RESIDENTIAL LAND PRICES: A MODEL AND EMPIRICAL STUDY OF INTER-TEMPORAL VARIATIONS

by

PHILIPPE EMILE MONDOR

B.A.(Hon.), University of Saskatchewan, 1971

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES
(The School of Community and Regional Planning)

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
September, 1978

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

School
~~Department~~ of Community and Regional Planning

The University of British Columbia
2075 Wesbrook Place
Vancouver, Canada
V6T 1W5

Date Ocotber 11, 1978

ABSTRACT

The objective of this thesis is to gain a better understanding of the process by which residential land prices are determined and change over time. A special concern is also shown for the causal relationship between the prices of building lots and the selling prices of new single-detached housing built on those lots.

In the introductory chapter, the upward climb over the years in the average price of building lots relative to the increase in new house prices is identified as a matter in need of closer study. The significance of this subject for planning practice is seen to lie in the power of planning authorities to intervene in the operation of property markets, and in the role of planning authorities implied in many proposals for solving the land price problem.

In Chapter Two, numerous theoretical analyses and empirical studies of the determination and inter-temporal variation in residential land prices are surveyed.

A critical assessment of the literature made in the first part of Chapter Three identifies several shortcomings. A static rather than dynamic approach, the assumption of market equilibrium and perfect competition, inadequate treatment of supply-demand interaction, and a limited behavioral content, characterize most of the works surveyed. A theoretical model is subsequently developed to explain the process by which residential lot prices are determined and change over time. Its fundamental hypothesis is that the level of new house prices and their changes over time are a prime determinant of lot prices and their inter-temporal variation, while the profit-maximizing behavior of lot sellers and housebuilders generates the process by which lot prices increase

over time.

In Chapter Four, an empirical investigation is proposed for testing the theoretical model. Data on residential construction in Canada over the 1951-1977 period and financed under the provisions of the National Housing Act are selected for the investigation. Since the data pertain to a portion rather than the whole of the lot market, the theoretical model is reformulated in light of this and other empirical conditions. The Chapter is concluded with an outline of the statistical procedures to be used in the investigation.

The results of the study are presented in Chapter Five. They are found to be generally consistent with the hypotheses of the empirical model, and the postulates of the theoretical model. It is concluded, among other things, that lot sellers and housebuilders behave in the manner proposed by the models, and that lot price increases are determined by house price increases. However, the validity of the model and wider application of the empirical findings are judged to be limited by the characteristics of the data used in the study.

The concluding chapter offers several suggestions for future research on land prices and some implications for planning and public policy. The need for an improved economic understanding in urban planning is identified. A potential role is identified for planners in the provision of information in a market where imperfect information is a major source of observed market failure.

TABLE OF CONTENTS

	Page
List of Tables	vi
List of Illustrations	vii
CHAPTER ONE: INTRODUCTION	1
1.1 Purpose of the Study	1
1.2 The Problem	3
1.3 Scope of the Study	10
1.4 Outline of the Study	11
CHAPTER TWO: REVIEW OF THE LITERATURE	13
2.1 Theory	13
2.2 Evidence	85
CHAPTER THREE: A THEORETICAL MODEL	120
3.1 Evaluation of Existing Theory	120
3.2 Theoretical Model	133
CHAPTER FOUR: PROPOSED EMPIRICAL STUDY	180
4.1 The Data	180
4.2 Empirical Model	193
4.3 Methodology	216
CHAPTER FIVE: THE RESULTS	225
5.1 Reservation Prices	226
5.2 Reduced-Form Equations	228
5.3 Lot Supply and Demand	233
5.4 Further Tests	239
5.5 Evaluation of the Model	244
5.6 Theoretical Implications	246

Page

CHAPTER SIX: CONCLUSION 251

6.1 Directions for Future Research 251

6.2 Implications for Planning 255

Bibliography 265

LIST OF TABLES

Table		Page
I	Consumer Price Index, Selected Components and All-Items, Canada, 1961-1977 (1961=100)	4
II	Estimated Costs of New Single-Detached Housing Financed Under the National Housing Act, Canada, 1951-1977.	7
III	List and Description of the Variables in the Theoretical Model	164
IV	Summary Comparative Static Results of the Theoretical Model	166
V	The Number and Estimated Costs and Prices of New Single-Detached Housing Financed Under the National Housing Act, Canada, 1951-1977.	182
VI	Single-Detached Residential Construction, Canada, 1951-1977.	188
VII	Estimated Selling Prices of New Single-Detached Dwellings, Canada, 1951-1977.	190
VIII	Loan-to-Value and Loan Limit Provisions of the National Housing Act of Canada, 1951-1977.	198
IX	Computed Reservation Prices of Lot Buyers and Sellers, Canada, 1953-1977.	226
X	Disequilibrium Situations in the N.H.A. Lot Market, Canada, 1953-1977.	237
XI	Regression Results of Sub-Period Tests.	239
XII	Regression Results of Tests of Two Alternate Models.	241
XIII	Counterfactual Comparative Static Analysis.	258

LIST OF ILLUSTRATIONS

Figure		Page
1	Demand and Supply in Market Equilibrium.	131
2	Illusory Supply Curve When Supply Shifts are Ignored.	132
3	Illusory Demand Curve When Demand Shifts are Ignored.	132
4	Illustrated Linear Equation.	139
5	Relative Market Equilibrium.	167
6	Short Run Demand Function.	169
7	Shifting Demand Function	170
8	Long Run Demand and Supply Equilibrium.	171
9	Transactions and Average Price of Building Lots, Canada, 1951-1977.	211
10	Long Run Demand and Supply in the N.H.A. Lot Market.	212
11	Movement in Building Lot Prices and Reservation Prices, 1953-1977.	227
12	Estimated Lot Demand, 1953-1977.	235
13	Estimated Lot Supply, 1953-1977.	235
14	Movement of Actual Average Lot Price and Estimated Equilibrium Lot Price, 1953-1977.	238

CHAPTER ONE

INTRODUCTION

1.1 PURPOSE OF THE STUDY

Planning literature gives the impression that urban planning is quite distinct from economic planning, yet it can be argued that planning is an economic activity, as this illustration suggests.

> Economic planning is governmental intervention in the conduct of business or industry, and this is precisely the function of town planning. ... Town planning imposes a wide range of controls on the quantity and quality of shelter that can be put on to the market, and in principle these are no different from those which might be put on a manufacturing industry; ... (White, 1963: 1).

Planning is not just regulation but is often involved in public expenditure programs. An example of this is provided by publicly-initiated redevelopment projects which are usually based on planners' proposals and plans. In this regard it has been noted that

> In a very real sense, planners look to the private sector for the implementation of significant portions of their schemes. ... (yet) many have little awareness of the process by which private developers make investment decisions. A result is that policies may be shaped which rely for their efficacy on a certain pattern of response from real estate investors; if this response is wrongly conjectured, then such policies may be less effectual than intended. (Whipple, 1964: 7).

Numerous other examples could be found to illustrate the economic character of planning.

Local governments are given many powers by provincial legislation to affect the operation of property markets, frequently through the activities of their planning agencies. Planning thus shares with economic policy-making a general public policy problem identified by Harman.

> ... Classical economic theory attempted to explain how the market mechanism could operate to constitute, from individual self-interest microdecisions, macrodecisions that would operate for the general good. As time went on, the invisible hand clearly needed a little help in the form of governmental rule-making and umpiring ... Yet the basic dilemma of unsatisfactory macrodecisions worsens.
>
> ... If the basic problem concerns unsatisfactory macrodecisions arising from self-interest-directed microdecisions, then the almost obvious thing to do is to turn the situation upside down. That is, select appropriate macrodecisions ... then see what pattern of microdecisions would be necessary to achieve these goals. (1972: 13,15)

A broad purpose consequently selected for this thesis is an exploration of the need for improved economic understanding in planning practice. The objective of developing a better understanding of the operation of property markets was adopted for the achievement of this purpose.

The overall strategy adopted for this study is first to select a significant and highly-debated problem in the operation of property markets. The second step is to survey the literature treating this problem. Thirdly, an evaluation of the pertinent literature reveals areas in need of further study. Fourth, such an investigation would be undertaken. The final step would involve the derivation of implications from the investigation about the importance of economic understanding in planning. This introductory chapter pursues the first step.

1.2 THE PROBLEM

Just over fifty years ago it was written in the journal of the Town Planning Institute of Canada that

> The high cost of urban lands in Canada bids fair to be a national disgrace. It has been stated by a well-informed authority in the United States to be, in proportion to population, in excess of that prevailing in any other region of the world. Attention has been drawn again to the evils of land speculation ... But as yet no real attempt has been made to attack this problem ... (and) to challenge the attention of the citizens of Canada to a serious situation, which affects the welfare of the nation. (Dalzell, 1916)

While the vocabulary has changed, the sentiment of this invective is similar to what has been expressed on more recent occasions.

In the fifties and early sixties only the lowest income groups in the Canadian population had difficulty acquiring adequate and affordable accommodation. Most Canadian families could afford to buy housing for themselves without too many problems. During the mid-sixties, rapid housing price inflation began and has raised considerable debate ever since.

Table I shows the movement of the Consumer Price Index over the 1961-1977 period in relation to the index of shelter costs. Over the period, average shelter costs for urban home-owners and renters, and for new housing as well as existing homes, increased 316 per cent while the general consumer price level -- the overall cost of living -- rose 215 per cent, only 68 per cent as much as shelter costs.

TABLE I.
Consumer Price Index, Selected Components and All-Items, Canada, 1961-1977 (1961=100).

Period	Housing	All-Items	Ratio:Housing/All-Items
1961	100.0	100.0	1.0000
1962	102.8	101.2	1.0158
1963	105.9	103.0	1.0282
1964	110.4	104.8	1.0534
1965	115.0	107.4	1.0708
1966	120.1	111.4	1.0781
1967	126.9	115.4	1.0997
1968	136.1	120.1	1.1332
1969	148.3	125.5	1.1817
1970	161.3	129.7	1.2436
1971	174.3	133.4	1.3066
1972	188.3	139.8	1.3469
1973	207.0	150.4	1.3763
1974	227.1	166.8	1.3615
1975	250.3	184.8	1.3544
1976	284.8	198.6	1.4340
1977	315.8	214.5	1.4723

Source: Canadian Housing Statistics. Ottawa: Central Mortgage and Housing Corporation, 1977.

