48     2        3053    90     3
3020    58     2        3054    95     3
3021    66     2        3055   102     3
3022    70     2        3056   109     3
3023    74     2        3057   119     3
3024    78     2        3058   138     3
3025    82     2        3059   181     3
3026    86     2        3060    26     4
3027    90     2        3061    42     4
3028    94     2        3062    48     4
3029    98     2        3063    53     4
3030   102     2        3064    57     4
3031   106     2        3065    61     4
3032   112     2        3066    65     4
3033   120     2        3067    70     4
3034   130     2        3068    77     4

0000 INCOME by TYPE     0000 ALPHA by TYPE      0000 ZONAL DATA
20 111204               21 1.1436               40 1 9582   79
20 213612               21 2.1187               40 2 9562   96
20 313387               21 3.1288               40 3 8008   25
20 413715               21 4.1091               40 4 6913   18
20 5 7597               21 5.1837               40 5 9279   97
20 6 7433               21 6.2058               40 613081   68
20 7 8769               21 7.1622
20 8 4633               21 8.2354
```

Figure A3:13-6(cont) SUDBURY: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	2.7332	1.6140
	(24.2)	(7.59)
BATH	0.1530	na
	(2.78)	
TOILET	-.0753	0.0710
	(1.17)	(0.78)
SUBSIDIS	-.6130	-.0050
	(21.9)	(0.04)
LNLIVING	0.2538	0.2401
	(7.79)	(5.68)
LNINCOM	0.1437	0.2567
	(10.1)	(11.1)
TYPE	-.0398	-.2579
	(2.40)	(11.0)
LNDIST	0.0066	-.0100
	(0.87)	(1.11)
B5160	-.1338	-.0647
	(5.40)	(2.66)
B4650	-.1651	-.0732
	(6.17)	(2.40)
B2145	-.1846	-.1461
	(8.67)	(5.58)
BPRE20	-.2083	-.2239
	(8.67)	(5.93)
LGLVSIZE	0.1219	0.1120
	(7.75)	(3.93)
LGBDSIZE	0.0757	0.1106
	(9.33)	(6.34)
OPENSP	-.0382	0.0070
	(2.25)	(0.30)
HIGHDEN	-.0676	-.0325
	(4.29)	(1.11)
COMMERC	-.0130	na
	(0.68)	
NEIGHBD	0.0754	na
	(3.39)	
FINANCE	-.0429	-.0859
	(2.58)	(2.80)
AMRATE	na	0.0671
		(14.1)
R2	0.63	0.50
Observations	1313	1240

note: "t" statistics in brackets
: data source: SUB.REG02

Figure A3:14-6 SUDBURY: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	406.9	98.6	1.542	1.350	0.2947
min	97.7	30.2	1.409	1.350	0.0757
max	2382.4	237.4	1.711	1.350	0.9755
TYPE 2					
mean	513.2	116.1	1.554	1.350	0.2870
min	69.8	25.9	1.394	1.350	0.0513
max	1530.4	259.0	1.781	1.350	0.9143
TYPE 3					
mean	921.1	141.9	1.552	1.350	0.1868
min	88.9	52.7	1.407	1.350	0.0304
max	3120.4	340.1	1.781	1.350	0.9134
TYPE 4					
mean	601.1	135.0	1.577	1.350	0.2668
min	81.7	31.1	1.386	1.350	0.0414
max	1878.1	322.0	1.781	1.350	0.9709
TYPE 5					
mean	884.1	152.0	1.580	1.350	0.1908
min	197.5	44.9	1.398	1.350	0.0606
max	2054.2	299.6	1.781	1.350	0.6971
TYPE 6					
mean	669.2	227.8	1.856	1.350	0.3862
min	166.8	50.2	1.484	1.350	0.0804
max	2831.5	1268.5	2.000	1.350	0.9361
TYPE 7					
mean	787.9	247.8	1.855	1.350	0.3459
min	180.7	56.1	1.445	1.350	0.0750
max	2659.2	595.3	2.010	1.350	0.8826
TYPE 8					
mean	1159.3	267.5	1.911	1.350	0.2505
min	325.2	81.3	1.498	1.350	0.0683
max	3771.1	769.3	2.032	1.350	0.8157
TYPE 9					
mean	929.9	271.5	1.944	1.350	0.3045
min	160.9	77.1	1.503	1.350	0.1043
max	2804.0	1327.6	2.053	1.350	0.8608
TYPE 10					
mean	1224.1	286.0	1.952	1.350	0.2494
min	181.0	80.8	1.491	1.350	0.0451
max	3716.6	1012.5	2.064	1.350	0.8452

Figure A3:15-6 SUDBURY : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2627	-.1963	0.1929	-.0056	0.0119	63.6	228.4	406.9	155
	(95.8)	(24.8)	(33.8)	(0.19)	(1.29)				
2	-.2374	-.1390	0.1752	0.1181	-.0500	74.7	294.2	513.2	351
	(206.)	(26.8)	(57.2)	(7.08)	(11.0)				
3	-.1598	-.0629	0.1284	0.4000	-.1058	91.5	577.3	921.1	272
	(166.)	(10.6)	(52.8)	(17.3)	(23.0)				
4	-.2373	-.1258	0.1964	0.1611	0.0056	85.6	345.3	601.1	331
	(171.)	(17.9)	(53.4)	(5.83)	(0.99)				
5	-.1763	-.0974	0.1231	0.2432	-.1333	96.1	542.3	884.1	204
	(217.)	(16.5)	(43.1)	(7.90)	(20.0)				
6	-.3533	-.2042	0.2198	0.0258	0.0215	122.4	326.9	669.2	225
	(152.)	(17.9)	(35.9)	(0.90)	(2.21)				
7	-.3256	-.1845	0.1991	0.0242	-.0236	133.9	400.1	787.9	125
	(116.)	(19.0)	(17.3)	(0.91)	(1.08)				
8	-.2372	-.1546	0.1476	0.0639	-.1127	140.4	660.6	1159.3	185
	(144.)	(17.2)	(24.9)	(1.97)	(9.82)				
9	-.2966	-.1708	0.1974	0.1084	-.0201	139.1	487.7	929.9	324
	(244.)	(30.5)	(38.2)	(7.62)	(2.60)				
10	-.2399	-.1551	0.1477	0.0984	-.1066	146.0	694.8	1224.1	381
	(221.)	(29.2)	(37.2)	(5.90)	(13.1)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-6 SUDBURY : Direct Translog-Expenditure Share
[all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3380	-.1789	0.2265	0.0891	0.0715	51.4	123.5	245.7	103
	(101.)	(26.0)	(19.2)	(5.36)	(4.09)				
2	-.3507	-.1508	0.2178	0.1401	0.0046	64.7	144.5	295.7	163
	(179.)	(15.1)	(33.7)	(5.50)	(0.44)				
3	-.2171	-.0742	0.1735	0.3550	-.0525	86.1	365.9	626.6	144
	(198.)	(9.37)	(47.9)	(13.8)	(8.43)				
4	-.3206	-.1404	0.2517	0.1681	0.0782	76.0	199.8	389.4	163
	(178.)	(10.7)	(41.1)	(4.32)	(8.21)				
5	-.2152	-.0868	0.1667	0.3443	-.0643	88.3	380.5	652.6	112
	(204.)	(10.1)	(26.7)	(8.83)	(4.78)				
6	-.4388	-.1728	0.3007	0.1054	0.1337	104.9	186.5	444.2	131
	(143.)	(9.88)	(19.6)	(2.81)	(5.89)				
7	-.3914	-.1602	0.2500	0.0815	0.0594	122.7	269.1	587.5	70
	(94.2)	(8.03)	(8.59)	(1.71)	(1.12)				
8	-.2776	-.1631	0.1859	0.1080	-.0575	118.3	446.4	828.1	94
	(109.)	(7.98)	(15.2)	(1.65)	(2.32)				
9	-.3062	-.1446	0.2281	0.1843	0.0218	116.2	383.7	742.2	186
	(171.)	(14.1)	(23.2)	(6.54)	(1.61)				
10	-.2693	-.1664	0.1812	0.0762	-.0642	128.0	514.3	943.8	224
	(184.)	(19.6)	(19.5)	(3.21)	(3.80)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-6 SUDBURY : Direct Translog-Expenditure Share
[below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1894	-.0900	0.0914	0.3154	-.2918	87.8	436.1	726.1	52
	(163.)	(13.4)	(16.4)	(8.55)	(13.0)				
2	-.1844	-.0851	0.0843	0.3178	-.3240	83.5	423.9	701.9	188
	(264.)	(18.8)	(10.3)	(12.9)	(8.46)				
3	-.1269	0.0365	0.2226	0.6268	1.5692	97.5	815.1	1252.5	128
	(51.5)	(4.50)	(31.5)	(10.9)	(32.0)				
4	-.1850	-.0790	0.0881	0.3882	-.2891	94.9	486.4	806.6	168
	(253.)	(17.6)	(10.7)	(15.8)	(7.54)				
5	-.1432	-.0804	0.0514	0.2496	-.5291	105.7	739.3	1166.0	92
	(154.)	(11.9)	(4.09)	(5.17)	(6.52)				
6	-.2881	-.1693	0.1730	0.0803	-.0958	146.8	522.7	982.7	94
	(117.)	(13.0)	(13.2)	(1.79)	(2.77)				
7	-.2796	-.0337	0.3389	0.7542	0.7145	148.1	566.8	1043.1	55
	(41.9)	(1.02)	(9.94)	(7.23)	(6.91)				
8	-.2103	-.1378	0.0473	0.0231	-.5214	163.2	882.0	1501.4	91
	(116.)	(15.0)	(2.25)	(0.51)	(6.06)				
9	-.2871	-.1811	0.1549	0.0479	-.1440	169.9	627.9	1182.9	138
	(211.)	(22.1)	(11.4)	(1.79)	(3.41)				
10	-.2098	-.1197	0.0953	0.2013	-.2739	171.7	952.3	1623.9	157
	(171.)	(18.8)	(11.6)	(8.36)	(9.06)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-6 SUDBURY : Direct Translog-Expenditure Share
[above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3836	-.1869	0.2919	0.0965	0.1713	41.1	80.4	171.5	55
	(58.8)	(5.98)	(10.1)	(1.30)	(4.13)				
2	-.4947	-.1967	0.2601	0.0573	0.0689	59.1	70.1	186.1	87
	(196.)	(14.7)	(23.8)	(2.02)	(4.08)				
3	-.2923	-.1072	0.2059	0.2754	-.0101	82.0	234.3	443.5	64
	(154.)	(7.41)	(31.1)	(7.16)	(0.99)				
4	-.4230	-.0998	0.3119	0.2714	0.1680	67.3	110.6	255.1	77
	(160.)	(5.39)	(26.1)	(6.08)	(9.54)				
5	-.2476	-.0842	0.1952	0.3515	-.0102	78.3	281.8	503.4	46
	(153.)	(6.75)	(20.0)	(7.63)	(0.48)				
6	-.4888	-.1385	0.3870	0.1419	0.2543	92.3	133.4	348.5	71
	(120.)	(3.96)	(13.7)	(2.13)	(6.01)				
7	-.4516	-.2290	0.2436	-.0187	0.0329	105.2	178.5	433.1	28
	(70.1)	(6.69)	(10.5)	(0.27)	(0.91)				
8	-.3363	-.1576	0.2208	0.1353	-.0093	107.3	301.5	610.2	43
	(79.0)	(3.25)	(6.43)	(1.00)	(0.13)				
9	-.3537	-.1237	0.2865	0.1998	0.0956	108.8	285.8	591.5	79
	(103.)	(6.57)	(14.4)	(4.81)	(3.57)				
10	-.2993	-.1625	0.2203	0.0870	-.0122	121.2	414.3	792.5	104
	(115.)	(10.1)	(10.6)	(2.12)	(0.34)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-6 SUDBURY : Direct Translog-Expenditure Share [quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2952	-.1309	0.1405	0.1968	-.1938	63.1	172.8	330.8	48
	(154.)	(14.4)	(8.81)	(6.92)	(5.23)				
2	-.2629	-.1010	0.1556	0.3258	-.1023	71.1	229.8	421.2	76
	(201.)	(11.3)	(13.4)	(9.57)	(3.74)				
3	-.1770	-.0837	0.0689	0.2640	-.4441	89.4	471.1	773.1	80
	(198.)	(6.06)	(2.82)	(3.10)	(3.57)				
4	-.2601	-.1201	0.1620	0.2502	-.1090	83.8	279.7	509.6	86
	(197.)	(6.66)	(5.75)	(3.50)	(1.17)				
5	-.1973	-.0756	0.0996	0.4194	-.2773	95.3	449.2	756.6	66
	(166.)	(4.22)	(1.82)	(4.73)	(1.06)				
6	-.3962	-.1346	0.3160	0.1316	0.0696	119.8	249.3	557.4	60
	(102.)	(4.77)	(5.86)	(1.96)	(0.63)				
7	-.3628	-.0824	0.4278	0.1417	0.2639	134.4	329.4	690.4	42
	(87.3)	(3.80)	(9.38)	(1.84)	(3.56)				
8	-.2435	-.1463	0.1566	0.1204	-.1836	127.6	568.5	1011.8	51
	(78.8)	(4.13)	(3.48)	(0.88)	(1.26)				
9	-.2787	-.1266	0.2069	0.2084	-.0992	121.6	456.0	853.4	107
	(163.)	(6.58)	(4.02)	(2.81)	(0.63)				
10	-.2474	-.1261	0.2024	0.1896	-.0123	133.9	601.1	1075.0	120
	(167.)	(7.85)	(8.36)	(3.10)	(0.18)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-6 SUDBURY : Direct Translog-Expenditure Share
[quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2325	-.0911	0.1516	0.3837	-.1409	78.3	296.0	521.5	37
	(174.)	(12.0)	(10.6)	(10.4)	(2.89)				
2	-.1964	-.0764	0.1417	0.3600	-.1563	76.9	359.5	604.3	118
	(84.0)	(0.43)	(0.17)	(0.32)	(0.04)				
3	-.1333	-.0437	0.1289	0.5124	0.0937	93.8	695.8	1084.1	84
	(212.)	(4.97)	(4.69)	(7.74)	(0.48)				
4	-.1952	-.0772	0.1373	0.3992	-.1273	87.5	415.9	698.1	104
	(207.)	(7.66)	(4.25)	(7.27)	(0.89)				
5	-.1680	-.0881	0.0670	0.2591	-.6217	106.9	621.6	1009.4	58
	(149.)	(9.32)	(1.89)	(4.57)	(3.29)				
6	-.3225	-.1573	0.2394	0.0878	-.0055	135.0	407.7	805.9	65
	(109.)	(7.15)	(6.54)	(1.24)	(0.06)				
7	-.2929	-.1956	0.1115	-.0762	-.4447	140.6	470.8	897.5	40
	(73.1)	(3.12)	(0.94)	(0.39)	(1.35)				
8	-.2141	-.1396	0.0493	-.0397	-.7992	148.2	767.5	1314.8	58
	(97.2)	(9.15)	(1.05)	(0.53)	(4.35)				
9	-.2790	-.1594	0.1546	0.0891	-.2006	146.0	553.5	1033.9	94
	(161.)	(6.71)	(3.92)	(1.09)	(1.84)				
10	-.2313	-.1133	0.1745	0.2533	-.0974	162.2	782.4	1373.5	103
	(138.)	(6.87)	(5.47)	(4.06)	(0.94)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-6 SUDBURY : Direct Translog-Expenditure Share
[quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1442	-.1004	0.0754	0.1976	-.2981	111.3	781.8	1230.9	15
	(61.8)	(2.89)	(5.83)	(0.86)	(3.61)				
2	-.1698	-.0665	0.0859	0.4107	-.2564	94.6	532.5	866.4	70
	(156.)	(7.27)	(4.30)	(7.26)	(2.30)				
3	-.1051	-.0464	0.0476	0.4675	-.4388	104.6	1042.8	1574.1	44
	(86.9)	(3.94)	(2.83)	(4.55)	(2.96)				
4	-.1731	-.0741	0.0702	0.3796	-.4062	106.8	601.1	982.9	64
	(143.)	(12.8)	(4.24)	(10.6)	(4.59)				
5	-.1127	-.0500	-.0009	0.4301	-.9916	103.5	940.1	1433.1	34
	(87.6)	(4.30)	(0.03)	(4.24)	(3.59)				
6	-.2339	-.1195	0.1013	0.2617	-.3447	173.1	780.4	1379.2	29
	(54.8)	(4.84)	(3.26)	(3.26)	(3.02)				
7	-.2242	-.1471	0.0485	-.0156	-.5189	168.1	822.9	1431.2	15
	(41.4)	(3.59)	(0.58)	(0.07)	(1.56)				
8	-.2085	-.1887	0.0468	-.2236	-.4927	189.5	1083.2	1829.5	33
	(133.)	(15.1)	(1.85)	(3.72)	(3.98)				
9	-.2975	-.1942	0.1585	-.0120	-.1548	221.1	786.9	1501.3	44
	(135.)	(12.5)	(7.68)	(0.20)	(2.25)				
10	-.1830	-.0970	0.1041	0.2514	-.1683	189.8	1276.6	2101.5	54
	(120.)	(14.0)	(9.49)	(8.23)	(3.51)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-6 SUDBURY : Direct Translog-Expenditure Share
[quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.6196	0.6244	0.6374	-1.0047	-1.3977	-0.7954
Q02	0.5311	0.5265	0.5255	-1.0099	-1.2476	-0.8389
Q03	0.4688	0.5101	0.5325	-1.0019	-1.2002	-0.7709
Q04	0.3108	0.3019	0.3009	-0.9942	-1.2360	-0.5346
TYPE 2						
Q01	0.7213	0.7256	0.7341	-1.0018	-1.8629	-0.6289
Q02	0.4886	0.5310	0.5366	-0.9943	-1.2767	-0.8512
Q03	0.4066	0.4219	0.4204	-1.0281	-1.1146	-0.9542
Q04	0.3585	0.3909	0.4036	-0.9930	-1.1543	-0.7688
TYPE 3						
Q01	0.5298	0.5442	0.5488	-1.0292	-1.6358	-0.7601
Q02	0.3762	0.3473	0.3539	-1.0194	-1.1347	-0.9296
Q03	0.2827	0.3505	0.3635	-1.0047	-1.1088	-0.9153
Q04	0.2724	0.2793	0.2804	-0.9954	-1.1352	-0.7605
TYPE 4						
Q01	0.6817	0.7016	0.7238	-1.0341	-1.6574	-0.7181
Q02	0.4862	0.5020	0.5029	-1.0071	-1.2089	-0.8811
Q03	0.4097	0.4468	0.4491	-1.0054	-1.0973	-0.9314
Q04	0.3988	0.3935	0.3918	-0.9970	-1.1760	-0.7559
TYPE 5						
Q01	0.4821	0.4991	0.5115	-1.0342	-1.5833	-0.8288
Q02	0.4468	0.4651	0.4617	-0.9937	-1.0677	-0.9266
Q03	0.3948	0.3443	0.3364	-1.0453	-1.1480	-0.9386
Q04	0.5352	0.2895	0.2657	-1.0072	-1.1330	-0.8007
TYPE 6						
Q01	0.7184	0.7237	0.7307	-1.0548	-1.6078	-0.8277
Q02	0.6269	0.6119	0.6032	-1.1195	-1.4132	-0.9302
Q03	0.5414	0.5212	0.5232	-1.0718	-1.2215	-0.9177
Q04	0.4977	0.4779	0.4661	-0.9934	-1.3727	-0.6050
TYPE 7						
Q01	0.6663	0.6661	0.6643	-1.0170	-1.8105	-0.7551
Q02	0.5579	0.4760	0.5460	-1.2800	-1.2315	-1.4057
Q03	0.4984	0.4414	0.4606	-1.0775	-1.1760	-0.9736
Q04	0.4568	0.3723	0.3410	-1.0258	-1.3803	-0.5524
TYPE 8						
Q01	0.5647	0.5664	0.5679	-1.0249	-1.6759	-0.7775
Q02	0.4535	0.4391	0.4387	-1.0298	-1.1812	-0.9121
Q03	0.4252	0.3348	0.3370	-1.1273	-1.2755	-1.0163
Q04	0.3715	0.3246	0.3135	-1.0306	-1.2393	-0.7286
TYPE 9						
Q01	0.5884	0.5921	0.5924	-1.0648	-1.7237	-0.8741
Q02	0.5134	0.5094	0.5055	-1.0555	-1.2070	-0.9485
Q03	0.4897	0.4765	0.4776	-1.0303	-1.1262	-0.9483
Q04	0.5064	0.4875	0.4717	-1.0189	-1.3352	-0.6278
TYPE 10						
Q01	0.5059	0.5017	0.5020	-1.0420	-1.3905	-0.9026
Q02	0.4560	0.4569	0.4571	-1.0393	-1.1504	-0.9382
Q03	0.4531	0.4562	0.4582	-1.0235	-1.1635	-0.8828
Q04	0.3533	0.3691	0.3756	-0.9962	-1.2215	-0.7053

Figure A3:23-6 SUDBURY : Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	321.92	215.37	186.17	125.28	156.10	134.18	56.00
BM1=BM2=0	320.73	206.90	142.79	108.05	115.74	106.76	51.46
statistic	2.38	16.95	86.75	34.45	80.72	54.83	9.08
TYPE 2							
normal	880.29	397.23	649.01	223.89	246.20	409.83	245.60
BM1=BM2=0	800.76	376.48	562.42	215.46	183.20	354.51	216.91
statistic	159.06	41.50	173.18	16.86	125.98	110.64	57.38
TYPE 3							
normal	757.72	434.26	279.20	189.26	293.51	330.83	161.95
BM1=BM2=0	626.18	378.38	425.74	169.00	266.22	301.48	142.76
statistic	263.09	111.76	-293.07	40.53	54.58	58.71	38.37
TYPE 4							
normal	767.99	397.88	577.08	188.59	277.65	360.74	221.31
BM1=BM2=0	749.54	361.24	465.66	148.84	258.59	314.68	175.39
statistic	36.90	73.27	222.84	79.52	38.11	92.11	91.84
TYPE 5							
normal	634.95	355.95	327.94	148.92	224.18	208.38	128.29
BM1=BM2=0	524.33	296.64	281.93	118.45	194.54	188.10	117.34
statistic	221.24	118.62	92.01	60.93	59.29	40.55	21.90
TYPE 6							
normal	468.75	272.88	234.82	157.06	139.12	164.79	76.95
BM1=BM2=0	466.12	254.13	224.12	131.33	136.20	162.31	71.05
statistic	5.27	37.51	21.39	51.45	5.83	4.94	11.79
TYPE 7							
normal	277.30	148.94	99.74	63.46	100.49	100.85	42.31
BM1=BM2=0	275.06	147.22	131.43	63.30	92.79	96.77	41.56
statistic	4.47	3.44	-63.37	0.31	15.39	8.15	1.49
TYPE 8							
normal	463.41	228.98	260.41	99.49	136.13	167.65	118.67
BM1=BM2=0	425.56	220.76	242.43	97.26	130.55	153.11	111.32
statistic	75.70	16.43	35.96	4.46	11.15	29.08	14.70
TYPE 9							
normal	816.25	454.68	390.86	181.28	302.33	268.45	129.73
BM1=BM2=0	791.47	434.75	367.44	167.44	289.82	254.82	119.31
statistic	49.56	39.85	46.83	27.69	25.02	27.27	20.83
TYPE10							
normal	968.83	562.99	462.59	243.24	347.39	298.36	175.14
BM1=BM2=0	874.31	542.74	377.20	238.46	330.08	270.27	133.91
statistic	189.04	40.50	170.79	9.55	34.63	56.17	82.48

Figure A3:24-6 SUDBURY : Log Likelihood Values:
[test of unity income elasticity]

0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1685	1	-6	8
10	2	2848	1	806	164
10	3	4646	1	2065	381
10	410305		1	9285	2708
10	5	1101	2	-20	16
10	6	2004	2	880	189
10	7	3093	2	1933	346
10	8	4424	2	3394	639
10	9	5683	2	4678	973
1010	6435		2	5773	1283
1011	7083		2	6764	1599
1012	7591		2	7238	1752
1013	8052		2	7195	1741
1014	9296		2	9205	2481
101511859			213271		4410
1016	4192		3	2103	408
1017	6987		3	5234	1069
1018	8376		3	6800	1554
1019	9944		3	9057	2108
102011633			311074		2644
102113114			313242		3437
102214894			315206		3958
102320161			323815		7989
1024	1088		4	-687	17
1025	2677		4	970	206
1026	3876		4	1430	255
1027	5132		4	2741	498
1028	6167		4	3706	712
1029	6955		4	4475	912
1030	7642		4	5630	1246
1031	8332		4	6523	1517
1032	8824		4	6726	1584
1033	9670		4	7911	1983
103410905			4	9438	2565
103514206			415364		5534
1036	5411		5	2545	568
1037	7842		5	5347	1160
1038	9041		5	6934	1596
103910461			5	8452	2005
104011987			510494		2501
104113477			512488		3179
104218075			519266		5911
1043	3205		6	-128	53
1044	4427		6	857	183
1045	5271		6	1054	235
1046	6412		6	1962	409
1047	7553		6	2703	573
1048	8838		6	4116	849
104910759			6	6507	1584
105015931			611843		3978
1051	4627		7	1714	333
1052	7441		7	4154	871
1053	8672		7	5775	1290
1054	9746		7	6658	1585
105511355			7	9279	2558
105618208			720287		8565
1057	6132		8	2396	480
1058	9344		8	5576	1193
105911526			8	8826	2014
106013158			810608		2708
106114234			812168		3161
106215546			813135		3372
106316879			814724		3985
106418667			817000		4654
106524770			827391		9897
1066	3125		9	-427	37
1067	6597		9	3097	606
1068	7930		9	4634	971
1069	8784		9	5623	1240
1070	9517		9	6431	1488
107110126			9	6809	1619
107210585			9	7352	1800
107310910			9	7834	1961
107411206			9	7786	1948
107511747			9	8418	2197
107612535			9	9398	2586
107712968			911014		3238
107813844			911049		3279
107915459			912153		3807
108021193			922163		9845
1081	5734		10	1344	397
1082	9130		10	4899	1141
1083	9975		10	5543	1176
108410461			10	6395	1440
108511009			10	7669	1970
108611518			10	7677	1842
108711984			10	8302	2144
108812532			10	9669	2554
108913050			10	9785	2408
109013651			1010821		2783
109114132			1010324		2663
109214647			1011178		2650
109315276			1013217		3467
109416049			1013767		3755
109516868			1013658		3960
109617577			1016139		4727
109719286			1018245		5358
109821642			1020462		6603
109924360			1023950		7207
11	033654		104472120666		

Figure A3:25-6 SUDBURY: Demand Calibration Data

```
0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1171.5330.8521.51231.          | 20 6348.5557.4805.91379.
20 2186.1421.2604.3866.4          | 20 7433.1690.4897.51431.
20 3443.5773.11084.1574.          | 20 8610.21012.1315.1830.
20 4255.1509.6698.1982.9          | 20 9591.5853.41034.1501.
20 5503.4756.61009.1433.          | 2010792.51075.1374.2102.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.384-.187.2919.0965.171341.1380.39171.51.520
21 2    0-.495-.197.2601.0573.068959.0770.06186.11.550
21 3    0-.292-.107.2059.2754-.01081.98234.3443.51.554
21 4    0-.423-.100.3119.2714.168067.28110.6255.11.580
21 5    0-.248-.084.1952.3515-.01078.30281.8503.41.573
21 6    0-.489-.139.3870.1419.254392.31133.4348.51.819
21 7    0-.452-.229.2436-.019.0329105.2178.5433.11.839
21 8    0-.336-.158.2208.1353-.009107.3301.5610.21.895
21 9    0-.354-.124.2865.1998.0956108.8285.8591.51.885
2110    0-.299-.163.2203.0870-.012121.2414.3792.51.921
0000  (quartile 02)
22 1    0-.295-.131.1405.1968-.19463.05172.8330.81.547
22 2    0-.263-.101.1556.3258-.10271.11229.8421.21.559
22 3    0-.177-.084.0689.2640-.44489.43471.1773.11.538
22 4    0-.260-.120.1620.2502-.10983.76279.7509.61.577
22 5    0-.197-.076.0996.4194-.27795.30449.2756.61.574
22 6    0-.396-.135.3160.1316.0696119.8249.3557.41.847
22 7    0-.363-.082.4278.1417.2639134.4329.4690.41.846
22 8    0-.243-.146.1566.1204-.184127.6568.51012.1.914
22 9    0-.279-.127.2069.2084-.099121.6456.0853.41.953
2210    0-.247-.126.2024.1896-.012133.9601.11075.1.971
0000  (quartile 03)
23 1    0-.233-.091.1516.3837-.14178.30296.0521.51.555
23 2    0-.196-.076.1417.3600-.15676.86359.5604.31.549
23 3    0-.133-.044.1289.5124.093793.83695.81084.1.546
23 4    0-.195-.077.1373.3992-.12787.52415.9698.11.560
23 5    0-.168-.088.0670.2591-.622106.9621.61009.1.590
23 6    0-.323-.157.2394.0878-.006135.0407.7805.91.903
23 7    0-.293-.196.1115-.076-.445140.6470.8897.51.855
23 8    0-.214-.140.0493-.040-.799148.2767.51315.1.893
23 9    0-.279-.159.1546.0891-.201146.0553.51034.1.964
2310    0-.231-.113.1745.2533-.097162.2782.41374.1.945
0000  (quartile 04)
24 1    0-.144-.100.0754.1976-.298111.3781.81231.1.575
24 2    0-.170-.067.0859.4107-.25694.59532.5866.41.564
24 3    0-.105-.046.0476.4675-.439104.61043.1574.1.584
24 4    0-.173-.074.0702.3796-.406106.8601.1982.91.600
24 5    0-.113-.050-.001.4301-.992103.5940.11433.1.583
24 6    0-.234-.120.1013.2617-.345173.1780.41379.1.863
24 7    0-.224-.147.0485-.016-.519168.1822.91431.1.912
24 8    0-.209-.189.0468-.224-.493189.51083.1830.1.960
24 9    0-.297-.194.1585-.012-.155221.1786.91501.1.984
2410    0-.183-.097.1041.2514-.168189.81277.2102.1.981
```

Figure A3:25-6(cont) SUDBURY: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1   46    1    1 | 3035   67    5    1 | 3069  154    2    2
30 2   66    1    1 | 3036   75    5    1 | 3070  160    2    2
30 3   78    1    1 | 3037   83    5    1 | 3071  165    2    2
30 4   88    1    1 | 3038   90    5    1 | 3072  171    2    2
30 5   97    1    1 | 3039  101    5    1 | 3073  180    2    2
30 6  103    1    1 | 3040  113    5    1 | 3074  218    2    2
30 7  109    1    1 | 3041  129    5    1 | 3075   84    3    2
30 8  121    1    1 | 3042  150    5    1 | 3076   99    3    2
30 9   26    2    1 | 3043   93    1    2 | 3077  109    3    2
3010   64    2    1 | 3044  113    1    2 | 3078  117    3    2
3011   80    2    1 | 3045  122    1    2 | 3079  122    3    2
3012   96    2    1 | 3046  129    1    2 | 3080  129    3    2
3013  112    2    1 | 3047  135    1    2 | 3081  136    3    2
3014  142    2    1 | 3048  139    1    2 | 3082  145    3    2
3015   42    3    1 | 3049  142    1    2 | 3083  227    3    2
3016   53    3    1 | 3050  145    1    2 | 3084  102    4    2
3017   60    3    1 | 3051  149    1    2 | 3085  131    4    2
3018   65    3    1 | 3052  152    1    2 | 3086  149    4    2
3019   70    3    1 | 3053  155    1    2 | 3087  169    4    2
3020   75    3    1 | 3054  157    1    2 | 3088   84    5    2
3021   79    3    1 | 3055  160    1    2 | 3089  120    5    2
3022   83    3    1 | 3056  165    1    2 | 3090  133    5    2
3023   88    3    1 | 3057  170    1    2 | 3091  142    5    2
3024   93    3    1 | 3058  218    1    2 | 3092  151    5    2
3025   99    3    1 | 3059   67    2    2 | 3093  157    5    2
3026  116    3    1 | 3060   96    2    2 | 3094  162    5    2
3027   43    4    1 | 3061  111    2    2 | 3095  167    5    2
3028   59    4    1 | 3062  118    2    2 | 3096  172    5    2
3029   68    4    1 | 3063  125    2    2 | 3097  178    5    2
3030   76    4    1 | 3064  131    2    2 | 3098  185    5    2
3031   84    4    1 | 3065  137    2    2 | 3099  193    5    2
3032   94    4    1 | 3066  141    2    2 | 31 0  244    5    2
3033  117    4    1 | 3067  145    2    2
3034   47    5    1 | 3068  150    2    2 |

0000 ZONAL Data
40 1 9582   79      | 40 2 9562   96      | 40 3 8008   25
40 4 6913   18      | 40 5 9279   97      | 40 613081   68
0000  Parameters
5011 .42            | 50121.14            | 5013 0.0
5016 .42            | 50171.49            | 5018 0.0
50201.350           |

0000 Calibration Data
70 11.7300.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  135021.000127.2
70 21.7460.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  116211.000126.8
70 31.7100.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  120641.000 99.6
70 41.7510.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   97321.000 99.3
70 51.6010.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  117931.000133.7
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:25-6(cont) SUDBURY: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1685	1	-6	8
10	2	2848	1	806	164
10	3	4646	1	2065	381
10	410305		1	9285	2708
10	5	1101	2	-20	16
10	6	2004	2	880	189
10	7	3093	2	1933	346
10	8	4424	2	3394	639
10	9	5683	2	4678	973
1010	6435		2	5773	1283
1011	7083		2	6764	1599
1012	7591		2	7238	1752
1013	8052		2	7195	1741
1014	9296		2	9205	2481
101511859			213271		4410
1016	4192		3	2103	408
1017	6987		3	5234	1069
1018	8376		3	6800	1554
1019	9944		3	9057	2108
102011633			311074		2644
102113114			313242		3437
102214894			315206		3958
102320161			323815		7989
1024	1088		4	-687	17
1025	2677		4	970	206
1026	3876		4	1430	255
1027	5132		4	2741	498
1028	6167		4	3706	712
1029	6955		4	4475	912
1030	7642		4	5630	1246
1031	8332		4	6523	1517
1032	8824		4	6726	1584
1033	9670		4	7911	1983
103410905			4	9438	2565
103514206			415364		5534
1036	5411		5	2545	568
1037	7842		5	5347	1160
1038	9041		5	6934	1596
103910461			5	8452	2005
104011987			510494		2501
104113477			512488		3179
104218075			519266		5911
1043	3205		6	-128	53
1044	4427		6	857	183
1045	5271		6	1054	235
1046	6412		6	1962	409
1047	7553		6	2703	573
1048	8838		6	4116	849
104910759			6	6507	1584
105015931			611843		3978
1051	4627		7	1714	333
1052	7441		7	4154	871
1053	8672		7	5775	1290
1054	9746		7	6658	1585
105511355			7	9279	2558
105618208			720287		8565
1057	6132		8	2396	480
1058	9344		8	5576	1193
105911526			8	8826	2014
106013158			810608		2708
106114234			812168		3161
106215546			813135		3372
106316879			814724		3985
106418667			817000		4654
106524770			827391		9897
1066	3125		9	-427	37
1067	6597		9	3097	606
1068	7930		9	4634	971
1069	8784		9	5623	1240
1070	9517		9	6431	1488
107110126			9	6809	1619
107210585			9	7352	1800
107310910			9	7834	1961
107411206			9	7786	1948
107511747			9	8418	2197
107612535			9	9398	2586
107712968			911014		3238
107813844			911049		3279
107915459			912153		3807
108021193			922163		9845
1081	5734		10	1344	397
1082	9130		10	4899	1141
1083	9975		10	5543	1176
108410461			10	6395	1440
108511009			10	7669	1970
108611518			10	7677	1842
108711984			10	8302	2144
108812532			10	9669	2554
108913050			10	9785	2408
109013651			1010821		2783
109114132			1010324		2663
109214647			1011178		2650
109315276			1013217		3467
109416049			1013767		3755
109516868			1013658		3960
109617577			1016139		4727
109719286			1018245		5358
109821642			1020462		6603
109924360			1023950		7207
11	033654		104472120666		

Figure A3:26-6 SUDBURY: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1171.5330.8521.51231.          |  20 6348.5557.4805.91379.
20 2186.1421.2604.3866.4          |  20 7433.1690.4897.51431.
20 3443.5773.11084.1574.          |  20 8610.21012.1315.1830.
20 4255.1509.6698.1982.9          |  20 9591.5853.41034.1501.
20 5503.4756.61009.1433.          |  2010792.51075.1374.2102.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.384-.187.2919.0965.171341.1380.39171.51.520
21 2    0-.495-.197.2601.0573.068959.0770.06186.11.550
21 3    0-.292-.107.2059.2754-.01081.98234.3443.51.554
21 4    0-.423-.100.3119.2714.168067.28110.6255.11.580
21 5    0-.248-.084.1952.3515-.01078.30281.8503.41.573
21 6    0-.489-.139.3870.1419.254392.31133.4348.51.819
21 7    0-.452-.229.2436-.019.0329105.2178.5433.11.839
21 8    0-.336-.158.2208.1353-.009107.3301.5610.21.895
21 9    0-.354-.124.2865.1998.0956108.8285.8591.51.885
2110    0-.299-.163.2203.0870-.012121.2414.3792.51.921
0000  (quartile 02)
22 1    0-.295-.131.1405.1968-.19463.05172.8330.81.547
22 2    0-.263-.101.1556.3258-.10271.11229.8421.21.559
22 3    0-.177-.084.0689.2640-.44489.43471.1773.11.538
22 4    0-.260-.120.1620.2502-.10983.76279.7509.61.577
22 5    0-.197-.076.0996.4194-.27795.30449.2756.61.574
22 6    0-.396-.135.3160.1316.0696119.8249.3557.41.847
22 7    0-.363-.082.4278.1417.2639134.4329.4690.41.846
22 8    0-.243-.146.1566.1204-.184127.6568.51012.1.914
22 9    0-.279-.127.2069.2084-.099121.6456.0853.41.953
2210    0-.247-.126.2024.1896-.012133.9601.11075.1.971
0000  (quartile 03)
23 1    0-.233-.091.1516.3837-.14178.30296.0521.51.555
23 2    0-.196-.076.1417.3600-.15676.86359.5604.31.549
23 3    0-.133-.044.1289.5124.093793.83695.81084.1.546
23 4    0-.195-.077.1373.3992-.12787.52415.9698.11.560
23 5    0-.168-.088.0670.2591-.622106.9621.61009.1.590
23 6    0-.323-.157.2394.0878-.006135.0407.7805.91.903
23 7    0-.293-.196.1115-.076-.445140.6470.8897.51.855
23 8    0-.214-.140.0493-.040-.799148.2767.51315.1.893
23 9    0-.279-.159.1546.0891-.201146.0553.51034.1.964
2310    0-.231-.113.1745.2533-.097162.2782.41374.1.945
0000  (quartile 04)
24 1    0-.144-.100.0754.1976-.298111.3781.81231.1.575
24 2    0-.170-.067.0859.4107-.25694.59532.5866.41.564
24 3    0-.105-.046.0476.4675-.439104.61043.1574.1.584
24 4    0-.173-.074.0702.3796-.406106.8601.1982.91.600
24 5    0-.113-.050-.001.4301-.992103.5940.11433.1.583
24 6    0-.234-.120.1013.2617-.345173.1780.41379.1.863
24 7    0-.224-.147.0485-.016-.519168.1822.91431.1.912
24 8    0-.209-.189.0468-.224-.493189.51083.1830.1.960
24 9    0-.297-.194.1585-.012-.155221.1786.91501.1.984
2410    0-.183-.097.1041.2514-.168189.81277.2102.1.981
```

Figure A3:26-6(cont) SUDBURY: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1   54    1    1 | 3027   78    4    1 | 3053  151    2    2
30 2   75    1    1 | 3028  103    4    1 | 3054  155    2    2
30 3   89    1    1 | 3029   59    5    1 | 3055  160    2    2
30 4  131    1    1 | 3030   92    5    1 | 3056  166    2    2
30 5   46    2    1 | 3031  108    5    1 | 3057  171    2    2
30 6   74    2    1 | 3032  136    5    1 | 3058  186    2    2
30 7   90    2    1 | 3033   89    1    2 | 3059   67    3    2
30 8  104    2    1 | 3034  105    1    2 | 3060   78    3    2
30 9  142    2    1 | 3035  113    1    2 | 3061   85    3    2
3010   38    3    1 | 3036  121    1    2 | 3062   87    3    2
3011   53    3    1 | 3037  124    1    2 | 3063   89    3    2
3012   61    3    1 | 3038  126    1    2 | 3064   91    3    2
3013   64    3    1 | 3039  128    1    2 | 3065   93    3    2
3014   67    3    1 | 3040  130    1    2 | 3066   95    3    2
3015   71    3    1 | 3041  132    1    2 | 3067   97    3    2
3016   75    3    1 | 3042  134    1    2 | 3068   98    3    2
3017   79    3    1 | 3043  137    1    2 | 3069  135    3    2
3018   85    3    1 | 3044  155    1    2 | 3070  166    3    2
3019   93    3    1 | 3045   72    2    2 | 3071   68    4    2
3020  106    3    1 | 3046   94    2    2 | 3072   88    4    2
3021  143    3    1 | 3047  114    2    2 | 3073   97    4    2
3022   35    4    1 | 3048  127    2    2 | 3074  103    4    2
3023   51    4    1 | 3049  132    2    2 | 3075  116    4    2
3024   58    4    1 | 3050  137    2    2 | 3076  124    5    2
3025   64    4    1 | 3051  141    2    2
3026   70    4    1 | 3052  146    2    2

0000 ZONAL Data
40 1 9582   79      | 40 2 9562   96      | 40 3 8008   25
40 4 6913   18      | 40 5 9279   97      | 40 6 9081   68
0000  Parameteers
50 1 .3             | 50 2 .2             |
5011 .42            | 50121.14            | 5013 45.
5016 .42            | 50171.49            | 5018 77.
50201.350           |

0000 Calibration Data
70 11.5690.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  127131.000 87.4
70 21.5440.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  115301.000 87.1
70 31.5790.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  119540.992 78.6
70 41.6320.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   95980.943 79.4
70 51.6650.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  127631.000 85.9
70 61.4430.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  125101.000115.0
70 71.9580.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  132970.948141.0
70 81.9220.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  116320.888147.9
70 91.9200.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  121410.865126.3
70101.9650.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   97690.898124.9
70111.8720.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  114271.000163.7
70121.8750.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  122771.000163.4
```

Figure A3:26-6(cont) SUDBURY: Supply Calibration Data

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
10  1 1685     1   -5    8          251.311 44.7
10  2 2848     1  806  164          131.487 56.4
10  3 4646     1 2065  381          161.540 69.8
10  410305     1 9285 2708          201.580102.7
10  5 1101     2  -19   16          121.263 39.3
10  6 2004     2  880  189          141.470 57.6
10  7 3093     2 1933  346          271.531 71.9
10  8 4424     2 3394  639          171.555 74.7
10  9 5683     2 4678  973           61.583 72.0
1010 6435      2 5773 1283         9991.716 63.9
1011 7083      2 6764 1599         9991.716 63.9
1012 7591      2 7238 1752         9991.716 65.7
1013 8052      2 7195 1741         9991.716 68.4
1014 9296      2 9205 2481          191.563 88.6
101511859      213271 4410         9991.716 90.5
1016 4192      3 2103  408          151.544 66.3
1017 6987      3 5234 1069         9991.716 76.9
1018 8376      3 6800 1554         9991.716 76.3
1019 9944      3 9057 2108         9991.716 75.0
102011633      311074 2644         9991.716 77.1
102113114      313242 3437           71.592 88.7
102214894      315206 3958         9991.716 82.2
102320161      323815 7989          211.490124.9
1024 1088      4 -686   17           11.253 34.2
1025 2677      4  970  206          261.520 63.3
1026 3876      4 1430  255          181.553 79.6
1027 5132      4 2741  498          301.556 86.6
1028 6167      4 3706  712         9991.716 72.7
1029 6955      4 4475  912         9991.716 74.4
1030 7642      4 5630 1246           31.581 86.3
1031 8332      4 6523 1517         9991.716 73.4
1032 8824      4 6726 1584          281.527 94.2
1033 9670      4 7911 1983         9991.716 81.6
103410905      4 9438 2565           81.594101.6
103514206      415364 5534           91.562133.7
1036 5411      5 2545  568           21.567 71.5
1037 7842      5 5347 1160          311.512 96.9
1038 9041      5 6934 1596         9991.716 80.7
103910461      5 8452 2005         9991.716 87.2
104011987      510494 2501          321.492118.8
104113477      512488 3179           41.516117.7
104218075      519266 5911         9991.716 92.2
1043 3205      6 -127   53          591.728 77.2
1044 4427      6  857  183          611.768101.4
1045 5271      6 1054  235          621.822108.3
1046 6412      6 1962  409         9992.101 97.0
1047 7553      6 2703  573         9992.101105.5
1048 8838      6 4116  849         9992.101113.3
104910759      6 6507 1584          761.840153.2
105015931      611843 3978          491.879170.0
```

Figure A3:27-6 SUDBURY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
1051 4627     7 1714  333          601.817 96.4
1052 7441     7 4154  871         9992.101108.2
1053 8672     7 5775 1290         9992.101114.9
1054 9746     7 6658 1585         9992.101116.7
105511355     7 9279 2558         9992.101119.7
105618208     720287 8565          441.836189.8
1057 6132     8 2396  480          721.761101.8
1058 9344     8 5576 1193          731.883123.7
105911526     8 8826 2014         9992.101108.8
106013158     810608 2708         9992.101114.4
106114234     812168 3161         9992.101119.3
106215546     813135 3372          361.860152.0
106316879     814724 3985          401.863163.1
106418667     817000 4654          521.858181.2
106524770     827391 9897          581.890233.9
1066 3125     9 -426   37          711.561 65.2
1067 6597     9 3097  606          631.822108.8
1068 7930     9 4634  971          331.907115.6
1069 8784     9 5623 1240          651.912120.5
1070 9517     9 6431 1488          661.919123.1
107110126     9 6809 1619          461.939123.0
107210585     9 7352 1800          681.936127.8
107310910     9 7834 1961         9992.101115.0
107411206     9 7786 1948          751.869143.6
107511747     9 8418 2197          381.849153.4
107612535     9 9398 2586          411.862162.2
107712968     911014 3238          431.864168.5
107813844     911049 3279          531.852183.7
107915459     912153 3807          561.874205.2
108021193     922163 9845         9992.101240.4
1081 5734    10 1344  397          451.782 84.0
1082 9130    10 4899 1141          641.919118.6
1083 9975    10 5543 1176          671.922126.4
108410461    10 6395 1440          741.902131.8
108511009    10 7669 1970         9992.101114.3
108611518    10 7677 1842          341.920135.5
108711984    10 8302 2144          351.886141.7
108812532    10 9669 2554          471.891143.2
108913050    10 9785 2408          371.852150.9
109013651    1010821 2783          391.852155.9
109114132    1010324 2663          481.871157.2
109214647    1011178 2650          691.849164.4
109315276    1013217 3467          421.869166.1
109416049    1013767 3755          501.875170.9
109516868    1013658 3960          511.876176.2
109617577    1016139 4727          541.836187.5
109719286    1018245 5358          701.829199.1
109821642    1020462 6603          551.885200.0
109924360    1023950 7207          571.876211.4
11 033654    104472120666         9992.101233.0
```

Figure A3:27-6 SUDBURY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1171.5330.8521.51231.          | 20 6348.5557.4805.91379.
20 2186.1421.2604.3866.4          | 20 7433.1690.4897.51431.
20 3443.5773.11084.1574.          | 20 8610.21012.1315.1830.
20 4255.1509.6698.1982.9          | 20 9591.5853.41034.1501.
20 5503.4756.61009.1433.          | 2010792.51075.1374.2102.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.384-.187.2919.0965.171341.1380.39171.51.520
21 2    0-.495-.197.2601.0573.068959.0770.06186.11.550
21 3    0-.292-.107.2059.2754-.01081.98234.3443.51.554
21 4    0-.423-.100.3119.2714.168067.28110.6255.11.580
21 5    0-.248-.084.1952.3515-.01078.30281.8503.41.573
21 6    0-.489-.139.3870.1419.254392.31133.4348.51.819
21 7    0-.452-.229.2436-.019.0329105.2178.5433.11.839
21 8    0-.336-.158.2208.1353-.009107.3301.5610.21.895
21 9    0-.354-.124.2865.1998.0956108.8285.8591.51.885
2110    0-.299-.163.2203.0870-.012121.2414.3792.51.921
0000  (quartile 02)
22 1    0-.295-.131.1405.1968-.19463.05172.8330.81.547
22 2    0-.263-.101.1556.3258-.10271.11229.8421.21.559
22 3    0-.177-.084.0689.2640-.44489.43471.1773.11.538
22 4    0-.260-.120.1620.2502-.10983.76279.7509.61.577
22 5    0-.197-.076.0996.4194-.27795.30449.2756.61.574
22 6    0-.396-.135.3160.1316.0696119.8249.3557.41.847
22 7    0-.363-.082.4278.1417.2639134.4329.4690.41.846
22 8    0-.243-.146.1566.1204-.184127.6568.51012.1.914
22 9    0-.279-.127.2069.2084-.099121.6456.0853.41.953
2210    0-.247-.126.2024.1896-.012133.9601.11075.1.971
0000  (quartile 03)
23 1    0-.233-.091.1516.3837-.14178.30296.0521.51.555
23 2    0-.196-.076.1417.3600-.15676.86359.5604.31.549
23 3    0-.133-.044.1289.5124.093793.83695.81084.1.546
23 4    0-.195-.077.1373.3992-.12787.52415.9698.11.560
23 5    0-.168-.088.0670.2591-.622106.9621.61009.1.590
23 6    0-.323-.157.2394.0878-.006135.0407.7805.91.903
23 7    0-.293-.196.1115-.076-.445140.6470.8897.51.855
23 8    0-.214-.140.0493-.040-.799148.2767.51315.1.893
23 9    0-.279-.159.1546.0891-.201146.0553.51034.1.964
2310    0-.231-.113.1745.2533-.097162.2782.41374.1.945
0000  (quartile 04)
24 1    0-.144-.100.0754.1976-.298111.3781.81231.1.575
24 2    0-.170-.067.0859.4107-.25694.59532.5866.41.564
24 3    0-.105-.046.0476.4675-.439104.61043.1574.1.584
24 4    0-.173-.074.0702.3796-.406106.8601.1982.91.600
24 5    0-.113-.050-.001.4301-.992103.5940.11433.1.583
24 6    0-.234-.120.1013.2617-.345173.1780.41379.1.863
24 7    0-.224-.147.0485-.016-.519168.1822.91431.1.912
24 8    0-.209-.189.0468-.224-.493189.51083.1830.1.960
24 9    0-.297-.194.1585-.012-.155221.1786.91501.1.984
2410    0-.183-.097.1041.2514-.168189.81277.2102.1.981
```

Figure A3:27-6(cont) SUDBURY: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   54    1    1 | 3027   78    4    1 | 3053  151    2    2
30 2   75    1    1 | 3028  103    4    1 | 3054  155    2    2
30 3   89    1    1 | 3029   59    5    1 | 3055  160    2    2
30 4  131    1    1 | 3030   92    5    1 | 3056  166    2    2
30 5   46    2    1 | 3031  108    5    1 | 3057  171    2    2
30 6   74    2    1 | 3032  136    5    1 | 3058  186    2    2
30 7   90    2    1 | 3033   89    1    2 | 3059   67    3    2
30 8  104    2    1 | 3034  105    1    2 | 3060   78    3    2
30 9  142    2    1 | 3035  113    1    2 | 3061   85    3    2
3010   38    3    1 | 3036  121    1    2 | 3062   87    3    2
3011   53    3    1 | 3037  124    1    2 | 3063   89    3    2
3012   61    3    1 | 3038  126    1    2 | 3064   91    3    2
3013   64    3    1 | 3039  128    1    2 | 3065   93    3    2
3014   67    3    1 | 3040  130    1    2 | 3066   95    3    2
3015   71    3    1 | 3041  132    1    2 | 3067   97    3    2
3016   75    3    1 | 3042  134    1    2 | 3068   98    3    2
3017   79    3    1 | 3043  137    1    2 | 3069  135    3    2
3018   85    3    1 | 3044  155    1    2 | 3070  166    3    2
3019   93    3    1 | 3045   72    2    2 | 3071   68    4    2
3020  106    3    1 | 3046   94    2    2 | 3072   88    4    2
3021  143    3    1 | 3047  114    2    2 | 3073   97    4    2
3022   35    4    1 | 3048  127    2    2 | 3074  103    4    2
3023   51    4    1 | 3049  132    2    2 | 3075  116    4    2
3024   58    4    1 | 3050  137    2    2 | 3076  124    5    2
3025   64    4    1 | 3051  141    2    2
3026   70    4    1 | 3052  146    2    2 |

0000 ZONAL Data
40 1 9582   79      | 40 2 9562   96      | 40 3 8008   25
40 4 6913   18      | 40 5 9279   97      | 40 6 9081   68

0000  Parameters
50 10.300           | 50 20.200           |
50 30.550           | 50 40.400           | 50 71.170
50 50.425           | 50 60.475           | 50 81.031
50110.420           | 50121.140           | 5013 45.0
50160.420           | 50171.490           | 5018 77.0
50201.350           |                     |
```

Figure A3:27-6(cont) SUDBURY: MODIFIED Policy Dataset

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	19	28
2	35	37
3	5	9
4	48	80
5	13	18
A	-	6
Total	120	178

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 5

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	100.	150.	21,067.	34,979.	3,633.	10,572.	26.
2	79.	114.	12,877.	25,267.	3,169.	8,221.	29.
3	151.	220.	25,195.	45,809.	5,130.	18,880.	42.
4	83.	136.	14,250.	27,829.	4,027.	10,241.	82.
5	58.	118.	12,166.	26,786.	2,496.	9,410.	153.
A		102.		25,424.		8,516.	220.
total	85.	133.	15,339.	28,871.	3,616.	9,931.	70.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	40,598.	61,215.	17.7	21,074.	34.4	18.1
2	75,156.	89,675.	26.0	18,658.	20.8	16.0
3	8,857.	12,425.	3.6	3,577.	28.8	3.1
4	83,703.	134,865.	39.0	54,762.	40.6	47.0
5	20,076.	31,455.	9.1	12,285.	39.1	10.5
A		15,895.	4.6	6,188.	38.9	5.3
tot	228,392.	345,530.	100.0	116,542.	33.7	100.0

source: program "CZONE.FORT": files VAN61.INPUT and VAN71.INPUT.

Figure A3:01-7 VANCOUVER: Zonal Characteristics (5 zones)

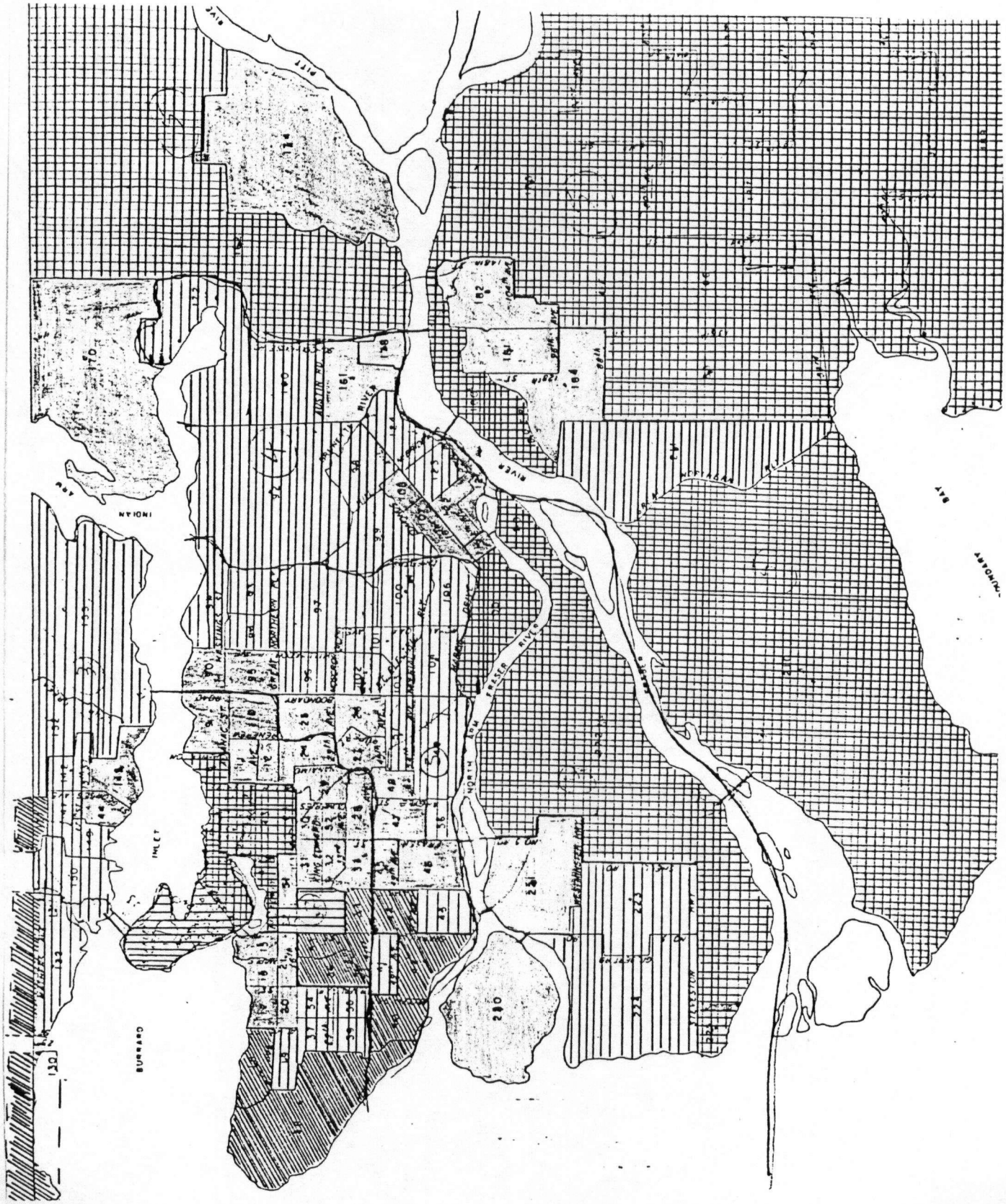

Figure A3:02-7 VANCOUVER: Clustering (5 zones)

Demographic Characteristics:

Population [1] 1961: 790,165.
[2] 1971:1,082,350.

Households [1] 1961: 228,532.
[2] 1971: 346,215.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 9,931.
1974 SHU data [4] : 10,879.

deflator : 0.8528

SHU deflated : 10,191.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file VAN.SHU

SHU dataset:

Sample size : 2830.
Sum of the WEIGHTs : 235,455.

RATIO of SHU weights
to actual households : 0.68008

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	7,558.	12,482.	5.	2,496.	3,670.
2	12,692.	63,434.	27.	2,349.	3,454.
3	11,133.	13,852.	6.	2,309.	3,395.
4	13,640.	41,890.	18.	2,327.	3,422.
5	7,049.	23,404.	10.	2,340.	3,441.
6	7,457.	23,150.	10.	2,315.	3,404.
7	9,079.	35,257.	15.	2,350.	3,455.
8	3,976.	21,986.	9.	2,443.	3,592.

source: program "HH1.FORT" :file VAN.SHU

Figure A3:03-7 VANCOUVER: HOUSEHOLD Characteristics.

Total 1961 dwellings : 228,392.

Rental	:	69,177.
Owner-occupier	:	159,215.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	95.	17,993.	20,008.	22,605.	0.0576
2	77.	28,238.	12,506.	46,918.	0.0744
3	142.	629.	25,062.	8,230.	0.0684
4	82.	18,385.	14,320.	65,318.	0.0696
5	58.	3,932.	11,993.	16,144.	0.0588
total	83.	69,177.	14,912.	159,215.	0.0672

source: program "D61.FORT" : dataset VAN61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings : TOTAL 228,392.
: RATIO of EXISTING unannexed/TOTAL 96.0%
: TOTAL 1961 Dwellings EXISTING in 1971 228,988.
: TOTAL 1961 Dwellings ADJUSTED for ANNEXED 238,502.
: 1971 "model" Dwellings 100.
: 1971 RATIO ACTUAL/"model" 3455.
: 1961 "model" Dwellings 69.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	40,598.	12.	3383.	0.8043	0.7953
2	75,156.	23.	3268.	0.9952	0.9841
3	8,859.	3.	2953.	0.9298	0.9194
4	83,703.	25.	3348.	1.0609	1.0490
5	20,076.	6.	3346.	1.2022	1.1888

error of fit 0.01791

source: program "D61.FORT" : dataset VAN61.INPUT.

Figure A3:04-7 VANCOUVER: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	6.6027	6.6700	4.6985	4.1219
	(28.9)	(37.9)	(15.6)	(17.2)
MULTIPLE	0.6871	0.6275	0.2303	0.2620
	(18.7)	(18.3)	(4.88)	(8.47)
CONSTRUCTED PRE 20	-.2931	-.4124	-.4258	-.3471
	(6.79)	(10.6)	(7.50)	(9.49)
20-45	-.1476	-.1540	-.1377	-.1608
	(5.00)	(6.77)	(3.46)	(4.97)
CONDITION	0.2318	0.1438	0.1758	0.2025
	(6.41)	(4.85)	(3.67)	(6.02)
LN ROOMS	1.1482	1.3975	0.7345	0.5513
	(23.6)	(34.4)	(11.2)	(11.9)
LN INCOME	0.1158	0.0666	0.1388	0.2361
	(4.20)	(3.11)	(3.83)	(8.24)
ACCESS	-.0010	.0008	-.0029	-.0023
	(5.18)	(5.60)	(11.0)	(11.6)
R2	0.50	0.99	0.35	0.99
OBSERVATIONS	1213	1213	1147	1147

note : "t" statistis in brackets
: data source: VAN61.EA

MEANS:

LN INCOME	8.1423
MULTIPLE	0.2251
ACCESS	53.4

Figure A3:05-7 VANCOUVER: 1961 Hedonic Estimates

Total 1971 dwellings : 345,500.

Rental : 142,260.
Owner-occupier : 203,240.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	142.	38,375.	37,541.	22,835.	0.0465
2	115.	44,605.	24,081.	45,055.	0.0576
3	222.	1,955.	45,437.	10,485.	0.0588
4	131.	49,990.	27,519.	100,755.	0.0576
5	118.	7,335.	26,989.	24,110.	0.0528
total	129.	142,260.	28,744.	203,240.	0.0540

source: program "D71.FORT" : dataset VAN71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual calculated	"RHS"/actual weighted	SERVICES
1	61,210.	18.	3401.	0.8778	0.8338	
2	89,660.	26.	3448.	1.1054	1.0499	
3	12,440.	4.	3110.	0.7061	0.6706	
4	150,745.	43.	3506.	1.0792	1.0250	
5	31,445.	9.	3494.	1.1085	1.0528	
			3455.			

error of fit 0.01464

source: program "D71.FORT" : dataset VAN71.INPUT.

Figure A3:06-7 VANCOUVER: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 345,500.

Built prior 1961 : 228,927.
Built 1961-1971 : 116,573.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	128.	19,595.	36,446.	20,539.	0.0420
2	109.	30,101.	23,939.	40,897.	0.0552
3	180.	686.	43,295.	8,165.	0.0504
4	113.	22,030.	25,868.	67,746.	0.0528
5	96.	4,450.	23,966.	14,718.	0.0480
99	147.	65,397.	32,690.	51,175.	0.0540
CMA	129.	142,260.	28,829.	203,240.	0.0540

source: program "D71.FORT" : dataset VAN71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual calculated	"RHS"/actual SERVICES weighted
1	40,134.	11.	3,649.	0.9046	0.8556
2	70,998.	20.	3,550.	1.1216	1.0608
3	8,851.	3.	2,950.	0.7453	0.7049
4	89,776.	26.	3,453.	1.1462	1.0841
5	19,168.	6.	3,195.	1.2494	1.1817
99	116,573.	34.	3,429.	0.9481	0.8967
			3,454.		

error of fit 0.02320

source: program "D71.FORT" : dataset VAN71.INPUT.

Figure A3:07-7 VANCOUVER: 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	8.6618	8.4802	5.654	5.7846
	(51.9)	(50.0)	(43.0)	(49.5)
MULTIPLE	0.1128	0.1549	-.0560	-.1019
	(3.63)	(4.45)	(1.70)	(3.06)
CONSTRUCTION 51-60	-.1854	-.1886	-.1550	-.1161
	(5.10)	(5.24)	(5.81)	(3.98)
46-50	-.2579	-.2222	-.1859	-.1727
	(6.77)	(5.89)	(4.76)	(4.20)
20-45	-.2836	-.2846	-.2599	-.2463
	(8.34)	(8.53)	(8.79)	(8.08)
PRE 20	-.3499	-.3923	-.3254	-.3119
	(8.62)	(9.80)	(8.50)	(8.26)
FACILITIES	0.1100	0.1287	0.2403	0.2211
	(1.12)	(1.24)	(4.98)	(4.82)
LN INCOME	0.0769	0.0968	0.1447	0.1325
	(5.42)	(6.85)	(10.5)	(10.7)
LN ROOMS	0.5186	0.5031	0.2580	0.2738
	(15.1)	(13.5)	(10.4)	(11.1)
R2	0.31	0.99	0.35	0.98
OBSERVATIONS	1082	1082	1150	1150
WEIGHTED 20-45/PRE 20	-.3008	-.3126	-.2832	-.2696

note : "t" statistis in brackets
: data source: VAN.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	9.0414
MULTIPLE	0.2080
ACCESS	65.0

Figure A3:08-7 VANCOUVER: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	28,871.	62,843.	0.45941
RENT	133.	178.	0.74719
INCOME	9,931.	11,644.	0.85288

R/V ratio: 0.0540 P(j)/PN ratio: 1.03382

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.9837 (83.7)	0.1976	3.0581 (83.0)	0.2129	0.2087
DUMMY (TYPE 2)	-.3272 (8.05)	0.1425	-.4533 (10.9)	0.1353	0.1323
DUMMY (TYPE 3)	-.3062 (6.19)	0.1455	-.3968 (7.55)	0.1431	0.1400
DUMMY (TYPE 4)	-.4549 (10.5)	0.1254	-.5489 (12.7)	0.1230	0.1203
DUMMY (TYPE 5)	0.0909 (1.99)	0.2164	0.0024 (0.05)	0.2134	0.2091
DUMMY (TYPE 6)	0.1221 (2.69)	0.2233	0.0282 (0.61)	0.2190	0.2147
DUMMY (TYPE 7)	-.1428 (3.20)	0.1713	-.2075 (4.66)	0.1730	0.1694
DUMMY (TYPE 8)	0.5326 (10.8)	0.3366	0.4426 (9.18)	0.3314	0.3258
R2	0.24		0.84		
OBSERVATIONS	2658		2658		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-7 VANCOUVER: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	10.153 (68.1)	9.8026 (68.2)	0.1964	0.1477	0.3488
DUMMY (TYPE 2)	0.0342 (1.12)	-.0382 (1.21)	0.1271	0.0779	0.2666
DUMMY (TYPE 3)	-.0511 (1.41)	-.0873 (2.23)	0.1378	0.1039	0.2283
DUMMY (TYPE 4)	-.0371 (1.13)	-.0927 (2.80)	0.1140	0.0724	0.2523
DUMMY (TYPE 5)	-.0257 (0.77)	-.0889 (2.51)	0.1895	0.1131	0.3618
DUMMY (TYPE 6)	0.1879 (0.57)	-.0103 (3.58)	0.1963	0.1188	0.4596
DUMMY (TYPE 7)	-.0901 (2.78)	-.1169 (3.58)	0.1519	0.0911	0.3981
DUMMY (TYPE 8)	-.0349 (0.92)	-.1230 (3.30)	0.2838	0.1767	0.5968
LN INCOME	-.8050 (48.8)	-.7643 (47.7)			
R2	0.60	0.91			
OBSERVATIONS	2658	2658			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Figure A3:09-7(b) VANCOUVER: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	672.0	1017.	5,588	-	-	-
1962	680.0	993.	7,387	0.059	40.1	58.6
1963	686.0	973.	8,941	0.079	48.7	69.1
1964	699.0	997.	12,791	0.101	70.6	100.7
1965	717.0	1086.	11,684	0.093	66.7	101.0
1966	738.0	1259.	9,138	0.072	53.1	90.6
1967	773.0	1435.	13,896	0.110	85.0	157.9
1968	818.0	1732.	15,690	0.124	101.4	214.8
1969	860.0	2107.	17,690	0.140	120.4	295.0
1970	917.0	2306.	13,437	0.106	97.2	250.8
1971	975.0	2369.	15,533	0.123	120.0	291.4

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	672.0	1017.0	1689.0	0.398	0.602	1.000	--
decade weighted	803.0	1630.0	2433.0	0.475	0.965	1.440	56.7
1971	975.6	2369.0	3344.6	0.578	1.402	1.980	41.2

Figure A3:10-7 VANCOUVER: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 1 7557
20 212692
20 311133
20 413639
20 5 7049
20 6 7456
20 7 9079
20 8 3975

0000 ALPHA by TYPE
21 1.2129
21 2.1353
21 3.1431
21 4.1230
21 5.2134
21 6.2190
21 7.1730
21 8.3314

0000 "MODEL" HOUSEHOLDS
10 1 2160     1
10 2 5105     1
10 3 7231     1
10 4 9248     1
10 514070     1
10 6 2523     2
10 7 4178     2
10 8 5606     2
10 9 6429     2
1010 7067     2
1011 7822     2
1012 8346     2
1013 8752     2
1014 9189     2
1015 9671     2
101610165     2
101710377     2
101810747     2
101911258     2
102011828     2
102112382     2
102212797     2
102313344     2
102413984     2
102515143     2
102616442     2
102717383     2
102817997     2
102919506     2
103021248     2
103124454     2
103236890     2
1033 3469     3
1034 6994     3
1035 9595     3
103612619     3
103714787     3
103819307     3
1039 2412     4
1040 4661     4
1041 6317     4
1042 7316     4
1043 8261     4
1044 9087     4
104510121     4
104610732     4
104711617     4
104812589     4
104913766     4
105014994     4
105116235     4
105217806     4
105319231     4
105420964     4
105524401     4
105636658     4
1057 1721     5
1058 2670     5
1059 3497     5
1060 4111     5
1061 4563     5
1062 5359     5
1063 6702     5
1064 8630     5
106511663     5
106621736     5
1067 1166     6
1068 2155     6
1069 3468     6
1070 4659     6
1071 6119     6
1072 7048     6
1073 7969     6
1074 9043     6
107511294     6
107622272     6
1077 1110     7
1078 2056     7
1079 3284     7
1080 4602     7
1081 5568     7
1082 6287     7
1083 7108     7
1084 7726     7
1085 8396     7
1086 9255     7
108710557     7
108812051     7
108913455     7
109016916     7
109127676     7
1092  786     8
1093 1554     8
1094 2000     8
1095 2220     8
1096 2838     8
1097 3756     8
1098 4675     8
1099 6376     8
11 011170     8
```

