REGIONAL MODEL OF MULTI FAMILY HOUSING STARTS: AN INVENTORY ADJUSTMENT APPROACH

by

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ABSTRACT

The decline in multi family housing starts in Urban Canada during the 1970's and the attendant low vacancy rates has generated comment on the efficiency of housing markets and the possibity of a housing crisis. Traditionally, existing vacant units are cited as a buffer between the demand and supply. This paper proposes that the inventory of new units offers a more direct buffer. Therefore the use of an inventory adjustment model to estimate and predict multi family housing starts is suggested. The theoretical model suggests that there is some desired inventory level which builders or investors will try to maintain depending on expected profitability, the relative yield on other investments and the cost of maintaining vacant units. Demand for new rental units will depend upon the deomographic structure of the population, unemployment, income, and the relationship between rents ownership costs and the cost of other goods and services. Starts will be set to satisfy the expected demand and adjust actual inventory levels to the desired inventory level.

Quarterly data for the Vancouver CMA, from 1963 to 1982 are used to test this model. The empirical analysis consists of three parts: a structural model based on the inventory adjustment process, a time series model to provide a measure for evaluating the success of the structural model, and an analysis of the forecasting capabilities of these two models. Data from 1963 to 1980 are used to estimate the models and 1981 to 1982 data are maintained to test the forecasts.

The results suffer from inadequacies of the available data, immeasurable impacts of government policy and programs and possible idiosyncracies of the Vancouver housing market. In general, the results indicate that inventories do provide a buffer between the demand and supply of multi family housing units. As such, the vacancy rate of existing units, in isolation, is an insufficient indicator of market activity and response. Similar analysis for other urban centres in Canada is needed to determine the uniqueness of these results. Also, it may be possible to develop an improved forecasting model by incorporating the time series coefficients with the structural model.

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1. INTRODUCTION

The extreme volatility of residential construction has attracted extensive research and comment. Over the last two decades, in Canada, total annual residential unit starts increased from 130,095 in 1962, to a peak in 1976 of 273,203 units and dropped to a low of 125,860 units in 1982. Similar extreme patterns can be noted in most Canadian urban centres with residential construction activity peaking in the mid 1970's. To aid in economic analysis, forecasting, government policy evaluation and implementation, research has been undertaken to explain this volatility in construction and the structure of housing markets. Traditionally, vacancy rates have been cited as linking the demand and supply components of the housing market. This paper attempts to examine the role of inventory of new units as a more direct buffer between the demand and supply of units in the housing market. Investigation of the importance of inventory levels in the determination of housing production will enhance forecasts of future residential construction activity, understanding of the underlying market forces, and the impact of existing market conditions and demographic trends on the housing market.

Despite the obvious cyclical nature of total residential construction, distinct trends in the multi family and single family markets suggests the need to examine these two market sectors separately. Multi family starts in Canada peaked in 1969 at 104,622 units, and then, after a relatively stable

period, dropped dramatically from 1973 to 1974 (98,776 units to 67,599 units). Since 1974, multi family starts have been declining with extreme lows noted in 1977 and even further declines by 1982. Single family construction also peaked in 1973 at 85,089 units but did not decline as significantly in 1974. Multi family construction is still at about 50 per cent of the pre-1973 levels of construction. This reinforces the belief that the two markets respond to different stimuli and should be examined as separate entities. The focus of this study is on the multi family housing submarket.

Within the multi family market, vacancy rates are cited as a key indicator of demand. Assuming that the market is efficient and has some long run equilibrium point, an increase in demand should result in a decline in vacancies, an increase in rents and subsequent increase in new stock. However, throughout the 1970's there have been consistently low vacancy rates in all major centres in Canada and simultaneous declines in the level of multi family unit starts. In Vancouver vacancy rates were below one percent for much of the period from 1974 to 1981, but starts declined from 2,962 in the fourth quarter of 1973 to a low of 213 units in the fourth quarter of 1982. It may be argued that this apparent disequilibrium is the result of rent controls; prices were not permitted to find their market levels and consequently supply failed to respond to the increased demand. Counter to this, evidence indicates that similar declines in construction were noted in cities without controls (see Jones,1983,p6). Recent comments from market

participants indicate that the uncertainty and low investment returns in the rental market have discouraged investment. Therefore, the market dynamics requires investigation beyond the simplistic assumption that vacancy rates reflect demand conditions and builders will respond to these changes in the long term.

The dynamics of the multi family housing market have been further clouded by government intervention in the market and policy implementation. These have been intensified during the 1970's with direct subsidy programs, subsidized rental programs and changes in the tax legislation. The basic rationale has been that without such policy, the market would be unwilling to supply "adequate and affordable" rental units (Weicher,1976).

Low levels of multi family starts, consistently low vacancy rates and the perceived need for government intervention have lent support to the belief that there is a rental housing crisis in most Canadian urban centres. But it is also possible that the structure of the housing market is changing and this alarm may be premature. Declining household size, lower birth rates, a greater demand for inner city locations and the use of housing as an investment suggest that the market is undergoing adjustment, rather than a crisis. The response of market participants to these changes is slow and will therefore be noted in the long term cycle but may not be reflected in the overlapping short cycle of the market.

Given the inability of vacancy rates to explain the cycle in housing construction and the possibility of the market

undergoing a process of adjustments, this paper proposes the use of inventories as a link between the demand for and supply of multi family units. The multi family construction cycle consists of two components; the long cycle which is responding to changing demographics and market structure; and the short cycle which reflects the more immediate economic conditions. The ability of builders or investors to maintain inventories of completed and unoccupied units provides a buffer to absorb any unanticipated changes in demand. The specific level of inventory held, at any time, will reflect expected demand and current economic conditions. This is similar to manufacturing inventory cycles and pricing mechanisms, but the immobility and durability of housing make it a unique commodity, restricting the application of inventory adjustment theory. Rather than estimating the level of starts with only economic variables, the suggested approach is to incorporate demographic change and inventories into the model. Assuming builders or investors have some desired level of inventories based on economic conditions and expected demand from demographic change, the level of starts will be set to maintain inventories at this level and to satisfy expected demand. Clearly fluctuations between the actual and desired level of inventories will exist from unanticipated changes in demand and the inability to adjust inventories immediately. Gradual adjustments for unanticipated demand changes and fluctuations in the desired inventory level will generate the noted cycle in starts.

This paper will develop the theoretical structure of this

technique and report the empirical analysis using Vancouver Census Metropolitan Area data from 1963 to 1982. In this development of a regional inventory adjustment model for the multi family housing market, two main questions will be addressed:

1. Are there identifiable causes for the decline in rental apartment development and of the attendant decline in vacancy rates in Urban Canada during the 1970's?
2. Are developers/builders responding to an inventory cycle within the housing market? Do starts therefore reflect the desired level of inventories in each period based on other economic conditions?

The next chapter will briefly outline the current state of the art in housing starts models. In recognition of the impact government policy has had on the housing market, Chapter 3 will present a summary of those policies most directly influencing the multi family housing market in Vancouver. Chapter 4 will discuss the inventory adjustment concept and the theoretical model developed in this paper. Chapter 5 will discuss the data series and the inherent difficulties with these data. Chapter 6 will present the empirical results of the model, a time series model based on the data and the testing of the model's reliability and forecasting ability. A summary of the findings and the implications for further research are outlined in Chapter 7.

2. LITERATURE REVIEW

The existing literature on housing starts and the structure of housing markets may be divided into four broad categories. Essentially, these encompass discussions of (1) cycles in residential construction, (2) the price and income elasiticities of housing demand and supply, (3) the rationale and implications of government policy and intervention in the housing market, (4) econometric models of the market and estimations of housing starts and demand.

The literature on housing cycles tends to be very general and descriptive, with later studies examining the specific forces of these cycles and the development of econometric models. Since these provide background for the econometric analysis reviewed, the general concepts and theories of housing cycles will be presented.

There is no concensus in the literature on the price or income elasticities of demand or supply; estimates range from near zero to infinity (see Rydell,1981,p3). Attempting to reconcile these differences, studies have distinguished between renters and owners, low and high income groups, on the premise that an understanding of these elasticities and the difficulties in their estimations will provide a better understanding of the market and its participants. The results of this literature will be reviewed briefly.

Government policy and intervention will undoubtedly affect the results of any empirical analysis. However, this literature

does not provide any background for the theoretical model. A separate chapter is devoted to discussion of Canadian Government housing policy and its impact on the multi family housing market.

Finally, an increasing emphasis has been placed on the development of econometric models to explain and/or predict housing starts. The specific nature of previous econometric models and the estimation techniques are of great significance to the alternate approach proposed in this paper. The emphasis of this chapter will be on the development and success of existing housing starts models, with four specific models discussed as background to the theoretical model presented in Chapter 4.

2.1 HOUSING CYCLES

Some argue that the housing cycle is anticyclical to the general business cycle (Guttentag,1961;Alberts,1962). Others maintain that although the housing cycle does not match the general cycle, it is not anticyclical, rather, it has a different time horizon (Chung,1976;Stevens,1976). The duration and amplitude of the cycles are usually measured by the peaks and troughs, although it is also possible to use deviations from the expected trend as a measure of volatility. The former measure is generally used in the literature on housing cycles and is the relevant measure in the following discussion.

Support for the housing cycle being anticyclical is offered by evidence in the United States during the postwar period.

Housing construction declined during the periods of business expansion from 1945 to 1948, again until mid-1953, and from late 1954 to late 1957. Similarly, during the recessions of 1948 to 1949 and 1953 to 1954, the housing cycle was on an upswing. More recent Canadian trends have not supported the anticyclical theory as strongly; the business cycle peaked in 1965 and 1968, but residential construction was at a low in 1965 and close to a peak in 1968 (Chung, 1976,p34). It is generally accepted that residential construction is cyclical and that this cycle does not correspond to the business cycle, nor does it follow the non-residential construction cycle (see Chung,1976,pp35-6). Several theories have been proposed to explain these cycles, focusing on credit conditions and the demographic structure of the population.

The cost and availability of credit clearly influence residential construction. Interest rates represent the cost of credit and the potential yield in both the bond and mortgage markets, thereby influencing the flow of funds between the two markets. Succinctly, as the yield on bonds increases, funds will move into this market at the expense of the mortgage market.[1] Since the flow of funds will restrict activity in each market, the logical conclusion is that housing and the general business investment cycles will be anticyclical. But this ignores the greater complexity of the mortgage market. Interest rates do not fully reflect origination or other fees required by the lender. Mortgages for larger projects have their own individual characteristics and therefore they are not comparable

simply on the basis of interest rates. Further, the flow of funds from the mortgage market will be constrained by prior loan commitments by lenders.[2] It is also possible for lenders in the mortgage market to influence borrowing, and subsequently construction activity, through the availability of credit by adjustments in loan-to-value ratios, the amortization period or the term. Each will affect the required mortgage payment, the resultant profitability of the project and consequently, construction activity. Obviously, the expected yields in the bond and mortgage markets will influence the quantity of funds available for investment in each market, but interest rates alone are insufficient to explain the noted cycles.

Alternatively, the level of construction activity will be influenced by the demographic structure, rising incomes, changing social values and relative prices for single and multi family housing units.[3] From 1953 to 1973, the ratio of multi family to single family starts in the United States trended upward to a peak of 83 percent in the third quarter of 1973. This fell to 32 percent by the first quarter of 1975. Although new housing construction was increasing from early 1975, apartment construction did not recover to the same extent, and has remained at about 30 percent of total starts. The increase in multi family construction from 1959 to 1973 has been attributed to the movement of the "baby boom" population into the 15 to 29 age cohort. The industry responded to the expected increase in demand for rental units by increasing multi family construction. As this "bubble" in the population ages, the

demand for single family units is expected to increase, but the multi family rental market is less likely to rebound. Stevens suggests that the consistent decline in starts since 1975 may be the result of "overbuilding" apartment units in the boom period of 1971 to 1972 (1976,p.18).

The evidence indicates that the relationship may be more complex than two interactive cycles and therefore, investigation must extend beyond explaining the link between these cycles. Studies suggest that construction cycles range from 16 to 20 years, while business cycles range from 8 to 12 years (Chung,1976,p35). Further, there may be long and short cycles within the housing market. Guttentag (1961) suggests that the long cycles are the result of fluctuations in the demand for housing and the short cycles are more closely linked to the mortgage market. Consequently, if demand is influencing changes in the level of construction, mortgage yields and construction should move in the same direction. Alternatively, mortgage yields and construction levels would be expected to move in opposite directions when the supply of credit is influencing the market. Undoubtedly, the demographic structure and economic conditions will influence the demand for specific types of units and the responsiveness of builders, however, the magnitude of the impacts attributable to different forces and stimuli requires further investigation.

2.2 SUPPLY OF HOUSING - ELASITICITIES

The supply of housing obviously refers to the quantity of

housing services available in the market. Similarly, the demand is the quantity of services that the population requires at any given point in time. The price elasticity of the housing supply is then the percentage change in the quantity of housing services provided, associated with a one percent increase in the price of those services. Similar definitions can be derived for the income elasticity of supply, and the price and income elasticities of demand. But, within all of these, there is no clear definition of 'housing services'. Standardization of the quantity of housing services has been achieved by using some rental index, costs of inputs, or standard house price in recognition of the varying qualities of housing available in the market.

There is general agreement in the literature that the price elasticity of demand for housing is between 0.17 and 1.28 (Rydell,1981,p21). Follain (1979) suggests that this may reflect the price elasticity of demand for the overall population, but low-income, rental households are much less responsive to changes in price or income. This raises the question of whether the elasticities should be measured for the total population, or whether it more appropriate to disaggregate the population by income and tenure.

The literature offers less agreement about the price elasticity of supply. Rydell(1981) attempts to reconcile some of the differences by examining the data used, or definitions of the housing stock, which may affect the results significantly. This provides an explanation of the divergent estimates, but

still leaves no concensus of the "correct" measure of elasticity of supply. Based on a sample of 59 metropolitan centres in the United States, Rydell suggests that the long run price elasticity is 11.3, and the short run or occupancy rate price elasticity is 0.2 where the vacancy rate is 3 per cent, and 2.0 where the vacancy rate is 15 per cent (1981,p2). The distinction is that in the long run, supply is flexible and can adjust to demand changes; in the short run the only adjustment is in the number of units occupied and the total supply does not adjust. This does not address the question of separate elasticities for rental or owner-occupied units. Do builders respond differently to prices and other stimuli in each of these markets? Evidence presented in the development of econometric models suggests that in fact the two markets are very distinct.

2.3 HOUSING STARTS MODELS

The cyclical nature of the residential construction industry and the market adjustment mechanisms have been discussed extensively in several theoretical and empirical analyses. The focus of these has ranged from national economic models where housing is an integral part (Smith,1969; Waslander,1973) to regional models (Rosen,1979), and from viewing the housing market as a whole (Maisel,1963; Jaffee & Rosen,1979; Fair,1972) to disaggregating the multi and single family markets (Smith,1969). Despite these differences, credit and financial variables are consistently singled out to be the key in explaining market fluctuations. Some other determinants

which have been incorporated into models include change in population (increase or decrease; age-sex breakdown; household formation, migration), income and employment, consumer asset holdings, the price of housing, occupancy costs, consumer tastes and preferences, the condition of existing stock and the responsiveness of builders and investors to changes in demand (Grebler & Maisel,1963,pp76-7).

The assumptions of the underlying market structure follow two major approaches. The first assumes that there is some long run equilibrium in the housing market. Price and supply then respond to changes in the market in accordance to classical economic theory, attempting to acheive this equilibrium point. The fluctuations in the supply result in the noted cycles in construction (Quigley,1978). The second approach assumes disequilibrium in the housing market. To analyse the market forces it is necessary to first determine whether supply or demand is constraining the market adjustment process at any given time (see Fair,1972;Fair & Jaffee,1972). In response to these diverse approaches, Smith suggests that the assumption of long run equilibrium may be correct, but studies should concentrate on the process of adjustments in the market as it approaches equilibrium, not the final equilibrium result.[4]

The four models discussed here provide an overview of the 'state of the art' in estimating housing starts. Each of these models assumes some long run equilibrium in the housing market and that the market is efficient. They by no means exhaust the existing work, but do indicate the general trends in housing

starts models.

2.3.1 Maisel - Inventory Adjustment Model

Maisel's model is based on the supposition that inventory cycles in the housing market are similar to the cycles noted in manufacturing. Volatility in the level of starts is not attributed to credit conditions and costs, but inventories and responses of market participants. The adjustment process for unit starts and inventory levels involves a series of lags and partial adjustments which foster instability in the system.

The basic argument of Maisel's model states that, assuming the housing market is in equilibrium, builders would initiate housing starts sufficient to maintain a constant level of inventory. Therefore, the completion of units would exactly equal demand; stock would increase by the number of completions, less any removals or demolitions. It is then possible for some exogeneous force to initiate change in the rate of household formation, an increase or decrease in the number of demolitions, or change builder expectations of future demand and/or profit. The resultant disequilibrium in the system will be noted internally through vacancy rates and the relative prices for rental and ownership units. Subsequently, builders' profits will be affected directly by price fluctuations, or indirectly through the holding costs of vacant units, unexpected changes in demand (by increased or reduced rates of household formation). If conditions are favourable, starts should increase until vacancies begin to increase. This rise in vacancy rates and

inventory levels will feed back through the system until the level of starts decreases. This ongoing feedback mechanism will generate the inventory cycle and cause the noted volatility in starts.

Given the basic framework for the housing market, Maisel suggests a model based on four functional equations and a final identity for starts. The level of starts in any period will equal the sum of net household formation, net removals, changes in inventories and deviations in vacancies from the expected trend. Net household formation forms the demographic component of the model. Changes in the number of households will depend upon the population structure, incomes, unemployment, credit and prices. This is consistent with other models that examine changes in household formation. Time and disturbance terms are added to account for any variation not explained by the other variables. Net removals are given as fluctuating in accordance with government policy and programs which may encourage or discourage new construction, income levels, existing vacancies and the stock of housing. The difficulty in measuring these impacts and the level of removals in any time period prevented these from being included in Maisel's empirical analysis. Vacancies are thought to fluctuate about a trend. Maisel measured the deviation of vacancy rates from this trend, and concluded these were a function of costs, household and builder market expectations, credit availability and prices, rents and the existing disequilibrium in vacancies. Inventories are included to incorporate the time lag between starts and

completions. The change in inventories will be a function of starts and completions (which are a direct function of previous starts).

The lack of reliable, consistent data dictated that Maisel's housing starts equation be estimated using a reduced form equation with interest rates, deviations in vacancy rates from the trend, lagged starts, the ratio of rents to residential costs, estimated removals and the change in the number of households. Based on quarterly data from 1950 to 1960, the estimated equation yielded an R^2 of .878.

The conceptualization of Maisel's model appears sound, but difficulties arise in the empirical development. The most severe criticism is the estimation of the removals series; calculated as the residual of the change in stock not accounted for by new starts. Consequently, the high R^2 and significance of this variable could be expected. Also, using national data ignores the localized nature of the housing market. Residential construction will be dependent upon local economic conditions and expectations. When some areas are experiencing lower construction, other areas may be noting higher levels of construction activity. Consequently, by aggregation of these data, national results will not fully reflect the responsiveness of residential construction.

2.3.2 Smith - Bi-Sectoral Housing Model

The housing market can be described as a series of overlapping submarkets based on location, dwelling type, tenure,

age and quality. Smith attempts to disaggregate the single family and multi family markets by developing a bi-sectoral model which investigates the differences between these two sectors. His premise for this distinction is the changing proportions of starts in each sector and the very different rates of change in rents and house prices between 1951 and 1967 (1969, p559). The overall model developed is a "stock-flow model in which the volume of housing starts depends upon a comparison of house prices or rents and vacancy rates with construction, land and financing costs, and the availability of public and private mortgage credit. Prices, rents and vacancy rates are determined by the demand for and supply of each type of housing accomodation. The demand for single unit dwellings depends upon the price and carrying costs of this form of accomodation and the price of non-housing goods and services, permanent real disposable income, demographic factors, and the costs and availability of mortgage credit." (1969,p559)

The equations presented for the level of starts in each sector are essentially the same, with the price of housing and the single family stock entering the single starts equation, and rents and the multi family stock being used for the multi family starts equation. Multi family starts are given as a function of rents, vacancy rates in multi dwelling structures, construction costs, land costs, the cost of credit, the availability of private mortgage funds and the costs and availability of public (CMHC) mortgage funds.

Some of the variables were eliminated from the estimated

regressions, or proxy variables derived, since the data series available for estimating the equations were either of poor quality or unavailable. During the period under investigation, 1954 to 1965, there was no reliable vacancy rate series. Elimination of vacancy rates from the empirical results implies that market conditions are fully represented in house prices and rents. The difference between mortgage rates and bond yields was used as a proxy for the availability of mortgage credit. Finally, a dummy variable was used for the government winter building program which was in effect from 1963 to 1966.

The results yield an R^2 of 0.89 for the multiple dwelling starts equation and 0.93 for the single starts equation. The main distinction for the two sectors is in the cost and availability of credit. The cost of credit coefficient is similar and significant for both sectors, but the proxy for the availability of credit was significant only in the single family sector. From this Smith concludes that developers of multi unit projects will be more sensitive to the cost of credit, or interest rates which affect profitability than to non-price terms. This is supported by the greater willingness of financial institutions to lend to "large corporate borrowers who dominate the multiple dwelling construction rather than smaller builders who are prevelant in the construction of single unit dwellings".(p563)

Other variables in the equation suppported the hypothesis that the two market segments are distinct. Higher land costs increase the number of multiple starts and decrease the number

of single starts. This change of sign was expected on the basis maximizing land use as land costs increase. The ratio of rents to construction costs is more significant than the ratio of housing prices to construction costs. Smith suggests this may be the impact of custom house construction in the single sector and speculative building in the rental sector.

To complete the model, Smith then derives equations for the demand for single and multiple units, the relative prices and the total supply of units in each market sector. These further support his hypothesis of distinct markets. By developing similar equations for each market segment, Smith does not address the possibility of demand or supply influences being different for either market. The model would suggest that both markets are supply driven which is in contrast to other studies.

2.3.3 Jaffee & Rosen -
Credit Availability & Residential Construction

Jaffee and Rosen develop a national model for the housing, mortgage and deposit sectors of the economy based on five equations; the stock-level demand for home ownership, single family housing starts, multi family housing starts, the interest rate on mortgages and the deposit flows of thrift institutions. Of special significance is the explicit modelling of demographic change and the development of separate equations for the single and multi family housing markets.

The stock-level demand for housing is estimated based on the demographic composition of the population and the headship

rates for each age cohort. Jaffee and Rosen propose that the actual population and age distribution are generally known. The transformation of this data into household units contains some uncertainty, but is fairly predictable in the short run. By assuming constant headship rates for owner-occupied housing over the estimation period, the number of households can be projected. The ratio of the actual number of households to this adjusted number of households provides an indicator of household formation which cannot be attributed to demographic change and, therefore, must be the result of changing economic conditions.

This estimation procedure is only used for the single family housing market. Jaffee and Rosen state that in the single family market, construction is determined by the demand side variables. The equation for the change in the number of owners includes four economic variables: the ratio of ownership costs to rental costs, the unemployment rate and a measure of mortgage availability, together with the previous stock of owner-occupied housing. The adjusted number of households is used as a multiplicative factor in this equation so that the coefficients of the economic variables will reflect only non-demographic shifts. Single unit starts are then given as a function of the change in the number of owner-occupied housing units, the existing stock, the number of vacant units and mortgage credit availability and costs. In the estimation of this starts equation, the fitted change in the number of owners is used for the actual change in the number of owner-occupied housing units.

Jaffee and Rosen follow the general concensus and assume that the multi family construction is determined by supply side variables and profit maximization of the market participants. Five factors are then proposed for the multi unit starts equation: profit margins, mortgage interest rates, multi family vacancy rates, mortgage fund rationing and the stock of multi family units (used as a scaling factor). Using U.S. national data, quarterly from 1964:1 to 1978:2, the estimation yielded an R^2 of 0.944 with all variables significant. The final equation included profit (estimated as the rental CPI deflated by the total CPI), real interest rates and the change in deposits to thrift institutions deflated by the total CPI was as a proxy for mortgage fund rationing.