This order of magnitude has provoked several housing analysts to sound an alarm over the housing problem. With 1961 as the base year, the stride with which shelter costs advanced has continuously outpaced increases in general consumer prices. It was especially in 1968 and 1969 that the average annual increase in shelter costs really moved ahead of the cost of living in general. In that year, when consumer prices rose 4 per cent, shelter costs climbed $7\frac{1}{2}$ per cent. In the following year, the increases were $4\frac{1}{2}$ and 9 per cent respectively!

Although the urban affairs literature in Canada is a growing and ever more varied one, very little of it appears to have addressed the subject of residential land prices in such a way as to shed more

definitive light on the topic than existed fifty years ago. The evidence for this lies in the absence of any firm consensus about the nature and sources of the land price problem. Bourne (1977a, 1977b) has recently identified five 'schools of thought' among the many explanations of soaring house prices.

The 'conspiracy school' argues that rising house prices, and the increasing land prices associated with them, are the outcome of speculative activity in the land market, monopolistic and oligopolistic behavior by land subdividers and property developers, and manipulation in financial and mortgage markets. Lorimer (1970), for example, exemplifies this position, arguing that land developers and speculators seek to maximize their profits by limiting the flow of developed land on to the market through concentration of ownership and collusion.

The 'multiple bottleneck school' cites several factors, such as increasingly lengthy and complicated subdivision plan and development plan approvals processes, which seriously restrict the volume of new housing flowing on to the market and in turn increase house prices because of reduced supply. This argument is best propounded by Derkowski (1975) who undertook a detailed analysis of the hurdles which developers and builders must leap in many Canadian jurisdictions.

The 'neo-marxian school' is a more ideological one arguing that urban problems, of whatever kind, are 'the logical outcomes of the capitalist mode of production' that prevails in our society. It provides no direct account of land price increases.

The 'cost-push school' argues that rapidly escalating costs of material, labour, money, land as well as ever more stringent servicing standards and higher property taxes reduce the amount of new housing

produced and consequently raise house prices.

Finally, the 'demand-pull school' sees the increases in house and land prices as the result of the interplay of conventional demand and supply forces. Prices are viewed as rising primarily because people have been both willing and able to pay more for housing and to consume more. Government-assisted home-ownership and new income tax regulations are also seen to have increased demand pressures while rent controls and tax regulations have had a restrictive influence on the ability of supply to respond to increased demand.

Each of these five schools of thought has not only offered an explanation of housing price inflation but also some public policy recommendations. The conspiracy school has suggested land-banking, rent control, land speculation taxes, more publicly-provided housing, municipal expropriation of development rights, and land nationalization. The demand-pull school has suggested that income subsidies, negative income tax, mortgage interest deduction be used to lower the housing costs of those households with affordability problems. The multiple-bottleneck school calls for a streamlining of the planning process and public approval procedure through which development proposals must pass. It also recommends that government activities in housing be co-ordinated between levels of government and that they be reduced in scope. The cost-push school pleads for a removal of the sales tax on building materials, removal of rent controls, lowering of property taxes and development levies, less restrictive servicing standards and building codes, and less stringent design controls on new building. The neo-marxian school proposes few practical policy options and emphasizes instead the abolition of the capitalistic market system.

It can be concluded from Bourne's overview that there is little

agreement about the nature and causes of the land and housing price problem. There is also little consensus about proposed remedies. About the problem itself as a problem there is popular agreement.

Some idea of the dimension and seriousness of the probably can be obtained from Table II which shows land and construction costs for all new single-detached dwellings constructed in Canada since 1951 that were financed under the National Housing Act (by direct assistance loans from Central Mortgage and Housing Corporation or through mortgage loans insured under the National Housing Act and provided through government-approved lenders).

TABLE II. Estimated Costs of New Single-Detached Dwellings Financed Under the National Housing Act, Canada, 1951-1977.

Year	Land Cost	Construction	Other Costs	Total Cost
1951	$1,048	$9,568	$332	$10,948
1952	1,182	9,730	388	11,300
1953	1,197	10,084	456	11,738
1954	1,687	10,472	259	12,418
1955	1,819	10,777	245	12,841
1956	2,025	11,574	255	13,854
1957	2,260	11,766	252	14,278
1958	2,471	11,762	246	14,479
1959	2,533	11,946	250	14,729
1960	2,473	11,920	246	14,639
1961	2,602	12,041	245	14,888
1962	2,783	12,204	246	15,233
1963	2,973	12,448	261	15,682
1964	3,082	13,100	296	16,478
1965	3,095	13,992	315	17,402
1966	3,480	15,457	356	19,293
1967	3,580	15,669	362	19,611
1968	3,746	15,774	378	19,898
1969	4,201	17,197	462	21,860
1970	4,191	16,724	431	21,346
1971	4,588	17,051	455	22,094
1972	4,887	18,114	474	23,475
1973	4,673	20,359	485	25,517
1974	4,867	24,378	565	29,810
1975	7,246	17,364	882	35,492
1976	9,226	29,389	1,266	39,881
1977	10,272	30,644	1,218	42,134

Source: Canadian Housing Statistics (annual). Ottawa: Central Mortgage and Housing Corporation.

Over the twenty-six year period average total house price has risen 5.3 per cent annually, and construction costs 4.6 per cent while land costs rose 9.2 per cent, twice the growth rate in construction costs.

Some analysts have inferred from these relative magnitudes that increasing land prices have pushed up the price of housing. Dennis and Fish (1972), for example, using similar data view builders as treating construction costs as a mark-up over land costs. Consequently, land price increases tend to be passed on to the house buyer. However, since not all price increases will meet consumer acceptance, dwelling size is reduced slightly to provide a more appealing price. Reductions in the level of new residential construction which accompany increased land prices are interpreted as evidence that builders have been pushing up prices to levels where fewer and fewer buyers are capable of purchasing a new home (1972: 77-83).

This explanation is clearly unsatisfactory. For one thing, the sizes of N.H.A. dwellings have not steadily declined since 1951. For another, total annual single-detached dwelling construction has generally increased since 1951 -- it is N.H.A. building which has declined.

Several crucial questions are raised by the present confusion. Why do increases occur in land price levels? How do they occur? How are they causally related to house price increases? Do they cause them or are they caused by them?

Bourne's survey suggests that there is no single explanation available to give us satisfactory answers to these questions. He concluded his overview with the suggestion that, notwithstanding their disparate characteristics, each of the five 'theories' offers a partial

explanation. The one which provides the most critical insight will depend on the given market being studied:

> At one time demand may lead in producing housing price inflation, at another time it may be construction costs and at still other times the cost of money. Sometimes oligopolies in the development industry are able to influence market prices, at other times they are only price takers. In some instances the bottlenecks facing the residential development process introduce significant new costs; while in other instances they are largely irrelevant nuisances. At some points the private market or capitalist system is a socially efficient producer and distributor of housing; at other points it clearly is not. At one point in time the actions of one level of government exert the most influence on housing prices; at another time it is the policies of a different level of government. Similarly, over one period of time the market for newly-built houses may set the price (or rent), while over a different period the existing stock dominates. (1977a:46-47)

For this reason Bourne suggests a sixth theory,

> based on an essentially social democratic view of the utility of economic markets in our society. This view, which we will call "interventionalist", says that while the competitive market may be the most precise mechanism we have for allocating land to different uses and housing to people, it cannot be allowed to operate without firm public controls. The problem becomes one of finding the appropriately tight controls which do not also reduce the efficiency of the market in those sectors where it seems to perform reasonably well. Regulation is the key concept. (1977a:45-46)

The different schools of thought on the land and housing price problem, including Bourne's sixth theory, represent different understandings of the operation of land and housing markets. The various

policy proposals which they recommend for the solution of land and housing price problems also represent different types and degrees of intervention by government in those markets. Since planners on behalf of local Councils exercise powers which influence markets, they are implicated in the problems that many have identified and in the solutions that have been proposed. If these responsibilities are to be adequately discharged, an improved explanation of land price increases is obviously required.

1.3 SCOPE OF THE STUDY

In the circumstances just outlined, planners and policy analysts who are in a position at various levels of government to advise public policy and action on land and housing, should have a better understanding of land and housing markets. However this will surely not be accomplished in one burst of endeavour. Instead it must be approached through a set of more manageable tasks. For example, Bourne below identifies two analytically distinct temporal perspectives. Our comments in parentheses, in respect of the spatial dimension, expand them to four.

> It is essential that we separate those factors which are short-term (local) perturbations from those which are continuing and longer-term(regional or national) considerations. Each requires a somewhat different explanatory framework; and each necessitates a corresponding policy response. (1977a:48)

We might also distinguish the residential land market from the housing market and further classify these in terms of different housing types and forms of tenure. In so doing a broad scope of potential investigation

with component studies is outlined.

The delimitation of the scope of this particular study is predicated in part on personal inclinations, competence, and the availability of data for empirical study. It was decided to focus on the long-term aspect of the land market's operation at its most general level. In so doing, some indication may be obtained of universally-applicable factors and processes that characterize the operation of the residential land market.

Upon further reflection, it was judged that the proposed scope of the study could be justified on some firm ground. Any study which is limited in geographic extent or historical scope, runs the risk of producing results of limited relevance to further study, and of limited policy application. On the other hand, a more general study has a greater chance of uncovering some universal principles. An early reading of the literature has suggested that more general studies have generated results which are more pertinent to the development of theory than are limited case studies.

1.4 OUTLINE OF THE STUDY

The investigation conducted in the following chapter represents an attempt to identify and characterize existing explanations and supporting evidence about the process by which residential land prices are established, how they change over time, and how they might influence or be influenced by new house prices. The search conducted was an extensive one but by necessity the report is selective, limiting itself to the literature that addresses the central topic in a significant way. That is, it is generally limited to those studies which address in

a pertinent way the long-run, inter-temporal, location-invariant aspect of land price determination.

Following this general survey of relevant theory and research, the first part of Chapter Three offers a critical appraisal of the literature and identifies several shortcomings which further theoretical and empirical analysis should address. The second part of Chapter Three presents the development of a theoretical model that strives to incorporate some of the basic theoretical propositions identified in the literature as well as any reformulations suggested in their evaluation.

In Chapter Four is presented the source and characteristics of the data to be employed in the subsequent empirical investigation. An empirical model is subsequently developed which translates the theoretical model into a quantified, refutable form suitable for empirical testing. This reformulation also allows some adjustments to be made in light of data limitations. The chapter is concluded with a discussion of the statistical methods and procedure utilized in the investigation.

In Chapter Five, the results of the statiscal analyses are presented. An overall assessment of the empirical model's validity is reached, and a practical interpretation provided. The theoretical implications of the empirical investigation are also derived.

Chapter Six begins with an indication of several accomplishments achieved by the study. Suggestions for further research follow. The chapter then considers the study's implications for urban planning.