Figure A3:11-7 VANCOUVER: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1    44    32     1 | 3035   102    74     2 | 3069    97    70     4
30 2    62    45     1 | 3036   105    76     2 | 3070    99    72     4
30 3    71    52     1 | 3037   108    79     2 | 3071   101    73     4
30 4    78    57     1 | 3038   111    81     2 | 3072   103    75     4
30 5    83    60     1 | 3039   115    83     2 | 3073   104    76     4
30 6    87    64     1 | 3040   119    87     2 | 3074   106    77     4
30 7    91    66     1 | 3041   124    90     2 | 3075   108    78     4
30 8    94    68     1 | 3042   130    94     2 | 3076   109    79     4
30 9    97    71     1 | 3043   139   101     2 | 3077   111    81     4
3010   101    73     1 | 3044   165   120     2 | 3078   113    82     4
3011   104    76     1 | 3045    80    58     3 | 3079   115    83     4
3012   108    79     1 | 3046   108    79     3 | 3080   117    85     4
3013   113    82     1 | 3047   131    95     3 | 3081   120    87     4
3014   118    86     1 | 3048   171   124     3 | 3082   122    89     4
3015   125    91     1 | 3049    27    20     4 | 3083   125    91     4
3016   135    99     1 | 3050    46    34     4 | 3084   128    93     4
3017   157   114     1 | 3051    52    38     4 | 3085   131    96     4
3018   199   145     1 | 3052    57    41     4 | 3086   135    98     4
3019    33    24     2 | 3053    61    45     4 | 3087   139   101     4
3020    49    36     2 | 3054    64    47     4 | 3088   144   105     4
3021    55    40     2 | 3055    67    49     4 | 3089   151   110     4
3022    60    44     2 | 3056    70    51     4 | 3090   165   120     4
3023    64    47     2 | 3057    73    53     4 | 3091   211   153     4
3024    67    49     2 | 3058    75    55     4 | 3092    38    28     5
3025    71    51     2 | 3059    78    56     4 | 3093    58    42     5
3026    74    54     2 | 3060    80    58     4 | 3094    69    50     5
3027    77    56     2 | 3061    82    60     4 | 3095    79    57     5
3028    80    58     2 | 3062    84    61     4 | 3096    88    64     5
3029    83    60     2 | 3063    86    62     4 | 3097    98    71     5
3030    86    63     2 | 3064    88    64     4 | 3098   109    80     5
3031    89    65     2 | 3065    90    65     4 | 3099   126    91     5
3032    92    67     2 | 3066    91    66     4 | 31 0   169   123     5
3033    95    69     2 | 3067    93    68     4 |
3034    99    72     2 | 3068    95    69     4 |

0000 ZONAL DATA
40 110572    26 |
40 2 8221    29 |
40 318880    42 |
40 410060    96 |
40 5 9410   153 |
40 6 9931    69 |

0000 Calibration Data
70 11.4380.0320.2410.0410.1410.1060.0980.2020.139105701.000103.8
70 21.5460.0640.3480.0500.1150.1040.0690.1460.103 82201.000 92.0
70 31.2210.0580.5910.0320.1340.0860.0110.0500.039188761.000122.5
70 41.5050.0950.4910.0580.1150.0780.0310.0720.060100581.000100.3
70 51.5690.0880.4830.0480.1040.1260.0170.0560.078 94091.000 92.7
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:11-7A VANCOUVER: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 1 7557
20 212692
20 311133
20 413639
20 5 7049
20 6 7456
20 7 9079
20 8 3975

0000 ALPHA by TYPE
21 1.2129
21 2.1353
21 3.1431
21 4.1230
21 5.2134
21 6.2190
21 7.1730
21 8.3314

0000 "MODEL" HOUSEHOLDS
10 1 2160     1
10 2 5105     1
10 3 7231     1
10 4 9248     1
10 514070     1
10 6 2523     2
10 7 4178     2
10 8 5606     2
10 9 6429     2
1010 7067     2
1011 7822     2
1012 8346     2
1013 8752     2
1014 9189     2
1015 9671     2
101610165     2
101710377     2
101810747     2
101911258     2
102011828     2
102112382     2
102212797     2
102313344     2
102413984     2
102515143     2
102616442     2
102717383     2
102817997     2
102919506     2
103021248     2
103124454     2
103236890     2
1033 3469     3
1034 6994     3
1035 9595     3
103612619     3
103714787     3
103819307     3
1039 2412     4
1040 4661     4
1041 6317     4
1042 7316     4
1043 8261     4
1044 9087     4
104510121     4
104610732     4
104711617     4
104812589     4
104913766     4
105014994     4
105116235     4
105217806     4
105319231     4
105420964     4
105524401     4
105636658     4
1057 1721     5
1058 2670     5
1059 3497     5
1060 4111     5
1061 4563     5
1062 5359     5
1063 6702     5
1064 8630     5
106511663     5
106621736     5
1067 1166     6
1068 2155     6
1069 3468     6
1070 4659     6
1071 6119     6
1072 7048     6
1073 7969     6
1074 9043     6
107511294     6
107622272     6
1077 1110     7
1078 2056     7
1079 3284     7
1080 4602     7
1081 5568     7
1082 6287     7
1083 7108     7
1084 7726     7
1085 8396     7
1086 9255     7
108710557     7
108812051     7
108913455     7
109016916     7
109127676     7
1092  786     8
1093 1554     8
1094 2000     8
1095 2220     8
1096 2838     8
1097 3756     8
1098 4675     8
1099 6376     8
11 011170     8
```

Figure A3:12-7 VANCOUVER: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1    38     1        3035  181     2        3069  196     5
30 2    55     1        3036   83     3
30 3    63     1        3037  118     3
30 4    69     1        3038  165     3
30 5    74     1        3039   29     4
30 6    80     1        3040   50     4
30 7    85     1        3041   59     4
30 8    93     1        3042   64     4
30 9   101     1        3043   69     4
3010   113     1        3044   73     4
3011   134     1        3045   77     4
3012   178     1        3046   81     4
3013    23     2        3047   85     4
3014    41     2        3048   88     4
3015    52     2        3049   91     4
3016    57     2        3050   95     4
3017    61     2        3051   98     4
3018    65     2        3052  101     4
3019    68     2        3053  104     4
3020    71     2        3054  108     4
3021    74     2        3055  111     4
3022    77     2        3056  114     4
3023    80     2        3057  118     4
3024    83     2        3058  123     4
3025    86     2        3059  128     4
3026    89     2        3060  136     4
3027    93     2        3061  145     4
3028    96     2        3062  158     4
3029   101     2        3063  223     4
3030   105     2        3064   41     5
3031   110     2        3065   71     5
3032   115     2        3066   86     5
3033   122     2        3067  101     5
3034   134     2        3068  123     5

0000 ZONAL DATA
40 110572   26
40 2 8221   29
40 318880   42
40 410060   96
40 5 9410  153
40 6 9931   69

0000 Calibration Data
70 11.4100.0360.2830.0390.1380.1120.0820.1780.132112230.989102.4
70 21.5460.0650.3620.0470.1130.1070.0630.1400.102 83470.945 89.0
70 31.3560.0580.6000.0310.1290.0850.0120.0470.038192211.000104.9
70 41.5880.0910.4940.0540.1160.0840.0280.0710.062100861.000 90.6
70 51.6340.0860.4750.0470.1020.1330.0170.0580.082 91310.955 86.1
70 61.4400.0800.4010.0570.1210.0840.0580.1170.083 97561.000123.0
```

Figure A3:12-7A VANCOUVER: "BETA" Calibration Data

0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA

10 1 2160	1	171.230 52.7	105116235	4	9991.440118.5
10 2 5105	1	491.348 83.9	105217806	4	9991.440125.3
10 3 7231	1	551.359102.9	105319231	4	9991.440131.2
10 4 9248	1	9991.440115.6	105420964	4	621.325143.9
10 514070	1	381.362153.3	105524401	4	121.295159.5
10 6 2523	2	161.140 46.8	105636658	4	9991.440193.2
10 7 4178	2	41.249 60.3	1057 1721	5	411.112 47.6
10 8 5606	2	221.319 69.9	1058 2670	5	191.223 58.6
10 9 6429	2	241.327 75.7	1059 3497	5	211.300 66.5
1010 7067	2	361.391 78.2	1060 4111	5	61.320 72.6
1011 7822	2	81.331 85.0	1061 4563	5	661.310 77.7
1012 8346	2	511.317 88.8	1062 5359	5	271.329 84.9
1013 8752	2	521.315 91.5	1063 6702	5	531.353 96.1
1014 9189	2	9991.440 90.0	1064 8630	5	681.336112.6
1015 9671	2	9991.440 92.8	106511663	5	611.353134.0
101610165	2	541.340 99.1	106621736	5	9991.440188.1
101710377	2	9991.440 96.8	1067 1166	6	401.095 40.0
101810747	2	9991.440 98.9	1068 2155	6	31.220 54.2
101911258	2	101.358104.7	1069 3468	6	51.346 68.1
102011828	2	9991.440104.7	1070 4659	6	481.350 81.2
102112382	2	9991.440107.7	1071 6119	6	91.378 94.5
102212797	2	371.396111.5	1072 7048	6	561.339104.6
102313344	2	9991.440112.6	1073 7969	6	9991.440108.1
102413984	2	9991.440115.8	1074 9043	6	591.375119.7
102515143	2	111.366124.7	107511294	6	9991.440133.3
102616442	2	9991.440127.6	107622272	6	631.360206.8
102717383	2	9991.440132.0	1077 1110	7	641.099 32.8
102817997	2	9991.440134.8	1078 2056	7	21.168 45.9
102919506	2	9991.440141.4	1079 3284	7	431.220 59.3
103021248	2	9991.440148.9	1080 4602	7	451.315 69.7
103124454	2	691.266172.9	1081 5568	7	251.319 78.0
103236890	2	9991.440207.3	1082 6287	7	261.360 82.6
1033 3469	3	181.201 55.3	1083 7108	7	671.304 90.9
1034 6994	3	71.361 78.9	1084 7726	7	291.357 93.6
1035 9595	3	9991.440 92.7	1085 8396	7	9991.440 95.4
103612619	3	9991.440109.3	1086 9255	7	321.334105.2
103714787	3	601.338124.7	108710557	7	331.356112.9
103819307	3	9991.440141.1	108812051	7	341.340123.0
1039 2412	4	151.136 42.6	108913455	7	9991.440126.6
1040 4661	4	651.218 61.0	109016916	7	9991.440145.2
1041 6317	4	231.283 71.2	109127676	7	9991.440195.1
1042 7316	4	471.312 76.9	1092 786	8	141.219 35.2
1043 8261	4	9991.440 79.0	1093 1554	8	421.187 54.0
1044 9087	4	281.322 87.3	1094 2000	8	201.230 61.4
104510121	4	9991.440 89.2	1095 2220	8	441.262 64.2
104610732	4	9991.440 92.4	1096 2838	8	461.303 72.9
104711617	4	311.334100.7	1097 3756	8	501.312 85.9
104812589	4	571.310106.6	1098 4675	8	301.343 96.5
104913766	4	9991.440107.3	1099 6376	8	581.371114.8
105014994	4	9991.440113.0	110011170	8	351.321164.5

Figure A3:13-7 VANCOUVER: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   38    1        3035  181    2        3069  196    5
30 2   55    1        3036   83    3
30 3   63    1        3037  118    3
30 4   69    1        3038  165    3
30 5   74    1        3039   29    4
30 6   80    1        3040   50    4
30 7   85    1        3041   59    4
30 8   93    1        3042   64    4
30 9  101    1        3043   69    4
3010  113    1        3044   73    4
3011  134    1        3045   77    4
3012  178    1        3046   81    4
3013   23    2        3047   85    4
3014   41    2        3048   88    4
3015   52    2        3049   91    4
3016   57    2        3050   95    4
3017   61    2        3051   98    4
3018   65    2        3052  101    4
3019   68    2        3053  104    4
3020   71    2        3054  108    4
3021   74    2        3055  111    4
3022   77    2        3056  114    4
3023   80    2        3057  118    4
3024   83    2        3058  123    4
3025   86    2        3059  128    4
3026   89    2        3060  136    4
3027   93    2        3061  145    4
3028   96    2        3062  158    4
3029  101    2        3063  223    4
3030  105    2        3064   41    5
3031  110    2        3065   71    5
3032  115    2        3066   86    5
3033  122    2        3067  101    5
3034  134    2        3068  123    5

0000 INCOME by TYPE   0000 ALPHA by TYPE    0000 ZONAL DATA
20 1 7557             21 1.2129             40 1 7858   26
20 212692             21 2.1353             40 2 5879   29
20 311133             21 3.1431             40 311149   42
20 413639             21 4.1230             40 4 7563   96
20 5 7049             21 5.2134             40 5 8300  153
20 6 7456             21 6.2190             40 615277   69
20 7 9079             21 7.1730
20 8 3975             21 8.3314
```

Figure A3:13-7(cont) VANCOUVER: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	2.5335	1.4999
	(21.9)	(5.50)
BATH	0.6068	na
	(3.41)	
TOILET	-.4338	0.1913
	(2.41)	(0.98)
SUBSIDIS	-.2940	-.0251
	(10.1)	(0.50)
LNLIVING	0.2176	0.1254
	(7.21)	(3.31)
LNINCOM	0.1546	0.2032
	(11.9)	(9.62)
TYPE	-.1354	-.3077
	(8.51)	(9.34)
LNDIST	-.0062	-.0041
	(0.86)	(0.50)
B5160	-.0892	-.1106
	(4.19)	(4.55)
B4650	-.0986	-.0904
	(3.33)	(3.47)
B2145	-.0558	-.1183
	(2.56)	(5.51)
BPRE20	-.1466	-.1183
	(4.90)	(5.51)
LGLVSIZE	0.1644	0.2455
	(8.53)	(8.53)
LGBDSIZE	0.0640	0.0295
	(13.2)	(2.50)
OPENSP	0.0310	0.0332
	(1.65)	(1.09)
HIGHDEN	0.0301	-.1426
	(1.78)	(1.09)
COMMERC	-.0413	na
	(2.40)	
NEIGHBD	0.0589	na
	(2.78)	
FINANCE	-.0382	-.0655
	(2.37)	(2.72)
AMRATE	na	0.0891
		(16.9)
R2	0.58	0.51
Observations	1345	1228

note: "t" statistics in brackets
: data source: VAN.REG02

Figure A3:14-7 VANCOUVER: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	454.9	132.7	1.532	1.270	0.3533
min	88.3	34.4	1.423	1.270	0.0910
max	2038.9	470.7	1.913	1.270	0.9369
TYPE 2					
mean	448.5	129.4	1.563	1.270	0.3568
min	63.3	39.1	1.423	1.270	0.0690
max	2237.5	342.4	1.890	1.270	0.9773
TYPE 3					
mean	844.1	162.1	1.592	1.270	0.2316
min	83.1	38.3	1.423	1.270	0.0265
max	3241.9	465.2	1.938	1.270	0.9823
TYPE 4					
mean	587.3	170.8	1.654	1.270	0.3466
min	179.7	39.9	1.423	1.270	0.0596
max	3241.6	408.9	1.913	1.270	0.9004
TYPE 5					
mean	756.8	185.1	1.665	1.270	0.2768
min	141.8	46.9	1.423	1.270	0.0806
max	2231.9	469.9	1.957	1.270	0.9372
TYPE 6					
mean	837.4	329.6	2.305	1.270	0.4544
min	238.0	65.2	1.534	1.270	0.0701
max	3842.4	949.6	2.505	1.270	0.9593
TYPE 7					
mean	765.0	295.5	2.364	1.270	0.4232
min	218.7	98.3	1.564	1.270	0.1378
max	2090.4	834.4	2.565	1.270	0.9299
TYPE 8					
mean	1256.4	327.9	2.426	1.270	0.2825
min	371.8	78.1	1.573	1.270	0.0605
max	3576.6	838.8	2.584	1.270	0.7154
TYPE 9					
mean	1055.1	354.1	2.156	1.270	0.3542
min	347.0	55.1	1.396	1.270	0.0729
max	3500.6	999.0	2.284	1.270	0.9135
TYPE 10					
mean	1110.0	343.5	2.475	1.270	0.3280
min	267.1	98.0	1.593	1.270	0.0926
max	3538.0	948.5	2.596	1.270	0.8770

Figure A3:15-7 VANCOUVER : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3050	-.1757	0.1980	0.0645	-.0152	86.6	253.7	454.9	259
	(195.)	(28.5)	(51.9)	(3.59)	(2.60)				
2	-.3041	-.1986	0.2220	-.0122	0.0376	82.8	251.2	448.5	438
	(196.)	(20.3)	(60.5)	(0.49)	(7.78)				
3	-.2040	-.1839	0.1512	-.1244	-.0447	101.2	537.0	844.1	384
	(130.)	(20.7)	(33.8)	(4.27)	(6.12)				
4	-.3020	-.1689	0.1854	0.1091	-.0303	102.8	328.0	587.3	139
	(127.)	(15.7)	(33.0)	(3.81)	(3.34)				
5	-.2518	-.1370	0.1747	0.2238	-.0325	110.6	450.1	756.8	125
	(120.)	(12.3)	(30.8)	(7.74)	(3.87)				
6	-.4068	-.2117	0.2368	-.0042	0.0554	142.4	399.8	837.4	243
	(159.)	(18.2)	(37.4)	(0.15)	(6.16)				
7	-.3948	-.2344	0.2456	-.0209	0.0425	124.7	369.7	765.0	130
	(153.)	(16.1)	(26.7)	(0.60)	(3.17)				
8	-.2635	-.1430	0.1380	0.1422	-.1672	135.1	731.1	1256.4	281
	(221.)	(23.2)	(25.1)	(7.19)	(13.5)				
9	-.3439	-.1980	0.2062	0.0110	-.0023	164.6	552.0	1055.1	217
	(199.)	(24.0)	(31.1)	(0.46)	(0.21)				
10	-.3146	-.1896	0.1890	0.0508	-.0483	138.6	603.6	1110.0	357
	(343.)	(33.2)	(44.6)	(3.24)	(6.64)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-7 VANCOUVER : Direct Translog-Expenditure Share
[all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4069	-.1563	0.2545	0.1451	0.0647	72.7	130.7	277.3	153
	(198.)	(14.3)	(27.4)	(4.74)	(4.59)				
2	-.4285	-.2223	0.3015	-.0035	0.1380	76.1	131.2	285.7	231
	(225.)	(14.1)	(43.7)	(0.10)	(15.2)				
3	-.2703	-.2193	0.2250	-.0825	0.0457	94.3	335.5	574.4	217
	(150.)	(14.7)	(27.8)	(1.93)	(3.42)				
4	-.4105	-.1562	0.2639	0.1493	0.0792	95.9	180.5	385.4	76
	(140.)	(12.5)	(21.9)	(5.00)	(4.17)				
5	-.3109	-.1101	0.2248	0.3347	0.0269	99.8	288.3	530.9	68
	(125.)	(7.70)	(19.3)	(8.77)	(1.80)				
6	-.5261	-.2447	0.3181	-.0513	0.1636	131.1	218.2	580.5	153
	(193.)	(11.8)	(20.1)	(1.26)	(7.91)				
7	-.4583	-.2198	0.3009	-.0156	0.1173	107.4	242.3	558.2	78
	(133.)	(7.95)	(16.1)	(0.32)	(4.50)				
8	-.3112	-.1633	0.1546	0.1048	-.1589	120.6	511.0	940.3	161
	(189.)	(14.7)	(12.0)	(3.50)	(5.95)				
9	-.3712	-.1658	0.2782	0.0872	0.1008	139.4	409.4	817.4	130
	(170.)	(12.8)	(18.0)	(2.49)	(4.09)				
10	-.3646	-.2030	0.2363	0.0338	0.0149	125.8	431.7	857.1	203
	(256.)	(19.9)	(23.6)	(1.35)	(0.93)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-7 VANCOUVER : Direct Translog-Expenditure Share
[below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2356	-.1321	0.1635	0.1867	-.0451	106.7	431.3	711.2	106
	(176.)	(19.8)	(19.7)	(6.97)	(1.57)				
2	-.2233	-.1334	0.0970	0.1255	-.3342	90.3	385.1	630.1	207
	(220.)	(21.9)	(12.3)	(5.25)	(11.1)				
3	-.1577	0.0561	0.1521	0.6029	0.9694	110.2	798.9	1194.5	167
	(60.8)	(6.68)	(61.4)	(14.2)	(788.)				
4	-.2268	-.1305	0.0999	0.1680	-.2895	111.0	505.8	830.9	63
	(107.)	(9.92)	(8.02)	(3.34)	(5.60)				
5	-.2082	-.1410	0.1175	0.1470	-.1495	123.4	643.2	1026.2	57
	(98.4)	(6.88)	(5.90)	(1.53)	(1.50)				
6	-.2970	-.1613	0.1598	0.1022	-.1095	161.5	708.7	1274.1	90
	(95.3)	(12.1)	(10.4)	(2.22)	(2.78)				
7	-.3364	-.1579	0.1699	0.1836	-.1419	150.5	560.8	1075.1	52
	(118.)	(9.34)	(6.43)	(3.70)	(2.21)				
8	-.2240	-.0989	0.1171	0.3104	-.1996	154.5	1026.4	1680.5	120
	(142.)	(10.1)	(9.23)	(7.69)	(4.18)				
9	-.3128	-.1627	0.1377	0.0960	-.2053	202.3	765.1	1410.3	87
	(150.)	(8.75)	(9.92)	(1.77)	(5.32)				
10	-.2706	-.1468	0.1284	0.1659	-.2215	155.3	830.1	1443.4	154
	(612.)	(42.4)	(23.3)	(13.8)	(12.5)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-7 VANCOUVER : Direct Translog-Expenditure Share
[above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.5082	-.1933	0.3239	0.0561	0.1634	65.3	77.3	198.3	78
	(207.)	(14.2)	(20.4)	(1.76)	(7.12)				
2	-.5744	-.2315	0.3552	-.0207	0.2229	70.1	65.9	194.0	110
	(204.)	(11.9)	(28.5)	(0.53)	(13.7)				
3	-.3386	-.1756	0.2897	0.0271	0.1344	89.4	226.6	427.0	108
	(122.)	(6.74)	(16.8)	(0.40)	(4.94)				
4	-.4893	-.1254	0.3258	0.2126	0.1708	90.5	119.7	297.2	41
	(133.)	(8.64)	(17.5)	(5.88)	(7.05)				
5	-.3790	-.1337	0.2729	0.2738	0.0888	95.9	203.8	417.6	31
	(135.)	(9.87)	(22.5)	(8.65)	(5.94)				
6	-.5897	-.1724	0.3858	0.0640	0.2556	117.4	147.9	457.2	71
	(122.)	(4.15)	(11.3)	(0.85)	(5.75)				
7	-.5574	-.2369	0.3527	-.0788	0.1956	99.8	150.0	422.8	34
	(117.)	(4.28)	(11.2)	(0.80)	(4.55)				
8	-.3635	-.1922	0.1825	0.0692	-.1219	113.6	380.6	758.5	73
	(138.)	(8.60)	(6.50)	(1.26)	(2.13)				
9	-.4251	-.1653	0.3425	0.0851	0.1932	129.1	305.6	663.8	57
	(140.)	(7.56)	(12.4)	(1.57)	(4.41)				
10	-.3929	-.1727	0.2728	0.0669	0.0602	110.5	331.0	688.7	87
	(153.)	(8.89)	(15.3)	(1.75)	(2.15)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-7 VANCOUVER : Direct Translog-Expenditure Share [quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3402	-.1139	0.2057	0.2636	-.0663	80.4	186.3	359.5	75
	(195.)	(8.24)	(7.65)	(5.37)	(1.06)				
2	-.3425	-.2149	0.1100	-.0728	-.3401	81.5	190.6	369.1	121
	(221.)	(12.7)	(4.00)	(1.57)	(5.08)				
3	-.2171	-.0721	0.1988	0.4723	0.0750	99.1	443.4	720.5	109
	(187.)	(4.15)	(12.0)	(7.66)	(1.34)				
4	-.3443	-.0912	0.3300	0.2897	0.1877	102.3	251.7	488.7	35
	(95.7)	(3.47)	(11.0)	(4.15)	(3.55)				
5	-.2695	-.1295	0.1355	0.1449	-.3409	103.0	359.1	625.9	37
	(87.4)	(3.11)	(1.37)	(0.91)	(1.08)				
6	-.4871	-.1467	0.4115	0.1129	0.2797	142.9	279.0	687.3	82
	(174.)	(4.06)	(13.5)	(1.48)	(6.57)				
7	-.4031	-.2168	0.2922	-.0978	0.0068	113.4	313.7	662.9	44
	(95.8)	(3.68)	(3.67)	(0.71)	(0.04)				
8	-.2812	-.1500	0.1442	0.0792	-.2269	126.4	619.2	1091.1	88
	(134.)	(5.96)	(3.04)	(0.89)	(1.71)				
9	-.3379	-.1340	0.2846	0.1500	0.0855	147.3	490.4	937.3	73
	(127.)	(6.98)	(7.14)	(2.75)	(1.39)				
10	-.3472	-.1555	0.2885	0.1708	0.1288	137.3	507.3	983.4	116
	(205.)	(6.60)	(5.66)	(2.25)	(0.92)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-7 VANCOUVER : Direct Translog-Expenditure Share [quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2744	-.1164	0.2307	0.2478	0.1167	98.9	318.9	555.5	67
	(185.)	(11.4)	(11.4)	(6.55)	(1.90)				
2	-.2534	-.1369	0.1076	0.1107	-.4050	85.1	307.1	523.2	133
	(201.)	(12.8)	(4.46)	(2.86)	(5.18)				
3	-.1656	-.0920	0.0761	0.2552	-.4452	102.4	656.7	999.6	110
	(141.)	(6.20)	(2.28)	(3.23)	(2.59)				
4	-.2663	-.1182	0.1407	0.2364	-.2131	109.1	398.2	691.0	44
	(107.)	(4.84)	(3.09)	(2.72)	(1.38)				
5	-.2339	-.0800	0.2340	0.5284	0.4395	121.4	531.2	879.1	36
	(81.5)	(2.24)	(4.27)	(3.55)	(2.06)				
6	-.3169	-.1431	0.2223	-.0168	-.1579	142.1	542.6	1009.5	60
	(85.2)	(5.38)	(4.75)	(0.18)	(1.43)				
7	-.3495	-.1410	0.2842	0.1973	0.0370	129.3	450.7	881.3	32
	(71.0)	(3.18)	(3.35)	(1.37)	(0.19)				
8	-.2398	-.0863	0.1895	0.3776	0.0128	139.9	840.0	1405.9	75
	(115.)	(4.53)	(4.16)	(4.78)	(0.09)				
9	-.3381	-.3006	-.0144	-.3528	-.7105	179.0	608.6	1162.6	57
	(179.)	(15.0)	(0.41)	(5.91)	(8.98)				
10	-.2786	-.1432	0.1537	0.1984	-.1685	139.6	713.6	1255.0	99
	(484.)	(17.9)	(8.63)	(6.69)	(2.89)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-7 VANCOUVER : Direct Translog-Expenditure Share [quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1866	-.0729	0.0887	0.4145	-.3473	120.2	624.3	978.8	39
	(103.)	(5.68)	(5.43)	(7.95)	(5.42)				
2	-.1894	-.1202	0.0874	0.1517	-.3289	99.5	525.4	822.2	74
	(140.)	(12.2)	(8.33)	(3.45)	(6.61)				
3	-.1322	-.0795	0.0394	0.2580	-.5449	125.3	1073.5	1570.8	57
	(96.3)	(9.25)	(3.31)	(4.56)	(6.82)				
4	-.1677	-.1101	0.0577	0.2374	-.4817	115.4	755.1	1154.8	19
	(53.8)	(4.72)	(3.19)	(2.27)	(4.31)				
5	-.1700	-.1164	0.0485	0.1375	-.5397	126.8	835.2	1278.4	21
	(50.9)	(2.66)	(1.09)	(0.54)	(2.03)				
6	-.2714	-.1653	0.1511	0.1097	-.1399	200.3	1040.7	1803.4	30
	(295.)	(30.9)	(24.5)	(5.50)	(7.58)				
7	-.3251	-.1276	0.2229	0.2386	-.0095	184.4	736.9	1385.1	20
	(144.)	(8.33)	(7.33)	(5.32)	(0.10)				
8	-.2059	-.0942	0.1113	0.3190	-.2071	178.8	1337.1	2138.3	45
	(82.1)	(7.50)	(3.90)	(4.93)	(1.71)				
9	-.2817	-.1319	0.1168	0.1447	-.2997	246.6	1062.4	1881.0	30
	(69.0)	(4.07)	(4.36)	(1.34)	(3.85)				
10	-.2595	-.1193	0.1462	0.2509	-.1294	183.7	1040.0	1782.7	55
	(477.)	(28.9)	(25.8)	(16.3)	(7.74)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-7 VANCOUVER : Direct Translog-Expenditure Share
[quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.7342	0.7354	0.7455	-1.0193	-1.4626	-0.6918
Q02	0.5971	0.6111	0.6110	-1.0276	-1.2064	-0.8984
Q03	0.4736	0.5115	0.5212	-1.0214	-1.2127	-0.8618
Q04	0.4179	0.4332	0.4415	-0.9948	-1.2984	-0.6964
TYPE 2						
Q01	0.7780	0.7826	0.7906	-1.0052	-1.9487	-0.6438
Q02	0.5698	0.5191	0.5143	-1.0395	-1.3097	-0.8772
Q03	0.4969	0.4339	0.4359	-1.0489	-1.1675	-0.9081
Q04	0.3917	0.3642	0.3544	-1.0021	-1.2741	-0.5804
TYPE 3						
Q01	0.5344	0.5258	0.5245	-1.0769	-1.8791	-0.8284
Q02	0.4640	0.5448	0.5406	-1.0013	-1.1202	-0.9070
Q03	0.3709	0.3422	0.3407	-1.0164	-1.1491	-0.9119
Q04	0.3270	0.2853	0.2723	-0.9964	-1.2453	-0.6674
TYPE 4						
Q01	0.7557	0.7626	0.7875	-1.0168	-1.4490	-0.7699
Q02	0.5888	0.6095	0.6067	-1.0757	-1.2275	-0.9504
Q03	0.5048	0.4990	0.4985	-1.0129	-1.1496	-0.8815
Q04	0.4015	0.3636	0.3482	-0.9828	-1.2997	-0.4680
TYPE 5						
Q01	0.6693	0.6907	0.7097	-0.9937	-1.4271	-0.8063
Q02	0.4932	0.4527	0.4717	-1.0638	-1.1457	-1.0078
Q03	0.4479	0.6411	0.7043	-0.9455	-1.0665	-0.8455
Q04	0.3936	0.3275	0.3283	-0.9992	-1.2163	-0.7536
TYPE 6						
Q01	0.8036	0.8074	0.8150	-1.0164	-1.5132	-0.7406
Q02	0.7074	0.7100	0.7117	-1.0800	-1.2889	-0.9126
Q03	0.5365	0.4442	0.4574	-1.1784	-1.3690	-1.0180
Q04	0.4873	0.4869	0.4867	-0.9945	-1.3483	-0.5689
TYPE 7						
Q01	0.7400	0.7355	0.7315	-1.0567	-1.8662	-0.7131
Q02	0.5897	0.5559	0.5662	-1.1337	-1.2829	-1.0155
Q03	0.6066	0.6063	0.6060	-1.0644	-1.2403	-0.8929
Q04	0.5629	0.5824	0.6003	-1.0237	-1.3240	-0.7360
TYPE 8						
Q01	0.5983	0.5953	0.5917	-1.0090	-1.5033	-0.8121
Q02	0.4815	0.4649	0.4640	-1.0438	-1.1707	-0.9259
Q03	0.4754	0.5109	0.5261	-1.0081	-1.1291	-0.8880
Q04	0.4116	0.4339	0.4399	-0.9928	-1.2159	-0.7276
TYPE 9						
Q01	0.6415	0.6416	0.6418	-1.0680	-1.5230	-0.8746
Q02	0.5564	0.5512	0.5509	-1.0843	-1.1908	-0.9855
Q03	0.5073	0.4700	0.4675	-1.0542	-1.1805	-0.9425
Q04	0.5309	0.4838	0.4742	-1.0366	-1.2919	-0.7255
TYPE 10						
Q01	0.6083	0.6043	0.6014	-1.0598	-1.5974	-0.8558
Q02	0.5912	0.5983	0.6064	-1.0313	-1.1894	-0.9123
Q03	0.5198	0.5216	0.5218	-1.0018	-1.0993	-0.9033
Q04	0.4794	0.4971	0.5084	-0.9957	-1.2121	-0.7215

Figure A3:23-7 VANCOUVER : Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	617.03	366.50	314.68	207.43	222.21	208.48	127.35
BM1=BM2=0	605.92	353.27	269.01	180.93	189.92	173.98	103.86
statistic	22.20	26.45	91.33	53.01	64.58	68.98	46.98
TYPE 2							
normal	917.51	525.04	615.62	258.65	340.14	390.05	233.93
BM1=BM2=0	884.34	418.23	526.40	179.53	327.34	345.16	204.92
statistic	66.35	213.63	178.43	158.26	25.60	89.78	58.03
TYPE 3							
normal	812.03	494.16	284.38	239.61	343.49	346.76	188.78
BM1=BM2=0	796.30	465.32	448.61	205.80	297.92	328.53	144.89
statistic	31.45	57.68	-328.46	67.63	91.14	36.47	87.78
TYPE 4							
normal	317.36	186.21	181.53	104.79	91.67	125.21	61.05
BM1=BM2=0	303.07	172.28	147.77	91.84	84.13	107.07	52.05
statistic	28.58	27.85	67.54	25.89	15.08	36.28	18.01
TYPE 5							
normal	305.33	179.73	161.40	89.75	100.20	106.38	64.25
BM1=BM2=0	282.50	150.18	142.07	66.71	91.10	94.06	59.49
statistic	45.65	59.10	38.67	46.08	18.20	24.63	9.51
TYPE 6							
normal	472.04	327.43	202.05	145.92	199.46	136.06	123.05
BM1=BM2=0	449.97	274.30	188.18	117.17	165.23	132.05	87.99
statistic	44.14	106.25	27.72	57.49	68.46	8.02	70.12
TYPE 7							
normal	291.92	178.83	132.89	81.93	106.11	77.17	69.43
BM1=BM2=0	286.33	163.95	125.58	67.07	103.57	75.82	58.53
statistic	11.17	29.76	14.62	29.71	5.08	2.69	21.80
TYPE 8							
normal	735.88	418.99	334.74	190.44	233.46	207.31	129.17
BM1=BM2=0	640.06	383.57	288.81	182.96	216.96	189.39	110.58
statistic	191.64	70.84	91.85	14.96	32.99	35.83	37.19
TYPE 9							
normal	509.87	310.76	237.97	145.32	183.19	172.17	81.61
BM1=BM2=0	509.63	301.67	211.63	128.06	179.12	162.26	65.75
statistic	0.47	18.20	52.67	34.52	8.14	19.81	31.72
TYPE10							
normal	974.86	529.27	606.47	218.86	327.86	393.80	235.14
BM1=BM2=0	943.42	528.24	472.46	216.15	324.05	339.15	154.49
statistic	62.87	2.06	268.03	5.41	7.62	109.30	161.30

Figure A3:24-7 VANCOUVER : Log Likelihood Values:
[test of unity income elasticity]

0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10 1 1125	1 -605	0
10 2 2037	1 301	61
10 3 2332	1 226	96
10 4 2924	1 760	184
10 5 3831	1 1324	251
10 6 4671	1 2176	448
10 7 6207	1 4232	867
10 810322	1 9013	2424
10 9 893	2 -169	0
1010 1476	2 396	45
1011 1901	2 657	153
1012 2538	2 1451	295
1013 3252	2 2140	367
1014 3870	2 2877	529
1015 4406	2 3539	684
1016 4895	2 4162	832
1017 5335	2 4547	940
1018 5789	2 5026	1073
1019 6124	2 5590	1229
1020 6725	2 6142	1409
1021 7592	2 7246	1762
1022 8607	2 8507	2214
102312459	215288	5708
1024 2683	3 498	172
1025 4889	3 2994	568
1026 6169	3 4421	870
1027 6954	3 5266	1070
1028 8010	3 6413	1256
1029 9081	3 7920	1742
103010285	3 9422	2080
103111450	310860	2559
103212815	312808	3253
103314715	315625	4496
103420179	325476	9615
1035 2359	4 721	186
1036 4844	4 3058	561
1037 6881	4 4677	976
103810620	410187	3286
1039 4907	5 2142	451
1040 7649	5 5141	1065
104112972	511680	3183
1042 3397	6 -717	0
1043 4519	6 -293	26
1044 5437	6 799	216
1045 6403	6 612	182
1046 6883	6 1410	287
1047 7565	6 2053	397
1048 8335	6 2240	492
104910142	6 4482	959
105012116	6 7400	1860
105113757	6 7794	1938
105221942	619036	6719
1053 3618	7 564	124
1054 5844	7 2511	478
1055 6985	7 4079	858
1056 7871	7 4510	954
1057 8541	7 6443	1528
1058 9533	7 6437	1535
105910754	7 7273	1804
106013527	7 9491	2659
106118965	718523	7408
1062 5834	8 1991	433
1063 8699	8 4726	973
106410234	8 5911	1259
106511070	8 7603	1785
106611925	8 8098	1739
106712847	8 9630	2319
106814007	810674	2479
106914785	811492	2839
107015517	812949	3302
107116766	814094	3601
107218172	814913	3805
107320084	818151	5571
107421776	818521	5336
107528526	83131	911673
1076 6127	9 2181	494
1077 8782	9 4554	970
1078 9999	9 6066	1391
107910954	9 6763	1614
108011925	9 8310	2157
108112807	9 8722	2320
108213820	9 9613	2751
108315775	912621	4074
108422339	92283	10174
1085 5802	10 1605	422
1086 8161	10 3866	777
1087 9018	10 4922	996
1088 9868	10 5207	1163
108910635	10 6123	1386
109011094	10 6546	1462
109111595	10 6189	1414
109211991	10 7011	1629
109312845	10 8568	1978
109413475	10 8787	2159
109514461	1010196	2462
109615517	1011323	2707
109716450	1011777	2911
109817566	1013016	3396
109919416	1016523	4894
11 025366	1024824	9582

Figure A3:25-7 VANCOUVER: Demand Calibration Data

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0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1198.3359.5555.5978.8          |  20 6457.2687.31010.1803.
20 2194.0369.1523.2822.2          |  20 7422.8662.9881.31385.
20 3427.0720.5999.61571.          |  20 8758.51091.1406.2138.
20 4297.2488.7691.01155.          |  20 9663.8937.31163.1881.
20 5417.6625.9879.11278.          |  2010688.7983.41255.1783.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.508-.193.3239.0561.163465.3277.29198.31.533
21 2    0-.574-.232.3552-.021.222970.1165.93194.01.572
21 3    0-.339-.176.2897.0271.134489.41226.6427.01.559
21 4    0-.489-.125.3258.2126.170890.50119.7297.21.609
21 5    0-.379-.134.2729.2738.088895.92203.8417.61.642
21 6    0-.590-.172.3858.0640.2556117.4147.9457.22.279
21 7    0-.557-.237.3527-.079.195699.80150.0422.82.337
21 8    0-.364-.192.1825.0692-.122113.6380.6758.52.421
21 9    0-.425-.165.3425.0851.1932129.1305.6663.82.136
2110    0-.393-.173.2728.0669.0602110.5331.0688.72.439
0000  (quartile 02)
22 1    0-.340-.114.2057.2636-.06680.40186.3359.51.534
22 2    0-.343-.215.1100-.073-.34081.50190.6369.11.561
22 3    0-.217-.072.1988.4723.075099.15443.4720.51.576
22 4    0-.344-.091.3300.2897.1877102.3251.7488.71.640
22 5    0-.269-.130.1355.1449-.341103.0359.1625.91.644
22 6    0-.487-.147.4115.1129.2797142.9279.0687.32.330
22 7    0-.403-.217.2922-.098.0068113.4313.7662.92.337
22 8    0-.281-.150.1442.0792-.227126.4619.21091.2.417
22 9    0-.338-.134.2846.1500.0855147.3490.4937.32.138
2210    0-.347-.155.2885.1708.1288137.3507.3983.42.469
0000  (quartile 03)
23 1    0-.274-.116.2307.2478.116798.89318.9555.51.526
23 2    0-.253-.137.1076.1107-.40585.10307.1523.21.563
23 3    0-.166-.092.0761.2552-.445102.4656.7999.61.616
23 4    0-.266-.118.1407.2364-.213109.1398.2691.01.692
23 5    0-.234-.080.2340.5284.4395121.4531.2879.11.679
23 6    0-.317-.143.2223-.017-.158142.1542.61010.2.261
23 7    0-.349-.141.2842.1973.0370129.3450.7881.32.383
23 8    0-.240-.086.1895.3776.0128139.9840.01406.2.424
23 9    0-.338-.301-.014-.353-.711179.0608.61163.2.187
2310    0-.279-.143.1537.1984-.168139.6713.61255.2.494
0000  (quartile 04)
24 1    0-.187-.073.0887.4145-.347120.2624.3978.81.539
24 2    0-.189-.120.0874.1517-.32999.51525.4822.21.557
24 3    0-.132-.079.0394.2580-.545125.31073.1571.1.643
24 4    0-.168-.110.0577.2374-.482115.4755.11155.1.686
24 5    0-.170-.116.0485.1375-.540126.8835.21278.1.714
24 6    0-.271-.165.1511.1097-.140200.31041.1803.2.388
24 7    0-.325-.128.2229.2386-.009184.4736.91385.2.441
24 8    0-.206-.094.1113.3190-.207178.81337.2138.2.454
24 9    0-.282-.132.1168.1447-.300246.61062.1881.2.178
2410    0-.259-.119.1462.2509-.129183.71040.1783.2.514
```

Figure A3:25-7(cont) VANCOUVER: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1    47     1      1  | 3035   124     4      1  | 3069    90     4      2
30 2    67     1      1  | 3036   130     4      1  | 3070    93     4      2
30 3    77     1      1  | 3037   138     4      1  | 3071    96     4      2
30 4    84     1      1  | 3038   145     4      1  | 3072    98     4      2
30 5    89     1      1  | 3039   167     4      1  | 3073   101     4      2
30 6    93     1      1  | 3040    81     5      1  | 3074   103     4      2
30 7    98     1      1  | 3041   137     5      1  | 3075   105     4      2
30 8   103     1      1  | 3042    83     1      2  | 3076   106     4      2
30 9   110     1      1  | 3043   100     1      2  | 3077   108     4      2
3010   120     1      1  | 3044   108     1      2  | 3078   110     4      2
3011   157     1      1  | 3045   116     1      2  | 3079   111     4      2
3012    43     2      1  | 3046   124     1      2  | 3080   113     4      2
3013    61     2      1  | 3047   134     1      2  | 3081   115     4      2
3014    70     2      1  | 3048   149     1      2  | 3082   117     4      2
3015    79     2      1  | 3049    82     2      2  | 3083   119     4      2
3016    87     2      1  | 3050   100     2      2  | 3084   121     4      2
3017    94     2      1  | 3051   110     2      2  | 3085   122     4      2
3018   101     2      1  | 3052   116     2      2  | 3086   124     4      2
3019   106     2      1  | 3053   121     2      2  | 3087   126     4      2
3020   110     2      1  | 3054   126     2      2  | 3088   129     4      2
3021   115     2      1  | 3055   130     2      2  | 3089   132     4      2
3022   122     2      1  | 3056   135     2      2  | 3090   135     4      2
3023   131     2      1  | 3057   140     2      2  | 3091   140     4      2
3024   155     2      1  | 3058   145     2      2  | 3092   148     4      2
3025   118     3      1  | 3059   152     2      2  | 3093   164     4      2
3026    48     4      1  | 3060   161     2      2  | 3094    90     5      2
3027    71     4      1  | 3061   180     2      2  | 3095   121     5      2
3028    85     4      1  | 3062    93     3      2  | 3096   137     5      2
3029    94     4      1  | 3063   110     3      2  | 3097   150     5      2
3030   101     4      1  | 3064   127     3      2  | 3098   163     5      2
3031   106     4      1  | 3065    55     4      2  | 3099   178     5      2
3032   110     4      1  | 3066    74     4      2  | 31 0   210     5      2
3033   114     4      1  | 3067    81     4      2
3034   118     4      1  | 3068    87     4      2  |

0000 ZONAL Data
40 1 7858    26          | 40 2 5879    29          | 40 311149    42
40 4 7563    96          | 40 5 8300   153          | 40 615277    69
0000  Parameters
5011 .43                 | 50121.16                 | 5013 0.0
5016 .43                 | 50171.80                 | 5018 0.0
50201.270                |

0000 Calibration Data
70 11.9400.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  106321.000103.2
70 22.1840.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   82201.000114.3
70 31.9220.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  188771.000111.8
70 42.2450.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  100591.000111.1
70 52.4130.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   94101.000140.7
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0     0.0
```

Figure A3:25-7(cont) VANCOUVER: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1125	1	-605	0	105113757	6 7794 1938
10	2	2037	1	301	61	105221942	619036 6719
10	3	2332	1	226	96	1053 3618	7 564 124
10	4	2924	1	760	184	1054 5844	7 2511 478
10	5	3831	1	1324	251	1055 6985	7 4079 858
10	6	4671	1	2176	448	1056 7871	7 4510 954
10	7	6207	1	4232	867	1057 8541	7 6443 1528
10	810322		1	9013	2424	1058 9533	7 6437 1535
10	9	893	2	-169	0	105910754	7 7273 1804
1010		1476	2	396	45	106013527	7 9491 2659
1011		1901	2	657	153	106118965	718523 7408
1012		2538	2	1451	295	1062 5834	8 1991 433
1013		3252	2	2140	367	1063 8699	8 4726 973
1014		3870	2	2877	529	106410234	8 5911 1259
1015		4406	2	3539	684	106511070	8 7603 1785
1016		4895	2	4162	832	106611925	8 8098 1739
1017		5335	2	4547	940	106712847	8 9630 2319
1018		5789	2	5026	1073	106814007	810674 2479
1019		6124	2	5590	1229	106914785	811492 2839
1020		6725	2	6142	1409	107015517	812949 3302
1021		7592	2	7246	1762	107116766	814094 3601
1022		8607	2	8507	2214	107218172	814913 3805
102312459			215288		5708	107320084	818151 5571
1024		2683	3	498	172	107421776	818521 5336
1025		4889	3	2994	568	107528526	83131911673
1026		6169	3	4421	870	1076 6127	9 2181 494
1027		6954	3	5266	1070	1077 8782	9 4554 970
1028		8010	3	6413	1256	1078 9999	9 6066 1391
1029		9081	3	7920	1742	107910954	9 6763 1614
103010285			3	9422	2080	108011925	9 8310 2157
103111450			310860		2559	108112807	9 8722 2320
103212815			312808		3253	108213820	9 9613 2751
103314715			315625		4496	108315775	912621 4074
103420179			325476		9615	108422339	92283310174
1035		2359	4	721	186	1085 5802	10 1605 422
1036		4844	4	3058	561	1086 8161	10 3866 777
1037		6881	4	4677	976	1087 9018	10 4922 996
103810620			410187		3286	1088 9868	10 5207 1163
1039		4907	5	2142	451	108910635	10 6123 1386
1040		7649	5	5141	1065	109011094	10 6546 1462
104112972			511680		3183	109111595	10 6189 1414
1042		3397	6	-717	0	109211991	10 7011 1629
1043		4519	6	-293	26	109312845	10 8568 1978
1044		5437	6	799	216	109413475	10 8787 2159
1045		6403	6	612	182	109514461	1010196 2462
1046		6883	6	1410	287	109615517	1011323 2707
1047		7565	6	2053	397	109716450	1011777 2911
1048		8335	6	2240	492	109817566	1013016 3396
104910142			6	4482	959	109919416	1016523 4894
105012116			6	7400	1860	11 025366	1024824 9582

Figure A3:26-7 VANCOUVER: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1198.3359.5555.5978.8          |  20 6457.2687.31010.1803.
20 2194.0369.1523.2822.2          |  20 7422.8662.9881.31385.
20 3427.0720.5999.61571.          |  20 8758.51091.1406.2138.
20 4297.2488.7691.01155.          |  20 9663.8937.31163.1881.
20 5417.6625.9879.11278.          |  2010688.7983.41255.1783.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.508-.193.3239.0561.163465.3277.29198.31.533
21 2    0-.574-.232.3552-.021.222970.1165.93194.01.572
21 3    0-.339-.176.2897.0271.134489.41226.6427.01.559
21 4    0-.489-.125.3258.2126.170890.50119.7297.21.609
21 5    0-.379-.134.2729.2738.088895.92203.8417.61.642
21 6    0-.590-.172.3858.0640.2556117.4147.9457.22.279
21 7    0-.557-.237.3527-.079.195699.80150.0422.82.337
21 8    0-.364-.192.1825.0692-.122113.6380.6758.52.421
21 9    0-.425-.165.3425.0851.1932129.1305.6663.82.136
2110    0-.393-.173.2728.0669.0602110.5331.0688.72.439
0000  (quartile 02)
22 1    0-.340-.114.2057.2636-.06680.40186.3359.51.534
22 2    0-.343-.215.1100-.073-.34081.50190.6369.11.561
22 3    0-.217-.072.1988.4723.075099.15443.4720.51.576
22 4    0-.344-.091.3300.2897.1877102.3251.7488.71.640
22 5    0-.269-.130.1355.1449-.341103.0359.1625.91.644
22 6    0-.487-.147.4115.1129.2797142.9279.0687.32.330
22 7    0-.403-.217.2922-.098.0068113.4313.7662.92.337
22 8    0-.281-.150.1442.0792-.227126.4619.21091.2.417
22 9    0-.338-.134.2846.1500.0855147.3490.4937.32.138
2210    0-.347-.155.2885.1708.1288137.3507.3983.42.469
0000  (quartile 03)
23 1    0-.274-.116.2307.2478.116798.89318.9555.51.526
23 2    0-.253-.137.1076.1107-.40585.10307.1523.21.563
23 3    0-.166-.092.0761.2552-.445102.4656.7999.61.616
23 4    0-.266-.118.1407.2364-.213109.1398.2691.01.692
23 5    0-.234-.080.2340.5284.4395121.4531.2879.11.679
23 6    0-.317-.143.2223-.017-.158142.1542.61010.2.261
23 7    0-.349-.141.2842.1973.0370129.3450.7881.32.383
23 8    0-.240-.086.1895.3776.0128139.9840.01406.2.424
23 9    0-.338-.301-.014-.353-.711179.0608.61163.2.187
2310    0-.279-.143.1537.1984-.168139.6713.61255.2.494
0000  (quartile 04)
24 1    0-.187-.073.0887.4145-.347120.2624.3978.81.539
24 2    0-.189-.120.0874.1517-.32999.51525.4822.21.557
24 3    0-.132-.079.0394.2580-.545125.31073.1571.1.643
24 4    0-.168-.110.0577.2374-.482115.4755.11155.1.686
24 5    0-.170-.116.0485.1375-.540126.8835.21278.1.714
24 6    0-.271-.165.1511.1097-.140200.31041.1803.2.388
24 7    0-.325-.128.2229.2386-.009184.4736.91385.2.441
24 8    0-.206-.094.1113.3190-.207178.81337.2138.2.454
24 9    0-.282-.132.1168.1447-.300246.61062.1881.2.178
2410    0-.259-.119.1462.2509-.129183.71040.1783.2.514
```

Figure A3:26-7(cont) VANCOUVER: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1   46    1    1 | 3024   95    1    2 | 3047   95    4    2
30 2   68    1    1 | 3025  100    1    2 | 3048   99    4    2
30 3   80    1    1 | 3026  105    1    2 | 3049  104    4    2
30 4   93    1    1 | 3027  110    1    2 | 3050  108    4    2
30 5  129    1    1 | 3028  185    1    2 | 3051  112    4    2
30 6   28    2    1 | 3029   66    2    2 | 3052  116    4    2
30 7   52    2    1 | 3030   86    2    2 | 3053  118    4    2
30 8   65    2    1 | 3031   89    2    2 | 3054  120    4    2
30 9   75    2    1 | 3032   93    2    2 | 3055  122    4    2
3010   83    2    1 | 3033   96    2    2 | 3056  124    4    2
3011   91    2    1 | 3034  100    2    2 | 3057  126    4    2
3012  100    2    1 | 3035  103    2    2 | 3058  129    4    2
3013  110    2    1 | 3036  107    2    2 | 3059  131    4    2
3014  139    2    1 | 3037  110    2    2 | 3060  133    4    2
3015   49    4    1 | 3038  114    2    2 | 3061  136    4    2
3016   78    4    1 | 3039  117    2    2 | 3062  140    4    2
3017   93    4    1 | 3040  121    2    2 | 3063  144    4    2
3018  105    4    1 | 3041  124    2    2 | 3064  182    4    2
3019  119    4    1 | 3042  142    2    2 | 3065   73    5    2
3020  157    4    1 | 3043  121    3    2 | 3066  104    5    2
3021  126    5    1 | 3044  190    3    2 | 3067  117    5    2
3022   76    1    2 | 3045   63    4    2 | 3068  130    5    2
3023   89    1    2 | 3046   91    4    2 | 3069  160    5    2

0000 ZONAL Data
40 1 7858   26       | 40 2 5879   29       | 40 311149   42
40 4 7563   96       | 40 5 8300  153       | 40 615277   69
0000  Parameters
50 1 .4              | 50 2 .1              |
5011 .43             | 50121.16             | 5013 45.
5016 .43             | 50171.80             | 5018 71.
50201.270            |

0000 Calibration Data
70 11.5890.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   88371.000100.5
70 21.6190.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   80361.000 99.8
70 31.4050.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  205191.000114.7
70 41.5790.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   96301.000110.9
70 51.6700.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   90701.000107.3
70 61.5770.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   88821.000122.9
70 72.0440.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  135820.894109.0
70 82.3370.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   85770.872106.4
70 91.9090.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  191130.992123.5
70102.3330.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  102341.000115.0
70112.3680.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   91500.912113.2
70122.0920.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  108751.000138.0
```

Figure A3:26-7(cont) VANCOUVER: Supply Calibration Data

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
10 1 1125     1 -604     0          151.421 34.6
10 2 2037     1  301    61           21.543 55.7
10 3 2332     1  226    96          161.542 63.8
10 4 2924     1  760   184          101.574 70.4
10 5 3831     1 1324   251           41.559 77.5
10 6 4671     1 2176   448         9991.749 67.5
10 7 6207     1 4232   867         9991.749 77.3
10 810322     1 9013 2424         9991.749 93.7
10 9  893     2 -168     0           11.406 31.7
1010 1476     2  396    45           71.588 44.3
1011 1901     2  657   153           91.531 60.0
1012 2538     2 1451   295          111.558 75.0
1013 3252     2 2140   367          171.593 79.7
1014 3870     2 2877   529          121.565 83.3
1015 4406     2 3539   684         9991.749 68.0
1016 4895     2 4162   832         9991.749 69.8
1017 5335     2 4547   940         9991.749 70.8
1018 5789     2 5026  1073         9991.749 71.0
1019 6124     2 5590  1229         9991.749 70.5
1020 6725     2 6142  1409         9991.749 72.6
1021 7592     2 7246  1762         9991.749 76.4
1022 8607     2 8507  2214         9991.749 79.4
102312459    215288  5708         9991.749101.9
1024 2683     3  498   172           81.511 51.0
1025 4889     3 2994   568          181.568 87.8
1026 6169     3 4421   870         9991.749 83.0
1027 6954     3 5266  1070         9991.749 84.8
1028 8010     3 6413  1256         9991.749 84.0
1029 9081     3 7920  1742         9991.749 83.6
103010285     3 9422  2080         9991.749 87.1
103111450    310860  2559         9991.749 88.7
103212815    312808  3253         9991.749 92.6
103314715    315625  4496         9991.749100.5
103420179    325476  9615         9991.749120.1
1035 2359     4  721   186           31.537 63.9
1036 4844     4 3058   561          191.614102.5
1037 6881     4 4677   976           51.624111.3
103810620    410187  3286          141.653122.4
1039 4907     5 2142   451          131.628 95.7
1040 7649     5 5141  1065          211.608107.5
104112972    511680  3183          201.641136.5
1042 3397     6 -716     0          652.069 83.5
1043 4519     6 -292    26          462.126107.0
1044 5437     6  799   216          242.257118.8
1045 6403     6  612   182         9992.453117.9
1046 6883     6 1410   287         9992.453122.7
1047 7565     6 2053   397          372.312139.8
1048 8335     6 2240   492          672.294147.2
104910142     6 4482   959          392.297148.5
105012116     6 7400  1860         9992.453125.9
```

Figure A3:27-7 VANCOUVER: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
105113757    6 7794 1938        9992.453139.5
105221942    619036 6719        9992.453198.1
1053 3618    7  564  124         222.055 85.3
1054 5844    7 2511  478         322.239113.9
1055 6985    7 4079  858         332.260118.7
1056 7871    7 4510  954         472.279118.5
1057 8541    7 6443 1528         482.283123.4
1058 9533    7 6437 1535         662.298130.0
105910754    7 7273 1804         502.327136.1
106013527    7 9491 2659         602.328166.8
106118965    718523 7408         642.330226.9
1062 5834    8 1991  433         302.051 94.8
1063 8699    8 4726  973         252.261121.5
106410234    8 5911 1259         262.302129.9
106511070    8 7603 1785         492.333130.5
106611925    8 8098 1739         362.324133.7
106712847    8 9630 2319         272.307136.5
106814007    810674 2479         382.306141.3
106914785    811492 2839         522.312144.1
107015517    812949 3302         402.292149.0
107116766    814094 3601         552.308151.2
107218172    814913 3805         572.329157.4
107320084    818151 5571         612.325169.4
107421776    818521 5336         622.347175.9
107528526    83131911673         282.287225.8
1076 6127    9 2181  494         312.080105.6
1077 8782    9 4554  970        9992.453112.2
1078 9999    9 6066 1391        9992.453117.1
107910954    9 6763 1614        9992.453119.1
108011925    9 8310 2157        9992.453127.1
108112807    9 8722 2320        9992.453137.1
108213820    9 9613 2751        9992.453148.7
108315775    912621 4074        9992.453163.6
108422339    92283310174        9992.453199.5
1085 5802   10 1605  422         232.076 99.0
1086 8161   10 3866  777         342.274121.7
1087 9018   10 4922  996         352.319127.7
1088 9868   10 5207 1163         512.302137.6
108910635   10 6123 1386         532.301144.8
109011094   10 6546 1462         542.312147.8
109111595   10 6189 1414         412.308152.3
109211991   10 7011 1629         562.323153.2
109312845   10 8568 1978         682.298158.7
109413475   10 8787 2159         582.314158.4
109514461   1010196 2462         432.378152.4
109615517   1011323 2707         592.330161.5
109716450   1011777 2911         422.303172.9
109817566   1013016 3396         632.338177.9
109919416   1016523 4894         692.317195.6
11 025366   1024824 9582         442.383238.5
```

Figure A3:27-7 VANCOUVER: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1198.3359.5555.5978.8          |  20 6457.2687.31010.1803.
20 2194.0369.1523.2822.2          |  20 7422.8662.9881.31385.
20 3427.0720.5999.61571.          |  20 8758.51091.1406.2138.
20 4297.2488.7691.01155.          |  20 9663.8937.31163.1881.
20 5417.6625.9879.11278.          |  2010688.7983.41255.1783.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.508-.193.3239.0561.163465.3277.29198.31.533
21 2    0-.574-.232.3552-.021.222970.1165.93194.01.572
21 3    0-.339-.176.2897.0271.134489.41226.6427.01.559
21 4    0-.489-.125.3258.2126.170890.50119.7297.21.609
21 5    0-.379-.134.2729.2738.088895.92203.8417.61.642
21 6    0-.590-.172.3858.0640.2556117.4147.9457.22.279
21 7    0-.557-.237.3527-.079.195699.80150.0422.82.337
21 8    0-.364-.192.1825.0692-.122113.6380.6758.52.421
21 9    0-.425-.165.3425.0851.1932129.1305.6663.82.136
2110    0-.393-.173.2728.0669.0602110.5331.0688.72.439
0000  (quartile 02)
22 1    0-.340-.114.2057.2636-.06680.40186.3359.51.534
22 2    0-.343-.215.1100-.073-.34081.50190.6369.11.561
22 3    0-.217-.072.1988.4723.075099.15443.4720.51.576
22 4    0-.344-.091.3300.2897.1877102.3251.7488.71.640
22 5    0-.269-.130.1355.1449-.341103.0359.1625.91.644
22 6    0-.487-.147.4115.1129.2797142.9279.0687.32.330
22 7    0-.403-.217.2922-.098.0068113.4313.7662.92.337
22 8    0-.281-.150.1442.0792-.227126.4619.21091.2.417
22 9    0-.338-.134.2846.1500.0855147.3490.4937.32.138
2210    0-.347-.155.2885.1708.1288137.3507.3983.42.469
0000  (quartile 03)
23 1    0-.274-.116.2307.2478.116798.89318.9555.51.526
23 2    0-.253-.137.1076.1107-.40585.10307.1523.21.563
23 3    0-.166-.092.0761.2552-.445102.4656.7999.61.616
23 4    0-.266-.118.1407.2364-.213109.1398.2691.01.692
23 5    0-.234-.080.2340.5284.4395121.4531.2879.11.679
23 6    0-.317-.143.2223-.017-.158142.1542.61010.2.261
23 7    0-.349-.141.2842.1973.0370129.3450.7881.32.383
23 8    0-.240-.086.1895.3776.0128139.9840.01406.2.424
23 9    0-.338-.301-.014-.353-.711179.0608.61163.2.187
2310    0-.279-.143.1537.1984-.168139.6713.61255.2.494
0000  (quartile 04)
24 1    0-.187-.073.0887.4145-.347120.2624.3978.81.539
24 2    0-.189-.120.0874.1517-.32999.51525.4822.21.557
24 3    0-.132-.079.0394.2580-.545125.31073.1571.1.643
24 4    0-.168-.110.0577.2374-.482115.4755.11155.1.686
24 5    0-.170-.116.0485.1375-.540126.8835.21278.1.714
24 6    0-.271-.165.1511.1097-.140200.31041.1803.2.388
24 7    0-.325-.128.2229.2386-.009184.4736.91385.2.441
24 8    0-.206-.094.1113.3190-.207178.81337.2138.2.454
24 9    0-.282-.132.1168.1447-.300246.61062.1881.2.178
2410    0-.259-.119.1462.2509-.129183.71040.1783.2.514
```