The next stage of the model is an estimation for mortgage interest rates based on the supply and demand for mortgage funds. Finally, the flow of funds to thrift institutions is estimated using interest rates and rates of personal savings. The differences in the Canadian and U.S. mortgage markets reduce the applicability of these further model derivations.

With respect to the multi family markets, Jaffee and Rosen conclude that construction is determined by the supply side profit incentives for builders. Although they explicitly model the non-demographic demand for single family units, they ignore this component in the multi family sector, on the assumption that construction in the multi family housing market is supply oriented and therefore the market demand is reflected in vacancy rates and prices (rents). Finally, although the results of the

estimates are significant, regional impacts cannot be determined from the national results derived.

2.3.4 Rosen - Regional Model of Multi Family Housing Starts

Rosen proposes that the extreme volatility in multi family housing construction is the result of inventories accumulating until there is a sharp reduction in starts to permit the additional units to be absorbed. This is based on the assumption of the disequilibrium process, whereby vacancies adjust quickly to changes in the market, but rental prices and the stock respond more slowly. Essentially, the first response in the market to an increase(decrease) in demand will be reflected in vacancies, then, with a lag, rental prices should adjust to reflect the increase(decrease) in demand. Finally, new construction and conversions should be undertaken (delayed or abandoned).

Given this overview of market operations, Rosen states that the supply of multi family units will be dependent upon the profit maximization decisions of existing landlords and new potential investors. Profit includes expected revenues, the occupancy rate, occupancy costs, construction and land costs, depreciation tax benefits and capital gains.

For the empirical analysis, the U.S. is divided into four regions (Northeast, North Central, South, West) and logged equation estimated for housing starts in each region. The results indicate distinct regional differences and emphasis the importance of profitability. Profitability is estimated as the

rental component of the CPI deflated by the total CPI. The elasticity of this variable ranged from 5.69 (North Central) to 14.31 (South).

The regression results for these equations are significant, but, Rosen notes that the results do not yet include the demand side of the market, nor the impact of taxes and government policy. These are proposed for future study. A further criticism is in the assumption that vacancy rates will reflect all available inventory. This ignores newly completed units which have not yet been included in the stock survey for vacancies. Although the benefits of regional results are evident, the regions chosen may still be too large to reflect the housing market accurately. Within each of the four regions defined, there could be very diverse market trends which will influence the final results.

2.4 COMMENTS ON EXISTING WORK

Examination of the existing literature on housing markets and more specifically housing starts indicates some concensus on the nature of the market, but also raises several issues. With some deviations, the demand for housing units, or the rate of household formation is generally given as a function of income, unemployment rates, the price of housing (rents and/or ownership costs) and the price of other goods and services. Where the supply of rental and owner-occupied housing units are segregated, the supply of single units is assumed to respond to demand variations. Alternatively, multi dwelling construction

is thought to be supply oriented; responding to profit maximization, vacancies and interest rates. These variables seem to be the key components in the theoretical models, but, there is no concensus on the estimation techniques or results. Some of the key issues which raise questions in the existing literature, or require further investigation include:

1. The existing research on housing starts has focused on the impact of credit costs and availability. Evidence suggests that the cost of credit may be important, but not necessarily the primary consideration. Difficulty in this regard is complicated by the differences of Canadian and U.S. mortgage markets and the limited research in the Canadian market.
2. Most of the analysis have been based on national starts data. Since housing is an immobile and durable good, there will be regional differences in market conditions and activities. By ignoring these submarkets, information on the impact of regional economic conditions will not be considered.
3. The importance of the demographic structure of the population on future demand is noted in most of the previous work. There are few attempts, however, to estimate the importance of this demand, or changes in the expected demand on the supply of housing units.
4. More recent studies have recognized the distinction between the single and multi dwelling unit

markets. However, most models are still based on the total housing market, implicitly assuming that the submarkets are responding to similar stimuli. Of greater importance is the need to recognize the substitutability of the shelter component of rental or owner-occupied housing and the added investment component of homeownership.

5. The need for government intervention in rental markets has been discussed in some papers, but as yet, the impacts fo government and tax policy on the housing market remain uncertain and controversial.

6. There is a lack of reliable and consistent data on the housing market. Consequently, many models rely on proxy measures and estimated series. This has severely reduced the validity of results.

7. The link between the demand for and supply of housing units has not been fully explored. There is little discussion of the use of inventory levels as a buffer between the market participants and unexpected events in the market.

In addition to these problems with the overall research on housing starts, there is very little research relating to the Canadian market. Since Canadian mortgage markets, tax laws, government policy and perhaps housing consumption patterns are different than those found in U.S. cities, it would be reasonable to anticipate different empirical results.

3. IMPACTS OF GOVERNMENT PROGRAMS AND POLICY

The proposed model is based on the assumption of a competitive housing market with no government programs or policies to influence investment in the rental market or the attractiveness of home ownership. This idealistic scenario does not accurately reflect the state of the post-war Canadian housing market. Government intervention has had a significant impact on the housing market, therefore, an understanding of these policies is a prerequisite to any discussion of the market structure or forecasting model. Despite some programs specifically designed to encourage investment in the rental market, the general bias of Federal housing policy has been toward homeownership. Policies in the Province of British Columbia have echoed this bias. The following provides a brief overview of the policies and programs influencing the Vancouver multi family housing market during the study period. It is beyond the scope of this paper to discuss these programs and their impacts in any detail. Comments therefore, are limited to the implications for the proposed theoretical and empirical analysis.[5]

3.1 GENERAL POLICY CHANGES:

(a) Strata Titles

In British Columbia in 1966, legislation was passed permitting the registration of strata titles, ownership of

individual units within a multi-unit structure. Further legislation in 1974 restricted the conversion of existing rental buildings to condominiums by requiring approval from at least 90 percent of the existing tenants. The ability to own a unit in a multi-unit dwelling clearly affects the multi family housing market, invalidating the common assumption that multi family units are automatically rental units. Estimations of the existing multiple stock must distinguish between owner-occupied and rental units. New construction may be for either market. Buildings can be registered as a condominiums, but actually end up being rented upon completion. The development of the condominium market in the Vancouver area creates difficulties in analysing the available construction data and trying to determine the size of the rental market.

3.2 DEMAND ORIENTED POLICIES

(a) Provincial Home Owner Grant Act

Passed in 1957, this act provided a fixed annual grant to all homeowners in British Columbia. Distribution was through municipal taxes, where the grant was applied to the resident's taxes up to the lesser of the maximum grant or total property taxes. Initially, only single-detached and duplex units qualified; however, in 1960 this was amended to include any property where the owner is resident.[6] The maximum grant rose from $28 in 1957 to $200 in 1973.

(b) Home Acquisition Program

This program, started in April 1966, provided purchasers of new and existing dwellings who had resided in British Columbia for at least one year, a grant of $500. In April 1967 the grant was increased to $525 with the intent of annual increases of $25.

The program underwent changes and in 1976 purchasers of new housing units were eligible for a $1000 building or acquisition grant or a $5000 second mortgage. Purchasers of existing houses were eligible for a $500 acquisition grant, or a $2500 second mortgage. The second mortgage could be applied to the downpayment, except where the first mortgage was NHA insured.[7] At the time this program was cancelled in July 1983, grants of $1000 were available for single households and of $2500 for households with at least one dependent less than 19 years of age.

(c) Renters' Resource Grant Act

To offset the benefits to homeowners, the Provincial Government of British Columbia passed the Renter's Resource Grant Act in 1974. Grants of $30 per annum were available to all renters who applied, with an additional $50 to those over 65. Distribution changed in 1976; forms were included with income tax returns, income limitations were imposed and rebates increased (up to $100, depending on the income of the applicant). This program ceased with the filing of 1982 tax returns.

(d) Grant to New Home Buyers

From November 1974 to October 1975 the Federal Government provided a grant of $500 to first time home buyers. To qualify, the units purchased had to be newly constructed and priced below a set limit. Limits were set by CMHC according to average house prices in each region.

(e) Assisted Home Ownership Program (AHOP)

The objective of this program was to enable lower income families to own houses without spending over 25 percent of their income on shelter. Mortgages were provided by CMHC at favourable interest rates and with high loan-to-value ratios. A mortgage subsidy of up to $1200 per year was available to offset the mortgage costs. The AHOP program, administered by the Federal Government was in effect from 1973 to 1978.

3.2 SUPPLY ORIENTED POLICIES

(a) Winter House Building Program

In place from 1963 to the spring of 1966, the Winter House Building Program provided a subsidy of $500 per dwelling substantially constructed between December 1 and March 31 each year. This was available only for structures of 1 to 4 dwellings, eliminating most multi family dwellings. Consequently, it would be expected that single family construction would be shifted to the fourth quarter to benefit from this program, while multiple unit construction may subsequently be shifted to other quarters.

(b) NHA Multi-unit Loans

The National Housing Act restricted the level of interest rates, loan-to-lending value ratios and the maximum loan available per unit in multiple dwelling structures. In 1969 all interest rate ceilings were removed. The maximum loan amounts for apartment buildings were increased from $12,000 to $18,000 per unit in 1968, and further increased in 1972 to $23,000.

(c) Tax Legislation

In November 1971, new tax legislation was passed which reduced the benefits of real estate investments. Income losses from real estate investments could only be applied to other real estate income, removing the tax shelter benefits of real estate. Assets over $50,000 required separate CCA schedules, eliminating the possibility of delaying recapture taxes through asset pooling. Capital gains taxes were introduced for financial and real estate investments. These were payable on increases in the property value over the holding period and therefore payable upon reversion.

(d) Multiple Unit Residential Buildings (MURB)

In response to extensive public pressure, the MURB program was introduced in the November 1974 Federal Budget. The underlying rationale for the program was that it would provide greater returns for investors in the multi family market. Hence, construction of multiple dwelling structures was expected to increase, permitting vacancy rates to return to a "normal"

level. "Excess returns" were acheived by permitting full CCA benefits to be claimed on MURB's and any income losses could be used to shelter other income. The MURB program was to be in effect for one year, but, was extended annually until 1979. In October 1980 MURB benefits were reinstated until December 1981.

(e) Assisted Rental Program (ARP)

The ARP program, in effect from 1975 to 1978, provided rental units for lower income households. Initally, ARP offered an annual grant to developers of up to $900 per unit. This subsidy was paid monthly, and reduced by 10 percent each year. In 1976, the grant was changed to a graduated payment loan of up to $1200 per unit annually, reduced by 10 percent per year, for 10 years. The loan was interest free for 10 years and registered as a second mortgage on the property. In British Columbia, a complementary program was in effect from 1975 to 1977, where a grant was available from the provincial government of up to $600 annually per unit. This was also reduced by 10 percent per annum for the 10 year duration of the agreement.

(f) Rent Controls

Rent controls were initially introduced in British Columbia in 1974 and removed with the Budget in July 1983. The exact restrictions and review process underwent several changes including removal of restrictions for new units and upward adjustment of the upper limit of units to be exempted from controls. The impact of rent controls on the rental market is

controversial and cannot be adequately discussed here.[8] The added uncertainty and greater restrictions imposed on the market are cited as reducing the attractiveness of investment in the rental market.

(g) Canada Rental Supply Program (CRSP)

Following the announcement of the removal of the MURB program in November 1981, CRSP was introduced. Its objective was to assist in the construction of 15,000 rental units across Canada in areas of tight rental market, thereby preventing further deterioration of vacancy levels. In March 1982 the number of units was increased to 30,000.

Fifteen year, interest free loans of up to $7500 per unit were made available to assist in the financing of construction. The loan was registered as a second mortgage on the property and will become due and payable at the end of the 15 year term, or if the property is used for other that rental residential units, or upon default of the first mortgage. Comments in the media at the time of the programs inception suggest that the amount would be insufficient to encourage extensive investment.

3.4 IMPACTS ON THE MULTI FAMILY MARKET

The above outline of the prevalent housing programs supports the statement that the bias of Canadian post-war housing policy has encouraged homeownership. Other developments such as amendments to the Bank Act, the non-taxation of construction materials and zoning[9] will also influence the

housing market and construction activity. In the context of this study, the important issue is, how will the policy bias toward homeownership and other government programs influence the demand and supply of multi family housing units? Any discussion on this question may be distorted by lifestyle preferences, other economic conditions and demographic changes.

Assuming that there are only two housing submarkets, rental and owner-occupied and that these markets are competitive, it could be argued that policy encouraging homeownerhip will reduce the demand for and supply of multiple units. Developing this briefly, if the demand for homeownership increases due to a government policy , the demand for rental accomodation will simultaneously decline, assuming no change in household formation as a result of that policy. Since the short run supply curve for housing is inelastic, the price of rental units will decline, followed by a decline in the quantity constructed. Similarly, the rise in the demand for single units will result in a price increase and subsequent increase in the quantity of units constructed.

This line of argument ignores changes in demand from the demographic structure and lifestyle preferences, and the possibility of elasticity in the supply curve provided by inventories and units under construction. (These could be added to the stock in the short run.) It also assumes that government policies which reduce the cost of single family housing do not cause an increase in household formation.

The highest rental component of the population is the 15-29

age cohort. As the "baby boom" segment moved through these years the demand for rental units increased. However, with the aging of this segment of the population and the decline in the number of people in the younger and high rental age cohorts, greater demand is expected for ownership units and less emphasis on rental units.

A further consideration is the common attitude of housing providing a "hedge" against inflation, thereby offering investment and shelter components.[10] Since the price of housing is commonly perceived to have kept pace or surpassed inflation, and there are no taxes on the imputed rents or capital gains from housing, households which may not have entered the ownership market previously are doing so for the investment opportunities. Demographic changes, lifestyle preferences and the investment benefits of housing have increased the demand for ownership. The decline in multi family construction over the past two decades is therefore not an unreasonable expectation. But, the question of how government policy affect the multi family housing market remains.

The tax changes in 1971 and the introduction of rent controls in 1974 are quoted as two significant forces detering investment in the multi family housing market. The MURB program was designed to encourage private investment in the multi family housing market. Two conflicting views on the success of the program have been offered. The first suggests that the level of starts was significantly increased for the duration of the program.[11] The alternate argument is that the benefits of the

program were shortlived, with the benefits being capitalized into land prices.[12] An examination of the data suggests that multi family starts were generally declining in the 1970's, with an increase in 1975 when the program was introduced and a sudden surge in 1981 with the announcement of the program's cancellation. Simultaneous programs, such as ARP, AHOP and government grants cloud any interpretation of the specific impacts of the MURB program.

Another possible impact of the MURB program, suggested by Smith(1981), is a shift in the seasonality of multi family construction. In anticipation of removal of MURB benefits each year in the Federal Budget, Smith proposes there is a tendency for builders to increase starts in the fourth quarter.

Government intervention in the housing market has undoubtedly changed the market structure and the responsiveness of builders to demand and other economic variables. Although it can be argued that the housing market is efficient, current market participants recognize the strong influence of government programs over new construction. Without the benefits of some government incentive scheme, construction is drastically scaled down. Alternatively, construction plans are escalated upon the announcement of new incentive programs. The rationale for government programs has focused on providing "affordable and adequate" housing and to reduce the cyclical nature of residential construction. It may be possible to argue that the residential construction industry is now so dependent upon incentive programs that these are a driving force in the housing

market. If this is the real market scenario, the task of determining the market dynamics becomes increasingly difficult since the precise impacts of government programs are not known with any accuracy. There is also a need to distinguish market and non-market housing construction to enable a better understanding of policy impacts and the determination of economic variables influencing the market. Although dummy variables can be used in the empirical analysis during the periods where programs were implemented, there is little evidence to support the design and structure of these variables.

4. THEORETICAL MODEL

Previous research has estimated the level of starts using reduced form equations based on economic variables or proxies, with little discussion devoted to the inventory of completed units or units under construction maintained by builders. The model components and lag structure adopted depend upon the exact specification, nature and purpose of the model. An alternate approach was taken by Maisel(1963), who attempted to develop an inventory adjustment model where the construction level of new housing units was set to satisfy expected demand and maintain a desired level of inventory. Rosen (1979) endorsed the concept of an inventory approach and indicated that the initial reaction to an increased demand would be reduced inventories. Builders would increase construction in response to reduced inventories, depending upon other economic conditions and the current desired level of inventory.

Assuming the housing market is in equilibrium, some exogeneous force could initiate an increase in the demand for housing units which would be met through existing vacancies and inventories of completed and unoccupied units. If builders desire to maintain a constant level of inventory, the level of starts in the following periods would be increased to replenish inventories and meet expected continued increases in demand. The reverse process naturally follows; starts would be reduced if demand declined and inventories increased. It is also possible for the desired level of inventory to change based on

builders or investors costs to maintain vacant units, and expectations of future demand.

Given this expected adjustment process in the housing market, it is suggested that an inventory adjustment model would be appropriate to estimate the level of starts in a given period. It may be possible to expand the following theoretical model to the single family housing market, but for the purpose of this paper, only the multi family market will be reviewed.

4.1 INVENTORY ADJUSTMENT CONCEPT

The theoretical inventory adjustment model uses expected and actual sales and deviations from projected sales to estimate the production for a given period. If sales exceed expectations, producers may repsond through: price adjustments, increases in production schedules, permitting some unsatisfied demand, or inventory reductions. Price adjustments are generally resisted since the market may interpret this as some error on the part of the producer, reducing consumer confidence. Since immediate production changes are generally costly they are avoided and producers prefer to change production levels gradually in response to market demand. Backlog orders provide an indicator of pent-up demand, but unsatisfied demand is generally difficult to determine. Given these alternatives, and the assumption that it is possible to maintain inventories of completed goods, the logical conclusion is that inventories will be used to buffer discrepancies between expected and actual sales. When actual sales exceed expected sales, inventories

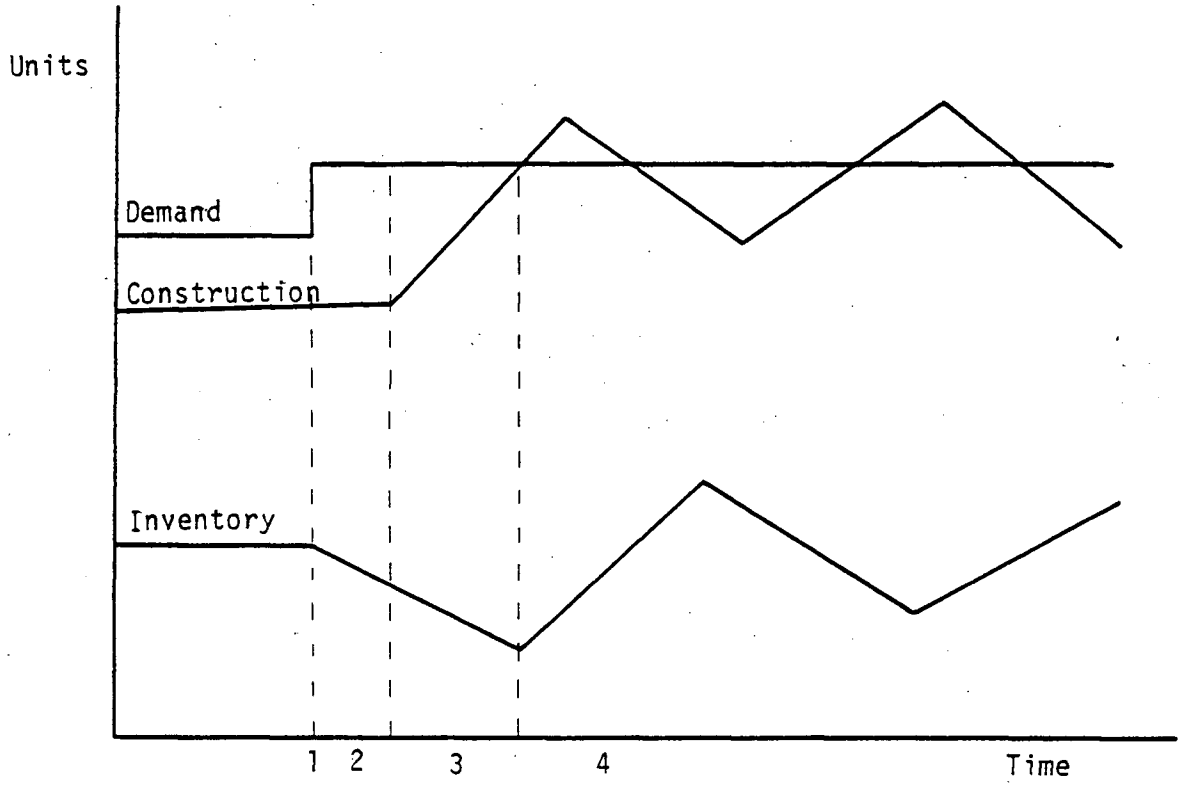
will be reduced. Conversely, if actual sales are less than projected, the excess production will be maintained as inventory.

Presumably, there is some desired level of inventory which producers wish to maintain and any change in the level of inventory due to excess(deficit) sales will then be reflected in production levels. However, production changes will not be through drastic reductions(increases), rather, there will be some rate of adjustment between changes in inventories and production levels, referred to as the accelerator. Also, the desired level of inventories may not be constant, but will adjust to current and expected economic conditions, or other exogeneous forces. The model therefore incorporates a coefficient of adjustment to represent the fluctuations in the desired inventory level. Finally, assuming producers are not myopic and have some expectations of future sales, a coefficient can be incorporated to reflect the magnitude and direction of expected changes in sales. Any estimation for production will then include: production for expected sales, production to replenish inventory and production to adjust output to a given proportion of expected sales, assuming that it is not possible to adjust immediately to a new level of expected sales.

The above discussion briefly describes the process of inventory adjustments, how producers may respond to changes in demand and the impact on inventory and production levels.[13] Figure 4.1 presents the expected patterns of inventories, sales and production. Assuming initial equilibrium, production will

Figure 4.1

INVENTORY ADJUSTMENT PROCESS



1. Increase in demand.
2. Decrease in inventory.
3. Increase in construction to meet demand and replenish inventory.
4. Adjustment of construction and inventory to new equilibrium.

be for sales and inventories will be maintained at some desired level. If some initial new, unanticipated demand is generated by an exogeneous force, then sales will increase and inventories subsequently reduced. Production will then be increased to return inventories to the desired level, however, overcompensation is likely. Production and inventory levels continue to adjust, oscillating about the new equilibrium.

The direct application of this theoretical model to the rental housing market has several inherent difficulties. First, the absorption of new units may be used as a measure of sales, but there is also a large "used goods market" in the existing stock. Second, excess demand may be indicated through vacancy rates, but may be met through alternate housing such as conversions. Third, in the theoretical specification of the inventory adjustment model, production is estimated using production from previous periods, but does not measure the precise impact of inventory levels on production. Finally, there is no distinction for inventory under construction (work in progress) and completed, unoccupied units (finished inventory). Hirsch and Lovell (1969) pool these two components in an examination of durable and non-durable manufacturing, however, a distinction may be important in the multi family market to include the impact of a long construction horizon.

Restructuring the inventory adjustment process to include a distinction between inventory and units under construction may suggest a two stage response model. The initial response to an increased demand would be an increase in completions as these

would have a more immediate impact on the inventory level. Units under construction would then be reduced, and assuming that there is some desired level of units under construction to be maintained, starts would then be increased. This suggests that starts will have a greater lag behind inventory changes, assuming that when completions increase there is no simultaneous increase in starts. A more probable solution is that starts will respond to changes in inventory and units under construction.

4.2 MODEL SPECIFICATION

Before presenting the overall theoretical model, two issues should be considered. First, what is defined as a housing unit? Second, does multi family housing include public and private units, rental and ownership units? Rather than using the number of housing units, some previous studies have attempted to standardize a measure of housing services, while others have considered expenditures as a more appropriate measure of construction activity (Jaffee & Rosen, 1979). Measures of housing services or expenditures provide an indicator of activity in the market, however, it is difficult to convert these to the actual number of units started, completed, absorbed, or the number of units in inventory or existing stock. It is the number of individual housing units which is important in relating the supply and demand for housing, and which is most applicable for policy and planning decisions. Consequently, despite possible discrepancies with respect to housing quality,

age and size, housing will be measured as the raw number of units.