CHAPTER TWO

REVIEW OF THE LITERATURE

This chapter surveys the literature on the causes and processes by which the level of residential land prices varies over time. The survey is reported in two parts. The focus of the first part is upon theoretical propositions pertaining to the inter-temporal price variation in residential land prices. The purpose of this part of the review is to identify the substance of available theory. The focus of the second part is upon those empirical investigations which have attempted to provide a test of some element of theory. The purpose of that part is to characterize the evidence in support of theory. A critical review of both theory and empirical research is undertaken in the following chapter.

The literature surveyed is a large and varied one with early origins and an uneven history. An historical review was made for time is most convenient dimension by which to place an intelligible pattern on the literature. No other scheme of classification suggests itself in view of the wide variety of approaches discovered in the literature.

2.1 THEORY

The very earliest writers on land value, such as Adam Smith (1776) and David Ricardo (1817), were preoccupied with differential agricultural land prices. They wondered why some lands commanded higher 'rents' than others. They also wondered how land could indeed command a rent for the landlord when it was a "gift of nature" requiring no human resources to produce it.

The concept of land rent was developed to refer to the unearned return to land and was to provide considerable debate for many

years after. However, the useful notion put forward by Smith and Ricardo was that the rent on agricultural land is the value yielded by the fertility of the land, just as wages are the value of labour services. That is, equally productive lands would command the same rent from tenant farmers -- other things being equal. Furthermore, this rent would be a surplus equal to the difference between the market price of agricultural produce harvested from the land, and the costs of creating that produce. Adam Smith expresses this notion as follows:

> ... it is because (a commodity's) price is a great deal more, or a very little more, or no more, than what is sufficient to pay those wages and profits (to be paid to bring the particular commodity to market), that it affords a high rent, or a low rent, or no rent at all. (1776: 146)

Some time later England became engaged in the Napoleonic Wars and its grain inventory was run low. The high price of 'corn' (grain) after the wars generated a great deal of argument among English economists. There were some who held that grain land had a high price because tenant farmers were being charged higher rents by landlords and had to raise the price of corn accordingly. There was another group, Ricardo (1817) among them who argued that the situation was the reverse. Observing differential rents for agricultural lands of differing productivities, these economists proposed that the Napoleonic Wars had depleted England's grain supplies and that this shortage had pulled up the price of grain. Since grain had a higher price, keen competition among farmers for land bid up the rents for land. The group thus held that the rent of corn land was high because the price of corn was high, and not vice versa. The eventual trend of grain prices in the post-Napoleonic period saw the triumph of this particular land value concept.

David Ricardo (1817) provices an illustrative statement of this concept:

> Corn is not high because a rent is paid, but a rent is paid because corn is high; and it has been justly observed, that no reduction would take place in the price of corn, although landlords should forego the whole of their rent. (1817: 51-52)

In other words, any change in the rent of land would have no effect upon the price paid for the land's produce because the price of produce is demand-determined (given supply) and not determined by its costs of production.

Karl Marx was later to base his theory of rent partly on Ricardo's concepts. He proposed that differentials in land rents were related not only to varying land fertility but also to varying locational advantage. Most importantly, he noted in partial agreement with Ricardo that "differential (rent) ... does not enter as a determining factor in the average price ... of commodities but rather it is based on it" (1909:757).

It was J.H.Von Thunen (1826) who fully developed the theory of location-differential rent. His argument related the rent of land to the transportation costs resulting by the land's location relative to the produce market. The rent of a piece of land was the value of its product minus the production and transportation costs. Because of transportation costs, lands located closer to market are more valuable than lands located a greater distance away. In a competitive land market, this relationship was argued to determine the land use pattern, with higher-valued products being produced closer to market since their producers could bid higher prices for the use of land.

Henry George (1879), who gained fame as the founder and proponent of a movement for a "single tax", held a theory of income distribution which had Ricardo's principle of rent as one of its bases:

> The rent of land is determined by the excess of its produce over that which the same application can secure from the least productive land in use.(1879: 168).

However, George saw wages and interest as a residual.

> ... wages and interest do not depend on the produce of labor and capital, but upon what is left after rent is taken out. ... And hence, no matter what be the increase in productive power, if the increase in rent keeps pace with it, neither wages nor interest can increase. (1879: 171)

This position is clearly counter to the classical view. George also went so far as to find the cause of economic depressions in speculative increases in land rents which undercut wages and interest rates.

The classical view of land rent as surveyed by Kieper, et al (1961), and Mills (1969), was that it is a residual which just absorbs the excess of revenue over returns to other factors priced on competitive markets. Neo-classical economists later introduced the theory of marginal productivity to economic analysis. They viewed the payment to each factor of production as being equal to the value of the factor's marginal product (the addition to total output obtained by an additional unit of a given input). Wicksteed (1894) argued that the value of the marginal product of any use of land should equal the land's rent, and furthermore that this view was no different than the classical view. That is, the rent of a piece of land should just absorb whatever revenues are left over after other inputs have been paid at whatever prices the market dictates. Wicksell (1935) some time later demonstrated that in both the classical and neo-classical cases competitive factor pricing will exhaust firms' revenues and leave no excess profits.

Through the efforts of Alfred Marshall the general principles of land rent and value were more firmly established. He saw the rent of land being "in some sense a residual income after deducting the expenses of working it" (1890: 441). The value of land was seen to be related to rent just as savings or investment are related to interest. Rent, or "the

annual site value ... is the income which that price would yield at the current rate of interest" (1890: 441). More explicitly, he proposed that "the capitalized value of any plot of land is the actuarial 'discounted' value of all the net incomes which it is likely to afford" (1890: 445).

Marshall was probably the first economist to give attention to the techniques of establishing or determining the value of land. He was also the first to extend the principles to income-producing urban land. Prior theoretical analysis had been generally restricted to agricultural lands. One of Marshall's greatest accomplishments is probably his redefinition of land rent as but one type of 'producer's surplus'. Subsequently, rent as an economic concept was generalized still further and eventually was completely dissociated from land.

At the turn of the century, a literature was begun that more exclusively addresses urban land value. An appraiser, Richard Hurd (1903), was the first of many writers to attempt to outline a theory of urban land values. He followed closely Von Thunen's theory of agricultural land value. Hurd retained the concept of accessibility but replaced the notion of differential fertility with a 'desirability' differential. In his analyses he didn't give much attention to residential land, observing simply that it goes to the highest bidder. Hurd's significant contribution, based most likely on his experience and activity as a property appraiser, and identical to Marshall's economic principle of value, is his establishment of the commonly accepted procedure of calculating the residual return to land and capitalizing these returns to obtain present land value, as summarized in this equation:

$$\text{Land Value} = \frac{\text{Net Return to Land}}{\text{Rate of Return}}$$

After Hurd came several studies and theoretical analyses treating land economics. Richard T. Ely and E. Morehouse (1924) were

among the first to give some attention to trends in land values. They argued that land values would decline over time with the introduction of greater efficiencies in transportation methods and construction techniques. Population growth and incomes were nevertheless viewed as the underlying influences or determinants of urban land values.

Robert M. Haig (1926) was among the first writers to organize a growing land economics literature and shape it into an urban land value theory following the principles established by Marshall and Hurd. Haig was also among the first to treat the subject of residential land, viewing 'site rents' as related to population size, incomes, transportation costs, and the value of time to households.

Dorau and Hinman (1928) regarded population and incomes as responsible for rising rents and land values but emphasized that the relationship was not a direct one. They view land value as affected by three variables: land income, the rate of income capitalization, and the satisfactions of land ownership. Dorau and Hinman's significant contribution, following Marshall, appears to be their explicit consideration of the supply and demand factors which affect land income or rents, and therefore land value. Also of significance is their treatment of the rate of capitalization, viewing its shifts over time, with respect to real estate investment, as a function of changes in interest rates, expectation of risk, chance for capital gain, and investor preferences.

Homer Hoyt (1933) undertook one of the first major empirical studies of urban values. In this study Hoyt defined the 'residential developer' as an entrepreneur who sought to maximize returns on his investment while satisfying the demand for housing. Hoyt's analysis added some insights into the relationship between land use and land value. He is well-known for his sector theory of urban spatial structure, a criticism of the concentric pattern theory introduced by Von Thunen and

later popularized by Ernest W. Burgess in Park, et al(1925).

Another significant work published in the early thirties was a major theory of real estate economics and appraisal by Frederick M. Babcock (1932). It followed Marshall's economic principles as well as the value theory and mathematical techniques developed by economist Irving Fisher (1906). Babcock developed the theory that value represents the net worth of future returns from property, which in turn depend upon use and location. Quite similar to Hurd's work thirty years earlier, Babcock's techniques and principles were far more precisely formulated and illustrated.

At the same time as land economists were seeking satisfactory explanations for the determination and distribution of land values, sociologists and 'human ecologists' such as Park, Burgess, et al (1925), were also seeking an explanation of urban land use patterns. Like the economists, they correlated land values with land uses. However, they reversed the explanation given by land economists. Louis Wirth argued that "land values are the chief determining influence ... of the uses to which an area is put. Land values determine the type of building that is to be erected in a given area" (1925: 203). Land economists argued the contrary. They held that various uses, by bidding for the most advantageous sites, will establish land prices. It would take several years before both of these arguments would be accepted as but the two sides of the same phenomenon. The sociologists' interpretation corresponds to the situation confronting the individual land user at the micro-level while the land economists' view addressed the macro-level, aggregate situation.

Few new developments occurred in land value theory until the post-war period. Richard U. Ratcliff (1949), who presented a comprehensive theory of the land economy of American cities, offered the first of the 'contemporary' theoretical treatments of urban land value. It is an

extensive treatise, although largely descriptive and non-mathematical, addressing a variety of topics. Only those which bear directly upon our topic will be reviewed here.

Ratcliff's organizing principle is that urban land use, value, and income are products of market forces and activities. Following the thinking of Marshall and others, he held that the market price of land reflects economic decisions about the future productivity of that land as measured by its net income for various uses. If the investment of capital in the ownership of land and its improvements is to be maintained or induced, payment for the services of improved land must cover

> ... the current expenses of operation for the property; a return on the capital invested in improvements and an amount sufficient to amortize all capital loss over the economic life of the major wasting improvements; and an additional return high enough to outbid agricultural use and all other urban uses that are competing for the site. The return on the total investment must (also) be high enough to attract capital in competition with alternative investments in other fields. (1949: 347)

This principle was also applied to non-income-producing properties such as privately-owned dwellings where the direct returns are in the form of services and other utility rather than income. The interpretation differs only slightly.