Figure A3:27-7(cont) VANCOUVER: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   46    1    1 | 3024   95    1    2 | 3047   95    4    2
30 2   68    1    1 | 3025  100    1    2 | 3048   99    4    2
30 3   80    1    1 | 3026  105    1    2 | 3049  104    4    2
30 4   93    1    1 | 3027  110    1    2 | 3050  108    4    2
30 5  129    1    1 | 3028  185    1    2 | 3051  112    4    2
30 6   28    2    1 | 3029   66    2    2 | 3052  116    4    2
30 7   52    2    1 | 3030   86    2    2 | 3053  118    4    2
30 8   65    2    1 | 3031   89    2    2 | 3054  120    4    2
30 9   75    2    1 | 3032   93    2    2 | 3055  122    4    2
3010   83    2    1 | 3033   96    2    2 | 3056  124    4    2
3011   91    2    1 | 3034  100    2    2 | 3057  126    4    2
3012  100    2    1 | 3035  103    2    2 | 3058  129    4    2
3013  110    2    1 | 3036  107    2    2 | 3059  131    4    2
3014  139    2    1 | 3037  110    2    2 | 3060  133    4    2
3015   49    4    1 | 3038  114    2    2 | 3061  136    4    2
3016   78    4    1 | 3039  117    2    2 | 3062  140    4    2
3017   93    4    1 | 3040  121    2    2 | 3063  144    4    2
3018  105    4    1 | 3041  124    2    2 | 3064  182    4    2
3019  119    4    1 | 3042  142    2    2 | 3065   73    5    2
3020  157    4    1 | 3043  121    3    2 | 3066  104    5    2
3021  126    5    1 | 3044  190    3    2 | 3067  117    5    2
3022   76    1    2 | 3045   63    4    2 | 3068  130    5    2
3023   89    1    2 | 3046   91    4    2 | 3069  160    5    2

0000 ZONAL Data
40 1 7858   26      | 40 2 5879   29      | 40 311149   42
40 4 7563   96      | 40 5 8300  153      | 40 615277   69

0000  Parameters
50 10.400           | 50 20.100           |
50 30.500           | 50 40.350           | 50 71.193
50 50.600           | 50 60.325           | 50 81.115
50110.430           | 50121.160           | 5013 65.0
50160.430           | 50171.800           | 5018 80.0
50201.270           |
```

Figure A3:27-7(cont) VANCOUVER: MODIFIED Policy Dataset

Number of Zones: 05

Distribution of Census Tracts to Zones:

Zone	1961	1971
1	39	41
2	25	30
3	12	12
4	21	20
5	1	1
A	-	2
Total	98	106

note: "A" indicates annexed tracts.
: annexed census tracts included in Zone 5

Selected Calculated Statistics:

	monthly rent		value		income		access
	1961	1971	1961	1971	1961	1971	
1	80.	99.	12,361.	14,585.	3,526.	7,793.	38.
2	89.	135.	16,449.	22,088.	4,610.	11,353.	60.
3	60.	77.	10,332.	13,320.	2,545.	6,594.	21.
4	62.	127.	12,614.	21,701.	3,678.	10,572.	104.
5	57.	85.	34,206.	53,510.	4,532.	30,529.	87.
A		145.		25,314.		11,636.	115.
total	79.	113.	18,221.	21,304.	3,814.	9,382.	54.

Total Dwellings in Zones:

	1961	1971				
	dwellings	dwellings	%CMA stock	NEW	%new	%CMA new
1	62,815.	72,740.	43.7	10,084.	13.9	24.1
2	40,807.	52,985.	31.8	14,980.	28.3	35.8
3	15,125.	14,325.	8.6	1,235.	8.6	2.9
4	9,212.	22,235.	13.4	12,579.	56.6	30.0
5	442.	805.	0.5	370.	45.9	0.9
A		3,380.	2.1	2,638.	78.0	6.3
tot	128,401.	166,470.	100.0	41,885.	25.2	100.0

source: program "CZONE.FORT": files WIN61.INPUT and WIN71.INPUT.

Figure A3:01-8 WINNIPEG: Zonal Characteristics (5 zones)

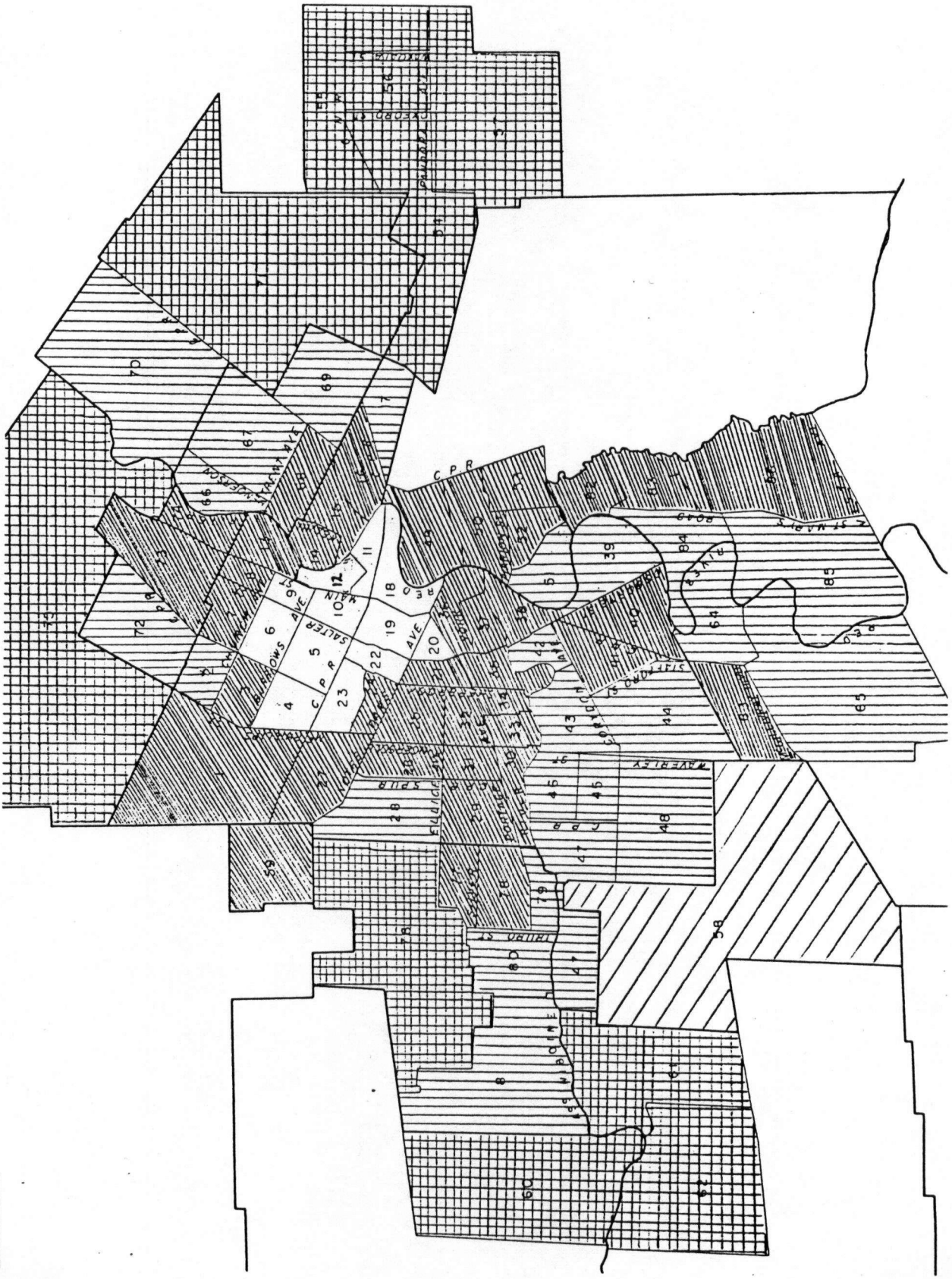

Figure A3:02-8 WINNIPEG: Clustering (5 zones)

Demographical Characteristics:

Population [1] 1961: 475,989.
[2] 1971: 540,265.

Households [1] 1961: 128,532.
[2] 1971: 166,670.

Sources:[1] Statistics Canada. CT 95-535 CT-20
:[2] Statistics Canada. CT 95-728 series A

Mean Household Incomes:

1971 Census [3] : 9,380.
1974 SHU data [4] : 9,858.

deflator : 0.9517

SHU deflated : 9,476.

Sources: [3] Statistics Canada. CT 95-731 series B,variable 49
: [4] file WIN.SHU

SHU dataset:

Sample size : 2812.
Sum of the WEIGHTs : 169,982.

RATIO of SHU weights
to actual households : 1.01987

"Model" Households:

household type	mean income	# SHU h'holds	# "model" h'holds	SHU h'holds/ model	actual h'holds /"model"
1	8,777.	15,446.	9.	1,716.	1,683.
2	11,662.	53,765.	32.	1,680.	1,647.
3	11,280.	12,329.	7.	1,761.	1,727.
4	11,494.	26,592.	16.	1,685.	1,652.
5	6,666.	15,783.	9.	1,754.	1,720.
6	6,837.	13,971.	8.	1,746.	1,712.
7	7,181.	18,791.	11.	1,708.	1,675.
8	4,167.	12,945.	8.	1,618.	1,586.

source: program "HH1.FORT" :file WIN.SHU

Figure A3:03-8 WINNIPEG: HOUSEHOLD Characteristics.

Total 1961 dwellings : 128,401.

Rental	:	42,684.
Owner-occupier	:	85,719.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	78.	23,532.	11,726.	39,283.	0.0792
2	89.	8,501.	16,287.	32,306.	0.0660
3	59.	9,060.	10,025.	6,065.	0.0708
4	58.	1,548.	12,623.	7,664.	0.0552
5	57.	43.	34,206.	399.	0.0204
total	75.	42,684.	13,509.	85,719.	0.0672

source: program "D61.FORT" : dataset WIN61.INPUT.

1961 "Model" Dwellings:

derivation: 1961 Dwellings : TOTAL 128,401.
: RATIO of EXISTING unannexed/TOTAL 96.4%
: TOTAL 1961 Dwellings EXISTING in 1971 124,585.
: TOTAL 1961 Dwellings ADJUSTED for ANNEXED 129,171.
: 1971 "model" Dwellings 100.
: 1971 RATIO ACTUAL/"model" 1665.
: 1961 "model" Dwellings 78.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	62,815.	38.	1653.	1.0425	0.9834
2	40,807.	24.	1700.	0.9562	0.9020
3	15,125.	9.	1681.	1.1752	1.1086
4	9,212.	6.	1535.	1.1104	1.0475
5	442.	1.	442.	0.7855	0.7410

error of fit 0.02919

source: program "D61.FORT" : dataset WIN61.INPUT.

Figure A3:04-8 WINNIPEG: 1961 Dwelling Characteristics.

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	4.9785	4.9536	2.4903	3.2668
	(15.1)	(19.0)	(6.20)	(10.6)
MULTIPLE	0.5586	0.4923	0.1171	0.1150
	(15.1)	(15.0)	(0.26)	(3.66)
CONSTRUCTED PRE 20	-.3149	-.3767	-.2124	-.3063
	(7.70)	(11.5)	(4.28)	(8.37)
20-45	-.1684	-.2146	-.1837	-.1880
	(4.73)	(8.16)	(4.10)	(4.77)
CONDITION	0.2255	0.1851	0.0723	0.0509
	(5.91)	(5.88)	(1.58)	(1.57)
LN ROOMS	0.8993	1.1440	0.4674	0.4964
	(17.1)	(25.6)	(7.30)	(11.6)
LN INCOME	0.3484	0.3100	0.4655	0.3635
	(8.53)	(9.41)	(9.37)	(9.68)
ACCESS	-.0001	0.0002	-.0026	-.0020
	(0.20)	(0.97)	(6.27)	(5.46)
R2	0.54	0.99	0.38	0.99
OBSERVATIONS	834	834	775	775

note : "t" statistis in brackets
: data source: WIN61.EA

MEANS:

LN INCOME	8.2010
MULTIPLE	0.2608
ACCESS	46.4

Figure A3:05-8 WINNIPEG: 1961 Hedonic Estimates

Total 1971 dwellings : 166,475.

Rental : 68,100.
Owner-occupier : 98,375.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	97.	35,620.	14,623.	37,151.	0.0804
2	137.	18,405.	21,967.	34,605.	0.0744
3	77.	9,135.	12,698.	5,185.	0.0720
4	126.	4,000.	21,876.	18,225.	0.0696
5	141.	940.	31,823.	3,245.	0.0528
total	108.	68,100.	19,016.	98,375.	0.0684

source: program "D71.FORT" : dataset WIN71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	72,735.	43.	1692.	1.0609	1.0406
2	53,010.	32.	1657.	0.8945	0.8773
3	14,320.	9.	1591.	1.2158	1.1925
4	22,225.	13.	1710.	0.9982	0.9791
5	4,185.	3.	1395.	0.8015	0.7861
			1664.		

error of fit 0.02088

source: program "D71.FORT" : dataset WIN71.INPUT.

Figure A3:06-8 WINNIPEG: 1971 Dwelling Characteristics. ["GAMMA" Calibration Set]

Total 1971 dwellings : 166,475.

Built prior 1961 : 124,618.
Built 1961-1971 : 41,857.

Selected Calculated Statistics:

zone	rent	#rental units	value	#o-o units	annual rent/value
1	89.	27,109.	14,880.	35,571.	0.0720
2	117.	9,106.	20,880.	28,926.	0.0672
3	76.	8,009.	13,621.	5,074.	0.0672
4	87.	1,667.	17,847.	7,975.	0.0588
5	91.	240.	30,973.	941.	0.0360
99	141.	21,969.	25,056.	19,888.	0.0648
CMA	108.	68,100.	19,191.	98,375.	0.0672

source: program "D71.FORT" : dataset WIN71.INPUT.

1971 "Model" Dwellings:

total number of "model" dwellings: 100.

distribution:

zone	# dwellings	# "model" dwelling	actual/ "model"	"RHS"/actual SERVICES calculated	weighted
1	62,679.	37.	1,694.	1.0834	1.0632
2	38,032.	23.	1,654.	0.9502	0.9325
3	13,084.	8.	1,636.	1.1872	1.1650
4	9,642.	6.	1,607.	1.1938	1.1715
5	1,181.	1.	1,181.	0.9298	0.9118
99	41,857.	25.	1,674.	0.8418	0.8261
			1,664.		

error of fit 0.01599

source: program "D71.FORT" : dataset WIN71.INPUT.

Figure A3:07-8 WINNIPEG: 1971 Dwelling Characteristics. ["BETA" Calibration Set]

	OWNER/OCCUPIER MODEL		RENTAL MODEL	
	O.L.S.	W.L.S.	O.L.S.	W.L.S.
CONSTANT	7.8647	7.8134	5.4747	5.4589
	(48.9)	(51.3)	(44.0)	(50.5)
MULTIPLE	0.1522	0.2116	0.0778	0.0670
	(4.22)	(5.67)	(3.27)	(2.85)
CONSTRUCTION 51-60	-.0637	-.1398	-.2027	-.1905
	(1.94)	(4.58)	(8.09)	(6.82)
46-50	-.2482	-.3073	-.3259	-.2785
	(6.97)	(9.13)	(8.86)	(7.11)
20-45	-.3645	-.4725	-.3732	-.3366
	(11.4)	(15.3)	(14.3)	(12.4)
PRE 20	-.5497	-.6261	-.4521	-.3980
	(15.8)	(18.9)	(16.9)	(14.4)
FACILITIES	0.1281	0.1343	0.2925	0.2822
	(1.48)	(1.63)	(7.21)	(7.59)
LN INCOME	0.0886	0.0994	0.1465	0.1437
	(6.18)	(6.95)	(10.6)	(11.8)
LN ROOMS	0.6674	0.6728	0.2026	0.2247
	(16.3)	(16.4)	(8.67)	(10.0)
R2	0.42	0.99	0.49	0.98
OBSERVATIONS	1099	1099	1119	1119
WEIGHTED 20-45/PRE 20	-.4377	-.5332	-.4119	-.3668

note : "t" statistis in brackets
: data source: WIN.SHU
: weighted coefficient for 20-45 and pre 20 used as actual census data combines these variables

MEANS:

LN INCOME	8.95347
MULTIPLE	0.4521
ACCESS	54.0

Figure A3:08-8 WINNIPEG: 1971 Hedonic Estimates

adjustment values:

	1971 Census	1974 SHU	deflator
PRICE	18,221.	32,050.	0.56852
RENT	113.	138.	0.81884
INCOME	9,382.	9,858.	0.9517

R/V ratio: 0.0684 P(j)/PN ratio: 0.91624

regression coefficients and ALPHAs:

	O.L.S. MODEL		W.L.S. MODEL		
	coefficients	ALPHAs [1]	coefficients	ALPHAs [1]	ALPHAs [2]
CONSTANT (TYPE 1)	2.6807 (94.7)	0.1460	2.7282 (86.0)	0.1531	0.1613
DUMMY (TYPE 2)	-.1529 (4.36)	0.1253	-.2231 (5.98)	0.1224	0.1292
DUMMY (TYPE 3)	-.1721 (4.02)	0.1229	-.2339 (4.80)	0.1211	0.1278
DUMMY (TYPE 4)	-.2710 (6.51)	0.1113	-.3552 (8.27)	0.1073	0.1133
DUMMY (TYPE 5)	0.2963 (6.88)	0.1963	0.1564 (3.26)	0.1790	0.1882
DUMMY (TYPE 6)	0.3632 (8.65)	0.2099	0.3226 (6.83)	0.2113	0.2218
DUMMY (TYPE 7)	0.1514 (3.54)	0.1698	0.1008 (2.23)	0.1693	0.1781
DUMMY (TYPE 8)	0.7732 (16.6)	0.3162	0.5907 (11.6)	0.2763	0.2889
R2	0.24		0.75		
OBSERVATIONS	2566		2566		

note:[1] ALPHA values are calculated as;
ALPHA(1) = EXP(INTERCEPT)
ALPHA(2)-(8) = EXP(INTERCEPT+COEFFICIENT)
[2] ALPHA values adjusted as described in Section A1.32
[3] "t" values in brackets

Figure A3:09-8 WINNIPEG: Household ALPHAs

regression coefficients and ALPHAs

$$\log\left(\frac{R}{Y(i)}\right) = \log(a) + \log(Y(i))$$

	O.L.S. MODEL	W.L.S. MODEL			
			ALPHAs [1]		
	coefficient	coefficient	at mean [2]	lowest	highest
CONSTANT (TYPE 1)	9.8140 (60.7)	9.9232 (62.9)	0.1421	0.1009	0.3292
DUMMY (TYPE 2)	0.0009 (0.03)	-.0129 (0.46)	0.1117	0.0683	1.1035*
DUMMY (TYPE 3)	0.0245 (0.76)	-.0082 (0.22)	0.1153	0.0896	0.1821
DUMMY (TYPE 4)	-.0691 (2.19)	-.1121 (3.48)	0.1024	0.0648	0.2215
DUMMY (TYPE 5)	0.0201 (0.61)	-.1119 (3.11)	0.1583	0.0933	0.3126
DUMMY (TYPE 6)	0.1039 (3.24)	0.0576 (1.63)	0.1639	0.1073	0.3844
DUMMY (TYPE 7)	-.0443 (1.37)	-.1026 (3.04)	0.1506	0.0939	0.3734
DUMMY (TYPE 8)	0.0785 (2.05)	-.1067 (2.63)	0.2320	0.1328	0.4293
LN INCOME	-.7905 (44.5)	-.8006 (46.1)			
R2	0.57	0.86			
OBSERVATIONS	2566	2566			

note: [1] ALPHA values are calculated by the solution algorithm program by substituting the household's "model" incomes, as described in Section A1.32. These are unadjusted values.

[2] calculated by substituting TYPEs mean income.

[3] "t" values in brackets.

Figure A3:09-8(b) WINNIPEG: Household ALPHAs [modified]

Operating and Capital Costs:

Year	Annual Operating Costs	Annual Capital Costs	Dwelling Starts	Weight	Weighted Operating Costs	Weighted Capital Costs
1961	680.0	1047.	4,187	-	-	-
1962	691.0	1049.	2,857	0.057	39.4	59.8
1963	699.0	1103.	4,519	0.091	63.6	100.4
1964	713.0	1091.	4,189	0.084	59.9	91.6
1965	730.0	1097.	3,898	0.078	57.0	85.6
1966	753.0	1187.	2,922	0.059	44.4	70.0
1967	787.0	1428.	3,216	0.065	51.2	92.8
1968	833.0	1641.	4,739	0.095	79.2	155.9
1969	880.0	1957.	9,030	0.181	159.3	354.2
1970	940.0	2146.	6,661	0.134	126.1	287.6
1971	994.0	1916.	7,726	0.155	154.1	297.0

"Model" Costs:

	Annual Operating Costs	Annual Capital Costs	Total Annual Cost	PO	PC	PN	QM
1961	680.0	1047.0	1727.0	0.394	0.606	1.000	--
decade weighted	834.0	1595.0	2429.0	0.484	0.926	1.410	54.6
1971	994.2	1916.0	2910.2	0.576	1.109	1.685	45.7

Figure A3:10-8 WINNIPEG: Prices, Costs and Quantities [New Construction]

```
0000 GAMMA CALIBRATION

0000 INCOME by TYPE
20 1 8776
20 211662
20 311279
20 411494
20 5 6666
20 6 6836
20 7 7181
20 8 4167

0000 ALPHA by TYPE
21 1.1531
21 2.1224
21 3.1211
21 4.1073
21 5.1790
21 6.2113
21 7.1693
21 8.2763

0000 "MODEL" HOUSEHOLDS
10 1 1526     1
10 2 4070     1
10 3 5987     1
10 4 7252     1
10 5 8583     1
10 6 9721     1
10 711221     1
10 813032     1
10 917884     1
1010   99     2
1011  841     2
1012 2835     2
1013 4149     2
1014 4931     2
1015 5981     2
1016 6691     2
1017 7497     2
1018 7973     2
1019 8421     2
1020 8813     2
1021 9366     2
1022 9733     2
102310025     2
102410476     2
102510873     2
102611440     2
102711793     2
102812129     2
102912437     2
103012799     2
103113455     2
103213856     2
103314426     2
103415048     2
103515609     2
103616621     2
103717486     2
103818728     2
103921262     2
104025012     2
104132518     2
1042 4355     3
1043 7724     3
1044 9406     3
104510884     3
104612518     3
104715150     3
104819083     3
1049 2304     4
1050 4409     4
1051 5854     4
1052 7152     4
1053 8133     4
1054 8648     4
1055 9421     4
105610016     4
105710920     4
105811668     4
105912454     4
106013470     4
106115176     4
106216947     4
106318995     4
106429789     4
1065 1617     5
1066 2784     5
1067 3590     5
1068 4038     5
1069 4729     5
1070 6220     5
1071 7756     5
1072 9937     5
107320044     5
1074 1159     6
1075 2178     6
1076 3624     6
1077 5027     6
1078 7029     6
1079 8503     6
108010715     6
108116512     6
1082 1085     7
1083 1993     7
1084 3332     7
1085 4629     7
1086 5545     7
1087 6242     7
1088 7263     7
1089 8404     7
109010060     7
109112075     7
109219192     7
1093 1157     8
1094 1844     8
1095 1978     8
1096 2215     8
1097 2616     8
1098 3933     8
1099 6173     8
11 013309     8
```

Figure A3:11-8 WINNIPEG: "GAMMA" Calibration Data

```
0000 GAMMA CALIBRATION

0000 "MODEL" Dwellings
30 1   20   17    1 | 3035  117   98    1 | 3069  115   96    2
30 2   36   30    1 | 3036  120  100    1 | 3070  119   99    2
30 3   42   35    1 | 3037  124  104    1 | 3071  123  103    2
30 4   46   39    1 | 3038  128  107    1 | 3072  129  108    2
30 5   50   41    1 | 3039  132  111    1 | 3073  137  114    2
30 6   53   44    1 | 3040  137  115    1 | 3074  148  124    2
30 7   56   47    1 | 3041  144  121    1 | 3075  201  168    2
30 8   59   49    1 | 3042  153  128    1 | 3076   27   23    3
30 9   61   51    1 | 3043  187  157    1 | 3077   56   47    3
3010   64   53    1 | 3044   30   25    2 | 3078   72   60    3
3011   66   55    1 | 3045   44   37    2 | 3079   83   70    3
3012   68   57    1 | 3046   50   42    2 | 3080   94   78    3
3013   70   59    1 | 3047   55   46    2 | 3081  102   86    3
3014   73   61    1 | 3048   58   49    2 | 3082  113   94    3
3015   74   62    1 | 3049   62   52    2 | 3083  127  106    3
3016   76   64    1 | 3050   65   54    2 | 3084  159  133    3
3017   78   65    1 | 3051   67   56    2 | 3085   32   27    4
3018   80   67    1 | 3052   70   58    2 | 3086   53   44    4
3019   82   69    1 | 3053   72   60    2 | 3087   64   53    4
3020   84   70    1 | 3054   74   62    2 | 3088   72   60    4
3021   86   72    1 | 3055   77   64    2 | 3089   78   65    4
3022   88   73    1 | 3056   79   66    2 | 3090   84   70    4
3023   89   75    1 | 3057   81   68    2 | 3091   89   75    4
3024   91   76    1 | 3058   84   70    2 | 3092   95   80    4
3025   93   78    1 | 3059   86   72    2 | 3093  101   85    4
3026   95   79    1 | 3060   88   74    2 | 3094  108   91    4
3027   97   81    1 | 3061   91   76    2 | 3095  118   99    4
3028   99   83    1 | 3062   93   78    2 | 3096  131  110    4
3029  101   85    1 | 3063   96   80    2 | 3097  168  140    4
3030  103   86    1 | 3064   99   83    2 | 3098   62   52    5
3031  106   88    1 | 3065  102   85    2 | 3099   98   82    5
3032  108   91    1 | 3066  105   87    2 | 31 0  144  120    5
3033  111   93    1 | 3067  108   90    2
3034  114   95    1 | 3068  111   93    2

0000 ZONAL DATA
40 1 7793   38
40 211353   60
40 3 6594   21
40 410572  104
40 515270  110
40 6 9381   54

0000 Calibration Data
70 11.2880.0740.3480.0560.1170.1160.0680.1210.101 77921.000 89.8
70 21.3390.0810.4730.0540.1350.0950.0300.0700.062113521.000 91.1
70 31.2100.0740.3390.0420.0770.1260.0440.1590.139 65931.000 92.5
70 41.3330.1230.6230.0550.0860.0490.0100.0300.024105711.000 91.8
70 51.1700.1310.6140.0600.0890.0490.0170.0250.016152921.000101.2
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0    0.0
```

Figure A3:11-8A WINNIPEG: "GAMMA" Calibration Data

```
0000 BETA CALIBRATION

0000 INCOME by TYPE
20 1 8776
20 211662
20 311279
20 411494
20 5 6666
20 6 6836
20 7 7181
20 8 4167

0000 ALPHA by TYPE
21 1.1531
21 2.1224
21 3.1211
21 4.1073
21 5.1790
21 6.2113
21 7.1693
21 8.2763
```

```
0000 "MODEL" HOUSEHOLDS
10 1 1526     1
10 2 4070     1
10 3 5987     1
10 4 7252     1
10 5 8583     1
10 6 9721     1
10 711221     1
10 813032     1
10 917884     1
1010   99     2
1011  841     2
1012 2835     2
1013 4149     2
1014 4931     2
1015 5981     2
1016 6691     2
1017 7497     2
1018 7973     2
1019 8421     2
1020 8813     2
1021 9366     2
1022 9733     2
102310025     2
102410476     2
102510873     2
102611440     2
102711793     2
102812129     2
102912437     2
103012799     2
103113455     2
103213856     2
103314426     2
103415048     2
103515609     2
103616621     2
103717486     2
103818728     2
103921262     2
104025012     2
104132518     2
1042 4355     3
1043 7724     3
1044 9406     3
104510884     3
104612518     3
104715150     3
104819083     3
1049 2304     4
1050 4409     4
1051 5854     4
1052 7152     4
1053 8133     4
1054 8648     4
1055 9421     4
105610016     4
105710920     4
105811668     4
105912454     4
106013470     4
106115176     4
106216947     4
106318995     4
106429789     4
1065 1617     5
1066 2784     5
1067 3590     5
1068 4038     5
1069 4729     5
1070 6220     5
1071 7756     5
1072 9937     5
107320044     5
1074 1159     6
1075 2178     6
1076 3624     6
1077 5027     6
1078 7029     6
1079 8503     6
108010715     6
108116512     6
1082 1085     7
1083 1993     7
1084 3332     7
1085 4629     7
1086 5545     7
1087 6242     7
1088 7263     7
1089 8404     7
109010060     7
109112075     7
109219192     7
1093 1157     8
1094 1844     8
1095 1978     8
1096 2215     8
1097 2616     8
1098 3933     8
1099 6173     8
11 013309     8
```

Figure A3:12-8 WINNIPEG: "BETA" Calibration Data

```
0000 BETA CALIBRATION

0000 "MODEL" Dwellings
30 1   21    1 |3035  120    1 |3069   92    3
30 2   35    1 |3036  125    1 |3070  106    3
30 3   43    1 |3037  137    1 |3071  144    3
30 4   50    1 |3038  184    1 |3072   37    4
30 5   55    1 |3039   37    2 |3073   66    4
30 6   58    1 |3040   53    2 |3074   83    4
30 7   60    1 |3041   60    2 |3075  100    4
30 8   62    1 |3042   65    2 |3076  118    4
30 9   64    1 |3043   70    2 |3077  166    4
3010   65    1 |3044   74    2 |3078  124    5
3011   67    1 |3045   78    2
3012   69    1 |3046   81    2
3013   70    1 |3047   83    2
3014   72    1 |3048   86    2
3015   73    1 |3049   89    2
3016   74    1 |3050   91    2
3017   76    1 |3051   94    2
3018   77    1 |3052   97    2
3019   78    1 |3053  100    2
3020   80    1 |3054  103    2
3021   82    1 |3055  106    2
3022   83    1 |3056  109    2
3023   85    1 |3057  113    2
3024   87    1 |3058  119    2
3025   89    1 |3059  125    2
3026   91    1 |3060  133    2
3027   93    1 |3061  149    2
3028   95    1 |3062  214    2
3029   98    1 |3063   23    3
3030  101    1 |3064   44    3
3031  104    1 |3065   56    3
3032  108    1 |3066   67    3
3033  111    1 |3067   75    3
3034  115    1 |3068   83    3

0000 ZONAL DATA
40 1 7793   38 |
40 211353   60 |
40 3 6594   21 |
40 410572  104 |
40 515270  110 |
40 6 9381   54 |

0000 Calibration Data
70 11.2650.0730.3490.0540.1160.1190.0670.1220.101 77570.998 89.7
70 21.3730.0750.4740.0490.1350.1040.0270.0690.067114730.933 83.8
70 31.1940.0750.3440.0430.0760.1280.0430.1550.137 66080.866 95.0
70 41.3980.1130.6020.0530.0940.0620.0100.0340.032102161.000 82.0
70 51.1440.1170.6210.0540.0920.0630.0130.0220.019186721.000 96.7
70 61.4100.1050.4940.0620.1110.0670.0380.0710.053103311.000109.9
```

Figure A3:12-8A WINNIPEG: "BETA" Calibration Data

```
0000 Policy Dataset

0000 "MODEL" HOUSEHOLDs and BASE DATA
10 1 1526     1    400.930 40.3  |  1051 5854     4    431.210 60.3
10 2 4070     1    161.186 63.0  |  1052 7152     4    441.289 65.8
10 3 5987     1    471.325 74.9  |  1053 8133     4    221.243 72.4
10 4 7252     1    501.355 83.1  |  1054 8648     4    461.320 72.9
10 5 8583     1    751.364 91.6  |  1055 9421     4    741.355 75.8
10 6 9721     1   9991.410 97.1  |  105610016     4    271.256 81.6
10 711221     1    361.285111.0  |  105710920     4   9991.410 81.2
10 813032     1    601.319119.7  |  105811668     4    301.268 89.0
10 917884     1   9991.410139.9  |  105912454     4   9991.410 87.9
1010   99     2     00.0    0.0  |  106013470     4    551.316 95.3
1011  841     2    640.701 29.8  |  106115176     4   9991.410 99.0
1012 2835     2    411.054 48.3  |  106216947     4    761.356107.8
1013 4149     2    121.149 57.9  |  106318995     4    781.381114.4
1014 4931     2    671.172 63.5  |  106429789     4   9991.410148.4
1015 5981     2    201.232 69.5  |  1065 1617     5     60.928 44.0
1016 6691     2    681.269 73.2  |  1066 2784     5    101.133 54.1
1017 7497     2    481.310 77.1  |  1067 3590     5    151.172 61.8
1018 7973     2    491.313 79.9  |  1068 4038     5    181.191 65.8
1019 8421     2   9991.410 79.8  |  1069 4729     5    451.286 69.3
1020 8813     2   9991.410 82.0  |  1070 6220     5    691.285 81.7
1021 9366     2    521.327 87.6  |  1071 7756     5    311.297 92.8
1022 9733     2   9991.410 87.0  |  1072 9937     5    351.304107.4
102310025     2    531.340 90.8  |  107320044     5   9991.410157.0
102410476     2    701.300 94.7  |  1074 1159     6    650.946 42.9
102510873     2    331.270 98.0  |  1075 2178     6    421.168 55.0
102611440     2   9991.410 95.9  |  1076 3624     6    211.249 71.7
102711793     2   9991.410 97.6  |  1077 5027     6    281.307 85.1
102812129     2   9991.410 99.3  |  1078 7029     6    341.319103.5
102912437     2   9991.410100.8  |  1079 8503     6    591.357114.2
103012799     2   9991.410102.5  |  108010715     6    611.312133.8
103113455     2    581.344108.2  |  108116512     6   9991.410166.6
103213856     2   9991.410107.5  |  1082 1085     7     40.829 36.2
103314426     2   9991.410110.2  |  1083 1993     7     80.955 47.7
103415048     2   9991.410113.0  |  1084 3332     7    131.140 58.5
103515609     2    371.278121.3  |  1085 4629     7    191.239 68.0
103616621     2   9991.410120.0  |  1086 5545     7    231.266 74.9
103717486     2    711.301128.7  |  1087 6242     7    251.296 79.4
103818728     2   9991.410128.9  |  1088 7263     7    291.289 87.2
103921262     2   9991.410139.1  |  1089 8404     7    321.278 95.6
104025012     2   9991.410153.3  |  109010060     7    571.356103.2
104132518     2    621.271189.0  |  109112075     7   9991.410112.8
1042 4355     3    731.206 56.7  |  109219192     7    771.359151.9
1043 7724     3    241.288 77.3  |  1093 1157     8     70.961 46.3
1044 9406     3    511.340 85.3  |  1094 1844     8    111.116 55.4
104510884     3    541.335 93.3  |  1095 1978     8    661.158 56.4
104612518     3   9991.410 98.8  |  1096 2215     8    141.154 60.5
104715150     3   9991.410110.8  |  1097 2616     8    171.202 65.2
104819083     3   9991.410127.2  |  1098 3933     8    261.272 80.4
1049 2304     4     50.885 40.9  |  1099 6173     8    561.377100.4
1050 4409     4     91.118 53.0  |  110013309     8    381.303164.6
```

Figure A3:13-8 WINNIPEG: Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   21    1 |3035  120    1 |3069   92    3
30 2   35    1 |3036  125    1 |3070  106    3
30 3   43    1 |3037  137    1 |3071  144    3
30 4   50    1 |3038  184    1 |3072   37    4
30 5   55    1 |3039   37    2 |3073   66    4
30 6   58    1 |3040   53    2 |3074   83    4
30 7   60    1 |3041   60    2 |3075  100    4
30 8   62    1 |3042   65    2 |3076  118    4
30 9   64    1 |3043   70    2 |3077  166    4
3010   65    1 |3044   74    2 |3078  124    5
3011   67    1 |3045   78    2
3012   69    1 |3046   81    2
3013   70    1 |3047   83    2
3014   72    1 |3048   86    2
3015   73    1 |3049   89    2
3016   74    1 |3050   91    2
3017   76    1 |3051   94    2
3018   77    1 |3052   97    2
3019   78    1 |3053  100    2
3020   80    1 |3054  103    2
3021   82    1 |3055  106    2
3022   83    1 |3056  109    2
3023   85    1 |3057  113    2
3024   87    1 |3058  119    2
3025   89    1 |3059  125    2
3026   91    1 |3060  133    2
3027   93    1 |3061  149    2
3028   95    1 |3062  214    2
3029   98    1 |3063   23    3
3030  101    1 |3064   44    3
3031  104    1 |3065   56    3
3032  108    1 |3066   67    3
3033  111    1 |3067   75    3
3034  115    1 |3068   83    3

0000 INCOME by TYPE   0000 ALPHA by TYPE    0000 ZONAL DATA
20 1 8776             |21 1.1531            |40 1 6136   38
20 211662             |21 2.1224            |40 2 9525   60
20 311279             |21 3.1211            |40 3 6515   21
20 411494             |21 4.1073            |40 412250  104
20 5 6666             |21 5.1790            |40 519889  110
20 6 6836             |21 6.2113            |40 615661   54
20 7 7181             |21 7.1693
20 8 4167             |21 8.2763
```

Figure A3:13-8(cont) WINNIPEG: Policy Dataset

	RENTAL MODEL	OWNER-OCCUPIER MODEL
CONSTANT	2.0054	0.6901
	(15.0)	(3.07)
BATH	0.0454	na
	(0.33)	
TOILET	0.1414	0.4524
	(1.08)	(4.08)
SUBSIDIS	-.2397	0.0744
	(9.12)	(0.96)
LNLIVING	0.1775	0.2318
	(5.72)	(5.27)
LNINCOM	0.1402	0.2428
	(11.0)	(12.1)
TYPE	-.0200	-.1485
	(1.38)	(4.38)
LNDIST	-.0008	-.0279
	(0.12)	(2.91)
B5160	-.0798	-.0743
	(4.14)	(2.87)
B4650	-.0861	-.1289
	(2.98)	(2.87)
B2145	-.1539	-.1934
	(7.99)	(4.41)
BPRE20	-.2067	-.3548
	(9.95)	(11.9)
LGLVSIZE	0.2450	0.2146
	(10.4)	(6.58)
LGBDSIZE	0.0624	0.0920
	(11.2)	(6.72)
OPENSP	-.0159	0.0534
	(0.96)	(1.62)
HIGHDEN	0.0179	-.0632
	(1.30)	(1.18)
COMMERC	-.0332	na
	(2.42)	
NEIGHBD	0.0298	na
	(1.77)	
FINANCE	-.0542	-.0721
	(3.89)	(3.20)
AMRATE	na	0.0687
		(13.4)
R2	0.59	0.52
Observations	1305	1183

note: "t" statistics in brackets
: data source: WIN.REG02

Figure A3:14-8 WINNIPEG: 1971 Hedonic Estimates for Translogs

translog variables

	M	ph*XH	ph	pg	ph*XH / M
TYPE 1					
mean	375.5	113.1	1.429	1.289	0.3885
min	88.3	24.7	1.368	1.289	0.0755
max	2860.7	397.4	1.536	1.289	0.9410
TYPE 2					
mean	439.5	111.0	1.431	1.289	0.3229
min	46.7	20.6	1.366	1.289	0.0540
max	1863.4	288.6	1.533	1.289	0.9723
TYPE 3					
mean	737.5	129.1	1.431	1.289	0.2056
min	142.9	33.0	1.366	1.289	0.0444
max	1934.4	329.8	1.533	1.289	0.8961
TYPE 4					
mean	493.3	121.0	1.429	1.289	0.3091
min	97.2	45.3	1.367	1.289	0.0466
max	1803.8	263.8	1.533	1.289	0.9553
TYPE 5					
mean	702.9	131.5	1.429	1.289	0.2193
min	157.1	33.8	1.365	1.289	0.0717
max	1747.4	234.1	1.509	1.289	0.9395
TYPE 6					
mean	651.5	239.6	1.646	1.289	0.4264
min	108.8	27.9	1.355	1.289	0.0939
max	2686.8	1254.9	1.765	1.289	0.9839
TYPE 7					
mean	665.1	221.2	1.656	1.289	0.3645
min	158.7	63.9	1.362	1.289	0.0927
max	1667.9	548.8	1.809	1.289	0.8995
TYPE 8					
mean	1028.7	231.1	1.643	1.289	0.2395
min	241.8	50.2	1.245	1.289	0.0540
max	2777.2	709.1	1.809	1.289	0.8272
TYPE 9					
mean	858.9	249.1	1.705	1.289	0.3025
min	212.6	76.8	1.369	1.289	0.0959
max	2623.6	1285.0	1.875	1.289	0.8778
TYPE 10					
mean	1034.0	239.9	1.658	1.289	0.2457
min	163.7	59.0	1.344	1.289	0.0359
max	2325.1	694.8	1.831	1.289	0.9829

Figure A3:15-8 WINNIPEG : Translog Input Variables Statistics

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3180	-.1872	0.2120	0.0717	0.0094	79.1	203.5	375.5	202
	(169.)	(26.3)	(53.0)	(3.90)	(1.62)				
2	-.2689	-.1638	0.2073	0.0597	0.0146	77.5	254.8	439.5	373
	(182.)	(25.1)	(59.0)	(2.87)	(3.09)				
3	-.1822	-.1029	0.1467	0.2264	-.0678	90.2	472.0	737.5	373
	(238.)	(21.0)	(70.9)	(11.8)	(20.6)				
4	-.2605	-.1744	0.1998	0.0087	0.0118	84.5	288.9	493.3	192
	(143.)	(14.9)	(43.3)	(0.22)	(1.96)				
5	-.1950	-.1206	0.1671	0.2338	-.0146	92.0	443.2	702.9	165
	(144.)	(9.56)	(44.2)	(4.22)	(2.68)				
6	-.3839	-.2073	0.2333	0.0095	0.0503	145.4	319.6	651.5	229
	(170.)	(24.3)	(50.9)	(0.53)	(7.87)				
7	-.3392	-.1822	0.2180	0.0819	0.0034	133.4	344.4	665.1	118
	(205.)	(20.3)	(39.5)	(3.61)	(0.43)				
8	-.2298	-.1333	0.1561	0.1445	-.0871	140.6	618.8	1028.7	231
	(246.)	(31.0)	(38.4)	(8.64)	(10.2)				
9	-.2936	-.1573	0.1943	0.1453	-.0294	145.7	473.0	858.9	252
	(339.)	(28.6)	(55.0)	(9.66)	(5.44)				
10	-.2383	-.1231	0.1862	0.2033	0.0186	144.9	616.0	1034.0	353
	(253.)	(24.1)	(61.1)	(11.8)	(4.03)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:16-8 WINNIPEG : Direct Translog-Expenditure Share
[all income levels]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.4359	-.1818	0.2697	0.1177	0.0911	66.7	99.1	223.3	132
	(237.)	(17.8)	(44.3)	(4.66)	(10.5)				
2	-.3884	-.1606	0.2755	0.1249	0.1022	69.5	129.3	266.2	199
	(212.)	(17.6)	(44.4)	(4.98)	(11.9)				
3	-.2399	-.1116	0.1948	0.2289	-.0114	84.8	309.0	519.9	197
	(283.)	(20.8)	(57.5)	(13.1)	(2.27)				
4	-.3674	-.1343	0.2649	0.1638	0.0936	73.8	149.3	297.9	101
	(161.)	(7.68)	(34.7)	(3.42)	(9.15)				
5	-.2473	-.0950	0.2191	0.3464	0.0520	84.7	294.9	501.3	91
	(153.)	(7.52)	(34.9)	(7.60)	(6.18)				
6	-.4786	-.1968	0.3017	0.0435	0.1451	121.8	176.0	427.3	147
	(226.)	(20.6)	(39.2)	(2.19)	(13.9)				
7	-.3945	-.1904	0.2651	0.0601	0.0686	109.3	221.6	466.9	62
	(187.)	(15.9)	(28.8)	(2.31)	(5.27)				
8	-.2632	-.1414	0.1764	0.1317	-.0603	120.7	443.4	770.6	121
	(183.)	(19.2)	(18.1)	(4.70)	(3.01)				
9	-.3163	-.1564	0.2248	0.1465	0.0145	121.8	353.4	662.6	138
	(264.)	(19.3)	(34.5)	(7.64)	(1.57)				
10	-.2629	-.1123	0.2255	0.2591	0.0676	123.5	454.7	790.0	189
	(212.)	(13.8)	(42.5)	(9.80)	(9.26)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:17-8 WINNIPEG : Direct Translog-Expenditure Share
[below mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2224	-.1137	0.1214	0.2384	-.2115	102.4	400.5	662.5	70
	(306.)	(32.7)	(29.8)	(16.3)	(15.2)				
2	-.1945	-.0917	0.0889	0.2989	-.3253	86.7	398.5	637.7	174
	(512.)	(36.1)	(23.2)	(23.5)	(18.6)				
3	-.1407	-.0778	0.0661	0.2641	-.3656	96.3	654.5	981.1	176
	(501.)	(26.3)	(17.9)	(12.6)	(14.7)				
4	-.1945	-.1035	0.0825	0.2549	-.3509	96.4	443.8	710.3	91
	(338.)	(18.4)	(14.4)	(9.65)	(13.5)				
5	-.1520	-.0918	0.0709	0.2477	-.3805	100.9	625.7	950.8	74
	(378.)	(13.5)	(13.5)	(6.17)	(11.2)				
6	-.3028	-.1672	0.1827	0.1019	0.0097	187.8	576.9	1053.5	82
	(122.)	(15.8)	(22.1)	(3.75)	(0.56)				
7	-.3017	-.1560	0.1559	0.1507	-.1391	160.1	480.2	884.5	56
	(218.)	(11.6)	(9.46)	(3.03)	(2.74)				
8	-.2039	-.0973	0.1239	0.2824	-.1527	162.4	811.6	1312.5	110
	(249.)	(22.7)	(19.2)	(16.6)	(6.35)				
9	-.2730	-.1270	0.1300	0.2349	-.2223	174.8	617.9	1096.4	114
	(333.)	(23.0)	(14.4)	(14.5)	(7.74)				
10	-.2173	-.1281	0.1071	0.1377	-.2258	169.5	802.0	1315.1	164
	(278.)	(22.1)	(10.2)	(5.27)	(5.08)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:18-8 WINNIPEG : Direct Translog-Expenditure Share
[above mean income]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.5353	-.1659	0.3262	0.1319	0.1805	60.0	58.4	161.1	76
	(263.)	(17.4)	(30.8)	(7.33)	(13.2)				
2	-.5425	-.1602	0.3393	0.1114	0.1993	63.0	60.3	167.9	96
	(224.)	(13.3)	(37.7)	(4.19)	(16.7)				
3	-.3067	-.1076	0.2459	0.2600	0.0533	81.3	210.4	387.7	88
	(259.)	(13.9)	(39.7)	(10.3)	(6.12)				
4	-.4980	-.2334	0.3147	-.0339	0.1622	69.8	80.0	202.5	49
	(193.)	(7.18)	(22.9)	(0.50)	(9.18)				
5	-.3092	-.0839	0.2725	0.3532	0.1162	82.2	209.0	386.9	44
	(133.)	(5.85)	(24.3)	(8.07)	(8.53)				
6	-.5735	-.1744	0.3497	0.0632	0.2216	109.0	104.6	313.7	73
	(197.)	(13.8)	(26.3)	(2.57)	(12.6)				
7	-.4845	-.1761	0.3061	0.0715	0.1343	96.6	136.1	337.2	26
	(165.)	(12.0)	(22.5)	(2.52)	(6.95)				
8	-.3115	-.1897	0.1965	0.0384	-.0468	108.5	315.6	585.6	49
	(140.)	(17.9)	(14.1)	(1.23)	(1.68)				
9	-.3568	-.2208	0.2536	-.0091	0.0503	109.6	266.8	529.7	59
	(198.)	(8.01)	(18.7)	(0.12)	(2.63)				
10	-.2992	-.1509	0.2561	0.1634	0.1109	108.8	338.6	615.4	78
	(138.)	(9.81)	(28.3)	(3.82)	(9.60)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:19-8 WINNIPEG : Direct Translog-Expenditure Share
[quartile 01]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.3552	-.1449	0.2386	0.2127	0.0432	75.8	154.4	307.6	56
	(293.)	(10.7)	(15.5)	(5.30)	(1.31)				
2	-.3030	-.1254	0.1905	0.2545	-.0524	75.6	193.6	357.7	103
	(468.)	(26.6)	(23.6)	(13.9)	(2.77)				
3	-.2017	-.0913	0.1684	0.3099	0.0058	87.7	388.7	626.6	109
	(430.)	(14.9)	(16.8)	(9.59)	(0.14)				
4	-.2855	-.1357	0.1169	0.2130	-.2838	77.5	214.5	387.7	52
	(338.)	(13.9)	(8.47)	(6.11)	(6.81)				
5	-.2052	-.1074	0.0910	0.2520	-.3038	87.2	375.4	608.4	47
	(385.)	(13.8)	(4.64)	(7.46)	(3.45)				
6	-.4143	-.1793	0.2670	0.0980	0.0868	134.4	246.5	539.4	74
	(229.)	(13.4)	(16.4)	(3.09)	(3.34)				
7	-.3504	-.2372	0.1391	-.1146	-.2434	118.4	283.4	560.6	36
	(188.)	(10.4)	(4.56)	(1.57)	(3.17)				
8	-.2373	-.0998	0.1382	0.2766	-.2206	129.0	530.4	896.5	72
	(210.)	(11.5)	(4.17)	(6.73)	(1.92)				
9	-.2941	-.1322	0.2432	0.2090	0.0610	130.9	418.0	761.9	79
	(245.)	(10.0)	(10.0)	(4.70)	(1.00)				
10	-.2438	-.1189	0.1324	0.2040	-.2276	133.8	536.3	912.8	111
	(269.)	(14.7)	(5.29)	(6.44)	(2.79)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:20-8 WINNIPEG : Direct Translog-Expenditure Share
[quartile 02]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.2599	-.1210	0.1523	0.2360	-.1572	90.7	287.6	500.3	47
	(297.)	(22.3)	(10.8)	(9.60)	(3.52)				
2	-.2161	-.0910	0.1030	0.3504	-.2943	80.4	322.9	531.4	103
	(424.)	(16.5)	(6.41)	(11.6)	(4.54)				
3	-.1613	-.0852	0.0923	0.2782	-.2700	94.0	544.0	835.4	108
	(436.)	(16.6)	(6.28)	(8.20)	(3.24)				
4	-.2169	-.1127	0.1197	0.2504	-.2431	92.9	374.1	615.6	60
	(299.)	(16.4)	(6.32)	(8.66)	(3.24)				
5	-.1779	-.0998	0.1008	0.2492	-.3065	101.6	523.4	820.3	43
	(344.)	(9.91)	(3.94)	(4.49)	(2.39)				
6	-.3078	-.1016	0.2503	0.3494	0.1559	154.4	442.1	822.4	55
	(145.)	(5.39)	(12.3)	(5.83)	(3.33)				
7	-.3367	-.1945	0.1552	0.0277	-.2201	155.2	395.4	766.6	35
	(187.)	(7.38)	(3.13)	(0.30)	(1.54)				
8	-.2125	-.0739	0.2324	0.3816	0.1671	148.6	698.3	1142.7	68
	(210.)	(7.94)	(8.56)	(7.53)	(1.63)				
9	-.2802	-.1369	0.1412	0.1664	-.2621	157.7	535.5	958.4	73
	(305.)	(8.87)	(4.04)	(2.97)	(2.39)				
10	-.2265	-.1539	0.0787	0.0171	-.4408	154.6	690.5	1145.8	103
	(246.)	(12.6)	(2.26)	(0.31)	(3.14)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:21-8 WINNIPEG : Direct Translog-Expenditure Share
[quartile 03]

$$SHARE = \frac{A1 + B11 * lnXH + B12 * lnXG}{-1. + BM1 * lnXH + BM2 * lnXG}$$

TYPE	A1	B11	B12	BM1	BM2	MQH	MQX	ME	#
1	-.1823	-.0968	0.1091	0.2764	-.2226	126.2	631.1	993.8	23
	(228.)	(22.9)	(13.6)	(10.9)	(6.20)				
2	-.1737	-.0881	0.0911	0.2775	-.2792	95.7	508.0	791.9	71
	(354.)	(24.7)	(13.3)	(15.2)	(7.25)				
3	-.1181	-.0595	0.0601	0.3348	-.3511	99.8	830.1	1212.6	68
	(333.)	(14.7)	(8.56)	(10.7)	(5.93)				
4	-.1643	-.0705	0.0623	0.4100	-.4133	103.1	578.8	893.6	31
	(241.)	(8.78)	(7.95)	(9.65)	(8.46)				
5	-.1262	-.0683	0.0720	0.3766	-.2555	99.9	767.5	1131.7	31
	(303.)	(9.93)	(8.91)	(8.39)	(3.79)				
6	-.2847	-.1298	0.1739	0.2312	0.0365	256.0	851.5	1524.3	27
	(92.2)	(12.6)	(16.7)	(8.64)	(2.48)				
7	-.2584	-.1233	0.1234	0.2523	-.2503	168.2	621.7	1081.0	21
	(154.)	(8.99)	(6.09)	(4.73)	(3.82)				
8	-.1923	-.1014	0.0955	0.2575	-.3145	184.8	995.1	1587.6	42
	(176.)	(13.2)	(7.67)	(8.44)	(5.23)				
9	-.2648	-.1286	0.1352	0.2247	-.2165	205.2	764.7	1342.2	41
	(192.)	(20.1)	(9.98)	(12.0)	(5.79)				
10	-.2036	-.1021	0.0810	0.2535	-.3358	194.8	990.2	1601.1	61
	(173.)	(12.3)	(4.36)	(6.29)	(4.19)				

note: [1] "t" values in brackets
[2] MQH is the mean quantity of "housing" services
MQX is the mean quantity of other goods and services
ME is the mean expenditure
is the number of observations

Figure A3:22-8 WINNIPEG : Direct Translog-Expenditure Share
[quartile 04]

	income elasticity			price elasticity		
	mean	below	above	mean	below	above
TYPE 1						
Q01	0.7871	0.7981	0.8096	-0.9918	-1.4572	-0.7533
Q02	0.5941	0.6303	0.6321	-1.0026	-1.2154	-0.8522
Q03	0.4883	0.4936	0.4945	-1.0118	-1.2429	-0.8254
Q04	0.3705	0.3803	0.3847	-1.0038	-1.4171	-0.5488
TYPE 2						
Q01	0.7723	0.7807	0.7952	-1.0095	-1.6686	-0.6549
Q02	0.5389	0.5655	0.5735	-1.0041	-1.2561	-0.8548
Q03	0.4560	0.4666	0.4676	-0.9989	-1.1308	-0.8858
Q04	0.3619	0.3586	0.3581	-1.0053	-1.1933	-0.7884
TYPE 3						
Q01	0.5443	0.5565	0.5550	-1.0518	-1.5319	-0.8758
Q02	0.3978	0.4208	0.4214	-1.0164	-1.1181	-0.9088
Q03	0.3399	0.3379	0.3376	-1.0076	-1.0976	-0.9109
Q04	0.2678	0.2639	0.2630	-1.0048	-1.1780	-0.8005
TYPE 4						
Q01	0.7023	0.7037	0.7053	-1.0170	-1.8446	-0.6848
Q02	0.5410	0.5298	0.5308	-0.9993	-1.1832	-0.8241
Q03	0.4382	0.4354	0.4352	-1.0055	-1.1402	-0.9093
Q04	0.3844	0.3913	0.3940	-0.9901	-1.2172	-0.7168
TYPE 5						
Q01	0.5717	0.6077	0.5985	-1.0516	-1.4887	-0.8871
Q02	0.4156	0.4139	0.4134	-0.9954	-1.1580	-0.9054
Q03	0.3776	0.3684	0.3637	-1.0126	-1.1729	-0.9079
Q04	0.2813	0.3065	0.3118	-0.9899	-1.1228	-0.8058
TYPE 6						
Q01	0.7811	0.7833	0.8037	-1.0119	-1.8587	-0.7108
Q02	0.6421	0.6524	0.6568	-1.0151	-1.2286	-0.8476
Q03	0.5272	0.6228	0.6278	-0.9914	-1.1423	-0.8365
Q04	0.4466	0.5172	0.5863	-0.9748	-1.3013	-0.5665
TYPE 7						
Q01	0.7028	0.7059	0.7099	-1.0267	-2.0785	-0.6817
Q02	0.5494	0.5253	0.5218	-1.0306	-1.2224	-0.8855
Q03	0.5710	0.5513	0.5322	-1.0274	-1.1851	-0.8691
Q04	0.5047	0.5054	0.5054	-0.9967	-1.1620	-0.7744
TYPE 8						
Q01	0.5211	0.5180	0.5174	-1.0106	-1.6128	-0.8266
Q02	0.4659	0.4622	0.4602	-1.0280	-1.1548	-0.9034
Q03	0.4209	0.4494	0.4675	-1.0498	-1.1761	-0.9532
Q04	0.4026	0.3928	0.3886	-1.0052	-1.2096	-0.7512
TYPE 9						
Q01	0.5712	0.5698	0.5684	-1.0221	-1.5756	-0.8026
Q02	0.5264	0.5314	0.5398	-1.0324	-1.1872	-0.8857
Q03	0.5144	0.4984	0.4931	-1.0354	-1.1456	-0.9221
Q04	0.5043	0.5035	0.5018	-1.0013	-1.3293	-0.6232
TYPE 10						
Q01	0.5231	0.5336	0.5353	-1.0340	-1.5541	-0.8453
Q02	0.4590	0.4526	0.4499	-1.0232	-1.1406	-0.9182
Q03	0.4121	0.3830	0.3830	-1.0304	-1.1147	-0.9423
Q04	0.4137	0.4052	0.4051	-0.9966	-1.1415	-0.8180

Figure A3:23-8 WINNIPEG :Income and Price Elasticities

	ALL	BELOW	ABOVE	Q01	Q02	Q03	Q04
TYPE 1							
normal	475.02	349.83	272.74	221.08	193.39	182.38	100.46
BM1=BM2=0	468.89	303.68	199.01	170.62	170.97	142.38	67.15
statistic	12.27	92.30	147.46	100.92	44.85	79.99	66.63
TYPE 2							
normal	832.13	473.90	712.76	240.61	385.61	413.85	303.66
BM1=BM2=0	824.45	408.30	549.41	178.19	296.97	321.84	233.32
statistic	15.35	131.21	326.70	124.83	177.28	184.03	140.69
TYPE 3							
normal	1060.04	605.41	760.28	279.26	430.97	461.62	311.03
BM1=BM2=0	903.16	544.71	600.04	246.70	321.56	398.75	250.98
statistic	313.76	121.40	320.50	65.14	218.82	125.73	120.11
TYPE 4							
normal	446.65	251.19	358.35	134.88	203.76	239.18	135.29
BM1=BM2=0	444.57	219.06	266.21	96.90	147.21	205.75	96.90
statistic	4.16	64.25	184.27	75.95	113.10	66.86	76.78
TYPE 5							
normal	441.38	260.41	332.92	128.93	205.58	191.12	152.30
BM1=BM2=0	423.17	233.27	280.69	100.22	172.59	180.05	130.57
statistic	36.42	54.29	104.44	57.42	65.99	22.13	43.46
TYPE 6							
normal	485.26	359.64	208.75	182.31	219.26	158.97	82.31
BM1=BM2=0	453.84	276.68	198.95	124.26	213.19	139.88	64.42
statistic	62.84	165.93	19.60	116.10	12.13	38.18	35.78
TYPE 7							
normal	322.25	178.70	186.20	80.30	116.30	118.55	76.65
BM1=BM2=0	315.94	165.17	152.72	64.40	108.50	109.53	59.44
statistic	12.60	27.07	66.96	31.79	15.61	18.06	34.41
TYPE 8							
normal	669.94	339.93	381.98	141.09	246.26	238.85	157.69
BM1=BM2=0	572.11	298.39	296.15	134.91	205.25	192.85	126.54
statistic	195.65	83.08	171.65	12.37	82.02	92.01	62.31
TYPE 9							
normal	754.68	411.12	404.37	176.62	261.27	264.90	147.06
BM1=BM2=0	707.24	387.88	341.18	170.27	231.32	244.95	114.38
statistic	94.88	46.48	126.37	12.71	59.91	39.89	65.35
TYPE10							
normal	951.96	527.40	537.74	212.34	378.59	348.28	210.68
BM1=BM2=0	885.17	452.59	451.84	169.03	328.58	308.50	163.80
statistic	133.58	149.62	171.79	86.63	100.01	79.54	93.76

Figure A3:24-8 WINNIPEG : Log Likelihood Values:
[test of unity income elasticity]

0000 Demand Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10 1 1305	1 -515	0	
10 2 1919	1 188	12	
10 3 2217	1 130	52	
10 4 3132	1 462	127	
10 5 4171	1 1357	284	
10 6 8259	1 7305	2614	
10 7 845	2 -239	0	
10 8 1558	2 491	64	
10 9 1860	2 754	179	
1010 2470	2 1502	325	
1011 3406	2 2342	442	
1012 4159	2 3168	637	
1013 4787	2 4244	926	
1014 5505	2 5008	1159	
1015 6098	2 5798	1404	
1016 6944	2 6711	1728	
1017 8111	2 8081	2244	
101810758	212915	4718	
1019 3207	3 1116	278	
1020 4905	3 2876	570	
1021 6095	3 4330	912	
1022 7133	3 5713	1254	
1023 7670	3 6357	1366	
1024 8685	3 7518	1626	
1025 9380	3 8386	1948	
102610153	3 9337	2191	
102711163	310751	2624	
102812685	312572	3364	
102916138	317446	5156	
1030 728	4-1084	0	
1031 2469	4 632	144	
1032 3830	4 1758	348	
1033 5153	4 2648	523	
1034 6716	4 4248	944	
1035 7962	4 5911	1447	
103611180	411011	3829	
1037 4170	5 983	296	
1038 6355	5 3936	839	
1039 7899	5 5601	1281	
1040 9803	5 7990	2072	
104113268	512576	3505	
1042 2355	6 -396	12	
1043 3572	6 -370	46	
1044 4272	6 -273	38	
1045 5164	6 525	173	
1046 5937	6 1193	295	
1047 6730	6 1850	377	
1048 7545	6 2566	577	
1049 8683	6 3430	779	
105010382	6 5772	1448	
105119076	616618	6180	
1052 3266	7 811	207	
1053 5486	7 3016	622	
1054 6698	7 4314	966	
1055 8127	7 5794	1411	
1056 9034	7 6016	1489	
105710272	7 7441	2002	
105812663	711355	3873	
1059 5604	8 2539	573	
1060 7931	8 5009	1157	
1061 9128	8 6350	1499	
1062 9957	8 7162	1801	
106310562	8 8017	1927	
106411215	8 8984	2122	
106511960	8 9690	2487	
106612902	810585	2709	
106713859	812330	3210	
106815103	813685	3677	
106916436	815051	4429	
107023718	82771611097		
1071 2276	9 -593	94	
1072 5437	9 2356	496	
1073 7193	9 3873	833	
1074 8045	9 4635	1050	
1075 8680	9 5827	1431	
1076 9407	9 6242	1562	
107710121	9 7225	1912	
107810633	9 7201	1904	
107911182	9 8149	2269	
108011967	9 9225	2701	
108112831	910722	3383	
108213865	911680	3914	
108318543	920151	9028	
1084 4868	10 1152	362	
1085 7288	10 3875	1015	
1086 8500	10 5370	1308	
1087 9379	10 6242	1568	
108810160	10 6814	1640	
108910654	10 7631	1841	
109011068	10 7996	2045	
109111808	10 8856	2324	
109212338	10 9124	2551	
109312806	10 9903	2516	
109413236	1010046	2653	
109513692	1010613	2930	
109614498	1012768	3729	
109715846	1013993	3977	
109817135	1015531	4843	
109919096	1019074	6643	
11 023868	1025577	9440	

Figure A3:25-8 WINNIPEG: Demand Calibration Data

```
0000 Demand Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1161.1307.6500.3993.8          |  20 6313.7539.4822.41524.
20 2167.9357.7531.4791.9          |  20 7337.2560.6766.61081.
20 3387.7626.6835.41213.          |  20 8585.6896.51143.1588.
20 4202.5387.7615.6893.6          |  20 9529.7761.9958.41342.
20 5386.9608.4820.31132.          |  2010615.4912.81146.1601.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.535-.166.3262.1319.180560.0458.35161.11.430
21 2    0-.543-.160.3393.1114.199363.0260.25167.91.431
21 3    0-.307-.108.2459.2600.053381.29210.4387.71.434
21 4    0-.498-.233.3147-.034.162269.7980.02202.51.422
21 5    0-.309-.084.2725.3532.116282.16209.0386.91.430
21 6    0-.574-.174.3497.0632.2216109.0104.6313.71.642
21 7    0-.485-.176.3061.0715.134396.65136.1337.21.667
21 8    0-.312-.190.1965.0384-.047108.5315.6585.61.639
21 9    0-.357-.221.2536-.009.0503109.6266.8529.71.695
2110    0-.299-.151.2561.1634.1109108.8338.6615.41.648
0000  (quartile 02)
22 1    0-.355-.145.2386.2127.043275.78154.4307.61.430
22 2    0-.303-.125.1905.2545-.05275.61193.6357.71.431
22 3    0-.202-.091.1684.3099.005887.66388.7626.61.433
22 4    0-.285-.136.1169.2130-.28477.53214.5387.71.432
22 5    0-.205-.107.0910.2520-.30487.16375.4608.41.430
22 6    0-.414-.179.2670.0980.0868134.4246.5539.41.654
22 7    0-.350-.237.1391-.115-.243118.4283.4560.61.650
22 8    0-.237-.100.1382.2766-.221129.0530.4896.51.652
22 9    0-.294-.132.2432.2090.0610130.9418.0761.91.699
2210    0-.244-.119.1324.2040-.228133.8536.3912.81.659
0000  (quartile 03)
23 1    0-.260-.121.1523.2360-.15790.68287.6500.31.427
23 2    0-.216-.091.1030.3504-.29480.45322.9531.41.430
23 3    0-.161-.085.0923.2782-.27094.01544.0835.41.428
23 4    0-.217-.113.1197.2504-.24392.93374.1615.61.433
23 5    0-.178-.100.1008.2492-.307101.6523.4820.31.433
23 6    0-.308-.102.2503.3494.1559154.4442.1822.41.630
23 7    0-.337-.195.1552.0277-.220155.2395.4766.61.654
23 8    0-.213-.074.2324.3816.1671148.6698.31143.1.634
23 9    0-.280-.137.1412.1664-.262157.7535.5958.41.705
2310    0-.227-.154.0787.0171-.441154.6690.51146.1.662
0000  (quartile 04)
24 1    0-.182-.097.1091.2764-.223126.2631.1993.81.427
24 2    0-.174-.088.0911.2775-.27995.71508.0791.91.433
24 3    0-.118-.059.0601.3348-.35199.83830.11213.1.430
24 4    0-.164-.071.0623.4100-.413103.1578.8893.61.427
24 5    0-.126-.068.0720.3766-.25599.91767.51132.1.423
24 6    0-.285-.130.1739.2312.0365256.0851.51524.1.664
24 7    0-.258-.123.1234.2523-.250168.2621.71081.1.655
24 8    0-.192-.101.0955.2575-.315184.8995.11588.1.647
24 9    0-.265-.129.1352.2247-.216205.2764.71342.1.731
2410    0-.204-.102.0810.2535-.336194.8990.21601.1.665
```