The second issue, which addresses the definition of multi family units, can be easily resolved in the theoretical context, but creates some difficulty for the empirical analysis. Traditionally, the structure type (single family or multi family) and tenure (ownership or rental) have been assumed to be synonymous. To own implied a single family or detached unit and to rent implied a multi family unit. With the introduction of strata titles enabling ownership of multi family units, the rental of detached units, the conversion of detached housing to duplexes and the greater acceptance of row housing, this generalization may be an inaccurate representation of the market. These changes in the form of the housing stock have increased the substitutability between structure types, increasing the difficulty in examining specific submarkets within the total housing market. For the development of the theoretical model, it is assumed that the submarket being examined is the privately initiated, rental, multi family (apartment) housing market. The difficulties with this definition for the empirical analysis will be addressed in the sections on the data and the empirical results.

4.2.1 Overall Model

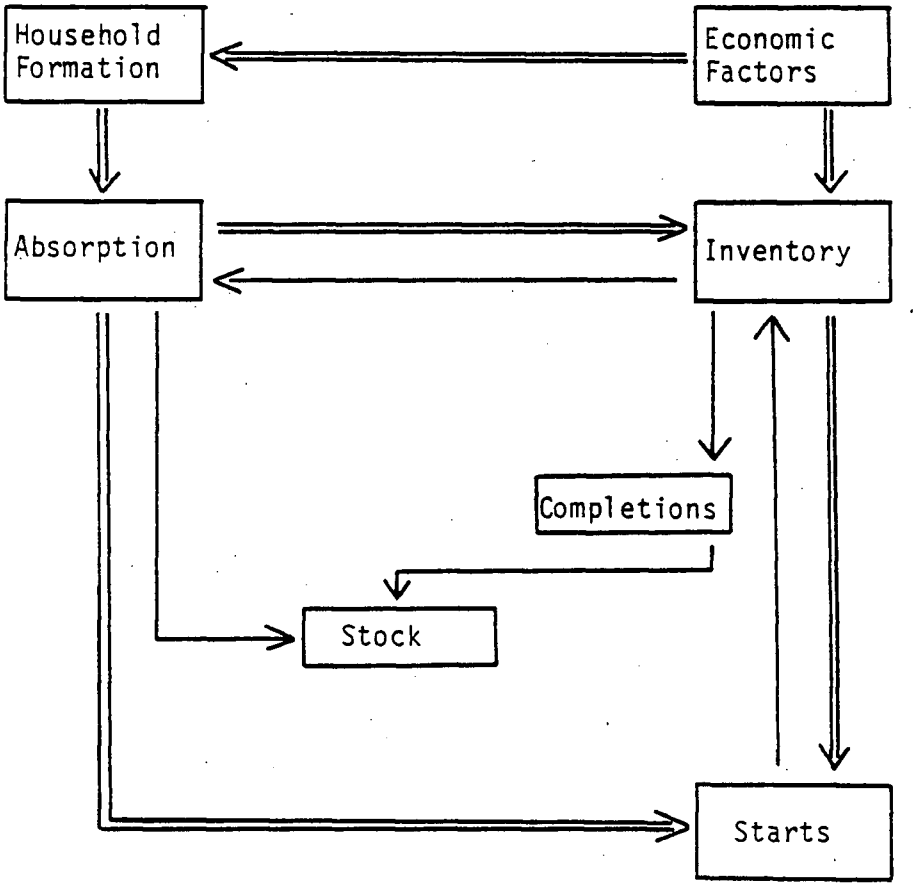
The three key components of the overall model correspond to the components of manufacturing inventory models with the major differences being the durability and immobility of housing units

and longer construction time. These components include the rate at which new units are absorbed by the market (sales/rental), the number of units available (inventory) and the level of starts (production).

The structure of the model is such that changes in each component may be initiated from two sources with the existing stock as the focus of market adjustments. (see Figure 4.2) Absorptions(sales) will depend upon the number of new households demanding rental accomodation. This will adjust according to the demographic structure of the population and other economic conditions.[14] The number of units in inventory available for rent (or sale) will increase(decrease) if the rate of absorption increases(decreases), assuming no new units are simultaneously constructed to meet the change in demand. Inventories levels will also reflect builders' or investors' desired level of inventory. Presumably, if economic conditions are unfavourable for holding vacant units, starts will be reduced and the level of inventory will be permitted to decline. Conversely, as the desired level of inventory increases, starts will be generated to replenish inventories. The production of new units will be to meet the expected rate of absorption, and to adjust inventories accordingly. This is in keeping with the theoretical model where production is for anticipated sales and inventory replacement(decline). Finally, as units are completed they become part of the existing housing stock. The central focus is the existing stock which is increased with completions and will influence the absorption of new units. The number of

Figure 4.2

MODEL STRUCTURE
MULTI FAMILY HOUSING
STARTS



vacant units in the existing stock, the condition and location of existing units will influence the desirability of new and existing housing units. This will subsequently influence the rate of absorption of new units, initiating further adjustments in the system through inventory levels.

4.2.2 Demand

The demand for housing units is from the formation of new households and from existing households changing their tenure and/or structure type. The number of new households can be estimated given the demographic structure of the population, the natural aging process and expected rental patterns. However, the actual number of households and the type of units demanded will be influenced by economic conditions and lifestyle preferences. The decision for a household to consume additional (or fewer) housing units can be subdivided into three steps. First, the decision to form a household, second, the tenure type preferred (ownership or rental); third, the structural type of housing sought (detached, row, apartment, etc.). Steele (1979) suggested that the third decision should be expenditure; the amount a household choose to, or could afford to spend on housing. As such, expenditures could be interpreted as an additional step. Since the decisions of tenure and structure would be restricted by any expenditure constraints, the expenditure restriction is implicitly considered and does not require specification.

As mentioned, change in the number of households may result

from the demographic structure of the population, or economic conditions affecting the decision to form a household. Assuming there was no change in the rate at which each age cohort formed households, the demand for housing units could be easily estimated from knowledge of the existing population structure. This ignores the possibility of migration in the region, and any economic variables considered in the household formation decision. The economic vector will include real disposable incomes, the unemployment rate, real rents and the real price of housing. The equation to estimate the number of households then becomes:

HH = H(Yd,U,R/CPI,Ph/CPI,HH(-1),pop)

where:

HH	number of households
Yd	real disposable income
U	unemployment rate
R/CPI	real rents
Ph/CPI	real price of housing
HH(-1)	number of households in previous period
pop	population (by age and sex)

As incomes rise, ceteris paribus, there will be a tendency toward more rapid household formation with the undoubling of existing households, more one person households, etc. The question arises, which income measure most accurately reflects household behaviour? Is the relevant income measure permanent or measured income, per capita disposable income or some other

measure? The general argument suggests that housing purchases depend upon perceptions of permanent disposable income per household and therefore this should be the relevant measure. In the short term, household formation may be delayed due to cash flow constraints, supporting the use of measured disposable income. An increase in unemployment should have a negative impact on household formation. However, unemployment may be reflected in measured incomes, and only delay household formation decisions. It is expected that unemployment may not prove significant in the long run analysis, but is mentioned for completeness in the theoretical framework. Permanent disposable income and unemployment rates combined are suggested to ensure the short run and long run impacts of income are included.

Assuming equilibrium, the user costs of owning a housing unit should equal the rent on a similar housing unit, taking into account all tax benefits, and appreciation of the housing unit. Since it is expected that these two factors may not be in equilibrium, both should be included in the household formation equation. The alternate argument is that new households have a greater tendency to rent, and therefore only rental costs need be included. There is no definitive solution to these arguments, therefore both are included with the expectation that one will prove dominant in the empirical analysis. This raises the question of whether the price of new housing or the expected user costs of housing should be entered into the equation. It is then necessary to derive the correct measure of user costs.

The above functional equation for total households ignores

the tenure and structure choices of households. However, the model is based on rental, multi family housing units, therefore, the appropriate household measure is the number of rental or multi family unit dwellers. Given the demographic structure of the population and the percentage choosing to rent, it is possible to estimate the change in the number of rental households from only demographic shifts. Any deviations from the expected number of rental households can then be attributed to economic conditions or migration. This is similar to the approach adopted by Jaffee and Rosen (1979) for estimating the demand for owner-occupied housing.

The number of new rental households may then be expressed using the same economic variables given for household formation. There is no reason to expect that the impact of these variables will be different for rental households than for total households. Therefore, the expected impacts will be as outlined above. The relevant population measure here will be based on the expected rental households assuming constant headship rates and rental demand per age cohort.

RHH=R(Yd,U,R/CPI,Ph/CPI,pop)

The absorption of multi family housing units is similar to the concept of sales in the manufacturing inventory adjustment model. It is possible to consider the housing stock as a whole and absorptions as the reduction in the number of vacant units available, plus any newly completed units which are occupied (sold) during the period. This provides an indicator of total

demand for multi family housing. Difficulty arises in separating the demand and subsequent supply changes for new units or existing stock. Since the model developed here is to provide an estimation of multi family starts, a more appropriate measure is the absorption of new rental units. This is then defined by the following identity, assuming that inventories refer to completed and unoccupied units.

ABSORB(new) = COMPL + (INV(-1) - INV)

where:

ABSORB(new)	new units occupied in the period
COMPL	the multi family housing units completed
INV	newly completed and unoccupied multi family housing units

The rate at which these new multi dwelling units will be absorbed into the market will be dependent upon the number of vacant units in the existing stock, the demolition of existing units and the conversion of other housing types to rental units. In addition, some measure of the expected new rental households will be included as an indicator of new demand. The functional equation for absorptions will be:

ABSORB(new) = A(RHH,vac,demo,conv)

where:

RHH	expected new rental households
vac	the vacancy rate for multi family units
demo	the number of units demolished in the period

conv the number of new units from conversions

Any increase in the number of rental households should increase the absorption of new multi family housing units. However, this may be counteracted if there are a large number of existing units vacant. The change in the number of rental households is expected to have a positive sign, while the vacancy rate should be negative. If there are a large number of units demolished in a period, the absorption of new units should increase. As the existing stock is reduced, new units are required to replenish the supply of available units.

This does not explicitly account for the conversion of existing units to meet any changes in demand. When vacancies are low, single family units may be duplexed, increasing the effective stock without any new construction. The absorption of new units would then be lower than otherwise expected. From this it is evident that the price of housing and rents may not fully reflect market conditions. Conversions offer a substitute good which is not accounted for in the classical supply and demand curves for multi family housing.

4.2.3 Supply

The inventory adjustment approach suggests production levels are based upon the expected sales and the desire to maintain some inventory level. Within the multi family housing market, the absorption of new units represents the actual 'sales' level. Difficulty arises in determining if both inventory and units under construction should be incorporated in

the model; is there some desired level for each series which needs to be considered? It is proposed that these must be distinguished in light of the construction horizon for multi family housing units and the possibility that builders will view the desirability and costs of maintaining completed and incomplete units differently.

The level of inventory desired by builders or investors will be dependent upon their expected profits and the costs of maintaining vacant units. Expected profitability can be determined from the potential selling price less any construction costs and land acquistition costs, plus(less) any benefits(costs) from taxes, CCA reductions and capital gains. This is similar to Rosen's regional model where profit is estimated as the discounted after-tax cash flow plus returns at reversion, less any initial expenditures (see Rosen, 1979). In an efficient market, ignoring tax, leverage, or government policy, the profit estimation becomes[15]:

$$PROFIT = \frac{(1-vac)RENT - op\ exp}{cap\ rate} - CC - LAND$$

where:

vac	vacancy rate
RENT	expected rental income
op exp	expected operating expenses
cap rate	market capitalization rate
CC	construction costs
LAND	land costs

Then, assuming that some interest rate on investments of equivalent risk would accurately reflect the cost of holding vacant units, the desired level of inventory can be expressed as:

$$INV(d) = I(PROFIT, i)$$

An increase in the expected profits will increase the attractiveness of holding inventories of multi family units. If other investments are more attractive, or costs increase through higher interest rates, the desired level of inventories will decline.

Starts will be some proportion of the previous period starts with adjustments to reflect expected absorptions and deviations of actual inventory levels from the desired levels. Expected absorptions will be some proportion of the previous period's absorptions, depending on builders or investors market expectations. Adjustments for inventory will be some proportion of the deviation from the desired leveld assuming that there will be a gradual adjustment process. The estimated equation for starts is then:

$$START = \alpha\, START(-1) + \beta\, ABSORB(-1) + \lambda(INV(-1)-INV(d)) + \delta(UC(-1)-UC(d))$$

where:

START	multi family unit starts
START(-1)	previous period starts
ABSORB(-1)	previous period absorptions
INV(-1)	previous period inventory

INV(d)	desired inventory
UC(-1)	units under construction
UC(d)	desired units under construction

This provides the basic theoretical framework for the model explored in this paper. Within the context of the inventory adjustment model, expected rental households will influence the rate of absorptions for new rental units. These can be considered 'sales' within the production framework. Starts, or production levels, will then be set to satisfy any expected demand (absorptions) and to maintain inventories with adjustments for both completed and unoccupied units and units under construction.

Obviously, this paper supports the use of the inventory approach in the housing market, but two concerns may limit the success of the empirical results. First, there is no conclusive evidence to support the assumption that the level of unit starts is the most appropriate measure to estimate construction activity. It is feasible to expect completions to respond more rapidly to demand change, and provide an indicator of new stock. However, starts do indicate the level of new construction activity and assuming that most units started are completed, starts should reflect both demand and economic factors in the market. Second, multi family units are reported as the entire structure, there is no uniform structure size and individual units within a structure are not occupied until the entire structure is complete. Such indivisibilities may bias the application of the inventory model to the multi family housing

market since it is not possible to start or complete individual units as may be desired.

5. DATA

Empirical models of the housing market have suffered severe data limitations; frequently desired series were unavailable, inadequate or inconsistent. Despite improvements, this study is also constrained by the form and availability of published data series. This chapter will briefly review the data requirments of the model, the respective series chosen, general trends in the data and how these support the general concept of the model. As previously noted, the data is for the Vancouver CMA, quarterly from 1963:1 to 1982:4.

5.1 MODEL REQUIREMENTS

The proposed model is based on the demand for rental units, and the resultant changes in available inventories and starts of multi family housing units. Ideally, these data and the respective economic variables from the functional equations would be applied in the empirical analysis.

The Canadian Census, conducted every five years, provides the most complete and reliable household data, including a breakdown by the type of accomodation (rental or ownership) and age of the household head. The economic vector for the change in the number of households includes income, unemployment, rents and the price of housing. Income measures available for the entire time period include the total current income per month and the estimated disposable income for all of British Columbia.

Similarly, the only measure of unemployment is for all of British Columbia, from 1966 to 1982. Vancouver's unemployment may be over or understated by this measure, but, is expected to follow a similar trend. Consumer price indexes are used for rents, the price of housing and the price of other goods and services. Indexes for Vancouver are available from 1970; prior to this, the Canadian index have been substituted.

Absorptions, calculated as the change in inventories plus completions, are determined from monthly data published by CMHC. The independent variables in this functional equation, the change in rental households, vacancy rate, demolitions and conversions, are not as easily obtained. As mentioned above, household data is only available for the census years and must be interpolated for the intervening periods. Vacancy rates are available from the CHMC survey of multi family housing, annually from 1963 to 1969 and semi-annually from 1970 to 1982. Annual demolition data for 1971 to 1981 has been obtained from Statistics Canada, but data from previous years is unavailable. Finally, estimates of conversions and expenditures on conversions are not readily available in a form which can be incorporated into the model structure.

Actual starts and inventory for each quarter are readily available from published CMHC data. The difficulty with the definition of multi family or apartment units for the available series will be discussed later. Missing for the estimation of the supply equations are the desired inventory level and the profitability of multi family investments. Obviously, the

former cannot be obtained, and it is necessary to derive a proxy for profitability. Previous studies (Rosen, 1979) have used the rental CPI deflated by the construction cost CPI or the total CPI as a proxy. A similar form will be used in the empirical specification. The Bank Rate and the chartered bank prime business loan rate have been collected for the last Wednesday of each quarter. Although it is recognized that there is volatility within each quarter, the last observation is used to avoid the difficulties with average values.

Before examining the specific trends and data series, one general concern should be addressed, CMA boundaries and data definitions change periodically or with each census. However, this concern does not affect the empirical tests presented in the next chapter. The focus of this study is multi family housing units which are located in the urbanized areas of the CMA, therefore over the study period, the number of multi units in stock, started or in inventory and the number of multi family rental households are not be affected by adjustments in the CMA boundaries. With regard to other changes in data definitions, the most significant have been in the CPI measures and inventory. These will be noted in the respective discussions of the data trends.

5.2 POPULATION AND HOUSEHOLDS

To develop a quarterly series for population and households (rental and total) it is necessary to interpolate from the available census data. From Table 5.1 it can be noted that the

Table 5.1

Households - Vancouver CMA

Year	Age of Hsehold Head	Single Detached	Apartment	Owner Occupied	Rental	Total
1961	<25	4248	3414	2081	5612	7693
	25-34	32650	9834	24798	17812	42610
	35-44	44448	7446	38366	13626	51922
	45-54	39618	7973	36397	11297	47694
	55-64	25499	7087	24910	7749	32659
	65+	34000	11876	32862	13086	45948
	TOTAL	180463	47630	159414	69182	228596
1966	<25	4639	10434	2089	13050	15139
	25-34	32275	16307	23933	24834	48767
	35-44	47342	11524	42036	16956	58992
	45-54	43884	11347	41277	14103	55380
	55-64	29804	11028	29284	11691	40975
	65+	33431	19161	32776	19927	52703
	TOTAL	191375	79802	171395	100561	271956
1971	<25	7395	17380	2620	22325	24945
	25-34	41440	27980	30565	39270	69835
	35-44	53995	13585	48110	19775	67885
	45-54	51145	14430	47905	18025	65930
	55-64	39000	15315	38115	16725	54840
	65+	37060	24975	36295	26145	62440
	TOTAL	230030	113665	203615	142260	345870
1976	<25	11445	20830	4430	28155	32585
	25-34	58255	34630	45260	48435	93695
	35-44	55815	14380	53640	20010	73650
	45-54	56165	15630	54185	18345	72530
	55-64	42890	18335	43625	18705	62330
	65+	39155	32470	41000	31780	72780
	TOTAL	266720	136285	242130	165430	407560

Source: Statistics Canada, Census Reports

number of households is increasing but the total percentage demanding rental accomodation is relatively stable. However, changes within the age cohorts can be noted. To interpolate rental demand from these data using a straight line trend assumes that the population or number of households are growing at a constant rate. A more accurate population series could be derived from birth, death and migration data, but, this would not incorporate household formation, or the tenure decisions of these households. Clearly, it is not possible to estimate an equation for quarterly changes in the number of households. However, in considering the demand for rental units and the absorption of new multi family units, some estimate of rental households is needed. As discussed within the model, this demand may be the result of demographic or non-demographic change.

To calculate the number of new rental households attributable to the demographic structure of the population, it is assumed that the headship rates and the percentage of apartment dwellers for each age cohort will remain constant. To be consistent with other data series where 1971 is the base year (CPI indicies), the headship rates and rental rates for 1971 were chosen as the base. Using population data from each census it is possible to develop an estimate of new rental households in each quarter. (see Appendix A) By eliminating the demographic demand, any additional changes in the number of new rental households may be attributed to economic factors, as proposed in the model.[16]

A second component of demand is migration for which net family allowance transfers in British Columbia are used as a proxy. The difficulty with such a series is twofold. First, it will not account for migration within the province which may be a major factor in Vancouver. Second, family allowance transfers do not record the movement of single person households, or households without children. These two segments will have the greatest impact on the rental market. However, in Canada, there are no other migration series available, so this series is used as the best proxy of household movement.

5.3 CPI INDEXES

Rental costs, the price of housing, construction costs and the price of other goods and services are required in estimating the demand for new rental units and estimating the profitability of construction. The most commonly used series are the CPI indexes as reported monthly by Statistics Canada. These are available for the required measures, however, some adjustments were necessary.

The CPI indexes are updated periodically to reflect changes in the consumer 'basket of goods' and the base year. The 'basket of goods' changes are to ensure that the index reflects typical consumption patterns and consequently should not generate any concern for this study. The adjustment of the base year from 1949 to 1961 and again to 1971 requires that the relevant series be adjusted to a common base. The series were all adjusted to reflect 1971 as the base year.[17] For all of the

CPI series, except the Vancouver total CPI, prior to 1970, data was not collected on a regional basis. It was, therefore, necessary to substitute the Canadian data for these missing values. This substitution should not create any difficulty in the analysis since plots of the series indicate that the general trends are similar and the model does not require a comparison of Vancouver and Canadian rates.

One of the arguments to explain the decline in multi family construction is the "rent-cost squeeze", decreasing the profitability of investments in the rental market. Examination of the rental component of the CPI, the construction cost index and the total CPI support this hypothesis (see Appendix B). The increases in rents are clearly less that those experienced in the other series. Further, if rents are declining with respect to other goods (ie, real rents are declining) then the demand for rental units should be increasing. Presumably this would result in price increases until the market reached a new equilibrium. However the persistent decline in real rents (before and during rent controls) together with low vacancies supports the expectation that other market forces need to be considered.

5.4 STARTS/INVENTORIES

In the development of the theoretical model, the relevant measure of multi family units was defined as, privately initiated rental dwellings in structures of greater than two

units (excluding row housing). This definition excludes condominium units and government housing projects. Data provided by CMHC on housing distinguishes between singles, double, row, apartment and mobile units, but there is no distinction within these for tenure or the source construction funds (private or public). Consequently, the best consistent series available is the number of apartment units started, completed, in inventory and absorbed where apartment units include: double duplexes, triplexes, row duplexes, apartments and dwellings over or at the back of non-residential structures.[18] Further, these will include private units and units receiving any form of government assistance.

Since 1970, the government has taken a more active role in the housing market. Prior to this time, it is expected that the government involvement would not have significantly altered the results. In 1982, CMHC started to collect multi family housing data according to source of funds (private or public) as well as the type of structure. Tables 5.2 and 5.3 present the monthly starts and completions for Vancouver in 1982. Market rental units range from less than 10 percent of total starts to greater than 90 percent. With this volatility in the structure of the starts series, it is impossible to use this data to estimate previous non-market rental starts in previous years. However, the two segments do appear anticyclical. Government housing projects may result in a smoother starts series than would exist with only privately initiated units.

As a second indicator of government involvement, approvals

Table 5.2

Market and Non Market Housing Starts
Vancouver 1982

Month	Non Profit Rent		Co op		Total Non Market		Market Rent	
	Row	Apt	Row	Apt	Row	Apt	Row	Apt
Jan	68	14	90	0	158	14	4	291
Feb	0	38	0	223	0	261	0	338
Mar	33	78	0	0	33	78	48	492
Apr	0	0	305	101	305	101	15	750
May	41	18	56	63	97	81	8	226
Jun	88	76	71	0	159	76	0	188
Jul	30	0	24	170	54	170	0	39
Aug	36	20	34	99	70	119	0	86
Sep	57	199	40	0	97	199	51	81
Oct	0	0	0	92	0	92	0	54
Nov	36	40	38	0	74	40	54	4
Dec	52	42	61	28	113	70	72	148
TOTAL	441	525	719	776	1160	1301	252	2697

Source: unpublished CMHC Files, Vancouver Regional Office

Table 5.3

Market and Non Market Housing Completions
Vancouver 1982

Month	Non Profit Rent		Co op		Total Non Market		Market Rent	
	Row	Apt	Row	Apt	Row	Apt	Row	Apt
Jan	0	0	14	0	14	0	112	101
Feb	0	41	188	154	188	195	14	668
Mar	0	85	91	0	91	85	91	299
Apr	83	66	13	0	96	66	205	431
May	0	67	0	0	0	67	50	573
Jun	0	66	0	112	0	178	74	359
Jul	106	75	0	111	106	186	120	430
Aug	96	183	166	30	262	213	22	327
Sep	101	92	196	152	297	244	98	472
Oct	183	18	58	13	241	31	40	168
Nov	86	53	76	0	162	53	28	342
Dec	30	0	172	88	202	88	43	700
TOTAL	685	746	974	660	1659	1406	814	4870

Source: unpublished CMHC Files, Vancouver Regional Office

of social housing projects from 1968 to 1983 were examined (see Table 5.4). These are given by the date of the project approval by CMHC and therefore do not correspond directly with the starts series and cannot be used to adjust the starts series to remove government housing. However, the large number of approvals in 1974 through 1976 and again in 1980 and 1981 support the expectation that government projects will distort the data and possibly the results.