Ratcliff outlined several reasons why urban property commands an income:

> Urban land provides area and support for buildings and the other capital improvements that combine to make it usable; the improvements ... provide shelter and facilities that are essential to its use as housing or for commercial and production purposes; (and) location -- i.e., the space relationships with all other urban activities and with all other physical features of the landscape -- invests the land with a complex quality of convenience that is the primary basis of its utility in the urban economy. (1949: 346-347)

Several factors which influence the amount of income that can be obtained on a piece of urban land were identified:

> The variables that determine the net return that can be produced by the development of any urban site are the location of the site, the nature of the land use, the amount of the capital investment, the operating costs, the productive life of the improvements, and the loss in value during the life of the improvements. It is the location of the site that is the key factor. The location determines the nature of the land use that is appropriate; the nature of the use largely controls the nature and amount of the improvements; the improvements, in turn, are determinants of operating expenses. (1949: 253)

The site's net income will further depend on the operating costs and other expenditures associated with the use of the land, as he indicated earlier. Finally, it is the capitalization of this net income to determine its present worth which establishes the present value of the land.

These concepts have immediate application to property development activity:

> The balance of revenue or profit, which remains after the deduction of operating costs and depreciation, is the major consideration in business decisions with respect to property development. The general objective is to maximize this net return over the life of the improvement. Thus the nature of the improvement and the size of the investment are determined by the owner's or prospective owner's estimate of what kind of development will yield the highest residual return. The market price of vacant land is based on estimates of the maximum profit that can be produced through the most favorable of the alternative development plans. (1949: 253)

The sales price of a property is the result of negotiations between buyer and vendor. Insofar as the buyer is concerned, his entrepreneurial calculation differs little from investment analysis undertaken in other fields:

> The entrepreneur seeks that combination of the factors of production, in this case primarily land and buildings, which will yield the most favorable return ... If he assumes that so many dollars must be invested in the buildings and land improvements, then the calculated net worth less this sum will represent what he would be justified in paying for the land. But if he assumes an acquisition cost for the land, then the balance of the net worth after deducting land cost will represent what he would be justified in paying for the (construction of the) building and improvements. His decision to proceed with the investment in the enterprise will depend upon the relationship of the hypothetical initial net worth of the proposed land development and the necessary or actual total capital cost of acquiring the land and erecting the buildings. (1949: 356)

In this statement is a description of the behavior of the building or development firm which represents a conventional wisdom about the behavioral process in land price determination -- insofar as land demand is concerned. It is a concept which will reappear with little modification many times in the subsequent literature (thus justifying an in-depth summary of Ratcliff's analysis).

A further noteworthy characteristic about Ratcliff's treatise is his strong position that it is the interaction of supply and demand forces which determine land values. This is exemplified in his discussion of how the supply of accommodation is adjusted to changes in demand:

> When the pressure of demand continues to push against supply, vacancies decrease and prices and rents rise. At some point, prices and rents on existing properties reach a level that makes it attractive for producers and investors to enter the market. Builders are able to sell their products at a price that will yield a profit in competition with existing space. Investors find that rental yields are attractive relative to capital investment as determined by costs of construction. Thus new construction is undertaken and the market is supplied with additional space. New construction is checked or

> stopped by a number of forces, often working together. If the production of new space overtakes the increase in demand, vacancies will begin to appear, first in existing properties, and prices and rents will soften. It will become more difficult to dispose of new units in competition with existing units at lower prices. Thus the prices on new units will be affected and will ultimately fall below the level at which manufacture and investment are profitable. (1949: 286)

While later theoreticians will bring more sophisticated treatment to bear upon the interaction of supply and demand, Ratcliff remains the first to have made explicit application of these economic concepts.

Paul F. Wendt (1957) took strong issue with the propositions of Haig and Ratcliff. He suggested that

> their conclusions are based on a highly theoretical and oversimplified application of classical price and rent theory to urban land markets; that their acceptance requires unrealistic and unstated assumptions; that they fail to consider the dynamics of demand influences; and that they have little or no applicability to present-day urban land value trends. (1957: 228)

Wendt developed a theoretical model of aggregate urban land values which sought to predict temporal variations in land value but it was not defined precisely enough to be made operational.

Wendt's model identified multiple influences affecting total land values in an urban area. The value of an individual urban site was first viewed as the present value of the expected future net incomes attributable to land, that is,

$$V = \frac{R_x - C_x}{\text{Capitalization Rate}}$$

where V is land value and where the numerator, $R_x - C_x$, represents the estimated residual net income to land after allowing for costs. That is,

R_x are the expected annual gross revenues to the property (both land and improvements or structures on the land), and C_x are the expected annual costs of maintaining the property. (1957: 235).

Wendt formulated the following equation with respect to the aggregate of land values in an urban area:

$$V = \left[\frac{f_x(P,Y,S,P_u,PI) - {}_x(T + O_c + I_{im} + D_{im})}{f_x(i,R,C_g)} \right]$$

Since this is the first equation of this kind to appear in the literature, there is merit in examining its specific elements.

> Revenues which are expected to accrue to urban property (Rx) may be shown as dependent upon investors' expectations (x) as to population (P), the average amount of incomes spent for urban services (Y), the competitive pull of the urban area (Pu), the supply of competitive urban land (S) and the prospective investment in public improvements such as parking, street facilities, etc. (PI). Thus: Rx = fx (P, Y, Pu, S, PI).
>
> Similarly, cost expectations (Cx) ... can be represented as the sum of local property taxes (T) operating costs (Oc), interest on capital invested in present and future improvements, (i im), and depreciation allowances on present and future improvements (D im). Thus:
> C_x = sum of ${}_x(T + O_c + i_{im} + D_{im})$
>
> The capitalization rate ... can be represented as dependent upon interest rates (i), allowances for expected risk (R) and expectations concerning capital gains (Cg). This represents a conceptual average rate for all urban properties, the individual rates varying with risk, location etc. Thus: Cap Rate = fx (i, R, Cg). (1958 a: 235)

Unlike earlier formulations of the land value equation, Wendt's analysis gives a more explicit role to expectations. Most of the variables in his equation pertain to expected values of various factors influencing the determinants of land value. Such expectational variables were to pose insurmountable measurement problems for Wendt and prevented him from testing his theoretical model.

Ralph Turvey (1957, 1962) offered a theoretical treatment of the determination of land values comparable to Ratcliff's and Wendt's. Turvey's overview of the urban property market has significance in that he introduced slightly more rigorous economic thinking to the subject. Substantively, his view differed little from preceding ones, as indicated in the following statement.

> How much a developer will pay for a site depends upon what he expects to be able to sell the completed building for, and partly upon what it will cost him to have it built. If, for instance, a house appropriate to a particular site would sell for £4,000 and would cost £3,000 to build, the developer who expects 10 per cent profit on his turnover, i.e. £400, will be prepared to pay up to £600 for the site. (1957: 29)

Achieving a succinct illustration of the determination of the bid price for building land, Turvey underlines the role of expectations, like Wendt. He also draws attention to the entrepreneurial reward in construction and property development. Whether for illustrative purposes or theoretical reasons, he chose the total value of the building project as the 'base' on which the entrepreneur's reward is calculated. As shall be seen later, other approaches to this are possible.

Turvey's most significant contribution possibly lies in his analysis of the 'rationale of rising land prices'.

> From the point of view of the individual builder, of course, site value is a cost, not a surplus. The amount he has to pay to get building land has been rising; consequently the price at which he sells his houses has had to rise in order to preserve profitability. The point is, however, that each year he has been able to find buyers at higher prices than in the preceding year. The basic explanation therefore lies in the rise in the amount people have been willing to pay (for houses). If money incomes and population had not risen, and if credit for house purchase had steadily become more difficult to obtain, the values of sites for housing would not have risen. ...
>
> The basic point ... (is) that the behaviour of land prices has been a consequence, not a cause. The demand for accommodation has risen faster than the supply, so that rents and selling prices have gone up. Since building costs have risen more slowly, land values have been bid up. Land is thus dear because accommodation is dear and it is quite wrong to suggest that the converse is true ... (1962: 30-31)

With this analysis Turvey offers from a micro-economic perspective the first general treatment of changing urban land prices over time.

Raleigh Barlowe (1958, 1972) offered a highly rigorous economic analysis of land use, supply, and value. Like others before him, Barlowe saw investments in land as a function of land value's residual character:

> ... land resources have only a residual claim upon the gross returns received from their use in combination with other productive factors. (1958: 238)

He defined economic rent as "the surplus of income above the minimum supply price it takes to bring a factor into production" (1958: 150). Barlowe offers a complete economic analysis of land as a factor of production in economic activity. He used extensively the economist's familiar device of graphical analysis. He also incorporated the

appraiser's concept and method of income capitalization.

> From a theoretical point of view, the value of any productive land resource always equals the sum total of its future economic returns discounted back to the present. (1958: 169)

The capitalization formula which Barlowe presented for the computation of land values was expressed as

$$V = \frac{A}{(1+r)} + \frac{A}{(1+r)^2} + \cdots + \frac{A}{(1+4)^n}$$

> In this formula, V = value of the property, A = the average annual economic rent, and r = the capitalization interest rate. By way of illustration, one might assume a property with an average annual economic rent of $1,000. When this return is capitalized at 5 per cent, the property is valued at $1,000 divided by 0.05 or $20,000. (1958: 169)

The average annual economic rent, A, is the average annual level of net return -- or the difference between expected average gross income and expected operating costs. The formula can be modified to accommodate changing levels of income and expenses, i.e. replacing A by $a_1, a_2, \ldots, a_n$.

This formula was already in widespread use in real estate appraisal. Babcock, for example, provided an early exposition of it, as noted earlier in this review. However, in the mid-fifties the concept and technique of capitalization seemed to have firmly entered the conventional wisdom and would be taken for granted in most subsequent investigations and analyses.

In the early sixties there began to appear a series of writings which addressed the pattern of urban land use. William Alonso (1960, 1964) developed the first widely-regarded model of urban spatial patterns. It is a refinement of Von Thunen's earlier

analysis assisted by the many subsequent developments in economic thought and analytical methods. It was developed at about the same time as similar models by Lowdon Wingo, Jr. (1961), and John Kain (1961,1964). While all three models made significant contributions to urban theory, they shed little light upon the determination of and temporal variation in land values. Addressing instead locational or cross-sectional differentials in land prices, their emphasis was on the final demand side of the housing market. Household location, related to such factors as income, the price of housing, the price of land, the utility of land and housing, the distance to work, and transporation costs, was the dependent variable of concern.