Figure A3:25-8(cont) WINNIPEG: Demand Calibration Data

```
0000 Demand Calibration

0000 "MODEL" DWELLINGS
30 1   30    1    1 | 3035   87    3    1 | 3069  107    2    2
30 2   54    1    1 | 3036   98    3    1 | 3070  112    2    2
30 3   61    1    1 | 3037  111    3    1 | 3071  115    2    2
30 4   66    1    1 | 3038  146    3    1 | 3072  118    2    2
30 5   70    1    1 | 3039   77    4    1 | 3073  121    2    2
30 6   74    1    1 | 3040  124    4    1 | 3074  124    2    2
30 7   78    1    1 | 3041  109    5    1 | 3075  127    2    2
30 8   80    1    1 | 3042   46    1    2 | 3076  130    2    2
30 9   83    1    1 | 3043   66    1    2 | 3077  134    2    2
3010   86    1    1 | 3044   70    1    2 | 3078  139    2    2
3011   89    1    1 | 3045   74    1    2 | 3079  143    2    2
3012   92    1    1 | 3046   78    1    2 | 3080  147    2    2
3013   95    1    1 | 3047   83    1    2 | 3081  152    2    2
3014   99    1    1 | 3048   87    1    2 | 3082  162    2    2
3015  102    1    1 | 3049   91    1    2 | 3083  177    2    2
3016  106    1    1 | 3050   94    1    2 | 3084  218    2    2
3017  111    1    1 | 3051   97    1    2 | 3085   77    3    2
3018  115    1    1 | 3052  100    1    2 | 3086  111    3    2
3019  121    1    1 | 3053  103    1    2 | 3087  151    3    2
3020  129    1    1 | 3054  106    1    2 | 3088   66    4    2
3021  148    1    1 | 3055  109    1    2 | 3089   95    4    2
3022   51    2    1 | 3056  112    1    2 | 3090  109    4    2
3023   69    2    1 | 3057  115    1    2 | 3091  118    4    2
3024   78    2    1 | 3058  118    1    2 | 3092  125    4    2
3025   85    2    1 | 3059  123    1    2 | 3093  131    4    2
3026   90    2    1 | 3060  129    1    2 | 3094  137    4    2
3027   94    2    1 | 3061  136    1    2 | 3095  144    4    2
3028   99    2    1 | 3062  144    1    2 | 3096  151    4    2
3029  104    2    1 | 3063  175    1    2 | 3097  162    4    2
3030  110    2    1 | 3064   62    2    2 | 3098  193    4    2
3031  119    2    1 | 3065   82    2    2 | 3099  108    5    2
3032  145    2    1 | 3066   91    2    2 | 31 0  177    5    2
3033   41    3    1 | 3067   97    2    2
3034   76    3    1 | 3068  102    2    2 |

0000 ZONAL Data
40 1 6136   38       | 40 2 9525   60       | 40 3 6515   21
40 412250  104       | 40 519889  110       | 40 615661   54
0000  Parameters
5011 .39             | 50121.04             | 5013 0.0
5016 .39             | 50171.27             | 5018 0.0
50201.289            |

0000 Calibration Data
70 11.5680.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   77971.000 96.5
70 21.6640.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  113521.000115.9
70 31.4400.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   65931.000 99.6
70 41.6960.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  105741.000125.6
70 51.4790.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  152921.000131.0
70 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0       00.0     0.0
```

Figure A3:25-8(cont) WINNIPEG: Demand Calibration Data

0000 Supply Calibration

0000 "MODEL" MODIFIED HOUSEHOLDs

10	1	1305	1	-515	0	105119076	616618 6180
10	2	1919	1	188	12	1052 3266	7 811 207
10	3	2217	1	130	52	1053 5486	7 3016 622
10	4	3132	1	462	127	1054 6698	7 4314 966
10	5	4171	1	1357	284	1055 8127	7 5794 1411
10	6	8259	1	7305	2614	1056 9034	7 6016 1489
10	7	845	2	-239	0	105710272	7 7441 2002
10	8	1558	2	491	64	105812663	711355 3873
10	9	1860	2	754	179	1059 5604	8 2539 573
1010		2470	2	1502	325	1060 7931	8 5009 1157
1011		3406	2	2342	442	1061 9128	8 6350 1499
1012		4159	2	3168	637	1062 9957	8 7162 1801
1013		4787	2	4244	926	106310562	8 8017 1927
1014		5505	2	5008	1159	106411215	8 8984 2122
1015		6098	2	5798	1404	106511960	8 9690 2487
1016		6944	2	6711	1728	106612902	810585 2709
1017		8111	2	8081	2244	106713859	812330 3210
101810758			212915		4718	106815103	813685 3677
1019		3207	3	1116	278	106916436	815051 4429
1020		4905	3	2876	570	107023718	82771611097
1021		6095	3	4330	912	1071 2276	9 -593 94
1022		7133	3	5713	1254	1072 5437	9 2356 496
1023		7670	3	6357	1366	1073 7193	9 3873 833
1024		8685	3	7518	1626	1074 8045	9 4635 1050
1025		9380	3	8386	1948	1075 8680	9 5827 1431
102610153			3	9337	2191	1076 9407	9 6242 1562
102711163			310751		2624	107710121	9 7225 1912
102812685			312572		3364	107810633	9 7201 1904
102916138			317446		5156	107911182	9 8149 2269
1030		728	4	-1084	0	108011967	9 9225 2701
1031		2469	4	632	144	108112831	910722 3383
1032		3830	4	1758	348	108213865	911680 3914
1033		5153	4	2648	523	108318543	920151 9028
1034		6716	4	4248	944	1084 4868	10 1152 362
1035		7962	4	5911	1447	1085 7288	10 3875 1015
103611180			411011		3829	1086 8500	10 5370 1308
1037		4170	5	983	296	1087 9379	10 6242 1568
1038		6355	5	3936	839	108810160	10 6814 1640
1039		7899	5	5601	1281	108910654	10 7631 1841
1040		9803	5	7990	2072	109011068	10 7996 2045
104113268			512576		3505	109111808	10 8856 2324
1042		2355	6	-396	12	109212338	10 9124 2551
1043		3572	6	-370	46	109312806	10 9903 2516
1044		4272	6	-273	38	109413236	1010046 2653
1045		5164	6	525	173	109513692	1010613 2930
1046		5937	6	1193	295	109614498	1012768 3729
1047		6730	6	1850	377	109715846	1013993 3977
1048		7545	6	2566	577	109817135	1015531 4843
1049		8683	6	3430	779	109919096	1019074 6643
105010382			6	5772	1448	11 023868	1025577 9440

Figure A3:26-8 WINNIPEG: Supply Calibration Data

```
0000 Supply Calibration

0000 Mean AFTER TAX INCOME by Household TYPE
20 1161.1307.6500.3993.8          | 20 6313.7539.4822.41524.
20 2167.9357.7531.4791.9          | 20 7337.2560.6766.61081.
20 3387.7626.6835.41213.          | 20 8585.6896.51143.1588.
20 4202.5387.7615.6893.6          | 20 9529.7761.9958.41342.
20 5386.9608.4820.31132.          | 2010615.4912.81146.1601.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.535-.166.3262.1319.180560.0458.35161.11.430
21 2    0-.543-.160.3393.1114.199363.0260.25167.91.431
21 3    0-.307-.108.2459.2600.053381.29210.4387.71.434
21 4    0-.498-.233.3147-.034.162269.7980.02202.51.422
21 5    0-.309-.084.2725.3532.116282.16209.0386.91.430
21 6    0-.574-.174.3497.0632.2216109.0104.6313.71.642
21 7    0-.485-.176.3061.0715.134396.65136.1337.21.667
21 8    0-.312-.190.1965.0384-.047108.5315.6585.61.639
21 9    0-.357-.221.2536-.009.0503109.6266.8529.71.695
2110    0-.299-.151.2561.1634.1109108.8338.6615.41.648
0000  (quartile 02)
22 1    0-.355-.145.2386.2127.043275.78154.4307.61.430
22 2    0-.303-.125.1905.2545-.05275.61193.6357.71.431
22 3    0-.202-.091.1684.3099.005887.66388.7626.61.433
22 4    0-.285-.136.1169.2130-.28477.53214.5387.71.432
22 5    0-.205-.107.0910.2520-.30487.16375.4608.41.430
22 6    0-.414-.179.2670.0980.0868134.4246.5539.41.654
22 7    0-.350-.237.1391-.115-.243118.4283.4560.61.650
22 8    0-.237-.100.1382.2766-.221129.0530.4896.51.652
22 9    0-.294-.132.2432.2090.0610130.9418.0761.91.699
2210    0-.244-.119.1324.2040-.228133.8536.3912.81.659
0000  (quartile 03)
23 1    0-.260-.121.1523.2360-.15790.68287.6500.31.427
23 2    0-.216-.091.1030.3504-.29480.45322.9531.41.430
23 3    0-.161-.085.0923.2782-.27094.01544.0835.41.428
23 4    0-.217-.113.1197.2504-.24392.93374.1615.61.433
23 5    0-.178-.100.1008.2492-.307101.6523.4820.31.433
23 6    0-.308-.102.2503.3494.1559154.4442.1822.41.630
23 7    0-.337-.195.1552.0277-.220155.2395.4766.61.654
23 8    0-.213-.074.2324.3816.1671148.6698.31143.1.634
23 9    0-.280-.137.1412.1664-.262157.7535.5958.41.705
2310    0-.227-.154.0787.0171-.441154.6690.51146.1.662
0000  (quartile 04)
24 1    0-.182-.097.1091.2764-.223126.2631.1993.81.427
24 2    0-.174-.088.0911.2775-.27995.71508.0791.91.433
24 3    0-.118-.059.0601.3348-.35199.83830.11213.1.430
24 4    0-.164-.071.0623.4100-.413103.1578.8893.61.427
24 5    0-.126-.068.0720.3766-.25599.91767.51132.1.423
24 6    0-.285-.130.1739.2312.0365256.0851.51524.1.664
24 7    0-.258-.123.1234.2523-.250168.2621.71081.1.655
24 8    0-.192-.101.0955.2575-.315184.8995.11588.1.647
24 9    0-.265-.129.1352.2247-.216205.2764.71342.1.731
2410    0-.204-.102.0810.2535-.336194.8990.21601.1.665
```

Figure A3:26-8(cont) WINNIPEG: Supply Calibration Data

```
0000 Supply Calibration

0000 "MODEL" DWELLINGS
30 1   31    1   1 | 3027   47    1   2 | 3053   88    2   2
30 2   51    1   1 | 3028   65    1   2 | 3054   96    2   2
30 3   60    1   1 | 3029   80    1   2 | 3055  101    2   2
30 4   66    1   1 | 3030   84    1   2 | 3056  103    2   2
30 5   71    1   1 | 3031   86    1   2 | 3057  106    2   2
30 6   73    1   1 | 3032   88    1   2 | 3058  108    2   2
30 7   76    1   1 | 3033   91    1   2 | 3059  110    2   2
30 8   79    1   1 | 3034   93    1   2 | 3060  113    2   2
30 9   83    1   1 | 3035   95    1   2 | 3061  115    2   2
3010   87    1   1 | 3036   98    1   2 | 3062  118    2   2
3011   93    1   1 | 3037  100    1   2 | 3063  120    2   2
3012   99    1   1 | 3038  103    1   2 | 3064  123    2   2
3013  109    1   1 | 3039  105    1   2 | 3065  128    2   2
3014  139    1   1 | 3040  107    1   2 | 3066  132    2   2
3015   62    2   1 | 3041  110    1   2 | 3067  137    2   2
3016   81    2   1 | 3042  112    1   2 | 3068  145    2   2
3017   94    2   1 | 3043  116    1   2 | 3069  167    2   2
3018  111    2   1 | 3044  119    1   2 | 3070   60    3   2
3019  151    2   1 | 3045  122    1   2 | 3071   87    3   2
3020   26    3   1 | 3046  126    1   2 | 3072  101    3   2
3021   53    3   1 | 3047  129    1   2 | 3073  124    3   2
3022   68    3   1 | 3048  132    1   2 | 3074   63    4   2
3023   81    3   1 | 3049  137    1   2 | 3075   93    4   2
3024   93    3   1 | 3050  158    1   2 | 3076  109    4   2
3025  122    3   1 | 3051   63    2   2 | 3077  122    4   2
3026  112    4   1 | 3052   80    2   2 | 3078  144    4   2

0000 ZONAL Data
40 1 6136   38      | 40 2 9525   60      | 40 3 6515   21
40 412250  104      | 40 519889  110      | 40 615661   54
0000  Parameters
50 1 .4             | 50 2 .1             |
5011 .39            | 50121.04            | 5013 40.
5016 .39            | 50171.27            | 5018 79.
50201.289           |

0000 Calibration Data
70 11.3880.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   73291.000 97.1
70 21.4020.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  111321.000100.8
70 31.3240.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   65730.884101.1
70 41.4000.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  103451.000105.9
70 51.2520.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  159331.000123.0
70 61.5360.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   94001.000114.4
70 71.5670.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   80840.905109.8
70 81.7440.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  115800.896111.1
70 91.4590.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   66620.838117.3
70101.7720.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  101851.000121.3
70111.4220.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  193691.000146.9
70121.7210.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  113601.000135.0
```

Figure A3:26-8(cont) WINNIPEG: Supply Calibration Data

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
10  1 1305     1 -514     0          31.302 46.5
10  2 1919     1  188    12          51.398 61.7
10  3 2217     1  130    52          61.427 65.5
10  4 3132     1  462   127          91.433 75.0
10  5 4171     1 1357   284         241.417 82.6
10  6 8259     1 7305  2614         141.377118.1
10  7  845     2 -238     0         211.182 34.9
10  8 1558     2  491    64         151.372 52.3
10  9 1860     2  754   179         221.411 60.0
1010 2470     2 1502   325          81.431 71.2
1011 3406     2 2342   442         101.432 78.5
1012 4159     2 3168   637         161.454 74.8
1013 4787     2 4244   926        9991.573 66.9
1014 5505     2 5008  1159        9991.573 68.5
1015 6098     2 5798  1404        9991.573 68.2
1016 6944     2 6711  1728        9991.573 71.0
1017 8111     2 8081  2244        9991.573 76.7
101810758     212915 4718         9991.573 91.9
1019 3207     3 1116   278          41.415 58.4
1020 4905     3 2876   570         121.410 87.2
1021 6095     3 4330   912        9991.573 76.9
1022 7133     3 5713  1254        9991.573 76.1
1023 7670     3 6357  1366        9991.573 75.3
1024 8685     3 7518  1626        9991.573 77.9
1025 9380     3 8386  1948         261.399 97.5
102610153     3 9337  2191        9991.573 79.2
102711163     310751 2624          251.380104.0
102812685     312572 3364        9991.573 84.0
102916138     317446 5156          191.347123.7
1030  728     4-1083     0          11.303 24.1
1031 2469     4  632   144          71.446 69.8
1032 3830     4 1758   348         111.415 82.4
1033 5153     4 2648   523         171.416 83.3
1034 6716     4 4248   944         131.400 94.9
1035 7962     4 5911  1447         181.415 98.3
103611180     411011 3829        9991.573 89.1
1037 4170     5  983   296          231.443 74.0
1038 6355     5 3936   839        9991.573 75.9
1039 7899     5 5601  1281        9991.573 76.9
1040 9803     5 7990  2072        9991.573 85.6
104113268     512576 3505        9991.573 83.4
1042 2355     6 -395    12          281.519 76.3
1043 3572     6 -369    46          321.576110.0
1044 4272     6 -272    38          331.626119.6
1045 5164     6  525   173          371.624131.0
1046 5937     6 1193   295          401.612138.3
1047 6730     6 1850   377          421.606143.9
1048 7545     6 2566   577          441.599152.1
1049 8683     6 3430   779          621.622154.9
105010382     6 5772  1448         9991.826134.1
```

Figure A3:27-8 WINNIPEG: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" MODIFIED HOUSEHOLDS and BASE Data
105119076    616618 6180        9991.826232.2
1052 3266    7  811  207         521.505 91.5
1053 5486    7 3016  622         531.635116.1
1054 6698    7 4314  966         751.624121.8
1055 8127    7 5794 1411         431.599147.9
1056 9034    7 6016 1489         461.604161.4
105710272    7 7441 2002         481.610170.1
105812663    711355 3873         661.628173.3
1059 5604    8 2539  573         301.528 99.7
1060 7931    8 5009 1157         341.617121.3
1061 9128    8 6350 1499         361.620128.0
1062 9957    8 7162 1801         381.608132.8
106310562    8 8017 1927         391.605134.7
106411215    8 8984 2122         551.636134.0
106511960    8 9690 2487         571.629139.9
106612902    810585 2709        9991.826119.2
106713859    812330 3210        9991.826123.4
106815103    813685 3677        9991.826131.4
106916436    815051 4429        9991.826139.4
107023718    82771611097        9991.826191.0
1071 2276    9 -592   94         511.340 57.8
1072 5437    9 2356  496         311.585106.2
1073 7193    9 3873  833         541.643125.8
1074 8045    9 4635 1050         411.602138.3
1075 8680    9 5827 1431         591.617140.4
1076 9407    9 6242 1562         611.616146.5
107710121    9 7225 1912         731.608156.7
107810633    9 7201 1904         471.608162.9
107911182    9 8149 2269         491.599171.2
108011967    9 9225 2701         671.627176.0
108112831    910722 3383         501.589194.8
108213865    911680 3914         691.596207.0
108318543    920151 9028        9991.826215.7
1084 4868   10 1152  362         291.472 88.6
1085 7288   10 3875 1015         711.619113.4
1086 8500   10 5370 1308         351.624124.3
1087 9379   10 6242 1568         721.619131.4
108810160   10 6814 1640         561.627134.9
108910654   10 7631 1841         761.609140.1
109011068   10 7996 2045         581.621140.6
109111808   10 8856 2324         601.622147.1
109212338   10 9124 2551         451.600155.2
109312806   10 9903 2516         771.612157.2
109413236   1010046 2653         631.631157.6
109513692   1010613 2930         641.630161.3
109614498   1012768 3729         651.631168.0
109715846   1013993 3977         781.605184.0
109817135   1015531 4843         681.628189.6
109919096   1019074 6643        9991.826165.8
11 023868   1025577 9440        9991.826206.7
```

Figure A3:27-8 WINNIPEG: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 Mean AFTER TAX INCOME by Household TYPE
20 1161.1307.6500.3993.8          |  20 6313.7539.4822.41524.
20 2167.9357.7531.4791.9          |  20 7337.2560.6766.61081.
20 3387.7626.6835.41213.          |  20 8585.6896.51143.1588.
20 4202.5387.7615.6893.6          |  20 9529.7761.9958.41342.
20 5386.9608.4820.31132.          |  2010615.4912.81146.1601.

0000 Demand PARAMETERS by TYPE
0000  (quartile 01)
21 1    0-.535-.166.3262.1319.180560.0458.35161.11.430
21 2    0-.543-.160.3393.1114.199363.0260.25167.91.431
21 3    0-.307-.108.2459.2600.053381.29210.4387.71.434
21 4    0-.498-.233.3147-.034.162269.7980.02202.51.422
21 5    0-.309-.084.2725.3532.116282.16209.0386.91.430
21 6    0-.574-.174.3497.0632.2216109.0104.6313.71.642
21 7    0-.485-.176.3061.0715.134396.65136.1337.21.667
21 8    0-.312-.190.1965.0384-.047108.5315.6585.61.639
21 9    0-.357-.221.2536-.009.0503109.6266.8529.71.695
2110    0-.299-.151.2561.1634.1109108.8338.6615.41.648
0000  (quartile 02)
22 1    0-.355-.145.2386.2127.043275.78154.4307.61.430
22 2    0-.303-.125.1905.2545-.05275.61193.6357.71.431
22 3    0-.202-.091.1684.3099.005887.66388.7626.61.433
22 4    0-.285-.136.1169.2130-.28477.53214.5387.71.432
22 5    0-.205-.107.0910.2520-.30487.16375.4608.41.430
22 6    0-.414-.179.2670.0980.0868134.4246.5539.41.654
22 7    0-.350-.237.1391-.115-.243118.4283.4560.61.650
22 8    0-.237-.100.1382.2766-.221129.0530.4896.51.652
22 9    0-.294-.132.2432.2090.0610130.9418.0761.91.699
2210    0-.244-.119.1324.2040-.228133.8536.3912.81.659
0000  (quartile 03)
23 1    0-.260-.121.1523.2360-.15790.68287.6500.31.427
23 2    0-.216-.091.1030.3504-.29480.45322.9531.41.430
23 3    0-.161-.085.0923.2782-.27094.01544.0835.41.428
23 4    0-.217-.113.1197.2504-.24392.93374.1615.61.433
23 5    0-.178-.100.1008.2492-.307101.6523.4820.31.433
23 6    0-.308-.102.2503.3494.1559154.4442.1822.41.630
23 7    0-.337-.195.1552.0277-.220155.2395.4766.61.654
23 8    0-.213-.074.2324.3816.1671148.6698.31143.1.634
23 9    0-.280-.137.1412.1664-.262157.7535.5958.41.705
2310    0-.227-.154.0787.0171-.441154.6690.51146.1.662
0000  (quartile 04)
24 1    0-.182-.097.1091.2764-.223126.2631.1993.81.427
24 2    0-.174-.088.0911.2775-.27995.71508.0791.91.433
24 3    0-.118-.059.0601.3348-.35199.83830.11213.1.430
24 4    0-.164-.071.0623.4100-.413103.1578.8893.61.427
24 5    0-.126-.068.0720.3766-.25599.91767.51132.1.423
24 6    0-.285-.130.1739.2312.0365256.0851.51524.1.664
24 7    0-.258-.123.1234.2523-.250168.2621.71081.1.655
24 8    0-.192-.101.0955.2575-.315184.8995.11588.1.647
24 9    0-.265-.129.1352.2247-.216205.2764.71342.1.731
2410    0-.204-.102.0810.2535-.336194.8990.21601.1.665
```

Figure A3:27-8(cont) WINNIPEG: MODIFIED Policy Dataset

```
0000 Policy Dataset

0000 "MODEL" DWELLINGS
30 1   31    1   1 | 3027   47    1   2 | 3053   88    2   2
30 2   51    1   1 | 3028   65    1   2 | 3054   96    2   2
30 3   60    1   1 | 3029   80    1   2 | 3055  101    2   2
30 4   66    1   1 | 3030   84    1   2 | 3056  103    2   2
30 5   71    1   1 | 3031   86    1   2 | 3057  106    2   2
30 6   73    1   1 | 3032   88    1   2 | 3058  108    2   2
30 7   76    1   1 | 3033   91    1   2 | 3059  110    2   2
30 8   79    1   1 | 3034   93    1   2 | 3060  113    2   2
30 9   83    1   1 | 3035   95    1   2 | 3061  115    2   2
3010   87    1   1 | 3036   98    1   2 | 3062  118    2   2
3011   93    1   1 | 3037  100    1   2 | 3063  120    2   2
3012   99    1   1 | 3038  103    1   2 | 3064  123    2   2
3013  109    1   1 | 3039  105    1   2 | 3065  128    2   2
3014  139    1   1 | 3040  107    1   2 | 3066  132    2   2
3015   62    2   1 | 3041  110    1   2 | 3067  137    2   2
3016   81    2   1 | 3042  112    1   2 | 3068  145    2   2
3017   94    2   1 | 3043  116    1   2 | 3069  167    2   2
3018  111    2   1 | 3044  119    1   2 | 3070   60    3   2
3019  151    2   1 | 3045  122    1   2 | 3071   87    3   2
3020   26    3   1 | 3046  126    1   2 | 3072  101    3   2
3021   53    3   1 | 3047  129    1   2 | 3073  124    3   2
3022   68    3   1 | 3048  132    1   2 | 3074   63    4   2
3023   81    3   1 | 3049  137    1   2 | 3075   93    4   2
3024   93    3   1 | 3050  158    1   2 | 3076  109    4   2
3025  122    3   1 | 3051   63    2   2 | 3077  122    4   2
3026  112    4   1 | 3052   80    2   2 | 3078  144    4   2

0000 ZONAL Data
40 1 6136   38      | 40 2 9525   60      | 40 3 6515   21
40 412250  104      | 40 519889  110      | 40 615661   54

0000  Parameters
50 10.400           | 50 20.100           |
50 30.575           | 50 40.350           | 50 71.097
50 50.450           | 50 60.550           | 50 80.979
50110.390           | 50121.040           | 5013 66.0
50160.390           | 50171.270           | 5018 79.0
50201.289           |
```

Figure A3:27-8(cont) WINNIPEG: MODIFIED Policy Dataset

PROGRAM:FO9:SIMO1.FORT

```
      CS    FO9:SIMO1.FORT
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C    HOUSING MARKET SIMULATION PROGRAM with ORIGINAL MODE
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
            COMMON/BLK8/DU1(36720)
            COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),DU2(
            REAL*4 DAT(5)
            EQUIVALENCE (PAR(21),DAT(1)),(PAR(40),TOL),(IC1(7),
           * ,(IC1(8),IOP),(IC1(10),NS),(IC1(20),NCI),(IC1(6),M
      C...
      C.D   DEFINE FILE 7(502,251,U,M1),8(502,1506,U,M2),9(502,
      C...
            CALL CL$1(IR)
      C.DC  CALL REREAD
            MSIZE=120
            IP=0
            IG=0
      C...
      C... load DATA
          5 CALL IN$DAT(NER,IP,IG,IR)
            CALL OT$1
      C... calc # groups and error check
            CALL CL$2(NER)
      C...
            IP1=IP
      C...
            CALL OT$2(NER,IP1)
            IF(IP1.GE.1.AND.IP1.LE.10.AND.IOP.NE.0)CALL OT$CAL
      C...
      C... "parameter" iteration control
      C...
            IR1=1
            IR2=1
            IT1=0
            IT2=0
      C...
            DO 11 I=1,5
            IF(DAT(I).EQ.0)GOTO 11
            IF(IT1.NE.0.AND.IT2.EQ.0)IT2=I
            IF(IT1.EQ.0)IT1=I
         11 CONTINUE
      C...
            IF(IT1.EQ.0)GOTO 10
            IR1=4
            B1=PAR(IT1)
            IF(PAR(IT1).EQ.DAT(IT1))IR1=1
```

PROGRAM:F09:SIMO1.FORT

```
      IF(IT2.EQ.O)GOTO 1O
      IR2=4
      B2=PAR(IT2)
      IF(PAR(IT2).EQ.DAT(IT2))IR2=1
C...
   1O DO 3 I2=1,IR2
      IF(IR2.EQ.1)GOTO 12
      PAR(IT2)=B2+((DAT(IT2)-B2)/3.)*FLOAT(I2-1)
C...
   12 DO 3 I1=1,IR1
      IF(IR1.EQ.1)GOTO 13
      PAR(IT1)=B1+((DAT(IT1)-B1)/3.)*FLOAT(I1-1)
      IF(I1.NE.1)IP1=O
C...
   13 CALL CL$3(IP1,IST)
C... output initial conditions
      CALL OT$3(IP1)
C... simulating for convergence in externalities
      DO 1 I=1,NCI
      L=I
      IF(L.GT.2)L=2
C...
C... calc full utility for each simulation run
      CALL CL$4
      IF(IP1.GE.2.AND.IP1.LE.1O)CALL OT$4(IP1)
C...
C... call sort routine
      CALL SRT$1(L)
      IF(IP1.GT.2.AND.IP1.LE.1O)CALL OT$4A(IP1)
C... allocation routine
      CALL CL$5(IP)
      IF(IP1.EQ.1O.AND.NS.NE.O)CALL CL$SB1(1)
      IF(IP1.EQ.1O)CALL OT$5
C... calc externalities
      CALL CL$1O(SER)
      CALL OT$1O(SER)
      IF(SER.LT.TOL)GOTO 2
C...
    1 CONTINUE
C...
    2 IF(NS.NE.O)CALL CL$SB1(2)
      IF(IP1.EQ.1.OR.IP1.EQ.2)CALL OT$5
C...
      IF(IOP.EQ.1.OR.IOP.EQ.2)CALL CL$2O(IOP)
      IF(IOP.EQ.3)CALL OT$7
      IF(NS.NE.O)CALL OT$SB
      IF(IOP.EQ.3)CALL OT$BS
      IF(IG.NE.O)CALL AL$GRP(IG)
    3 CONTINUE
C...
C... reset parameters
```

PROGRAM:F09:SIMO1.FORT

```
      IF(IT1.NE.0)PAR(IT1)=B1
      IF(IT2.NE.0)PAR(IT2)=B2
C...
      GOTO 5
      END
C...
C...
      SUBROUTINE IN$DAT(NER,IP,IG,IR)
C... routine to load the REQUIRED data.
      INTEGER*2 EQ(502)
      REAL*4 DAT(5),ACT(12,11)
      INTEGER*4 IGIVEN(9),C1,C2
      REAL*8 ERR(10)
      COMMON/BLK8/ERR,RD(12)
      COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
      EQUIVALENCE (PAR(21),DAT(1)),(IC1(20),NCI)
     * ,(IC1(6),MSIZE),(IC1(8),IOP),(IC1(11),IGIVEN(1))
     * ,(PAR(26),YFORM),(PAR(27),COEF),(PAR(37),PPP)
     * ,(HHD(2001),ACT(1,1))
C
C... input data format
C...          DATA type identifier.
C...   1234            :56789   :*1234   :56789
C...   0000  title
C...   10    households :income  :type
C...   20    hhlds types:income
C...   21    hhlds types:alphas
C...   2200  TENURE BY TYPE
C...   2300  ALPHA ADJUSTMENT FACTOR
C...   2400 INCOME FORM USED INTERNALLY
C...
C...   30    dwellings  :services:zone
C...   40    zonal      :"wealth":distance
C...   5001  GAMMA1(PRICE )     5011
C...   5002  GAMMA2(WEALTH)     5012
C...   5003  GAMMA3(ACCESS)     5013
C...   5004  BETA1              5014
C...   5005  BETA2              5015
C...
C...   6001  operating cost
C...   6002  capital cost
C...   6003  MIN "Q"
C...
C...   70    actual zonal:price   :%type 1 :::::::%type8:
C...   810   POLICY CONTR:TYPE    :PAR1:  :  :  ::PAR6:IN
C...   8200             :ELIGIBLE HOUSEHOLD TYPES.
C...   8300             :GIVEN NEW PUBLIC HOUSING
C...   8400             :REDUCTION IN PURCHASING POWER
C...   8900             :PRICE ELASTICITY PARAMETER
C...   9000  MODEL SPECIFICATION
```

PROGRAM:F09:SIM01.FORT

```
C...   9100  print contol
C...   9200  graph control 0 or 60 or 120
C...   9201  graph type  1 print supply fn co-ords.
C...   9500  # ITERATIONS FOR CONVERGENCE
C...   9900  start "POLICY" run
C...   9901  start GAMMA CALIBRATION RUN
C...   9902  start BETA  CALIBRATION RUN
C...   9903  start "BASE" run
C
      IC=0
C...
  120 READ(IR,1,ERR=10,END=11)I1
C.DC  IQ=99
      IQ=IR
      BACKSPACE IR
      IC=IC+1
      IF(I1.EQ.0)GOTO 20
C...
      READ(IQ,1,ERR=10)C1,C2,I2,RD
    1 FORMAT(2I1,I2,12F5.0)
      I1=10*C1+C2
      IF(I1.EQ.99)GOTO 16
      I=I1/10
C
      IF(I.EQ.9)GOTO 90
      GOTO(21,22,23,24,25,27,44,80),I
C...TITLE
C
   20 READ(IQ,3)TITLE
    3 FORMAT(4X,6A4)
      GOTO 120
C...
C...HOUSEHOLD DATA
   21 I2=I2+100*C2
      IF(I2.GT.MSIZE-1.OR.I2.LT.1)GOTO 30
      DO 31 I=1,5
      IF(RD(I).EQ.0.0.AND.I.LE.2)GOTO 40
      K=I
      IF(K.GE.3)K=K+1
   31 HHD(I2,K)=RD(I)
      EQ(I2)=HFIX(RD(10))
      GOTO 120
C...
C...HOUSEHOLD TYPE DATA
   22 IF(I1.EQ.23)GOTO 33
      IF(I1.EQ.24)GOTO 34
      IF(I1.EQ.22)GOTO 32
      IF(I2.GT.10.OR.I2.LT.1)GOTO 30
      I=1
      IF(I1.EQ.21)I=2
      IF(RD(1).EQ.0)GOTO 40
```

```
204             HHT(I2,I)=RD(1)
205             GOTO 120
206       C...
207       C... TENURE BY TYPE
208          32 DO 132 I2=1,10
209             IF(RD(I2).LT.0.0.OR.RD(I2).GT.2.0)GOTO 120
210         132 HHT(I2,4)=RD(I2)
211             GOTO 120
212       C... ALPHA ADJUSTMENT FACTOR
213          33 COEF=RD(1)/10000.
214             GOTO 120
215       C... INCOME FORM USED
216          34 YFORM=RD(1)
217             GOTO 120
218       C...
219       C... DWELLING DATA
220          23 I2=I2+100*C2
221             IF(I2.GT.MSIZE-1.OR.I2.LT.1)GOTO 30
222       C...
223             IF(RD(2).LE.5)GOTO 35
224             RD(2)=RD(3)
225             RD(3)=RD(4)
226          35 DO 133 I=1,3
227             IF(RD(I).EQ.0.AND.I.NE.3)GOTO 40
228         133 DWD(I,I2)=RD(I)
229             IF(RD(3).GT.2.)DWD(3,I2)=0.0
230             GOTO 120
231       C...
232       C... ZONAL DATA
233          24 IF(I2.GT.11.OR.I2.LT.1)GOTO 30
234             DO 134 I=1,2
235             IF(RD(I).EQ.0.0)GOTO 40
236         134 ZOD(I,I2)=RD(I)
237             GOTO 120
238       C...
239       C... load zonal data for calibration
240          44 IF(I2.GT.20.OR.I2.LT.1)GOTO 30
241             DO 54 I=1,12
242             IF(RD(I).LT.0)GOTO 40
243          54 ACT(I,I2)=RD(I)
244             GOTO 120
245       C...
246       C... PARAMETERS
247          25 IF(I2.GE.11.AND.I2.LE.15)GOTO 26
248             IF(I2.LT.0.OR.I2.GT.5)GOTO 30
249             IF(RD(1).LT.0.OR.RD(1).GT.1.)GOTO 40
250             IF(RD(2).LT.0.OR.RD(2).GT.1.)GOTO 40
251             PAR(I2)=RD(1)
252             DAT(I2)=RD(2)
253             GOTO 120
254       C...
```

```
      26 IF(RD(1).LT.O.OR.RD(1).GT.1.)GOTO 40
         DAT(I2-10)=RD(1)
         GOTO 120
C...
      27 IF(I2.LT.O.OR.I2.GT.3)GOTO 30
         IF(RD(1).LT.O.)GOTO 40
         PAR(I2+5)=RD(1)
         GOTO 120
C...
C... POLICY PARAMETERS
      80 K=I1-80
         IF(K.EQ.9)GOTO 89
         IF(I2.EQ.O)I2=1
         IF(I2.LT.1.OR.I2.GT.4)GOTO 30
         GOTO(81,82,83,84),K
         GOTO 12
      81 IPOL(1,I2)=IFIX(RD(1))
         IPOL(2,I2)=IFIX(RD(1)*10.-FLOAT(IFIX(RD(1))*10)+.01
         DO 181 I=1,10
     181 POL(I,I2)=RD(I+1)
         GOTO 120
C... ELIGIBILITY
      82 DO 182 I=1,10
     182 HHT(I,3)=RD(I)
         GOTO 120
C... PUBLIC HOUSING
      83 DO 183 I=1,9
     183 IGIVEN(I)=IFIX(RD(I))
         GOTO 120
C... REDUCE PURCHASE POWER
      84 IF(RD(1).GE.O..AND.RD(1).LT.O.2)PPP=RD(1)
         GOTO 120
C... PRICE ELASTICITY ADJUSTOR
      89 PAR(36)=RD(1)
         GOTO 120
C...
C...
C... PRINT CONTROL
      90 I=I1-90
         IF(I.EQ.5)GOTO 95
         GOTO(91,92),I
         IC1(7)=IFIX(RD(1))
         GOTO 120
C...
      91 IP=IFIX(RD(1))
         GOTO 120
      92 IF(I2.EQ.O.AND.(RD(1).EQ.O.OR.RD(1).EQ.60.OR.RD(1).
        *  IG=IFIX(RD(1))
         IF(I2.EQ.1)ISUPLY=IFIX(RD(1))
         GOTO 120
C...
```

```
306          95 NCI=IFIX(RD(1))
307             GOTO 120
308       C...
309          12 WRITE(6,2)IC
310             GOTO 13
311       C...
312          30 WRITE(6,4)IC
313             GOTO 13
314       C...
315          10 IC=IC+1
316             WRITE(6,5)IC
317             GOTO 13
318       C...
319          40 WRITE(6,8)I,IC
320       C...
321       C...
322          13 CONTINUE
323       C.DC  IQ=99
324             IQ=IR
325             BACKSPACE IR
326             READ(IQ,6)ERR
327             WRITE(6,7)ERR
328             NER=2
329             GOTO 120
330       C...
331       C...
332          16 IOP=I2
333             IF(I2.EQ.99)STOP
334             RETURN
335       C...
336          11 IF(IR.EQ.5)STOP
337             IR=5
338             GOTO 120
339       C...
340           2 FORMAT(' error in column 1 or 2 :card',I4,'Card is:
341           4 FORMAT(' error in column 3 or 4 :card',I4, 'Card is
342           5 FORMAT(' read error - probably invalid character. C
343           6 FORMAT(10A8)
344           7 FORMAT(' ',10A8)
345           8 FORMAT(' missing data item',I2,' :card',I4,' Card i
346             END
347       C...
348       C...
349             SUBROUTINE CALC
350       C... routines for INITIALISATION and CHECKing input data
351             INTEGER*4 IGIVEN(9),IPOL(2,4)
352             REAL*4 XX(4730) ,BL/'    '/
353             COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
354            * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(28),AILI
355             EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
356            * ,(IC1(5),NMD1),(IC1(20),NCI),(IC1(11),IGIVEN(1))
```

PROGRAM:F09:SIMO1.FORT

```
     * ,(IC1(21),IPOL(1,1))
     * ,(PAR(1),GAMMA1),(PAR(2),GAMMA2),(PAR(4),BETA1),(P
     * ,(PAR(3),GAMMA3),(PAR(27),COEF),(PAR(28),SUBM),(IG
     * ,(PAR(6),PO),(PAR(7),PC),(PAR(8),QM)
     * ,(PAR(9),PN),(PAR(10),AMAX),(PAR(40),TOL)
     * ,(IC1(6),MSIZE),(IC1(8),IOP),(IC1(7),MTYPE),(IC1(1
     * ,(XX(1),HHD(1,1))
C...
      ENTRY CL$1(IR)
      IRUN=0
      DO 30 I=1,4730
   30 XX(I)=0.
C...
      DO 70 I=1,28
   70 IC1(I)=0
C...
      DO 71 I=1,6
   71 TITLE(I)=BL
      TOL=.01
      NCI=5
      IR=4
C... ELIGIBILITY FOR SUBSIDY
      DO 90 I=1,10
   90 HHT(I,3)=2.
      RETURN
C...
      ENTRY CL$2(NER)
      IRUN=IRUN+1
      PN=PO+PC
C...
C... checking prices are not zero
      IF(PO.GT.0.0)GOTO 43
      WRITE(6,108)
      NER=2
   43 IF(PC.GT.0.0)GOTO 44
      WRITE(6,109)
      NER=2
   44 IF(IOP.NE.0.OR.GAMMA1.GT.0.0)GOTO 45
      WRITE(6,110)
      NER=2
   45 CONTINUE
C...
C... obtaining number zones, dwells, hhld types and hhold
      NHH=1
      NMD=1
      DO 1 I=1,MSIZE
      IF(HHD(I,1).NE.0)NHH=I
    1 IF(DWD(1,I).NE.0)NMD=I
      NMD1=NMD+1
C...
      DO 2 I=1,NHH
```

```
      IF(HHD(I,1).NE.O)GOTO 2
      WRITE(6,101)I
      NER=2
    2 CONTINUE
C...
      DO 3 I=1,NMD
      IF(DWD(1,I).NE.O)GOTO 3
      WRITE(6,102)I
      NER=2
    3 CONTINUE
C...
      NHT=1
      NZ =1
      DO 4 I=1,10
    4 IF(HHT(I,1).NE.O)NHT=I
C...
      DO 14 IZ=1,11
   14 IF(ZOD(1,IZ).NE.O)NZ=IZ
C...
      DWD(2,NMD1)=NZ
      DO 5 I=1,NHT
      IF(HHT(I,1).NE.O)GOTO 5
      WRITE(6,103)I
      NER=2
    5 CONTINUE
C...
C... checking "TYPE" correct
      DO 15 I=1,NHH
      IF(HHD(I,2).LE.NHT)GOTO 15
      WRITE(6,105)I
      NER=2
   15 CONTINUE
C...
      AMAX=O
      DO 6 IZ=1,NZ
      IF(ZOD(2,IZ).GT.AMAX)AMAX=ZOD(2,IZ)
      IF(ZOD(1,IZ).NE.O)GOTO 6
      WRITE(6,104)IZ
      NER=2
    6 CONTINUE
C...
C... checking "ZONE" correct
      DO 16 J=1,NMD
      IZ=IFIX(DWD(2,J))
      IF(IZ.GT.NZ)GOTO 17
      IF(IRUN.EQ.1)EXT(1,2,IZ)=EXT(1,2,IZ)+1
      GOTO 16
C...
   17 WRITE(6,106)J
      NER=2
   16 CONTINUE
```

PROGRAM:F09:SIMO1.FORT

```
C...
      IF(IRUN.GT.1)GOTO 10
      IF(EXT(1,2,NZ).EQ.0.)EXT(1,2,NZ)=FLOAT(NHH-NMD)
      EXT(1,2,12)=AMAXO(NHH,NMD)
C... CALCULATING WEIGHTED MEAN OF INPUT EXTERNALITIES
      DO 31 IZ=1,NZ
   31 EXT(1,1,12)=EXT(1,1,12)+(ZOD(1,IZ)*EXT(1,2,IZ))
C...
      EXT(1,1,12)=EXT(1,1,12)/EXT(1,2,12)
C...
C... calc initial externalities.
C... USE INPUT ACTUAL INCOMES  - C.M.A. MEAN CALCULATED
C...
      DO 9 IZ=1,NZ
    9 EXT(1,1,IZ)=ZOD(1,IZ)/EXT(1,1,12)
C...
   10 NS=0
      SUBM=0.
      IF(IPOL(1,1).EQ.0)RETURN
C...
C... DERIVING POLICY SUB OPTIONS
      DO 7 L=1,4
      IF(IPOL(1,L).EQ.0)GOTO 7
C...
      NS=L
      AILIM(L)=POL(6,L)
      IF(AILIM(L).EQ.0)AILIM(L)=9999.
      IF(POL(10,L).EQ.0.)POL(10,L)=9999.
C...
      I=IPOL(1,L)
      GOTO(21,21,21,22,22,22,23,23,23,24,24,24,25,25,25),
      GOTO 26
C...
C... income subsidy
   21 IPOL(2,L)=2
      GOTO 7
C... in-kind
   22 IF(IPOL(2,L).NE.0)GOTO 7
      IF(POL(4,L)+POL(5,L).NE.0.0)IPOL(2,L)=5
      IF(POL(4,L).EQ.0.0)IPOL(2,L)=3
      IF(POL(5,L).EQ.0.0)IPOL(2,L)=1
      IF(POL(2,L).EQ.0.0)IPOL(2,L)=IPOL(2,L)+1
      GOTO 7
C... price subsidy
   23 IPOL(2,L)=1
      IF(POL(1,L).LT.0.01.OR.POL(1,L).GT.5.)POL(1,L)=PO
      IF(POL(2,L).LT.0.01.OR.POL(2,L).GT.5.)POL(2,L)=PC
      IF(POL(3,L).LT.0.01.OR.POL(3,L).GT.5.)POL(3,L)=PO
      IF(POL(4,L).LT.0.01.OR.POL(4,L).GT.5.)POL(4,L)=PC
      GOTO 7
C... direct demand subsidy
```

```
      24 IPOL(2,L)=1
         IF(POL(2,L).EQ.0.)IPOL(2,L)=2
         GOTO 7
C...
C... direct supply subsidy
      25 IF(IPOL(2,L).GE.1.AND.IPOL(2,L).LE.2)GOTO 7
         IPOL(2,L)=1
         IF(POL(2,L).EQ.0.)IPOL(2,L)=2
C...
C... constrained MINIMUM option
      26 IF(IPOL(2,L).EQ.0)IPOL(2,L)=1
         IF(POL(1,L).EQ.0.)POL(1,L)=QM
         SUBM=1.
C...
       7 CONTINUE
         IF(IPUB.EQ.0)RETURN
C...
         DO 830 I=2,9
         K=IGIVEN(I)
         IF(K.LE.NHH)GOTO 8
         WRITE(6,107)K
         NER=2
         GOTO 830
       8 IF(K.GT.0)HHD(K,2)=-HHD(K,2)
     830 CONTINUE
         RETURN
C...
     101 FORMAT(' Error: NO household number',I4)
     102 FORMAT(' Error: NO dwelling  number',I4)
     103 FORMAT(' Error: NO household type data for ',I4)
     104 FORMAT(' Error: NO zonal data for ',I4)
     105 FORMAT(' Error: INCORRECT "type" for ',I4)
     106 FORMAT(' Error: INCORRECT "zone" for ',I4)
     107 FORMAT(' ERROR:',I6,' INCORRECT ON *8003*')
     108 FORMAT(' ERROR: "6001": "P0" IS ZERO')
     109 FORMAT(' ERROR: "6002": "PC" IS ZERO')
     110 FORMAT(' ERROR: "5001": "GAMMA1" IS ZERO FOR POLICY
         END
C...
C...
         SUBROUTINE CALC1
C... routines for CALCulating demand-supply intercepts.
         INTEGER*2 ISUB(120,120)
         INTEGER*2 DWC(3,120,120)
         REAL*4 DU1(7260),GAMMA(10)
         COMMON/BLK8/DU1,DWC,ISUB
         COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
        * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
         EQUIVALENCE (IC1(2),NMD),(IC1(4),NHH),(IC1(5),NMD1)
        * ,(IC1(8),IOP),(IC1(10),NS),(DU1(503),GAMMA)
C...
```

PROGRAM:F09:SIMO1.FORT

```
      ENTRY CL$3(IP1,IST)
C...
C... QL= % OF QN ACCEPTABLE
      QL=0.95
      IF(IOP.EQ.1.OR.IOP.EQ.2)QL=0.
      IF(IP1.EQ.10)WRITE(6,999)IC1
  999 FORMAT(10I5/10I5
     *//'    SUB  PRICE  QUANTITY   Y    UTILITY     H
      DO 997 K=1,10
  997 GAMMA(K)=PAR(1)
C...
C... CALCULATING PRICE AND QUANTITY BY HOUSEHOLD
C...
      DO 1 I=1,NHH
      IH=I
C.D   IH=1
C...
      DO 40 J=1,MSIZE
      ISUB(IH,J)=0
      DO 40 L=1,3
   40 DWC(L,IH,J)=0
      IS=0
      U1=0.0
C...
      K=IFIX(ABS(HHD(I,2)))
      IT=HHT(K,4)
      CALL PQYI(I,K,AY,IP1)
      CALL PQYN(0,IS,0,PJ,QN,U,SUBH,PH,QH,UHS)
      IF(HHD(I,2).LT.0.0)GOTO 7
      IF(HHT(K,3).EQ.0.0.OR.NS.EQ.0)GOTO 17
C...
      DO 18 L=1,NS
      N=IPOL(1,L)
      IF(AY.GT.AILIM(L))GOTO 18
      IP=0
      IS1=IPOL(2,L)
C... income
      IF(N.EQ.1.OR.N.EQ.3)IP=1
C... in-kind
      IF(N.EQ.4.OR.N.EQ.6)IP=2
C... price
      IF(N.EQ.7.OR.N.EQ.9)IP=3
C... direct demand
      IF(N.EQ.10.OR.N.EQ.12)IP=4
C... direct supply
       IF(N.EQ.13.OR.N.EQ.15)IP=5
C... constrained MINIMUM option
      IF(N.EQ.20.OR.N.EQ.22)GOTO 16
C...
      IF(IP.EQ.0)GOTO 18
      IF(L.EQ.1)GOTO 20
```

```
612            SUBT=SUB(IP,IS1,L,AY,P1,Q1,999)
613            IF(IP.EQ.2.AND.SUBT.GT.P1*Q1)SUBT=P1*Q1
614      C...
615            IF(SUBT.GE.SUBH)GOTO 19
616      C...
617            IF(L.EQ.NS)GOTO 17
618         20 CALL PQYN(IP,IS1,L,P1,Q1,U1,SUBH)
619            ISH=L*10+IP
620      C...
621      C... check that in kind subsidy < P*Q
622            IF(IP.NE.2)GOTO 18
623            IF(SUBH.LT.P1*Q1)GOTO 18
624            IS1=0
625            CALL PQYN(IP,IS1,L,P1,Q1,U1,SUBH)
626      C...
627            GOTO 18
628      C...
629      C... constrained MINIMUM option
630         16 CALL PQNQ(IP,IS1,L,P1,Q1,U1,SUBH,PH,QH,UHS)
631            ISH=20
632            IF(QN.LT.POL(1,L))  U=0.
633            IF(IP1.EQ.10)WRITE(6,1009)PJ,QN,U,P1,Q1,U1,PH,QH,UH
634       1009 FORMAT(3(F5.2,F6.1,F12.4))
635      C...
636         18 CONTINUE
637      C...
638         19 IF(U1.LE.U)GOTO 17
639            IS=ISH
640            PJ=P1
641            QN=Q1
642            U =U1
643      C...
644         17 DWC(1,IH,NMD1)=HFIX((QN+.005)*10.)
645            DWC(2,IH,NMD1)=HFIX(U*10.)
646            DWC(3,IH,NMD1)=HFIX((PJ+.0005)*1000.)
647            ISUB(IH,NMD1)=IS
648            IF(IS.EQ.20)ISUB(IH,NMD1)=HFIX((SUBH+.005)*10.)
649      C...
650      C... EXISTING DWELLINGS
651            DO 11 J=1,NMD
652      C... TENURE CHECK
653            IDT=IFIX(DWD(3,J))
654            IF(IT.NE.0.AND.IT.NE.IDT)GOTO 11
655      C...
656            U1=0.0
657            IS=0
658            CALL PQYE(0,IS,0,J,PJ,QJ,U,SUBH,PH,QH,UHS)
659      C...
660            IF(HHT(K,3).EQ.0.OR.NS.EQ.0)GOTO 12
661      C...
662            DO 21 L=1,NS
```

```
663           N=IPOL(1,L)
664           IF(AY.GT.AILIM(L))GOTO 21
665     C...
666           IS1=IPOL(2,L)
667           IP=0
668     C... income
669           IF(N.EQ.1.OR.N.EQ.2)IP=1
670     C... in-kind
671           IF(N.EQ.4.OR.N.EQ.5)IP=2
672     C... price
673           IF(N.EQ.7.OR.N.EQ.8)IP=3
674     C... direct demand
675           IF(N.EQ.10.OR.N.EQ.11)IP=4
676     C... direct supply subsidy
677            IF(N.EQ.13.OR.N.EQ.14)IP=5
678     C... constrained MINIMUM option
679           IF(N.EQ.20.OR.N.EQ.21)GOTO 24
680     C...
681           IF(IP.EQ.0)GOTO 21
682           IF(L.EQ.1)GOTO 23
683           SUBT=SUB(IP,IS1,L,AY,P1,Q1,J)
684           IF(IP.EQ.2.AND.SUBT.GT.P1*Q1)SUBT=P1*Q1
685     C...
686           IF(SUBT.GE.SUBH)GOTO 22
687           IF(L.EQ.NS)GOTO 12
688        23 CALL PQYE(IP,IS1,L,J,P1,Q1,U1,SUBH)
689           ISH=L*10+IP
690     C...
691     C... check on in kind subsidy < P*Q
692           IF(IP.NE.2)GOTO 21
693           IF(SUBH.LT.P1*Q1)GOTO 21
694           IS1=0
695           CALL PQYE(IP,IS1,L,J,P1,Q1,U1,SUBH)
696           GOTO 21
697     C...
698     C... constrained MINIMUM option
699        24 CALL PQEQ(IP,IS1,L,J,P1,Q1,U1,SUBH,PH,QH,UHS)
700           IF(QJ.LT.POL(1,L))  U=0.
701           ISH=20
702           IF(IP1.EQ.10)WRITE(6,1009)PJ,QJ,U,P1,Q1,U1,PH,QH,UH
703     C...
704        21 CONTINUE
705     C...
706        22 IF(U1.LE.U)GOTO 12
707           IS=ISH
708           PJ=P1
709           QJ=Q1
710           U=U1
711        12 IF(QJ.LT.QL*QN)GOTO 11
712           DWC(1,IH,J)=HFIX((QJ+.005)*10.)
713           DWC(2,IH,J)=HFIX(U*10.)
```

```
      DWC(3,IH,J)=HFIX((PJ+.0005)*1000.)
      ISUB(IH,J)=IS
      IF(IS.EQ.20)ISUB(IH,J)=HFIX((SUBH+.005)*10.)
   11 CONTINUE
C...
C... ZERO OUT NEW DWELLING FOR GAMMA CALIBRATION
      IF(IOP.NE.1)GOTO 7
      DWC(1,IH,NMD1)=0
      DWC(2,IH,NMD1)=0
      DWC(3,IH,NMD1)=0
C...
    7 CONTINUE
C.D   WRITE(8'I)DWC
C.D   WRITE(9'I)ISUB
    1 CONTINUE
      RETURN
      END
C...
      SUBROUTINE CALCO
      INTEGER*2 EQ(502)
      REAL*4 MY
      COMMON/BLK8/ALPHA(502),GAMMA(10)
      COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),DU1(
      EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
     * ,(IC1(5),NMD1),(IC1(20),NCI)
     * ,(PAR(2),GAMMA2),(PAR(4),BETA1),(PAR(5),BETA2)
     * ,(PAR(3),GAMMA3),(PAR(27),COEF)
     * ,(PAR(6),PO),(PAR(7),PC),(PAR(8),QM)
     * ,(PAR(9),PN),(PAR(10),AMAX)
     * ,(PAR(26),YFORM),(PAR(37),PPP)
C...
      DATA TOL/0.0001/
C...
      ENTRY PQYI(I,K,AY,IP1)
      GAMMA1=GAMMA(K)
C...
C... "permanent" INCOME and ALPHAs
      HHD(I,3)=EXP(0.6*ALOG(HHD(I,1))+0.4*ALOG(HHT(K,1)))
      IF(YFORM.NE.0.)HHD(I,3)=HHD(I,1)/12.
      MY=HHD(I,3)
      AY=HHD(I,1)/12.
C... adjusting for purchase power
      IF(HHD(I,1).GT.HHT(K,1))MY=MY*(1.-PPP)
      IF(HHD(I,1).GT.HHT(K,1))AY=AY*(1.-PPP)
C...
      EQQ=0.0
      IF(YFORM.EQ.2.)EQQ=EQ(I)/10000.
C...
      ALPHA(I)=HHT(K,2)*(1.+COEF)
      HALPHA=ALPHA(I)
```

```
C...
      PB=PN
C...
      CALL PQMQI(GAMMA1,AY,MY,EQQ,HALPHA,PB)
C...
      RETURN
C...
C... "quantity" - "utility" of new construction "QN"
      ENTRY PQYN(IP,IS,L,P,Q,U,SUBA,PH,QH,UH)
      P=PB
      GOTO(11,12,13,14,14),IP
      Q=(HALPHA*MY/PB)/(1.-HALPHA*EQQ)
C... public housing
      IF(HHD(I,2).LT.0.0.AND.Q.LT.QM)Q=QM
      GOTO 16
C...
C... income
   11 Q=(HALPHA/PB)*(MY+POL(1,L)*(POL(3,L)-POL(4,L)*AY))/
      GOTO 10
C... in kind
   12 GOTO(31,32,33,34,35,36),IS
C...
      Q=(HALPHA*MY/PB)/((1.-HALPHA)*(1.+HALPHA*EQQ))
      GOTO 10
C...
   31 A=POL(1,L)*POL(2,L)
      IF(PAR(36).NE.0.)A=A*PAR(36)
CC    Q=(((1.-A*GAMMA1*(1.-HALPHA))*HALPHA*MY-HALPHA*POL(
CC   * *AY) / ((1.-A)*PB))
      Q=(HALPHA/PB)*(MY-POL(1,L)*POL(4,L)*AY)/(1.-HALPHA*
      GOTO 10
C...
   32 Q=(HALPHA/PB)*(MY+POL(1,L)*(POL(3,L)-POL(4,L)*AY))/
      GOTO 10
C...
   33 Q=(HALPHA/PB)*MY/(1.-HALPHA*(POL(1,L)*(POL(2,L)-POL
      GOTO 10
C...
   34 Q=(HALPHA/PB)*(MY+POL(1,L)*POL(3,L))/(1.+HALPHA*(PO
     *  -EQQ))
      GOTO 10
C...
   35 Q=(HALPHA/PB)*MY/(1.-HALPHA*(POL(1,L)*(POL(2,L)-POL
      GOTO 10
C...
   36 Q=(HALPHA/PB)*(MY+POL(1,L)*POL(3,L))/
     * (1.+HALPHA*(POL(1,L)*POL(5,L)*AY-EQQ))
      GOTO 10
C...
C... price
   13 PB=POL(1,L)+POL(2,L)
```

```
      Q=(HALPHA*MY/PB)/(1.-HALPHA*EQQ)
      GOTO 10
C... direct demand and supply
   14 GOTO(41,42),IS
   41 Q=((HALPHA/PB)*MY-POL(1,L)*POL(4,L)*AY/PB)/
     *   ((1.-POL(1,L)*POL(2,L))*(1.-HALPHA*EQQ))
      GOTO 10
C...
   42 Q=(HALPHA/PB)*MY+(POL(1,L)*(POL(3,L)-POL(4,L)*AY))/
      GOTO 10
C... check MINQ
   10 IF(Q.LT.POL(7,L))Q=POL(7,L)
C... check MAXR
      IF(PB*Q.GT.POL(10,L))Q=POL(10,L)/(PB*(1-EQQ))
C...
   16 SUBA=SUB(IP,IS,L,AY,PB,Q,999)
C...
      IF(SUBA.LT.0.)Q=0.
C...
      Y=MY+SUBA+EQQ*PB*Q
      CALL CL$UT(U,H,X,A,Q,HALPHA,MY,Y,PB,PB,NZ,GAMMA1)
      IF(IP1.EQ.10)WRITE(1,1000)I,IP,IS,PB,Q,Y,U,H,X,A
C...
      PH=PB
      QH=Q
      UH=U
      IF(Q.LT.QM)Q=0.
      IF(Q.EQ.0.)  U=0.
      IF(U.EQ.0.0)Q=0.0
C...
      RETURN
C...
C... PRICE QUANTITY AND UTILITY  - EXISTING DWELLINGS
C...
      ENTRY PQYE(IP,IS,L,J,PJ,Q,U,SUBA,PH,QH,UH)
      U=0.0
      Q=0.0
      QI=DWD(1,J)
      IZ=DWD(2,J)
C...
C... CL$PR COMPUTES A ROOT OF THE NON-LINEAR EQUATION FUN
C... METHOD USED IS A COMBINATION OF BISECTION AND THE SE
      B=10.
      C=0.1
C...
      IC=0
      ACBS=ABS(B-C)
      A=C
      FA=FUN(IP,IS,A,L,MY,AY,HALPHA,PB,QI,EQQ,GAMMA1)
      FB=FUN(IP,IS,B,L,MY,AY,HALPHA,PB,QI,EQQ,GAMMA1)
      FC=FA
```

```
      KOUNT=2
      FX=AMAX1(ABS(FB),ABS(FC))
   51 IF(ABS(FC).GE.ABS(FB))GOTO 52
C...
C... INTERCHANGE B AND C SO THAT ABS(F(B).LE.ABS(F(C))
C...
      A=B
      FA=FB
      B=C
      FB=FC
      C=A
      FC=FA
   52 CMB=0.5*(C-B)
      ACMB=ABS(CMB)
C...
C... TEST STOPPING CRITERION AND FUNCTION COUNT
C...
      IF(ACMB.LE.TOL)GOTO 58
      IF(KOUNT.GE.500)GOTO 62
C...
C... CALCULATE NEW ITERATE IMPLICITLY AS B+P/Q
C... WHERE P.GE.0.  THE IMPLICIT FORM IS USED TO
C... PREVENT OVERFLOW.
C...
      P=(B-A)*FB
      Q=FA-FB
      IF(P.GE.0.0)GOTO 53
      P=-P
      Q=-Q
C...
C... UPDATE A. CHECK IF REDUCTION IN THE SIZE OF BRACKETI
C... INTERVAL IS SATISFACTORY. IF NOT, BISECT UNTIL IT IS
C...
   53 A=B
      FA=FB
      IC=IC+1
      IF(IC.LT.4)GOTO 54
      IF(8.0*ACMB.GE.ACBS)GOTO 56
      IC=0
      ACBS=ACMB
C...
C... TEST FOR TOO SMALL A CHANGE
C...
   54 IF(P.GT.ABS(Q)*TOL)GOTO 55
C...
C... INCREMENT BY TOLERANCE
C...
      B=B+SIGN(TOL,CMB)
      GOTO 57
C...
C... ROOT OUGH TO BE BETWEEN B AND (C+B)/2
```

```
C...
   55 IF(P.GE.CMB*Q)GOTO 56
C...
C... USE SECANT RULE
      B=B+P/Q
      GOTO 57
C...
   56 B=0.5*(C+B)
C...
C... HAVE COMPLETED COMPUTATION FOR NEW ITERATE B
C...
   57 FB=FUN(IP,IS,B,L,MY,AY,HALPHA,PB,QI,EQQ,GAMMA1)
      IF(FB.EQ.0.0)GOTO 59
      IF(FB.EQ.-1.E5)GOTO 62
      KOUNT=KOUNT+1
      IF(SIGN(1.0,FB).NE.SIGN(1.0,FC))GOTO 51
      C=A
      FC=FA
      GOTO 51
C...
C... FINISHED SET IFLAG
C...
   58 IF(SIGN(1.0,FB).EQ.SIGN(1.0,FC))GOTO 61
      IF(ABS(FB).GT.FX)GOTO 60
      IFLAG=1
      GOTO 30
   59 IFLAG=2
      GOTO 30
   60 IFLAG=3
      GOTO 30
   61 IFLAG=4
      B=0.0
      GOTO 30
   62 IFLAG=5
      B=0.0
      GOTO 30
C...
   30 PJ=B
C...
      Q=(BETA1+2./3.*BETA2*(PJ-P0)/PC) * QI
C...
C... CHECK  MINQ
      IF(IP.EQ.0)GOTO 165
      IF(Q.GE.POL(7,L))GOTO 65
      Q=POL(7,L)
      PJ=((Q/QI-BETA1)*PC/(2./3.*BETA2))+ P0
C...
C... check MAXR
   65 IF(PJ*Q.LT.POL(10,L))GOTO 165
C...
      IF(IP1.EQ.10)WRITE(1,1000)J,IP,IS,PJ,Q
```

PROGRAM:F09:SIMO1.FORT

```
      C...
            AC=1.
            BC=-(BETA1-(2./3.*BETA2*PO/PC))*QI
            CC=-(2./3.*BETA2*POL(10,L)/PC)*QI
      C...
            IF(IP1.EQ.10)WRITE(1,1001)AC,BC,CC
       1001 FORMAT(T10,3F15.5)
            Q=QDD(AC,BC,CC)
      C...
            PJ=((Q/QI-BETA1)*PC/(2./3.*BETA2))+ PO
      C...
      C...
        165 SUBA=SUB(IP,IS,L,AY,PJ,Q,J)
      C...
            IF(SUBA.LT.0.)Q=0.
      C...
            Y=MY+SUBA+EQQ*PJ*Q
            CALL CL$UT(U,H,X,A,Q,HALPHA,MY,Y,PJ,PB,IZ,GAMMA1)
            PH=PJ
            QH=Q
            UH=U
            IF(PJ.LT.PO) U=0.0
            IF(U.EQ.0.0)Q=0.0
      C...
            IF(IP1.EQ.10)WRITE(1,1000)J,IP,IS,PJ,Q,Y,U,H,X,A,KO
            RETURN1
      C...
       1000 FORMAT(I4,2I2,2F8.2,2F8.0,3F8.2,2I5)
            END
      C...
            FUNCTION QDD(A,B,C)
      C...
            QDD=0.
      C...
            D=B**2 -4*A*C
            IF(D.LE.0.)RETURN
            D=SQRT(D).
      C...
            IF(A.EQ.0.)GOTO 1
            IF(B.GE.0.)X1=-(B+D)/(2.*A)
            IF(B.LT.0.)X1=(D-B)/(2.*A)
            X2=C/(X1*A)
            QDD=X1
            IF(X1.LT.0.)QDD=X2
            RETURN
      C...
          1 QDD=-C/B
            RETURN
            END
      C...
      C...
```

PROGRAM:F09:SIMO1.FORT