Prior to 1966, it was not possible to own a multi family housing unit. Introduction of strata titles increased the complexity of the multi family housing market. Buildings could be registered with a strata title upon completion and sold as condominium units. Or, units in the entire building could be maintained by one owner and the individual units rented. Or, the individual units could be sold and then rented by the individual owners or the building maintained by a management company. The ability to change to ownership from rental, or vis versa, increases the difficulty in defining the multi family housing stock. Also, these units are not included in the vacancy survey, suggesting potential for the vacancy rate to be underestimated. Data is currently being collected to distinguish rental and condominium units upon start and completion. Since tenure can change after completeion, such data will not alleviate fully the difficulties in defining the rental stock. Despite these shortcomings, CMHC provides the best measure of housing unit starts, completions, inventories and vacancy rates.

Table 5.4

Social Housing Project Approvals
Vancouver

Year	Qtr	Units	Year	Qtr	Units	Year	Qtr	Units
1968	1	0	1974	1	583	1980	1	0
	2	121		2	0		2	0
	3	59		3	0		3	0
	4	69		4	1002		4	1756
1969	1	174	1975	1	0	1981	1	0
	2	0		2	0		2	0
	3	0		3	0		3	0
	4	699		4	1214		4	1616
1970	1	86	1976	1	0	1982	1	129
	2	0		2	0		2	0
	3	0		3	0		3	0
	4	586		4	1508		4	1138
1971	1	0	1977	1	0	1983	1	419
	2	0		2	0		2	0
	3	0		3	0		3	0
	4	805		4	138		4	370
1972	1	19	1978	1	0			
	2	0		2	0			
	3	0		3	0			
	4	487		4	264			
1973	1	163	1979	1	69			
	2	0		2	0			
	3	0		3	0			
	4	322		4	83			

Source: CMHC, B.C. and Yukon Regional Office, Special Report

Starts for multi family housing are recorded when the footing has been installed, according to the number of units recorded on the structure plans and the building permit application. There is clearly room for error in recording both the timing of the start and the number of units which will be constructed. The extreme volatility in starts is evident in Figure 5.1, although there is some seasonality in the series. Since the peak in 1969, construction of multi family housing units has been declining, with a sudden increasein 1981 in response to the removal of the tax benefits for multi family dwellings (as of December 31, 1981).

Units under construction are expected to lag starts, and should, by definition, equal previous units under construction plus starts in the current period, less completions. However, this definition does not fit precisely since this series is used to account for any necessary adjustments. If construction ceases after a start has been recorded, or if upon completion a structure contains fewer or more units than reported as starts, adjustments are recorded in the number of units under construction. No corrections are made to the other data series involved.

A completion is recorded when all of the proposed construction work on the structure has been completed. For multi family units this includes the entire structure, not individual units. Consequently, completions should lag starts (see Figure 5.2), but it is difficult to define the precise lag structure since the size of structure will influence the

Figure 5.1

VANCOUVER

QUARTERLY MULTI FAMILY

HOUSING STARTS

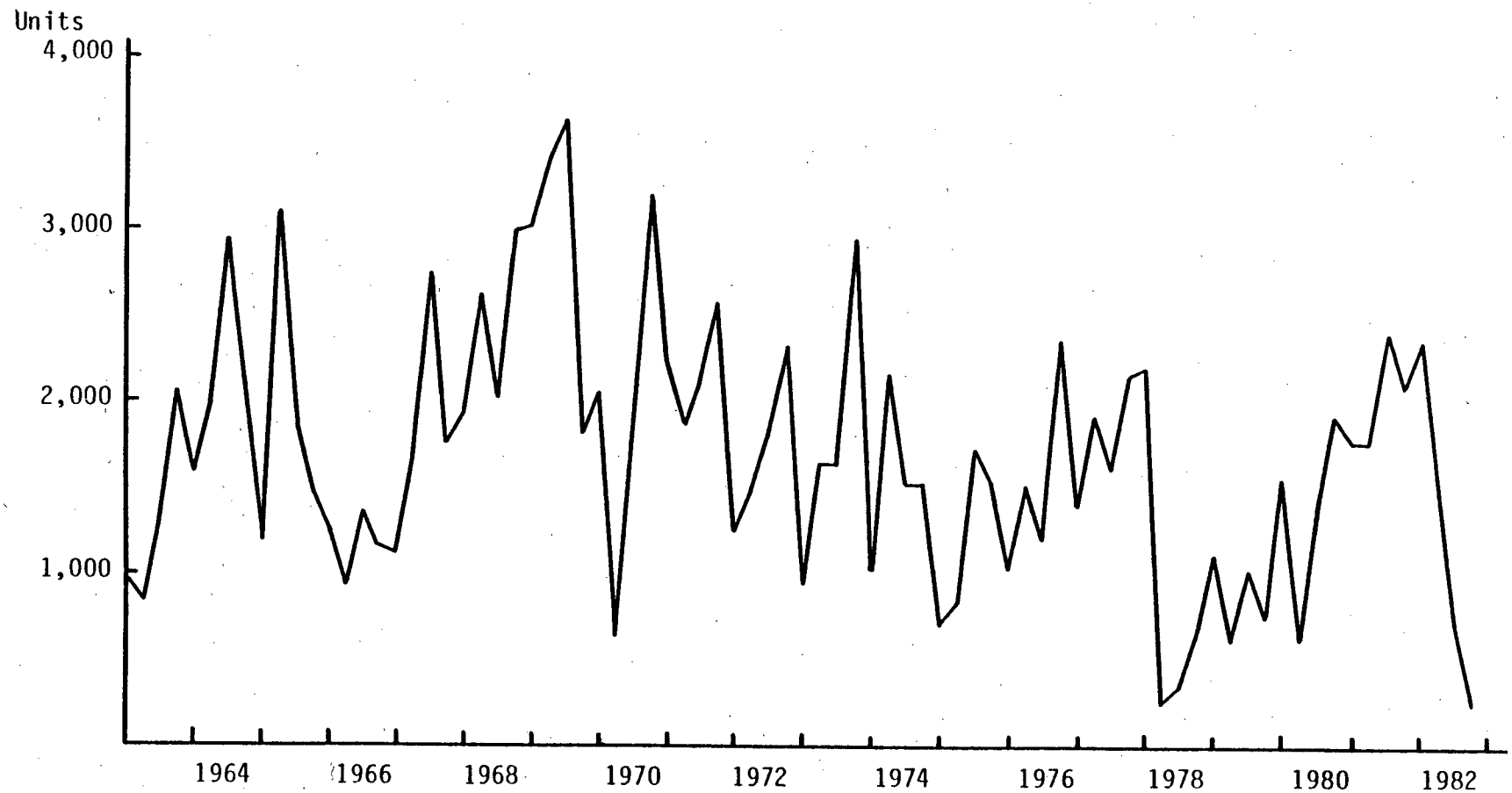
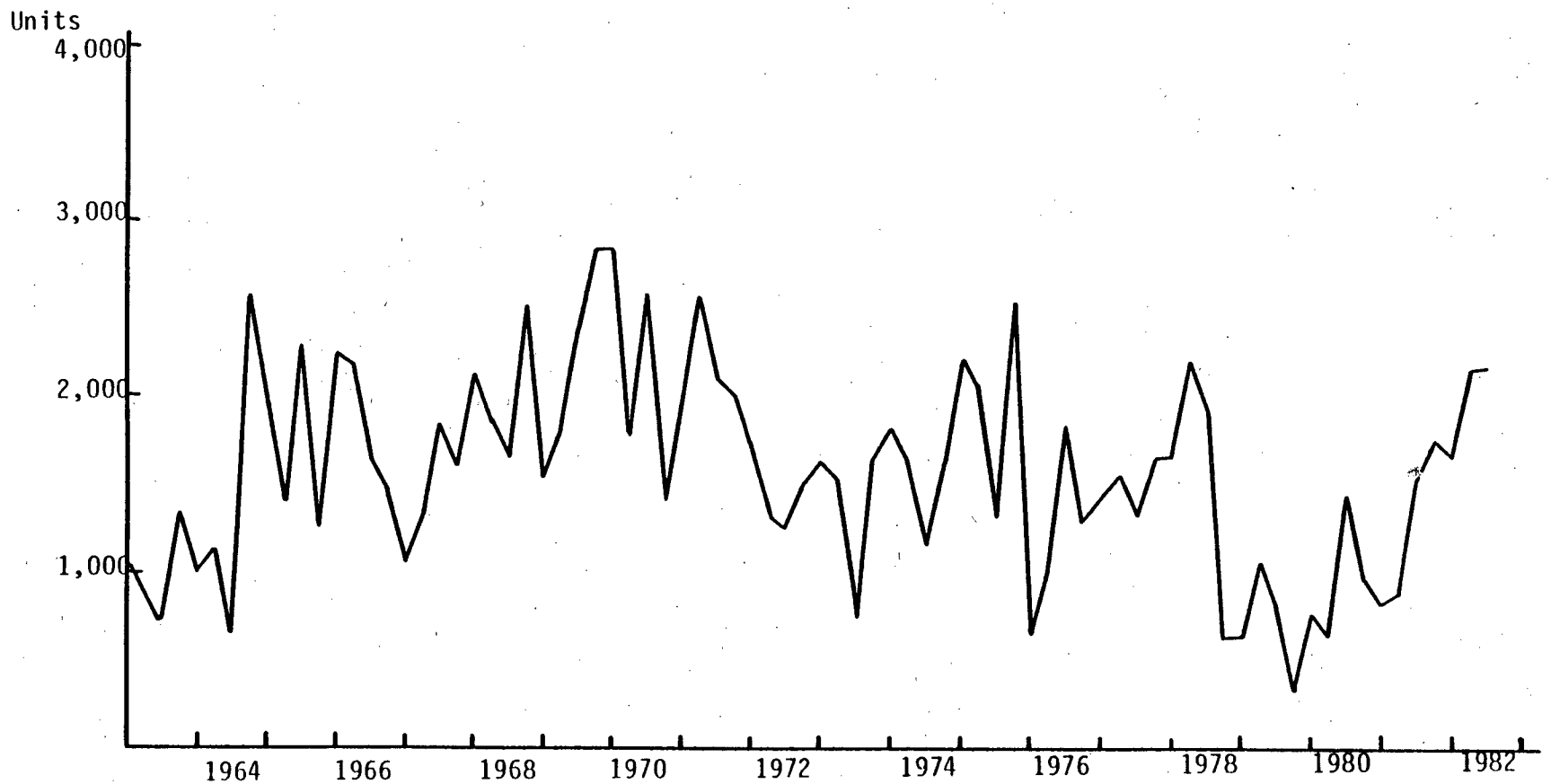


Figure 5.2

VANCOUVER

QUARTERLY MULTI FAMILY

HOUSING COMPLETIONS



construction horizon and large structures may distort the appearance of the data.

A regression of completions on starts lagged up to one year indicates the basic structure of these two series (see Table 5.5). The relatively low R^2 for two series which should be highly correlated is disturbing. As expected, starts in the current quarter are insignificant. The other coefficients suggest that completions lag starts by 6 months to a year. Clearly, the project size will influence the construction time. Also, if absorptions decrease, builders may delay or halt construction until demand warrants continuation. Since project size and delays cannot be determined, these results are not alarming and do not indicate errors in the respective series.

Inventories are units completed and not yet occupied (see Figure 5.3). Prior to 1970, unoccupied units were recorded as inventory for six months; if the units were still unoccupied after six months, the units were included in the vacancy rate survey. In 1979 this was increased to 12 months, and further increased to 36 months in 1982.

By definition, absorptions are those units from existing inventories or newly completed units which are occupied or rented in the period. This series is not published, but has been derived from the above data (see Figure 5.4).

Vacancy rates indicate the percentage of units in the existing stock which are available for rent. This information is available annually from 1963 to 1970 and semi-annually after 1970 (see Table 5.6). To expand the series to quarterly data, a

Table 5.5

Regression for Completions with Lagged Starts

Constant	Lagged Starts 0	-1	-2	-3	-4	R^2	$\bar{R}^2$	SE	DW
304.92	-0.028	0.194	0.316	0.035	0.223	0.455	0.416	461.40	6
	(0.361)	(2.285)	(3.682)	(0.408)	(2.757)				
460.92	-0.012	0.202	0.345	0.112	-	0.396	0.362	482.38	5
	(0.146)	(2.272)	(3.876)	(1.343)					
284.76	-	0.183	0.312	0.034	0.221	0.454	0.423	458.57	1
		(2.316)	(3.687)	(0.406)	(2.755)				
451.68	-	0.197	0.343	0.112	-	0.396	0.370	479.09	0
		(2.387)	(3.912)	(1.347)					

Notes: (1) t-statistics in parenthesis
(2) R^2 values reported are: first the unadjusted R^2, and second the adjusted R^2
(3) SE denotes the standard error
(4) DW denotes the Durbin-Watson statistic

Figure 5.3

VANCOUVER

QUARTERLY MULTI FAMILY

HOUSING INVENTORY

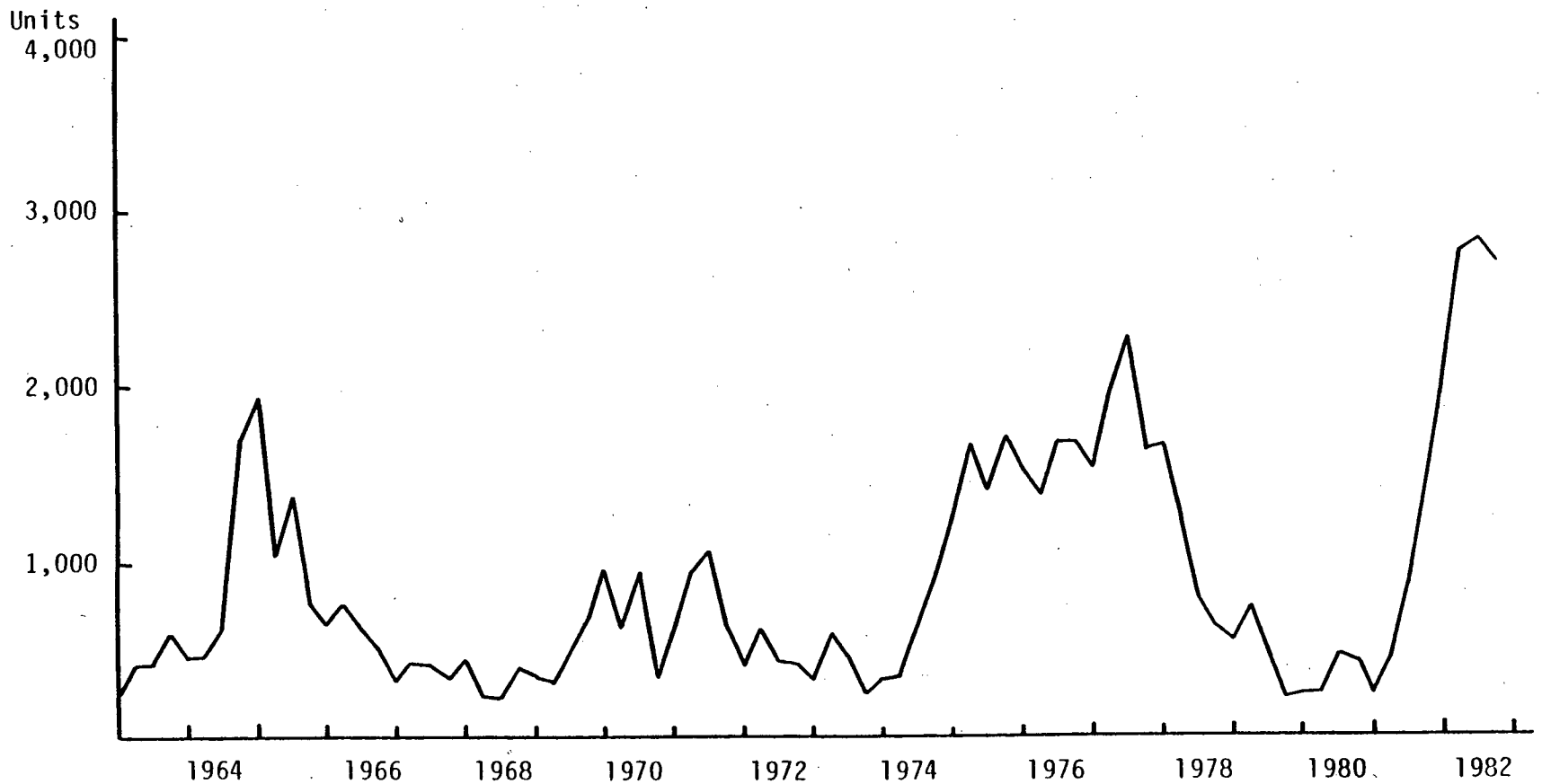


Figure 5.4

VANCOUVER

QUARTERLY MULTI FAMILY

HOUSING ABSORPTION

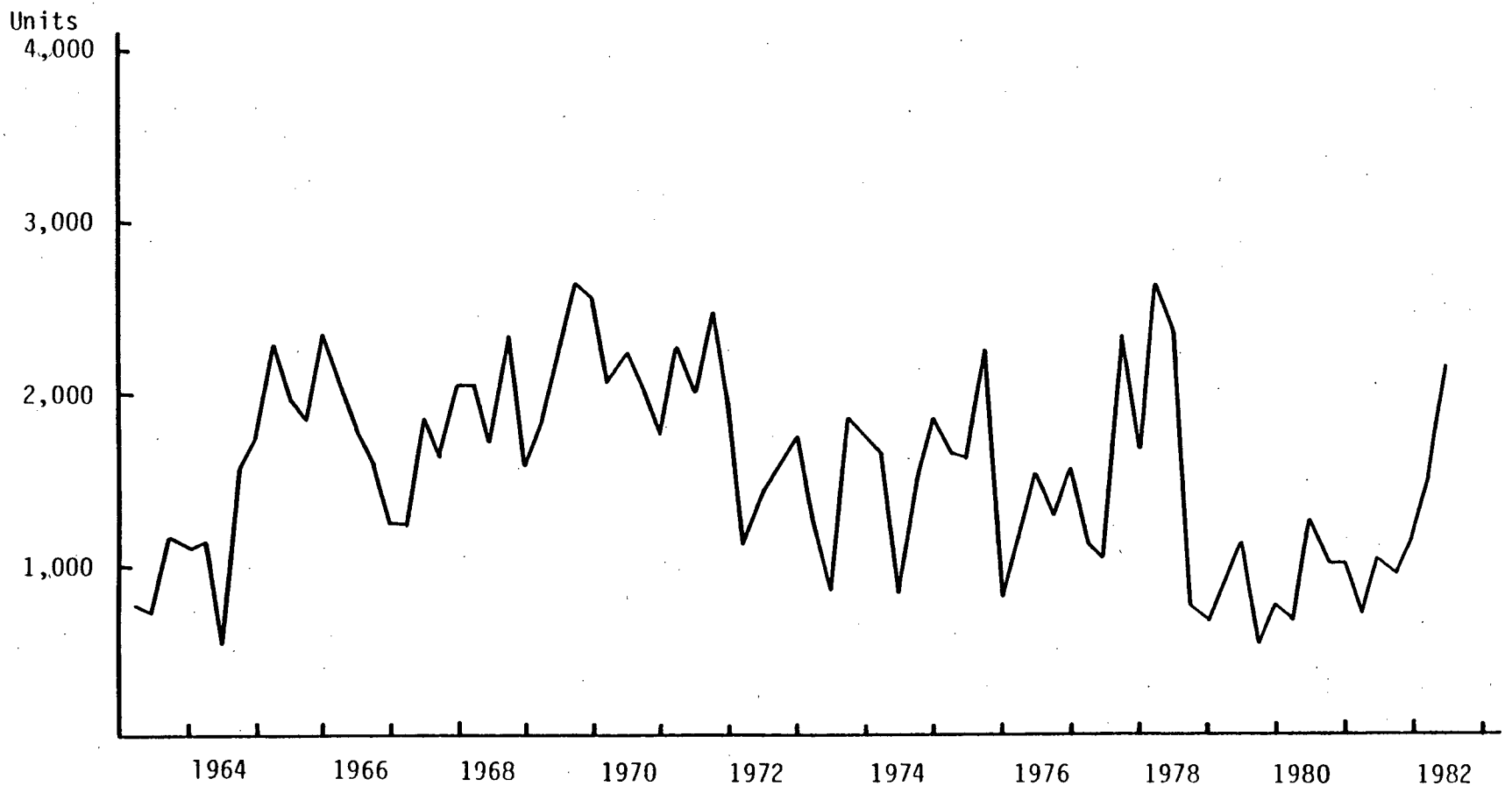


Table 5.6

Vancouver Vacancy Rates

Year	Rate	Year	Rate
1963	4.2	1975(Apr)	0.2
1964	4.7	(Oct)	0.1
1965	4.0	1976(Apr)	0.4
1966	1.5	(Oct)	0.7
1967	1.0	1977(Apr)	1.6
1968	1.3	(Oct)	1.6
1969	1.2	1978(Apr)	1.5
1970(June)	2.7	(Oct)	1.4
(Dec)	2.1	1979(Apr)	0.9
1971(June)	4.1	(Oct)	0.2
(Dec)	2.8	1980(Apr)	0.1
1972(June)	2.4	(Oct)	0.1
(Dec)	0.6	1981(Apr)	0.1
1973(June)	1.0	(Oct)	0.1
(Dec)	0.4	1982(Apr)	0.6
1974(June)	0.3	(Oct)	1.9
(Dec)	0.1		

Source: Canada Mortgage and Housing Corporation, vacancy survey

straight trend between periods was assumed. This may introduce some error, but changes in the series are relatively smooth, so it is anticipated that any error would be minimal.

The final stock series collected was demolitions. These were available annually from 1971 to 1981 (see Table 5.7). It may be possible to prepare a moving average series from the annual data to approximate the quarterly series. However, the gain from this was not seen as significant and these have not been included in the final model.

5.5 APPLICATION TO THE MODEL

Briefly, within the proposed model, the following data will be used.[19] The change in rental households from demographic factors is estimated using headship rates and the percentage of rental households in 1971 as a base. Family allowance transfers are used as a proxy for migration. The economic vector of variables affecting non-demographic change will include the disposable income for British Columbia (in constant 1971 dollars), the reported unemployment rate for British Columbia and the rental component of the CPI. Absorptions are calculated from the inventory and completions data reported by CMHC. The vacancy rate is expanded from the vacancy survey conducted by CMHC. Since there are no consistent series for demolitions and conversions, these impacts cannot be explicitly modelled.

Starts, completions and inventory are available as the number of apartment units for each period. The definition of apartment includes condominiums and government housing projects

Table 5.7

Vancouver Housing Unit Demolition Permits

Year	Singles	Doubles	Row	Apt	Total
1971	789	41	-	161	991
1972	819	32	-	115	966
1973	1238	71	12	299	1618
1974	1312	70	-	182	1564
1975	930	21	-	119	1070
1976	1334	57	-	118	1509
1977	1287	51	-	139	1477
1978	1181	61	-	241	1483
1979	1025	27	-	146	1198
1980	1592	93	63	501	2249
1981	1777	91	6	403	2277

Source: Statistics Canada, Special Report

which is inconsistent with the theoretical definition. Profits will be estimated as the rental CPI, deflated by the residential construction cost CPI. These measures are consistent with estimates used in most of the research as a consise, accurate profit measure for multi family housing units does not exist. The interest rate measure most consistent with construction loans will be the Bank Rate.