In 1962, in Great Britain, Turvey prefaced his article on rising land prices with the observation that

> In recent years property prices have been rising fast and land value is now becoming ... (an) important political issue. ... One (complaint) is that speculators are reaping unearned gains, that there is profiteering, while the point is rapidly approaching where ordinary, respectable people can hardly afford to buy houses. (1962: 27)

At the very same time in the United States, Clawson (1962) was expressing concern for urban sprawl and land speculation:

> One feature of post-war suburbanization has been its tendency to discontinuity -- large closely settled areas intermingling haphazardly with unused areas. ... One aspect of this picture has been large-scale speculation in land, with consequent high costs to the actual settler and with large areas priced out of any market except urban usage, but the latter not yet taken over. (1962: 99)

Clawson, treating primarily the supply side of the land market, begins his analysis with an overview of the important characteristics of the market for raw suburban land.

> The market for suburban land is a derived one, dependent upon the market for the dwellings, shopping centers, or industrial plants erected on it. As such, it is subject to the uncertainties of (the) market for the final product, compounded by the uncertainties of the conversion process. The market for suburban housing is a fragmented and not wholly consistent one, often variable in short distances and over brief times. Differences in price for houses are often reflected back into differences in price for undeveloped land, but in varying degrees. (1962: 102)

This last sentence expresses a scepticism which Clawson was to have for the classical position that house prices determine residential land prices. This scepticism is due in part to Clawson's observations about uncertainties in the suburban land market. But expectations also have a role to play.

> Undeveloped suburban land, not yet in use for urban purposes but already taken out of other land uses, obviously must derive its value from the expectation of its later development as urban land. ...
>
> An expected future income or value can be discounted back to a present worth or value. An interest or discount rate is required to do so. The discount rate may be thought of as having two parts; a more or less normal interest rate based upon alternative sources of investment or alternative sources of funds in competitive money markets; plus an uncertainty factor. ...
>
> The appropriate interest rate in land speculation depends to a large extent upon the situation of the particular individual. (1962: 102-103)

An investor with ample funds and a high marginal income tax rate might adopt a lower rate than a real estate developer who is short of capital and whose profits are taxed as income rather than capital gains, i.e. at

a higher rate. Differing expectations would also affect valuation. The same piece of land would therefore have different subjective values depending on the investor doing the investing. The objective or market value, however, is a single one, usually set by the highest bidder.

Clawson completes his economic analysis of the suburban land market with an explanation as to why there is speculation in land.

> If there was complete knowledge as to the time of future conversion, as to the value at that time, as to holding costs and as to discount rate, then obviously everyone would be in complete accord as to present worth. There would be no opportunity for speculative gain, because all future value would have been fully and accurately discounted into present value. ...
>
> As long as we have free markets in suburban land and as long as the total effect of the various factors in the formula promise some present value above alternative use value, and given imperfections of knowledge and incomplete concensus, then we can reasonably expect speculative bidding up of suburban land values. Viewed in this way, land speculation in and beyond the suburbs is not only normal but inevitable. (1962: 104)

This is probably as complete a statement as will ever be found to define the nature of land speculation, not just in suburban land but in all property. Clawson's work is also significant in that the study of land economics has moved into public policy areas where there is a concern to solve some problems in the land market which are quite different than the problems addressed by appraisers, assessors, investors, developers, and builders.

In 1963, Sherman J. Maisel published in several places the results of a series of investigations into the cost and price of single-detached housing (1963a, 1963b, 1963c). These studies were premised on the

need to understand processes in land and housing markets if they were to be made to operate better. Some of Maisel's studies were in fact sponsored by the State of California in a formal investigation of housing problems.

Maisel's work is largely empirical in nature but it is mentioned here for it does include some theoretical analysis about how land values are determined and how lot prices increase. He subscribes to what he calls the simplest theory of rent. Land values are argued to depend on the physical size and terrain of the city , its transportation costs, its population size and its level of income. These factors create urban rents. This view accords loosely with both Ratcliff's and Wendt's analyses. Maisel notes two additional influences on land prices, inflation and land scarcity but he does not specify how any of these factors actually operate to determine property values.

A major empirical investigation study by Grace Milgram, Gerald Adams, and others combined the approaches and premise of both Clawson and Maisel. In a report on their results, Adams , et al (1968), offered several theoretical considerations in respect of the growth of land prices. These were based on the earlier work of Marshall and Turvey.

First, the return on urban land is viewed as a site rent which measures the attributes of a parcel of property: its location, legal characteristics (such as zoning restrictions), property tax, and servicing. Second, the functioning of the market is seen to entail an adjustment of rents that equate demand for land and the available quantities of different types of land. Third, urban land value is viewed as a price determined as a result of the capitalization of site rents:

> In an effective market, the price of land will reflect capitalization of the anticipated future flow of net rent. ... If we assume a value V at the time of development ... and an appropriate discount

rate i, the present value, P, assuming continuous discounting, is as follows:

$$p = V / e^{it} \quad . \quad (1968: 249-250)$$

V, in turn, is the present value at the time of development of an expected series of future net returns. The discount rate, i, is viewed as a net rate of return which money can earn in other comparable investments. This formula differs in notation from those already shown only in providing a more comprehensive formulation.

The formula is then adjusted by taking into account the taxation of land that real estate is subject to. The discount rate would therefore be i + r, where r is the effective rate of property taxation. If all factors are taken into account by the holders of vacant land, prices would be expected to increase over time at the rate i + r. Any change in i + r would affect price movements over time, as would change in anticipated value V, and in the expected date of development (affecting t).

Adams, et al, note that the widely known imperfections in the real estate market can result in "substantial scattering of prices around expected market averages". Highly differentiated plots of land, lack of information, infrequent trading, high transaction costs, varied motivations, and diverse expectations are factors affecting prices but which are outside the theoretical capitalization process considered, without being inconsistent with that process. In so doing, they took into account the observations made by Clawson about land market imperfections.

G. Milgram (1968a, 1968b) addressed other aspects of the study conducted with her colleagues. In one report we find a rather detailed description of the actual process followed by the builder in carrying out his activity. It is similar in some respects to Ratcliff's. For example:

> ... (from) the estimated construction cost and selling price of the structure, the maximum payment for land (is) determined. Thus, land price, in effect, is a residual, with the important value not the price per acre of raw land but the price for a finished lot for each house. (1968a: 19-20)

It should be remarked at this juncture that several studies have been undertaken of builder and developer behaviour -- their locational decisions, and financial activities particularly. Weiss, et al(1966), Kaiser (1964 and 1968), and Goldberg and Ulinder (1972 and 1975) provide considerable evidence and insight on the basis of developer and builder surveys of the ways in which they go about their business. Unfortunately, none of these studies has addressed the topic of this thesis, namely how builders decide upon the price they will pay for building land.

Milgram underlines the price of land as one of the major factors in builder's decision-making. It must therefore be asked how residential developers and builders deal with higher land prices than they would otherwise be prepared to pay. Milgram offers the following answer:

> First, they can increase density and reduce the amount of land used for each dwelling unit, if this is permitted under current zoning or obtainable zoning changes; second, they can reduce the quality, and hence construction cost, of the structure; third, they can build the same or a more expensive house for a smaller market. The housing consumer thus loses either space or quality or both, and society may lose in the number of new units constructed to meet housing need, particularly in the lower price ranges.
>
> Alternatively, the developer may believe that a significant number of consumers would prefer to pay in accessibility rather than in money, and he may find land farther out from the city centre which will permit building at the

> lower density or the price which he originally desired. If he has judged his market correctly, he may be successful, but society still will pay in fewer houses and in the costs of extending facilities as well -- in fact, in urban sprawl. (196

With such an explanation of the builder's adjustment to asking prices for land which exceed his bid price, Milgram gives added dimension to the proposition that land price is a residual. Barlowe, for example, who provided a sophisticated micro-economic analysis of the land market's operation, did not treat this adjustment process.

F. G. Pennance (1969) offered an explanation of land market operations and land price determination in the tradition of classical economics.

> An individual contemplating development will look to the existing level of house prices for guidance on the possible value of new building in given location. His expectation of proceeds from a planned development thus determined, the level of his development costs will fix the maximum bid the developer can afford to make for land. Competition between developers will ensure that the site goes to the top bidder (the site owner always retaining the option of commissioning development himself if high enough bids are not forthcoming).
>
> To the individual developer the price he has to pay to secure building land represents a cost of production -- a cost that the prospective value of the completed development must cover if building is to proceed. But although individual developers take the price of building land as a cost outside their control, simply buying or hiring as much at that price as they find profitable, this fact is nonetheless quite consistent with the proposition that the total developers' demand so generated determines the level of land prices that each individual takes as given. The total demand in turn derives from the final demand for and the price of existing housing. (1969: 33-34)

This argument differs from Clawson's and Milgram's by the introduction of a macro-economic perspective, already evident in Turvey's analysis. This perspective views the individual as powerless to affect land price in a competitive market, but all firms collectively, or as an industry, do establish that price. Nevertheless, Pennance argues, even at the aggregate level land price is residually determined. This is a new dimension of the residual value theory which is presented for the first time. However, Pennance does not explore, like Milgram, the ways in which builders might adjust to unsatisfactory asking prices for land. He simply holds that they will pay the prices and buy the quantities which they can afford. Thus, at both the micro- and macro-levels, observed land prices will be residual ones. Milgram's analysis more realistically suggests an alternative in this context, namely that the building firm may pay a price for land that exceeds the residual value it calculated and will make compensating adjustments in the size, quality, location, and quantity of housing it will build.

Pennance was not insensitive to the concerns of Clawson and Milgram. In the following statement he explains why asking and bid prices for land might differ, with an emphasis on the role of time.

> ... owners of the land will assess the probability of profitable development on their sites and adjust their 'asking' prices to take up any slack between the expected value of completed development and its cost (including developer's profit). In the light of their knowledge and foresight both developers and land-owners assess consumers' preferences in quality and location and capacity to spend on housing, present and future, so that the price of a suitable building site tends to reflect the whole expected potential of profitable building opportunities through time. If deferred building were expected to yield a higher return after taking into account the interest cost of carrying a building site over into future periods,

> its current price would reflect this expectation, and builders wanting it for immediate development would be unable to outbid those who wanted to reserve it for future development. The price of land would thus reflect both current and expected future housing demand: the current rate of building and absorption of land would reflect only current demand. (1969: 35)

In the following statement he observes the role of expectations and uncertainty.