```
1020            FUNCTION FUN(IP,IS,PJ,L,MY,AY,A1,PB,QI,EQQ,GAMMA1)
1021            REAL*4 MY
1022            COMMON/BLK21/DUM(3058),DWD(3,502),ZOD(3,11),PAR(40)
1023            EQUIVALENCE (PAR(4),BETA1),(PAR(5),BETA2),(PAR(6),P
1024      C...
1025            D=(PB/PJ+GAMMA1*(1.-A1)*(1.-PB/PJ))*A1/PB
1026            S=(BETA1+2./3.*BETA2*(PJ-PO)/PC) * QI
1027            E=D*EQQ*PJ
1028            FUN=-1.E5
1029      C...
1030            GOTO(1,2,3,4,5),IP
1031      C... BASIC FUNCTION
1032            FUN=D*MY/(1.-E) -S
1033            RETURN
1034      C... income
1035          1 IF(E.EQ.1.)RETURN
1036            FUN=D*(MY+POL(1,L)*(POL(3,L)-POL(4,L)*AY))/(1.-E) -
1037            RETURN
1038      C... in-kind
1039          2 GOTO(21,22,23,24,25,26),IS
1040      C...
1041            IF((1.-PJ*D)*(1.-E).EQ.O.)RETURN
1042            FUN=(D*MY)/((1.-PJ*D)*(1.-E)) -S
1043            RETURN
1044      C...
1045         21 A=POL(1,L)*POL(2,L)
1046            IF(PAR(36).NE.O.)A=A*PAR(36)
1047      CC    D=(PB/PJ+GAMMA1*(1.-A1)*((1.-A)-PB/PJ))*A1/(PB*(1.-
1048      CC    FUN=D*MY - A1*POL(1,L)*POL(4,L)*AY/((1.-A)*PJ) - S
1049            IF(1.-D*A*PJ.EQ.E)RETURN
1050            FUN=D*(MY-POL(1,L)*POL(4,L)*AY)/(1.-D*A*PJ-E) -S
1051            RETURN
1052      C...
1053         22 FUN=D*(MY+POL(1,L)*(POL(3,L)-POL(4,L)*AY))/(1.-E) -
1054            RETURN
1055      C...
1056         23 IF(D*POL(1,L)*(POL(2,L)-POL(5,L))*PJ-E.EQ.1)RETURN
1057            FUN=D*MY/(1.-D*POL(1,L)*(POL(2,L)-POL(5,L))*PJ-E) -
1058            RETURN
1059      C...
1060         24 FUN=D*(MY+POL(1,L)*POL(3,L))/(1.+D*POL(1,L)*POL(5,L
1061            RETURN
1062      C...
1063         25 FUN=D*MY/(1.-D*POL(1,L)*(POL(2,L)-POL(5,L)*AY)*PJ-E
1064            RETURN
1065      C...
1066         26 FUN=D*(MY+POL(1,L)*POL(3,L))/(1.+D*POL(1,L)*POL(5,L
1067            RETURN
1068      C... price
1069          3 A=(PO-POL(3,L))+(PC-POL(4,L))
1070            FUN=(D*MY)/((1.-D*A)*(1.-E)) -S
```

```
1071            RETURN
1072      C... direct demand
1073           4 GOTO(41,42),IS
1074      C...
1075           41 FUN=(D*MY-POL(1,L)*POL(4,L)*AY/PJ)/(1.-POL(1,L)*POL
1076              RETURN
1077      C...
1078           42 FUN=(D*MY+POL(1,L)*(POL(3,L)-POL(4,L)*AY)/PJ)/(1.-E
1079              RETURN
1080      C...
1081      C... direct supply
1082           5 GOTO(51,52),IS
1083      C...
1084           51 FUN=D*MY/(1.-E)-(S-POL(1,L)*POL(4,L)*AY/PJ)/(1.-POL
1085              RETURN
1086      C...
1087           52 FUN=D*MY/(1.-E)-(S+POL(1,L)*(POL(3,L)-POL(4,L)*AY)/
1088              RETURN
1089      C...
1090              END
1091      C...
1092              SUBROUTINE UTILL
1093      C... routine to calculate utility
1094              REAL*4 MY
1095              COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
1096             * ,PAR(40)
1097              EQUIVALENCE (QM,PAR(8)),(GAMMA3,PAR(3)),(AMAX,PAR(1
1098      C...
1099              ENTRY CL$UT(U,UHS,UX,UA,Q,HALPHA,MY,Y,P,PB,IZ,GAMMA
1100      C...
1101              U=0.0
1102      C...
1103              IF(Y-Q*P-GAMMA1*(1.-HALPHA)*MY.LE.0.0)RETURN
1104              IF(Q.LE.GAMMA1*HALPHA*MY/PB)RETURN
1105      C...
1106              UHS=EXP(HALPHA*ALOG(Q-(GAMMA1*HALPHA*MY/PB)))
1107              UX=EXP((1.-HALPHA)*ALOG((Y-Q*P)-GAMMA1*(1.-HALPHA)*
1108              UA=EXP(GAMMA3/10.*ALOG(2.-ZOD(2,IZ)/AMAX))
1109      C...
1110              U=UHS*UX*UA
1111      C...
1112              RETURN
1113              END
1114      C...
1115      C...
1116              SUBROUTINE CALC2
1117              INTEGER*4 JO(2,3)
1118              REAL*4 SKEY(120),SOL(120,4),PDW(120),O(3),SKS(120)
1119              INTEGER*2 NDW(120),IODW(120,120),UAHH(120),ISUB(120
1120             * ,ISOL(120,2)
1121              INTEGER*2 DWC(3,120,120)
```

```
1122            COMMON/BLK8/NDW,IODW,DWC,ISUB,UAHH,ISOL,SOL
1123            COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
1124           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20)
1125            EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
1126           * ,(IC1(5),NMD1),(IC1(6),MSIZE),(IC1(10),NS)
1127           * ,(PAR(2),GAMMA2)
1128           * ,(PAR(6),PO),(PAR(7),PC),(PAR(28),SUBM)
1129      C...
1130            EQUIVALENCE (SOL(1,4),PDW(1),SKEY(1))
1131      C...
1132            ENTRY SRT$1(KJ)
1133      C... sorting routine
1134      C... order all households by "model" income to UAHH
1135      C... order each household's dwelling stack in terms of de
1136      C     utility to IODW
1137      C...
1138            IF(KJ.EQ.2)GOTO 4
1139      C...
1140      C... sorting households by "model" income
1141            DO 1 I=1,NHH
1142          1 SKEY(I)=HHD(I,3)
1143      C...
1144            DO 3 K=1,NHH
1145            IS=0
1146            X=0.
1147      C...
1148            DO 2 N=1,NHH
1149            IF(SKEY(N).LE.X)GOTO 2
1150            X=SKEY(N)
1151            IS=N
1152          2 CONTINUE
1153      C...
1154            SKEY(IS)=-1.
1155          3 UAHH(K)=IS
1156      C...
1157            UAHH(NHH+1)=NHH+1
1158      C...
1159      C... sorting dwelling stack
1160      C...
1161          4 DO 10 I=1,NHH
1162      C.D   READ(8'I)DWC
1163            IH=I
1164      C.D   IH=1
1165            DO 25 J=1,MSIZE
1166         25 IODW(IH,J)=0
1167      C...
1168            DO 11 J=1,NMD1
1169            IZ=DWD(2,J)
1170            SKEY(J)=DWC(2,IH,J)*ZW(IZ)
1171            SKS(J)=0.
1172            IF(SUBM.EQ.0.)GOTO 11
```

```
1173            SKS(J)=ISUB(I,J)
1174            IF(SKEY(J).EQ.O.)SKS(J)=9.1E10
1175         11 CONTINUE
1176      C...
1177            DO 13 J=1,NMD1
1178            IS=O
1179            X=O.
1180      C...
1181            S=9.E10
1182      C...
1183            IF(SUBM.EQ.O.)GOTO 14
1184      C...
1185      C... find lowest subsidy amount
1186            DO 15 N=1,NMD1
1187         15 IF(SKS(N).LT.S)S=SKS(N)
1188      C...
1189         14 DO 12 N=1,NMD1
1190            IF(SKS(N).GT.S)GOTO 12
1191            IF(SKEY(N).LE.X)GOTO 12
1192            X=SKEY(N)
1193            IS=N
1194         12 CONTINUE
1195            IF(X.LE.O.)GOTO 10
1196            SKEY(IS)=-1.
1197            SKS(IS)=9.1E10
1198            IODW(IH,J)=IS
1199            IF(IS.EQ.NMD1)GOTO 10
1200      C...
1201         13 CONTINUE
1202         10 CONTINUE
1203      C.D10 WRITE(7'I)IODW
1204            RETURN
1205      C...
1206      C... calculating TOTAL "utility" each run
1207      C... relative wealth utility
1208      C...
1209            ENTRY CL$4
1210      C...
1211            DO 22 IZ=1,NZ
1212         22 ZW(IZ)=EXP(GAMMA2/10.*ALOG(EXT(1,1,IZ)))
1213      C...
1214      C...
1215            RETURN
1216      C...
1217      C... allocate households among dwellings
1218      C...
1219            ENTRY CL$5(IP)
1220      C...
1221            IS=O
1222            IO=O
1223      C...
```

```
1224            DO 26 I=1,MSIZE
1225            NDW(I)=0
1226            DO 27 J=1,4
1227         27 SOL(I,J)=0.0
1228            DO 26 J=1,2
1229         26 ISOL(I,J)=0
1230      C...
1231            IF(IP.EQ.10)WRITE(6,101)
1232        101 FORMAT('1'//' *** tracing HOUSEHOLD ASSIGMENTs'//
1233           * 3(' HHOLD DWELL   PRICE  '))
1234      C...
1235            DO 44 IS=1,NHH
1236      C...
1237            NH=UAHH(IS)
1238      C...
1239            NX=UAHH(IS+1)
1240      C...
1241      C... LOOP START FOR DISPLACED HOUSEHOLD
1242         43 CONTINUE
1243      C.D   READ(7'NH)IODW
1244      C.D   READ(8'NH)DWC
1245            N=NH
1246      C.D   N=1
1247      C...
1248      C... LOOP START FOR UNALLOCATED HOUSEHOLD
1249         45 ND=IODW(N,1)
1250            PJ=DWC(3,N,ND)
1251            IF(IP.NE.10)GOTO 46
1252      C...
1253      C... copy to "trace" output
1254            IO=IO+1
1255            JO(1,IO)=NH
1256            JO(2,IO)=ND
1257             O(IO)=PJ
1258      C...
1259            IF(IO.LT.3)GOTO 46
1260      C...
1261            WRITE(6,102)((JO(I,J),I=1,2),O(J),J=1,IO)
1262        102 FORMAT(3(I3,I6,F11.3,2X))
1263            IO=0
1264      C...
1265      C.. popping household's dwelling stack
1266         46 DO 41 J=1,NMD
1267            IODW(N,J)=IODW(N,J+1)
1268            IF(IODW(N,J).EQ.0)GOTO 42
1269         41 CONTINUE
1270      C...
1271      C... no dwelling available?
1272         42 IF(ND.EQ.0)GOTO 50
1273            IH=NDW(ND)
1274      C... if new: select
```

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```
      IF(ND.EQ.NMD1)GOTO 51
C...  if bid price less than or equal to current: selectne
      IF(PJ.LE.PDW(ND))GOTO 45
C...  allocating to assigned stack
C.D   WRITE(7'NH)IODW
C.D   FIND(7'NX)
C.D   FIND(8'NX)
      NDW(ND)=NH
      PDW(ND)=PJ
   51 ISOL(NH,1)=ND
      SOL(NH,1)=DWC(3,N,ND)
      SOL(NH,2)=DWC(1,N,ND)
      SOL(NH,3)=DWC(2,N,ND)
C...  DWELLING EMPTY(INCLUDING NEW)
      IF(IH.EQ.O)GOTO 44
C...  HOUSEHOLD DISPLACED - LOOP INTERNALLY
      NH=IH
C.D   FIND(7'IH)
C.D   FIND(8'IH)
      GOTO 43
C...
C...  NO NEW DWELLING
   50 ISOL(NH,1)=-1
C...
   44 CONTINUE
C...
      IF(IO.NE.O)WRITE(6,102)((JO(I,J),I=1,2),O(J),J=1,IO
C...
C...  calculating solution set.
      DO 62 I=1,NHH
      IH=I
C.D   IH=1
      ND=ISOL(I,1)
      IF(ND.GT.O)GOTO 63
C.D   READ(8'I)DWC
C...
C...  no dwelling
C...  highest bid
      ND=1
      PJ=DWC(3,IH,1)
      DO 66 J=2,NMD
      IF(DWC(3,IH,J).LE.PJ)GOTO 66
      ND=J
      PJ=DWC(3,IH,J)
   66 CONTINUE
C...
      ISOL(I,1)=-ND
      SOL(I,1)=PJ/1000.
      SOL(I,2)=DWC(1,IH,ND)
      SOL(I,3)=DWC(2,IH,ND)
      GOTO 62
```

```
1326        63 CONTINUE
1327     C.D   IF(NS.NE.O)READ(9'I)ISUB
1328           ISOL(I,2)=ISUB(IH,ND)
1329           SOL(I,1)=SOL(I,1)/1000.
1330           SOL(I,2)=SOL(I,2)/10.
1331           IZ=DWD(2,ND)
1332           SOL(I,3)=SOL(I,3)/10.*ZW(IZ)
1333           IF(ND.EQ.NMD1)ISOL(I,1)=999
1334        62 CONTINUE
1335     C...
1336           RETURN
1337     C...
1338     C...
1339           ENTRY CL$10(SER)
1340     C... calculating actual externalities
1341     C...
1342           DO 21 IZ=1,12
1343           DO 21 J=1,2
1344           EXT(2,J,IZ)=EXT(1,J,IZ)
1345        21 EXT(1,J,IZ)=O.
1346     C...
1347     C...
1348           DO 23 I=1,NHH
1349     C...
1350           J=ISOL(I,1)
1351           IF(J.LE.O)GOTO 23
1352           IF(J.EQ.999)J=NMD1
1353           IF(ISOL(I,2).EQ.99)GOTO 23
1354           IZ=DWD(2,J)
1355     C...
1356           EXT(1,1,IZ)=EXT(1,1,IZ)+HHD(I,1)
1357           EXT(1,2,IZ)=EXT(1,2,IZ)+1
1358     C...
1359           EXT(1,1,12)=EXT(1,1,12)+HHD(I,1)
1360           EXT(1,2,12)=EXT(1,2,12)+1
1361        23 CONTINUE
1362     C...
1363     C... calculating relative "wealth"
1364           EXT(1,1,12)=EXT(1,1,12)/EXT(1,2,12)
1365     C...
1366           DO 24 IZ=1,NZ
1367           IF(EXT(1,2,IZ).EQ.O)GOTO 34
1368           EXT(1,1,IZ)=(EXT(1,1,IZ)/EXT(1,2,IZ))/EXT(1,1,12)
1369           GOTO 24
1370        34 EXT(1,1,IZ)=1.
1371        24  CONTINUE
1372     C...
1373     C... calculating error on externalities
1374     C...
1375           SER=O.
1376           DO 30 IZ=1,NZ
```

```
      30 SER=SER+(EXT(1,1,IZ)-EXT(2,1,IZ))**2
C...
      SER=SQRT(SER)/(2.*NZ)
      RETURN
      END
C...
      SUBROUTINE OT$DAT
C... output of the input data.
      INTEGER*4 IGIVEN(9),IWR1(10),IWR2(10),IWR3(10)
      REAL*4 DAT(5),ALPHA(120),SOL(120,4),DU1(200)
      INTEGER*2 EQ(502)
      REAL*4 WR1(10),WR2(10),WR3(10),WR4(10),WR5(10),WR6(
      INTEGER*2 IODW(120,120),UAHH(120),ISUB(120,120)
     * ,NDW(120),ISOL(120,2)
      INTEGER*2 DWC(3,120,120)
      COMMON/BLK8/NDW,IODW,DWC,ISUB,UAHH,ISOL,SOL
      COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
      EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
     * ,(IC1(5),NMD1),(IC1(10),NS),(IC1(11),IGIVEN(1))
     * ,(PAR(6),PO),(PAR(7),PC),(PAR(8),QM)
     * ,(PAR(9),PN)
     * ,(PAR(26),YFORM),(PAR(27),COEF),(PAR(37),PPP)
     * ,(PAR(21),DAT(1))
C...
      EQUIVALENCE (DU1(101),WR1(1)),(DU1(111),WR2(1)),(DU
     * ,(DU1(131),WR4(1)),(DU1(141),WR5(1)),(DU1(151),WR6
     * ,(DU1(161),WR7(1)),(DU1(171),IWR1(1)),(DU1(181),IW
     * ,(DU1(191),IWR3(1))
     * ,(DU1(1),NDW(1),ALPHA(1))
C...
      ENTRY OT$1
      WRITE(6,101)
  101 FORMAT('1'/' HOUSING MARKET SIMULATION PACKAGE'//
     *' PROGRAM: "SIMO1.FORT" : DEVELOPED AT '//
     *' UNIVERSITY OF BRITISH COLUMBIA : JUNE 79 - FEB 81
      RETURN
C...
      ENTRY OT$2(NER,IP1)
      IF(NER.EQ.2)GOTO 2
C...
      IF(IP1.EQ.0)RETURN
      WRITE(6,99)TITLE
C...
      IF(YFORM.NE.0.)WRITE(6,822)
  822 FORMAT(' USING "ACTUAL" INCOME DATA')
C...
      IF(IP1.EQ.1.OR.IP1.EQ.11)GOTO 34
   99 FORMAT(/2X,6A4/)
C...
      WRITE(6,114)NHH
```

```
  114 FORMAT(/' *** INPUT DATA'/
     *       /' *** "1CMA" MODEL HOUSEHOLDs:',T40,'number
     * ,I4)
      IF=0
    4 IS=IF+1
      IF=IS+9
      IF(IF.GT.NHH)IF=NHH
      WRITE(6,115)((I),I=IS,IF)
      WRITE(6,116)(HHD(I,1),I=IS,IF)
      WRITE(6,117)(HHD(I,2),I=IS,IF)
      IF(YFORM.EQ.2.)WRITE(6,151)(EQ(I),I=IS,IF)
C...
      IF(NS.EQ.0.OR.HHD(IS,4).EQ.0.0)GOTO 810
      WRITE(6,811)(HHD(I,4),I=IS,IF)
      WRITE(6,126)(HHD(I,5),I=IS,IF)
      WRITE(6,127)(HHD(I,6),I=IS,IF)
  811 FORMAT(' BASE DATA '/'  DWELLING  ',1X,10F6.0)
  810 IF(IP1.EQ.2)GOTO 34
      IF(IF.LT.NHH)GOTO 4
C...
  115 FORMAT(/' household  ',10I6)
  116 FORMAT(/'  income    ',2X,10F6.0)
  117 FORMAT('  type      ',1X,10F6.0)
  151 FORMAT('  %EQUITY   ',1X,10(' .',I4))
C...
   34 WRITE(6,110)NHT
  110 FORMAT(/' *** "2CMA" HOUSEHOLD TYPE GROUPs: ',T40,'
     * ,I4)
C...
      WRITE(6,111)((I),I=1,NHT)
      WRITE(6,112)(HHT(I,1),I=1,NHT)
      WRITE(6,113)(HHT(I,2),I=1,NHT)
      IF(HHT(1,4).NE.0)WRITE(6,823)(HHT(I,4),I=1,NHT)
      WRITE(6,821)COEF
C...
  111 FORMAT(/' TYPE group   ',10I6)
  112 FORMAT(/'  income      ',2X,10F6.0)
  113 FORMAT('  alpha       ',1X,10(F5.4,1X))
  821 FORMAT(/'  ALPHA ADJUSTMENT FACTOR',T30,F10.5)
  823 FORMAT('  TENURE      ',10F6.0)
C...
      IF(IP1.EQ.1)GOTO 799
      IF(IP1.EQ.11)RETURN
      WRITE(6,106)NMD
  106 FORMAT(/' *** "3CMA" MODEL DWELLINGS:',T40,'number
C...
      IF=0
    3 IS=IF+1
      IF=IS+9
      IF(IF.GT.NMD)IF=NMD
      WRITE(6,107)((J),J=IS,IF)
```

```
      WRITE(6,108)(DWD(1,J),J=IS,IF)
      WRITE(6,109)(DWD(2,J),J=IS,IF)
      IF(DWD(3,J).NE.0.0)WRITE(6,823)(DWD(3,J),J=IS,IF)
      IF(IP1.EQ.2)GOTO 35
      IF(IF.LT.NMD)GOTO 3
C...
  107 FORMAT(/' dwelling   ',10I6)
  108 FORMAT(/'  services  ',2X,10F6.0)
  109 FORMAT('  zone      ',1X,10F6.0)
C...
   35 WRITE(6,102)NZ
  102 FORMAT(/' *** "40  " ZONAL CHARACTERISTICS: ',T40,'
     * I2)
      WRITE(6,103)(I),I=1,NZ)
      WRITE(6,104)(ZOD(1,I),I=1,NZ)
      WRITE(6,105)(ZOD(2,I),I=1,NZ)
C...
  103 FORMAT(/' ZONE number',10I6)
  104 FORMAT(/' "wealth"   ',2X,10F6.0)
  105 FORMAT('  distance  ',1X,10F6.0)
C...
  799 WRITE(6,120)(PAR(I),I=1,5),(DAT(I),I=1,5)
  120 FORMAT(/' *** "50  " BEHAVIOURAL PARAMETERS'//
     *'   GAMMA1    GAMMA2    GAMMA3    BETA1    BETA2'/
     *'  (price )  (wealth)  (access)  (depre.) (elast)'/
     * 2(F8.4,4F10.4/))
C...
C...
      WRITE(6,121)PO,PC,QM
  121 FORMAT(/' *** "60  " CONSTRUCTION CHARACTERISTICS'/
     *'   PO        PC        QM '
     * /F8.2,2F10.2)
C...
      IF(NS.EQ.0)RETURN
C...
      WRITE(6,160)((I),I=1,10),((IPOL(I,K),I=1,2),(POL(I,
     * ,K=1,4)
  160 FORMAT(/' ***  80    POLICY PARAMETERS'//
     * ' option  ',10('POL',I2,2X)/4(I4,'.',I1,10F7.2/))
      WRITE(6,161)((I),I=1,10),(HHT(I,3),I=1,10)
  161 FORMAT(/' ELIGIBILITY BY TYPE:'/10I6/1X,10F6.0)
      IF(IGIVEN(1).NE.0)WRITE(6,162)IGIVEN
  162 FORMAT(/' PUBLIC HOUSING: option',I4/10I6)
      IF(PPP.NE.0.0)WRITE(6,163)PPP
  163 FORMAT(/' purchasing power adjustor',F10.4)
      IF(PAR(36).NE.0.)WRITE(6,164)PAR(36)
  164 FORMAT(/' price elasticity adjustor',F10.4)
C...
      RETURN
C...
C...  INPUT ERROR
```

PROGRAM:F09:SIMO1.FORT

```
1530          2 WRITE(6,129)
1531        129 FORMAT(/' *** ERROR in input data stopped execution
1532            STOP
1533      C...
1534            ENTRY OT$3(IP1)
1535      C...
1536            WRITE(6,99)TITLE
1537            IF(IP1.LE.1)RETURN
1538      C...
1539            WRITE(6,122)
1540        122 FORMAT(/' *** HOUSEHOLD CHARACTERISTICS:')
1541      C...
1542            IF=0
1543          5 IS=IF+1
1544            IF=IS+9
1545            IF(IF.GT.NHH)IF=NHH
1546      C...
1547            WRITE(6,115)((I),I=IS,IF)
1548            WRITE(6,113)(ALPHA(I),I=IS,IF)
1549            WRITE(6,118)(HHD(I,1),I=IS,IF)
1550            WRITE(6,119)(HHD(I,3),I=IS,IF)
1551            IF(IP1.EQ.2)GOTO 36
1552            IF(IF.LT.NHH)GOTO 5
1553      C...
1554        118 FORMAT('  "Y":actual',1X,10F6.0)
1555        119 FORMAT('  "Y":model ',1X,10F6.0)
1556         36 WRITE(6,123)TITLE
1557        123 FORMAT('1'/' *** PRICE, QUANTITY and "partial" UTIL
1558      C...
1559            DO 6 I=1,NHH
1560            IH=I
1561      C.D   IH=1
1562            WRITE(6,124)I
1563        124 FORMAT(/' (Household',I3,')')
1564      C.D   READ(8'I)DWC
1565      C.D   IF(NS.NE.0)READ(9'I)ISUB
1566      C...
1567            IF=0
1568          7 IS=IF+1
1569            IF=IS+9
1570            IF(IF.GT.NMD1)IF=NMD1
1571            K=0
1572            DO 60 J=IS,IF
1573            K=K+1
1574            WR1(K)=DWC(3,I,J)/1000.
1575            WR2(K)=DWC(1,I,J)/10.
1576         60 WR3(K)=DWC(2,I,J)/10.
1577      C...
1578            WRITE(6,125)((J),J=IS,IF)
1579            WRITE(6,126)(WR1(J),J=1,K)
1580            WRITE(6,127)(WR2(J),J=1,K)
```

```
1581            WRITE(6,128)(WR3(J),J=1,K)
1582            IF(NS.NE.0)WRITE(6,147)(ISUB(IH,J),J=IS,IF)
1583            IF(IP1.EQ.2.AND.IF.GE.20)RETURN
1584            IF(IF.LT.NMD1)GOTO 7
1585      C...
1586         125 FORMAT(/' DWELLING    ',10I6)
1587         126 FORMAT(/'  price      ',1X,10F6.3)
1588         127 FORMAT('  quantity   ',1X,10F6.1)
1589         128 FORMAT('  partial"U"',1X,10F6.0)
1590         139 FORMAT('  utility    ',1X,10F6.0)
1591         146 FORMAT('  "P"*"Q"    ',1X,10F6.1)
1592         147 FORMAT('  SUBSIDY'/'    :type',5X,10I6)
1593         148 FORMAT('    :AMOUNT   ',10F6.0)
1594           6 CONTINUE
1595             RETURN
1596      C...
1597             ENTRY OT$4(IP1)
1598             WRITE(6,138)TITLE
1599         138 FORMAT('0'/' *** "TOTAL" UTILITY: ',6A4)
1600      C...
1601             DO 20 I=1,NHH
1602      C.D    READ(8'I)DWC
1603             WRITE(6,124)I
1604      C...
1605             IF=0
1606          27 IS=IF+1
1607             IF=IS+9
1608             IF(IF.GT.NMD1)IF=NMD1
1609             K=0
1610             DO 61 J=IS,IF
1611             K=K+1
1612             IZ=DWD(2,J)
1613          61 WR1(K)=DWC(2,I,J)/10.*ZW(IZ)
1614      C...
1615             WRITE(6,125)((J),J=IS,IF)
1616             WRITE(6,139)(WR1(J),J=1,K)
1617             IF(IP1.EQ.2.AND.IF.GE.20)RETURN
1618          32 IF(IF.LT.NMD1)GOTO 27
1619          20 CONTINUE
1620             RETURN
1621      C...
1622      C...
1623             ENTRY OT$4A(IP1)
1624      C... sorted stacks output
1625             WRITE(6,131)(UAHH(I),I=1,NHH)
1626         131 FORMAT(/' *** ORDERED HOUSEHOLD STACK'//
1627            * 8(1X,15I4/))
1628             WRITE(6,132)
1629         132 FORMAT(//' *** HOUSEHOLD''s "ordered" dwelling STAC
1630      C...
1631             DO 38 I=1,NHH
```

```
PROGRAM:F09:SIMO1.FORT

      C.D   READ(7'I)IODW
         38 WRITE(6,133)I,(IODW(I,J),J=1,NMD1)
        133 FORMAT(/' household',I4//8(1X,15I4/))
            RETURN
      C...
      C...
            ENTRY OT$5
      C... allocationed dwellings-households output
            WRITE(6,134)
        134 FORMAT('1'/' *** ALLOCATION of HOUSEHOLDS'/' existi
      C...
            IF=O
          9 IS=IF+1
            IF=IS+9
            IF(IF.GT.NMD)IF=NMD
            K=O
            DO 1O J=IS,IF
            K=K+1
            WR1(K)=O.
            WR2(K)=O.
            WR3(K)=O.
            WR4(K)=O.
            WR5(K)=O.
            WR6(K)=O.
            WR7(K)=O.
            IWR1(K)=O
            IWR2(K)=O
      C...
            DO 7O I=1,NHH
            IF(ISOL(I,1).EQ.J)GOTO 71
         7O CONTINUE
            GOTO 1O
      C...
         71 IWR1(K)=I
            WR1(K)=HHD(I,2)
            WR2(K)=SOL(I,2)
            WR3(K)=SOL(I,3)
            WR4(K)=DWD(2,J)
            WR5(K)=SOL(I,1)*SOL(I,2)
            WR6(K)=SOL(I,1)
      C... CALCULATE SUBSIDY
            IF(NS.EQ.O)GOTO 1O
            IWR2(K)=ISOL(I,2)
            WR7(K)=SOL(I,4)
         1O CONTINUE
      C...
            WRITE(6,125)((J),J=IS,IF)
            WRITE(6,1O9)(WR4(J),J=1,K)
            WRITE(6,115)(IWR1(J),J=1,K)
            WRITE(6,117)(WR1(J),J=1,K)
            WRITE(6,139)(WR3(J),J=1,K)
```

```
1683            WRITE(6,126)(WR6(J),J=1,K)
1684            WRITE(6,127)(WR2(J),J=1,K)
1685            WRITE(6,146)(WR5(J),J=1,K)
1686      C... OUTPUT SUBSIDY
1687            IF(NS.EQ.O)GOTO 44
1688            WRITE(6,147)(IWR2(J),J=1,K)
1689            WRITE(6,148)(WR7(J),J=1,K)
1690      C...
1691         44 IF(IF.LT.NMD)GOTO 9
1692      C...
1693      C... new dwellings allocated
1694         37 WRITE(6,135)
1695        135 FORMAT('O'/' *** ALLOCATION OF HOUSEHOLDS'/' NEW DW
1696      C...
1697            I=O
1698         11 IS=I+1
1699            J=O
1700            DO 12 I=IS,NHH
1701            IF(ISOL(I,1).NE.999)GOTO 12
1702            J=J+1
1703            IWR1(J)=I
1704            WR1(J)=HHD(I,2)
1705            WR2(J)=SOL(I,2)
1706            WR3(J)=SOL(I,1)*SOL(I,2)
1707            WR4(J)=SOL(I,3)
1708            WR5(J)=SOL(I,1)
1709      C... SUBSIDY
1710            IF(NS.EQ.O)GOTO 41
1711            IWR2(J)=ISOL(I,2)
1712            WR6(J)=SOL(I,4)
1713         41 IF(J.EQ.1O)GOTO 14
1714         12 CONTINUE
1715            IF(IF.EQ.O.AND.J.EQ.O)GOTO 13
1716            IF(J.NE.O)GOTO 14
1717            WRITE(6,144)
1718        144 FORMAT(/'  NO NEW DWELLINGS CREATED')
1719            GOTO 13
1720      C...
1721         14 IF=O
1722            WRITE(6,115)(IWR1(K),K=1,J)
1723            WRITE(6,117) (WR1(K),K=1,J)
1724            WRITE(6,139) (WR4(K),K=1,J)
1725            WRITE(6,126) (WR5(K),K=1,J)
1726            WRITE(6,127) (WR2(K),K=1,J)
1727            WRITE(6,146) (WR3(K),K=1,J)
1728      C... OUTPUT SUBSIDY
1729            IF(NS.EQ.O)GOTO 42
1730            WRITE(6,147)(IWR2(K),K=1,J)
1731            WRITE(6,148)(WR6(K),K=1,J)
1732         42 IF(I.LT.NHH)GOTO 11
1733      C...
```

```
 1734          13 CONTINUE
 1735      C...
 1736      C... NO dwelling allocated to household
 1737      C...
 1738             DO 24 I=1,NHH
 1739             IF(ISOL(I,1).LE.O)GOTO 15
 1740          24 CONTINUE
 1741             RETURN
 1742      C...
 1743          15 WRITE(6,136)
 1744         136 FORMAT(//' ***ALLOCATION OF HOUSEHOLDS'/' NO DWELLI
 1745      C...
 1746             I=O
 1747          17 IS=I+1
 1748             J=O
 1749             DO 18 I=IS,NHH
 1750             IF(ISOL(I,1).GT.O)GOTO 18
 1751             J=J+1
 1752      C...
 1753             IWR1(J)=I
 1754             WR1(J)=HHD(I,2)
 1755             WR2(J)=SOL(I,1)
 1756             IWR2(J)=-ISOL(I,1)
 1757      C...
 1758             IF(J.EQ.1O)GOTO 19
 1759          18 CONTINUE
 1760             IF(J.EQ.O)GOTO 16
 1761      C...
 1762          19 WRITE(6,115)(IWR1(K),K=1,J)
 1763             WRITE(6,117) (WR1(K),K=1,J)
 1764             WRITE(6,125)(IWR2(K),K=1,J)
 1765             WRITE(6,137) (WR2(K),K=1,J)
 1766      C...
 1767         137 FORMAT('  HIGHEST BID',1OF6.3)
 1768      C...
 1769             IF(I.LT.NHH)GOTO 17
 1770      C...
 1771          16 CONTINUE
 1772      C...
 1773             RETURN
 1774      C...
 1775             ENTRY OT$1O(SER)
 1776      C... output "expected" and actual externalities.
 1777      C...
 1778             WRITE(6,14O)
 1779         14O FORMAT('O'/' *** "ACTUAL" AND "EXPECTED" EXTERNALIT
 1780            */T15,'"ACTUAL"',T3O,'"EXPECTED"'/
 1781            */' zone',2(' relative   "#"    ')
 1782            */3X, 2(4X,'wealth   units')/)
 1783      C...
 1784             WRITE(6,141)(I,((EXT(L,K,I),K=1,2),L=1,2),I=1,NZ)
```

PROGRAM:F09:SIMO1.FORT

```
      141 FORMAT(20(I4,2(F9.4,F8.0,3X)/))
          WRITE(6,142) SER
      142 FORMAT(/'  Root-Mean-Squared-Error:',F10.4)
          RETURN
C...
C...
          ENTRY OT$7
C...
C... output of POLICY data set
C...
          WRITE(1,801)TITLE
  801 FORMAT('0000POLICY ',6A4)
C...
          IWR1(1)=IFIX(10000.*(COEF+0.00009))
          WRITE(1,809)IWR1(1),(PAR(I),I=1,8)
  809 FORMAT('2300',I5/'5001',F5.3/'5002',F5.3/'5003',F5.
     * /'5004',F5.3/'5005',F5.3/'6001',F5.3/'6002',F5.3/'
C...
          DO 899 I=1,NHT
          IWR1(1)=IFIX(HHT(I,1)+.1)
C...
  899 WRITE(1,802)I,IWR1(1),I,HHT(I,2)
C...
  802 FORMAT('20',I2,I5/'21',I2,F5.4)
C...
          DO 898 I=1,NHH
C...
          J=ISOL(I,1)
          WR1(1)=SOL(I,1)
          WR1(2)=SOL(I,2)
          WR1(3)=SOL(I,3)
          IF(J.GT.0)GOTO 893
          J=0
          WR1(1)=0.0
          WR1(2)=0.0
          WR1(3)=0.0
C...
  893 IWR1(1)=IFIX(HHD(I,1)+.1)
          IWR1(2)=IFIX(HHD(I,2)+.1)
C...
          IF(WR1(3).GE.1000)GOTO 889
          IF(WR1(2).LT.1000.)WRITE(1,803)
         * I,IWR1(1),IWR1(2),J,WR1(1),WR1(2),WR1(3)
          IF(WR1(2).GE.1000.)WRITE(1,804)
         * I,IWR1(1),IWR1(2),J,WR1(1),WR1(2),WR1(3)
           GOTO 898
C...
  889 IF(WR1(2).LT.1000.)WRITE(1,807)
     * I,IWR1(1),IWR1(2),J,WR1(1),WR1(2),WR1(3)
          IF(WR1(2).GE.1000.)WRITE(1,808)
         * I,IWR1(1),IWR1(2),J,WR1(1),WR1(2),WR1(3)
```

```
1836        803 FORMAT('1',I3,3I5,F5.3,F5.1,F5.1)
1837        804 FORMAT('1',I3,3I5,F5.3,F5.0,F5.1)
1838        807 FORMAT('1',I3,3I5,F5.3,F5.1,F5.0)
1839        808 FORMAT('1',I3,3I5,F5.3,F5.0,F5.0)
1840      C...
1841        898 CONTINUE
1842      C...
1843            DO 892 IZ=1,NZ
1844            IWR1(1)=IFIX(EXT(1,1,IZ)*10000.)
1845            IWR1(2)=IFIX(ZOD(2,IZ)+.1)
1846      C...
1847        892 WRITE(1,805)IZ,IWR1(1),IWR1(2)
1848        805 FORMAT('40',I2,2I5)
1849      C...
1850            DO 891 J=1,NMD
1851            IWR1(1)=IFIX(DWD(1,J)+.1)
1852            IWR1(2)=IFIX(DWD(2,J)+.1)
1853      C...
1854        891 WRITE(1,806)J,IWR1(1),IWR1(2)
1855        806 FORMAT('3',I3,2I5)
1856      C...
1857            RETURN
1858            END
1859      C...
1860            SUBROUTINE CALBRT
1861      C... routine to calculate and print calibration statistic
1862            INTEGER*2 ISOL(120,2)
1863            REAL*4 CAL(15,12),ERR(15,2),ACT(12,11),SOL(120,4)
1864            COMMON/BLK8/DU1(36120),ISOL,SOL
1865            COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
1866           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20)
1867            EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
1868           * ,(IC1(5),NMD1)
1869           * ,(PAR(10),PO),(PAR(11),PC),(PAR(12),QM),(PAR(13),P
1870           * ,(HHD(2001),ACT(1,1)),(DU1(1),CAL(1,1)),(DU1(201),
1871      C...
1872            ENTRY OT$CAL
1873      C...
1874            WRITE(6,200)
1875            WRITE(6,102)((I),I=1,8)
1876      C...
1877            DO 20 IZ=1,NZ
1878         20 WRITE(6,110) IZ,(ACT(K,IZ),K=1,12)
1879        110 FORMAT(' zone',I3,F8.2,8F5.2,F7.0,F6.2,F6.1)
1880      C...
1881            RETURN
1882      C...
1883            ENTRY CL$20(IC)
1884      C...
1885            NZ1=NZ+1
1886      C...
```

```
      DO 1 J=1,12
      DO 1 I=1,15
    1 CAL(I,J)=0.
C...
C... aggregating data on existing dwellings.
C...
      DO 2 J=1,NMD
C...
      IZ=DWD(2,J)
      DO 15 I=1,NHH
      IF(ISOL(I,1).EQ.J)GOTO 16
   15 CONTINUE
      GOTO 3
C...
   16 IT=IFIX(HHD(I,2))
C...
C... p.q
      CAL( 1,IZ)=CAL( 1,IZ)+SOL(I,1)*SOL(I,2)
      CAL(1,NZ1)=CAL(1,NZ1)+SOL(I,1)*SOL(I,2)
C... type
      IF(NHT.LE.8)CAL(IT+1,IZ)=CAL(IT+1,IZ)+1
      IF(NHT.LE.8)CAL(IT+1,NZ1)=CAL(IT+1,NZ1)+1
C... income
      CAL(10,IZ)=CAL(10,IZ)+HHD(I,1)
      CAL(10,NZ1)=CAL(10,NZ1)+HHD(I,1)
C... utilisation
      CAL(11,IZ)=CAL(11,IZ)+1
      CAL(11,NZ1)=CAL(11,NZ1)+1
C... q
      CAL(12,IZ)=CAL(12,IZ)+SOL(I,2)
      CAL(12,NZ1)=CAL(12,NZ1)+SOL(I,2)
C...# hholds
      CAL(13,IZ)=CAL(13,IZ)+1
      CAL(13,NZ1)=CAL(13,NZ1)+1
C... # exist dwelling at start
    3 CAL(14,IZ)=CAL(14,IZ)+1
      CAL(14,NZ1)=CAL(14,NZ1)+1
C...
    2 CONTINUE
C...
C... aggregating by new
      DO 4 I=1,NHH
C...
      IF(ISOL(I,1).NE.999)GOTO 4
C...
      IT=IFIX(HHD(I,2))
C... p.q
      CAL( 1,NZ)=CAL( 1,NZ)+SOL(I,1)*SOL(I,2)
      CAL(1,NZ1)=CAL(1,NZ1)+SOL(I,1)*SOL(I,2)
C... type
      IF(NHT.LE.8)CAL(IT+1,NZ)=CAL(IT+1,NZ)+1
```

```
      IF(NHT.LE.8)CAL(IT+1,NZ1)=CAL(IT+1,NZ1)+1
C... income
      CAL(10,NZ)=CAL(10,NZ)+HHD(I,1)
      CAL(10,NZ1)=CAL(10,NZ1)+HHD(I,1)
C... utilisation
      CAL(11,NZ)=CAL(11,NZ)+1
      CAL(11,NZ1)=CAL(11,NZ1)+1
      CAL(14,NZ)=CAL(14,NZ)+1
      CAL(14,NZ1)=CAL(14,NZ1)+1
C... q
      CAL(12,NZ)=CAL(12,NZ)+SOL(I,2)
      CAL(12,NZ1)=CAL(12,NZ1)+SOL(I,2)
C...# hholds
      CAL(13,NZ)=CAL(13,NZ)+1
      CAL(13,NZ1)=CAL(13,NZ1)+1
C...
    4 CONTINUE
C...
C... calculating zonal and total averages
C...
      DO 5 IZ=1,NZ1
C... p
      IF(CAL(12,IZ).NE.0)CAL(1,IZ)=CAL(1,IZ)/CAL(12,IZ)
C...
      IF(CAL(13,IZ).EQ.0)GOTO 7
C...
C... type
      DO 6 IT=2,9
    6 CAL(IT,IZ)=CAL(IT,IZ)/CAL(13,IZ)
C...
C... income
      CAL(10,IZ)=CAL(10,IZ)/CAL(13,IZ)
C... q
      CAL(12,IZ)=CAL(12,IZ)/CAL(13,IZ)
C...
C... utilization
    7 IF(CAL(14,IZ).NE.0)CAL(11,IZ)=CAL(11,IZ)/CAL(14,IZ)
C...
    5 CONTINUE
C...
C... calculating calibration "mean error"
C...
      DO 9 K=1,12
    9 ERR(K,1)=0.
C...
      DO 10 IZ=1,NZ
      DO 10 K=1,12
   10 ERR(K,1)=ERR(K,1)+(CAL(K,IZ)-ACT(K,IZ))**2
C...
      IZ=NZ
      IF(ACT(1,NZ).EQ.0)IZ=NZ-1
```

```
C...
      DO 11 K=1,12
   11 ERR(K,1)=SQRT(ERR(K,1))/(2.*IZ)
C...
      SER1=0.
C...
      IT=0
      DO 12 K=1,12
C...
      ERR(K,2)=0.
      IF(CAL(K,NZ1).EQ.0)GOTO 12
C...
      ERR(K,2)=ERR(K,1)/CAL(K,NZ1)
   12 CONTINUE
C...
      IF(NHT.GT.8)GOTO 95
C...
C... adjusting TYPE to average over all types
      DO 13 K=2,9
      IF(ERR(K,2).EQ.0)GOTO 13
      SER1=SER1+ERR(K,2)
      IT=IT+1
   13 CONTINUE
C...
      SER1=SER1/FLOAT(IT)
   95 SER=0.
      IT=0
C...
      DO 14 K=1,12
      IF(K.GE.2.AND.K.LE.9)GOTO 14
      IF(ERR(K,2).EQ.0)GOTO 14
      SER=SER+ERR(K,2)
      IT=IT+1
   14 CONTINUE
C...
C...
      SER=SER/IT
C...
C... output of calibration test
C...
      WRITE(6,100)TITLE
  200 FORMAT(/' *** "70  " CALIBRATION DATA:')
  100 FORMAT('1'/' *** CALIBRATION output: ',6A4)
      WRITE(6,101)(PAR(I),I=1,5)
      WRITE(6,102) ((I),I=1,8)
C...
  101 FORMAT(/' *** AVERAGE "actual" and "solution" ZONAL
     * ' CHARACTERISTICS'//'  parameter values   ',
     *'GAMMA1  GAMMA2  GAMMA3  BETA1   BETA2'/18X,5F8.4)
  102 FORMAT(/T20,'********  household type  ********'
     *      /T12,'price',I3,7I5,T57,'income  usage  "Q"'/
```

PROGRAM:F09:SIMO1.FORT

```
C...
      WRITE(6,103)(IZ,(ACT(K,IZ),K=1,12),(CAL(K,IZ),K=1,1
C...
  103 FORMAT(' (zone',I3,')'//'  actual',F6.2,8F5.2,F8.0,F
     *                          /'  calc. ',F6.2,8F5.2,F8.0
C...
      WRITE(6,104)
  104 FORMAT(/' *** CALIBRATION ERRORS')
C...
      WRITE(6,102) ((I),I=1,8)
      WRITE(6,105)((ERR(K,L),K=1,12),L=1,2),SER,SER1
C...
  105 FORMAT('  R.M.S.E. ',F5.4,8F5.2,F8.1,F6.3,F6.1
     *      //'  R.M.S.E. ',F5.4,8F5.2,F7.4,F6.3,F6.3
     *       /' (weighted)',T18,15('-'),' averaged ',14('
     *      //10X,'MEAN ERRORS',2F10.4)
C...
      RETURN
      END
C...
C...
      FUNCTION SUB(IP,IS,L,AY,P,Q,ND)
      COMMON/BLK21/DUM(3058),DWD(3,502),ZOD(3,11),PAR(40)
C...
      EQUIVALENCE (PAR(6),PO),(PAR(7),PC)
C...
      GOTO(1,2,3,4,4),IP
C...
      SUB=0.0
      RETURN
C... income
    1 SUB=(POL(1,L)*(POL(3,L)-POL(4,L)*AY))
      RETURN
C...
    2 GOTO(21,22,23,24,25,26),IS
C...
      SUB=P*Q
      RETURN
C...
   21 SUB=(POL(1,L)*(POL(2,L)*P*Q-POL(4,L)*AY))
      RETURN
C...
   22 SUB=(POL(1,L)*(POL(3,L)-POL(4,L)*AY))
      RETURN
C...
   23 SUB=(POL(1,L)*(POL(2,L)-POL(5,L))*P*Q)
      RETURN
C...
   24 SUB=(POL(1,L)*(POL(3,L)-POL(5,L)*P*Q))
      RETURN
C...
```

```
2091          25 SUB=(POL(1,L)*(POL(2,L)*P*Q-POL(5,L)*AY*P*Q))
2092             RETURN
2093       C...
2094          26 SUB=(POL(1,L)*(POL(3,L)-POL(5,L)*AY*P*Q))
2095             RETURN
2096       C... price
2097           3 IF(ND.GT.500)SUB=Q* (PO-POL(1,L)+PC-POL(2,L))
2098             IF(ND.LE.500)SUB=Q* (PO-POL(3,L)+PC-POL(4,L))
2099             RETURN
2100       C...
2101       C... direct demand and supply
2102           4 GOTO(41,42),IS
2103       C...
2104          41 SUB=POL(1,L)*(POL(2,L)*P*Q-POL(4,L)*AY)
2105             RETURN
2106       C...
2107          42 SUB=POL(1,L)*(POL(3,L)-POL(4,L)*AY)
2108             RETURN
2109       C...
2110             END
2111       C...
2112             SUBROUTINE POLICY
2113       C... ROUTINE CALCULATES THE SUBSIDY PROFILE,AMOUNTS AND I
2114             INTEGER*4 IWR1(10)
2115             REAL*4 MEANS,MEDNS,DIFF(10,5),DIFF1(7),MER(5)
2116            * ,SUBP(2,4,13),YT(13),WR1(10),WR2(10),MY
2117            * ,SKEY(120),SOL(120,4)
2118             INTEGER*2 SAHH(120),UAHH(120),ISOL(120,2)
2119             COMMON/BLK8/DU1(36000),SAHH,UAHH,ISOL,SOL
2120             COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
2121            * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
2122             EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
2123            * ,(IC1(5),NMD1),(IC1(7),IP1),(IC1(10),NS)
2124            * ,(PAR(6),PO),(PAR(7),PC),(PAR(8),QM)
2125            * ,(PAR(9),PN),(PAR(37),PPP)
2126            * ,(IC1(10),NS)
2127            * ,(DIFF1(1),PART),(DIFF1(2),MEANS),(DIFF1(4),MEDNS)
2128            * ,(DIFF1(5),BNEW),(DIFF1(6),SNEW)
2129       C...
2130             EQUIVALENCE (DU1(1),SUBP(1,1,1),SKEY(1),DIFF(1,1))
2131            * ,(DU1(51),DIFF1(1)),(DU1(61),MER(1))
2132            * ,(DU1(101),WR1(1)),(DU1(111),WR2(1)),(DU1(121),IWR
2133       C...
2134             DATA YT/50.,100.,150.,200.,250.,300.,350.,400.,450.
2135            * 2000.,3000./
2136       C...
2137             ENTRY CL$SB1(KJ)
2138       C...
2139             IF(IP1.EQ.10.AND.KJ.EQ.2)GOTO 999
2140       C...
2141       C... calculating subsidy by h'hold
```

```
C...
      K=IPOL(1,1)
      DO 10 I=1,NHH
      SOL(I,4)=0.
C...
      IF(K.GE.20)GOTO 7
C...
      L=ISOL(I,2)/10
      J=ISOL(I,1)
      IF(J.LE.0.OR.L.EQ.0)GOTO 10
C...
      IP=ISOL(I,2)-10*L
      IS=IPOL(2,L)
      AY=HHD(I,1)/12.
      KT=IFIX(ABS(HHD(I,2)))
      IF(HHD(I,1).GT.HHT(KT,1))AY=AY*(1.-PPP)
C...
      SOL(I,4)=SUB(IP,IS,L,AY,SOL(I,1),SOL(I,2),J)
C...
      GOTO 10
C...
    7 SOL(I,4)=ISOL(I,2)/10.
      IF(SOL(I,4).GT.0.001)ISOL(I,2)=20+IPOL(2,1)
C...
   10 CONTINUE
C...
      IF(KJ.EQ.1)RETURN
C... SORTING HOUSEHOLDS BY SUBSIDY AMOUNT
  999 DO 1 I=1,NHH
    1 SKEY(I)=SOL(I,4)
C...
      DO 3 K=1,NHH
      IS=0
      X=-9.E10
C...
      DO 2 N=1,NHH
      IF(SKEY(N).LE.X)GOTO 2
      X=SKEY(N)
      IS=N
    2 CONTINUE
C...
      SKEY(IS)=-9.E10
    3 SAHH(K)=IS
C...
C...
      DO 20 I=1,10
      DO 20 J=1,5
   20 DIFF(I,J)=0.
C...
      DO 21 I=1,7
   21 DIFF1(I)=0.
```

PROGRAM:F09:SIMO1.FORT

```
C...
      DO 22 I=1,5
   22 MER(I)=0.0
C...
C... calculating DIFF1 values
      DO 30 I=1,NHH
      IF(SOL(I,4).GT.0.0)PART=PART+1
      MEANS=MEANS+SOL(I,4)
C...
      IF(HHD(I,4).EQ.999.)BNEW=BNEW+1.
      IF(ISOL(I,1).EQ.999) SNEW=SNEW+1
C...
   30 CONTINUE
C...
      IF(PART.EQ.0.OR.BNEW.EQ.0.0)RETURN
C...
      DO 23 J=1,5
   23 DIFF(5,J)=1E10
C...
      MEANS=MEANS/PART
      DIFF1(3)=PART*100./FLOAT(NHH)
C...
      I=IFIX(PART+2.1)/2.
      J=IFIX(PART+1.1)/2.
C...
      I1=SAHH(I)
      J1=SAHH(J)
      MEDNS=(SOL(I1,4)+SOL(J1,4))/2.
C...
      IF(BNEW.NE.0.0)DIFF1(7)=(SNEW-BNEW)*100./BNEW
C...
C... calculating DIFF values
C... numbers
      DIFF(1,1)=FLOAT(NHH)
      DIFF(1,2)=PART
      DO 31 I=3,5
   31 DIFF(1,I)=10.
C...
      DO 32 I=3,4
      IF(PART.LT.20.)DIFF(1,I)=FLOAT(IFIX(PART/2.))
   32 IF(DIFF(1,I).EQ.0.)DIFF(1,I)=1.
C...
      UNSUB=DIFF(1,1)-DIFF(1,2)
C...
      IF(UNSUB.LT.10)DIFF(1,5)=UNSUB
C...
      DO 40 L=1,5
C...
      TPB=0.
      TQB=0.
      TEB=0.
```

PROGRAM:FO9:SIMO1.FORT

```
 2244            TS=0.0
 2245            TI =0.
 2246            IF=0
 2247      C...
 2248            I1=IFIX(DIFF(1,L)+.01)
 2249            IF(I1.EQ.0)GOTO 40
 2250      C...
 2251            DO 33 K=1,I1
 2252      C...
 2253            GOTO(50,52,53,54,53),L
 2254      C...
 2255         50 I=K
 2256            GOTO 51
 2257      C...
 2258      C... all participants
 2259         52 IS=IF+1
 2260            DO 62 IF=IS,NHH
 2261            I=IF
 2262            IF(SOL(I,4).NE.0.0)GO TO 51
 2263         62 CONTINUE
 2264            GO TO 51
 2265      C...
 2266      C... high income
 2267         54 IS=IF+1
 2268            DO 63 IF=IS,NHH
 2269            I=UAHH(IF)
 2270            IF(SOL(I,4).NE.0.0)GOTO 51
 2271         63 CONTINUE
 2272            GOTO 51
 2273      C...
 2274      C... low income - both
 2275         53 IS=IF+1
 2276            DO 64 IF=IS,NHH
 2277            IK=NHH+1-IF
 2278            I=UAHH(IK)
 2279            IF(L.EQ.3.AND.SOL(I,4).NE.0.0)GOTO 51
 2280            IF(L.EQ.5.AND.SOL(I,4).EQ.0.0)GOTO 51
 2281         64 CONTINUE
 2282      C...
 2283      C... find dwelling
 2284         51 IF(ISOL(I,1).LE.0)GOTO 34
 2285      C...
 2286         38 DIFF(2,L)=DIFF(2,L)+SOL(I,1)
 2287            DIFF(3,L)=DIFF(3,L)+SOL(I,2)
 2288            DIFF(4,L)=DIFF(4,L)+SOL(I,1)*SOL(I,2)
 2289      C...
 2290         34 TPB=TPB+HHD(I,5)
 2291            TQB=TQB+HHD(I,6)
 2292            TEB=TEB+HHD(I,5)*HHD(I,6)
 2293            TS=TS+SOL(I,4)
 2294      C...
```

PROGRAM:F09:SIMO1.FORT

```
2295            AY=HHD(I,1)/12.
2296            UAY=AY
2297            KT=IFIX(ABS(HHD(I,2)))
2298            IF(HHD(I,1).GT.HHT(KT,1))AY=AY*(1.-PPP)
2299      C...
2300            IF(AY.LT.DIFF(5,L))DIFF(5,L)=AY
2301            IF(AY.GT.DIFF(6,L))DIFF(6,L)=AY
2302      C...
2303            TI=TI+UAY
2304            DIFF(7,L)=DIFF(7,L)+AY+SOL(I,4)
2305      C...
2306            DO 950 N=1,NS
2307            IF(AY.GT.AILIM(N))GOTO 950
2308            DIFF(10,L)=DIFF(10,L)+1.
2309            GOTO 33
2310          950 CONTINUE
2311      C...
2312           33 CONTINUE
2313      C...
2314      C... participation
2315            IF(L.EQ.1.AND.DIFF(10,1).NE.0.)DIFF(10,1)=PART*100.
2316      C...
2317            IF(MEANS*PART.NE.0.)DIFF(9,L)=(DIFF(7,L)-TI)*100./(
2318      C...
2319            IF(DIFF(7,L)-TI.NE.0.0)
2320           * DIFF(8,L)=(DIFF(4,L)-TEB)*100./(DIFF(7,L)-TI)
2321      C... %increase purchasing power
2322            IF(TI.NE.0.)DIFF(7,L)=(DIFF(7,L)-TI)*100./TI
2323      C... changes
2324            IF(TPB.NE.0.)DIFF(2,L)=(DIFF(2,L)-TPB)*100./TPB
2325            IF(TQB.NE.0.)DIFF(3,L)=(DIFF(3,L)-TQB)*100./TQB
2326            IF(TEB.NE.0.)DIFF(4,L)=(DIFF(4,L)-TEB)*100./TEB
2327      C...
2328      C... market efficiency ratio
2329            IF(DIFF(1,L).NE.0.)TS=TS/DIFF(1,L)
2330            IF(TS.NE.0.0)MER(L)=DIFF(3,L)/TS
2331      C...
2332           40 CONTINUE
2333              RETURN
2334      C...
2335              ENTRY OT$SB
2336      C...
2337              IO=1
2338              WRITE(6,99)TITLE
2339           99 FORMAT('1*** SUBSIDY AMOUNT: ',6A4/)
2340              CALL OT$ST(NS)
2341      C...
2342              IF(PART.EQ.0.0)GOTO 71
2343      C...
2344              WRITE(6,904)
2345      C...
```

PROGRAM:F09:SIMO1.FORT

```
      GOTO 199
C...
      ENTRY OT$BS
C...
      IO=2
      WRITE(6,110)TITLE
  110 FORMAT('1*** BASE AMOUNT: ',6A4
     * //T5,'HHOLD',T16,'INCOME',T36,'DWELLING'
     * /'  #  TYPE  ACTUAL     MODEL  #   PRICE  QUANTITY
C...
  199 DO 940 I=1,5
  940 WR2(I)=0.
C...
      DO 915 IS=1,NHH
C...
      I=UAHH(IS)
      AY=HHD(I,1)/12.
      MY=HHD(I,3)
      KT=IFIX(ABS(HHD(I,2)))
C...
      IF(HHD(I,1).GT.HHT(KT,1))MY=MY*(1.-PPP)
      IF(HHD(I,1).GT.HHT(KT,1))AY=AY*(1.-PPP)
      IF(ISOL(I,1).LE.0)GOTO 910
      J=ISOL(I,1)
C...
      WR1(1)=SOL(I,1)
      WR1(2)=SOL(I,2)
      WR1(3)=WR1(1)*WR1(2)
      IWR1(1)=ISOL(I,2)
      WR1(4)=SOL(I,4)
      GOTO 930
C... NO DWELLING
  910 DO 911 K=1,4
      IWR1(K)=0
  911 WR1(K)=0.
      J=0
      GOTO 930
C...
  930 DO 931 K=1,4
  931 WR2(K)=WR2(K)+WR1(K)
      WR2(5)=WR2(5)+AY
C...
      IF(IO.EQ.1)WRITE(6,905)I,HHD(I,2),AY,MY,J,(WR1(K),K
     * ,WR1(4)
      IF(IO.EQ.2)WRITE(6,905)I,HHD(I,2),AY,MY,J,(WR1(K),K
C...
      IF(IS.NE.50.AND.IS.NE.100.AND.IS.NE.150)GOTO 915
      IF(IS.EQ.NHH)GOTO 915
C...
      GOTO(8,9),IO
    8 WRITE(6,99)TITLE
```

```
      CALL OT$ST(NS)
      WRITE(6,904)
      GOTO 915
C...
    9 WRITE(6,110)TITLE
C...
  915 CONTINUE
C...
      IF(IO.EQ.1)WRITE(6,906)WR2(5),(WR2(K),K=2,4)
      IF(IO.EQ.2)WRITE(6,906)WR2(5),(WR2(K),K=2,3)
C...
  904 FORMAT(/T5,'HHOLD',T16,'INCOME',T36,'DWELLING',T59,
     *'  #  TYPE  ACTUAL     MODEL  #   PRICE  QUANTITY
     * 'AMOUNT')
  905 FORMAT(I4,F4.0,2F9.0,I4,F8.3,F8.1,F8.1,I4,F8.1)
  906 FORMAT(T2,66('-')/T9,F9.0,T39,2F8.1,T59,F8.1)
C...
      IF(IO.EQ.2)RETURN
C...
      WRITE(6,101)TITLE
      CALL OT$ST(NS)
  101 FORMAT('1*** SUBSIDY IMPACT: ',6A4/)
      IF(BNEW.EQ.0.0)RETURN
C...
      WRITE(6,102)DIFF1
  102 FORMAT(/'     Participants:',T30,F5.0,T40,'Subsidy:
     * F8.1/T18,': percent',T30,F5.2,'%',T47,': Median',T
     *//' New Construction: Base',T30,F5.0/T18,': Subsidi
     */T18,': % change',T30,F5.2,'%')
C...
      WRITE(6,103)((DIFF(I,J),J=1,5),I=1,7),(MER(I),I=1,4
      WRITE(6,104)((DIFF(I,J),J=2,4),I=8,9),DIFF(10,1)
C...
  103 FORMAT(/T22,'C.M.A.',T42,'RECIPIENTS',T62,'NON-'
     * /T35,'all  low "Y"   high "Y"  RECIPIENTS'
     *//' Number',T17,5F10.0, //' Changes'/'   Prices',T1
     * /'   quantity',T19,5(F9.2,'%')/'   expenditure',T1
     *//' Incomes'/'   Lowest',T19,5F10.0  /'   Highest',
     *//' Changes in'/' Purchasing Power',T19,5(F9.2,'%')
     *//' Efficiency Ratio',T19,4F10.3)
C...
  104 FORMAT(/' Earmarking Ratio',T28,3F10.2//' %Subsidy
     * ,3(F9.2,'%')//' participation'/8X,'rate',T18,F10.2
     * '  note:  NON-RECIPIENTS are lowest-income group'/
C...
      RETURN
C...
C... no participants
   71 WRITE(6,105)
  105 FORMAT(/' NO PARTICIPANTS')
      RETURN
```

PROGRAM:FO9:SIMO1.FORT

```
      C...
            END
      C...
            SUBROUTINE OT$ST(NS)
            COMMON /BLK21/DU1(4637),POL(10,4),DU2(79),IPOL(2,4)
            REAL*8 TOP(3)/'*AY)     ','*P*Q)    ','*P*Q*AY)'/
           * ,CON(3,6) /'income  ','        ','        '
           *           ,'in kind ','demand  ','        '
           *           ,'direct c','onstrain','ed      '
           *           ,'direct q','uantity ','        '
           *           ,'direct e','xpenditu','re      '
           *           ,'direct p','rice    ','        '/
      C...
            DO 800 L=1,NS
            IF(IPOL(1,L).GE.7.AND.IPOL(1,L).LE.9)GOTO 810
            IS=IPOL(2,L)
            IF(IPOL(1,L).GE.20)GOTO 820
      C...
            GOTO(1,2,3,4,5,6),IS
      C...
          1 WRITE(6,101)POL(1,L),POL(2,L),POL(4,L),TOP(1),AILIM
            GOTO 800
          2 WRITE(6,102)POL(1,L),POL(3,L),POL(4,L),TOP(1),AILIM
            GOTO 800
          3 WRITE(6,101)POL(1,L),POL(2,L),POL(5,L),TOP(2),AILIM
            GOTO 800
          4 WRITE(6,102)POL(1,L),POL(3,L),POL(5,L),TOP(2),AILIM
            GOTO 800
          5 WRITE(6,101)POL(1,L),POL(2,L),POL(5,L),TOP(3),AILIM
            GOTO 800
          6 WRITE(6,102)POL(1,L),POL(3,L),POL(5,L),TOP(3),AILIM
            GOTO 800
      C...
        810 WRITE(6,110)(POL(I,L),I=1,4),AILIM(L),POL(7,L)
            GOTO 800
      C... constrained MINIMUM option
        820 WRITE(6,120)(CON(I,IS),I=1,3),POL(1,L)
      C...
        800 IF(POL(10,L).LT.5000.)WRITE(6,111)POL(10,L)
            RETURN
      C...
        101 FORMAT(' SUB=',F6.4,'*(',F8.2,'*P*Q-',F6.4,A8,' :Y
           * ,'/MONTH :MINQ=',F5.0)
        102 FORMAT(' SUB=',F6.4,'*(',F8.2,4X,'-',F6.4,A8, ' :Y
           * ,'/MONTH :MINQ=',F5.0)
        110 FORMAT(' SUB=PRICE :PON=',F4.2,'PCN=',F4.2,'POE=',F
           * ,'PCE=',F4.2 ,' :Y LIMIT=',F6.0,'/MONTH :MINQ=',F5
        111 FORMAT(T64,':MAXR=',F5.0)
        120 FORMAT(' SUB= constrained: ',3A8,'MINQ= ',F7.2)
      C...
            END
```

PROGRAM:F09:SIMO1.FORT

```
C...
      SUBROUTINE AL$GRP(NWIDE)
      LOGICAL*1 HEAD(16,2),SHEAD1(16),SHEAD2(16)
      INTEGER*2 NCHAR(13),ISOL(120,2)
      INTEGER*4 HMAX
      REAL*4 SOL(120,4),DATAS(121,13)
      REAL*8 GTITLE(10),STITLE(10),RHEAD1(2),RHEAD2(2),BL
     *  ,TITLE(3)
C...
      COMMON/BLK1/A
      COMMON/BLK8/DU1(36120),ISOL,SOL
      COMMON/BLK21/TITLE,HHD(502,6),HHT(10,4),DWD(3,502),
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20)
      EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
     * ,(IC1(5),NMD1)
     * ,(PAR(6),PO),(PAR(7),PC),(PAR(8),QM),(PAR(9),PN)
C...
      EQUIVALENCE (DU1(1),GTITLE(1)),(DU1(21),BASE),(DU1(
     * ,(DU1(23),NTYPE),(DU1(24),HEAD(1,1)),(DU1(32),DATA
      EQUIVALENCE (RHEAD1(1),SHEAD1(1)),(RHEAD2(1),SHEAD2
C...
      DATA NCHAR/'1 ','2 ','3 ','4 ','5 ','6 ','7 ','8 ',
     * ,'N ','. ','. '/
     * ,STITLE/' PRICE-Q','UANTITY ','CURVES  ',7*'
     * ,RHEAD1/'        ','  price '/
     * ,RHEAD2/' "Q" of ','housing '/
     * ,BLANK/'        '/
C...
      HMAX=480
      K=IFIX(QM*FLOAT(NWIDE)/FLOAT(HMAX))
C...
      DO 4 J=1,13
      DO 4 I=1,120
    4 DATAS(I,J)=-1.
C...
C... load PN and PO
      DO 1 I=K,NWIDE
      DATAS(I,12)=PN
    1 DATAS(I,13)=PO
C...
      IF(ISUPLY.NE.1)GOTO 11
C...
C... intercept of supply function an "PO"
C...
      DO 10 J=1,NMD
      K=(BETA1*DWD(1,J))*FLOAT(NWIDE)/FLOAT(HMAX)
      I1=J-((J-1)/10)*10
      IF(K.LT.1)K=1
      IF(K.GT.NWIDE)K=NWIDE
      DATAS(K,I1)=PO
   10 DATAS(K,13)=-1.
```