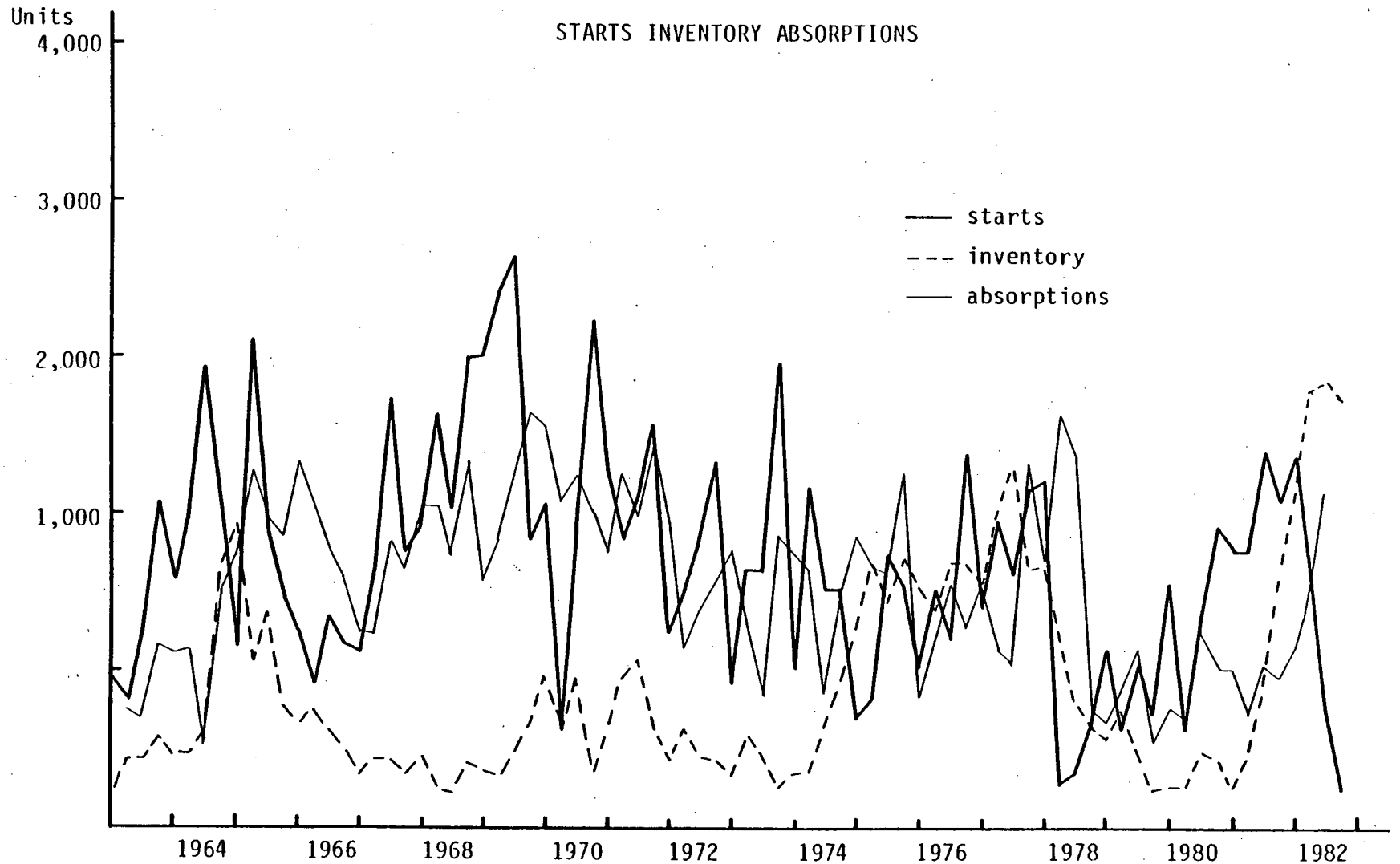
The expected patterns of the stock variables (starts, inventory, absorptions, vacancy rates) were outlined in the previous chapter. For the actual series, these patterns are not as well defined (see Figure 5.5), but some of the expected trends can be noted. Starts do decline after periods of high inventories. Conversely, starts are lower when inventory levels are increased. Obviously, the trends do not exactly match the theoretical model and do not account for changes in the desired inventory levels or the ability of the market to adjust through other mechanisms. However, the trends in the available data support the application of an inventory adjustment model.

Figure 5.5

VANCOUVER

INVENTORY ADJUSTMENT

STARTS INVENTORY ABSORPTIONS



6. EMPIRICAL ANALYSIS AND TESTING

Based on the available data for multi family housing, the empirical analysis will consist of three parts: a structural model designed within the proposed theoretical model and the constraints imposed by the available data; a time series model for multi family housing starts; and testing of these two models. The focus of this paper is on the results of the structural model. However, the time series model is offered as a measure to evaluate the performance of the structural model, within and outside the estimation period. The structural model will be estimated through multiple regression and the time series with a Box-Jenkins autoregressive-integrated-moving average (ARIMA) model. Quarterly data from 1963:1 to 1980:4 will be used for the model estimations and data for 1981:1 to 1982:4 will be maintained to test the results and the forecasting ability of these models.

6.1 EMPIRICAL MODEL AND ANALYSIS

The previous chapter outlined the available data and how these could be incorporated into the proposed model. Clearly, to fully develop the specified theoretical model with the available data series would be extending the data far beyond its capabilities, leading to rather dubious results. Therefore, the empirical model will consist of two equations; the first to estimate the absorption of new rental (multi family) units and

the second, the level of units starts in a given quarter. The absorption equation will be estimated with the economic variables specified for household formation, the expected new rental households from demographic change and migration. Starts will be estimated using predicted absorptions, inventory, a profit proxy and interest rates. Dummy variables for the respective demand and supply side government programs are proposed to remove the impacts of government intervention in the housing market.

Given the available data and model structure, Tables 6.1 and 6.2 present the variables and their expected sign in each equation. An examination of the data revealed obvious time trends for several of the series, increasing the likelihood of multi collinearity creating problems in the regression analysis. Plots of the data series and correlation analysis were used to determine which variables were most likely to create severe estimation problems. (see Appendix C) Distinct trends and high correlations were prominent between the independent variables for the absorption equations, but, did not appear to be a concern for the starts equation. Several techniques are available to overcome the problem of multi collinearity, including: differencing, scaling the variables or the systematic removal of variables.[20] The latter method has been adopted for this study. Absorptions were estimated using several specifications eliminating variables which were highly correlated or insignificant. When enterpreting the final results it must be noted that the omission of variables may

Table 6.1

Variable List For Absorption Equation

Variable	Expected Sign	Description
ABSORB	(dependent)	Absorption of new multi family units
BCFAMALN	+	B.C. family allowance transfers (net) proxy for migration
DEAPT	+	Expected new rental households from economic demand
BCUR	-	B.C. unemployment rate
BCURD	?	Dummy variable for missing unemployment data (1=1963-1966, 0=1967-1982)
RINC	+	Real income - B.C. disposable income
RRENT	-	Real rents - Vancouver rental CPI index
RENTMTG	-	Ratio of rent index to nominal mortgage rate
RENTRMTG	-	Ratio of rent index to real mortgage rate
VVAC	-	Vancouver vacancy rate for rental multi family units
VMFINV	+	Vancouver multi family inventory (newly completed and unoccupied units)
APTSTK	?	Existing stock of multi family units
RCONTR	+	Dummy variable for rent control (0=1963-1973, 1=1974-1982)
GRANT	-	Dummy variable for grants for new home owners (0=1963-1973 & 1976-1982, 1=1974-1975)
AHOP	-	Dummy variable for Assisted Home Ownership Program
Q1,Q2,Q3,Q4	?	Quarterly dummy variables

Table 6.2

Variable List For Starts Equation

Variable	Expected Sign	Description
VMFST	(dependent)	Vancouver multi family unit starts
VMFST1	+	Vanvouver multi family unit starts lagged one period
VMFINV	-	Vancouver mulit family units inventory (newly completed and unoccupied units)
VMFUC	-	Vancouver multi family units under construction
ABSPRED	+	Predicted absorption of new rental units
PROFIT	+	Profitability of rental units (rent CPI index/construction cost index)
BKRAT	-	Bank rate on prime business loans
VVAC	-	Vancouver vacancy rate for rental multi family units
DUM	+	Dummy variable for unusual data 1977,78 (see footnote 26)
MURB	+	Dummy variable for MURB program (0=1973-1974 & 1980, 1=1963-1972 & 1975-1979 & 1981)
Q1,Q2,Q3,Q4	?	Quarterly dummy variables

result in misleading coefficients for the remaining variables. The selection of the final equation was based on the stability of the coefficients, the adjusted R^2 and the standard error.

The second step of the model development was to estimate an equation for multi family housing starts using predicted absorptions. It was not necessary to restructure the starts equation to minimize correlation between the independent variables. Several specifications were tried based on assumptions of the inclusion and exclusion of units under construction and the significance of the other variables. Also, separate equations were estimated for 1963 to 1970 and 1971 to 1980 to determine if there were structural changes in the market based on government intervention and investment decision criteria.

6.2 EMPIRICAL RESULTS

6.2.1 Absorptions

In estimating the absorption equation, the problem of multi collinearity resulted in changes in the sign and magnitude of the coefficients. Alternate forms of the model tried included ratios of rents to mortgage costs or ownership costs, real incomes, or excluding other variables such as demographic change and family allowance transfers. The results presented in Table 6.3 offer the most consistent model with the best results. As was mentioned, since some variables have been omitted their impacts may be explained in the remaining coefficients. Also,

Table 6.3

Regression Results - Absorptions

1963-1980

	CONST	BCFAMALN	DEAPT	VMFINV1	VVAC1	BCUR	BCURD	RRENT	APTSTK	Q1	Q2	Q3	GRANT	AHOP	RCONTR	R^2	SE/DW
1.	-6289	0.143	0.862	0.652	-26.63	-128.49	-1172	65.95	0.017	136.31	34.76	-148.05				.570	398.37
		(0.058)	(1.210)	(5.334)	(0.375)	(2.002)	(2.903)	(4.550)	(2.421)	(0.792)	(0.194)	(1.017)				.490	1.69
2.	-6063	0.122	-0.878	0.636		-130.84	-1251	63.84	0.017	120.72	14.40	-160.45				.569	395.51
		(0.981)	(1.260)	(5.607)		(2.063)	(3.670)	(4.695)	(2.436)	(0.728)	(0.085)	(1.140)				.498	1.69
3.	-8757	0.347	-1.294	0.473		-175.26	-1296	82.30	0.025	352.92	214.19	-110.19	663.03	420.30		.569	395.51
		(2.478)	(1.996)	(3.251)		(2.946)	(4.138)	(5.887)	(3.656)	(2.075)	(1.267)	(1.267)	(2.984)	(1.588)		.498	1.69
4.	-5706	0.087	-0.923	0.594		-97.40	-1117	61.12	0.016							.543	397.52
		(0.869)	(1.320)	(5.445)		(1.654)	(3.395)	(4.537)	(2.230)							.492	1.70
5.	-9075	0.215	-0.890	0.595		-123.83	-1179	90.50	0.019	170.82	81.12	-137.89			548.3	.589	389.59
		(1.595)	(1.298)	(5.208)		(1.978)	(3.483)	(4.365)	(2.674)	(1.029)	(0.473)	(0.990)			(1.684)	.512	1.76
6.	-5882	0.084	-0.838	0.603		-134.14		63.02	0.017	130.89	-11.85	-147.51				.513	416.51
		(0.577)	(1.136)	(3.941)		(1.890)		(4.237)	(2.197)	(0.654)	(0.060)	(0.903)				.426	1.60

Notes: (1) t-statistics in parenthesis
(2) a '1' after the variable name indicates that the variable is lagged one period
(3) R^2 values reported are: first the unadjusted R^2, and second the adjusted R^2
(4) SE/DW denotes the standard error and Durbin-Watson statistic
(5) Equation 2 is used to estimate absorptions for the starts analysis
(6) Equation 6 uses only data from 1966 to 1980

the downward trend in absorptions may be partially explained in those variables portraying similar (or opposite) trends. Therefore, interpretation of the coefficients may be misleading, but, it is emphasized that this is not critical to the analysis of the starts equation.

The final absorption equation (Equation 2, Table 6.3) has an adjusted R^2 of approximately 0.5 and a standard error of just under 400 (25% of the mean of absorptions) as compared to a standard deviation of 558 (35% of the mean of absorptions). This equation represents the highest R^2 and lowest standard error without the inclusion of dummy variables for government programs. Since the precise impacts of these programs could not be determined, these variables were not included in the final analysis. It may be possible to improve these results by adjusting the lag structure of the individual variables. However, it is assumed that consumer response to changes in economic conditions will be within the quarter. Further, to adjust with different lags for each variable, without a priori reasons, may provide a better fit but does not comply with the model expectations or make intuitive sense. It is logical to expect that the decision to form a household or rent a new housing unit will be based on the current state of all variables, not the state of some variables for previous periods in an ad hoc arrangement.

It is not disturbing that some variables have the wrong sign, or are not significant, in light of the previous discussion on multi collinearity and data trends. The

insignificance of migration was anticipated due to the nature of the variable; family allowance transfers for British Columbia ignore intra-provincial migration and households without children. New rental households from demographic change has the wrong sign and is not very significant. In estimating this variable the unrealistic assumption of a constant rate of growth between census years was made. Consequently, the number of new rental households was increasing over the time period and may be acting as a time variable, not measuring demographic change. Also, if demographic demand influences the long run cycle, this variable would not be expected to be as important for the short cycle.

Increases in real rents are expected to reduce the rate of household formation and subsequently the absorption of new rental units. The positive coefficient is initially disturbing, suggesting either that the model is not fully specified, or that other influences are being explained through this variable. A possible argument to support the positive coefficent is that if real ownership costs have decreased more than real rents, the demand for ownership units will have increased at the expense of the demand for rental units. Therefore the demand for rental units would have decreased despite declining real rents.

The problems of multi collinearity and time trends are quite prevelant for the rent variable, possibly explaining the difficulties in estimation. A dummy for rent controls did not correct the sign or improve the model specification (see equation 5, Table 6.3). Alternate forms including mortgage

rates or adding real incomes also did not correct the problem. Therefore, despite difficulties with this variable, it has been left in the final results.

Since the unemployment rate was only available from 1966, a dummy variable was generated to compensate for the missing data.[21] To determine the full impact of unemployment and this dummy variable, an equation was estimated using only data for 1966 to 1980, where there was no missing data (see equation 6, Table 6.3). Although the dummy variable is significant, it does not alter the size and magnitude of the other coefficients suggesting it is more a time variable than explaining the impact of the missing unemployment data. It is important to note that the Home Acquisition Program was started in 1966, coinciding with the missing unemployment data. It is not unreasonable to expect the dummy variable to be including this impact. However, if this were true, the expected sign would be positive; encouraging home ownership will reduce apartment demand.[22] From an examination of the absorption data it is obvious that the period of 1963 to 1965 had lower absorptions, but this may be part of a cycle and not explained within the economic variables. With the existing data, this cannot be tested further.

The stock variable was estimated as the number of rental households multiplied by the occupancy rate. Consequently, the vacancy rate and stock variable are highly correlated. They are both entered in the initial equation, but vacancies are removed for the remaining estimations.

Finally, inventories represent the constraint for the

number of units absorbed. That is, the number of units that can be rented is limited to those currently available plus any completed during the quarter. The number of units available in inventory at the beginning of the period is entered to control for this constraint.

The final estimation for absorptions which was used to calculate predicted absorptions for the starts equation (equation 2, Table 6.3), clearly suffers data inadequancies and specification problems.[23] However, given that the coefficients may be measuring more than the economic impacts and the poor aggregate data available, the results are not surprising, or alarming. The emphasis of this paper is not on the demand aspects of multi family housing. Therefore, rather than dwell on the inadequacies of this estimation, it is preferable to move to the final results of the starts equation.

6.2.2 Starts

The interpretation of the specific results of the multi family starts equation is more critical than the final absorption equation. Fortunately, the estimation does not suffer the same problems with data inadequacies and multi collinearity. Analysis of these results will focus on the overall model, whether the signs and magnitudes of the coefficients are significant and consistent with the theoretical expectations and the possibility of a structural change for pre and post 1970.[24] Therefore, the full study period has been used to determine the model structure (1963-1980) and complete the

second step of the analysis. Similar equations were then estimated for 1963 to 1970 and for 1971 to 1980 to determine any changes in the model structure.

The starts equation was initially estimated using all of the variables outlined in Table 6.2, except for the dummy variables for government programs (equation 1, Table 6.4). The structure of the model assumes that production will be dependent upon the previous period's level of production, current inventories and expected demand. It is not possible to determine desired inventories, therefore a profit proxy and the bank rate have been entered into the equation directly. Quarterly dummies are used to remove any seasonality in the series. Given this structure, the overall model does not appear very satisfactory with an adjusted R^2 of only 0.268 and a standard error of 38 per cent of the mean of starts.

Previous discussion considered whether both units under construction and inventory should be included in the final estimation. It may be argued that starts should be responding to both, however, there is some difficulty in the data for units under construction as it is used as a correction factor in the stock variables. Units under construction are entered into the first equation, but since this variable is insignificant, it has been omitted from further runs. The omission of units under construction increases the adjusted R^2 to 0.278; still not very satisfactory.

Some interest rate and a profitability measure are given in the function equation for desired inventories and therefore

Table 6.4

Regression Results - Multi Family Housing Starts

1963-1980

	CONSTANT	VMFST1	ABSPRED	VMFINV1	VMFUC1	PROFIT	BKRAT	Q2	Q3	Q4	DUM	MURB	R^2	SE/DW
1.	-992	0.277	0.625	-0.180	-0.020	11.417	33.836	170.42	287.61	394.51			.362	646.87
		(2.026)	(2.314)	(0.951)	(0.411)	(0.960)	(0.633)	(0.746)	(1.254)	(1.751)			.268	2.023
2.	-1137	0.252	0.587	-0.169		12.552	37.439	167.92	292.44	400.65			.361	642.54
		(2.070)	(2.329)	(0.907)		(1.092)	(0.714)	(0.740)	(1.286)	(1.795)			.278	1.999
3.	185	0.258	0.691	-0.277				161.66	278.89	407.39			.347	638.83
		(2.157)	(3.081)	(1.750)				(0.719)	(1.235)	(1.846)			.286	2.004
4.	341	0.223	0.775	-0.295									.310	642.10
		(1.945)	(3.545)	(1.865)									.297	1.937
5.	238	0.235	0.676	-0.336				271.57	353.65	450.13	354.19		.429	602.15
		(2.079)	(3.197)	(2.233)				(1.263)	(1.650)	(2.158)	(3.006)		.366	1.991
6.	223	0.235	0.674	-0.340				271.76	355.11	451.62	354.63	21.49	.429	606.94
		(2.065)	(3.159)	(2.182)				(1.254)	(1.640)	(2.143)	(2.984)	(0.010)	.356	1.993

Notes: (1) t-statistics in parenthesis
(2) a '1' after the variable name indicates that the variable is lagged one period
(3) R^2 values reported are: first the unadjusted R^2, and second the adjusted R^2
(4) SE/DW denotes the standard error and Durbin-Watson statistic

enter the estimation. However, the interest rate (bank rate) is not significant and has the wrong sign. Smith (1979) found multi family housing to be insensitive to credit availablility, but sensitive to credit costs. Other studies (Rosen, Jaffee and Rosen) have used interest rates and found them significant with varying coefficients. It is possible that the nature of multi family construction is influencing this variable. Construction loans are negotiated before the start and therefore it may be more correct to lag this variable more than one period. Other credit conditions such as the term, amortization period, any origination or lender fees and the non-standard design of these loans may mean that actual credit costs are not fully represented by the nominal interest rate.

Profit does have the correct sign but is marginally significant. It should not be discounted merely on the basis of its significance. Clearly, profitability will influence the investment decision, however the proxy may be inadequate to accurately reflect market conditions.[25]

Due to the possible difficulties with the profit proxy and interest rates, the next regression excluded these two variables, improving the adjusted R^2 to 0.286 (equation 3, Table 6.4). This provided the best overall model without any adjustments for government programs. Final estimations excluded the quarterly dummies to confirm the seasonality expectation and then included a dummy for MURBs and the unusual data in 1977 to 1978.[26] Little is gained with the MURB dummy, or other dummies which were tested for other government programs. The impacts of

these programs are undoubtedly too complex to be captured with a zero/one variable, but there is insufficient knowledge on market responses to structure a more sophisticated variable.

Equations 3 and 5 (Table 6.4) provided the best overall results. The following discussion on the specific coefficients will key on these results.

Lagged starts are expected to have a positive sign based on the adjustment process of the inventory model. The coefficient for this variable indicates the speed of adjustment of starts to the desired level. For the complete estimation period, this coefficient of 0.258 (Equation 3) or 0.235 (Equation 5). Therefore, the mean lag of the adjustment process is approximately one third.[27] That is, adjustment will occur within one third of a quarter, which suggests an almost instantaneous adjustment.

Absorptions represent the expected demand, which, to maintain a constant level of inventory will have close to a one-to-one relationship with starts. Some response lag is expected depending on other market conditions. Also, the lumpiness of multi family units may affect the response to demand; it is obviously not possible to build one multi family unit. Depending on the size of plannned projects, the response rate of market participants will vary. Therefore, a coefficient around 0.6 is reasonable and within the theoretical expectation.

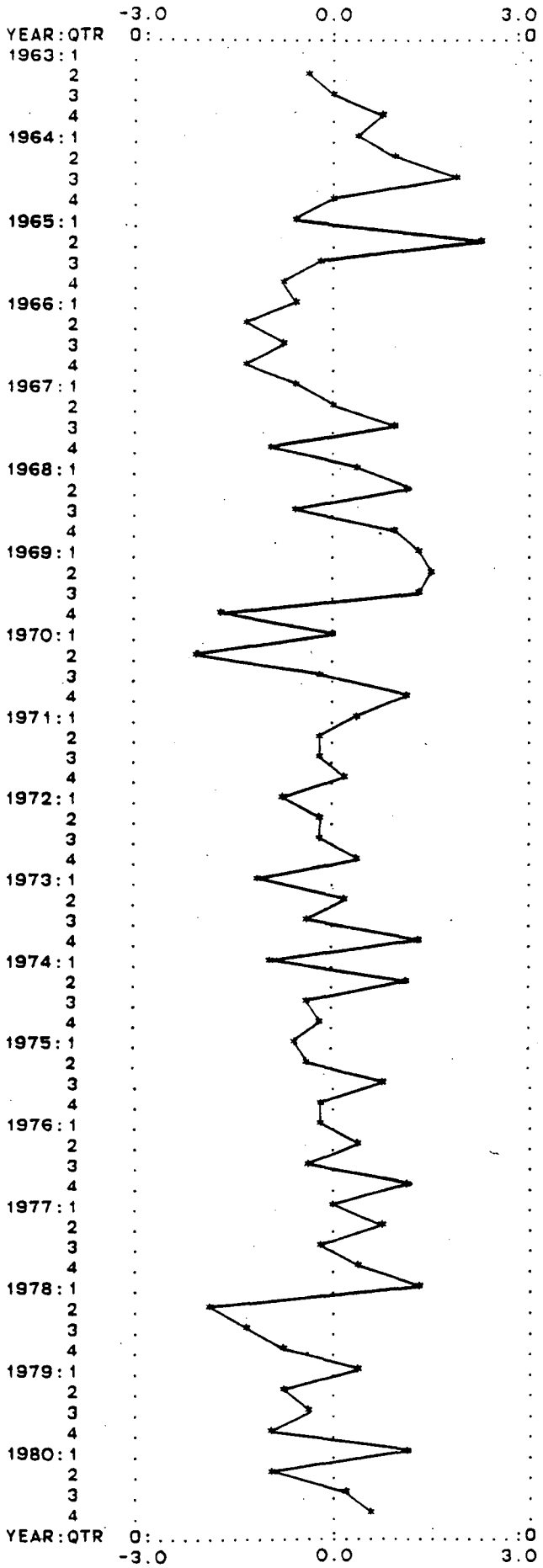
The premise of the theoretical model is that there is some desired inventory level to be maintained, depending on the cost of holding vacant units. As the actual number of units in

inventory increases, starts should decline. Conversely, a reduction in inventory should generate an increase in starts to replenish the stock. Inventories do have the expected negative coefficient. A second consideration is the size of the coefficient and whether it make sense within the structural framework of the model. The coefficient of approximately -0.3 indicates that expected starts will be reduced by about 30 per cent of the existing inventory. The regression of completions with lagged starts indicated that the expected construction time from start to completion was between 6 months to 1 year. It has also been suggested that the response should be less than one to accomodate an adjustment lag between changes in inventory and starts. Although this variable is only marginally significant for some of the equations, the size of the coefficient is consistent with expectations. Further, its size does not change drastically when the sample is split for the pre and post 1970 analysis.

Finally, the quarterly dummies indicate that there is some seasonality with the first quarter being the lowest. Although these coefficients are not very significant individually, they do improve the overall model and have been maintained in the estimation.