> In real life such a situation will be further complicated by uncertainty and differences in expectations among and between developers and landowners. Uncertainty about expected proceeds from and costs of development will effectively reduce developers' bid prices for land: differences in expectations may produce an 'untidy' patchwork of development leap-frogging over pockets of land withheld from development. (1969: 35)

Pennance notes that in the circumstances explored, land prices appear to be a determinant of the rate of house-building and house costs. He suggests that future demand plays a role in the market's determination of current land prices and the fact that asking prices may exceed bid prices simply reflects the force of all forms of demand, both present and future. Land price thus operates to allocate it between present and future demand. He described the economic function of land prices as follows:

> Land costs to any user, private or public, represent the alternative use-values of the sites thrown up by the demands of the community which must be outbid if the use of the site is to be obtained. To wish land costs lower is either to wish that the total level of demand for land resources was lower -- with all that implies for general prosperity -- or to suggest that some land users ought to be able to secure land without reference to its value for other users. (1969: 40)

The residual nature of land value is pointedly illustrated in this discussion:

> If, for example, land prices were subjected to price control in an attempt to freeze or to lower house prices, the impact would not be found in lower house prices but in increased developers' profits. Only over time, to the extent that additions to the stock of housing rose relatively to demand as a result of the increased profitability of building, would any tendency emerge for house prices to fall. (1969: 40)

The proposition that land prices are determined by house prices was further clarified in a later article (1974). Builders' bids for land

> ... are based on their expectations about house prices and construction costs including developer's profit. In turn their expectations of house prices are governed by current prices paid for the flow of services provided by the stock of dwellings. (1974: 9)

However, he notes that the owners of building land also base their asking prices on expectations. As Clawson and Milgram demonstrated, future development value, development timing, interest rates and property taxes are some of the major variables determining present value of building land. Therefore, land-owners' expectations about the aggregate of builders' bids for building land are one of the determinants of their asking price for land. A 'circle' is thus completed, as Pennance implies, with behavior on the demand side of the residential land market linked to behavior on the supply side by means of suppliers' expectations of demand.

Pennance quite explicitly indicated that the direction of causation in price relations is from the existing stock of housing, to new housing, to building lots, and finally to raw land. He suggested that while the basic economics of the relationship between land and

housing were simple enough, the mechanics of the market through which these relationships are realized are far from simple and lead to confused debate. It cannot be determined if Pennance made the debate any less confusing but it has to be recognized that his theoretical argument adds a new dimension to the understanding of land prices and of the operation of the land market. Namely, their analyses must consider the macro-economic as well as the micro-economic aspects, and the short-term as well as the long-run characteristics. To ignore any one of these and limit explanation is to risk a faulty explanation.

Richard F. Muth (1969) after writing several articles in the preceding decade, provided a fairly comprehensive model of the spatial pattern of urban housing markets. Substantively, Muth's model is similar to those of Alonso, Kain, and Wingo but it differs considerably from them in two respects. First, Muth considered land as an input in the production of housing and not, like Alonso for example, as a commodity for which households have a final demand distinct from their demand for dwellings. Second, Muth achieved an integration of both the supply and demand sides of the housing market where the other models emphasized the demand side. It is his analysis of the supply side which is of significance to this investigation.

Muth's general model includes a sub-model of housing production -- an equilibrium theory of housing producers. It represents a fairly complete theoretical formulation of builder behavior in product and factor markets. While it is primarily concerned with the spatial aspects of housing production, it contains several implications for temporal aspects of land prices.

The model is based upon a few key assumptions. First, it is assumed that firms are competitive in both product and factor markets. Consequently, firms cannot affect the prices they pay for productive

factors or the price received for output (except by choice of building location). Second, it is assumed that housing is a composite good that includes the services of both land and dwelling. Thus, the demand for land is a producer demand, derived from the final demand for housing. The other conventional assumptions of profit-maximization goals, perfect knowledge, and so on, are also made.

Muth first postulates the equilibrium condition of firms at any given location of housing production.

> Assume that firms purchase two classes of inputs, land, L, and non-land, N, at unit prices r and n, respectively. Let π stand for the firm's profit or income, p and Q the price per unit received and output, respectively, and the subscript i for firms in the i-th industry. (1969: 48)

This equation specifies the firm's profit function:

$$\pi_i = p_i Q_i(L_i, N_i) - r_i L_i - n_i N_i$$

In equilibrium, profit will be at a maximum when changes in the quantity of factor inputs yield no more increase in profit.

The second postulate defines what Muth calls locational equilibrium.

> ... (it) requires that firms choose their locations in such a way that their incomes cannot be increased by any move. ... (this) requires that their profits are the same everywhere and are independent of location. (1969: 49)

Muth obtains the following implications of these two conditions:

> If all firms producing housing are identical or have the same production functions, then all must earn equal incomes or profits if the existing locational pattern is to be an equilibrium one. ... equality of profits requires that rentals vary directly with prices received at the point of production and inversely with non-land costs. If, for example, housing firms were to pay the same prices

> for all productive factors at all locations but the price received for housing varied inversely with distance from the CBD, firms located close to the city center would earn greater incomes than those located farther away. It would then be in the interest of firms located at greater distances to offer more for land located close to the CBD than centrally located firms were currently paying. Land rentals would thus rise in the central locations and fall in the more distant ones, and this process would continue so long as firms in different locations earned different incomes. (1969: 51-52).

Muth then considers the reactions of housing producers to changes in housing demand, construction costs, and the supply of residential land. A change in demand will change the value of housing produced per unit of land at various locations in the city. This change might arise from changes in population, incomes, or transportation costs. An increase in demand will increase the quantity of housing builders will produce by raising the intensity and quantity of residential land use, while a decrease will lower them. Muth notes that an increase in the value of housing produced will, given constant non-land costs, raise the value of land. While there may be excess profits in the short run during the time it takes for the building industry to adjust to new conditions, in the long run output will be increased and new firms will enter the industry such as to eliminate these profits as well as the incentive to expand production any further.

Exogenous changes in construction or non-land costs, other things remaining equal, will affect the amount of housing produced with a consequent, later effect on housing prices, which will in turn affect land prices. The reason for this, Muth does not fully explain, is that changing construction or other non-land costs, given unchanging housing demand, will alter builders' bid prices for land and thus the quantity they can obtain.

Muth's treatment of land market operations is limited in its treatment of inter-temporal price variations for the reason that his sub-model forms but a small part of a larger analysis directed to a different question. However, Muth's method of comparative statics analysis -- specifying the reactions of builders to changing conditions -- offers a basis for the analysis of these variations.

Muth also ignores the process of land valuation, emphasizing rentals rather than values or prices. He writes,

> I shall not concern myself very much with the relation of rentals to value. Value, of course, is the capitalized value of expected future net rentals. But factors affecting expectations and capitalization rates are not very important for the kinds of problems I discuss below, least of all for the analysis of long-run equilibrium. I find it convenient to consider rentals, primarily, rather than values in most of my discussion. (1969: 48).

Muth does not explain or further justify his decision. The convenience of dealing with annual land rentals rather than values may lie in not having to take into account changes over time in capitalization rates as well as differences in these rates between land buyers and sellers.

Muth does not deny the significance of expectations. This is obvious in an earlier work where he wrote:

> Since housing is a very long-lived asset, we might expect that investment in housing depends not only upon the current profitability of housing, the ratio of rent to price, but also upon investor's expectations about its future profitability. Looking at this a little differently, the current ratio of rent to price is a measure of the position of the desired stock-demand schedule relative to the actual housing stock. It seems not unreasonable that investment in housing depends not only upon the current demand for housing but also on investor's expectations about housing demand in the future. If this hypothesis is

> correct, then, just as we needed a measure of consumer's expectations about their normal income in the previous section, now we need a measure of investor's expectations about the profitability of investment in housing. (1960: 59)

To summarize Muth's contribution, his theoretical analysis of housing production, designed to explain urban residential spatial patterns, also assists an understanding of spatial and inter-temporal land price variations. That the value of land is residually determined is clearly implied by the model. So is the notion that this residual can be affected by construction and non-land cost changes and changes in land supply and housing demand. Further, changes in this residual will in turn affect the quantity of housing production as well as its land-use intensity.

A special contribution made by Muth are the economist's analytical methods which he brings to his study. While only one of his equations was noted here, he mathematically specifies most of his propositions to form a complete structural model of a perfectly competitive housing production industry in equilibrium (long-run).

William Lean (1969) gave some analysis to land use and land prices that combines Muth's locational concern with a more specific attention to land residual valuation. Lean's statement is especially informative for the way he places rent-paying business firms, property investors, and real estate developers in economic relation to one another. Beginning first with the business firm,

> ... (it) will estimate what it expects to be its revenue in a given location. From this it will deduct all its costs except the cost of the use of the land and buildings, plus what it considers to be an adequate profit. The residual sum will give the firm its rent-paying ability for the use of the land and buildings. The firm may find that its costs and

> revenues will be different in different locations, and hence its rent-paying ability will vary between the locations. It will locate itself on those sites where its rent-paying ability is above that of other potential users of the sites. (1969: 34)

Turning then to the property investor.

> If a user is prepared to pay rent to use land and buildings, it must mean placing a value on them, for if the user is going to rent them, it is necessary for someone else to hold the land and buildings as an investment. The investor, who can be the user if he is prepared to pay a capital sum for the land and buildings instead of rent, will calculate the present value of the stream of net rents which will be receivable from the property over time. He will do this by discounting each increment of net rent (income) at what he considers to be an appropriate rate of interest to a present value. The appropriate rate of interest is determined by the amount of money he requires in the future in order to persuade him to give up a given sum at present.
>
> The sum of the present values of the incomes receivable will give the investor the value of the land and buildings to him. The formula will be:

$$P.V. = \frac{R^1}{(1+i)^1} + \frac{R^2}{(1+i)^2} + \frac{R^3}{(1+i)^3} + \frac{R^4}{(1+i)^4} \cdots + \frac{R^n}{(1+i)^n}$$

> P.V. is the present value, R_1, R_2, ... R_n represents the increments of net rents receivable, and i represents the appropriate rate of interest.(1969: 35).

Finally, the developer.

> Real property developers will endeavour to find out the capital sums that investors are prepared to pay for the land and buildings with different possible buildings erected on the sites.