PROGRAM:F09:SIMO1.FORT

```
2550      C...
2551         11 DO 2 I=1,NHH
2552            IF(ISOL(I,1).LE.0)GOTO 2
2553            K=IFIX(SOL(I,2)*FLOAT(NWIDE)/FLOAT(HMAX))
2554            IF(K.LT.1)GOTO 2
2555            IF(K.GT.NWIDE)K=NWIDE
2556      C...
2557            J=ISOL(I,1)
2558            IF(J.NE.999)GOTO 3
2559      C...
2560            DATAS(K,12)=-1.
2561            DATAS(K,11)=SOL(I,1)
2562            GOTO 2
2563      C...
2564          3 I1=J-((J-1)/10)*10
2565            DATAS(K,I1)=SOL(I,1)
2566          2 CONTINUE
2567      C...
2568            NTYPE=1
2569            NT=120
2570            NO=13
2571            NHIGH=50
2572            BASE=0.
2573      C...
2574            DO 5 I=1,16
2575            HEAD(I,1)=SHEAD1(I)
2576          5 HEAD(I,2)=SHEAD2(I)
2577      C...
2578            GTITLE(1)=BLANK
2579            DO 6 I=2,10
2580          6 GTITLE(I)=STITLE(I-1)
2581            DO 8 I=5,7
2582          8 GTITLE(I)=TITLE(I-4)
2583      C...
2584      C...
2585            DO 7 I=1,9
2586          7 A(I)=BLANK
2587      C...
2588            CALL OUT$GP(NT,NO,NHIGH,NWIDE,6,NCHAR)
2589      C...
2590            RETURN
2591            END
2592      C...
2593            SUBROUTINE OUT$GP(NT,NO,NHIGH,NWIDE,P,NCHAR)
2594            INTEGER*4 HCORD(24),NOLD(2),HMAX
2595            INTEGER*2 NCHAR(NO),GRAP1(52,120)
2596            LOGICAL*1 HEAD(16,2),HOLD(8)
2597            REAL*8 GTITLE(10),VCORD(51),CORD8,BLANK
2598            INTEGER*2 A,B,HST
2599            REAL*8 TITLE(9)
2600            COMMON/BLK1/TITLE
```

PROGRAM:F09:SIMO1.FORT

```
      COMMON/BLK8/GTITLE,BASE,HMAX,NTYPE,HEAD,DATAS(121,1
C
      EQUIVALENCE (HOLD(1),CORD8),(NOLD(1),CORD8)
      INTEGER P
      DATA A/'-'/,B/' '/,HST/'*'/
     *     ,CORD8/'         '/,BLANK/'         '/
C
      ML=O
      MULT=O
 1000 FORMAT(4I10)
C
      NF=NHIGH+1
      DO 1 J=1,NWIDE
      DO 1 I=1,NF
    1 GRAP1(I,J)=B
C
C... "FIND MAX AND MIN VALUE"
      CMIN=1000000000.O
      CMAX=-CMIN
      DO 2 J=1,NO
      DO 2 J1=1,NT
      IF(DATAS(J1,J).EQ.-1.)GOTO 2
      IF(DATAS(J1,J).GT.CMAX)CMAX=DATAS(J1,J)
      IF(DATAS(J1,J).LT.CMIN)CMIN=DATAS(J1,J)
2     CONTINUE
      IF(CMAX.LT.O)CMAX=O.
      IF(NTYPE.EQ.1)CMIN=BASE
      BASEV=CMIN
      IF(CMIN.EQ.CMAX)GOTO 89
C...
C
      BASEV=(FLOAT(IFIX(CMIN/1000.)))*1000.
      IF(CMIN.LT.O)BASEV=BASEV-1000.
C
C..." CALCULATE SPREAD"
   80 IF(NTYPE.GT.1)GO TO 94
C
      SPREAD=CMAX-BASEV
      SPRATE=SPREAD/FLOAT(NF)
      IF(SPRATE.LT.1.)GOTO 92
      DO 91 N=1,20
      SPRATE=SPRATE/10.
      IF(SPRATE.LT.1.)GOTO 93
   91 CONTINUE
C  89 CALL OUT$C1(4)
   89 RETURN
   93 MULT=N
      GO TO 94
   92 MULT=O
      IF(SPRATE.GT.O.O1)GO TO 94
      DO 95 N=1,20
```

```
2652            SPRATE=SPRATE*10.
2653            IF(SPRATE.GT.0.01)GO TO 96
2654         95 CONTINUE
2655            GOTO 89
2656         96 MULT=-N
2657      C
2658      C...."GENERATE VERTICAL AXIS COORDINATES FREQ"
2659         94 XIM=10.
2660            DO 202 I=1,4
2661            X=SPRATE*(I+3)
2662      C
2663            DO 203 K=1,15
2664            IF(X.LE.0.0)GOTO 204
2665        203 X=X-0.5
2666      C
2667        204 K=K-1
2668      C
2669      C
2670            XI=(FLOAT(K)*0.5)-FLOAT(I+3)*SPRATE
2671            IF(XI.GE.XIM)GOTO 202
2672            XIM=XI
2673            IFREQ=I+3
2674            XS=(FLOAT(K)*0.5)/FLOAT(IFREQ)
2675        202 CONTINUE
2676      C
2677            SPRATE=XS
2678      C
2679            SPACE=(10.**MULT*SPRATE)
2680      C...."INSERTION POINT FOR FLOATING AXIS"
2681            IF(SPREAD.LE.CMAX)INPT=NHIGH+1
2682            IF(SPREAD.GT.CMAX)INPT=IFIX(NF-(ABS(BASEV)/SPACE))
2683            IF(CMAX.LE.0)INPT=1
2684      C
2685         97 NOV=NT
2686            IFREQH=NWIDE/NT
2687            IF(IFREQH.GT.4)IFREQH=4
2688            IF(IFREQH.NE.0)GOTO 230
2689            NOV=NWIDE
2690            IFREQH=1
2691      C
2692      C...."CONVERT INPUT DATA TO OUTPUT MATRIX"
2693        230 DO 3 J=1,NO
2694            DO 3 J1=1,NOV
2695            IF(DATAS(J1,J).EQ.-1.)GOTO 3
2696            N=IFIX(NF-((DATAS(J1,J)-BASEV)/SPACE))
2697            IF(N.LT.1)N=1
2698            IF(N.GT.NHIGH+1)N=NHIGH+1
2699            JW=(IFREQH*(J1-1))+1
2700            IF(GRAP1(N,JW).EQ.8)GOTO 4
2701            GRAP1(N,JW)=HST
2702            GO TO 3
```

```
      4     GRAP1(N,JW)=NCHAR(J)
            GO TO 3
      3     CONTINUE
      30    CONTINUE
      C..."INSERTING HORIZONTAL AXIS"
            DO 201 J=1,NWIDE
        201 IF(GRAP1(INPT,J).EQ.B)GRAP1(INPT,J)=A
         10 DO 218 J=1,NWIDE
        218 GRAP1(NF+1,J)=A
      C
      C..."VERTICAL COORDINATES"
            DO 217 J=1,NF
        217 VCORD(J)=BLANK
      C...
            NS=INPT-(INPT/IFREQ)*IFREQ
            SVALUE=BASEV+FLOAT(NF-NS)*SPACE
            ADJ=0.00001*10.**MULT
            IF(ABS(CMIN).LT.100)MULT=MULT-2
            IF(MULT.GT.0)MULT=0
      C...
            IF(INPT.NE.NF)SVALUE=SVALUE-(BASEV+FLOAT(NF-INPT)*S
      C...
            DO 211 J=NS,NF,IFREQ
            IF(SVALUE.GT.0)NVALUE=IFIX((SVALUE+ADJ)/10.**MULT)
            IF(SVALUE.LE.0)NVALUE=IFIX((SVALUE-ADJ)/10.**MULT)
            CALL BTD(NVALUE,HOLD(1),8,I,' ')
            VCORD(J)=CORD8
      C...
        211 SVALUE=SVALUE-FLOAT(IFREQ)*SPACE
      C...
      C..."HORIZONTAL COORDINATES"
            NCORDS=NOV/5
            GOTO(11,12),NTYPE
      C
         11 DO 212 J=1,NCORDS
        212 HCORD(J)=J*5*HMAX/NWIDE
            GOTO 7
         12 CONTINUE
      C
          7 CONTINUE
      C
      C..."HEADING FOR GRAPH"
            WRITE(P,99)TITLE
         99 FORMAT('1',9A8/)
      C
      C..."GRAPHICAL OUTPUT"
            DO 31 J=1,NF
            IF(J.LE.16)WRITE(P,101)HEAD(J,1),VCORD(J),
           *(GRAP1(J,MC),MC=1,NWIDE)
            IF(J.GT.16)WRITE(P,102)VCORD(J),(GRAP1(J,MC),MC=1,N
         31 CONTINUE
```

```
      C
        101 FORMAT(T2,A1,A8,T11,'|',120A1)
        102 FORMAT(T3,A8,T11,'|',120A1)
        103 FORMAT(1H+,T12,120A1)
        104 FORMAT(T12,120A1)
      C
      C..."BOTTOM AXIS"
            IF(INPT.NE.NF)WRITE(P,104)(GRAP1(NF+1,MC),MC=1,NWID
      C
      C..."CO-ORDINATES"
            IF(IFREQH.EQ.1)WRITE(P,111)(HCORD(J),J=1,NCORDS)
            IF(IFREQH.EQ.2)WRITE(P,112)(HCORD(J),J=1,NCORDS)
            IF(IFREQH.EQ.3)WRITE(P,113)(HCORD(J),J=1,NCORDS)
            IF(IFREQH.EQ.4)WRITE(P,114)(HCORD(J),J=1,NCORDS)
      C
        111 FORMAT(T12,24I5)
        112 FORMAT(T11,12I10)
        113 FORMAT(T12,8I15)
        114 FORMAT(T11,6I20)
      C
            NC=NO*2
            IF(NC.GT.10)NC=10
      C
      C..."TITLES"
            IF(NWIDE.LE.30)WRITE(P,105)(HEAD(J,2),J=1,16),(GTIT
        105 FORMAT(T18,16A1//T17,4A8/T2,6A8)
            IF(NWIDE.EQ.60)WRITE(P,106)(HEAD(J,2),J=1,16),(GTIT
        106 FORMAT(T54,16A1//T3,10A8)
            IF(NWIDE.GT.60)WRITE(P,107)(HEAD(J,2),J=1,16),(GTIT
        107 FORMAT(T80,16A1//T3,10A8)
      C
            RETURN
            END
      C...
      C... this routine solves for P when household constrained
      C...
            SUBROUTINE QCON
      C...
            REAL*4 MY
            COMMON/BLK21/TITLE(6),HHD(502,6),HHT(10,4),DWD(3,50
           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20)
            EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
           * ,(IC1(5),NMD1),(IC1(7),IP1),(IC1(20),NCI)
           * ,(PAR(2),GAMMA2),(PAR(4),BETA1),(PAR(5),BETA2)
           * ,(PAR(3),GAMMA3),(PAR(27),COEF)
           * ,(PAR(6),PO),(PAR(7),PC),(PAR(8),QM)
      C...
            DATA TOL/0.0001/
      C...
            ENTRY PQMQI(GAMMA1,AY,MY,EQQ,HALPHA,PB)
      C...
```

```
      UHS=0.
      UX=0.
      UA=0.
C...
      IF(IP1.EQ.10)WRITE(6,1001)GAMMA1,AY,MY,HALPHA,PB
 1001 FORMAT(5F15.5)
      RETURN
C...
      ENTRY PQNQ(IP,IS1,L,PX,QX,U,SUBA,PH,QH,UH)
C...
      Y=0.
      U=-1.
C...
      PX=PB
      QX=POL(1,L)
      IF(QX.LT.QM)GOTO 9
      IF(QH.GE.QX)RETURN
C...
      GOTO(1,2,3,4,5,6),IS1
C...
C... income subsidy
    1 Y=PB*QX/HALPHA
      SUBA=Y-MY
      GOTO 10
C...
C... inkind subsidy
    2 Y=PB*QX/HALPHA
      SUBA=Y-MY
      IF(SUBA.GT.PB*QX)SUBA=PB*QX
      GOTO 10
C...
C... direct constrained
C... solve for U=UH at QX
    3 IF(UH.EQ.0.)RETURN
      CALL PQDCI(UH,PX,QX,HALPHA,MY,PB,NZ,GAMMA1)
      CALL PQDC(PX,PJ)
C...
      IF(PJ.EQ.0.)RETURN
      SUBA=(PX-PJ)*QX
C...
      Y=MY+SUBA
      CALL CL$UT(U,UHS,UX,UA,QX,HALPHA,MY,MY,PJ,PB,NZ,GAM
      U=UH+ 0.01
C...
      GOTO 9
C...
C... direct quantity
    4 IF(QH.EQ.0.)RETURN
      SUBA=(QX-QH)*PB
      GOTO 10
C...
```

PROGRAM:F09:SIMO1.FORT

```
C... direct expenditure
    5 IF(QH.EQ.O.)RETURN
      SUBA=(QX-QH)*PB
      GOTO 1O
C...
C... direct price subsidy
    6 A=(HALPHA*MY)/(PB*QX)
      PJ=A* PX
      SUBA=(1.-A)*PB*QX
      Y=MY+SUBA
C...
      CALL CL$UT(U,UHS,UX,UA,QX,HALPHA,MY,MY,PJ,PB,NZ,GAM
      GOTO 9
C...
   1O Y=MY+SUBA
C...
      CALL CL$UT(U,UHS,UX,UA,QX,HALPHA,MY,Y,PX,PB,NZ,GAMM
C...
    9 IF(IP1.EQ.1O)WRITE(6,1OOO)IP,PX,QX,Y,U,UHS,UX,UA
      IF(U.LE.O.)QX=O.O
      RETURN
C...
C... PRICE QUANTITY AND UTILITY  - EXISTING DWELLINGS
C...
      ENTRY PQEQ(IP,IS1,L,J,PX,QX,U,SUBA,PH,QH,UH)
C...
      U=-1.
      QX=POL(1,L)
      IF(QH.GE.QX)RETURN
C...
      QI=DWD(1,J)
      IZ=IFIX(DWD(2,J))
C...
      PX=((QX/QI-BETA1)*PC/(2./3.*BETA2)) +PO
      D= (PB/PX+GAMMA1*(1.-HALPHA)*(1.-PB/PX))*HALPHA/PB
C...
      GOTO(11,12,13,14,15,16),IS1
C...
C... income subsidy
   11 Y=QX/D
      SUBA=Y-MY
      GOTO 2O
C...
C... in kind subsidy
   12 Y=QX/D
      SUBA=Y-MY
      IF(SUBA.GT.PX*QX)SUBA=PX*QX
      GOTO 2O
C...
C... direct constrained
   13 IF(UH.EQ.O.)RETURN
```

PROGRAM:F09:SIMO1.FORT

```
2907            CALL PQDCI(UH,PX,QX,HALPHA,MY,PB,IZ,GAMMA1)
2908            CALL PQDC(PX,PJ)
2909            IF(PJ.EQ.O.)RETURN
2910      C...
2911            SUBA=(PX-PJ)*QX
2912            Y=MY+SUBA
2913            CALL CL$UT(U,UHS,UX,UA,QX,HALPHA,MY,MY,PJ,PB,IZ,GAM
2914            U=UH+ O.O1
2915            GOTO 19
2916      C...
2917      C... direct quantity
2918         14 IF(QH.EQ.O.)RETURN
2919            QHX=(PB/PX+GAMMA1*(1.-HALPHA)*(1.-PB/PX))*(HALPHA/P
2920            SUBA=(QX-QHX)*PX
2921            GOTO 2O
2922      C...
2923      C... direct expenditure
2924         15 IF(QH.EQ.O.)RETURN
2925            SUBA=(QX*PX-QH*PH)
2926            GOTO 2O
2927      C...
2928      C... direct price
2929         16 A=((1.-GAMMA1*(1.-HALPHA))/PX)
2930           * *(1./(QX/(HALPHA*MY)- GAMMA1*(1.-HALPHA)/PB))
2931            PJ=A *PX
2932            SUBA=(1.-A)*PX*QX
2933            Y=MY+SUBA
2934      C...
2935            CALL CL$UT(U,UHS,UX,UA,QX,HALPHA,MY,MY,PJ,PB,IZ,GAM
2936            GOTO 19
2937      C...
2938         2O Y=MY+SUBA
2939            CALL CL$UT(U,UHS,UX,UA,QX,HALPHA,MY,Y,PX,PB,IZ,GAMM
2940      C...
2941         19 IF(IP1.EQ.1O)WRITE(6,1OOO)J,PX,QX,Y,U,UHS,UX,UA
2942            RETURN
2943      C...
2944       1OOO FORMAT(I5,2F8.2,2F8.O,3F8.2)
2945      C...
2946            END
2947      C...
2948      C... subroutine to return difference in utilities
2949      C...
2950            SUBROUTINE CALC5
2951            REAL*4 MY
2952      C...
2953            ENTRY PQDCI(UH,PX,QX,HALPHA,MY,PB,IZ,GAMMA1)
2954            RETURN
2955      C...
2956            ENTRY FQ(PJ,F)
2957      C...
```

```
2958            SUBA=(PX-PJ)*QX
2959            Y=MY+SUBA
2960      C...
2961            CALL CL$UT(UX,H,X,A,QX,HALPHA,MY,MY,PJ,PB,IZ,GAMMA1
2962      C...
2963            F=UH-UX
2964      C...
2965            IF(IP1.EQ.10)WRITE(6,1000)  UH,UX,PJ,PX,QX,F
2966       1000 FORMAT(2F20.2,2F10.4,F10.2,F20.5)
2967      C...
2968            RETURN
2969            END
2970      C...
2971      C... routine to match utilities
2972      C...
2973            SUBROUTINE CALC4
2974      C...
2975            DATA TOL/0.0001/
2976      C...
2977            ENTRY PQDC(PX,PJ)
2978      C...
2979            B=PX
2980            C=0.1
2981      C...
2982            IC=0
2983            ACBS=ABS(B-C)
2984            A=C
2985      C...
2986            CALL FQ(A,FA)
2987            CALL FQ(B,FB)
2988            FC=FA
2989            KOUNT=2
2990            FX=AMAX1(ABS(FB),ABS(FC))
2991         51 IF(ABS(FC).GE.ABS(FB))GOTO 52
2992      C...
2993      C... INTERCHANGE B AND C SO THAT ABS(F(B).LE.ABS(F(C))
2994      C...
2995            A=B
2996            FA=FB
2997            B=C
2998            FB=FC
2999            C=A
3000            FC=FA
3001         52 CMB=0.5*(C-B)
3002            ACMB=ABS(CMB)
3003      C...
3004      C... TEST STOPPING CRITERION AND FUNCTION COUNT
3005      C...
3006            IF(ACMB.LE.TOL)GOTO 58
3007            IF(KOUNT.GE.100)GOTO 62
3008      C...
```

```
C... CALCULATE NEW ITERATE IMPLICITLY AS B+P/Q
C... WHERE P.GE.O.  THE IMPLICIT FORM IS USED TO
C... PREVENT OVERFLOW.
C...
      P=(B-A)*FB
      Q=FA-FB
      IF(P.GE.O.O)GOTO 53
      P=-P
      Q=-Q
C...
C... UPDATE A. CHECK IF REDUCTION IN THE SIZE OF BRACKETI
C... INTERVAL IS SATISFACTORY. IF NOT, BISECT UNTIL IT IS
C...
   53 A=B
      FA=FB
      IC=IC+1
      IF(IC.LT.4)GOTO 54
      IF(8.O*ACMB.GE.ACBS)GOTO 56
      IC=O
      ACBS=ACMB
C...
C... TEST FOR TOO SMALL A CHANGE
C...
   54 IF(P.GT.ABS(Q)*TOL)GOTO 55
C...
C... INCREMENT BY TOLERANCE
C...
      B=B+SIGN(TOL,CMB)
      GOTO 57
C...
C... ROOT OUGH TO BE BETWEEN B AND (C+B)/2
C...
   55 IF(P.GE.CMB*Q)GOTO 56
C...
C... USE SECANT RULE
      B=B+P/Q
      GOTO 57
C...
   56 B=O.5*(C+B)
C...
C... HAVE COMPLETED COMPUTATION FOR NEW ITERATE B
C...
   57 CALL FQ(B,FB)
      IF(FB.EQ.O.O)GOTO 59
      IF(FB.EQ.-1.E5)GOTO 62
      KOUNT=KOUNT+1
      IF(SIGN(1.O,FB).NE.SIGN(1.O,FC))GOTO 51
      C=A
      FC=FA
      GOTO 51
C...
```

PROGRAM:F09:SIMO1.FORT

```
C... FINISHED SET IFLAG
C...
   58 IF(SIGN(1.0,FB).EQ.SIGN(1.0,FC))GOTO 61
      IF(ABS(FB).GT.FX)GOTO 60
      IFLAG=1
      GOTO 30
   59 IFLAG=2
      GOTO 30
   60 IFLAG=3
      GOTO 30
   61 IFLAG=4
      B=0.0
      GOTO 30
   62 IFLAG=5
      B=0.0
      GOTO 30
C...
   30 PJ=B
      RETURN
      END
```

PROGRAM:F10:SIM02.FORT

```
      CS    F10:SIM02.FORT
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C    HOUSING MARKET SIMULATION PROGRAM with MODIFIED MODE
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
            COMMON/BLK8/DU1(36720)
            COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
            REAL*4 DAT(8)
            EQUIVALENCE (PAR(21),DAT(1)),(PAR(31),TOL)
           * ,(IC1(8),IOP),(IC1(10),NS),(IC1(20),NCI),(IC1(6),M
           * ,(IC1(7),IP1)
      C...
            CALL CL$1(IR)
      C.DC  CALL REREAD
            MSIZE=120
            IP=0
            IG=0
      C...
      C... load DATA
          5 CALL IN$DAT(NER,IP,IG,IR)
            CALL OT$1
      C... calc # groups and error check
            CALL CL$2(NER)
      C...
            IP1=IP
      C...
            CALL OT$2(NER,IP1)
            IF(IP1.GE.1.AND.IP1.LE.10.AND.(IOP.EQ.1.OR.IOP.EQ.2
      C...
      C... "parameter" iteration control
      C...
            IR1=1
            IR2=1
            IT1=0
            IT2=0
      C...
      C... check for iteration parameters
      C...
            IF(IOP.EQ.1.AND.DAT(1).NE.0.)IT1=1
            IF(IOP.EQ.1.AND.DAT(2).NE.0.)IT2=2
      C...
            IF(IOP.EQ.2.AND.DAT(3)+DAT(5).NE.0.)IT1=3
            IF(IOP.EQ.2.AND.DAT(4)+DAT(6).NE.0.)IT2=4
      C...
            IF(IT1+IT2.EQ.0)GOTO 10
            IF(DAT(3).EQ.0..AND.IT1.EQ.3)DAT(3)=PAR(3)
            IF(DAT(5).EQ.0..AND.IT1.EQ.3)DAT(5)=PAR(5)
```

PROGRAM:F10:SIMO2.FORT

```
      IF(DAT(4).EQ.O..AND.IT2.EQ.4)DAT(4)=PAR(4)
      IF(DAT(6).EQ.O..AND.IT2.EQ.4)DAT(6)=PAR(6)
C...
   14 IF(IT1.EQ.O)GOTO 11
      IR1=4
      B1=PAR(IT1)
      IF(IOP.EQ.2)B5=PAR(5)
   11 IF(IT2.EQ.O)GOTO 10
      IR2=4
      B2=PAR(IT2)
      IF(IOP.EQ.2)B6=PAR(6)
C...
   10 DO 3 I1=1,IR1
      IF(IR1.EQ.1)GOTO 12
      PAR(IT1)=B1+((DAT(IT1)-B1)/3.)*FLOAT(I1-1)
      IF(IOP.EQ.2)PAR(5)=B5+((DAT(5)-B5)/3.)*FLOAT(I1-1)
C...
   12 DO 3 I2=1,IR2
      IF(IR2.EQ.1)GOTO 13
      PAR(IT2)=B2+((DAT(IT2)-B2)/3.)*FLOAT(I2-1)
      IF(IOP.EQ.2)PAR(6)=B6+((DAT(6)-B6)/3.)*FLOAT(I2-1)
C...
      IF(I1.NE.1)IP1=O
C...
   13 CALL CL$3(IP1,IST)
C... output initial conditions
      CALL OT$3(IP1)
C... simulating for convergence in externalities
      DO 1 I=1,NCI
      L=I
      IF(L.GT.2)L=2
C...
C... calc full utility for each simulation run
      CALL CL$4
      IF(IP1.GE.2.AND.IP1.LE.10)CALL OT$4(IP1)
C...
C... call sort routine
      CALL SRT$1(L)
      IF(IP1.GT.2.AND.IP1.LE.10)CALL OT$4A(IP1)
C... allocation routine
      CALL CL$5(IP)
      IF(IP1.EQ.10.AND.NS.NE.O)CALL CL$SB1(1)
      IF(IP1.EQ.10)CALL OT$5
C... calc externalities
      CALL CL$10(SER)
      CALL OT$10(SER)
      IF(SER.LT.TOL)GOTO 2
C...
    1 CONTINUE
C...
    2 IF(NS.NE.O)CALL CL$SB1(2)
```

PROGRAM:F10:SIMO2.FORT

```
      IF(IP1.EQ.1.OR.IP1.EQ.2)CALL OT$5
C...
      IF(IOP.EQ.1.OR.IOP.EQ.2)CALL CL$20(IOP)
      IF(IOP.EQ.3)CALL OT$7
      IF(NS.NE.0)CALL OT$SB
      IF(IOP.EQ.3)CALL OT$BS
      IF(IG.NE.0)CALL AL$GRP(IG)
    3 CONTINUE
C...
C... reset parameters
      IF(IT1.NE.0)PAR(IT1)=B1
      IF(IT2.NE.0)PAR(IT2)=B2
      IF(IT1.NE.0.AND.IOP.EQ.2)PAR(5)=B5
      IF(IT2.NE.0.AND.IOP.EQ.2)PAR(6)=B6
C...
      GOTO 5
      END
C...
C...
      SUBROUTINE IN$DAT(NER,IP,IG,IR)
C... routine to load the REQUIRED data.
      REAL*4 DAT(8)
      INTEGER*4 C1,C2
      REAL*8 ERR(10)
      COMMON/BLK8/ERR,RD(12)
      COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
      COMMON/PARA/AB(15,4,10),DD(25)
      COMMON/BLK22/ACT(12,20)
      EQUIVALENCE (PAR(21),DAT(1)),(IC1(20),NCI)
     * ,(IC1(6),MSIZE),(IC1(8),IOP)
     * ,(PAR(32),PPP)
C
C... input data format
C...          DATA type identifier.
C...   1234             :56789   :*1234   :56789
C...   0000  title
C...   10    hholds :income:type :taxable:taxes:%return:#
C...   20    hhlds types income :0   :Q01  :Q02  :Q03  :Q
C...   21    hhlds types:parameters : Q01
C...        A0 :A1  :B11 :B12  :B22 :BM1 :BM2 :MXH :MXG :
C...   22    hhlds types:parameters : Q02
C...        A0 :A1  :B11 :B12  :B22 :BM1 :BM2 :MXH :MXG :
C...   23    hhlds types:parameters : Q03
C...        A0 :A1  :B11 :B12  :B22 :BM1 :BM2 :MXH :MXG :
C...   24    hhlds types:parameters : Q04
C...        A0 :A1  :B11 :B12  :B22 :BM1 :BM2 :MXH :MXG :
C...
C...   30    dwellings  :services:zone:tenure
C...   40    zonal      :"wealth":distance
C...
```

```
153      C...    5001 EXT1 (wealth)
154      C...    5002 EXT2 (access)
155      C...
156      C...    5003 B1 (rental)
157      C...    5004 B2 (rental)
158      C...    5005 B1 (owners)
159      C...    5006 B2 (owners)
160      C...
161      C...    5007  OC   (rental)
162      C...    5008  OC   (owners)
163      C...    5011 RPC  (rental)
164      C...    5012 RPO  (rental)
165      C...    5013 RQM  (rental)
166      C...
167      C...    5016 OPC  (owners)
168      C...    5017 OPO  (owners)
169      C...    5018 OQM  (owners)
170      C...
171      C...    5020 CPI
172      C...    70    actual zonal:price   :                    :
173      C...    810   POLICY equat:TYPE    :PAR1:   :   :  ::PAR6:IN
174      C...    8200               :ELIGIBLE HOUSEHOLD TYPES.
175      C...    8300               :GIVEN NEW PUBLIC HOUSING
176      C...    8400               :REDUCTION IN PURCHASING POWER
177      C...    9100  print contol
178      C...    9200  graph control 0 or 60 or 120
179      C...    9201  graph type  1 print supply fn co-ords.
180      C...    9500  # ITERATIONS FOR CONVERGENCE
181      C...    9900  start "POLICY" run
182     *C...    9901  start ecternalities calibration run
183      C...    9902  start B calibration run
184      C...    9903  start "BASE" run
185      C
186            IC=0
187      C...
188        120 READ(IR,1,ERR=10,END=11)I1
189      C.DC  IQ=99
190            IQ=IR
191            BACKSPACE IR
192            IC=IC+1
193            IF(I1.EQ.0)GOTO 20
194      C...
195            READ(IQ,1,ERR=10)C1,C2,I2,RD
196          1 FORMAT(2I1,I2,12F5.0)
197            I1=10*C1+C2
198            IF(I1.EQ.99)GOTO 16
199            GOTO(21,22,23,24,25,12,44,80,90),C1
200      C...
201      C... "0000" title
202         20 READ(IQ,3)TITLE
203          3 FORMAT(4X,6A4)
```

```
            GOTO 120
C...
C... "1CMA" household data
   21 I2=I2+100*C2
            IF(I2.GT.MSIZE-1.OR.I2.LT.1)GOTO 30
            RD(5)=RD(5)/10000.
            DO 31 I=1,8
            IF(RD(I).EQ.0.0.AND.I.LE.2)GOTO 40
   31 HHD(I2,I)=RD(I)
            GOTO 120
C...
C...HOUSEHOLD TYPE DATA
   22 GOTO(32,32,32,32),C2
C... "20  " mean after-tax income
            IF(I2.GT.10.OR.I2.LT.1)GOTO 30
            DO 203 I=1,4
  203 HHT(I2,I)=RD(I)
            GOTO 120
C...
C... "21  "-"24  " demand function parameters
   32 IF(I2.GT.10.OR.I2.LT.1)GOTO 30
            AB(1,C2,I2)=RD(1)
            AB(2,C2,I2)=RD(2)
            AB(3,C2,I2)=-(1.-ABS(RD(2)))
            AB(4,C2,I2)=RD(3)
            AB(5,C2,I2)=RD(4)
            AB(6,C2,I2)=RD(4)
            AB(7,C2,I2)=RD(6)-RD(4)
            AB(8,C2,I2)=RD(5)
            AB(9,C2,I2)=RD(6)
            AB(10,C2,I2)=RD(7)
            AB(11,C2,I2)=RD(8)
            AB(12,C2,I2)=RD(9)
            AB(13,C2,I2)=RD(10)
            GOTO 120
C...
C... DWELLING DATA
   23 I2=I2+100*C2
            IF(I2.GT.MSIZE-1.OR.I2.LT.1)GOTO 30
C...
            DO 133 I=1,3
            IF(RD(I).EQ.0.)GOTO 40
  133 DWD(I,I2)=RD(I)
            GOTO 120
C...
C... ZONAL DATA
   24 IF(I2.GT.11.OR.I2.LT.1)GOTO 30
            DO 134 I=1,2
            IF(RD(I).EQ.0.0)GOTO 40
  134 ZOD(I,I2)=RD(I)
            GOTO 120
```

PROGRAM:F10:SIMO2.FORT

```
C...
C... "50  " parameters
   25 IF(I2.LT.0.OR.I2.GT.40)GOTO 30
      PAR(I2)=RD(1)
      IF(I2.LE.6)DAT(I2)=RD(2)
      GOTO 120
C...
C... "70  " zonal data for calibration
   44 IF(I2.GT.20.OR.I2.LT.1)GOTO 30
      DO 54 I=1,12
      IF(RD(I).LT.0)GOTO 40
   54 ACT(I,I2)=RD(I)
      GOTO 120
C...
C... "8CMA" policy parameters
   80 GOTO(81,82,83,84),C2
      GOTO 12
C...
   81 IF(I2.EQ.0)I2=1
      IF(I2.LT.1.OR.I2.GT.4)GOTO 30
      IPOL(1,I2)=IFIX(RD(1))
      IPOL(2,I2)=IFIX(RD(1)*10.-FLOAT(IFIX(RD(1))*10)+0.1
      DO 181 I=1,10
  181 POL(I,I2)=RD(I+1)
      GOTO 120
C... ELIGIBILITY
   82 DO 182 I=1,10
  182 HHT(I,5)=RD(I)
      GOTO 120
C... PUBLIC HOUSING
   83 DO 183 I=1,9
  183 IGIVEN(I)=IFIX(RD(I)+.01)
      GOTO 120
C... REDUCE PURCHASE POWER
   84 IF(RD(1).GE.0..AND.RD(1).LT.0.2)PPP=RD(1)
      GOTO 120
C...
C... PRINT CONTROL
   90 I=I1-90
      IF(I.EQ.5)GOTO 95
      GOTO(91,92),I
      GOTO 12
C...
   91 IP=IFIX(RD(1))
      GOTO 120
   92 IF(I2.EQ.0.AND.(RD(1).EQ.0.OR.RD(1).EQ.60.OR.RD(1).
     *  IG=IFIX(RD(1))
      IF(I2.EQ.1)ISUPLY=IFIX(RD(1))
      GOTO 120
C...
   95 NCI=IFIX(RD(1))
```

```
      GOTO 120
C...
   12 WRITE(6,2)IC
      GOTO 13
C...
   30 WRITE(6,4)IC
      GOTO 13
C...
   10 IC=IC+1
      WRITE(6,5)IC
      GOTO 13
C...
   40 WRITE(6,8)I,IC
C...
C...
   13 CONTINUE
C.DC  IQ=99
      IQ=IR
      BACKSPACE IR
      READ(IQ,6)ERR
      WRITE(6,7)ERR
      NER=2
      GOTO 120
C...
C...
   16 IOP=I2
      IF(I2.EQ.99)STOP
      RETURN
C...
   11 IF(IR.EQ.5)STOP
      IR=5
      GOTO 120
C...
    2 FORMAT(' error in column 1 or 2 :card',I4,'Card is:
    4 FORMAT(' error in column 3 or 4 :card',I4, 'Card is
    5 FORMAT(' read error - probably invalid character. C
    6 FORMAT(10A8)
    7 FORMAT(' ',10A8)
    8 FORMAT(' missing data item',I2,' :card',I4,' Card i
      END
C...
      BLOCK DATA
      COMMON/BLK21/ TITLE(6),D21A(1792),ID21A(37)
      COMMON/PARA/  DPA(625)
      COMMON/BLK22/D22A(240)
C...
      DATA TITLE/6*'    '/,D21A/1240*0.,10*2.,542*0./
     * ,ID21A/37*0/,DPA/622*0./,D22A/240*0./
      END
C...
      SUBROUTINE CALC
```

PROGRAM:F10:SIMO2.FORT

```
C...
C... routines for INITIALISATION and CHECKing input data
      INTEGER*4 INMD(2,2)
      COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
      COMMON/PARA/AB(15,4,10)
      COMMON/BLK22/ACT(240)
      EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
     * ,(IC1(5),NMD1),(IC1(20),NCI)
     * ,(IC1(6),MSIZE),(IC1(8),IOP),(IC1(10),NS),(IC1(11)
     * ,(IGIVEN(1),IPUB)
     * ,(PAR(11),RPO),(PAR(12),RPC),(PAR(13),RQM),(PAR(14
     * ,(PAR(16),OPO),(PAR(17),OPC),(PAR(18),OQM),(PAR(19
     * ,(PAR(20),CPI),(PAR(28),SUBM),(IGIVEN(1),IPUB)
     * ,(PAR(31),TOL),(PAR(33),AMAX)
C...
      ENTRY CL$1(IR)
      IRUN=0
      TOL=.01
      NCI=5
      IR=4
      RETURN
C...
      ENTRY CL$2(NER)
      IRUN=IRUN+1
      RPN=(RPO+RPC)*1.1
      OPN=(OPO+OPC)*1.1
C...
C... check on CPI
      IF(CPI.NE.0.)GOTO 126
      WRITE(6,113)
      NER=2
  126 CONTINUE
C...
      DO 171 I=3,6
      IF(IOP.EQ.1.OR.PAR(I).NE.0.)GOTO 171
      WRITE(6,114)
      NERR=2
  171 CONTINUE
C...
C... obtaining number zones, dwells, hhld types and hhold
      NHH=1
      NMD=1
      DO 1 I=1,MSIZE
      IF(HHD(I,1).NE.0)NHH=I
    1 IF(DWD(1,I).NE.0)NMD=I
      NMD1=NMD+1
C...
      DO 2 I=1,NHH
      IF(HHD(I,1).NE.0)GOTO 2
      WRITE(6,101)I
```

```
      NER=2
    2 CONTINUE
C...
      INMD(1,1)=1
      INMD(2,2)=NMD
C...
      DO 3 J=1,NMD
      IF(IFIX(DWD(3,J)+.01).EQ.1)INMD(2,1)=J
      IF(DWD(1,J).NE.0)GOTO 3
      WRITE(6,102)J
      NER=2
    3 CONTINUE
C...
      INMD(1,2)=INMD(2,1)+1
C...
      NHT=1
      NZ =1
      DO 4 I=1,10
    4 IF(HHT(I,2).NE.0)NHT=I
C...
      DO 14 IZ=1,11
   14 IF(ZOD(1,IZ).NE.0)NZ=IZ
C...
      DWD(2,NMD1)=NZ
      DO 5 I=1,NHT
      IF(HHT(I,2).NE.0)GOTO 5
      WRITE(6,103)I
      NER=2
    5 CONTINUE
C...
C... checking "TYPE" correct
      DO 15 I=1,NHH
      IF(HHD(I,2).LE.NHT)GOTO 15
      WRITE(6,105)I
      NER=2
   15 CONTINUE
C...
C... checking demand parameter
      DO 18 I=1,NHT
      DO 18 K=1,4
C... computing share elasticities at mean
      AB(14,K,I)=AB(4,K,I)+AB(2,K,I)*AB(8,K,I)
      AB(15,K,I)=AB(14,K,I)
C...
      IF(AB(1,K,I)+AB(2,K,I).NE.0.)GOTO 18
      WRITE(6,111)K,I
      NER=2
   18 CONTINUE
C...
      AMAX=0
      DO 6 IZ=1,NZ
```

PROGRAM:F10:SIMO2.FORT

```
            IF(ZOD(2,IZ).GT.AMAX)AMAX=ZOD(2,IZ)
            IF(ZOD(1,IZ).NE.0)GOTO 6
            WRITE(6,104)IZ
            NER=2
          6 CONTINUE
C...
C... checking "ZONE" correct
            DO 16 J=1,NMD
            IZ=IFIX(DWD(2,J))
            IF(IZ.GT.NZ)GOTO 17
            IF(IRUN.EQ.1)EXT(1,2,IZ)=EXT(1,2,IZ)+1
            GOTO 16
C...
         17 WRITE(6,106)J
            NER=2
         16 CONTINUE
C...
            IF(NERR.EQ.2)GOTO 10
CC          IF(IRUN.GT.1)GOTO 10
            EXT(1,2,NZ)=FLOAT(NHH-NMD)
            EXT(1,2,12)=AMAXO(NHH,NMD)
C... CALCULATING WEIGHTED MEAN OF INPUT EXTERNALITIES
            DO 31 IZ=1,NZ
         31 EXT(1,1,12)=EXT(1,1,12)+(ZOD(1,IZ)*EXT(1,2,IZ))
C...
            EXT(1,1,12)=EXT(1,1,12)/EXT(1,2,12)
C...
C... calc initial externalities.
C... USE INPUT ACTUAL INCOMES  - C.M.A. MEAN CALCULATED
C...
            DO 9 IZ=1,NZ
          9 EXT(1,1,IZ)=ZOD(1,IZ)/EXT(1,1,12)
C...
         10 NS=0
            SUBM=0.
            IF(IPOL(1,1).EQ.0)RETURN
C...
C... DERIVING POLICY SUB OPTIONS
            DO 7 L=1,4
            IF(IPOL(1,L).EQ.0)GOTO 7
C...
            NS=L
            IF(POL(6,L).EQ.0)POL(6,L)=9999.
            IF(POL(10,L).EQ.0.)POL(10,L)=9999.
C...
            I=IPOL(1,L)
            GOTO(21,21,21,22,22,22,23,23,23,24,24,24,25,25,25),
            GOTO 26
C...
C... income subsidy
         21 IPOL(2,L)=2
```

```
510           GOTO 7
511      C... in-kind
512          22 IF(IPOL(2,L).NE.0)GOTO 7
513             IF(POL(4,L)+POL(5,L).NE.0.0)IPOL(2,L)=5
514             IF(POL(4,L).EQ.0.0)IPOL(2,L)=3
515             IF(POL(5,L).EQ.0.0)IPOL(2,L)=1
516             IF(POL(2,L).EQ.0.0)IPOL(2,L)=IPOL(2,L)+1
517             GOTO 7
518      C... price subsidy
519          23 IPOL(2,L)=1
520             IF(POL(1,L).LT.0.01.OR.POL(1,L).GT.5.)POL(1,L)=PO
521             IF(POL(2,L).LT.0.01.OR.POL(2,L).GT.5.)POL(2,L)=PC
522             IF(POL(3,L).LT.0.01.OR.POL(3,L).GT.5.)POL(3,L)=PO
523             IF(POL(4,L).LT.0.01.OR.POL(4,L).GT.5.)POL(4,L)=PC
524             GOTO 7
525      C... direct demand subsidy
526          24 IPOL(2,L)=1
527             IF(POL(2,L).EQ.0.)IPOL(2,L)=2
528             GOTO 7
529      C...
530      C... direct supply subsidy
531          25 IF(IPOL(2,L).GE.1.AND.IPOL(2,L).LE.2)GOTO 7
532             IPOL(2,L)=1
533             IF(POL(2,L).EQ.0.)IPOL(2,L)=2
534      C...
535      C...
536      C... constrained MINIMUM option
537          26 IF(IPOL(2,L).EQ.0)IPOL(2,L)=1
538             IF(POL(1,L).EQ.0.)POL(1,L)=PAR(13)
539             IF(POL(2,L).EQ.0.)POL(2,L)=PAR(18)
540             SUBM=1.
541      C...
542           7 CONTINUE
543      C...
544             IF(IPUB.EQ.0)RETURN
545      C...
546             DO 830 I=2,9
547             K=IGIVEN(I)
548             IF(K.LE.NHH)GOTO 8
549             WRITE(6,107)K
550             NER=2
551             GOTO 830
552           8 IF(K.GT.0)HHD(K,2)=-HHD(K,2)
553         830 CONTINUE
554             RETURN
555      C...
556         101 FORMAT(' Error: NO household number',I4)
557         102 FORMAT(' Error: NO dwelling  number',I4)
558         103 FORMAT(' Error: NO household type data for ',I4)
559         104 FORMAT(' Error: NO zonal data for ',I4)
560         105 FORMAT(' Error: incorrect "TYPE" for ',I4)
```

```
      106 FORMAT(' Error: incorrect "zone" for ',I4)
      107 FORMAT(' Error:',I6,' incorrect on "8300"')
      111 FORMAT(' Error: demand parameters- QO',I1,':TYPE',I
      113 FORMAT(' Error: CPI zero')
      114 FORMAT(' Error: BETA parameter zero')
          END
C...
C...
          SUBROUTINE CALC1
C... routines for CALCulating demand-supply intercepts.
          INTEGER*2 ISUB(120,120)
          INTEGER*2 DWC(3,120,120)
          INTEGER*4 INMD(2,2)
          REAL*4 DU1(7260)
          COMMON/BLK8/DU1,DWC,ISUB
          COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
         * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
          EQUIVALENCE (IC1(2),NMD),(IC1(4),NHH),(IC1(5),NMD1)
         * ,(IC1(8),IOP),(IC1(10),NS),(IC1(11),INMD(1,1))
C...
          ENTRY CL$3(IP1,IST)
C...
C... QL= % OF QN ACCEPTABLE
          QL=0.95
          IF(IOP.EQ.1.OR.IOP.EQ.2.OR.IOP.EQ.3)QL=0.
          IF(IP1.EQ.10)WRITE(6,999)IC1
  999 FORMAT(/10I5/10I5
         *//'    sub  price  quantity   Y    utility    UHX
C...
C... CALCULATING PRICE AND QUANTITY BY HOUSEHOLD
C...
          DO 1 I=1,NHH
          IH=I
C.D       IH=1
C...
          DO 40 J=1,MSIZE
          ISUB(IH,J)=0
          DO 40 L=1,3
   40 DWC(L,IH,J)=0
          IS=0
          U1=0.0
C...
          K=IFIX(ABS(HHD(I,2)))
C...
          CALL PQYI(I,K,IT,AY,IP1)
          CALL PQYN(0,IS,0,PJ,QN,U,SUBH,PH,QH,UH)
C...
C... public housing
          IF(HHD(I,2).LT.0.0)GOTO 7
C...
          IF(HHT(K,5).EQ.0.0.OR.NS.EQ.0)GOTO 17
```

```
C...
      DO 18 L=1,NS
      N=IPOL(1,L)
      IF(AY.GT.POL(6,L))GOTO 18
      IP=0
      IS1=IPOL(2,L)
C... income
      IF(N.EQ.1.OR.N.EQ.3)IP=1
C... in-kind
      IF(N.EQ.4.OR.N.EQ.6)IP=2
C... price
      IF(N.EQ.7.OR.N.EQ.9)IP=3
C... direct demand
      IF(N.EQ.10.OR.N.EQ.12)IP=4
C... direct supply
       IF(N.EQ.13.OR.N.EQ.15)IP=5
C... CONSTRAINED MINIMUM OPTION
      IF(N.EQ.20.OR.N.EQ.22)GOTO 16
C...
      IF(IP.EQ.0)GOTO 18
      IF(L.EQ.1)GOTO 20
C... checking subsidy amount against previous amount
      SUBT=SUB(IP,IS1,L,AY,P1,Q1,999)
      IF(IP.EQ.2.AND.SUBT.GT.P1*Q1)SUBT=P1*Q1
C...
      IF(SUBT.GE.SUBH)GOTO 19
C...
      IF(L.EQ.NS)GOTO 17
   20 CALL PQYN(IP,IS1,L,P1,Q1,U1,SUBH)
      ISH=L*10+IP
C...
C... check that in kind subsidy < P*Q
      IF(IP.NE.2)GOTO 18
      IF(SUBH.LT.P1*Q1)GOTO 18
      IS1=0
      CALL PQYN(IP,IS1,L,P1,Q1,U1,SUBH)
      GOTO 18
C...
C... CONSTRAINED MINIMUM OPTION
   16 IF(QN.LT.POL(IT,L))  U=0.
      CALL PQNQ(IP,IS1,L,P1,Q1,U1,SUBH,PH,QH,UH)
      IF(SUBH.GT.3250.)SUBH=3250.
      ISH=20
C...
   18 CONTINUE
C...
   19 IF(U1.LE.U)GOTO 17
      IS=ISH
      PJ=P1
      QN=Q1
      U =U1
```

```
663      C...
664         17 DWC(1,IH,NMD1)=HFIX((QN+.005)*10.)
665            DWC(2,IH,NMD1)=HFIX(U*1000.)
666            DWC(3,IH,NMD1)=HFIX((PJ+.0005)*1000.)
667            ISUB(IH,NMD1)=IS
668            IF(IS.EQ.20)ISUB(IH,NMD1)=HFIX((SUBH+0.005)*10.)
669      C...
670      C... EXISTING DWELLINGS
671            NIS=INMD(1,IT)
672            NIF=INMD(2,IT)
673      C...
674            DO 11 J=NIS,NIF
675      C...
676            U1=0.0
677            IS=0
678            CALL PQYE(0,IS,0,J,PJ,QJ,U,SUBH,PH,QH,UH)
679      C...
680            IF(HHT(K,5).EQ.0.OR.NS.EQ.0)GOTO 12
681      C...
682            DO 21 L=1,NS
683            N=IPOL(1,L)
684            IF(AY.GT.POL(6,L))GOTO 21
685      C...
686            IS1=IPOL(2,L)
687            IP=0
688      C... income
689            IF(N.EQ.1.OR.N.EQ.2)IP=1
690      C... in-kind
691            IF(N.EQ.4.OR.N.EQ.5)IP=2
692      C... price
693            IF(N.EQ.7.OR.N.EQ.8)IP=3
694      C... direct demand
695            IF(N.EQ.10.OR.N.EQ.11)IP=4
696      C... direct supply subsidy
697             IF(N.EQ.13.OR.N.EQ.14)IP=5
698      C... CONSTRAINED MINIMUM OPTION
699            IF(N.EQ.20.OR.N.EQ.21)GOTO 24
700      C...
701            IF(IP.EQ.0)GOTO 21
702            IF(L.EQ.1)GOTO 23
703            SUBT=SUB(IP,IS1,L,AY,P1,Q1,J)
704            IF(IP.EQ.2.AND.SUBT.GT.P1*Q1)SUBT=P1*Q1
705      C...
706            IF(SUBT.GE.SUBH)GOTO 22
707            IF(L.EQ.NS)GOTO 12
708      C...
709         23 CALL PQYE(IP,IS1,L,J,P1,Q1,U1,SUBH)
710            ISH=L*10+IP
711      C...
712      C... check on in kind subsidy < P*Q
713            IF(IP.NE.2)GOTO 21
```

```
            IF(SUBH.LT.P1*Q1)GOTO 21
            IS1=0
            CALL PQYE(IP,IS1,L,J,P1,Q1,U1,SUBH)
            GOTO 21
C...
C... CONSTRAINED MINIMUM OPTION
         24 IF(QJ.LT.POL(IT,L))  U=0.
            CALL PQEQ(IP,IS1,L,J,P1,Q1,U1,SUBH,PH,QH,UH)
            IF(SUBH.GT.3250.)SUBH=3250.
            ISH=20
C...
         21 CONTINUE
C...
         22 IF(U1.LE.U)GOTO 12
            IS=ISH
            PJ=P1
            QJ=Q1
            U=U1
C...
         12 IF(QJ.LE.QL*QN)GOTO 11
            DWC(1,IH,J)=HFIX((QJ+.005)*10.)
            DWC(2,IH,J)=HFIX(U*1000.)
            DWC(3,IH,J)=HFIX((PJ+.0005)*1000.)
            ISUB(IH,J)=IS
            IF(IS.EQ.20)ISUB(IH,J)=HFIX((SUBH+0.005)*10.)
         11 CONTINUE
C...
C... no new dwellings for externalities calibration
            IF(IOP.NE.1)GOTO 7
            DWC(1,IH,NMD1)=0
            DWC(2,IH,NMD1)=0
            DWC(3,IH,NMD1)=0
C...
          7 CONTINUE
C.D         WRITE(8'I)DWC
C.D         WRITE(9'I)ISUB
          1 CONTINUE
            RETURN
            END
C...
            SUBROUTINE CALCO
            REAL*4 PRICE(5,2),DP(15),BETA(2,2),OCD(2)
            COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
C...
            COMMON/PARA/AB(15,4,10),SPP(10),DPP(15)
            EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
           * ,(IC1(5),NMD1),(IC1(8),IOP),(IC1(10),NS),(IC1(20),
           * ,(PAR(32),PPP),(PAR(11),PRICE(1,1))
           * ,(PAR(3),BETA(1,1)),(PAR(7),OCD(1))
C...
```

PROGRAM:F10:SIMO2.FORT

```
      ENTRY PQYI(I,K,IT,AY,IP1)
C...
      IT=1
      IF(K.GT.5)IT=2
C... for test data set (TYPE 2 forced to be o-oer)
      IF(IP1.GT.5 )IT=K
C...
      HHD(I,10)=HHD(I,1)/12.
      IF(HHD(I,10).GT.HHT(2,K))HHD(I,10)=HHD(I,10)*(1.-PP
C...
      AY=HHD(I,10)
      GY=HHD(I,10)+HHD(I,4)/12.
C...
C... derive base parameters to DP's - DPP's are varied as
C...
      CALL PARA1(K,AY,HHD(I,9),DP)
C...
      BSHARE=HHD(I,9)
C...
      B1=BETA(1,IT)
      B2=BETA(2,IT)*4
      OC=OCD(IT)
C...
      PM=DP(13)
C...
      PO=PRICE(1,IT)
      PN=PRICE(4,IT)
      QM=PRICE(3,IT)
C...
      IF(IP1.EQ.10)WRITE(6,1010)I,K,PO,PN,QM,BSHARE
 1010 FORMAT(/' hhold',I4,' TYPE',I3,2F5.2,F5.1,F8.5)
      PB=PN
C...
      IF(NS.EQ.0)RETURN
C...
      CALL PQMQI(K,BSHARE,AY,QM,PB,IT)
C...
      RETURN
C...
C... "quantity" - "utility" of new construction "QN"
C...
      ENTRY PQYN(IP,IS,L,PJ,Q,U,SUBA,PH,QH,UH)
C...
      PJ=PB
C...
C... load basic data to COMMON storage
C...
      SPP(1)  =AY
      SPP(2)  =GY
      SPP(3)  =PM
      SPP(4)  =0.
```

```
      SPP(5)  =B1
      SPP(6)  =B2
      SPP(7)  =OC
      SPP(8)  =BSHARE
      SPP(9)  =DP(13)
      SPP(10) =DP(14)
C...
      DO 2 LL=1,15
    2 DPP(LL)=DP(LL)
C...
C... solve for Q given PN on demand system
C...
      SHARE=HHD(I,9)+DP(14)*ALOG(PB/DP(13))
      Y=AY
C...
      IF(IP.NE.O)GOTO 21
C...
C.SE solve for QN for given price
      Q=SHARE*AY/PB
C...
      IF(IP1.EQ.10)WRITE(6,1000)IP,IS,L,PB,Q,AY,HHD(I,9),
C...
C... public housing
      IF(HHD(I,2).LT.O.O.AND.Q.LT.QM)Q=QM
      GOTO 16
C...
C...
C... iterate on NET INCOME for SHARE variation with SUBSI
   21 BY=AY
      XSHARE=SHARE
C...
      DO 22 N=1,10
C...
      CALL CCYN(IP,IS,L,PB,Q,AY,GY,XSHARE,DP(13),DP(14))
C...
      SUBA=SUB(IP,IS,L,GY,PB,Q,999,PN,O.)
C...
      IF(SUBA.LT.O.)Q=O.
C...
      Y=AY+SUBA
      IF(ABS(Y-BY).LT.O.O1)GOTO 16
C...
      BY=Y
      CALL PARA1(K,Y,XSHARE,DPP)
C...
      XSHARE=XSHARE+DPP(14)*ALOG(PB/DPP(13))
C...
      IF(IP1.EQ.10)WRITE(6,1011)AY,Y
 1011 FORMAT(' ITS ON QN:',2F10.4)
   22 CONTINUE
C...
```

```
      Y=-1.
C...
   16 CALL CL$UT(U,UHS,UA,PM,Q,Y,NZ)
C...
      IF(IP1.EQ.10)WRITE(6,1000)I,IP,IS,PB,Q,Y,U,UHS,UA
C...
      PH=PB
      QH=Q
      UH=U
C...
      IF(Q.LT.QM)Q=0.
      IF(Q.EQ.0.)  U=0.
      IF(U.EQ.0.0)Q=0.0
      RETURN
C...
C... PRICE QUANTITY AND UTILITY  - EXISTING DWELLINGS
C...
      ENTRY PQYE(IP,IS,L,J,PJ,Q,U,SUBA,PH,QH,UH)
C...
      U=0.0
      Q=0.0
C...
      DO 3 LL=1,15
    3 DPP(LL)=DP(LL)
C...
      QI=IFIX(DWD(1,J))
      IZ=IFIX(DWD(2,J))
C...
C... load basic data to COMMON storage
C...
      SPP(1)  =AY
      SPP(2)  =GY
      SPP(3)  =PM
      SPP(4)  =QI
      SPP(5)  =B1
      SPP(6)  =B2
      SPP(7)  =OC
      SPP(8)  =BSHARE
      SPP(9)  =DP(13)
      SPP(10) =DP(14)
C...
      IF(IOP.NE.1)GOTO 11
C..
C... externalities calibration
C... solve for PJ for given Q=QI
      Q=QI
      PJ=(HHD(I,9)-DP(14)*ALOG(Q/DP(10))) *AY/Q
C...
      GOTO 166
C...
C... solve for both PJ @ Q
```

PROGRAM:F10:SIMO2.FORT

```
   11 Q=0.
      PJ=0.
C...
      IF(IP.NE.0)GOTO 12
C...
      CALL CCYE(IP,IS,L,PJ,Q)
      Y=AY
      GOTO 166
C...
C... iterate on NET income for SHARE adjustment with SUBS
   12 BY=AY
      DO 13 N=1,10
C...
      CALL CCYE(IP,IS,L,PJ,Q)
C...
      SUBA=SUB(IP,IS,L,GY,PJ,Q,J,0.,SPP(3))
      IF(SUBA.LT.0.)SUBA=0.
C...
      Y=AY+SUBA
C...
      IF(ABS(Y-BY).LT.0.05)GOTO 166
C...
      IF(IP1.EQ.10)WRITE(6,1001)BY,Y,SUBA,PJ,Q
C...
      BY=Y
C...
C... call to recompute BSHARE etc
C...
      CALL PARA1(K,Y,XSHARE,DPP)
C...
      SPP(1)=Y
      SPP(3)=DPP(13)
      SPP(8)=XSHARE
      SPP(9)=DPP(13)
      SPP(10)=DPP(14)
   13 CONTINUE
C...
      Y=0.
C...
  166 CALL CL$UT(U,UHS,UA,PJ,Q,Y,IZ)
C...
      IF(IP1.EQ.10)WRITE(6,1000)J,IP,IS,PJ,Q,Y,U,UHS,UA
C...
      PH=PJ
      QH=Q
      UH=U
C...
      IF(PJ.LT.P0)  U=0.0
      IF(U.EQ.0.0)Q=0.0
      RETURN
C...
```

PROGRAM:F10:SIM02.FORT

```
 1000  1000 FORMAT(I4,2I2,2F8.2,F8.0,3F12.6)
 1001  1001 FORMAT(10X    ,3F8.2,F8.4,F8.2)
 1002       END
 1003 C...
 1004 C...
 1005       SUBROUTINE CALC3A
 1006 C...
 1007       COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
 1008      * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
 1009 C...
 1010       ENTRY CCYN(IP,IS,L,PB,Q,AY,GY,SHARE,DP13,DP14)
 1011 C...
 1012       GOTO(11,12,13,14,14),IP
 1013 C... income
 1014    11 Q=(SHARE/PB)*(AY+POL(1,L)*(POL(3,L)-POL(4,L)*GY))
 1015       GOTO 10
 1016 C... in-kind
 1017    12 GOTO(31,32,33,34,35,36),IS
 1018 C...
 1019       Q=(SHARE*AY/PB)/(1.-SHARE)
 1020       GOTO 10
 1021 C...
 1022    31 Q=(SHARE/PB)*(AY-POL(1,L)*POL(4,L)*GY)/
 1023      *    (1.-SHARE*POL(1,L)*POL(2,L))
 1024       GOTO 10
 1025    32 Q=(SHARE/PB)*(AY+POL(1,L)*(POL(3,L)-POL(4,L)*GY))
 1026       GOTO 10
 1027    33 Q=(SHARE/PB)*AY/(1.-SHARE*(POL(1,L)*(POL(2,L)-POL(5
 1028       GOTO 10
 1029    34 Q=(SHARE/PB)*(AY+POL(1,L)*POL(3,L))/
 1030      *    (1.+SHARE*(POL(1,L)*POL(5,L)))
 1031       GOTO 10
 1032    35 Q=(SHARE/PB)*AY/(1.-SHARE*(POL(1,L)*(POL(2,L)-POL(5
 1033       GOTO 10
 1034    36 Q=(SHARE/PB)*(AY+POL(1,L)*POL(3,L))/
 1035      *    (1.+SHARE*(POL(1,L)*POL(5,L)*GY))
 1036       GOTO 10
 1037 C...
 1038 C... price
 1039    13 PB=POL(1,L)+POL(2,L)
 1040       SHARE=(HHD(I,9)+DP14*ALOG(PB/DP13))
 1041       Q=SHARE*AY/PB
 1042       GOTO 10
 1043 C...
 1044 C... direct demand and supply
 1045 C...
 1046    14 GOTO(41,42),IS
 1047 C...
 1048    41 Q=((SHARE/PB)*AY-POL(1,L)*POL(4,L)*GY/PB)/
 1049      *     (1.-POL(1,L)*POL(2,L))
 1050       GOTO 10
```

PROGRAM:F10:SIMO2.FORT

```
1020         42 Q=(SHARE/PB)*AY+(POL(1,L)*(POL(3,L)-POL(4,L)*GY))/P
1021            GOTO 10
1022      C...
1023      C... check MINQ
1024         10 IF(Q.LT.POL(7,L))Q=POL(7,L)
1025      C...
1026      C... check MAXR
1027            IF(PB*Q.GT.POL(10,L))Q=POL(10,L)/PB
1028      C...
1029            RETURN
1030            END
1031      C...
1032            SUBROUTINE CALC3
1033      C...
1034            COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
1035           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
1036            COMMON/PARA/AB(15,4,10),SPP(10)
1037      C...
1038            EQUIVALENCE (SPP(1),AY),(SPP(3),PM),(SPP(4),QI),(SP
1039           * ,(SPP(6),B2),(SPP(7),OC),(SPP(8),BSHARE)
1040      C...
1041            DATA TOL/0.00001/
1042      C...
1043      C... CL$PR COMPUTES A ROOT OF THE NON-LINEAR EQUATION FUN
1044      C... METHOD USED IS A COMBINATION OF BISECTION AND THE SE
1045      C...
1046            ENTRY CCYE(IP,IS,L,PJ,Q)
1047      C...
1048            B=BSHARE*AY/(B1*QI)
1049            C=BSHARE*AY/(1.5*QI)
1050      C...
1051      C...
1052            IF(B.LT.OC)GOTO 62
1053            IF(C.GT.PM)GOTO 62
1054      C...
1055            IC=0
1056            ACBS=ABS(B-C)
1057            A=C
1058            FA=FUN(IP,IS,L,A)
1059            FB=FUN(IP,IS,L,B)
1060            FC=FA
1061            KOUNT=2
1062            FX=AMAX1(ABS(FB),ABS(FC))
1063         51 IF(ABS(FC).GE.ABS(FB))GOTO 52
1064      C...
1065      C... INTERCHANGE B AND C SO THAT ABS(F(B).LE.ABS(F(C))
1066      C...
1067            A=B
1068            FA=FB
1069            B=C
1070            FB=FC
```

```
1071            C=A
1072            FC=FA
1073         52 CMB=0.5*(C-B)
1074            ACMB=ABS(CMB)
1075      C...
1076      C... TEST STOPPING CRITERION AND FUNCTION COUNT
1077      C...
1078            IF(ACMB.LE.TOL)GOTO 58
1079            IF(KOUNT.GE.500)GOTO 62
1080      C...
1081      C... CALCULATE NEW ITERATE IMPLICITLY AS B+P/Q
1082      C... WHERE P.GE.0.  THE IMPLICIT FORM IS USED TO
1083      C... PREVENT OVERFLOW.
1084      C...
1085            P=(B-A)*FB
1086            Q=FA-FB
1087            IF(P.GE.0.0)GOTO 53
1088            P=-P
1089            Q=-Q
1090      C...
1091      C... UPDATE A. CHECK IF REDUCTION IN THE SIZE OF BRACKETI
1092      C... INTERVAL IS SATISFACTORY. IF NOT, BISECT UNTIL IT IS
1093      C...
1094         53 A=B
1095            FA=FB
1096            IC=IC+1
1097            IF(IC.LT.4)GOTO 54
1098            IF(8.0*ACMB.GE.ACBS)GOTO 56
1099            IC=0
1100            ACBS=ACMB
1101      C...
1102      C... TEST FOR TOO SMALL A CHANGE
1103      C...
1104         54 IF(P.GT.ABS(Q)*TOL)GOTO 55
1105      C...
1106      C... INCREMENT BY TOLERANCE
1107      C...
1108            B=B+SIGN(TOL,CMB)
1109            GOTO 57
1110      C...
1111      C... ROOT OUGH TO BE BETWEEN B AND (C+B)/2
1112      C...
1113         55 IF(P.GE.CMB*Q)GOTO 56
1114      C...
1115      C... USE SECANT RULE
1116            B=B+P/Q
1117            GOTO 57
1118      C...
1119         56 B=0.5*(C+B)
1120      C...
1121      C... HAVE COMPLETED COMPUTATION FOR NEW ITERATE B
```

```
C...
   57 FB=FUN(IP,IS,L,B)
      IF(FB.EQ.0.0)GOTO 59
      IF(FB.EQ.-1.E5)GOTO 62
      KOUNT=KOUNT+1
      IF(SIGN(1.0,FB).NE.SIGN(1.0,FC))GOTO 51
      C=A
      FC=FA
      GOTO 51
C...
C... FINISHED SET IFLAG
C...
   58 IF(SIGN(1.0,FB).EQ.SIGN(1.0,FC))GOTO 61
      IF(ABS(FB).GT.FX)GOTO 60
      IFLAG=1
      GOTO 30
   59 IFLAG=2
      GOTO 30
   60 IFLAG=3
      GOTO 30
   61 IFLAG=4
      RETURN
   62 IFLAG=5
      RETURN
C...
   30 PJ=B
C...
      Q=(B1+B2*(PJ-OC)/PM) * QI
      IF(Q.LT.B1*QI)Q=B1*QI
C...
C... CHECK  MINQ
      IF(IP.EQ.0)RETURN
      IF(Q.GE.POL(7,L))GOTO 65
      Q=POL(7,L)
      IF(Q.LT.B1*QI)Q=0.
      PJ=((Q/QI-B1)*PM/B2)+ OC
C...
C... check MAXR
   65 IF(PJ*Q.LT.POL(10,L))RETURN
C...
      IF(IP1.EQ.10)WRITE(1,1000)J,IP,IS,PJ,Q
C...
      Q=B1*QI
      PJ=POL(10,L)/Q
      IF(PJ.LE.OC)RETURN
C...
      AC=1.
      BC=-(B1-(B2*OC/PM))*QI
      CC=-(B2*POL(10,L)/PM)*QI
C...
      IF(IP1.EQ.10)WRITE(1,1001)AC,BC,CC
```

```
      Q=QDD(AC,BC,CC)
C...
  107 PJ=((Q/QI-B1)*PM/B2)+ OC
      RETURN
 1000 FORMAT(3I3,F8.4,F8.1)
 1001 FORMAT(T10,3F15.5)
C...
      END
C...
      FUNCTION FUN(IP,IS,L,PJ)
C...
      COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
      COMMON/PARA/AB(15,4,10),SPP(10)
C...
      EQUIVALENCE (SPP(1),AY),(SPP(2),GY),(SPP(3),PM),(SP
     *           ,(SPP(5),B1),(SPP(6),B2),(SPP(7),OC),(SP
     *           ,(SPP(9),DP13),(SPP(10),DP14)
     * ,(IC1(7),IP1)
C...
C...
      IF(IP1.EQ.10)WRITE(6,1111)BSHARE
      SHARE=(BSHARE+DP14*ALOG(PJ/PM))
      IF(IP1.EQ.10)WRITE(6,1111)SHARE,AY,PJ,PM
C...
      D=SHARE/PJ
      IF(PJ.GT.OC)S=(B1+B2*(PJ-OC)/PM) *QI
      IF(PJ.LE.OC)S=B1*QI
C...
      FUN=-1.E5
C...
      GOTO(1,2,3,4,5),IP
C...
C... basic function
      FUN=D*AY -S
      IF(IP1.EQ.10)WRITE(6,1200)D,S,FUN
 1200 FORMAT(3F20.10)
      RETURN
C...
C... INCOME
    1 FUN=D*(AY+POL(1,L)*(POL(3,L)-POL(4,L)*GY)) -S
      RETURN
C...
C... IN-KIND
    2 GOTO(21,22,23,24,25,26),IS
C...
      IF(1.-PJ*D.EQ.0.)RETURN
      FUN=(D*AY)/(1.-PJ*D) -S
      RETURN
C...
   21 IF(1.-D*PJ.EQ.0.)RETURN
```