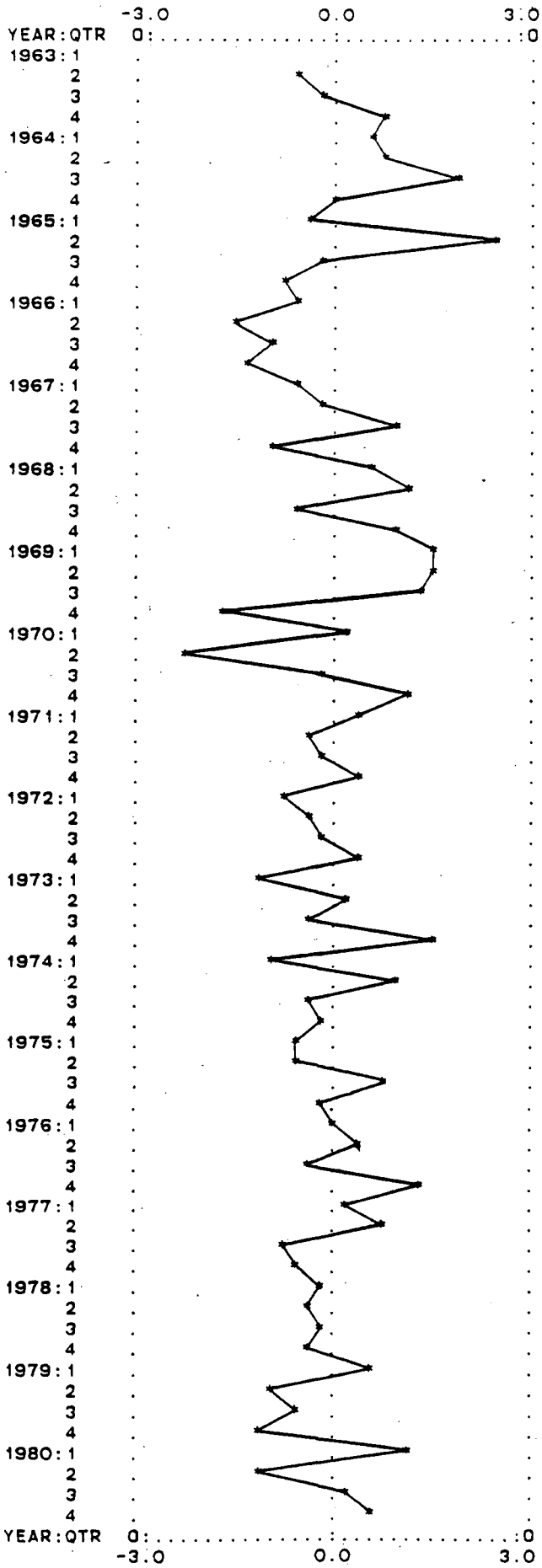
An examination of the residuals for equations 3 and 5 (Figures 6.1 and 6.2) indicate some cycling which is not explained by the independent variables. The literature suggests that housing cycles may be anti-cyclical to the general business cycle. The real Canadian gross national product was used as a

FIGURE 6.1 - RESIDUAL ANALYSIS FOR EQUATION 3



STARTS	PREDICTED STARTS	RESIDUAL
971.		
820.	1104.0541	-284.0541
1231.	1250.0276	-19.0276
2045.	1521.5022	523.4978
1592.	1328.2089	263.7911
1984.	1396.1963	587.8037
2928.	1644.4923	1283.5077
1992.	2044.5740	-52.5740
1164.	1498.7922	-334.7922
3108.	1519.8645	1588.1355
1884.	2066.3704	-182.3704
1430.	1948.9689	-518.9689
1220.	1610.2254	-390.2254
920.	1781.1592	-861.1592
1349.	1893.7127	-544.7127
1184.	2082.6736	-898.6736
1128.	1515.4064	-387.4064
1678.	1676.7407	1.2593
2756.	2090.0690	665.9310
1798.	2418.7977	-620.7977
1932.	1658.1372	273.8628
2735.	1940.7288	794.2712
2051.	2382.5008	-331.5008
3003.	2387.8534	615.1466
3031.	2195.6955	835.3045
3445.	2438.9771	1006.0229
3627.	2757.5685	869.4315
1842.	2969.3607	-1127.3607
2020.	1959.7913	60.2087
634.	2022.0929	-1388.0929
1899.	1983.6171	-84.6171
3213.	2484.7391	728.2609
2261.	2054.8848	206.1152
1875.	2062.9864	-187.9864
2099.	2268.9200	-169.9200
2587.	2408.8086	178.1914
1288.	1839.0240	-551.0240
1493.	1639.7097	-146.7097
1779.	1898.1353	-119.1353
2336.	2035.1021	300.8979
959.	1688.8795	-729.8795
1686.	1526.3424	159.6576
1674.	1891.2378	-217.2378
2963.	2020.9327	942.0673
1128.	1802.7369	-674.7369
2181.	1437.0753	743.9247
1525.	1753.6546	-228.6546
1515.	1671.7428	-156.7428
700.	1093.8711	-393.8711
855.	1134.3843	-279.3843
1727.	1270.0148	456.9852
1587.	1725.7102	-138.7102
1015.	1150.5176	-135.5176
1507.	1215.5907	291.4093
1210.	1473.4341	-263.4341
2372.	1589.4486	782.5514
1435.	1429.7477	5.2523
1903.	1434.7520	468.2480
1612.	1787.6069	-175.6069
2132.	1845.1206	286.8794
2206.	1346.2683	859.7317
290.	1629.8705	-1339.8705
373.	1226.7910	-853.7910
686.	1229.8603	-543.8603
1115.	806.3649	308.6351
632.	1166.5118	-534.5118
1013.	1272.7137	-259.7137
765.	1452.7979	-687.7979
1574.	789.4486	784.5514
626.	1244.9633	-618.9633
1334.	1160.1336	173.8664
1901.	1513.0067	387.9933

FIGURE 6.2 - RESIDUAL ANALYSIS FOR EQUATION 5



STARTS	PREDICTED STARTS	RESIDUAL
971.	-0.1000E+07	-0.1000E+07
820.	1216.5122	-396.5122
1231.	1318.0302	-87.0302
2045.	1547.1288	497.8712
1592.	1281.8199	310.1801
1984.	1476.6967	507.3033
2928.	1680.3339	1247.6661
1992.	2017.4753	-25.4753
1164.	1378.2870	-214.2870
3108.	1511.7118	1596.2882
1884.	2038.5488	-154.5488
1430.	1893.9440	-463.9440
1220.	1557.2904	-337.2904
920.	1847.9164	-927.9164
1349.	1924.2876	-575.2876
1184.	2082.4273	-898.4273
1128.	1485.2835	-357.2835
1678.	1769.5482	-91.5482
2756.	2125.7629	630.2371
1798.	2399.2097	-601.2097
1932.	1623.8722	308.1278
2735.	2006.0127	728.9873
2051.	2403.5798	-352.5798
3003.	2393.9473	609.0527
3031.	2125.6450	905.3550
3445.	2479.0508	965.9492
3627.	2753.4809	873.5191
1842.	2918.1153	-1076.1153
2020.	1898.1850	121.8150
634.	2051.3606	-1417.3606
1899.	2025.8939	-126.8939
3213.	2443.7191	769.2809
2261.	1988.1171	272.8829
1875.	2105.5579	-230.5579
2099.	2261.5210	-162.5210
2587.	2358.0681	228.9319
1288.	1767.5280	-479.5280
1493.	1723.2381	-230.2381
1779.	1928.4141	-149.4141
2336.	2037.3425	298.6575
959.	1638.6861	-679.6861
1686.	1623.3503	62.6497
1674.	1918.6161	-244.6161
2963.	2023.9507	939.0493
1128.	1749.7756	-621.7756
2181.	1533.9738	647.0262
1525.	1790.3828	-265.3828
1515.	1671.6707	-156.6707
700.	1040.3700	-340.3700
855.	1185.3028	-330.3028
1727.	1254.8968	472.1032
1587.	1673.9795	-86.9795
1015.	1043.7362	-28.7362
1507.	1241.2898	265.7102
1210.	1461.4285	-251.4285
2372.	1531.3736	840.6264
1435.	1303.2487	131.7513
1903.	1445.8177	457.1823
1612.	2077.4231	-465.4231
2132.	2444.4816	-312.4816
2206.	2293.2257	-87.2257
290.	556.5535	-266.5535
373.	542.9858	-169.9858
686.	898.4314	-212.4314
1115.	791.9354	323.0646
632.	1254.2208	-622.2208
1013.	1320.4895	-307.4895
765.	1480.6049	-715.6049
1574.	800.9942	773.0058
626.	1343.8859	-717.8859
1334.	1244.9243	89.0757
1901.	1535.1301	365.8699

proxy to test this possibility. It did not improve the model or reduce the cycle in the residuals. A second consideration in the residual analysis is the reduction in the size of the errors after 1971. This coincides with the expectation of a possible change in the market structure for pre and post 1970. The results of this analysis confirms this expectation.

The estimated equations for 1963 to 1970 are presented in Table 6.5. These results are much poorer than the results for the total time period; the adjusted R^2 for equation 3 is reduced to 0.109 and the standard error is increased to 52 per cent of the mean of starts for this period. The coefficients for starts, predicted absorptions and inventory have the same signs, but the sizes and significance are very different. In the estimation for the total period, absorptions were the most significant variable. In the 1963-70 period, lagged starts are most significant. Also, the size of the coefficients for the quarterly dummies are quite different, suggesting a shift in the seasonality.

The reasons for the poor fit may be in the estimation, or the reduced number of observations (reducing the degrees of freedom). The predicted absorptions is based on data for the full period. Consequently, later periods may bias this variable, however, it is not expected that this bias will affect the results drastically.

The expectations of a change in market structure is supported by the estimation of the equations for 1971-1980 (see Table 6.6). The overall model results are better. The removal

Table 6.5

Regression Results - Multi Family Housing Starts

1963-1970

	CONSTANT	VMFST1	ABSPRED	VMFINV1	VMFUC1	PROFIT	BKRAT	Q2	Q3	Q4	DUM	MURB	R^2	SE/DW
1.	5074	0.435	-0.046	0.308	-0.135	-45.467	182.836	378.610	649.847	355.289			.346	795.81
		(1.366)	(0.045)	(0.491)	(0.892)	(0.555)	(0.734)	(0.899)	(1.358)	(0.715)			.066	1.923
2.	8920	0.252	-0.337	0.127		-75.566	96.281	386.665	653.133	420.982			.321	792.11
		(1.040)	(0.351)	(0.214)		(1.017)	(0.422)	(0.922)	(1.372)	(0.861)			.075	1.845
3.	327	0.388	0.471	-0.221				317.558	446.749	168.927			.287	777.20
		(2.037)	(1.258)	(0.580)				(0.783)	(1.097)	(0.415)			.109	1.899
4.	632	0.366	-0.283	0.481									.247	752.98
		(2.044)	(0.780)	(1.329)									.163	1.873

Notes: (1) t-statistics in parenthesis
(2) a '1' after the variable name indicates that the variable is lagged one period
(3) R^2 values reported are: first the unadjusted R^2, and second the adjusted R^2
(4) SE/DW denotes the standard error and Durbin-Watson statistic

Table 6.6

Regression Results - Multi Family Housing Starts

1971-1980

	CONSTANT	VMFST1	ABSPRED	VMFINV1	VMFUC1	PROFIT	BKRAT	Q2	Q3	Q4	DUM	MURB	R^2	SE/DW
1.	-1674	-0.106	1.242	-0.285	0.061	10.186	75.898	-197.679	-193.874	245.538			.452	531.75
		(0.510)	(1.791)	(1.056)	(0.842)	(0.481)	(1.112)	(0.678)	(0.581)	(0.756)			.288	2.040
2.	-1697	-0.031	1.020	-0.238		18.422	54.299	-135.539	-113.680	321.369			.439	529.25
		(0.164)	(1.598)	(0.905)		(0.986)	(0.862)	(0.483)	(0.357)	(1.034)			.295	2.034
3.	235	-0.023	1.087	-0.334				-164.833	-128.356	345.354			.417	523.03
		(0.123)	(3.015)	(1.822)				(0.604)	(0.436)	(1.244)			.311	2.036
4.	200	-0.014	1.102	-0.321									.313	543.70
		(0.093)	(3.471)	(1.748)									.256	2.086
5.	308	-0.045	1.034	-0.405				31.267	13.113	419.760	343.077		.606	436.45
		(0.295)	(3.438)	(2.628)				(0.134)	(0.053)	(1.806)	(3.923)		.520	2.198
6.	442	-0.062	1.006	-0.341				19.477	-17.573	391.851	338.543	-142.44	.613	439.73
		(0.396)	(3.288)	(1.917)				(0.083)	(0.069)	(1.651)	(3.833)	(0.742)	.513	2.183

Notes: (1) t-statistics in parenthesis
(2) a '1' after the variable name indicates that the variable is lagged one period
(3) R^2 values reported are: first the unadjusted R^2, and second the adjusted R^2
(4) SE/DW denotes the standard error and Durbin-Watson statistic

of the 1977-78 abnormal data with a dummy significantly improved the results with an adjusted R^2 of .52 and the standard error reduced to 436 (29 per cent of the mean of starts).

Several of the coefficients are quite different for the two periods. The negative and insignificant coefficient for lagged starts for the 1971-80 period may be interpredted as zero, or immediate adjustment. The coefficient for predicted absorptions increased which may be in part due to the lower vacancy rates experienced during the 1970's. With fewer existing units available, the demand and absorption for new units should increase. The coefficient for inventories is relatively stable, but more significant. If the model is reflecting market responses, these changes suggest that the market throughout the 1970's was more responsive to demand and inventories, supporting the inventory adjustment approach.

The possibility of a change in seasonality is also supported. The ratio of the fourth quarter dummy to either of the other quarters is substantially larger than for the results for either the total period, or the 1963-70 period. Smith (1979) proposed that starts in the fourth quarter were increased in response to annual expectations of removal of the MURB benefits. These results would seem to support this proposal.

Overall, the model performs better for the post 1970 period, but, the results are not as good as those studies reviewed.[28] The significance of the inventory, absorptions and starts variables is encouraging and support the proposed theoretical structure of an inventory adjustment model.

The proposed theoretical model suggests that inventory levels act as a buffer between the supply and demand for multi family housing units. The traditional measure has been vacancy rates with the argument that during periods of low vacancy rates, investment and subsequently starts for multi family (rental) housing should increase. As a test of the validity of the claim that vacancy rates are not a sufficient indicator of demand and supply motivation, four additional equations are reported. These are the best overall models from the above analysis, with vacancy rates for the beginning of the quarter added with predicted absorptions still in the estimation and with predicted absorptions removed. These are presented in Table 6.7. The regression results for the overall model are not as good as without vacancy rates. Further, the vacancy variable is only marginally significant in the equation for 1971 to 1983 with absorptions, but flips signs when absorptions are removed. These results suggest that vacancies, in isolation, are an inadequate and unreliable indicator of activity in the multi family housing market.

6.3 TIME SERIES MODEL

Time series models developed with the ARIMA process are based on the previous values for the estimated series and the error of the last predicted value.[29] The volatility of the multi family housing starts series and previous work on developing a time series model for housing suggests that the application of ARIMA models to multi family starts will be limited. A time

Table 6.7

Regression Results - Multi Family Housing Starts

Including Vacancy Rates

	CONSTANT	VMFST1	ABSPRED	VMFINV1	VVAC1	Q2	Q3	Q4	R^2	SE/DW
					1963-1980					
1.	176	0.256	0.682	-0.277	15.996	157.46	274.38	406.74	.348	643.43
		(2.120)	(2.996)	(1.773)	(0.295)	(0.694)	(1.204)	(1.829)	.276	2.00
2.	691	0.429		-0.101	36.879	257.95	422.46	528.11	.256	682.34
		(3.813)		(0.640)	(0.648)	(1.085)	(1.790)	(2.278)	.186	2.19
					1971-1980					
3.	-47	-0.104	1.673	-0.514	-192.08	-243.23	-234.80	216.61	.454	514.24
		(0.547)	(3.125)	(2.355)	(1.462)	(0.889)	(0.787)	(0.755)	.334	2.12
4.	687	0.281		-0.002	115.79	106.21	237.84	677.74	.287	578.52
		(1.737)		(0.011)	(1.184)	(0.378)	(0.823)	(1.737)	.157	2.22

Notes: (1) t-statistics in parenthesis
(2) a '1' after the variable name indicates that the variable is lagged one period
(3) R^2 values reported are: first the unadjusted R^2, and second the adjusted R^2
(4) SE/DW denotes the standard error and Durbin-Watson statistic

series model has been developed to provide a comparison and to aid in testing the reliability of the structural model. Discussion will be limited to a brief outline of the model design, with the results presented in Table 6.8.

Multi family starts data from 1963:1 to 1980:4 were used to estimate the time series model. Stationarity was acheived with first differences. Two models were derived from the differenced series; one based on an autoregressive term and a moving average term, and the second based on these plus seasonal autoregressive and moving average terms. Seasonal differencing and second order differencing were tested but the results indicated that the resultant series were over-differenced. Additional parameters were added but were not significant.

Finally, since the structural model supported the possibility of a change in the structure of the starts series, another time series using only data for 1971 to 1980 was considered. From the autocorrelations and partial autocorrelations it was not possible to identify a model. Recognizing that forty data points may be insufficient to estimate a time series model, this was not pursued.

The success of the time series model, as it compares to the structural model, will be discussed in the next section on forecasting and test measures.

6.4 FORECASTS AND TESTS OF MODEL RELIABILITY

The final step of the analysis is to choose the optimal estimation of the structural model and measure the ability to

Table 6.8

Time Series Models

Model	Lag	Autoregressive Terms 1	4	Moving Average Terms 1	4	Residual Variance
5		0.2103		0.7966		$0.49771*10^6$
		(1.262)		(7.854)		
6		0.3712	0.7900	0.9597	0.62987	$0.46684*10^6$
		(3.065)	(4.311)	(23.785)	(3.0089)	

Note: t-statistics in parenthesis

predict the level of multi family housing starts both within and outside the estimation period. The coefficients for the structual model are fairly stable so there is little concern that the chosen model will not accurately reflect the estimation capabilities of the model. However, there were some changes when only the 1971 to 1980 data was used for the regression analysis. Therefore, four equations from the regression results have been chosen to measure the reliability of the proposed model; two from the 1963-1980 results and the equivalent equations from the 1971-1980 results. These will include equation 3 (the best overall model) and equation 5 which is identical, with the addition of the dummy to remove the impact of the unusual data in 1977 and 1978. As mentioned, time series models have been developed as a comparative for the structural model. In addition, a naive series has been constructed on the assumption that the best forecast is the actual level of starts in the previous period. In summary, the following models will be tested:

Model 1 Equation 3, Table 6.4
Model 2 Equation 5, Table 6.4
Model 3 Equation 3, Table 6.6
Model 4 Equation 5, Table 6.6
Model 5 Time series, autoregressive and moving average terms
Model 6 Time series, non-seasonal and seasonal autoregressive and moving average terms
Model 7 Naive model, previous value

It is important to recognize that the time series models have only one lagged parameter and therefore require information on the preceding period to forecast the next period. Therefore, the forecasting ability is limited to one period. Similar

restrictions are in effect for the structural model since it requires the current level of inventory and the previous level of starts to forecast for the next period. When preparing the forecasted series for all of the model, it was assumed that this data would be available. That is, the forecasted measures outside the estimation period are for one period forward and assume that the actual levels for the preceding period are available.[30]

The prediction results for the seven models given in Table 6.9 are divided into three periods; 1963 to 1982, the study period; 1963 to 1980, the estimation period; and 1981 to 1982, the forecast period. For each time period the reported statistics include the root mean square error (RMSE), mean absolute error (MAE) and Theil U statistic.[31] The most important results are within the estimation period and the forecast period. The results for 1963 to 1980 suggest that the structural model is superior. The preferred equation is more difficult to identify since the RMSE is higher for Models 1 and 2, but, the MAE is higher for Models 3 and 4. Since the RMSE penalizes the for large errors, the performance of Models 3 and 4 would appear slightly better.[32]

The results for the forecast period seem to cast doubt on the reliability of the structural model, especially in comparison to the time series model. The performance of the naive model improves, but, it is still outperformed by the other series and will not be discussed further. Before dismissing the forecasting ability of the structural model in favour of the

TABLE 6.9

FORECASTING RESULT MEASURES

MODEL	1	2	3	4	5	6	7
			1963-1982				
RMSE	862.603	812.668	820.021	766.560	966.528	1040.813	1318.178
MAE	514.968	477.948	600.529	599.504	577.935	583.734	641.564
THEIL	1.088	1.025	1.034	0.967	1.206	1.289	1.663
			1963-1980				
RMSE	881.687	825.011	825.212	774.948	1004.833	1086.575	1373.249
MAE	488.654	449.678	544.721	541.991	574.189	579.104	663.686
THEIL	1.079	1.009	1.010	0.948	1.214	1.301	1.680
			1981-1982				
RMSE	719.376	743.399	826.502	736.387	578.001	589.903	709.683
MAE	851.677	828.937	1244.401	1260.282	696.887	709.459	512.000
THEIL	1.265	1.307	1.454	1.295	1.017	1.037	1.248

time series models an important point should be considered. It was noted that all of the predictions were only one period forward, so the unusual activity in the forecast period would be detected by the time series model and not the structural model. Nineteen-eighty-one and 1982 were unusual years for the multi family market with the removal of the MURB program as of December 31, 1981. The announcement of the discontinuation of the MURB program initiated an abnormal number of starts as builders or investors attempted to construct footings for future projects and thereby qualify for the tax benefits associated with MURBs. Without building a dummy to capture this impact, the structural model is unable to detect the unusual market activity. The coefficient of such a dummy cannot be determined without further regression analysis.

The results would appear mixed. The results during the estimation period support the inventory adjustment approach and indicate that the structural model is superior to the time series model. However, for forecasting, the time series model performs better during 1981 and 1982. The difficulty with the reported statistical tests is that they do not indicate if the model is missing turning points or not measuring the extreme points; the nature of the errors cannot be determined. To further evaluate the performance of the models, plots of the predicted and actual series are presented in Figures 6.3 through 6.5.