> The developer will then compare the capital sums realisable with the costs of making the different real properties. Providing he can make an adequate profit, the developer will create that real property that will give him the highest capital value over costs. This will be the real property required by the user with the highest rent-paying ability for a given site, for this will tend to be the real property with the highest value, and to give the developer the greatest value over costs.
>
> The rent-paying ability of the use will also determine the value of the land. As just explained, this will determine the value of the real property created on a site. The developer can calculate all his costs of creating the real property, except the cost of the land. To this he will add his minimum profit required to carry out the work. This sum deducted from the value of the real property will give the amount that he is prepared to pay for the land. The land with the uses that have the highest rent-paying ability will have the highest value real properties created on it and have the highest land value. There will be this correlation between the rents payable for the use of the real property and the value of the land. Hence in the final analysis it will be the profitability of the use that determines the land value. (1969: 35-36)

Lean's brief analysis does not add much to the existing theoretical development. It was extensively quoted here for it provides a succinct description of the major activities and participants in the urban land market. Interestingly, Lean also provided a corresponding description of the residential part of this market in terms paralleling the non-residential side.

> With land used for private residential purposes, the principle is the same as with other profit-making uses. In this case, the rents which the users will be prepared to pay will depend on such factors as their incomes, family responsibilities,

> tastes, costs of travelling, etc. If a person rents the real property he occupies, someone else will be owning it as an investment, and the investor will make a valuation of it in the same way as if the property were to be occupied for profit-making purposes. If the user purchases the real property, he will have to place a value on it. This will be based on the same factors as he would consider when he rents, plus his present availability of capital, and if he needs to borrow, his mortgage repayments.[1] The developers will make the same calculations of values, costs, and money available to purchase the land as with real property to be used for profit-making. (1969: 36)

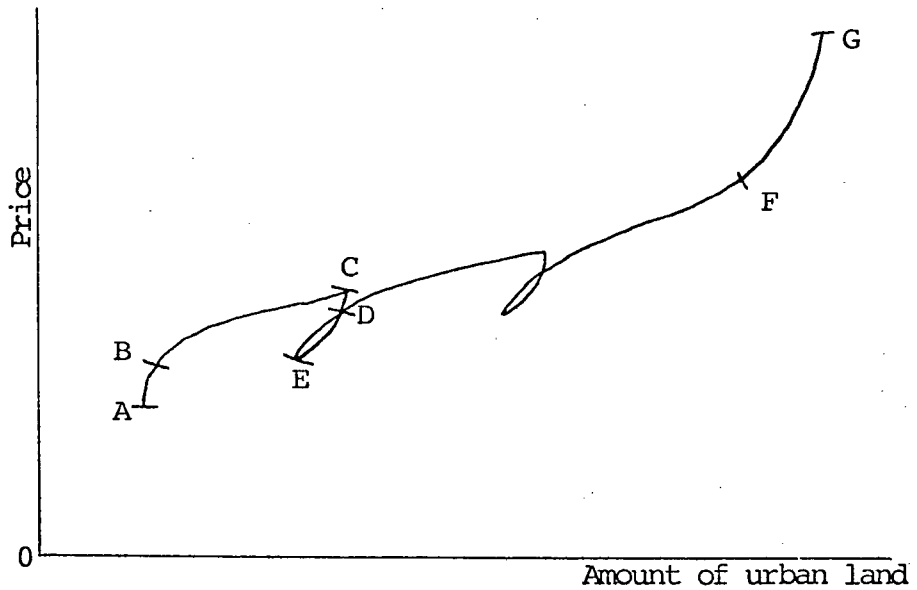
The special significance of Lean's theoretical contribution beyond the context of this investigation but in reference to the planning problem addressed in the introductory chapter, is his incorporation of the 'economics of property' in a work on the 'economics of planning'. Lean's analysis could thus be said to represent the state of economic understanding of land prices by planners at the time of his writing.

Arthur P. Becker (1969) offered a very tangible and special interpretation of changing land prices that is quite different in its conclusions or implications than those of Pennance or Muth. Becker described a "ratchet effect" in the land market that resulted from the fluctuating growth and decline in demand for urban land. With reference to the figure below, he argued as follows.

> If a rising demand for urban land due to a growing population and economic base of an urban area is assumed, the price of land will rise. Physical, technical, and legal problems will permit a very small response immediately and only a little more in the short run, which will reflect a price inelasticity in the first stages of the price rise (AB in Figure 1.1). If the higher price remains steady or increases further for a long enough period, however, it will be possible to convert fringe farm

land into urban land and to build vertically on land already in urban use. Thus, the long-run supply of urban land is elastic in the face of a price rise (AC), assuming no political or physical barriers.

Now if the demand for urban land declines in an urban area because of a population loss, weakening of its economic base, higher taxes, or interest, the price of land will fall. The response (in terms of the supply of urban land) to this price fall will be negligible at first (CD) and slow and small over a protracted period of time (CE). Thus, a decrease in the supply of urban land will be inelastic in the short run and only a little less so in the long run. (1969: 18-19)



AB = short-run response to rising demand.
AC = long-run response to rising demand.
CD = short-run response to falling demand.
CE = long-run response to falling demand.
FG = long-run response to rising or falling demand where rural fringe is unavailable or is a poor substitute because of zoning, inaccessibility, and so on.

Figure 1.1. The Supply of Urban Land

Becker concluded this short treatment as follows:

> Over the long run, then, the supply of urban land tends to be inelastic with a price decline and elastic with a price rise. (1969: 19)

What Becker does not show in his diagram, or make explicit in his brief discussion, are the supply and demand schedules. The 'ratchet-like' effect depicted in the diagram results from the shifting over time of these schedules as well as movements or changes in position on these schedules. Becker's discussion will not be treated any further for it has been introduced here simply to indicate one of the earlier expressions of concern for the disequilibrium aspects of the land market.

Another perspective on the urban land ratchet was provided by Wallace F. Smith (1970). In his view, in times when the demand for buildings rises, property values will increase.

> Since the increase in demand must be met initially from the existing supply of buildings, the price of such buildings and their rents must rise, often taking the form of decreased space per user and falling physical standards. (1970: 70-71)

In such a situation, for example, in a period of housing shortage,

> ... housing developers wishing to satisfy the intensified demand for housing can only acquire "land" -- with or without buildings -- by paying the inflated prices for property in this market ... (that is) land cannot be acquired from willing sellers save by paying the escalated price. Once that price is paid, the capital structure of the new building demands a rent level which is no improvement upon the escalated level. (1969: 71)

The conclusion on this matter provided by Smith is that

> ... a ratchet effect may come into existence, with prices going up in periods of scarcity but not falling when the increase in demand levels off. (1970: 71)

Such a result is by no means inevitable. It is a market failure contingent upon several factors. Smith does not discuss these. He appears to ignore the further price adjustments that will likely follow the quantity adjustment brought about by reduced demand. Yet Smith, like Becker, identifies a potential imperfection in the land market, namely the lag it takes for supply to adapt to changing demand. The consequence of this imperfection may be to impose higher costs upon property users, during the period of supply adjustment, than if adjustment was nearly instantaneous.

Smith's text in its entirety is of considerable significance. It is prefaced with the remark that it is

> ... an introduction to economic reasoning for people who are concerned about housing, and it is an introduction to housing issues for people who are trained in economics. Its double premise is that economics is too narrowly understood by most of those who think and argue and write about housing today, and that housing is a more complex commodity than most economists realize. (1970: xi)

He warns however that it is not an econometric undertaking, for the parameters that emerge are functional ones rather than quantitative relationships.

With respect to builder behavior in the residential land market, Smith offers some useful observations. He first represents the 'developer' as

> ... a producer of a commodity for sale. He formulates a plan, assembles resources, manages the transformation of these resources into a product -- new housing -- and sells that product. His own inputs are his knowledge of the "market", skill in business and legal matters related to the production of housing, knowledge of housing technology and design in a broad sense, and a willingness to bear the risk that his efforts may yield less than was

> expected. In addition, he may supply some circulating capital. (1970: 208)

He further identifies different kinds of developers, with special emphasis on the "speculative" developer,

> ... who undertakes the construction of new housing in anticipation of a market for it, a market of users or investors, or both. Thus, the developer owns the product while it is being created, much as an appliance manufacturer owns refrigerators on the assembly line and in the distribution channels. (1970: 271)

Smith then considers the profitability of development. An especially useful point is made in the following discussion about the return to development. In this regard we might recall Turvey's and Milgram's approach to this matter. Turvey used the total value of the property produced as the base for calculating the builder's return. Smith suggests that only the inputs provided by the builder form part of that base.

> Most of the possible forms of developer gain might be translated into the difference between value of the completed property and the sum of all land and development costs. It is reasonable to suppose that the typical entrepreneur wishes to maximize this difference, that is, to develop the property in such a way that per unit of his own resources committed to it the maximum equity value is created. This criterion requires amplification on two counts. First, it must be emphasized that it is the developer's inputs only which serve as the base for measuring profitability, and only the equity in the completed property which is measured against that base. Total costs and total property value are not directly relevant, nor is their difference. The developer's inputs may include some financing but the most significant input cost will probably be the developer's own entrepreneurial skills and knowledge -- his capacity to make decisions concerning the property in such a way that his own interests are served.

> The second point concerns the measurement of those costs of "management". Clearly, the time dimension must be borne in mind, for a project which takes two years to complete and yields a gain equivalent to $100,000 may be less attractive to a developer than a one-year project producing a gain of $75,000, assuming that other developer inputs would be the same and that both projects would require the maximum available effort of the developer. (1970: 269, 271)

Finally, Smith observes that the developer's actual earnings from a particular undertaking depend partly upon the price paid for land. This price will be related to land's residual value,

> ... residual value being defined as the difference between the market value of the completed property and the cost of the improvement. Thus, if a building which costs $75,000 to construct results in a property with a market value of $100,000, the residual value of the land so used is $25,000. (1970: 289)

Smith implied in his earlier comments, however, that the residual value of land which determines the builder's bid is the residual 'after' he has deducted his desired profit from the total value of the completed property along with the other costs of development. Smith also might have noted that the realized or actual developer's profit finally depends not only on the price paid for land and the development costs incurred, but also on the selling price which is eventually obtained for the completed project.

A highly pertinent model of land valuation was developed by Howard Clonts, Jr. (1970). Although his empirical study was centrally concerned with the effect of land use transition on prices at the urban periphery, it contains a relevant 'income expectations' model of land value determination.

> The basic form of the income expectations approach for determination of land value may be used to

> estimate property values at the urban periphery. Theoretically, this approach assumes the value of a property is equal to the present value of all its future income. The mathematical equation for this approach is the summation of the capitalized value of the income expected from the land each year, continuing to perpetuity, ... (1970: 490).

This equation takes the familiar form found in Barlowe's discussion. Clonts next proceeds to develop an equation that is applicable in the case where land in rural use is expected to be converted immediately into another use.