PROGRAM:F10:SIMO2.FORT

```
1224            FUN=D*(AY-POL(1,L)*POL(4,L)*GY)/(1.-D*POL(1,L)*POL(
1225            RETURN
1226      C...
1227         22 FUN=D*(AY+POL(1,L)*(POL(3,L)-POL(4,L)*GY)) -S
1228            RETURN
1229      C...
1230         23 IF(D*POL(1,L)*(POL(2,L)-POL(5,L))*PJ.EQ.1.)RETURN
1231            FUN=D*AY/(1.-D*POL(1,L)*(POL(2,L)-POL(5,L))*PJ) -S
1232            RETURN
1233      C...
1234         24 FUN=D*(AY+POL(1,L)*POL(3,L))/(1.+D*POL(1,L)*POL(5,L
1235            RETURN
1236      C...
1237         25 FUN=D*AY/(1.-D*POL(1,L)*(POL(2,L)-POL(5,L)*GY)*PJ)
1238            RETURN
1239      C...
1240         26 FUN=D*(AY+POL(1,L)*POL(3,L))/(1.+D*POL(1,L)*POL(5,L
1241            RETURN
1242      C...
1243      C... price
1244          3 SHARE=BSHARE+DP14*ALOG(PJ/(POL(3,L)+POL(4,L)))
1245            D=SHARE/PJ
1246            FUN=D*AY -S
1247            RETURN
1248      C...
1249      C... direct demand
1250          4 GOTO(41,42),IS
1251      C...
1252         41 FUN=(D*AY-POL(1,L)*POL(4,L)*GY /PJ)/(1.-POL(1,L)*PO
1253            RETURN
1254         42 FUN=(D*AY+POL(1,L)*(POL(3,L)-POL(4,L)*GY)/PJ) -S
1255            RETURN
1256      C...
1257      C... direct supply
1258          5 GOTO(51,52),IS
1259      C...
1260         51 FUN=D*AY -(S-POL(1,L)*POL(4,L)*GY/PJ)/(1.-POL(1,L)*
1261            RETURN
1262         52 FUN=D*AY -(S+POL(1,L)*(POL(3,L)-POL(4,L)*GY)/PJ)
1263            RETURN
1264       1111 FORMAT(5F12.5)
1265            END
1266      C...
1267            SUBROUTINE PARA1(K,YY,BSHARE,DP)
1268      C...
1269            REAL*4 DP(15)
1270            COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
1271           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
1272      C...
1273            COMMON/PARA/AB(15,4,10)
1274            IS=1
```

PROGRAM:F10:SIMO2.FORT

```
      DO 2 I1=1,4
      IF=I1
      IF(YY.LT.HHT(K,I1))GOTO 3
    2 IS=I1
C...
    3 WS=0.5
      WF=0.5
      IF(IS.EQ.IF)GOTO 5
C...
      WF=(YY-HHT(K,IS))/(HHT(K,IF)-HHT(K,IS))
      WS=1.-WF
C...
C...
    5 DO 1 I1=1,15
    1 DP(I1)=AB(I1,IS,K)*WS+AB(I1,IF,K)*WF
      A1=-DP(2)
      BSHARE=A1
      IF(IS.EQ.IF)BSHARE=A1+AB(15,IS,K)*ALOG(YY/DP(12))
     *  /HHT(K,IS)
      RETURN
      END
C...
      FUNCTION SUB(IP,IS,L,GY,P,Q,ND,PN,PM)
C...
      COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
C...
C...
      GOTO(1,2,3,4,4),IP
C...
      SUB=0.0
      RETURN
C... income
    1 SUB=(POL(1,L)*(POL(3,L)-POL(4,L)*GY))
      RETURN
C...
    2 GOTO(21,22,23,24,25,26),IS
C...
      SUB=P*Q
      RETURN
C...
   21 SUB=(POL(1,L)*(POL(2,L)*P*Q-POL(4,L)*GY))
      RETURN
C...
   22 SUB=(POL(1,L)*(POL(3,L)-POL(4,L)*GY))
      RETURN
C...
   23 SUB=(POL(1,L)*(POL(2,L)-POL(5,L))*P*Q)
      RETURN
C...
   24 SUB=(POL(1,L)*(POL(3,L)-POL(5,L)*P*Q))
```

```
1326            RETURN
1327      C...
1328           25 SUB=(POL(1,L)*(POL(2,L)*P*Q-POL(5,L)*GY*P*Q))
1329            RETURN
1330      C...
1331           26 SUB=(POL(1,L)*(POL(3,L)-POL(5,L)*GY*P*Q))
1332            RETURN
1333      C... price
1334            3 IF(ND.GT.500)SUB=Q* (PN-(POL(1,L)+POL(2,L)))
1335              IF(ND.LE.500)SUB=Q* (PM-(POL(3,L)+POL(4,L)))
1336              RETURN
1337      C...
1338      C... direct demand and supply
1339            4 GOTO(41,42),IS
1340      C...
1341           41 SUB=POL(1,L)*(POL(2,L)*P*Q-POL(4,L)*GY)
1342              RETURN
1343      C...
1344           42 SUB=POL(1,L)*(POL(3,L)-POL(4,L)*GY)
1345              RETURN
1346      C...
1347              END
1348      C...
1349              FUNCTION QDD(A,B,C)
1350      C...
1351              QDD=0.
1352      C...
1353              D=B**2 -4*A*C
1354              IF(D.LE.0.)RETURN
1355              D=SQRT(D)
1356      C...
1357              IF(A.EQ.0.)GOTO 1
1358              IF(B.GE.0.)X1=-(B+D)/(2.*A)
1359              IF(B.LT.0.)X1=(D-B)/(2.*A)
1360              X2=C/(X1*A)
1361              QDD=X1
1362              IF(X1.LT.0.)QDD=X2
1363              RETURN
1364      C...
1365            1 QDD=-C/B
1366              RETURN
1367              END
1368      C...
1369      C...
1370              SUBROUTINE UTILL
1371      C... routine to calculate utility
1372              REAL*4 LNU,LQ,LQX
1373              COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
1374             * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
1375              COMMON/PARA/AB(15,4,10),SPP(10),DPP(15)
1376              EQUIVALENCE (PAR(2),EXT2),(PAR(33),AMAX) ,(PAR(20),
```

```
      * ,(IC1(7),IP1)
C...
       ENTRY CL$UT(U,UHX,UA,P,Q,Y,IZ)
C...
       U=0.0
       UHX=0.
       UA=0.
C...
       IF(Q.LE.0.)RETURN
       IF(P*Q.GE.Y)RETURN
C...
       LQ=ALOG(Q/DPP(10))
       LQX=ALOG(((Y-P*Q)/CPI)/DPP(11))
       LNU=-(DPP(1)+DPP(2)*LQ+DPP(3)*LQX
      * +0.5*(DPP(4)*LQ*LQ+(DPP(5)+DPP(6))*LQ*LQX+DPP(7)*L
       UHX=EXP(LNU)
C...
       UA=EXP(EXT2/10.*ALOG(2.-ZOD(2,IZ)/AMAX))
C...
       U=UHX*UA
C...
       IF(IP1.EQ.10)WRITE(6,1000)LQ,LQX,LNU,UHX,U
       RETURN
 1000 FORMAT(' U',6F12.5)
       END
C...
C...
       SUBROUTINE CALC2
       INTEGER*4 JO(2,3)
       REAL*4 SKEY(120),SOL(120,4),PDW(120),D(3),SKS(120)
       INTEGER*2 NDW(120),IODW(120,120),UAHH(120),ISUB(120
      * ,ISOL(120,2)
       INTEGER*2 DWC(3,120,120)
       COMMON/BLK8/NDW,IODW,DWC,ISUB,UAHH,ISOL,SOL
       COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
      * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
       EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
      * ,(IC1(5),NMD1),(IC1(6),MSIZE),(IC1(10),NS)
      * ,(PAR(2),EXT1)
      * ,(PAR(28),SUBM)
C...
       EQUIVALENCE (SOL(1,4),PDW(1),SKEY(1))
C...
       ENTRY SRT$1(KJ)
C... sorting routine
C... order all households by "model" income to UAHH
C... order each household's dwelling stack in terms of de
C     utility to IODW
C...
       IF(KJ.EQ.2)GOTO 4
C...
```

```
C... sorting households by "model" income
      DO 1 I=1,NHH
    1 SKEY(I)=HHD(I,10)
C...
      DO 3 K=1,NHH
      IS=0
      X=0.
C...
      DO 2 N=1,NHH
      IF(SKEY(N).LE.X)GOTO 2
      X=SKEY(N)
      IS=N
    2 CONTINUE
C...
      SKEY(IS)=-1.
    3 UAHH(K)=IS
C...
      UAHH(NHH+1)=NHH+1
C...
C... sorting dwelling stack
C...
    4 DO 10 I=1,NHH
C.D   READ(8'I)DWC
      IH=I
C.D   IH=1
      DO 25 J=1,MSIZE
   25 IODW(IH,J)=0
C...
      DO 11 J=1,NMD1
      IZ=DWD(2,J)
      SKEY(J)=DWC(2,IH,J)*ZW(IZ)
      SKS(J)=0.
      IF(SUBM.EQ.0.)GOTO 11
      SKS(J)=ISUB(I,J)
      IF(SKEY(J).EQ.0.)SKS(J)=9.1E10
   11 CONTINUE
C...
      DO 13 J=1,NMD1
      IS=0
      X=0.
C...
      S=9.E10
C...
      IF(SUBM.EQ.0.)GOTO 14
C...
C... find lowest subsidy amount
      DO 15 N=1,NMD1
   15 IF(SKS(N).LT.S)S=SKS(N)
C...
   14 DO 12 N=1,NMD1
      IF(SKS(N).GT.S)GOTO 12
```

```
1479            IF(SKEY(N).LE.X)GOTO 12
1480            X=SKEY(N)
1481            IS=N
1482         12 CONTINUE
1483            IF(X.LE.0.)GOTO 10
1484            SKEY(IS)=-1.
1485            SKS(IS)=9.1E10
1486            IODW(IH,J)=IS
1487            IF(IS.EQ.NMD1)GOTO 10
1488      C...
1489         13 CONTINUE
1490         10 CONTINUE
1491      C.D10 WRITE(7'I)IODW
1492            RETURN
1493      C...
1494      C... calculating TOTAL "utility" each run
1495      C... relative wealth utility
1496      C...
1497            ENTRY CL$4
1498      C...
1499            DO 22 IZ=1,NZ
1500         22 ZW(IZ)=EXP(EXT1/10.*ALOG(EXT(1,1,IZ)))
1501      C...
1502      C...
1503            RETURN
1504      C...
1505      C... allocate households among dwellings
1506      C...
1507            ENTRY CL$5(IP)
1508      C...
1509            IS=0
1510            IO=0
1511      C...
1512            DO 26 I=1,MSIZE
1513            NDW(I)=0
1514            DO 27 J=1,4
1515         27 SOL(I,J)=0.0
1516            DO 26 J=1,2
1517         26 ISOL(I,J)=0
1518      C...
1519            IF(IP.EQ.10)WRITE(6,101)
1520        101 FORMAT('1'/' *** tracing HOUSEHOLD ASSIGMENTs'//
1521           `    * 3(' HHOLD DWELL   PRICE  '))
1522      C...
1523            DO 44 IS=1,NHH
1524      C...
1525            NH=UAHH(IS)
1526      C...
1527            NX=UAHH(IS+1)
1528      C...
1529      C... LOOP START FOR DISPLACED HOUSEHOLD
```

```
1530        43 CONTINUE
1531     C.D   READ(7'NH)IODW
1532     C.D   READ(8'NH)DWC
1533           N=NH
1534     C.D   N=1
1535     C...
1536     C... LOOP START FOR UNALLOCATED HOUSEHOLD
1537        45 ND=IODW(N,1)
1538     C... no dwelling available?
1539           IF(ND.EQ.0)GOTO 50
1540           PJ=DWC(3,N,ND)
1541           IF(IP.NE.10)GOTO 46
1542     C...
1543     C... copy to "trace" output
1544           IO=IO+1
1545           JO(1,IO)=NH
1546           JO(2,IO)=ND
1547            O(IO)=PJ
1548     C...
1549           IF(IO.LT.3)GOTO 46
1550     C...
1551           WRITE(6,102)((JO(I,J),I=1,2),O(J),J=1,IO)
1552      102  FORMAT(3(I3,I6,F11.3,2X))
1553           IO=0
1554     C...
1555     C.. popping household's dwelling stack
1556        46 DO 41 J=1,NMD
1557           IODW(N,J)=IODW(N,J+1)
1558           IF(IODW(N,J).EQ.0)GOTO 42
1559        41 CONTINUE
1560     C...
1561        42 IH=NDW(ND)
1562     C... if new: select
1563           IF(ND.EQ.NMD1)GOTO 51
1564     C... if bid price less than or equal to current: selectne
1565           IF(PJ.LE.PDW(ND))GOTO 45
1566     C... allocating to assigned stack
1567     C.D   WRITE(7'NH)IODW
1568     C.D   FIND(7'NX)
1569     C.D   FIND(8'NX)
1570           NDW(ND)=NH
1571           PDW(ND)=PJ
1572        51 ISOL(NH,1)=ND
1573           SOL(NH,1)=DWC(3,N,ND)
1574           SOL(NH,2)=DWC(1,N,ND)
1575           SOL(NH,3)=DWC(2,N,ND)
1576     C... DWELLING EMPTY(INCLUDING NEW)
1577           IF(IH.EQ.0)GOTO 44
1578     C... HOUSEHOLD DISPLACED - LOOP INTERNALLY
1579           NH=IH
1580     C.D   FIND(7'IH)
```

```
1581      C.D   FIND(8'IH)
1582            GOTO 43
1583      C...
1584      C... NO NEW DWELLING
1585         50 ISOL(NH,1)=-1
1586            IO=IO+1
1587            JO(1,IO)=NH
1588            JO(2,IO)=O
1589            O(IO)=O.
1590      C...
1591         44 CONTINUE
1592      C...
1593            IF(IO.NE.O)WRITE(6,102)((JO(I,J),I=1,2),O(J),J=1,IO
1594      C...
1595      C... calculating solution set.
1596            DO 62 I=1,NHH
1597            IH=I
1598      C.D   IH=1
1599            ND=ISOL(I,1)
1600            IF(ND.GT.O)GOTO 63
1601      C.D   READ(8'I)DWC
1602      C...
1603      C... no dwelling
1604      C... highest bid
1605            ND=1
1606            PJ=DWC(3,IH,1)
1607            DO 66 J=2,NMD
1608            IF(DWC(3,IH,J).LE.PJ)GOTO 66
1609            ND=J
1610            PJ=DWC(3,IH,J)
1611         66 CONTINUE
1612      C...
1613            ISOL(I,1)=-ND
1614            SOL(I,1)=PJ/1000.
1615            SOL(I,2)=DWC(1,IH,ND)
1616            SOL(I,3)=DWC(2,IH,ND)
1617            GOTO 62
1618         63 CONTINUE
1619      C.D   IF(NS.NE.O)READ(9'I)ISUB
1620            ISOL(I,2)=ISUB(IH,ND)
1621            SOL(I,1)=SOL(I,1)/1000.
1622            SOL(I,2)=SOL(I,2)/10.
1623            IZ=DWD(2,ND)
1624            SOL(I,3)=SOL(I,3)/10.*ZW(IZ)
1625            IF(ND.EQ.NMD1)ISOL(I,1)=999
1626         62 CONTINUE
1627      C...
1628            RETURN
1629      C...
1630      C...
1631            ENTRY CL$10(SER)
```

```
      C... calculating actual externalities
      C...
            DO 21 IZ=1,12
            DO 21 J=1,2
            EXT(2,J,IZ)=EXT(1,J,IZ)
         21 EXT(1,J,IZ)=0.
      C...
      C...
            DO 23 I=1,NHH
      C...
            J=ISOL(I,1)
            IF(J.LE.0)GOTO 23
            IF(J.EQ.999)J=NMD1
            IF(ISOL(I,2).EQ.99)GOTO 23
            IZ=DWD(2,J)
      C...
            EXT(1,1,IZ)=EXT(1,1,IZ)+HHD(I,1)+HHD(I,4)
            EXT(1,2,IZ)=EXT(1,2,IZ)+1
      C...
            EXT(1,1,12)=EXT(1,1,12)+HHD(I,1)+HHD(I,4)
            EXT(1,2,12)=EXT(1,2,12)+1
         23 CONTINUE
      C...
      C... calculating relative "wealth"
            EXT(1,1,12)=EXT(1,1,12)/EXT(1,2,12)
      C...
            DO 24 IZ=1,NZ
            IF(EXT(1,2,IZ).EQ.0)GOTO 34
            EXT(1,1,IZ)=(EXT(1,1,IZ)/EXT(1,2,IZ))/EXT(1,1,12)
            GOTO 24
         34 EXT(1,1,IZ)=1.
         24  CONTINUE
      C...
      C... calculating error on externalities
      C...
            SER=0.
            DO 30 IZ=1,NZ
         30 SER=SER+(EXT(1,1,IZ)-EXT(2,1,IZ))**2
      C...
            SER=SQRT(SER)/(2.*NZ)
            RETURN
            END
      C...
            SUBROUTINE OT$DAT
      C... output of the input data.
            INTEGER*4 IWR1(10),IWR2(10),IWR3(10)
            REAL*4 DAT(8),SOL(120,4),DU1(200)
            REAL*4 WR1(10),WR2(10),WR3(10),WR4(10),WR5(10),WR6(
            INTEGER*2 IODW(120,120),UAHH(120),ISUB(120,120)
           * ,NDW(120),ISOL(120,2)
            INTEGER*2 DWC(3,120,120)
```

```
      COMMON/BLK8/NDW,IODW,DWC,ISUB,UAHH,ISOL,SOL
      COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
      COMMON/PARA/AB(15,4,10)
      COMMON/BLK22/ACT(12,20)
      EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
     * ,(IC1(5),NMD1),(IC1(8),IOP),(IC1(10),NS)
     * ,(PAR(11),RPO),(PAR(12),RPC),(PAR(13),RQM),(PAR(14
     * ,(PAR(16),OPO),(PAR(17),OPC),(PAR(18),OQM),(PAR(19
     * ,(PAR(20),CPI)
     * ,(PAR(21),DAT(1)),(PAR(32),PPP)
C...
      EQUIVALENCE (DU1(101),WR1(1)),(DU1(111),WR2(1)),(DU
     * ,(DU1(131),WR4(1)),(DU1(141),WR5(1)),(DU1(151),WR6
     * ,(DU1(161),WR7(1)),(DU1(171),IWR1(1)),(DU1(181),IW
     * ,(DU1(191),IWR3(1))
     * ,(DU1(1),NDW(1))
C...
      ENTRY OT$1
      WRITE(6,101)
  101 FORMAT(':'/'1HOUSING MARKET SIMULATION PACKAGE'//
     *' PROGRAM: "SIMO2.FORT" : DEVELOPED AT '//
     *' UNIVERSITY OF BRITISH COLUMBIA : FEB 81 - OCT 81'
      RETURN
C...
      ENTRY OT$2(NER,IP1)
      IF(NER.EQ.2)GOTO 2
C...
      IF(IP1.EQ.0)RETURN
      WRITE(6,99)TITLE
C...
      IF(IP1.EQ.1.OR.IP1.EQ.11)GOTO 34
   99 FORMAT(/2X,6A4/)
C...
      WRITE(6,114)NHH
  114 FORMAT(/' *** INPUT DATA'/
     *       /' *** "1CMA" MODEL HOUSEHOLDs:',T40,'number
     * ,I4)
      IF=0
    4 IS=IF+1
      IF=IS+9
      IF(IF.GT.NHH)IF=NHH
      WRITE(6,115)((I),I=IS,IF)
      WRITE(6,116)(HHD(I,1),I=IS,IF)
      WRITE(6,117)(HHD(I,2),I=IS,IF)
CC    WRITE(6,151)(HHD(I,5),I=IS,IF)
C...
      IF(NS.EQ.0)GOTO 710
      WRITE(6,811)(HHD(I,6),I=IS,IF)
      WRITE(6,126)(HHD(I,7),I=IS,IF)
      WRITE(6,127)(HHD(I,8),I=IS,IF)
```

```
      811 FORMAT(' BASE DATA '/'  DWELLING  ',1X,10F6.0)
      710 IF(IP1.EQ.2)GOTO 34
          IF(IF.LT.NHH)GOTO 4
C...
      115 FORMAT(/' household  ',10I6)
      116 FORMAT('  income    ',2X,10F6.0)
      117 FORMAT('  type      ',1X,10F6.0)
      151 FORMAT('  %equity   ',1X,10F6.4)
C...
       34 WRITE(6,110)NHT
      110 FORMAT(/' *** "2CMA" HOUSEHOLD TYPE GROUPs: ',T40,'
     * ,I4)
C...
          WRITE(6,111)((I),I=1,NHT)
          WRITE(6,112)(HHT(I,1),I=1,NHT)
          WRITE(6,112)(HHT(I,2),I=1,NHT)
          WRITE(6,112)(HHT(I,3),I=1,NHT)
          WRITE(6,112)(HHT(I,4),I=1,NHT)
C...
          DO 21 L=1,4
          WRITE(6,601)L,L
          WRITE(6,615)((I),I=1,NHT)
C...
          WRITE(6,603)(AB(1,L,I),I=1,NHT)
          WRITE(6,604)(AB(2,L,I),I=1,NHT)
          WRITE(6,605)(AB(3,L,I),I=1,NHT)
          WRITE(6,606)(AB(4,L,I),I=1,NHT)
          WRITE(6,607)(AB(5,L,I),I=1,NHT)
          WRITE(6,608)(AB(6,L,I),I=1,NHT)
          WRITE(6,609)(AB(7,L,I),I=1,NHT)
          WRITE(6,610)(AB(8,L,I),I=1,NHT)
          WRITE(6,611)(AB(9,L,I),I=1,NHT)
          WRITE(6,612)(AB(10,L,I),I=1,NHT)
          WRITE(6,613)(AB(11,L,I),I=1,NHT)
          WRITE(6,614)(AB(12,L,I),I=1,NHT)
          WRITE(6,625)(AB(13,L,I),I=1,NHT)
          WRITE(6,626)(AB(14,L,I),I=1,NHT)
       21 WRITE(6,627)(AB(15,L,I),I=1,NHT)
C...
      601 FORMAT(/' *** "2',I1,'  " DEMAND PARAMETERs  QO',I1
      603 FORMAT('  AO',T9,10F7.4)
      604 FORMAT('  A1',T9,10F7.4)
      605 FORMAT('  A2',T9,10F7.4)
      606 FORMAT(' B11',T9,10F7.4)
      607 FORMAT(' B12',T9,10F7.4)
      608 FORMAT(' B21',T9,10F7.4)
      609 FORMAT(' B22',T9,10F7.4)
      610 FORMAT(' BM1',T9,10F7.4)
      611 FORMAT(' BM2',T9,10F7.4)
      612 FORMAT(' MXH',T9,10F7.1)
      613 FORMAT(' MXG',T9,10F7.1)
```

```
1785        614 FORMAT(' MEX',T9,10F7.1)
1786        625 FORMAT(' MPH',T9,10F7.4)
1787        626 FORMAT(' esP',T9,10F7.5)
1788        627 FORMAT(' esY',T9,10F7.5)
1789        615 FORMAT(/' TYPE',10I7)
1790      C...
1791        111 FORMAT(/' TYPE group   ',10I6)
1792        112 FORMAT(/'  income      ',2X,10F6.0)
1793      C...
1794            IF(IP1.EQ.1)GOTO 799
1795            IF(IP1.EQ.11)RETURN
1796            WRITE(6,106)NMD
1797        106 FORMAT(/' *** "3CMA" MODEL DWELLINGS:',T40,'number
1798      C...
1799            IF=0
1800          3 IS=IF+1
1801            IF=IS+9
1802            IF(IF.GT.NMD)IF=NMD
1803            WRITE(6,107)((J),J=IS,IF)
1804            WRITE(6,108)(DWD(1,J),J=IS,IF)
1805            WRITE(6,109)(DWD(2,J),J=IS,IF)
1806            WRITE(6,823)(DWD(3,J),J=IS,IF)
1807            IF(IP1.EQ.2)GOTO 35
1808            IF(IF.LT.NMD)GOTO 3
1809      C...
1810        107 FORMAT(/' dwelling   ',10I6)
1811        108 FORMAT(/'  services  ',2X,10F6.0)
1812        109 FORMAT('  zone      ',1X,10F6.0)
1813        823 FORMAT('  tenure    ',1X,10F6.0)
1814      C...
1815         35 WRITE(6,102)NZ
1816        102 FORMAT(/' *** "40  " ZONAL CHARACTERISTICS: ',T40,'
1817           * I2)
1818            WRITE(6,103)((I),I=1,NZ)
1819            WRITE(6,104)(ZOD(1,I),I=1,NZ)
1820            WRITE(6,105)(ZOD(2,I),I=1,NZ)
1821      C...
1822        103 FORMAT(/' ZONE number',10I6)
1823        104 FORMAT(/' "wealth"   ',2X,10F6.0)
1824        105 FORMAT('  distance  ',1X,10F6.0)
1825      C...
1826        799 WRITE(6,120)(PAR(I),I=1,4)
1827        120 FORMAT(/' *** "50  " EXTERNALITIES PARAMETERs'
1828           * //'    EXT1      EXT2 ' /'  (wealth)  (access)'/2(
1829      C...
1830            IF(IOP.NE.1)WRITE(6,620)(PAR(I),I=3,4),PAR(7),(PAR(
1831           * ,PAR(8)
1832      C...
1833        620 FORMAT(//' *** "50  " SUPPLY PARAMETERS'
1834           * //T11,'rental',T41,'owners'
1835           * /T2,'B1',T12,'B2',T22,'OC',T32,'B1',T42,'B2',T52,'
```

```
1836           * /F6.3,9F10.3)
1837      C...
1838      C...
1839            WRITE(6,121)RPO,RPC,RQM,OPO,OPC,OQM
1840          121 FORMAT(/' *** "501 " PRICE and MINQ PARAMETERs'
1841           * //T15,'rental',T45,'owners'
1842           * /'      RPO       RPC        RQM         OPO        OPC
1843           * /F8.2,5F10.2)
1844      C...
1845            WRITE(6,621)CPI
1846          621 FORMAT(/'  CPI = ',F10.5)
1847            IF(NS.EQ.0)RETURN
1848      C...
1849            WRITE(6,160)((I),I=1,10),((IPOL(I,K),I=1,2),(POL(I,
1850           * ,K=1,4)
1851          160 FORMAT(/' ***  80    POLICY PARAMETERS'//
1852           * ' option  ',10('POL',I2,2X)/4(I4,'.',I1,10F7.2/))
1853            WRITE(6,161)((I),I=1,10),(HHT(I,5),I=1,10)
1854          161 FORMAT(/' ELIGIBILITY BY TYPE:'/10I6/1X,10F6.0)
1855            IF(IGIVEN(1).NE.0)WRITE(6,162)IGIVEN
1856          162 FORMAT(/' PUBLIC HOUSING: option',I4/10I6)
1857            IF(PPP.NE.0.0)WRITE(6,163)PPP
1858          163 FORMAT(/' purchasing power adjustor',F10.4)
1859            IF(PAR(36).NE.0.)WRITE(6,164)PAR(36)
1860          164 FORMAT(/' price elasticity adjustor',F10.4)
1861      C...
1862            RETURN
1863      C...
1864      C...  INPUT ERROR
1865            2 WRITE(6,129)
1866          129 FORMAT(/' *** ERROR in input data stopped execution
1867            STOP
1868      C...
1869            ENTRY OT$3(IP1)
1870      C...
1871            WRITE(6,99)TITLE
1872            IF(IP1.LE.1)RETURN
1873      C...
1874            WRITE(6,122)
1875          122 FORMAT(/' *** HOUSEHOLD CHARACTERISTICS:')
1876      C...
1877            IF=0
1878            5 IS=IF+1
1879            IF=IS+9
1880            IF(IF.GT.NHH)IF=NHH
1881      C...
1882            WRITE(6,115)((I),I=IS,IF)
1883            WRITE(6,118)(HHD(I,1),I=IS,IF)
1884            WRITE(6,1119)(HHD(I,9),I=IS,IF)
1885            WRITE(6,119)(HHD(I,10),I=IS,IF)
1886            IF(IP1.EQ.2)GOTO 36
```

PROGRAM:F10:SIMO2.FORT

```
      IF(IF.LT.NHH)GOTO 5
C...
  118 FORMAT('  "Y":input ',1X,10F6.0)
  119 FORMAT('  "Y":actual',1X,10F6.0)
 1119 FORMAT('  Share     ',1X,10F6.4)
   36 WRITE(6,123)TITLE
  123 FORMAT('1'/' *** PRICE, QUANTITY and "partial" UTIL
C...
      DO 6 I=1,NHH
      IH=I
C.D   IH=1
      WRITE(6,124)I
  124 FORMAT(/' (Household',I3,')')
C.D   READ(8'I)DWC
C.D   IF(NS.NE.0)READ(9'I)ISUB
C...
      IF=0
    7 IS=IF+1
      IF=IS+9
      IF(IF.GT.NMD1)IF=NMD1
      K=0
      DO 60 J=IS,IF
      K=K+1
      WR1(K)=DWC(3,I,J)/1000.
      WR2(K)=DWC(1,I,J)/10.
   60 WR3(K)=DWC(2,I,J)/1000.
C...
      WRITE(6,125)((J),J=IS,IF)
      WRITE(6,126)(WR1(J),J=1,K)
      WRITE(6,127)(WR2(J),J=1,K)
      WRITE(6,128)(WR3(J),J=1,K)
      IF(NS.NE.0)WRITE(6,147)(ISUB(IH,J),J=IS,IF)
      IF(IP1.EQ.2.AND.IF.GE.20)RETURN
      IF(IF.LT.NMD1)GOTO 7
C...
  125 FORMAT(/' DWELLING   ',10I6)
  126 FORMAT(/'  price     ',1X,10F6.3)
  127 FORMAT('  quantity  ',1X,10F6.1)
  128 FORMAT('  partial"U"',1X,10F6.4)
  139 FORMAT('  utility   ',1X,10F6.0)
  146 FORMAT('  "P"*"Q"   ',1X,10F6.1)
  147 FORMAT('  SUBSIDY'/'   :type',5X,10I6)
  148 FORMAT('   :AMOUNT   ',10F6.0)
    6 CONTINUE
      RETURN
C...
      ENTRY OT$4(IP1)
      WRITE(6,138)TITLE
  138 FORMAT('0'/' *** "TOTAL" UTILITY: ',6A4)
C...
      DO 20 I=1,NHH
```

```
      C.D   READ(8'I)DWC
            WRITE(6,124)I
      C...
            IF=0
         27 IS=IF+1
            IF=IS+9
            IF(IF.GT.NMD1)IF=NMD1
            K=0
            DO 61 J=IS,IF
            K=K+1
            IZ=DWD(2,J)
         61 WR1(K)=DWC(2,I,J) *ZW(IZ)
      C...
            WRITE(6,125)((J),J=IS,IF)
            WRITE(6,139)(WR1(J),J=1,K)
            IF(IP1.EQ.2.AND.IF.GE.20)RETURN
         32 IF(IF.LT.NMD1)GOTO 27
         20 CONTINUE
            RETURN
      C...
      C...
            ENTRY OT$4A(IP1)
      C... sorted stacks output
            WRITE(6,131)(UAHH(I),I=1,NHH)
        131 FORMAT(/' *** ORDERED HOUSEHOLD STACK'//
           * 8(1X,15I4/))
            WRITE(6,132)
        132 FORMAT(//' *** HOUSEHOLD''s "ordered" dwelling STAC
      C...
            DO 38 I=1,NHH
      C.D   READ(7'I)IODW
         38 WRITE(6,133)I,(IODW(I,J),J=1,NMD1)
        133 FORMAT(/' household',I4//8(1X,15I4/))
            RETURN
      C...
      C...
            ENTRY OT$5
      C... allocationed dwellings-households output
            WRITE(6,134)
        134 FORMAT('1'/' *** ALLOCATION of HOUSEHOLDS'/' existi
      C...
            IF=0
          9 IS=IF+1
            IF=IS+9
            IF(IF.GT.NMD)IF=NMD
            K=0
            DO 10 J=IS,IF
            K=K+1
            WR1(K)=0.
            WR2(K)=0.
            WR3(K)=0.
```

```
1989            WR4(K)=0.
1990            WR5(K)=0.
1991            WR6(K)=0.
1992            WR7(K)=0.
1993            IWR1(K)=0
1994            IWR2(K)=0
1995      C...
1996            DO 70 I=1,NHH
1997            IF(ISOL(I,1).EQ.J)GOTO 71
1998         70 CONTINUE
1999            GOTO 10
2000      C...
2001         71 IWR1(K)=I
2002            WR1(K)=HHD(I,2)
2003            WR2(K)=SOL(I,2)
2004            WR3(K)=SOL(I,3)
2005            WR4(K)=DWD(2,J)
2006            WR5(K)=SOL(I,1)*SOL(I,2)
2007            WR6(K)=SOL(I,1)
2008      C... CALCULATE SUBSIDY
2009            IF(NS.EQ.0)GOTO 10
2010            IWR2(K)=ISOL(I,2)
2011            WR7(K)=SOL(I,4)
2012         10 CONTINUE
2013      C...
2014            WRITE(6,125)((J),J=IS,IF)
2015            WRITE(6,109)(WR4(J),J=1,K)
2016            WRITE(6,115)(IWR1(J),J=1,K)
2017            WRITE(6,117)(WR1(J),J=1,K)
2018            WRITE(6,139)(WR3(J),J=1,K)
2019            WRITE(6,126)(WR6(J),J=1,K)
2020            WRITE(6,127)(WR2(J),J=1,K)
2021            WRITE(6,146)(WR5(J),J=1,K)
2022      C... OUTPUT SUBSIDY
2023            IF(NS.EQ.0)GOTO 44
2024            WRITE(6,147)(IWR2(J),J=1,K)
2025            WRITE(6,148)(WR7(J),J=1,K)
2026      C...
2027         44 IF(IF.LT.NMD)GOTO 9
2028      C...
2029      C... new dwellings allocated
2030         37 WRITE(6,135)
2031        135 FORMAT('0'/' *** ALLOCATION OF HOUSEHOLDS'/' NEW DW
2032      C...
2033            I=0
2034         11 IS=I+1
2035            J=0
2036            DO 12 I=IS,NHH
2037            IF(ISOL(I,1).NE.999)GOTO 12
2038            J=J+1
2039            IWR1(J)=I
```

```
2040            WR1(J)=HHD(I,2)
2041            WR2(J)=SOL(I,2)
2042            WR3(J)=SOL(I,1)*SOL(I,2)
2043            WR4(J)=SOL(I,3)
2044            WR5(J)=SOL(I,1)
2045      C...  SUBSIDY
2046            IF(NS.EQ.O)GOTO 41
2047            IWR2(J)=ISOL(I,2)
2048            WR6(J)=SOL(I,4)
2049         41 IF(J.EQ.10)GOTO 14
2050         12 CONTINUE
2051            IF(IF.EQ.O.AND.J.EQ.O)GOTO 13
2052            IF(J.NE.O)GOTO 14
2053            WRITE(6,144)
2054        144 FORMAT(/'  NO NEW DWELLINGS CREATED')
2055            GOTO 13
2056      C...
2057         14 IF=O
2058            WRITE(6,115)(IWR1(K),K=1,J)
2059            WRITE(6,117) (WR1(K),K=1,J)
2060            WRITE(6,139) (WR4(K),K=1,J)
2061            WRITE(6,126) (WR5(K),K=1,J)
2062            WRITE(6,127) (WR2(K),K=1,J)
2063            WRITE(6,146) (WR3(K),K=1,J)
2064      C...  OUTPUT SUBSIDY
2065            IF(NS.EQ.O)GOTO 42
2066            WRITE(6,147)(IWR2(K),K=1,J)
2067            WRITE(6,148)(WR6(K),K=1,J)
2068         42 IF(I.LT.NHH)GOTO 11
2069      C...
2070         13 CONTINUE
2071      C...
2072      C...  NO dwelling allocated to household
2073      C...
2074            DO 24 I=1,NHH
2075            IF(ISOL(I,1).LE.O)GOTO 15
2076         24 CONTINUE
2077            RETURN
2078      C...
2079         15 WRITE(6,136)
2080        136 FORMAT(//' ***ALLOCATION OF HOUSEHOLDS'/' NO DWELLI
2081      C...
2082            I=O
2083         17 IS=I+1
2084            J=O
2085            DO 18 I=IS,NHH
2086            IF(ISOL(I,1).GT.O)GOTO 18
2087            J=J+1
2088      C...
2089            IWR1(J)=I
2090            WR1(J)=HHD(I,2)
```

```
      WR2(J)=SOL(I,1)
      IWR2(J)=-ISOL(I,1)
C...
      IF(J.EQ.10)GOTO 19
   18 CONTINUE
      IF(J.EQ.0)GOTO 16
C...
   19 WRITE(6,115)(IWR1(K),K=1,J)
      WRITE(6,117) (WR1(K),K=1,J)
      WRITE(6,125)(IWR2(K),K=1,J)
      WRITE(6,137) (WR2(K),K=1,J)
C...
  137 FORMAT('  HIGHEST BID',10F6.3)
C...
      IF(I.LT.NHH)GOTO 17
C...
   16 CONTINUE
C...
      RETURN
C...
      ENTRY OT$10(SER)
C... output "expected" and actual externalities.
C...
      WRITE(6,140)
  140 FORMAT('0'/' *** "ACTUAL" AND "EXPECTED" EXTERNALIT
     */T15,'"ACTUAL"',T30,'"EXPECTED"'/
     */' zone',2(' relative   "#"   ')
     */3X, 2(4X,'wealth   units')/)
C...
      WRITE(6,141)(I,((EXT(L,K,I),K=1,2),L=1,2),I=1,NZ)
  141 FORMAT(20(I4,2(F9.4,F8.0,3X)/))
      WRITE(6,142) SER
  142 FORMAT('  Root-Mean-Squared-Error:',F10.4)
      RETURN
      END
C...
      SUBROUTINE OT$DT2
C...
      REAL*8 READ(8)
      INTEGER*4 IWR1(10),IWR2(10),IWR3(10)
      REAL*4 DAT(8),SOL(120,4),DU1(200)
      REAL*4 WR1(10),WR2(10),WR3(10),WR4(10),WR5(10),WR6(
      INTEGER*2 IODW(120,120),UAHH(120),ISUB(120,120)
     * ,NDW(120),ISOL(120,2)
      INTEGER*2 DWC(3,120,120)
      COMMON/BLK8/NDW,IODW,DWC,ISUB,UAHH,ISOL,SOL
      COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
C...
      EQUIVALENCE (IC1(4),NHH)
      ENTRY OT$7
```

PROGRAM:F10:SIMO2.FORT

```
C...
C... output of POLICY data set
C...
      WRITE(1,800)TITLE
  800 FORMAT('0000POLICY ',6A4)
C...
      DO 899 I=1,20
      IF(I.GE.1.AND.I.LE.8)WRITE(1,801)I,PAR(I)
      IF(I.GE.11.AND.I.LE.12)WRITE(1,801)I,PAR(I)
      IF(I.GE.16.AND.I.LE.17)WRITE(1,801)I,PAR(I)
      IF(I.EQ.13.OR.I.EQ.18)WRITE(1,802)I,PAR(I)
  899 IF(I.EQ.20)WRITE(1,801)I,PAR(I)
C...
  801 FORMAT('50',I2,F5.3)
  802 FORMAT('50',I2,F5.1)
C...
      DO 898 I=1,NHH
C...
      J=ISOL(I,1)
      WR1(1)=SOL(I,1)
      WR1(2)=SOL(I,2)
      WR1(3)=SOL(I,3)
      IF(J.GT.0)GOTO 893
      J=0
      WR1(1)=0.0
      WR1(2)=0.0
      WR1(3)=0.0
C...
  893 IWR1(1)=IFIX(HHD(I,1)+.1)
      IWR1(2)=IFIX(HHD(I,2)+.1)
      IWR1(3)=IFIX(HHD(I,3)+.1)
      IWR1(4)=IFIX(HHD(I,4)+.1)
C...
      IF(WR1(3).GE.1000)GOTO 889
      IF(WR1(2).LT.1000.)WRITE(1,803)
     * I,(IWR1(K),K=1,4),J,WR1(1),WR1(2),WR1(3)
      IF(WR1(2).GE.1000.)WRITE(1,804)
     * I,(IWR1(K),K=1,4),J,WR1(1),WR1(2),WR1(3)
       GOTO 898
C...
  889 IF(WR1(2).LT.1000.)WRITE(1,807)
     * I,(IWR1(K),K=1,4),J,WR1(1),WR1(2),WR1(3)
      IF(WR1(2).GE.1000.)WRITE(1,808)
     * I,(IWR1(K),K=1,4),J,WR1(1),WR1(2),WR1(3)
  803 FORMAT('1',I3,4I5,5X,I5,F5.3,F5.1,F5.1)
  804 FORMAT('1',I3,4I5,5X,I5,F5.3,F5.0,F5.1)
  807 FORMAT('1',I3,4I5,5X,I5,F5.3,F5.1,F5.0)
  808 FORMAT('1',I3,4I5,5X,I5,F5.3,F5.0,F5.0)
C...
  898 CONTINUE
C...
```

PROGRAM:F10:SIM02.FORT

```
2193            REWIND 4
2194      C...
2195            DO 810 I=1,1000
2196            READ(4,811,END=99)II,READ
2197          811 FORMAT(I2,8A8)
2198            IF(II.LT.20.OR.II.GE.50)GOTO 810
2199            WRITE(1,811)II,READ
2200          810 CONTINUE
2201      C...
2202           99 RETURN
2203            END
2204      C...
2205            SUBROUTINE CALBRT
2206      C... routine to calculate and print calibration statistic
2207            INTEGER*2 ISOL(120,2)
2208            REAL*4 ERR(15,2),CAL(15,20),SOL(120,4),TERR(15,2,2)
2209            COMMON/BLK8/DU1(36120),ISOL,SOL
2210            COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
2211           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20)
2212            COMMON/BLK22/ACT(12,20)
2213            EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
2214           * ,(IC1(5),NMD1),(IC1(7),IP1),(IC1(8),IOP)
2215           * ,(DU1(1),CAL(1,1)),(DU1(201),ERR(1,1))
2216      C...
2217            ENTRY OT$CAL
2218      C...
2219            WRITE(6,200)
2220            WRITE(6,102)
2221            NZC=NZ
2222            IF(IOP.EQ.2)NZC=2*NZ
2223      C...
2224            DO 20 IZ=1,NZC
2225           20 WRITE(6,110) IZ,(ACT(K,IZ),K=1,12)
2226          110 FORMAT(' zone',I3,F8.2,8F5.2,F7.0,F6.2,F6.1)
2227      C...
2228            RETURN
2229      C...
2230            ENTRY CL$20(IC)
2231      C...
2232            NZ1=NZ+1
2233            IF(IOP.EQ.2)NZ1=2*(NZ+1)
2234            NZC=NZ
2235            IF(IOP.EQ.2)NZC=2*NZ
2236      C...
2237            DO 1 J=1,20
2238            DO 1 I=1,15
2239          1 CAL(I,J)=0.
2240      C...
2241      C... aggregating data on existing dwellings.
2242      C...
2243            DO 2 J=1,NMD
```

```
C...
      IZ=DWD(2,J)
C...
      IT=DWD(3,J)
      IF(IOP.EQ.2)IZ=IZ+NZ*(IT-1)
      IZ1=NZ1
      IF(IOP.EQ.2)IZ1=NZC+IT
      DO 15 I=1,NHH
      IF(ISOL(I,1).EQ.J)GOTO 16
   15 CONTINUE
      GOTO 3
C...
C... p.q
   16 CAL( 1,IZ)=CAL( 1,IZ)+SOL(I,1)*SOL(I,2)
      CAL(1,IZ1)=CAL(1,IZ1)+SOL(I,1)*SOL(I,2)
C... income
      CAL(10,IZ)=CAL(10,IZ)+HHD(I,1)+HHD(I,4)
      CAL(10,IZ1)=CAL(10,IZ1)+HHD(I,1)+HHD(I,4)
C... utilisation
      CAL(11,IZ)=CAL(11,IZ)+1
      CAL(11,IZ1)=CAL(11,IZ1)+1
C... q
      CAL(12,IZ)=CAL(12,IZ)+SOL(I,2)
      CAL(12,IZ1)=CAL(12,IZ1)+SOL(I,2)
C...# hholds
      CAL(13,IZ)=CAL(13,IZ)+1
      CAL(13,IZ1)=CAL(13,IZ1)+1
C... # exist dwelling at start
    3 CAL(14,IZ)=CAL(14,IZ)+1
      CAL(14,IZ1)=CAL(14,IZ1)+1
C...
    2 CONTINUE
C...
C... aggregating by new
      DO 4 I=1,NHH
      IZ=NZ
      K=IFIX(ABS(HHD(I,2)))
      IT=1
      IF(K.GT.5)IT=2
      IF(IP1.GT.5 )IT=K
      IF(IOP.EQ.2)IZ=IZ+NZ*(IT-1)
      IZ1=NZ1
      IF(IOP.EQ.2)IZ1=NZC+IT
C...
      IF(ISOL(I,1).NE.999)GOTO 4
C... p.q
      CAL( 1,IZ)=CAL( 1,IZ)+SOL(I,1)*SOL(I,2)
      CAL(1,IZ1)=CAL(1,IZ1)+SOL(I,1)*SOL(I,2)
C... income
      CAL(10,IZ)=CAL(10,IZ)+HHD(I,1)
      CAL(10,IZ1)=CAL(10,IZ1)+HHD(I,1)
```

```
C... utilisation
      CAL(11,IZ)=CAL(11,IZ)+1
      CAL(11,IZ1)=CAL(11,IZ1)+1
      CAL(14,IZ)=CAL(14,IZ)+1
      CAL(14,IZ1)=CAL(14,IZ1)+1
C... q
      CAL(12,IZ)=CAL(12,IZ)+SOL(I,2)
      CAL(12,IZ1)=CAL(12,IZ1)+SOL(I,2)
C...# hholds
      CAL(13,IZ)=CAL(13,IZ)+1
      CAL(13,IZ1)=CAL(13,IZ1)+1
C...
    4 CONTINUE
C...
C... calculating zonal and total averages
C...
      DO 5 IZ=1,NZ1
C... p
      IF(CAL(12,IZ).NE.0)CAL(1,IZ)=CAL(1,IZ)/CAL(12,IZ)
C...
      IF(CAL(13,IZ).EQ.0)GOTO 7
C...
C...
C... income
      CAL(10,IZ)=CAL(10,IZ)/CAL(13,IZ)
C... q
      CAL(12,IZ)=CAL(12,IZ)/CAL(13,IZ)
C...
C... utilization
    7 IF(CAL(14,IZ).NE.0)CAL(11,IZ)=CAL(11,IZ)/CAL(14,IZ)
C...
    5 CONTINUE
C...
C... calculating calibration "mean error"
C...
      IF(IOP.EQ.2)GOTO 51
C...
      DO 9 K=1,12
    9 ERR(K,1)=0.
C...
      DO 10 IZ=1,NZC
      DO 10 K=1,12
   10 ERR(K,1)=ERR(K,1)+(CAL(K,IZ)-ACT(K,IZ))**2
C...
      IZ=NZ
      IF(ACT(1,NZ).EQ.0)IZ=NZ-1
C...
      DO 11 K=1,12
   11 ERR(K,1)=SQRT(ERR(K,1))/(2.*IZ)
C...
      DO 12 K=1,12
```

PROGRAM:F10:SIMO2.FORT

```
C...
      ERR(K,2)=0.
      IF(CAL(K,NZ1).EQ.0)GOTO 12
C...
      ERR(K,2)=ERR(K,1)/CAL(K,NZ1)
   12 CONTINUE
C...
      SER=0.
      CC=0.
C...
      DO 14 K=1,12
      IF(K.GE.2.AND.K.LE.9)GOTO 14
      IF(ERR(K,2).EQ.0)GOTO 14
      SER=SER+ERR(K,2)
      CC=CC+1.
   14 CONTINUE
C...
      SER=SER/CC
C...
      GOTO 60
C...
C... UNDER OPTION 2
   51 DO 52 IT=1,2
      DO 52 K=1,12
   52 TERR(K,1,IT)=0.
C...
      DO 53 IZ=1,NZC
      DO 53 K=1,12
      IT=1
      IF(IZ.GT.NZ)IT=2
   53 TERR(K,1,IT)=TERR(K,1,IT)+(CAL(K,IZ)-ACT(K,IZ))**2
C...
      IZ=NZ
      IF(ACT(1,NZ).EQ.0)IZ=NZ-1
      DO 54 IT=1,2
      DO 54  K=1,12
   54 TERR(K,1,IT)=SQRT(TERR(K,1,IT))/(2.*IZ)
C...
      DO 55 IT=1,2
      SER=0.
      CC=0.
      IZ1=2*NZ+IT
C...
      DO 56 K=1,12
      TERR(K,2,IT)=0.
   56 IF(CAL(K,IZ1).NE.0.)TERR(K,2,IT)=TERR(K,1,IT)/CAL(K
C...
      DO 57 K=1,12
      IF(K.GE.2.AND.K.LE.9)GOTO 57
      IF(TERR(K,2,IT).EQ.0.)GOTO 57
      SER=SER+TERR(K,2,IT)
```

```
2397            CC=CC+1
2398         57 CONTINUE
2399            TSER(IT)=0.
2400      C...
2401         55 IF(CC.NE.1.)TSER(IT)=SER/CC
2402      C...
2403      C... output of calibration test
2404      C...
2405         60 WRITE(6,100)TITLE
2406        200 FORMAT(/' *** "70  " CALIBRATION DATA:'/)
2407        100 FORMAT('1*** CALIBRATION output: ',6A4)
2408            WRITE(6,101)(PAR(I),I=1,6)
2409            WRITE(6,102)
2410      C...
2411        101 FORMAT(/' *** AVERAGE "actual" and "solution" ZONAL
2412           * ' CHARACTERISTICS'
2413           *//' : EXT1',F6.2,' :EXT2',F6.2,' :B1R',F6.2,' :B2R'
2414           * ,F6.2,' :B20',F6.2)
2415        102 FORMAT(/T12,'price',       T57,'income  usage  "Q"'
2416      C...
2417            WRITE(6,103)(IZ,ACT(1,IZ),(ACT(K,IZ),K=10,12),CAL(1
2418           * ,(CAL(K,IZ),K=10,12),IZ=1,NZC)
2419      C...
2420        103 FORMAT(' (zone',I3,')'/'  actual',F6.2,40X,F8.0,F6.
2421           *                       /'  calc. ',F6.2,40X,F8.0,F6.
2422      C...
2423            WRITE(6,104)
2424        104 FORMAT(/' *** CALIBRATION ERRORS')
2425      C...
2426            WRITE(6,102)
2427            IF(IOP.EQ.1)WRITE(6,105)(ERR(1,L),(ERR(K,L),K=10,12
2428            IF(IOP.EQ.2)WRITE(6,105)((TERR(1,L,IT),(TERR(K,L,IT
2429           * ,L=1,2),TSER(IT),IT=1,2)
2430      C...
2431        105 FORMAT('  R.M.S.E. ',F5.4,40X,F8.1,F6.3,F6.1
2432           *      //'  R.M.S.E. ',F5.4,40X,F7.4,F6.3,F6.3
2433           *       /' (weighted)'
2434           *      //10X,'MEAN ERRORS',F10.4)
2435      C...
2436            RETURN
2437            END
2438      C...
2439      C... THIS ROUTINE SOLVES FOR P WHEN HOUSEHOLD CONSTRAINED
2440      C...
2441            SUBROUTINE QCON
2442            COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
2443           * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
2444            COMMON/PARA/AB(15,4,10),SPP(10),DPP(15)
2445      C...
2446            EQUIVALENCE (IC1(1),NZ),(IC1(7),IP1)
2447      C...
```

PROGRAM:F10:SIMO2.FORT

```
      ENTRY PQMQI(K,SHARE,AY,QM,PB,IT)
      UHS=O.
C...
      UX=O.
      UA=O.
      RETURN
C...
      ENTRY PQNQ(IP,IS1,L,PX,QX,U,SUBA,PH,QH,UH)
C...
      IF(IP1.EQ.1O)WRITE(6,1999)PH,QH,UH
C...
      U=-1.
      QX=POL(IT,L)
      IF(QX.LT.QM)GOTO 9
      IF(QH.GE.QX)RETURN
C...
      PX=PB
      BY=AY
      XSHARE=SHARE+DPP(14)*ALOG(PX/DPP(13))
C...
      GOTO(1,1,3,4,5,6,3),IS1
C...
C... INCOME AND IN-KIND SUBSIDY
    1 DO 21 N=1,5O
      Y=PX*QX/XSHARE
      SUBA=Y-AY
C...
      IF(IS1.EQ.2.AND.SUBA.GT.PX*QX)SUBA=PX*QX
      IF(IP1.EQ.1O)WRITE(6,999)AY,SUBA,XSHARE,Y,BY
  999 FORMAT(' -',5F12.5)
      IF(SUBA.LT.O.)GOTO 41
      Y=AY+SUBA
C...
      IF(ABS(Y-BY).LT.O.O5)GOTO 1O
C...
      BY=Y
      CALL PARA1(K,Y,XSHARE,DPP)
C...
      XSHARE=XSHARE+DPP(14)*ALOG(PX/DPP(13))
C...
   21 CONTINUE
      GOTO 1O
C...
   41 U=-1.
      SUBA=O.
      GOTO 9
C...
C... DIRECT CONSTRAINED
C... SOLVE FOR U=UH AT QX
    3 IF(UH.EQ.O.)RETURN
      CALL PQDCI(1,K,UH,QH,PX,QX,AY,NZ)
```

PROGRAM:F10:SIM02.FORT

```
2499            PA=((AY/QX)-0.01)*PX/DPP(13)
2500            IF(PA.GT.PX)PA=PX
2501            CALL PQDC(PA,PJ,Y,SUBA,IS1,&71)
2502      C...
2503            IF(PJ.EQ.0.)RETURN
2504      C...
2505            U=UH+0.00001
2506            GOTO 9
2507      C...
2508         71 SUBA=(PX-PJ)*QX
2509            Y=AY+SUBA
2510            CALL PARA1(K,Y,XSHARE,DPP)
2511            PP=PJ*DPP(13)/PX
2512            SUBA=SUBA+(PX-PP)*(QX-QH)
2513            Y=AY+SUBA
2514            CALL PARA1(K,Y,XSHARE,DPP)
2515            CALL CL$UT(U,UHS,UA,PP,QX,Y,NZ)
2516            IF(U.LE.0.)  U=-1.
2517            GOTO 9
2518      C...
2519      C... DIRECT QUANTITY
2520          4 IF(QH.EQ.0.)RETURN
2521            SUBA=(QX-QH)*PB
2522            Y=AY+SUBA
2523            GOTO 10
2524      C...
2525      C... DIRECT EXPENDITURE
2526          5 IF(QH.EQ.0.)RETURN
2527            SUBA=(QX-QH)*PB
2528            Y=AY+SUBA
2529            GOTO 10
2530      C...
2531      C... DIRECT PRICE SUBSIDY
2532          6 DO 26 N=1,50
2533            A=(XSHARE*AY)/(PX*QX)
2534            PJ=A*PX
2535            SUBA=(1.-A)*PX*QX
2536            Y=AY+SUBA
2537      C...
2538            IF(ABS(Y-BY).LT.0.05)GOTO 10
2539            IF(IP1.EQ.10)WRITE(6,999)A,SUBA,XSHARE,Y,BY
2540            IF(A.LT.0..OR.A.GE.1.)GOTO 27
2541      C...
2542            BY=Y
2543            CALL PARA1(K,Y,XSHARE,DPP)
2544      C...
2545            XSHARE=XSHARE+DPP(14)*ALOG(PJ/DPP(13))
2546      C...
2547            PP=PJ*DPP(13)/PB
2548            CALL CL$UT(U,UHS,UA,PP,QX,Y,NZ)
2549         26 CONTINUE
```

```
      GOTO 10
C...
   27 SUBA=0.
      U=-1.
      GOTO 9
C...
   10 CALL CL$UT(U,UHS,UA,DPP(13),QX,Y,NZ)
C...
    9 IF(IP1.EQ.10)WRITE(6,1000)IP,PX,QX,Y,U,UHS,UA,XSHAR
C...
      IF(U.LE.0.)QX=0.
      RETURN
C...
C... PRICE, QUANTITY AND UTILITY- EXISTING DWELLINGS
C...
      ENTRY PQEQ(IP,IS1,L,J,PX,QX,U,SUBA,PH,QH,UH)
C...
      IF(IP1.EQ.10)WRITE(6,1999)PH,QH,UH
C...
      U=-1.
      QX=POL(IT,L)
      IF(QH.GE.QX)RETURN
C...
      QI=DWD(1,J)
      IZ=IFIX(DWD(2,J))
C...
      PM=SPP(3)
      B1=SPP(5)
      B2=SPP(6)
      OC=SPP(7)
C...
C... SOLVE FOR PX FOR QX ON SUPPLY
C...
      IF(QX.LE.B1*QI)RETURN
      PX=((QX/QI-B1)*PM/B2) +OC
C...
      BY=AY
      XSHARE=SHARE+DPP(14)*ALOG(PX/DPP(13))
C...
      GOTO(11,11,13,14,15,16,13),IS1
C...
C... INCOME AND INKIND SUBSIDY
C...
   11 DO 31 N=1,50
      D=XSHARE/PX
      Y=QX/D
      SUBA=Y-AY
C...
      IF(IS1.EQ.2.AND.SUBA.GT.PX*QX)SUBA=PX*QX
      IF(SUBA.LT.0.)GOTO 42
      Y=AY+SUBA
```

PROGRAM:F10:SIMO2.FORT

```
      56 B=0.5*(C+B)
C...
C... HAVE COMPLETED COMPUTATION FOR NEW ITERATE B
C...
      57 CALL FQ(FB,B,Y,SUBA)
         IF(FB.EQ.0.0)GOTO 59
         IF(FB.EQ.-1.E5)GOTO 62
         KOUNT=KOUNT+1
         IF(SIGN(1.0,FB).NE.SIGN(1.0,FC))GOTO 51
         C=A
         FC=FA
         GOTO 51
C...
C... FINISHED SET IFLAG
C...
      58 IF(SIGN(1.0,FB).EQ.SIGN(1.0,FC))GOTO 61
         IF(ABS(FB).GT.FX)GOTO 60
         PJ=B
         RETURN
      59 PJ=B
         RETURN
      60 PJ=B
         RETURN
      61 PJ=0.
         IF(ISO.EQ.3)RETURN
         PJ=B
         RETURN 1
      62 PJ=0.
         RETURN
C...
         END
C... ROUTINE CALCULATES THE SUBSIDY PROFILE,AMOUNTS AND I
         SUBROUTINE POLICY
         INTEGER*4 IWR1(10)
         REAL*4 MEANS,MEDNS,DIFF(10,5),DIFF1(7),MER(5)
        * ,SUBP(2,4,13),YT(13),WR1(10),WR2(10),MY
        * ,SKEY(120),SOL(120,4)
         INTEGER*2 SAHH(120),UAHH(120),ISOL(120,2)
         COMMON/BLK8/DU1(36000),SAHH,UAHH,ISOL,SOL
         COMMON/BLK21/TITLE(6),HHD(120,10),HHT(10,6),DWD(3,1
        * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20),IPOL
         EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
        * ,(IC1(5),NMD1),(IC1(7),IP1),(IC1(10),NS)
        * ,(IC1(10),NS)
        * ,(DIFF1(1),PART),(DIFF1(2),MEANS),(DIFF1(4),MEDNS)
        * ,(DIFF1(5),BNEW),(DIFF1(6),SNEW)
C...
         EQUIVALENCE (DU1(1),SUBP(1,1,1),SKEY(1),DIFF(1,1))
        * ,(DU1(51),DIFF1(1)),(DU1(61),MER(1))
        * ,(DU1(101),WR1(1)),(DU1(111),WR2(1)),(DU1(121),IWR
C...
```

```
2754            FA=FB
2755            B=C
2756            FB=FC
2757            C=A
2758            FC=FA
2759         52 CMB=0.5*(C-B)
2760            ACMB=ABS(CMB)
2761      C...
2762      C... TEST STOPPING CRITERION AND FUNCTION COUNT
2763      C...
2764            IF(ACMB.LE.TOL)GOTO 58
2765            IF(KOUNT.GE.100)GOTO 62
2766      C...
2767      C... CALCULATE NEW ITERATE IMPLICITLY AS B+P/Q
2768      C... WHERE P.GE.0.  THE IMPLICIT FORM IS USED TO
2769      C... PREVENT OVERFLOW.
2770      C...
2771            P=(B-A)*FB
2772            Q=FA-FB
2773            IF(P.GE.0.0)GOTO 53
2774            P=-P
2775            Q=-Q
2776      C...
2777      C... UPDATE A. CHECK IF REDUCTION IN THE SIZE OF BRACKETI
2778      C... INTERVAL IS SATISFACTORY. IF NOT, BISECT UNTIL IT IS
2779      C...
2780         53 A=B
2781            FA=FB
2782            IC=IC+1
2783            IF(IC.LT.4)GOTO 54
2784            IF(8.0*ACMB.GE.ACBS)GOTO 56
2785            IC=0
2786            ACBS=ACMB
2787      C...
2788      C... TEST FOR TOO SMALL A CHANGE
2789      C...
2790         54 IF(P.GT.ABS(Q)*TOL)GOTO 55
2791      C...
2792      C... INCREMENT BY TOLERANCE
2793      C...
2794            B=B+SIGN(TOL,CMB)
2795            GOTO 57
2796      C...
2797      C... ROOT OUGH TO BE BETWEEN B AND (C+B)/2
2798      C...
2799         55 IF(P.GE.CMB*Q)GOTO 56
2800      C...
2801      C... USE SECANT RULE
2802            B=B+P/Q
2803            GOTO 57
2804      C...
```

PROGRAM:F10:SIMO2.FORT

```
      C...
            ENTRY FQ(F,PJ,Y,SUBA)
      C...
            SUBA=(PX-PJ)*QX
            Y=AY+SUBA
      C...
            CALL PARA1(K,Y,XSHARE,DPP)
      C...
            PP=PJ
            IF(IO.NE.1)GOTO 1
            PP=PJ*DPP(13)/PX
            SUBA=SUBA+(PX-PP)*(QX-QH)
            Y=AY+SUBA
            CALL PARA1(K,Y,XSHARE,DPP)
      C...
          1 CALL CL$UT(UX,UHS,UA,PP,QX,Y,IZ)
      C...
            F=UH-UX
      C...
            IF(IP1.EQ.10)WRITE(6,1000)  UH,UX,PJ,PX,QX,F
       1000 FORMAT(2F20.4,2F10.4,F10.2,F20.5)
      C...
            RETURN
            END
      C...
      C...
      C... routine to match utilities
      C...
            SUBROUTINE CALC4
      C...
            DATA TOL/0.0001/
      C...
            ENTRY PQDC(PA,PJ,Y,SUBA,ISO,*)
      C...
            B=PA
            C=0.1
      C...
            IC=0
            ACBS=ABS(B-C)
            A=C
      C...
            CALL FQ(FA,A,Y,SUBA)
            CALL FQ(FB,B,Y,SUBA)
            FC=FA
            KOUNT=2
            FX=AMAX1(ABS(FB),ABS(FC))
         51 IF(ABS(FC).GE.ABS(FB))GOTO 52
      C...
      C... INTERCHANGE B AND C SO THAT ABS(F(B).LE.ABS(F(C))
      C...
            A=B
```

PROGRAM:F10:SIMO2.FORT

```
      Y=AY+SUBA
      GOTO 20
C...
C... PRICE SUBSIDY
   16 DO 36 N=1,50
      A=(XSHARE*AY)/(PX*QX)
      PJ=A*PX
      SUBA=(1.-A)*PX*QX
      Y=AY+SUBA
C...
      IF(IP1.EQ.10)WRITE(6,999)A,SUBA,XSHARE,Y,BY
      IF(A.LT.0..OR.A.GE.1.)GOTO 37
      IF(ABS(Y-BY).LT.0.05)GOTO 20
C...
      BY=Y
      CALL PARA1(K,Y,XSHARE,DPP)
C...
      XSHARE=XSHARE+DPP(14)*ALOG(PJ/DPP(13))
C...
      CALL CL$UT(U,UHS,UA,PX,QX,AY,IZ)
   36 CONTINUE
      GOTO 20
C...
   37 SUBA=0.
      U=-1.
      GOTO 19
C...
   20 CALL CL$UT(U,UHS,UA,PX,QX,Y,IZ)
C...
   19 IF(IP1.EQ.10)WRITE(6,1000)IP,PX,QX,Y,U,UHS,UA,XSHAR
C...
      IF(U.LE.0.)QX=0.
      RETURN
C...
 1000 FORMAT(' sub:',I2,2F8.2,F8.0,3F8.4,2F8.4)
 1999 FORMAT(' C:',3F12.4)
C...
      END
C...
C...
C... SUBROUTINE TO RETURN DIFFERENCE IN UTILITIES
C...
      SUBROUTINE CALC5
C...
      COMMON/BLK21/D21(1798),IC1(20)
      COMMON/PARA/DDP(610),DPP(15)
C...
      EQUIVALENCE (IC1(7),IP1)
C...
      ENTRY PQDCI(IO,K,UH,QH,PX,QX,AY,IZ)
      RETURN
```