The structural model is generally successful in determining the trends in the data, but does not reach the extreme values

Figure 6.3

PREDICTED MULTI FAMILY

HOUSING STARTS

MODEL 2

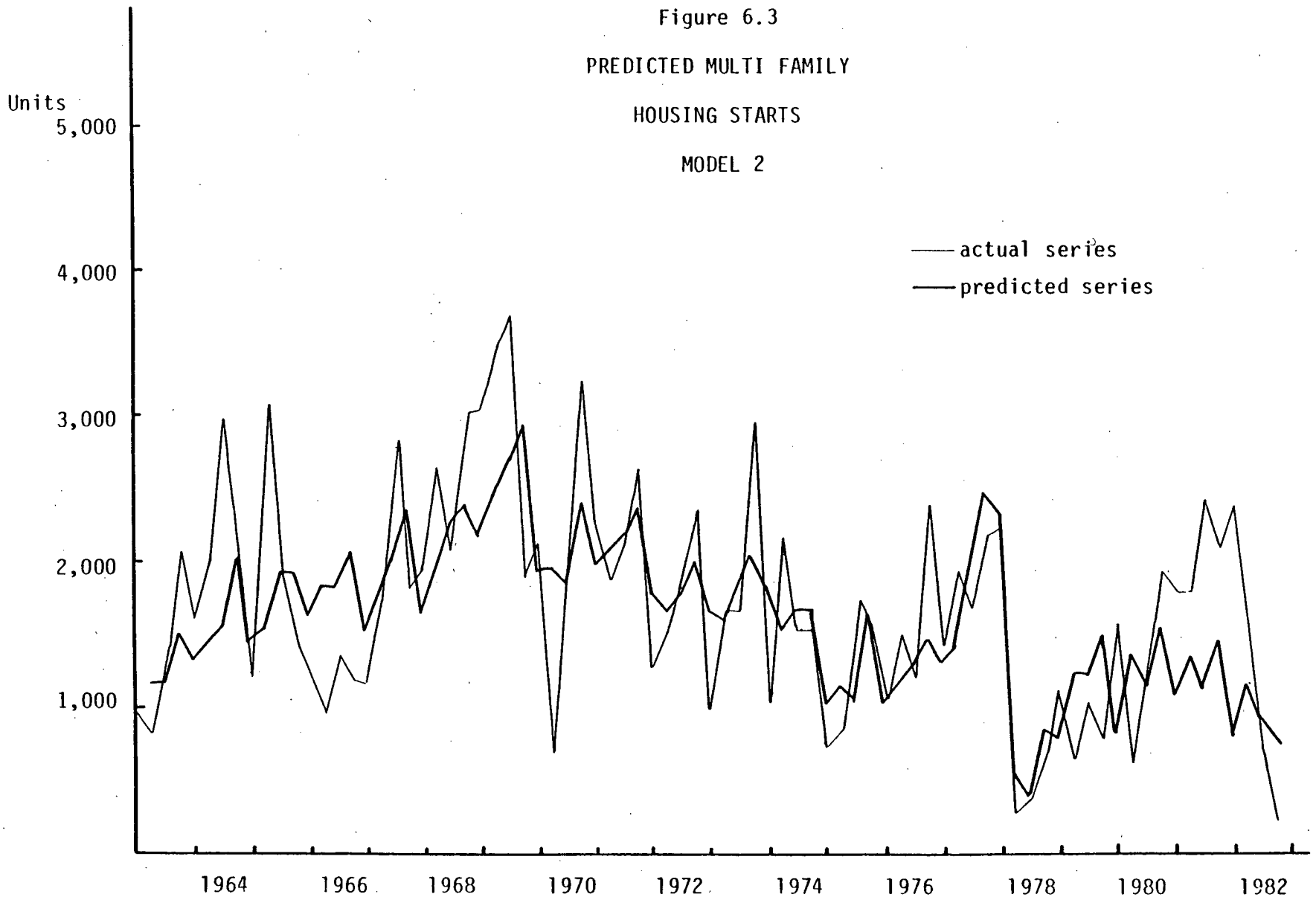


Figure 6.4

PREDICTED MULTI FAMILY

HOUSING STARTS

MODEL 4

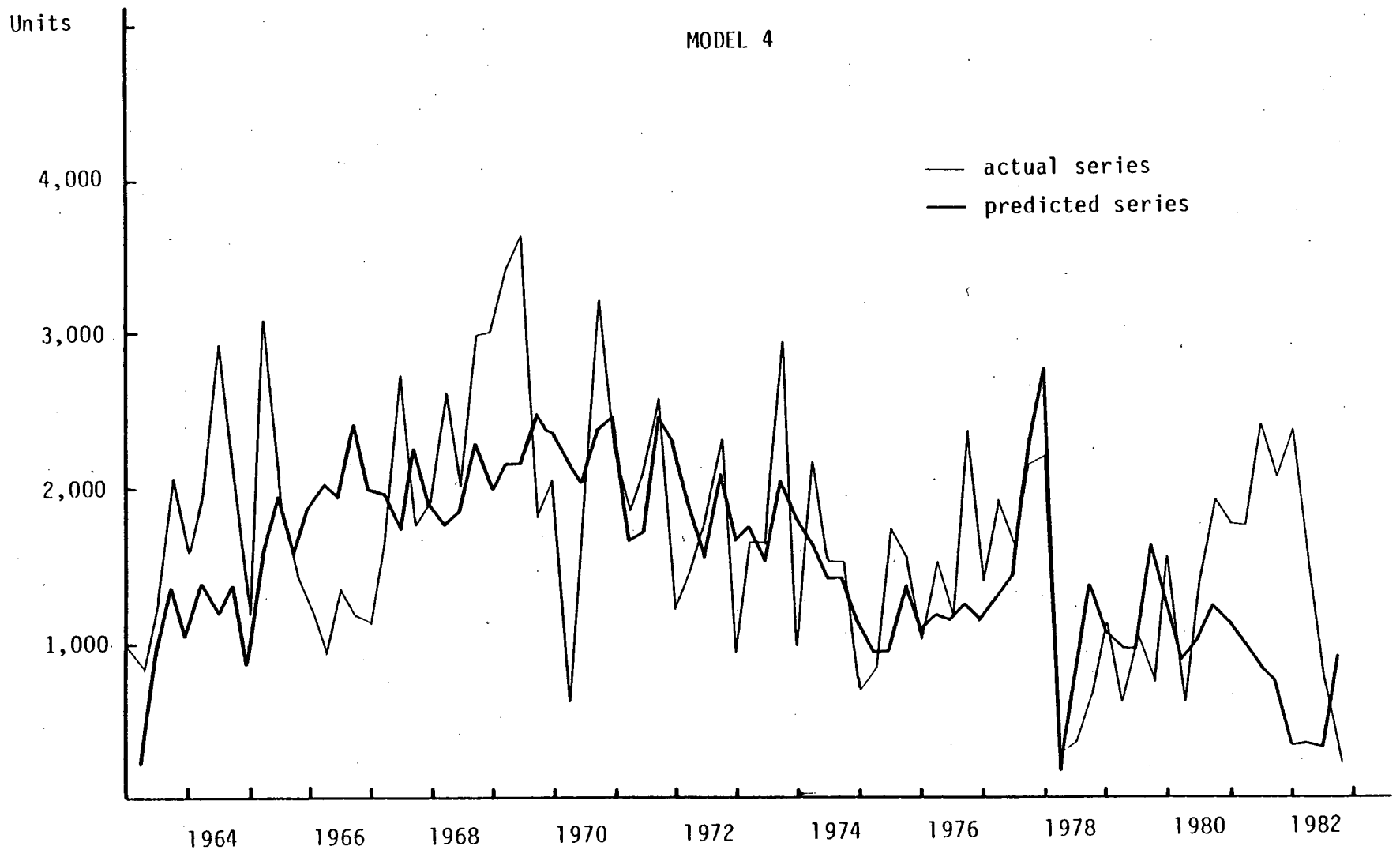
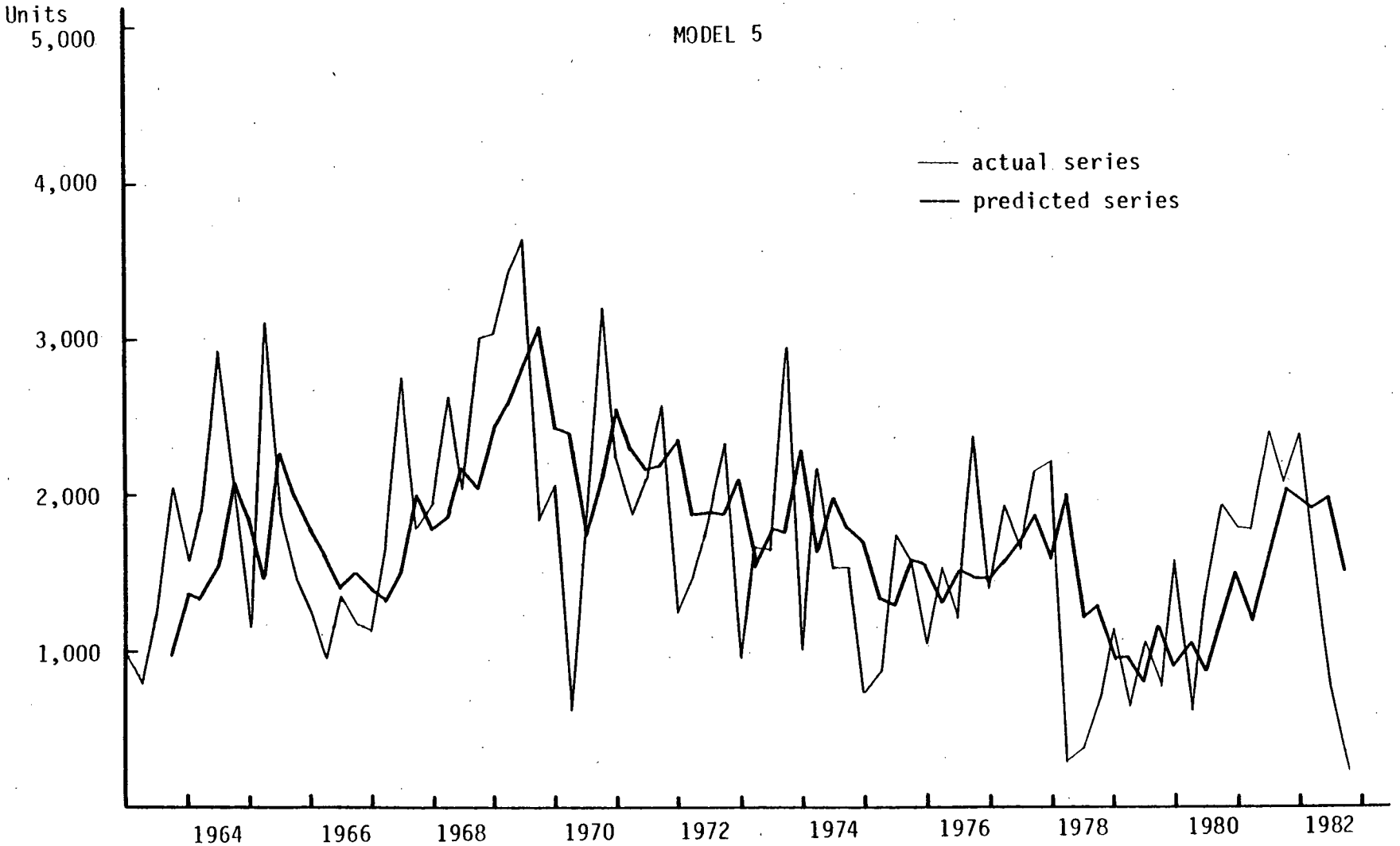


Figure 6.5

PREDICTED MULTI FAMILY

HOUSING STARTS

MODEL 5



evident in the actual starts series. Although the lagged starts enter the estimation of these series, there is no measurement of the prediction error. Therefore, if some unusual force, such as a change in government policy, disrupts the market, the structural model will be unable to detect the change and adjust accordingly. Alternatively, the time series model depends upon serial correlation in the series for predictions. For housing starts it is unable to determine the turning points, but is successful in periods where the trend is sustained for several periods. The apparent forecasting success of the time series model in 1981 and 1982 is obviously benefitting from such a pattern. The model does not detect the turning points within the estimation period and fails in predicting the initial increase or decline in starts in the forecasting period.

The stability of the coefficients in the regression analysis for the starts model and the ability of the model to outperform a time series model during the estimation period suggest that the proposed approach may be able to provide reasonable market predictions. Considering the abnormal market conditions in 1981, the lack of forecasting success does not create any great concern. It may be useful to further develop the model to incorporate a time series as well, thereby permitting the complete model to benefit from information on inventories, economic conditions and unusual market behaviour; the former through the structural variables, the latter through the error term of the time series model.

7. CONCLUSIONS AND FUTURE RESEARCH

This study has proposed the adoption of the inventory adjustment model to estimate and predict multi family housing starts. The theoretical model suggests that there is some desired inventory level which builders or investors will try to maintain depending on expected profitability, the relative yield on other investments and the cost of maintaining vacant units. Demand for new rental units will depend upon the demographic structure of the population, unemployment, income, and the relationship between rents ownership costs and the cost of other goods and services. Starts, or production, will be set to satisfy the expected demand and adjust actual inventory levels to the desired inventory level. This is in contrast to the tradtional approach which suggests that vacancy rates are an indicator of demand and during periods of low vacancies multi family housing starts will increase.

Quarterly data for the Vancouver CMA, from 1963:1 to 1982:4 has been used to develop and test a structural model based on the inventory adjustment approach. The available data posed problems in estimating the change in the number of total and rental households. Also, the apartment series for starts and inventories includes government projects, which do not respond to the same market forces as privately initiated construction, and condominiums, which are not necessarily part of the rental stock.

The model results yield an adjusted R^2 of about 0.3

(depending on the specification). Several points suggest that the model may warrant further investigation. As was noted previously, the size of multi family projects will influence the appearance of the data series and may bias the results. Also, by using regional data, there may be some collection error which is minimized by aggregating to the national level.

Vacancy rates were insignificant when included in the regression estimations suggesting that they are not a complete indicator of demand and may not be a major determinant in construction decisions. Inventories do enter the results with a significant negative coefficient, as expected. Plots of the predicted and realized series indicate that the model is successful in detecting the trends in starts, although it does not attain the same extreme volatility as the actual series. Predictions for 1981 and 1982 using the regression results are unable to accurately monitor the market activity. Since the high level of starts in this period is the result of discontinuation of MURB benefits, this is insufficient evidence to discount the model.

In answer to the questions posed at the outset, it would appear that inventories, the cost of maintaining inventory and the expected demand have contributed to the decline in starts throughout the 1970's. To conclude that vacancy rates have no impact and that the volatility of starts is attributable to an inventory cycle is too strong given the evidence presented in this paper. The results do support the inventory approach, but, data difficulties in estimating the empirical model are

sufficient to prohibit such a decisive conclusion. Before the application of the inventory adjustment approach to multi family housing can be discounted or argued more strongly, a couple of considerations should be addressed. Is Vancouver typical of Canadian urban centres, or are the successes or failings of these results caused by idiosyncracies of the Vancouver housing market? Studies of single family housing prices suggest that the Vancouver market is unique. A cross-sectional analysis, using other Canadian urban centres to estimate similar equations, is needed to determine the uniqueness of these results.

Also, the importance of market substitutes such as conversions and condominiums needs to be investigated and incorporated into the results. It would appear that legal and illegal suites have provided an alternate form of rental accomodation but have not been included since the data was not available. Condominiums may be rented upon completion even if a strata title is obtained for the project leading to inconsistent data on structure and tenure types. It is no longer valid to assume that apartment or multi family structures are rental.

Government intervention in the housing market has clouded interpretation of the results. Policy has been to encourage home ownership. Programs introduced throughout the 1970's and the inability to model their impacts suggest that the market has been disrupted. The precise implications on the results and future predictions cannot be measured. Clearly, the inability of the model to forecast for 1981 and 1982 is the result of the

MURB program, but it is impossible to monitor these impacts in advance, and improve the forecasting capabilities of the model.

Future research may be able to benefit from improved data collection. Starting in 1981, CMHC reports starts and inventories by source of funds and tenure type. It may then be possible to re-estimate the inventory adjustment model for only the privately initiated rental component of the multi family housing market, as proposed in the theoretical model.

The results presented suggest that the approach is appropriate, but, the data inadequacies have limited the significance and reliability of the results. Further cross-sectional analysis may provide more information on the success of the proposed technique. Also, the incorporation of a time series model with the regression analysis may be justified to monitor prediction errors and incorporate these in the forecasts.

NOTES

1. For a further discussion of this point see Alberts, 1962; Guttentag, 1961; Smith,1974,pp31-35.

2. Prior loan commitments will be especially important for construction loans on large projects where arrangements are usually made prior to the commencement of construction.

3. See Grebler & Maisel, 1963; Smith, 1974; Stevens,1976; Steele,1979.

4. In response to paper presented by Quigley, 1978. See Bourne & Hitchcock, Urban Housing Markets: Recent Directions in Research and Policy .

5. For more complete discussions of Canadian housing policy and its implications, see Dale-Johnston, 1977; Fallis, 1981; Gau & Wicks, 1982; Goldberg, 1983; Heung, 1976; Jones, 1983; Smith, 1977,1981,1982; Wicks, 1982.

6. With this amendment, multi family structures where the owner was resident, or commercial structures where there was a residence attached, qualified for these grants.

7. NHA mortgages require that the downpayment be unencumbered.

8. Rent controls and the impact on the market has been a controversial issue throughout the 1970's. Arguments on controls are presented in Jones, 1983; Smith & Tomlinson,1981.

9. Zoning and its implications for Vancouver are discussed in Heung, 1976; Jaffary, et al., 1975; Goldberg & Horwood, 1980.

10. For a discussion on inflation and housing see Capozza, 1983; Doughterty and Van Order, 1982; Goldberg, 1983; Hendershott, 1980; Kearl, 1979.

11. see Cameron & Johnston,1981.

12. see Gau & Wicks, 1982; Wicks, 1982.

13. For a complete discussion of the inventory concept and the derivation of the model see Meltzer, 1940; Allen, 1957; Lovell, 1966.

14. The age-sex breakdown and rental demand for the age cohort will be used to determine the future rental demand as the population ages. The rate of household formation may be accelerated or delayed depending on economic conditions. When the general economic conditions are favourable, an increase in household formation is expected.

15. This is similar to the land valuation function used by

Wicks, 1982.

16. This method of projecting the number of rental households is similar to the approached proposed by Jaffee & Rosen (1979) to project the demographic demand for single family units.

17. See Statistics Canada, Catologue 62-010, Consumer Prices and Price Indexes for an explanation of the conversion technique and changes in the basket of goods.

18. See definitions outlined in Statistics Canada Catalogue 64-002, pp5-6.

19. See Appendix B for a listing of the complete data series.

20. First differences will eliminate the problems of trends, however, if the equations are estimated for the changes, not the original levels, autocorrelation will be introduced into the results if the original data is serially independent. A common scaling factor will also reduce the trend, but the residuals will then be heteroscedastic and there is the possibility of "spurious" correlation from the scaling variable. Where data is insufficient to permit accurate measurement of the impacts of each independent variable, and more data cannot be collected, it may be necessary to omit some variables from the equation to reduce the multi collinearity. If it is not necessary to have a precise coefficient for each independent variable, this is the preferred approach.

21. The dummy variable is equal to zero where unemployment data is available (1966-1982) and one where data is missing (1963-1965).

22. Since the dummy variable is one when the program is NOT in effect and these years would be expected to have a higher number of absorptions if home ownership is encouraged, the sign should be positive.

23. Logs and absorptions as a percentage of stock were tried without any improvement in the specification or the elimination of these problems.

24. This data was chosen based on the increasing government programs in the 1970's and the extensive changes in tax legislation in the early 1970's.

25. The proxy for profit which yielded the best results is the rental CPI deflated by the construction cost index. Other measures derived to incorporate the vacancy rate or interest rate were less successful than the simplistic measure used. Alternate measures such as the rate of return series derived by Gau (1983) may prove more accurate. Part of the intent of this study is to use readily accessible data to permit cross-sectional analysis with other Canadian centres. Therefore,

these alternate measures were not pursued.

26. A dummy variable was specified as '1' before 1972 and '1' during the period when the MURB program was in place, and zero otherwise. The results did not contribute to the adjusted R1, or reduce the standard error. Attempts were also made to replicate the lagged effect of starts after the program's inception and announced removal. These also failed. No doubt the program influenced the market, but the design of an appropriate dummy variable could not be determined.
The period of 1977-78 portrayed an unusual drop in starts. Part of this maybe attributable to the ARP program, but the exact nature of the decline is unknown (2000 starts to 200 starts in one quarter). To reduce the impact of this period on the other coefficients a dummy was used with the following values:

zero except for:	1977:3	+1
	1977:4	+2
	1978:1	+3
	1978:2	-3
	1978:3	-2
	1978:4	-1

Removal of this unusual period improves the model results but will be of little forecasting value, expect perhaps in better coefficient estimates.

27. The estimated coefficient for the adjustment process will be $(1-\delta)$. The mean lag is then $(1-\delta)/\delta$, or .258/(1-.258).

28. See Smith, 1976; Jaffee & Rosen, 1979; Rosen, 1979; Maisel, 1963.

29. For a discussion of these techniques see Box & Jenkins, 1976 or Maddala, 1977.

30. The alternative assumption would be to project values for all the necessary variables and use the projected values to calculate the forecasts. The reliability of the structural model is then subject to the accuracy of the projected values. For consistency in comparing the time series and structural model this approach is not used.

31. See Maddala, 1977 for a description of these statistics.

32. No distinction is made between Models 1 and 2, and Models 3 and 4 since the only difference in these two equations is for 1977-78. Therefore, within the estimation period, removal of the unusual data of this period will obviously improve the results. What should be considered is the impact of this on the coefficients. Improved coefficient values will provide a better forecasting model.

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APPENDIX A

Estimation of Rental Household

A. To estimate the number of expected new rental households per quarter, based on demographic demand, the following assumptions were made:

1. The headship rates and percentage of apartment dwellers for each age cohort will be set at the 1971 rates.
2. The growth in the number of households is linear. Therefore, the rate of change or number of new households per quarter will be constant.
3. Adjustments to the base population are made per quarter based on the survivorship rates per cohort. No adjustment is made for births since these will not affect the cohorts likely to become a household head.
4. At each census, the total population is adjusted to account for growth from migration.

B. The following steps were taken to calculate the expected new rental households:

1. The population per cohort (by sex) was multiplied by a quarterly survivorship rate.
2. The population from (1) was multiplied by the headship rate per cohort to yield the total households expected.
3. The number of households from (2) was multiplied by the percentage of apartment dwellers to estimate the total rental households.
4. The quarterly change for the results in (3) were used as the variable 'DEAPT', or expected new rental households from demographic demand.

C. The following data represent the population, headship rates and percentages of apartment households for 1971. These are the base for the above calculations.