PROGRAM:F10:SIMO2.FORT

```
C...
      IF(ABS(Y-BY).LT.0.05)GOTO 20
C...
      BY=Y
      CALL PARA1(K,Y,XSHARE,DPP)
C...
      XSHARE=XSHARE+DPP(14)*ALOG(PX/DPP(13))
C...
   31 CONTINUE
      GOTO 20
C...
   42 U=-1.
      SUBA=0.
      GOTO 19
C...
C... DIRECT CONSTRAINED
C... SOLVE FOR U=UH AT QX
   13 IF(UH.EQ.0.)RETURN
      CALL PQDCI(2,K,UH,QH,PX,QX,AY,IZ)
      PA=(AY/QX)-0.01
      IF(PA.GT.PX)PA=PX
      CALL PQDC(PA,PJ,Y,SUBA,IS1,&72)
C...
      IF(PJ.EQ.0.)RETURN
C...
      U=UH+ 0.00001
      GOTO 19
C...
   72 SUBA=(PX-PJ)*QX
      Y=AY+SUBA
      CALL PARA1(K,Y,XSHARE,DPP)
      CALL CL$UT(U,UHS,UA,PJ,QX,Y,IZ)
      IF(U.LE.0.)  U=-1.
      GOTO 19
C...
C... DIRECT QUANTITY
   14 IF(QH.EQ.0.)RETURN
C...
      CALL PARA1(K,AY,XSHARE,DPP)
C...
      XSHARE=XSHARE+DPP(14)*ALOG(PX/DPP(13))
C..
      QXH=AY*XSHARE/PX
C...
      SUBA=(QX-QXH)*PX
      Y=AY+SUBA
      GOTO 20
C...
C... DIRECT EXPENDITURE
   15 IF(QH.EQ.0.)RETURN
      SUBA=(QX*PX-QH*PH)
```

```
      IF(IS.NE.50.AND.IS.NE.100.AND.IS.NE.150)GOTO 915
      IF(IS.EQ.NHH)GOTO 915
C...
      GOTO(8,9),IO
    8 WRITE(6,99)TITLE
      CALL OT$ST(NS)
      WRITE(6,904)
      GOTO 915
C...
    9 WRITE(6,110)TITLE
C...
  915 CONTINUE
C...
      IF(IO.EQ.1)WRITE(6,906)WR2(5),(WR2(K),K=2,4)
      IF(IO.EQ.2)WRITE(6,906)WR2(5),(WR2(K),K=2,3)
C...
  904 FORMAT(/T5,'HHOLD',T16,'INCOME',T36,'DWELLING',T59,
     *'  #  TYPE   gross      net   #   price  quantity
     * 'AMOUNT')
  905 FORMAT(I4,F4.0,2F9.0,I4,F8.3,F8.1,F8.1,I4,F8.1)
  906 FORMAT(T2,66('-')/T17,F9.0,T39,2F8.1,T59,F8.1)
C...
      IF(IO.EQ.2)RETURN
C...
      WRITE(6,101)TITLE
      CALL OT$ST(NS)
  101 FORMAT('1*** SUBSIDY IMPACT: ',6A4/)
C...
      IF(BNEW.EQ.0.)RETURN
C...
      WRITE(6,102)DIFF1
  102 FORMAT(/'     Participants:',T30,F5.0,T40,'Subsidy:
     * F8.1/T18,': percent',T30,F5.2,'%',T47,': Median',T
     *//' New Construction: Base',T30,F5.0/T18,': Subsidi
     */T18,': % change',T28,F7.2,'%')
C...
      WRITE(6,103)((DIFF(I,J),J=1,5),I=1,7),(MER(I),I=1,4
      WRITE(6,104)((DIFF(I,J),J=2,4),I=8,9),DIFF(10,1)
C...
  103 FORMAT(/T22,'C.M.A.',T42,'RECIPIENTS',T62,'NON-'
     * /T35,'all  low "Y"   high "Y"  RECIPIENTS'
     *//' Number',T17,5F10.0, //' Changes'/'   Prices',T1
     * /'   quantity',T19,5(F9.2,'%')/'   expenditure',T1
     *//' Incomes'/'   Lowest',T19,5F10.0  /'   Highest',
     *//' Changes in'/' Purchasing Power',T19,5(F9.2,'%')
     *//' Efficiency Ratio',T19,4F10.3)
C...
  104 FORMAT(/' Earmarking Ratio',T28,3F10.2//' %Subsidy
     * ,3(F9.2,'%')//' participation'/8X,'rate',T18,F10.2
     * '  note:  NON-RECIPIENTS are lowest-income group'/
C...
```

PROGRAM:F10:SIM02.FORT

```
3060         99 FORMAT('1*** SUBSIDY AMOUNT: ',6A4/)
3061            CALL OT$ST(NS)
3062      C...
3063            IF(PART.EQ.0.0)GOTO 71
3064      C...
3065            WRITE(6,904)
3066      C...
3067            GOTO 199
3068      C...
3069            ENTRY OT$BS
3070      C...
3071            IO=2
3072            WRITE(6,110)TITLE
3073        110 FORMAT('1*** BASE AMOUNT: ',6A4
3074           * //T5,'HHOLD',T16,'INCOME',T36,'DWELLING'
3075           * /'  #  TYPE  gross      net    #   price  quantity
3076      C...
3077        199 DO 940 I=1,5
3078        940 WR2(I)=0.
3079      C...
3080            DO 915 IS=1,NHH
3081      C...
3082            I=UAHH(IS)
3083            AY=HHD(I,10)
3084            GY=AY+HHD(I,4)/12.
3085            KT=IFIX(ABS(HHD(I,2)))
3086      C...
3087            IF(ISOL(I,1).LE.0)GOTO 910
3088            J=ISOL(I,1)
3089      C...
3090            WR1(1)=SOL(I,1)
3091            WR1(2)=SOL(I,2)
3092            WR1(3)=WR1(1)*WR1(2)
3093            IWR1(1)=ISOL(I,2)
3094            WR1(4)=SOL(I,4)
3095            GOTO 930
3096      C... NO DWELLING
3097        910 DO 911 K=1,4
3098            IWR1(K)=0
3099        911 WR1(K)=0.
3100            J=0
3101            GOTO 930
3102      C...
3103        930 DO 931 K=1,4
3104        931 WR2(K)=WR2(K)+WR1(K)
3105            WR2(5)=WR2(5)+AY
3106      C...
3107            IF(IO.EQ.1)WRITE(6,905)I,HHD(I,2),GY,AY,J,(WR1(K),K
3108           * ,WR1(4)
3109            IF(IO.EQ.2)WRITE(6,905)I,HHD(I,2),GY,AY,J,(WR1(K),K
3110      C...
```

```
3009          38 DIFF(2,L)=DIFF(2,L)+SOL(I,1)
3010             DIFF(3,L)=DIFF(3,L)+SOL(I,2)
3011             DIFF(4,L)=DIFF(4,L)+SOL(I,1)*SOL(I,2)
3012       C...
3013          34 TPB=TPB+HHD(I,7)
3014             TQB=TQB+HHD(I,8)
3015             TEB=TEB+HHD(I,7)*HHD(I,8)
3016             TS=TS+SOL(I,4)
3017       C...
3018             AY=HHD(I,10)
3019             GY=AY+HHD(I,4)/12.
3020       C...
3021             IF(AY.LT.DIFF(5,L))DIFF(5,L)=AY
3022             IF(AY.GT.DIFF(6,L))DIFF(6,L)=AY
3023       C...
3024             TI=TI+AY
3025             DIFF(7,L)=DIFF(7,L)+AY+SOL(I,4)
3026       C...
3027             DO 950 N=1,NS
3028             IF(AY.GT.POL(6,N))GOTO 950
3029             DIFF(10,L)=DIFF(10,L)+1.
3030             GOTO 33
3031        950 CONTINUE
3032       C...
3033          33 CONTINUE
3034       C...
3035       C... participation
3036             IF(L.EQ.1.AND.DIFF(10,1).NE.0.)DIFF(10,1)=PART*100.
3037       C...
3038             IF(MEANS*PART.NE.0.)DIFF(9,L)=(DIFF(7,L)-TI)*100./(
3039       C...
3040             IF(DIFF(7,L)-TI.NE.0.0)
3041            * DIFF(8,L)=(DIFF(4,L)-TEB)*100./(DIFF(7,L)-TI)
3042       C... %increase purchasing power
3043             IF(TI.NE.0.)DIFF(7,L)=(DIFF(7,L)-TI)*100./TI
3044       C... changes
3045             IF(TPB.NE.0.)DIFF(2,L)=(DIFF(2,L)-TPB)*100./TPB
3046             IF(TQB.NE.0.)DIFF(3,L)=(DIFF(3,L)-TQB)*100./TQB
3047             IF(TEB.NE.0.)DIFF(4,L)=(DIFF(4,L)-TEB)*100./TEB
3048       C...
3049       C... market efficiency ratio
3050             IF(DIFF(1,L).NE.0.)TS=TS/DIFF(1,L)
3051             IF(TS.NE.0.0)MER(L)=DIFF(3,L)/TS
3052       C...
3053          40 CONTINUE
3054             RETURN
3055       C...
3056             ENTRY OT$SB
3057       C...
3058             IO=1
3059             WRITE(6,99)TITLE
```

PROGRAM:F10:SIMO2.FORT

```
2958            UNSUB=DIFF(1,1)-DIFF(1,2)
2959      C...
2960            IF(UNSUB.LT.10)DIFF(1,5)=UNSUB
2961      C...
2962            DO 40 L=1,5
2963      C...
2964            TPB=0.
2965            TQB=0.
2966            TEB=0.
2967            TS=0.0
2968            TI =0.
2969            IF=0
2970      C...
2971            I1=IFIX(DIFF(1,L)+.01)
2972            IF(I1.EQ.0)GOTO 40
2973      C...
2974            DO 33 K=1,I1
2975      C...
2976            GOTO(50,52,53,54,53),L
2977      C...
2978         50 I=K
2979            GOTO 51
2980      C...
2981      C... all participants
2982         52 IS=IF+1
2983            DO 62 IF=IS,NHH
2984            I=IF
2985            IF(SOL(I,4).NE.0.0)GO TO 51
2986         62 CONTINUE
2987            GO TO 51
2988      C...
2989      C... high income
2990         54 IS=IF+1
2991            DO 63 IF=IS,NHH
2992            I=UAHH(IF)
2993            IF(SOL(I,4).NE.0.0)GOTO 51
2994         63 CONTINUE
2995            GOTO 51
2996      C...
2997      C... low income - both
2998         53 IS=IF+1
2999            DO 64 IF=IS,NHH
3000            IK=NHH+1-IF
3001            I=UAHH(IK)
3002            IF(L.EQ.3.AND.SOL(I,4).NE.0.0)GOTO 51
3003            IF(L.EQ.5.AND.SOL(I,4).EQ.0.0)GOTO 51
3004         64 CONTINUE
3005      C...
3006      C... find dwelling
3007         51 IF(ISOL(I,1).LE.0)GOTO 34
3008      C...
```

```
 2907          3 SAHH(K)=IS
 2908      C...
 2909      C...
 2910            DO 20 I=1,10
 2911            DO 20 J=1,5
 2912         20 DIFF(I,J)=0.
 2913      C...
 2914            DO 21 I=1,7
 2915         21 DIFF1(I)=0.
 2916      C...
 2917            DO 22 I=1,5
 2918         22 MER(I)=0.0
 2919      C...
 2920      C... calculating DIFF1 values
 2921            DO 30 I=1,NHH
 2922            IF(SOL(I,4).GT.0.0)PART=PART+1
 2923            MEANS=MEANS+SOL(I,4)
 2924      C...
 2925            IF(HHD(I,6).EQ.999.)BNEW=BNEW+1.
 2926            IF(ISOL(I,1).EQ.999) SNEW=SNEW+1
 2927      C...
 2928         30 CONTINUE
 2929      C...
 2930            IF(PART.EQ.0.OR.BNEW.EQ.0.0)RETURN
 2931      C...
 2932            DO 23 J=1,5
 2933         23 DIFF(5,J)=1E10
 2934      C...
 2935            MEANS=MEANS/PART
 2936            DIFF1(3)=PART*100./FLOAT(NHH)
 2937      C...
 2938            I=IFIX(PART+2.1)/2.
 2939            J=IFIX(PART+1.1)/2.
 2940      C...
 2941            I1=SAHH(I)
 2942            J1=SAHH(J)
 2943            MEDNS=(SOL(I1,4)+SOL(J1,4))/2.
 2944      C...
 2945            IF(BNEW.NE.0.0)DIFF1(7)=(SNEW-BNEW)*100./BNEW
 2946      C...
 2947      C... calculating DIFF values
 2948      C... numbers
 2949            DIFF(1,1)=FLOAT(NHH)
 2950            DIFF(1,2)=PART
 2951            DO 31 I=3,5
 2952         31 DIFF(1,I)=10.
 2953      C...
 2954            DO 32 I=3,4
 2955            IF(PART.LT.20.)DIFF(1,I)=FLOAT(IFIX(PART/2.))
 2956         32 IF(DIFF(1,I).EQ.0.)DIFF(1,I)=1.
 2957      C...
```

```
      DATA YT/50.,100.,150.,200.,250.,300.,350.,400.,450.
     * 2000.,3000./
C...
      ENTRY CL$SB1(KJ)
C...
      IF(IP1.EQ.10.AND.KJ.EQ.2)GOTO 999
C...
C... calculating subsidy by h'hold
C...
      K=IPOL(1,1)
      DO 10 I=1,NHH
      SOL(I,4)=0.
C...
      IF(K.GE.20)GOTO 7
C...
      L=ISOL(I,2)/10
      J=ISOL(I,1)
      IF(J.LE.0.OR.L.EQ.0)GOTO 10
C...
      IP=ISOL(I,2)-10*L
      IS=IPOL(2,L)
      AY=HHD(I,1)/12.
      KT=IFIX(ABS(HHD(I,2)))
      IF(HHD(I,1).GT.HHT(KT,1))AY=AY*(1.-PPP)
C...
      SOL(I,4)=SUB(IP,IS,L,AY,SOL(I,1),SOL(I,2),J)
C...
      GOTO 10
C...
    7 SOL(I,4)=ISOL(I,2)/10.
      IF(SOL(I,4).GT.0.001)ISOL(I,2)=20+IPOL(2,1)
C...
   10 CONTINUE
C...
      IF(KJ.EQ.1)RETURN
C...
C... SORTING HOUSEHOLDS BY SUBSIDY AMOUNT
  999 DO 1 I=1,NHH
    1 SKEY(I)=SOL(I,4)
C...
      DO 3 K=1,NHH
      IS=0
      X=-9.E10
C...
      DO 2 N=1,NHH
      IF(SKEY(N).LE.X)GOTO 2
      X=SKEY(N)
      IS=N
    2 CONTINUE
C...
      SKEY(IS)=-9.E10
```

PROGRAM:F10:SIMO2.FORT

```
 3468          31 CONTINUE
 3469      C
 3470        101 FORMAT(T2,A1,A8,T11,'|',120A1)
 3471        102 FORMAT(T3,A8,T11,'|',120A1)
 3472        103 FORMAT(1H+,T12,120A1)
 3473        104 FORMAT(T12,120A1)
 3474      C
 3475      C...."BOTTOM AXIS"
 3476            IF(INPT.NE.NF)WRITE(P,104)(GRAP1(NF+1,MC),MC=1,NWID
 3477      C
 3478      C...."CO-ORDINATES"
 3479            IF(IFREQH.EQ.1)WRITE(P,111)(HCORD(J),J=1,NCORDS)
 3480            IF(IFREQH.EQ.2)WRITE(P,112)(HCORD(J),J=1,NCORDS)
 3481            IF(IFREQH.EQ.3)WRITE(P,113)(HCORD(J),J=1,NCORDS)
 3482            IF(IFREQH.EQ.4)WRITE(P,114)(HCORD(J),J=1,NCORDS)
 3483      C
 3484        111 FORMAT(T12,24I5)
 3485        112 FORMAT(T11,12I10)
 3486        113 FORMAT(T12,8I15)
 3487        114 FORMAT(T11,6I20)
 3488      C
 3489            NC=NO*2
 3490            IF(NC.GT.10)NC=10
 3491      C
 3492      C...."TITLES"
 3493            IF(NWIDE.LE.30)WRITE(P,105)(HEAD(J,2),J=1,16),(GTIT
 3494        105 FORMAT(T18,16A1//T17,4A8/T2,6A8)
 3495            IF(NWIDE.EQ.60)WRITE(P,106)(HEAD(J,2),J=1,16),(GTIT
 3496        106 FORMAT(T54,16A1//T3,10A8)
 3497            IF(NWIDE.GT.60)WRITE(P,107)(HEAD(J,2),J=1,16),(GTIT
 3498        107 FORMAT(T80,16A1//T3,10A8)
 3499      C
 3500            RETURN
 3501            END
```

```
3417            GO TO 3
3418      4     GRAP1(N,JW)=NCHAR(J)
3419            GO TO 3
3420      3     CONTINUE
3421      30    CONTINUE
3422      C..."INSERTING HORIZONTAL AXIS"
3423            DO 201 J=1,NWIDE
3424        201 IF(GRAP1(INPT,J).EQ.B)GRAP1(INPT,J)=A
3425         10 DO 218 J=1,NWIDE
3426        218 GRAP1(NF+1,J)=A
3427      C
3428      C..."VERTICAL COORDINATES"
3429            DO 217 J=1,NF
3430        217 VCORD(J)=BLANK
3431      C...
3432            NS=INPT-(INPT/IFREQ)*IFREQ
3433            SVALUE=BASEV+FLOAT(NF-NS)*SPACE
3434            ADJ=0.00001*10.**MULT
3435            IF(ABS(CMIN).LT.100)MULT=MULT-2
3436            IF(MULT.GT.0)MULT=0
3437      C...
3438            IF(INPT.NE.NF)SVALUE=SVALUE-(BASEV+FLOAT(NF-INPT)*S
3439      C...
3440            DO 211 J=NS,NF,IFREQ
3441            IF(SVALUE.GT.0)NVALUE=IFIX((SVALUE+ADJ)/10.**MULT)
3442            IF(SVALUE.LE.0)NVALUE=IFIX((SVALUE-ADJ)/10.**MULT)
3443            CALL BTD(NVALUE,HOLD(1),8,I,' ')
3444            VCORD(J)=CORD8
3445      C...
3446        211 SVALUE=SVALUE-FLOAT(IFREQ)*SPACE
3447      C...
3448      C..."HORIZONTAL COORDINATES"
3449            NCORDS=NOV/5
3450            GOTO(11,12),NTYPE
3451      C
3452         11 DO 212 J=1,NCORDS
3453        212 HCORD(J)=J*5*HMAX/NWIDE
3454            GOTO 7
3455         12 CONTINUE
3456      C
3457          7 CONTINUE
3458      C
3459      C..."HEADING FOR GRAPH"
3460            WRITE(P,99)TITLE
3461         99 FORMAT('1',9A8/)
3462      C
3463      C..."GRAPHICAL OUTPUT"
3464            DO 31 J=1,NF
3465            IF(J.LE.16)WRITE(P,101)HEAD(J,1),VCORD(J),
3466           *(GRAP1(J,MC),MC=1,NWIDE)
3467            IF(J.GT.16)WRITE(P,102)VCORD(J),(GRAP1(J,MC),MC=1,N
```

```
3366            DO 95 N=1,20
3367            SPRATE=SPRATE*10.
3368            IF(SPRATE.GT.0.01)GO TO 96
3369         95 CONTINUE
3370            GOTO 89
3371         96 MULT=-N
3372      C
3373      C..."GENERATE VERTICAL AXIS COORDINATES FREQ"
3374         94 XIM=10.
3375            DO 202 I=1,4
3376            X=SPRATE*(I+3)
3377      C
3378            DO 203 K=1,15
3379            IF(X.LE.0.0)GOTO 204
3380        203 X=X-0.5
3381      C
3382        204 K=K-1
3383      C
3384      C
3385            XI=(FLOAT(K)*0.5)-FLOAT(I+3)*SPRATE
3386            IF(XI.GE.XIM)GOTO 202
3387            XIM=XI
3388            IFREQ=I+3
3389            XS=(FLOAT(K)*0.5)/FLOAT(IFREQ)
3390        202 CONTINUE
3391      C
3392            SPRATE=XS
3393      C
3394            SPACE=(10.**MULT*SPRATE)
3395      C..."INSERTION POINT FOR FLOATING AXIS"
3396            IF(SPREAD.LE.CMAX)INPT=NHIGH+1
3397            IF(SPREAD.GT.CMAX)INPT=IFIX(NF-(ABS(BASEV)/SPACE))
3398            IF(CMAX.LE.0)INPT=1
3399      C
3400         97 NOV=NT
3401            IFREQH=NWIDE/NT
3402            IF(IFREQH.GT.4)IFREQH=4
3403            IF(IFREQH.NE.0)GOTO 230
3404            NOV=NWIDE
3405            IFREQH=1
3406      C
3407      C..."CONVERT INPUT DATA TO OUTPUT MATRIX"
3408        230 DO 3 J=1,NO
3409            DO 3 J1=1,NOV
3410            IF(DATAS(J1,J).EQ.-1.)GOTO 3
3411            N=IFIX(NF-((DATAS(J1,J)-BASEV)/SPACE))
3412            IF(N.LT.1)N=1
3413            IF(N.GT.NHIGH+1)N=NHIGH+1
3414            JW=(IFREQH*(J1-1))+1
3415            IF(GRAP1(N,JW).EQ.8)GOTO 4
3416            GRAP1(N,JW)=HST
```

PROGRAM:F10:SIMO2.FORT

```
3315            COMMON/BLK1/TITLE
3316            COMMON/BLK8/GTITLE,BASE,HMAX,NTYPE,HEAD,DATAS(121,1
3317      C
3318            EQUIVALENCE (HOLD(1),CORD8),(NOLD(1),CORD8)
3319            INTEGER P
3320            DATA A/'-'/,B/' '/,HST/'*'/
3321           *     ,CORD8/'        '/,BLANK/'        '/
3322      C
3323            ML=0
3324            MULT=0
3325       1000 FORMAT(4I10)
3326      C
3327            NF=NHIGH+1
3328            DO 1 J=1,NWIDE
3329            DO 1 I=1,NF
3330          1 GRAP1(I,J)=B
3331      C
3332      C... "FIND MAX AND MIN VALUE"
3333            CMIN=1000000000.0
3334            CMAX=-CMIN
3335            DO 2 J=1,NO
3336            DO 2 J1=1,NT
3337            IF(DATAS(J1,J).EQ.-1.)GOTO 2
3338            IF(DATAS(J1,J).GT.CMAX)CMAX=DATAS(J1,J)
3339            IF(DATAS(J1,J).LT.CMIN)CMIN=DATAS(J1,J)
3340      2     CONTINUE
3341            IF(CMAX.LT.0)CMAX=0.
3342            IF(NTYPE.EQ.1)CMIN=BASE
3343            BASEV=CMIN
3344            IF(CMIN.EQ.CMAX)GOTO 89
3345      C...
3346      C
3347            BASEV=(FLOAT(IFIX(CMIN/1000.)))*1000.
3348            IF(CMIN.LT.0)BASEV=BASEV-1000.
3349      C
3350      C..." CALCULATE SPREAD"
3351         80 IF(NTYPE.GT.1)GO TO 94
3352      C
3353            SPREAD=CMAX-BASEV
3354            SPRATE=SPREAD/FLOAT(NF)
3355            IF(SPRATE.LT.1.)GOTO 92
3356            DO 91 N=1,20
3357            SPRATE=SPRATE/10.
3358            IF(SPRATE.LT.1.)GOTO 93
3359         91 CONTINUE
3360      C  89 CALL OUT$C1(4)
3361         89 RETURN
3362         93 MULT=N
3363            GO TO 94
3364         92 MULT=0
3365            IF(SPRATE.GT.0.01)GO TO 94
```

```
3264            DO 2 I=1,NHH
3265            IF(ISOL(I,1).LE.0)GOTO 2
3266            M=IFIX(SOL(I,2)*FLOAT(NWIDE)/FLOAT(HMAX))
3267            IF(M.LT.1)GOTO 2
3268            IF(M.GT.NWIDE)M=NWIDE
3269      C...
3270            J=ISOL(I,1)
3271            IF(J.NE.999)GOTO 3
3272            KT=IFIX(ABS(HHD(I,2)))
3273      C...
3274            IF(KT.LE.5)DATAS(M,12)=-1.
3275            IF(KT.GT.5)DATAS(M,13)=-1.
3276            DATAS(M,11)=SOL(I,1)
3277            GOTO 2
3278      C...
3279          3 IT=IFIX(ABS(HHD(I,2)))
3280            DATAS(M,IT)=SOL(I,1)
3281          2 CONTINUE
3282      C...
3283            NTYPE=1
3284            NT=120
3285            NO=13
3286            NHIGH=50
3287            BASE=0:
3288      C...
3289            DO 5 I=1,16
3290            HEAD(I,1)=SHEAD1(I)
3291          5 HEAD(I,2)=SHEAD2(I)
3292      C...
3293            GTITLE(1)=BLANK
3294            DO 6 I=2,10
3295          6 GTITLE(I)=STITLE(I-1)
3296            DO 8 I=5,7
3297          8 GTITLE(I)=TITLE(I-4)
3298      C...
3299      C...
3300            DO 7 I=1,9
3301          7 A(I)=BLANK
3302      C...
3303            CALL OUT$GP(NT,NO,NHIGH,NWIDE,6,NCHAR)
3304      C...
3305            RETURN
3306            END
3307      C...
3308            SUBROUTINE OUT$GP(NT,NO,NHIGH,NWIDE,P,NCHAR)
3309            INTEGER*4 HCORD(24),NOLD(2),HMAX
3310            INTEGER*2 NCHAR(NO),GRAP1(52,120)
3311            LOGICAL*1 HEAD(16,2),HOLD(8)
3312            REAL*8 GTITLE(10),VCORD(51),CORD8,BLANK
3313            INTEGER*2 A,B,HST
3314            REAL*8 TITLE(9)
```

PROGRAM:F10:SIMO2.FORT

```
     * ,'/MONTH :MINQ=',F5.0)
 110 FORMAT(' SUB=PRICE :PON=',F4.2,'PCN=',F4.2,'POE=',F
     * ,'PCE=',F4.2 ,' :Y LIMIT=',F6.0,'/MONTH :MINQ=',F5
 111 FORMAT(T64,':MAXR=',F5.0)
 120 FORMAT(' SUB= constrained: ',3A8,'MINQ= ',2F7.2)
C...
      END
C...
      SUBROUTINE AL$GRP(NWIDE)
      LOGICAL*1 HEAD(16,2),SHEAD1(16),SHEAD2(16)
      INTEGER*2 NCHAR(13),ISOL(120,2)
      INTEGER*4 HMAX
      REAL*4 SOL(120,4),DATAS(121,13),PRICE(5,2)
      REAL*8 GTITLE(10),STITLE(10),RHEAD1(2),RHEAD2(2),BL
     *  ,TITLE(3)
C...
      COMMON/BLK1/A
      COMMON/BLK8/DU1(36120),ISOL,SOL
      COMMON/BLK21/TITLE,HHD(120,10),HHT(10,6),DWD(3,120)
     * ,PAR(40),POL(10,4),EXT(2,2,12),ZW(11),IC1(20)
      EQUIVALENCE (IC1(1),NZ),(IC1(2),NMD),(IC1(3),NHT),(
     * ,(IC1(5),NMD1)
     * ,(PAR(11),PRICE(1,1))
C...
      EQUIVALENCE (DU1(1),GTITLE(1)),(DU1(21),BASE),(DU1(
     * ,(DU1(23),NTYPE),(DU1(24),HEAD(1,1)),(DU1(32),DATA
      EQUIVALENCE (RHEAD1(1),SHEAD1(1)),(RHEAD2(1),SHEAD2
C...
      DATA NCHAR/'r ','r ','r ','r ','r ','o ','o ','o ',
     * ,'n ','. ','. '/
     * ,STITLE/' PRICE-Q','UANTITY ','CURVES  ',7*'
     * ,RHEAD1/'        ',' price '/
     * ,RHEAD2/' "Q" of ','housing '/
     * ,BLANK/'        '/
C...
      HMAX=480
C...
      DO 9 J=1,13
      DO 9 I=1,120
    9 DATAS(I,J)=-1.
C...
C... load PN and PO
      K=IFIX(PRICE(3,1)*FLOAT(NWIDE)/FLOAT(HMAX))
      DO 1 I=K,NWIDE
    1 DATAS(I,12)=PRICE(4,1)
C...
      K=IFIX(PRICE(3,2)*FLOAT(NWIDE)/FLOAT(HMAX))
      DO 4 I=K,NWIDE
    4 DATAS(I,13)=PRICE(4,2)
C...
C...
```

PROGRAM:F10:SIMO2.FORT

```
      RETURN
C...
C... no participants
   71 WRITE(6,105)
  105 FORMAT(/' NO PARTICIPANTS')
      RETURN
C...
      END
C...
      SUBROUTINE OT$ST(NS)
      COMMON /BLK21/DU1(1699),POL(10,4),DU2(79),IPOL(2,4)
      REAL*8 TOP(3)/'*AY)    ','*P*Q)   ','*P*Q*AY)'/
     * ,CON(3,7) /'income  ','        ','        '
     *           ,'in kind ','demand  ','        '
     *           ,'direct c','onstrain','ed      '
     *           ,'direct q','uantity ','        '
     *           ,'direct e','xpenditu','re      '
     *           ,'direct p','rice    ','        '
     *           ,'direct m','inimum s','ubsidy  '/
C...
      DO 800 L=1,NS
      IF(IPOL(1,L).GE.7.AND.IPOL(1,L).LE.9)GOTO 810
      IS=IPOL(2,L)
      IF(IPOL(1,L).GE.20)GOTO 820
C...
      GOTO(1,2,3,4,5,6),IS
C...
    1 WRITE(6,101)POL(1,L),POL(2,L),POL(4,L),TOP(1),POL(6
      GOTO 800
    2 WRITE(6,102)POL(1,L),POL(3,L),POL(4,L),TOP(1),POL(6
      GOTO 800
    3 WRITE(6,101)POL(1,L),POL(2,L),POL(5,L),TOP(2),POL(6
      GOTO 800
    4 WRITE(6,102)POL(1,L),POL(3,L),POL(5,L),TOP(2),POL(6
      GOTO 800
    5 WRITE(6,101)POL(1,L),POL(2,L),POL(5,L),TOP(3),POL(6
      GOTO 800
    6 WRITE(6,102)POL(1,L),POL(3,L),POL(5,L),TOP(3),POL(6
      GOTO 800
C...
  810 WRITE(6,110)(POL(I,L),I=1,4),POL(6,L),POL(7,L)
      GOTO 800
C... constrained MINIMUM option
  820 WRITE(6,120)(CON(I,IS),I=1,3),POL(1,L),POL(2,L)
C...
  800 IF(POL(10,L).LT.5000.)WRITE(6,111)POL(10,L)
      RETURN
C...
  101 FORMAT(' SUB=',F6.4,'*(',F8.2,'*P*Q-',F6.4,A8,' :Y
     * ,'/MONTH :MINQ=',F5.0)
  102 FORMAT(' SUB=',F6.4,'*(',F8.2,4X,'-',F6.4,A8, ' :Y
```

SECTION A5: POLICY SIMULATION RESULTs

This section provides a brief overview of the means by which the simulation results referenced in the thesis are derived. Matching sets of simulations have been performed with both models although the main references in the text are to those obtained using the MODIFIED Version of the model. The presented tables involve simple summary statistics derived from the summary tables created by the simulation programs.

A5.01 Simulation Results: Impact of Subsidy Level

The policy simulations used in the thesis are based on situations involving supporting a minimum standard of housing in the individual markets. Obviously the level of this minimum standard has a large impact on the required subsidy bill and participation levels. In order to attempt to provide a relatively constant level of intervention across the eight selected CMAs the supported level has been set as a function of the minimum quantity of "housing" services available from a new dwelling. A unit of "housing" service does not represent the same amount of housing across the CMAs with the "poorer" CMAs typically reflecting higher mean quantities and lower prices with the "richer" CMAs the reverse and consequently the supported quantity will fluctuate.

The simulation output derived which is of interest to this study is best represented by actual subsidy costs and measures of the changes in consumption levels resulting from the intervention.

The simulation MODELs utilize a monthly interval with housing expenditures based on the household's monthly income. The reported

"subsidy amount" thus reflects the expected 1971 monthly cost of supporting the level of housing consumption of 100 representative households from the individual CMAs. Total 1971 annual costs for the CMAs are derived by factoring firstly to an annual amount, then by factoring in the ratio of actual households to "model" households for the respective CMA These ratios, with an indicated range of 165 through 3455, are presented in Table A5.01.

Calgary	Kitchener	Quebec City	St. John's
1211.	665.	1271.	287.

Saskatoon	Sudbury	Vancouver	Winnipeg
386.	165.	3455.	1665.

Table A5.01 Ratio of Actual Households to Model Households.

The included "efficiency" factors are as defined by Carlton and Ferriera (1975) and respresent a cost-standardised measure of the change in the quantity of housing sevices consumed. The indicated normal range for these coefficients is from zero, when there is no change in the quantity consumed, to approximately 2.0 when the selected group spend their entire subsidy on housing and prices remain unchanged. Coefficients less than zero indicate a decline in the quantity of housing services consumed: either as a result of simulated price inflation or a household's being forced from the market by a lack of suitable existing dwellings. Coefficients greater than 2.0 typically indicate that households have been forced to reduce their consumption of other goods and services to supplement their expenditure on housing. Typical subsidy operations will reflect "efficiency" coefficients in the range of 0.0 to 1.0. Whereas the "efficiency" coefficients reflect

changes in the quantity of housing consumed, the "earmarking" coefficients indicate changes in actual expenditures on housing by the recipients. These coefficients are computed as the percentage ratio of the increase in expenditure on housing made by the recipients to the total subsidy amount. Under a supported minimum quantity scenario these ratios will range from approximately 10%, for extremely inefficient policies, to well in excess of 100% when a recipient choice is constrained.

The following Tables report cost and efficiency factors on a CMA basis firstly for the ORIGINAL MODEL then for the MODIFIED MODEL for simulations that reflect various levels of intervention specified as a percent of the respective minimum quantities of new construction.

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	2	228.5	114.2	0.013	0.240	19.92
inkind	2	70.1	35.0	0.042	0.781	64.93
constrained	2	39.9	19.9	0.073	1.372	114.08
quantity	2	34.9	17.4	0.084	1.569	130.43
expenditure	2	45.1	22.5	0.065	1.214	100.93
price	2	48.4	24.2	0.060	1.131	94.05

minimum quantity: 42.80

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	518.1	103.6	0.045	0.173	26.66
inkind	5	275.3	55.1	0.084	0.326	50.17
constrained	5	113.0	22.6	0.205	0.794	122.23
quantity	5	97.3	19.5	0.238	0.923	141.95
expenditure	5	132.4	26.5	0.175	0.678	104.32
price	5	152.9	30.6	0.151	0.587	90.33

minimum quantity: 49.80

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Calgary]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	539.0	107.8	0.047	0.178	25.18
inkind	5	285.2	57.0	0.089	0.336	47.59
constrained	5	66.5	13.3	0.382	1.801	219.83
quantity	5	95.1	19.0	0.267	1.006	142.72
expenditure	5	101.8	20.4	0.250	0.940	143.60
price	5	102.8	20.6	0.247	0.931	142.20

minimum quantity: 50.30

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	9	1034.4	114.9	0.072	0.187	27.37
inkind	9	574.7	63.9	0.129	0.336	49.26
constrained	9	129.0	14.3	0.577	1.497	233.17
quantity	9	205.9	22.9	0.361	0.938	137.49
expenditure	9	213.2	23.7	0.349	0.906	137.85
price	9	213.9	23.8	0.348	0.903	140.62

minimum quantity: 57.80

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Calgary]

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	772.3	96.5	0.070	0.174	24.00
inkind	8	418.3	52.3	0.130	0.321	44.31
constrained	8	149.5	18.7	0.363	0.899	123.99
quantity	8	131.4	16.4	0.412	1.023	141.07
expenditure	8	183.9	23.0	0.295	0.731	100.80
price	8	219.2	27.4	0.247	0.613	84.56

minimum quantity: 52.90

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	12	1844.8	153.7	0.080	0.168	28.52
inkind	12	1027.9	85.7	0.143	0.301	51.18
constrained	12	436.8	36.4	0.336	0.708	120.44
quantity	12	378.4	31.5	0.388	0.818	139.03
expenditure	12	525.9	43.8	0.279	0.588	100.04
price	12	625.0	52.1	0.235	0.495	84.18

minimum quantity: 61.58

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Kitchener]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	13	1766.4	135.9	0.088	0.182	25.29
inkind	13	954.5	73.4	0.163	0.336	46.80
constrained	13	202.7	15.6	0.769	1.583	227.14
quantity	13	328.3	25.3	0.475	0.978	136.08
expenditure	13	338.5	26.0	0.460	0.948	134.18
price	13	337.0	25.9	0.462	0.952	136.62

minimum quantity: 62.20

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	20	3111.2	155.6	0.102	0.184	23.64
inkind	20	1668.5	83.4	0.190	0.342	44.09
constrained	20	350.7	17.5	0.905	1.629	210.49
quantity	20	578.2	28.9	0.549	0.988	127.22
expenditure	20	579.1	29.0	0.548	0.986	127.47
price	20	579.1	29.0	0.548	0.986	127.47

minimum quantity: 71.58

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Kitchener]

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	482.4	96.5	0.132	0.269	17.13
inkind	5	251.3	50.3	0.207	0.517	47.59
constrained	5	99.0	19.8	0.525	1.313	120.80
quantity	5	100.4	20.1	0.517	1.295	119.11
expenditure	5	85.4	17.1	0.745	1.522	96.77
price	5	93.6	18.7	0.680	1.389	88.29

minimum quantity: 37.90

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	9	1230.7	136.7	0.087	0.194	22.83
inkind	8	483.5	60.4	0.237	0.507	46.09
constrained	9	228.0	25.3	0.454	1.047	123.23
quantity	8	186.6	23.3	0.606	1.313	119.44
expenditure	9	280.1	31.1	0.369	0.852	100.31
price	8	253.3	31.7	0.447	0.967	87.99

minimum quantity: 44.15

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Quebec City]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	10	1149.6	115.0	0.054	0.209	20.09
inkind	10	554.7	55.5	0.121	0.433	41.55
constrained	10	91.5	9.1	0.593	2.626	255.91
quantity	9	180.9	20.1	0.469	1.391	122.83
expenditure	10	187.7	19.0	0.287	1.267	123.44
price	10	190.0	19.0	0.283	1.265	123.24

minimum quantity: 44.60

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	17	1954.1	114.9	0.079	0.202	20.04
inkind	17	968.4	57.0	0.153	0.407	40.43
constrained	17	157.4	9.3	0.668	2.503	266.46
quantity	17	321.3	18.9	0.467	1.226	121.86
expenditure	17	334.6	19.7	0.359	1.178	120.45
price	17	335.8	19.8	0.354	1.173	120.02

minimum quantity: 51.30

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Quebec City]

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	4	973.6	243.4	-0.553	0.074	20.67
inkind	4	328.8	82.3	-1.692	0.219	61.21
constrained	4	157.2	39.3	-3.537	0.458	128.02
quantity	6	255.5	42.6	0.116	0.934	101.78
expenditure	4	199.7	49.9	-2.744	0.361	100.78
price	4	201.7	50.4	-2.699	0.357	99.78

minimum quantity: 29.00

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	6	1896.6	316.1	-0.270	0.064	20.10
inkind	6	596.6	99.4	-0.859	0.203	63.89
constrained	6	309.7	51.6	-1.655	0.392	123.08
quantity	7	403.7	57.7	-0.762	0.507	101.92
expenditure	6	380.2	63.4	-1.348	0.319	100.26
price	6	383.1	63.8	-1.337	0.317	99.50

minimum quantity: 33.76

note: option(s) with households NOT allocated
quantity :1

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[St. Johns]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	887.6	110.9	-0.501	0.363	15.80
inkind	9	330.6	36.7	-1.353	0.896	42.71
constrained	7	59.3	8.5	-7.541	6.063	232.14
quantity	8	138.6	17.3	-3.208	2.328	101.21
expenditure	9	139.2	15.5	-3.213	2.128	101.43
price	9	139.2	15.5	-3.213	2.128	101.43

minimum quantity: 34.10

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	10	1298.8	129.9	-0.297	0.349	16.01
inkind	10	495.7	49.6	-0.779	0.914	41.95
constrained	10	86.7	8.7	-4.454	5.224	239.85
quantity	10	205.7	20.6	-1.877	2.202	101.09
expenditure	10	205.7	20.6	-1.877	2.202	101.09
price	10	205.7	20.6	-1.877	2.202	101.09

minimum quantity: 39.20

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[St. Johns]

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	4	403.2	100.8	0.073	0.303	32.08
inkind	4	241.8	60.4	0.134	0.505	53.50
constrained	4	98.6	24.6	0.451	1.238	131.20
quantity	4	102.0	25.6	0.433	1.191	126.20
expenditure	4	127.1	31.8	0.349	0.960	101.78
price	4	148.0	37.0	0.300	0.825	87.40

minimum quantity: 40.10

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	6	758.5	126.4	0.104	0.267	34.74
inkind	6	468.8	78.1	0.168	0.433	56.20
constrained	6	211.2	35.2	0.364	0.961	124.75
quantity	6	212.2	35.4	0.372	0.956	124.16
expenditure	6	260.7	43.4	0.296	0.778	101.06
price	6	299.0	49.8	0.264	0.678	88.12

minimum quantity: 46.73

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Saskatoon]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	7	492.3	70.3	0.100	0.410	21.01
inkind	8	286.5	35.8	0.177	0.681	36.16
constrained	6	46.5	4.9	1.094	4.548	225.80
quantity	7	99.4	14.2	0.481	2.029	104.05
expenditure	7	101.7	14.5	0.469	1.983	101.69
price	7	101.7	14.4	0.473	1.995	104.12

minimum quantity: 47.20

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	13	985.9	75.8	0.112	0.338	22.06
inkind	13	652.5	50.2	0.172	0.511	33.33
constrained	13	88.6	6.8	1.248	3.760	250.09
quantity	13	203.2	15.6	0.577	1.640	107.01
expenditure	13	205.4	15.8	0.494	1.622	105.87
price	13	204.6	15.7	0.516	1.628	106.92

minimum quantity: 54.30

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Saskatoon]

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	2	235.8	117.9	-0.150	0.168	14.34
inkind	2	77.0	38.5	-0.458	0.515	43.90
constrained	2	24.1	12.0	-1.465	1.646	140.27
quantity	2	26.1	13.0	-1.353	1.520	129.52
expenditure	2	32.2	16.1	-1.096	1.232	104.98
price	2	36.5	18.2	-0.967	1.087	92.62

minimum quantity: 28.40

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	544.5	108.9	-0.024	0.153	16.86
inkind	5	231.2	46.2	-0.056	0.359	39.72
constrained	5	66.1	13.2	-0.194	1.256	138.92
quantity	5	71.1	14.2	-0.181	1.168	129.15
expenditure	5	88.3	17.7	-0.146	0.940	103.99
price	5	101.8	20.4	-0.126	0.816	90.20

minimum quantity: 33.07

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Sudbury]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	563.2	112.6	-0.018	0.160	16.87
inkind	5	243.1	48.6	-0.042	0.371	39.09
constrained	5	37.7	7.5	-0.269	2.390	307.59
quantity	5	73.4	14.7	-0.138	1.228	129.45
expenditure	5	78.8	15.8	-0.128	1.143	123.76
price	5	83.2	16.6	-0.122	1.083	117.22

minimum quantity: 33.40

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	9	1104.2	122.7	0.034	0.157	17.66
inkind	9	464.5	51.6	0.081	0.374	41.99
constrained	9	69.9	7.8	0.536	2.484	305.85
quantity	9	151.1	16.8	0.248	1.149	129.09
expenditure	9	157.4	17.5	0.238	1.103	123.92
price	9	159.9	17.8	0.234	1.086	124.99

minimum quantity: 38.40

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Sudbury]

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	7	511.7	73.1	0.069	0.219	30.53
inkind	7	410.4	58.6	0.084	0.273	38.06
constrained	7	113.2	16.2	0.314	0.988	138.00
quantity	7	121.9	17.4	0.291	0.918	128.15
expenditure	7	153.5	21.9	0.218	0.729	101.77
price	7	179.8	25.7	0.192	0.622	86.88

minimum quantity: 48.20

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	11	1263.6	114.9	0.078	0.189	30.91
inkind	11	852.7	77.5	0.114	0.280	45.81
constrained	11	296.4	26.9	0.351	0.805	131.78
quantity	11	310.5	28.2	0.314	0.768	125.80
expenditure	11	386.2	35.1	0.252	0.618	101.14
price	11	444.7	40.4	0.234	0.537	87.83

minimum quantity: 56.13

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Vancouver]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	11	1186.2	107.8	0.039	0.213	25.34
inkind	11	753.8	68.5	0.056	0.336	39.88
constrained	11	103.2	9.4	0.421	2.451	296.15
quantity	11	244.4	22.2	0.187	1.035	122.99
expenditure	11	247.5	22.5	0.133	1.022	121.72
price	11	247.6	22.5	0.134	1.022	123.44

minimum quantity: 56.70

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	18	2253.7	125.2	0.051	0.200	24.71
inkind	18	1418.0	78.8	0.063	0.318	39.48
constrained	18	204.0	11.3	0.419	2.212	274.93
quantity	17	463.0	27.2	0.249	0.996	119.31
expenditure	18	466.9	25.9	0.157	0.966	120.13
price	18	466.9	25.9	0.167	0.966	120.13

minimum quantity: 65.20

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Vancouver]

Subsidy Level:85% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	7	1075.8	153.7	0.106	0.252	18.28
inkind	7	366.8	52.4	0.308	0.739	53.60
constrained	8	195.1	24.4	0.514	1.328	121.14
quantity	8	192.3	24.0	0.522	1.347	122.90
expenditure	7	193.8	27.7	0.577	1.399	101.46
price	7	207.1	29.6	0.540	1.310	94.94

minimum quantity: 46.40

Subsidy Level:99% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	11	2297.3	208.8	0.080	0.184	23.46
inkind	11	881.6	80.1	0.218	0.478	53.89
constrained	11	454.1	41.3	0.407	0.929	118.68
quantity	11	392.2	35.7	0.491	1.075	121.13
expenditure	11	531.5	48.3	0.348	0.793	101.39
price	11	509.6	46.3	0.378	0.827	93.23

minimum quantity: 54.05

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Winnipeg]

Subsidy Level:100% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	15	2224.6	148.3	0.022	0.175	21.62
inkind	15	955.2	63.7	0.032	0.407	51.17
constrained	16	206.1	12.9	-0.043	1.813	245.70
quantity	15	379.3	25.3	0.138	1.026	126.77
expenditure	15	387.1	25.8	0.067	1.005	126.28
price	16	391.2	24.4	-0.003	0.955	128.53

minimum quantity: 54.60

Subsidy Level:115% QN

Model:ORIGINAL

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	25	3777.9	151.1	0.036	0.161	21.92
inkind	25	1804.5	72.2	0.072	0.336	45.89
constrained	25	335.3	13.4	0.359	1.809	248.19
quantity	25	661.4	26.5	0.174	0.917	125.82
expenditure	25	661.4	26.5	0.178	0.917	125.82
price	25	661.4	26.5	0.176	0.917	125.82

minimum quantity: 62.80

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 ORIGINAL MODEL: Simulation Results
[Winnipeg]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	2	230.4	115.2	0.087	0.278	29.13
inkind	2	146.0	73.0	0.137	0.438	45.97
constrained	2	18.4	9.2	1.086	3.477	364.74
quantity	2	76.5	38.2	0.261	0.836	87.73
expenditure	2	67.1	33.5	0.298	0.953	100.02
price	2	58.2	29.1	0.343	1.099	115.31

minimum quantity: 42.50 46.75

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	4	1115.2	278.8	0.032	0.079	11.17
inkind	4	233.1	58.3	0.153	0.380	53.46
constrained	4	44.3	11.1	0.806	1.998	201.30
quantity	4	140.2	35.0	0.255	0.631	88.88
expenditure	4	124.3	31.1	0.287	0.712	100.25
price	4	112.0	28.0	0.318	0.790	112.50

minimum quantity: 49.50 54.60

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Calgary]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	253.8	50.8	0.130	0.339	39.65
inkind	5	231.9	46.4	0.142	0.371	43.40
constrained	5	15.2	3.0	1.979	5.654	678.87
quantity	5	114.4	22.9	0.288	0.751	87.97
expenditure	5	110.3	22.1	0.298	0.779	91.24
price	5	85.4	17.1	0.385	1.006	117.84

minimum quantity: 50.00 55.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	672.8	84.1	0.116	0.251	33.28
inkind	8	584.7	73.1	0.133	0.289	38.29
constrained	8	38.0	4.8	2.101	4.423	634.25
quantity	8	257.3	32.2	0.303	0.657	87.02
expenditure	8	238.2	29.8	0.327	0.709	93.99
price	8	191.3	23.9	0.398	0.883	117.04

minimum quantity: 57.50 63.25

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Calgary]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	2	129.4	64.7	0.214	0.736	41.02
inkind	2	123.5	61.8	0.224	0.771	42.98
constrained	3	52.9	17.6	1.968	2.884	296.00
quantity	2	56.7	28.3	0.370	1.680	93.61
expenditure	2	61.0	30.5	1.319	1.561	101.95
price	2	42.8	21.4	0.647	2.225	124.01

minimum quantity: 43.40 62.90

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	373.3	74.7	0.160	0.324	37.96
inkind	5	345.2	69.0	0.173	0.351	41.05
constrained	8	135.4	16.9	0.366	1.606	250.82
quantity	5	205.8	41.2	0.345	0.588	86.13
expenditure	5	166.0	33.2	0.396	0.729	99.96
price	5	118.0	23.6	0.545	1.026	120.10

minimum quantity: 50.50 73.30

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Kitchener]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	431.8	86.4	0.153	0.294	37.04
inkind	5	377.0	75.4	0.175	0.337	42.43
constrained	14	103.0	7.4	1.865	2.491	421.29
quantity	6	207.2	34.5	0.359	0.540	85.56
expenditure	6	186.1	31.0	0.333	0.601	95.09
price	5	134.9	27.0	0.501	0.942	118.57

minimum quantity: 51.00 74.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	25	8009.7	320.4	0.035	0.030	11.73
inkind	25	3997.9	159.9	0.070	0.061	23.50
constrained	44	225.1	5.1	2.380	2.236	516.45
quantity	26	913.8	35.1	0.308	0.267	81.06
expenditure	21	844.6	40.2	0.369	0.320	87.96
price	25	896.8	35.9	0.314	0.271	104.74

minimum quantity: 58.60 85.10

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Kitchener]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	331.3	66.3	0.167	0.448	36.67
inkind	5	257.5	51.5	0.215	0.576	47.18
constrained	5	50.5	10.1	1.108	2.937	283.82
quantity	5	159.9	32.0	0.350	0.927	89.64
expenditure	5	142.8	28.6	0.392	1.039	100.37
price	5	103.7	20.7	0.533	1.430	117.16

minimum quantity: 44.20 68.00

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	720.9	90.1	0.146	0.325	35.28
inkind	8	532.5	66.5	0.198	0.440	47.78
constrained	8	103.1	12.9	1.019	2.273	275.48
quantity	8	319.5	39.9	0.329	0.734	88.89
expenditure	8	284.4	35.5	0.370	0.824	99.86
price	8	220.2	27.5	0.480	1.064	115.51

minimum quantity: 51.50 79.20

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Quebec City]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	795.2	99.4	0.123	0.308	34.86
inkind	8	586.8	73.3	0.167	0.417	47.24
constrained	8	74.7	9.3	1.288	3.274	387.73
quantity	8	314.6	39.3	0.356	0.777	88.11
expenditure	8	284.4	35.5	0.393	0.860	98.05
price	8	241.5	30.2	0.406	1.013	114.78

minimum quantity: 52.00 80.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	15	2384.4	159.0	0.088	0.144	23.34
inkind	15	1649.0	109.9	0.127	0.208	33.75
constrained	16	151.6	9.5	1.331	2.187	360.13
quantity	15	610.8	40.7	0.339	0.561	85.37
expenditure	15	580.6	38.7	0.356	0.590	91.85
price	15	493.2	32.9	0.424	0.695	112.85

minimum quantity: 59.80 92.00

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Quebec City]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	599.0	119.8	0.164	0.481	37.38
inkind	5	431.4	86.3	0.227	0.668	51.91
constrained	4	50.5	12.6	-0.058	2.210	258.01
quantity	4	150.7	37.7	-0.020	0.741	85.72
expenditure	4	126.5	31.6	-0.023	0.882	103.00
price	5	180.7	36.1	0.542	1.595	123.92

minimum quantity: 56.90 65.50

note: option(s) with households NOT allocated
constrained:2 quantity :2 expenditure:2

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	2186.8	273.3	0.061	0.164	18.92
inkind	8	810.4	101.3	0.163	0.443	51.06
constrained	6	124.1	20.7	0.275	1.455	229.14
quantity	6	246.3	41.0	0.088	0.781	90.13
expenditure	6	280.0	46.7	0.122	0.645	101.56
price	8	352.8	44.1	0.375	1.018	117.29

minimum quantity: 66.30 76.20

note: option(s) with households NOT allocated
constrained:2 quantity :2 expenditure:2

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[St. Johns]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	10	1006.2	100.6	0.119	0.305	36.70
inkind	10	770.1	77.0	0.155	0.398	47.95
constrained	10	211.9	21.2	0.560	1.447	179.78
quantity	10	400.2	40.0	0.298	0.766	92.27
expenditure	10	372.0	37.2	0.321	0.825	98.52
price	10	311.6	31.2	0.383	0.984	118.51

minimum quantity: 67.00 77.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	16	2398.2	149.9	0.097	0.202	27.14
inkind	16	1884.0	117.7	0.124	0.258	39.49
constrained	14	303.4	21.7	0.763	1.624	212.78
quantity	16	704.9	44.1	0.330	0.688	92.32
expenditure	16	700.0	43.7	0.335	0.693	94.96
price	16	593.1	37.1	0.395	0.818	116.19

minimum quantity: 77.00 88.60

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[St. Johns]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	174.4	34.9	0.190	0.424	39.22
inkind	5	168.1	33.6	0.197	0.440	40.69
constrained	5	13.1	2.6	2.525	5.649	522.13
quantity	5	77.3	15.5	0.428	0.957	88.48
expenditure	5	67.8	13.6	0.488	1.091	100.88
price	5	56.3	11.3	0.587	1.314	121.58

minimum quantity: 48.50 59.50

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	517.3	64.7	0.155	0.305	35.47
inkind	8	480.7	60.1	0.167	0.328	38.18
constrained	7	38.4	5.5	0.341	4.349	434.01
quantity	7	183.6	26.2	0.071	0.910	90.77
expenditure	7	161.6	23.1	0.081	1.033	103.13
price	8	152.1	19.0	0.528	1.037	120.65

minimum quantity: 56.40 69.30

note: option(s) with households NOT allocated
constrained:1 quantity :1 expenditure:1

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Saskatoon]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	498.0	62.2	0.169	0.337	36.88
inkind	8	471.5	58.9	0.179	0.356	38.95
constrained	8	31.8	4.0	2.647	5.271	577.15
quantity	8	206.1	25.8	0.408	0.813	89.11
expenditure	8	191.3	23.9	0.440	0.876	97.57
price	8	150.3	18.8	0.560	1.115	122.19

minimum quantity: 57.00 70.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	15	2048.4	136.6	0.100	0.157	22.22
inkind	15	1617.6	107.8	0.126	0.198	28.13
constrained	15	76.9	5.1	2.651	4.169	577.79
quantity	15	476.8	31.8	0.428	0.672	88.50
expenditure	15	444.8	29.7	0.458	0.721	94.87
price	15	386.4	25.8	0.528	0.830	117.77

minimum quantity: 65.60 80.50

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Saskatoon]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	2	14.4	7.2	-1.504	0.615	44.74
inkind	2	14.4	7.2	-1.504	0.615	44.74
constrained	1	0.8	0.8	4.728	14.985	996.45
quantity	2	6.6	3.3	-3.281	1.341	97.61
expenditure	2	8.4	4.2	0.450	1.054	103.59
price	2	4.6	2.3	-5.996	1.925	140.04

minimum quantity: 38.30 65.50

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	4	164.0	41.0	-0.012	0.354	36.24
inkind	4	164.0	41.0	-0.012	0.354	36.24
constrained	4	7.8	1.9	0.067	7.438	781.51
quantity	4	68.1	17.0	-0.028	0.852	87.35
expenditure	4	60.7	15.2	0.009	0.956	100.40
price	4	48.4	12.1	-0.039	1.199	122.81

minimum quantity: 44.60 76.20

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Sudbury]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	4	177.7	44.4	-0.001	0.351	36.16
inkind	4	177.7	44.4	-0.001	0.351	36.16
constrained	5	14.3	2.9	-5.059	3.810	772.13
quantity	4	73.7	18.4	-0.002	0.846	87.26
expenditure	4	65.7	16.4	0.034	0.949	100.14
price	4	52.4	13.1	-0.003	1.190	122.64

minimum quantity: 45.00 77.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	7	764.8	109.3	0.075	0.143	30.32
inkind	7	703.5	100.5	0.081	0.155	32.96
constrained	9	39.8	4.4	-1.496	1.261	672.37
quantity	7	282.0	40.3	0.203	0.387	82.24
expenditure	6	191.2	31.9	0.287	0.698	100.42
price	7	204.1	29.2	0.281	0.535	113.60

minimum quantity: 51.80 88.60

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Sudbury]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	586.2	117.2	0.086	0.232	27.17
inkind	5	416.6	83.2	0.120	0.327	38.23
constrained	5	42.0	8.4	1.195	3.243	379.22
quantity	5	182.5	36.5	0.275	0.746	87.27
expenditure	5	162.2	32.4	0.309	0.840	98.19
price	5	138.7	27.7	0.362	0.982	114.83

minimum quantity: 55.30 68.00

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	2211.5	276.4	0.042	0.098	14.10
inkind	8	699.9	87.5	0.134	0.311	44.54
constrained	8	122.4	15.3	0.766	1.778	254.70
quantity	8	353.3	44.2	0.265	0.616	88.24
expenditure	8	315.7	39.5	0.297	0.690	98.75
price	8	281.0	35.1	0.334	0.775	110.92

minimum quantity: 64.40 79.20

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Vancouver]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	1581.5	197.7	0.062	0.144	18.74
inkind	8	649.8	81.2	0.147	0.350	39.47
constrained	8	73.0	9.1	1.068	2.849	332.14
quantity	8	280.6	35.1	0.350	0.810	91.41
expenditure	8	265.1	33.1	0.371	0.857	97.00
price	8	218.0	27.2	0.439	1.042	117.66

minimum quantity: 65.00 80.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	18	4700.8	261.2	0.045	0.072	13.04
inkind	18	2100.9	116.7	0.101	0.160	29.17
constrained	18	153.9	8.5	1.315	2.187	423.63
quantity	18	687.1	38.2	0.307	0.490	87.96
expenditure	18	663.4	36.9	0.318	0.507	91.88
price	18	540.7	30.0	0.370	0.623	111.75

minimum quantity: 74.70 92.00

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Vancouver]

Subsidy Level:85% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	5	357.2	71.4	0.171	0.493	43.94
inkind	5	299.1	59.8	0.204	0.589	52.48
constrained	5	99.5	19.9	0.654	1.771	200.08
quantity	5	218.7	43.7	0.291	0.806	91.03
expenditure	5	198.7	39.7	0.328	0.887	100.19
price	5	134.1	26.8	0.455	1.314	117.04

minimum quantity: 56.10 67.20

Subsidy Level:99% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	8	2188.9	273.6	0.053	0.129	14.65
inkind	8	707.7	88.5	0.163	0.399	45.31
constrained	8	190.4	23.8	0.607	1.482	197.22
quantity	9	421.2	46.8	0.284	0.641	90.78
expenditure	8	373.9	46.7	0.309	0.755	100.43
price	8	278.4	34.8	0.415	1.014	115.17

minimum quantity: 65.30 78.20

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Winnipeg]

Subsidy Level:100% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	11	1019.1	92.6	0.073	0.239	30.44
inkind	11	743.8	67.6	0.101	0.328	41.70
constrained	11	139.3	13.9	0.195	1.983	254.86
quantity	11	347.8	31.6	0.215	0.702	89.18
expenditure	11	328.1	29.8	0.269	0.744	96.23
price	11	271.2	24.7	0.168	0.900	114.37

minimum quantity: 66.00 79.00

Subsidy Level:115% QN

Model:MODIFIED

policy option	number recipients	subsidy amount	average subsidy	efficiency all[1]	efficiency subs[2]	earmarking coefficients
income	23	6392.3	277.9	0.029	0.064	11.17
inkind	23	2731.4	118.8	0.069	0.149	26.15
constrained	24	236.4	9.8	0.738	1.563	302.36
quantity	23	839.7	36.5	0.224	0.485	85.06
expenditure	22	786.5	35.7	0.242	0.536	90.69
price	23	652.1	28.4	0.287	0.625	109.53

minimum quantity: 75.90 90.90

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Table A5.01 MODIFIED MODEL: Simulation Results
[Winnipeg]

A5.02 A Comparison of the MODELs

A quick review of the preceding results indicates a significant spread in the total and average subsidy costs associated with the least and most efficient forms of intervention across the selected CMAs. Under both MODELs the alternative froms of intervention receive comparable cost rankings but the relative magnitude of the difference in cost and efficiency associated with the individual CMAs varies significantly as a result of the nature of the underlying theoretical structures. There is no consistant discrepancy between the two sets of results except that the explicit prevention from tenure switching associated with the MODIFIED MODEL does result in the existing stock not being able to provide sufficient additional housing services when required. This requirement arises when the minimum supported level is set below the minimum quantity of new housing services and frequently one or two households are left unaccommodated. A direct comparison of the two MODELs is provided in the following Table; wherein the percentage variation of the MODIFIED MODEL results from the corresponding basic MODEL results across the eight CMAs are presented. A positive percentage amount indicating that the respective average for the ORIGINAL MODEL is larger.

Percent Difference in Derived Results

Subsidy Level:85% QN

Model:ORIGINAL vs MODIFIED

policy option	number recipients %	subsidy amount %	average subsidy %	efficiency all[1] %	efficiency subs[2] %	earmarking coefficients %
income	-20.5	-48.3	-40.1	77.1	118.2	69.1
inkind	-20.5	-14.2	6.2	-85.5	14.3	-10.5
constrained	-25.0	-62.6	-53.6	-578.1	302.0	224.4
quantity	-28.6	-3.7	33.3	-229.7	-18.0	-27.8
expenditure	-23.1	-18.2	2.0	-323.8	2.0	-0.1
price	-20.5	-36.6	-24.1	53.4	62.0	33.7

Percent Difference in Derived Results

Subsidy Level:99% QN

Model:ORIGINAL vs MODIFIED

policy option	number recipients %	subsidy amount %	average subsidy %	efficiency all[1] %	efficiency subs[2] %	earmarking coefficients %
income	-18.5	-8.5	8.2	253.9	27.7	-0.1
inkind	-17.2	-17.5	-1.8	2224.5	4.1	-12.1
constrained	-18.5	-63.8	-57.2	1484.7	224.7	161.6
quantity	-21.5	-5.6	18.7	9.8	-23.6	-29.1
expenditure	-23.1	-31.7	-12.4	731.6	14.0	-1.0
price	-17.2	-43.6	-33.1	1101.6	51.7	29.6

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Figure A5.02 Simulation Results: Comparison of the MODELs

Percent Difference in Derived Results

Subsidy Level:100% QN

Model:ORIGINAL vs MODIFIED

policy option	number recipients %	subsidy amount %	average subsidy %	efficiency all[1] %	efficiency subs[2] %	earmarking coefficients %
income	-20.3	-34.6	-19.2	-589.9	22.6	58.0
inkind	-22.4	-8.1	19.4	-240.7	-23.4	-2.2
constrained	-5.5	-18.5	-12.8	-198.9	15.1	79.3
quantity	-17.8	26.3	56.6	-271.0	-45.5	-27.9
expenditure	-20.0	13.9	43.6	-246.8	-37.8	-20.7
price	-22.4	-8.0	19.1	-263.3	-20.7	-3.1

Percent Difference in Derived Results

Subsidy Level:115% QN

Model:ORIGINAL vs MODIFIED

policy option	number recipients %	subsidy amount %	average subsidy %	efficiency all[1] %	efficiency subs[2] %	earmarking coefficients %
income	5.0	76.4	51.3	209.5	-40.2	-0.7
inkind	5.0	89.8	78.5	925.9	-58.2	-25.3
constrained	22.3	-13.8	-22.7	3691.9	-7.0	82.3
quantity	6.7	71.1	68.5	226.5	-58.2	-28.8
expenditure	0.0	57.6	60.4	503.6	-51.7	-22.4
price	5.0	40.0	35.8	543.1	-46.5	-6.6

note: [1] indicates the change in the quantity of housing consumed within the CMA as a function of the subsidy amount

[2] indicates the change in the quantity of housing consumed by the subsidised households as a function of the subsidy

Figure A5.02 Simulation Results: Comparison of the MODELs

As indicated, the typical "number of recipients" is, on average, 20% lower for the MODIFIED MODEL at the lowest level of support, but with the margin declining as the level of support is increased such that at the highest level of support the average "number of recipients" for the MODIFIED MODEL exceeds those for the ORIGINAL MODEL. These differences arise firstly from changes in the household's income profiles associated with the deduction of taxes and, more significantly, from the inclusion of owner occupiers' imputed income and, secondly, from the respecification of the "minimum quantity of new construction". While these differences in the average number of recipients will distort the differences in the "subsidy amount", comparable performances by the two MODELs would be reflected by a consistent differential for the other factors. The fluctuations in the "efficiency" and "earmarking" coefficients arise jointly from the respecified demand system and the restructured supply functions.

The supply system has a significant impact on the indicated performance of the "income" orientated policies with the MODIFIED MODELs' more elastic specifications resulting in typically much higher market efficiencies. The exception is that the prevention from tenure switching in the MODIFIED MODEL, in conjunction with the limited existing stock, is offsetting in scenarios involving a subsidy level of 99% QN (when all recipients must occupy existing dwellings). For scenarios where the income transfer is constrained ("in-kind") the MODIFIED MODEL indicates, on average, a much lower "earmarking" level but higher efficiency levels for the recipients as a direct result of the more elastic supply functions. The major underlying trend is for the subsidy costs associated with "income" and "in-kind" policies of the MODIFIED MODEL to fall below those

for the ORIGINAL MODEL at the lower levels of support.

The three "direct product" orientated policies; "quantity", "expenditure" and "price" reflect variations in the indicated average subsidy amount and efficiencies in keeping with the variation and elasticity associated with the supply functions. At the lower levels of support, subsidy costs from the MODIFIED MODEL are generally higher as a result of the explicitly higher marginal costs associated with the provision of additional housing services. The exception is with the "price" subsidy where explicit consideration is made of the impact of the resultant price change on demand behaviour. On this basis the average subsidy required under the MODIFIED MODEL is significantly lower than that for the ORIGINAL MODEL.

At the higher levels of support the percentage of owner-occupiers requiring support increases. When explicitly considered in the MODIFIED MODEL, the larger margin between average prices for housing services under the two tenure forms results in a significant increase in average subsidy costs and corresponding declines in the efficiencies of the transfers.