AGE	POPULATION		HOUSEHOLDS		HEADSHIP RATE	
COHORT	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
<15	132155	126255				
15-24	89635	91515	18175	6770	.2028	.0740
25-34	73450	71260	60720	9115	.8267	.1279
35-44	64410	60155	60420	7465	.9381	.1241
45-54	58590	62730	55275	10650	.9434	.1698
55-64	45790	48940	42350	12490	.9249	.2552
65-69	15840	17140	13855	6360	.8747	.3710
70+	29695	40820	23430	18800	.7890	.4606

AGE	HOUSEHOLDS		APARTMENTS		% APARTMENT	
COHORT	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
15-24	18175	6770	11605	5775	63.85	85.30
25-34	60720	9115	21445	6535	35.32	71.70
35-44	60420	7465	9715	3875	16.08	51.91
45-54	55275	10650	9135	5295	16.52	49.72
55-64	42350	12490	9095	6220	21.48	49.80
65-69	13855	6360	3685	3260	26.60	51.26
70+	23430	18800	7505	10530	32.03	56.01

APPENDIX B

DATA SERIES

YEAR	QTR	ABSORB	BCFAMALN	DEAPT	VVAC	APTSTK
1963	1		-754	78.75	4.20	83680
1963	2	766	155	78.75	4.20	85317
1963	3	707	695	78.88	4.20	86955
1963	4	1161	922	78.88	4.20	88593
1964	1	1130	425	78.88	4.30	90324
1964	2	1143	573	78.81	4.45	92108
1964	3	528	937	78.94	4.60	93897
1964	4	1521	1139	78.88	4.70	95642
1965	1	1740	674	78.81	4.50	97085
1965	2	2278	602	78.88	4.30	98521
1965	3	1965	1664	78.88	4.10	99952
1965	4	1841	1999	78.81	4.00	101482
1966	1	2333	911	224.19	3.50	102582
1966	2	2089	924	224.19	3.00	103671
1966	3	1778	2058	224.06	2.00	104741
1966	4	1577	1854	224.19	1.50	106326
1967	1	1249	392	224.13	1.40	108333
1967	2	1237	201	224.19	1.30	110335
1967	3	1827	1165	224.19	1.20	112334
1967	4	1655	1405	224.13	1.00	114213
1968	1	2044	212	224.19	1.10	116437
1968	2	2033	207	224.13	1.20	118665
1968	3	1728	989	224.13	1.25	120836
1968	4	2337	1425	224.19	1.30	123009
1969	1	1591	414	224.13	1.28	125096
1969	2	1848	554	224.13	1.26	127182
1969	3	2242	1056	224.25	1.24	129268
1969	4	2632	2071	224.00	1.20	131326
1970	1	2579	519	224.25	2.00	134526
1970	2	2078	931	224.06	2.70	137636
1970	3	2255	1030	224.19	2.40	139349
1970	4	2003	1068	224.19	2.10	141052
1971	1	1746	492	520.35	3.10	144659
1971	2	2270	285	520.50	4.10	148342
1971	3	1994	1374	520.44	3.50	148620
1971	4	2434	1773	520.38	2.80	148742
1972	1	1972	814	520.38	2.60	149625
1972	2	1138	438	520.31	2.40	150506
1972	3	1411	1077	520.56	1.50	150307
1972	4	1557	1608	520.38	.60	150112
1973	1	1741	785	520.38	.80	151583
1973	2	1276	844	520.50	1.00	153059
1973	3	862	1465	520.38	.60	153608

YEAR	QTR	ABSORB	BCFAMALN	DEAPT	VVAC	APTSTK
1973	4	1864	1804	520.38	.40	154463
1974	1	1774	862	520.38	.40	155626
1974	2	1618	987	520.31	.30	156632
1974	3	872	954	520.50	.20	157636
1974	4	1478	1172	520.38	.10	158638
1975	1	1856	123	520.56	.10	159797
1975	2	1632	-269	520.44	.20	161118
1975	3	1609	-124	520.25	.20	162280
1975	4	2280	240	520.50	.10	163276
1976	1	813	-351	508.72	.20	164601
1976	2	1197	178	508.94	.40	166094
1976	3	1546	-64	508.63	.50	167893
1976	4	1295	92	508.75	.70	169867
1977	1	1587	140	508.75	1.10	172195
1977	2	1115	189	508.69	1.60	174721
1977	3	1030	561	508.81	1.60	176371
1977	4	2327	958	508.75	1.60	178021
1978	1	1647	312	508.56	1.50	179488
1978	2	2601	511	508.75	1.50	181137
1978	3	2364	990	508.69	1.40	182600
1978	4	786	945	508.63	1.40	184247
1979	1	693	397	509.00	1.20	185517
1979	2	861	556	508.56	.90	186594
1979	3	1129	1852	508.81	.60	187665
1979	4	568	1948	508.63	.20	188540
1980	1	755	1287	508.88	.10	189976
1980	2	667	995	508.81	.10	191602
1980	3	1248	1504	508.63	.10	193227
1980	4	1002	2152	508.81	.10	194853
1981	1	1013	917		.10	196477
1981	2	706	776		.10	198103
1981	3	1065	315		.10	199729
1981	4	943	713		.10	201353
1982	1	1165	-527		.10	202979
1982	2	1521	-79		.60	205634
1982	3	2144	-103		.90	207895
1982	4		-29		1.90	211669
MEAN		552.14	778.20	324.254	1.642	147976.88
MIN		528	-754		.10	83680
MAX		2632	2152	520.56	4.70	211669
STDEV		558.15	646.82	203.197	1.445	36267.71
VARIANCE		1534.8	418371.0	41289.0	2.089	*********

YEAR	QTR	BCUR	RINC	CPI
1963	1	0.0	6.45	80.10
1963	2	0.0	6.44	80.20
1963	3	0.0	6.42	80.40
1963	4	0.0	6.43	80.30
1964	1	0.0	6.81	80.40
1964	2	0.0	6.78	80.70
1964	3	0.0	6.76	81.00
1964	4	0.0	6.73	81.40
1965	1	0.0	7.25	82.00
1965	2	0.0	7.26	81.80
1965	3	0.0	7.19	82.60
1965	4	0.0	7.16	83.00
1966	1	4.90	7.66	83.90
1966	2	4.40	7.65	84.00
1966	3	4.40	7.57	84.90
1966	4	5.20	7.55	85.10
1967	1	5.40	8.00	85.90
1967	2	4.90	7.88	87.30
1967	3	3.90	7.79	88.30
1967	4	5.60	7.70	89.30
1968	1	6.30	8.10	89.90
1968	2	6.30	8.08	90.20
1968	3	5.10	7.98	91.30
1968	4	5.10	7.92	92.00
1969	1	5.30	8.71	92.60
1969	2	4.30	8.54	94.40
1969	3	4.40	8.57	94.10
1969	4	5.20	8.46	95.30
1970	1	6.60	8.88	95.90
1970	2	9.60	8.73	97.50
1970	3	7.20	8.76	97.20
1970	4	7.40	8.71	97.70
1971	1	8.20	9.51	98.50
1971	2	7.40	9.39	99.70
1971	3	6.20	9.28	100.90
1971	4	6.60	9.12	102.70
1972	1	8.70	10.11	103.90
1972	2	8.10	10.01	104.90
1972	3	7.40	9.89	106.20
1972	4	8.10	9.77	107.50
1973	1	7.50	11.21	109.80
1973	2	6.50	10.95	112.40
1973	3	6.00	10.64	115.60

YEAR	QTR	BCUR	RINC	CPI
1973	4	5.80	10.50	117.20
1974	1	5.80	11.93	120.70
1974	2	5.50	11.43	126.00
1974	3	6.10	11.10	129.70
1974	4	6.80	10.77	133.70
1975	1	9.20	12.02	135.00
1975	2	7.80	11.64	139.40
1975	3	8.80	11.28	143.80
1975	4	7.50	11.16	145.40
1976	1	9.10	12.27	150.20
1976	2	8.10	11.95	154.20
1976	3	7.70	11.74	157.00
1976	4	8.20	11.66	158.00
1977	1	9.30	12.65	161.30
1977	2	7.80	12.42	164.20
1977	3	7.50	12.23	166.80
1977	4	8.00	11.98	170.20
1978	1	9.10	12.96	173.50
1978	2	7.20	12.65	177.70
1978	3	7.30	12.48	180.20
1978	4	8.50	12.28	183.00
1979	1	8.60	13.24	187.50
1979	2	7.00	12.98	191.20
1979	3	6.80	12.76	194.50
1979	4	7.10	12.60	197.00
1980	1	8.40	13.67	201.60
1980	2	6.10	13.22	208.50
1980	3	5.90	12.91	213.60
1980	4	6.10	12.50	220.50
1981	1	6.80	13.56	231.20
1981	2	5.50	13.15	238.30
1981	3	7.00	12.79	245.10
1981	4	8.60	12.47	251.40
1982	1	10.60	0.0	257.60
1982	2	11.50	0.0	264.40
1982	3	12.80	0.0	268.70
1982	4	14.80	0.0	270.50
MEAN		6.0862	9.4968	134.770
MIN		0.0	0.0	80.10
MAX		14.80	13.67	270.50
STDEV		3.1466	3.1216	56.0409
VARIANCE		9.9012	9.744182	3140.58

YEAR	QTR	RRENT	RENTMTG	RENTRMTG
1963	1	102.37	1462.46	
1963	2	102.37	1481.46	1503.22
1963	3	102.24	1460.55	1503.51
1963	4	102.37	1462.37	1441.78
1964	1	102.24	1460.55	1481.72
1964	2	102.48	1489.51	1557.42
1964	3	102.22	1460.32	1525.71
1964	4	101.72	1453.14	1541.21
1965	1	100.98	1480.58	1623.40
1965	2	101.71	1489.19	1446.82
1965	3	100.97	1412.15	1590.06
1965	4	100.72	1361.12	1438.90
1966	1	99.88	1338.88	1522.57
1966	2	100.60	1328.87	1346.66
1966	3	100.12	1277.01	1442.62
1966	4	100.71	1266.73	1299.42
1967	1	100.23	1280.11	1425.79
1967	2	100.11	1270.49	1544.98
1967	3	100.00	1234.57	1408.45
1967	4	100.00	1173.71	1329.79
1968	1	100.00	1116.07	1196.17
1968	2	101.22	1102.61	1139.86
1968	3	100.99	1118.34	1273.46
1968	4	101.20	1112.04	1204.71
1969	1	101.08	1066.24	1138.29
1969	2	100.64	1038.55	1275.48
1969	3	101.91	1008.04	978.99
1969	4	101.57	967.37	1092.19
1970	1	101.56	959.96	1017.68
1970	2	100.62	955.51	1126.71
1970	3	101.65	981.14	953.53
1970	4	101.54	999.36	1051.09
1971	1	101.02	1088.53	1191.22
1971	2	100.30	1073.89	1232.20
1971	3	99.41	1040.89	1190.48
1971	4	97.96	1076.43	1341.85
1972	1	97.11	1082.64	1249.84
1972	2	96.57	1030.61	1153.74
1972	3	95.86	1021.93	1186.35
1972	4	95.16	1032.13	1201.55
1973	1	93.53	1031.24	1381.59
1973	2	92.53	971.92	1337.09
1973	3	91.09	899.21	1314.43

YEAR	QTR	RRENT	RENTMTG	RENTRMTG
1973	4	90.61	904.33	1076.18
1974	1	88.98	886.26	1360.56
1974	2	86.59	761.54	1426.48
1974	3	85.51	709.58	1024.01
1974	4	84.07	707.65	1066.86
1975	1	84.44	792.91	903.15
1975	2	83.50	743.55	1222.56
1975	3	82.68	692.50	1096.61
1975	4	83.08	698.75	807.40
1976	1	82.02	689.28	1155.27
1976	2	81.06	679.49	1022.24
1976	3	81.15	690.02	905.65
1976	4	81.84	726.14	796.84
1977	1	81.77	797.79	1176.59
1977	2	81.12	783.77	1088.87
1977	3	80.88	783.68	1047.61
1977	4	79.85	772.96	1152.20
1978	1	78.85	763.28	1121.58
1978	2	77.55	751.42	1267.10
1978	3	77.25	723.97	945.50
1978	4	76.78	665.88	879.45
1979	1	75.52	679.75	1142.51
1979	2	74.69	669.23	1001.15
1979	3	74.29	606.47	830.09
1979	4	74.21	546.49	669.79
1980	1	73.26	498.73	726.10
1980	2	71.56	553.86	1188.69
1980	3	71.11	490.44	756.53
1980	4	70.43	451.48	809.55
1981	1	68.56	435.27	1357.53
1981	2	68.02	366.70	594.09
1981	3	67.93	316.55	463.38
1981	4	68.02	382.34	591.99
1982	1	67.97	350.20	514.56
1982	2	68.08		
1982	3	68.74		
1982	4	69.43		
MEAN		89.4990	954.4249	1163.042
MIN		67.93	316.55	463.38
MAX		102.48	1489.51	1623.40
STDEV		12.3737	325.2779	269.2333
VARIANCE		153.110	105805.7	72486.56

YEAR	QTR	VMFST	VMFINV	VMFUC	ABSPRED
1963	1	971	254	2255	
1963	2	820	428	2037	793
1963	3	1231	429	2566	820
1963	4	2045	589	3269	1038
1964	1	1592	481	3801	1228
1964	2	1984	478	4662	1121
1964	3	2928	609	6864	998
1964	4	1992	1686	5959	1254
1965	1	1164	1918	4981	2005
1965	2	3108	1014	6720	2124
1965	3	1884	1351	6232	1484
1965	4	1430	761	6269	1914
1966	1	1220	664	5056	1902
1966	2	920	762	3835	1883
1966	3	1349	608	3365	1927
1966	4	1184	508	3085	1927
1967	1	1128	323	3116	1773
1967	2	1678	414	3454	1618
1967	3	2756	415	4085	1791
1967	4	1798	359	4567	1793
1968	1	1932	442	4134	1670
1968	2	2735	257	5009	1739
1968	3	2051	220	5288	1722
1968	4	3003	406	5758	1958
1969	1	3031	368	7231	2075
1969	2	3445	328	8680	2105
1969	3	3627	484	9817	2076
1969	4	1842	667	8864	2382
1970	1	2020	945	8027	2272
1970	2	634	629	6746	1998
1970	3	1899	953	5910	2035
1970	4	3213	346	7678	2404
1971	1	2261	662	7826	1711
1971	2	1875	964	6753	1877
1971	3	2099	1074	6596	2180
1971	4	2587	659	7045	2330
1972	1	1288	435	6792	1754
1972	2	1493	611	6970	1515
1972	3	1779	470	7323	1602
1972	4	2336	449	8112	1619
1973	1	959	354	7302	1614
1973	2	1686	606	7375	1541
1973	3	1674	491	8262	1601

YEAR	QTR	VMFST	VMFINV	VMFUC	ABSPRED
1973	4	2963	285	9325	1737
1974	1	1128	340	8321	1517
1974	2	2181	375	8682	1371
1974	3	1525	695	8972	1077
1974	4	1515	919	8590	1301
1975	1	700	1263	6805	1170
1975	2	855	1690	5566	1375
1975	3	1727	1417	5957	1329
1975	4	1587	1700	4898	1564
1976	1	1015	1539	5231	1556
1976	2	1507	1399	5358	1510
1976	3	1210	1699	4210	1279
1976	4	2372	1699	5295	1655
1977	1	1435	1578	5030	1682
1977	2	1903	1993	5049	1688
1977	3	1612	2289	5114	1882
1977	4	2132	1624	5270	2176
1978	1	2206	1641	5579	1608
1978	2	290	1246	3581	1733
1978	3	373	801	1951	1357
1978	4	686	637	2000	1051
1979	1	1115	575	2445	935
1979	2	632	782	1938	994
1979	3	1013	477	2058	1158
1979	4	765	222	2504	1104
1980	1	1574	253	3251	775
1980	2	626	252	3211	863
1980	3	1334	458	3042	777
1980	4	1901	418	4068	1110
1981	1	1772	232	5017	
1981	2	1748	432	5800	
1981	3	2400	870	6634	
1981	4	2080	1638	6946	
1982	1	2376	2161	7407	
1982	2	1630	2783	6714	
1982	3	734	2807		
1982	4	213	2691		
MEAN		1693.6	884.39	5532.0	2531.3
MIN		213	220	1938	775
MAX		3627	2807	9817	9999
STDEV		753.19	649.22	2055.5	2704.8
VARIANCE		567300	421486	******	******

YEAR	QTR	PROFIT	RENT	CC	BKRAT
1963	1	1.02	82.00	69.90	4.00
1963	2	1.02	82.10	72.70	3.50
1963	3	1.02	82.20	73.60	4.00
1963	4	1.02	82.20	74.20	4.00
1964	1	1.02	82.20	74.90	4.00
1964	2	1.02	82.70	77.80	4.00
1964	3	1.02	82.80	77.70	4.00
1964	4	1.02	82.80	78.10	4.25
1965	1	1.01	82.80	79.70	4.25
1965	2	1.02	83.20	79.80	4.25
1965	3	1.01	83.40	80.10	4.25
1965	4	1.01	83.60	80.40	4.75
1966	1	1.00	83.80	81.20	5.25
1966	2	1.01	84.50	81.90	5.25
1966	3	1.00	85.00	84.20	5.25
1966	4	1.01	85.70	84.20	5.25
1967	1	1.00	86.10	84.50	5.00
1967	2	1.00	87.40	85.10	4.50
1967	3	1.00	88.30	86.10	5.00
1967	4	1.00	89.30	87.10	6.00
1968	1	1.00	89.90	88.80	7.50
1968	2	1.01	91.30	90.40	7.50
1968	3	1.01	92.20	91.70	6.00
1968	4	1.01	93.10	92.90	6.50
1969	1	1.01	93.60	98.60	7.00
1969	2	1.01	95.00	98.00	7.50
1969	3	1.02	95.90	95.60	8.00
1969	4	1.02	96.80	95.20	8.00
1970	1	1.02	97.40	95.40	8.00
1970	2	1.01	98.10	94.60	7.00
1970	3	1.02	98.80	95.50	6.50
1970	4	1.02	99.20	95.40	6.00
1971	1	1.01	99.50	96.60	5.25
1971	2	1.00	100.00	99.60	5.25
1971	3	.99	100.30	102.00	5.25
1971	4	.98	100.60	103.90	4.75
1972	1	.97	100.90	105.60	4.75
1972	2	.97	101.30	108.20	4.75
1972	3	.96	101.80	110.90	4.75
1972	4	.95	102.30	114.80	4.75
1973	1	.94	102.70	119.60	4.75
1973	2	.93	104.00	121.20	6.25
1973	3	.91	105.30	122.50	7.25

YEAR	QTR	PROFIT	RENT	CC	BKRAT
1973	4	.91	106.20	125.90	7.25
1974	1	.89	107.40	130.20	7.25
1974	2	.87	109.10	132.30	8.75
1974	3	.86	110.90	134.60	9.25
1974	4	.84	112.40	131.40	8.75
1975	1	.84	114.00	134.50	8.25
1975	2	.84	116.40	142.70	8.25
1975	3	.83	118.90	146.50	9.00
1975	4	.83	120.80	149.20	9.00
1976	1	.82	123.20	153.90	9.50
1976	2	.81	125.00	155.40	9.50
1976	3	.81	127.40	161.60	9.50
1976	4	.82	129.30	165.50	8.50
1977	1	.82	131.90	168.80	8.00
1977	2	.81	133.20	174.80	7.50
1977	3	.81	134.90	180.20	7.50
1977	4	.80	135.90	180.20	7.50
1978	1	.79	136.80	186.40	8.00
1978	2	.78	137.80	192.40	8.50
1978	3	.77	139.20	195.70	9.50
1978	4	.77	140.50	199.80	10.75
1979	1	.76	141.60	208.10	11.25
1979	2	.75	142.80	212.00	11.25
1979	3	.74	144.50	215.60	12.25
1979	4	.74	146.20	209.40	14.00
1980	1	.73	147.70	214.00	14.79
1980	2	.72	149.20	219.80	10.67
1980	3	.71	151.90	224.10	11.02
1980	4	.70	155.30	226.70	17.26
1981	1	.69	158.50	234.20	16.59
1981	2	.68	162.10	250.20	19.07
1981	3	.68	166.50	248.80	19.63
1981	4	.68	171.00	248.00	14.66
1982	1	.68	175.10	248.10	15.11
1982	2	.68	180.00	257.10	
1982	3	.69	184.70	258.70	
1982	4	.69	187.80	262.20	
MEAN		.8950	113.98	137.61	7.8123
MIN		.68	82.00	69.90	3.50
MAX		1.02	187.80	262.20	19.63
STDEV		.1237	29.083	58.858	3.6694
VARIANCE		.01531	845.84	3464.2	13.465

APPENDIX C

CORRELATION MATRIX

	ABSORB	RRENT	APTSTK1	DEAPT	BCURD
ABSORB	1.000	0.382	-0.181	-0.138	-0.186
RRENT	0.382	1.000	-0.899	-0.751	0.408
APTSTK1	-0.181	-0.899	1.000	0.905	-0.651
DEAPT	-0.138	-0.751	0.905	1.000	-0.698
BCURD	-0.186	0.408	-0.651	-0.698	1.000
Q1	0.019	0.011	-0.002	0.040	-0.058
Q2	-0.040	0.014	-0.029	-0.013	0.019
Q3	-0.083	-0.004	0.003	-0.013	0.019
BCUR	0.074	-0.556	0.789	0.819	-0.880
RCONTR	-0.313	-0.933	0.802	0.674	-0.346
BCFAMALN	0.088	0.074	-0.034	-0.102	0.021
VMFINV1	0.203	-0.312	0.255	0.207	0.034
VVAC1	0.117	0.651	-0.717	-0.675	0.757
GRANT	0.114	-0.190	0.146	0.216	-0.105
AHOP	0.020	-0.551	0.481	0.449	-0.231
RINC	-0.251	-0.935	0.973	0.890	-0.595
RENTMTG	0.184	0.887	-0.960	-0.836	0.689
RENTRMTG	0.079	0.669	-0.776	-0.610	0.592

	BCUR	RCONTR	BCFAMALN	VMFINV1	VVAC1
ABSORB	0.074	-0.313	0.088	0.203	0.117
RRENT	-0.556	-0.933	0.074	-0.312	0.651
APTSTK1	-0.789	0.802	-0.034	0.255	-0.717
DEAPT	0.819	0.674	-0.102	0.207	-0.675
BCURD	-0.880	-0.346	0.021	0.034	0.757
Q1	0.169	0.020	-0.338	-0.004	-0.060
Q2	-0.032	-0.007	-0.353	-0.021	0.024
Q3	-0.105	-0.007	0.198	-0.009	0.059
BCUR	1.000	0.512	-0.218	0.212	-0.719
RCONTR	0.512	1.000	-0.236	0.415	-0.631
BCFAMALN	-0.218	-0.236	1.000	-0.331	0.142
VMFINV1	0.212	0.415	-0.331	1.000	0.017
VVAC1	-0.719	-0.631	0.142	0.017	1.000
GRANT	0.223	0.303	-0.349	0.246	-0.279
AHOP	0.467	0.668	-0.518	0.760	-0.372
RINC	0.751	0.868	-0.141	0.291	-0.735
RENTMTG	-0.780	-0.830	0.048	-0.187	0.832
RENTRMTG	-0.680	-0.611	-0.026	-0.111	0.670

	GRANT	AHOP	RINC	RENTMTG	RENTRMTG
ABSORB	0.114	0.020	-0.251	0.184	0.079
RRENT	-0.190	-0.551	-0.935	0.887	0.669
APTSTK1	0.146	0.481	0.973	-0.960	-0.776
DEAPT	0.216	0.449	0.890	-0.836	-0.610
BCURD	-0.105	-0.231	-0.595	0.689	0.592
Q1	0.006	0.013	0.106	0.024	0.071
Q2	-0.002	-0.004	0.003	0.043	0.192
Q3	-0.002	-0.004	-0.036	-0.020	-0.076
BCUR	0.223	0.467	0.751	-0.780	-0.680
RCONTR	0.303	0.668	0.868	-0.830	-0.611
BCFAMALN	-0.349	-0.518	-0.141	0.048	-0.026
VMFINV1	0.246	0.760	0.291	-0.187	-0.111
VVAC1	-0.279	-0.372	-0.735	0.832	0.670
GRANT	1.000	0.453	0.184	-0.216	-0.199
AHOP	0.453	1.000	0.544	-0.471	-0.371
RINC	0.184	0.544	1.000	-0.938	-0.704
RENTMTG	-0.216	-0.471	-0.938	1.000	0.840
RENTRMTG	-0.199	-0.371	-0.704	0.840	1.000

	Q1	Q2	Q3
ABSORB	0.019	-0.040	-0.083
RRENT	0.011	0.014	-0.004
APTSTK1	-0.002	-0.029	0.003
DEAPT	0.040	-0.013	-0.013
BCURD	-0.058	0.019	0.019
Q1	1.000	-0.327	-0.327
Q2	-0.327	1.000	-0.340
Q3	-0.327	-0.340	1.000
BCUR	0.169	-0.032	-0.105
RCONTR	0.020	-0.007	-0.007
BCFAMALN	-0.338	-0.353	0.198
VMFINV1	-0.004	-0.021	-0.009
VVAC1	-0.060	0.024	0.059
GRANT	0.006	-0.002	-0.002
AHOP	0.013	-0.004	-0.004
RINC	0.106	0.003	-0.036
RENTMTG	0.024	0.043	-0.020
RENTRMTG	0.071	0.192	-0.076

	VMFST	VMFST1	VMFINV1	ABSPRED
VMFST	1.000	0.420	-0.114	0.457
Q2	-0.105	-0.165	-0.021	-0.068
Q3	0.054	-0.095	-0.009	0.072
Q4	0.195	0.064	0.035	0.096
VMFST1	0.420	1.000	-0.118	0.407
ABSPRED	0.457	0.407	0.276	1.000
VMFUC1	0.249	0.560	0.007	0.455
BKRAT	-0.254	-0.310	0.044	-0.406
PROFIT	0.372	0.358	-0.286	0.410
VVAC1	0.129	0.114	0.017	0.180
VMFINV1	-0.114	-0.118	1.000	-0.114

	VMFUC1	BKRAT	PROFIT	VVAC1
VMFST	0.249	-0.254	0.372	0.129
Q2	-0.022	-0.068	0.016	0.024
Q3	-0.046	-0.019	-0.005	0.059
Q4	-0.015	0.086	-0.003	-0.025
VMFST1	0.560	-0.310	0.358	0.114
ABSPRED	0.455	-0.406	0.410	0.180
VMFUC1	1.000	-0.237	0.177	-0.096
BKRAT	-0.237	1.000	-0.819	-0.709
PROFIT	0.177	-0.819	1.000	0.702
VVAC1	-0.096	-0.709	0.702	1.000
VMFINV1	-0.021	-0.009	0.035	-0.118

	Q2	Q3	Q4
VMFST	-0.105	0.054	0.195
Q2	1.000	-0.340	-0.340
Q3	-0.340	1.000	-0.340
Q4	-0.340	-0.340	1.000
VMFST1	-0.165	-0.095	0.064
ABSPRED	-0.068	0.072	0.096
VMFUC1	-0.022	-0.046	-0.015
BKRAT	-0.068	-0.019	0.086
PROFIT	0.016	-0.005	-0.003
VVAC1	0.024	0.059	-0.025
VMFINV1	-0.021	-0.009	0.035