> The equation to estimate present value under these conditions takes the (reduced) form:

$$V = \frac{A}{i_a} + \frac{C_c}{(1 + i_c)^t} .$$

where:

- V = present value
- A = average annual income expected from rural use
- C_e = expected capital gains
- i_a = discount rate for capital gains (C_e)
- t = number of years over which income (A) is expected to continue before capital gains are received. (1970: 491).

In this situation capital gain represents the present value of the additional income from the new use over and above the perpetual income of the original use. Yet another form can be provided for this equation:

$$V = \frac{A}{i_a} + \frac{\left(S_t - \frac{A}{i_a} \right)}{(1+i_c)^t}$$

where S_t is the sale value of land in (t) years, and i_c is the discount rate for adjusted sale price.

The special significance of Clonts' formulation for this review lies in its applicability to the potential vendor of land, the one who sells to a builder. The formulae so far reviewed have applied to the buyer of land who will be actively using the land.

Also completed in 1970 was an empirical study of 'price movements in undeveloped land facing urbanization', a subject little different from the one treated by Clonts. Stanley W. Hamilton, in an unpublished doctoral dissertation, sought

> ... to explain the trend in values in undeveloped lands by reference to those variables which are considered as influencing expected values at the time of development and the risk-adjusted discount rates applicable. (1970: 69)

The variables which Hamilton uncovered in the literature included population growth, income level changes, changes in the supply of undeveloped land, new public expenditures and the prevailing level of interest rates. Hamilton found significant contributions had previously been made in this regard by Maisel, Gottlieb, and Milgram, but he judged that causal relationships had yet to be fully explained. He also took strong exception to some of the assumptions made in some of those studies. In particular, Clawson and Milgram were viewed as having failed "to recognize that investors and developers do not set the final price for land. The price of land is determined by the final use, the final demand for the developed property" (1970: 53). Hamilton employed in his theoretical analysis an income capitalization model not too dissimilar from Milgram's. It is interesting to see Hamilton's minor reservation about the use of such a model.

> Traditionally, writers assumed the value of undeveloped land was determined as the present worth of expected future benefits derived from the land at the time of development. Writers such as Wendt, Ratcliff, Clawson and Maisel employed present value models to explain the value generating process. While no reason exists for assuming landowners consciously adopt this model, it appears justifiable to state buyers and sellers "act as if" they use this approach. (1970: 55)

Hamilton correctly observes that no evidence has ever been obtained that participants in the land market actually use the income capitalization approach.

The actual formulation of the model employed by Hamilton is the following one:

$$PW = E\ (V_t)\ e^{-rt}$$

where PW is the present worth of a parcel of land, $E(V_t)$, is its expected value at the time of development (t), and r is the discount rate. Hamilton attached considerable importance to the role of expectations.

> Landowners face an uncertain market. ... The uncertainty ... makes forecasting in this market hazardous. ... (it) results in varying expectations as to future land values. This uncertainty, more than any monopolistic powers which might exist, results in price changes which appear unwarranted from a social viewpoint. (1970: 54-55)

This is related to the 'land ratchet' discussed earlier, where an unwarranted stickiness in land prices is observed when they should be seen to decline. Hamilton's theoretical analysis does not add anything of significance to the state of thinking but his empirical study, reviewed later, is of considerable interest.

Marion Clawson, in a second work (1971), addressed far more comprehensively than in his earlier article the subject of suburban land market operations. First, we note Clawson's statement about the

theory of rent.

> ... on the basis of generally accepted economic theory of rent, ... rent is, in effect a residual -- inputs other than land must be paid for at some incentive or alternative opportunity price, whereas land requires no incentive to be made to produce and ... (thus) residual income above other costs accrues to the owner of the land. (1971:117)

Clawson then seeks to demonstrate that this simple theory of rent is not adequate for the suburban land market. A major reason is the cost of land-ownership such as property taxes and other holding costs. The interest which could be earned by investing elsewhere the money that was invested in the land represents another strong influence on the land-owner. If residual value and capitalization were the only factors to be considered in land price determination then the theory of rent would apply. The theory assumes

> that workers or the producers of other inputs must be rewarded for their efforts and that their labor or materials would not be forthcoming otherwise. This puts the bulk of the fluctuation in demand for the output (housing or improved lots) upon the price of the land (whether improved or raw). (1971: 119)

Consequently, Clawson proceeds,

> one would expect the prices of such land to vary widely in response to variations in the volume of housing (annually or for other moderately short periods of time). (Furthermore) one would not expect the quantities of raw land drawn into the development process to change much more than proportionately to changes in the total volume of new housing ... (1971: 120)

Clawson judges that 'even a casual acquaintance with the suburban land market is enough to reveal that these expectations aren't borne out'. Hence it seems clear to Clawson that other factors are at work to modify

the theorized relationships. However, 'the fact that other factors must be considered does not invalidate the rent theory. It simply says that the theory is insufficient by itself.' Therefore,

> In order to provide a more nearly complete explanation of the market for raw suburban land, we must consider the structure of that market, and how the various operators in it actually react. (1971: 124)

Clawson did consider several aspects of the market's structure -- the absence of an organized market, the lack of information, the heterogeneity in land parcels, the limited amount of transactions. The presence of reservation prices drew considerable attention.

> It seems fairly clear that the suburban land holder has a reservation price, below which he will not sell his land. It may be hard to ascertain just what this reservation price is; even the owner may not know until he has a firm offer in hand and time in which to think it over. The typical suburban landholder expects the price of his land to rise over time. ... The owner always has the option to hold his hand as well as to sell it if an offer is made by someone. Holding land is far from costless, if he takes account of his alternative opportunities; but his cash costs of holding are relatively low. Few suburban landholders are sensitive to short-run downward fluctuations in demand for their land. If housing demand is down, and thus what the developer could reasonably pay for raw land is down, most landholders will not accept a lower price but will simply hold for the day when they can get their price. It is the volume of sales which fluctuates in response to changes in demand, not the price of raw suburban land. A few landholders, it is true, may be overextended, having used short-run credit for land speculation, and they may be shaken out if demand for land is down. But the average suburban landholder is able to weather such periods of reduced demand. On the other hand, he may well respond to short-run increases in

> demand for housing and for buildable land by selling at what he considers is a good price. (1971: 125)

Clawson then originates the extremely useful notion that while land may not need a return its owner does.

> It was noted earlier that the accepted rent doctrine emphasized that land as a factor of production does not have to be rewarded in order to be used, that land tends to be the residual claimant of income after other inputs have been paid at their alternative use prices. This theory implicitly assumes the land will be used as long as rent is positive. We may amend this statement, for suburban land, to say that land may not need to be rewarded but the landowners must be. Suburban land need not be "used"; it may be appreciating in value as fast if idle as if used. As long as the landholder has a reservation price, which he has a reasonable expectation of achieving at some future date, he will not sell unless his price is met. In the past 20 years, prices of raw suburban land have reflected landowners' reservation prices far more than they have reflected year-to-year variations in demand for that land. (1971: 126)

In this phenomenon lies the origin of the ratchet effect, according to Clawson.

> It should be clearer now why suburban land prices tend to ratchet upward. Landowners have reservation prices, below which they will not sell, but they are prepared to take advantages of higher prices. Developers will pay higher prices, perhaps reluctantly, rather than cease to operate, especially during periods of high demand for housing. The pressures are all upward, with no effective pressure leading to a reduction in land price. The uncertainty lies in how rapidly the upward pressures will be effective. (1971: 126)

Clawson's analysis is more clearly and strongly stated than Smith's. It also presents a forceful set of propositions running counter to those

offered by Pennance (1969), Hamilton (1970) and others. This contrarity of views is also likely to confuse anyone seeking a better understanding of the causes and processes by which land prices change over time.

The importance of a better understanding is signified in the social problems which analyses like Clawson's assist to define. For example, Clawson finds that the various factors at work in the suburban land market result in socially and economically undesirable consequences which are inevitable given the structure of the market.

> The market tends to push up the price of raw land dollar by dollar as more and more speculation occurs, to levels beyond those explainable in terms of alternative use values of the land plus costs of development. The home buyer, of course, must buy the whole package, including the lot on which his house is built. If the lot price inches up, the kind of house that can profitably be built on it rises even faster, since the cost of the site is only a fifth or a fourth of the total sales price of the finished house. The climb in the cost of suburban housing that comes from rising land costs thus helps to price it out of the reach of low-income families. (1971: 140)

Some doubts about these assertions are inevitable without a firmer theoretical and empirical basis supporting them.

Further understanding of the supply side of the land market is offered by Shoup (1970). He begins with a simple model of the value of land to the developer or investor. If there are no holding costs or interim revenues preceding the time of development,

> the present value (at time t) of the land, P(t, T), for any future development date, T, is given by the formula
>
> $$P(t, T) = V(T).e^{-r(T-t)}, \quad t < T$$
>
> where r is the (instantaneous) rate of discount applicable in the real estate market. (1970: 37)

To maximize the present value with respect to a given date of development, the relationship between present value of development, V(T) should be related to future development value, V'(T), as follows.

$$\frac{V'(T)}{V(T)} = r.$$

> Thus, the land should be developed when the rate of increase of the development value, V(T), of the bare site equals the discount rate...(1970: 37).

Shoup draws the following conclusion.

> the rate of increase in the capitalized value of the land is
>
> $$\frac{P'_t(t, T_o)}{P(t, T_o)} = r, \quad t < T_o.$$
>
> This implies that, with unchanged expectations, we should expect unused land awaiting development to a higher use to appreciate at a rate equal to the interest rate at which future values are capitalized in the real estate market. (1970: 38).

Shoup modifies this result to take into account the effect of property taxes levied on land as a fixed proportion of its market value, and the effect of revenue from an interim use. The present value of the land at any time prior to development will be determined accordingly. In such a circumstance the rate of price appreciation is

$$\frac{P'(t, T_o)}{P(t, T_o)} = r + a - \frac{A(t, T_o)}{P(t, T_o)}, \quad t < T_o.$$

> That is, the rate of appreciation of land awaiting development to a higher use is the sum of the interest rate and the tax rate, minus the rate of return earned in any interim use in that period. This result follows strictly from the assumption that the value of the land is determined by capitalization of future returns. (1970: 41)

In this context, Shoup refers to the study by Adams, et al (1968), which examined this phenomenon. It was found that vacant land

awaiting urbanization appreciated at a rate of 9.7 per cent per year between 1954 and 1962, but real estate taxes reduced this return to 7.7 per cent, judged by the authors to represent a normal rate of return 'considering the risk, illiquidity, and transaction costs involved in land development'.

Shoup's contribution is to show, as suggested by Clawson, that land owners require a return, even though the land may not. Shoup also importantly demonstrated that

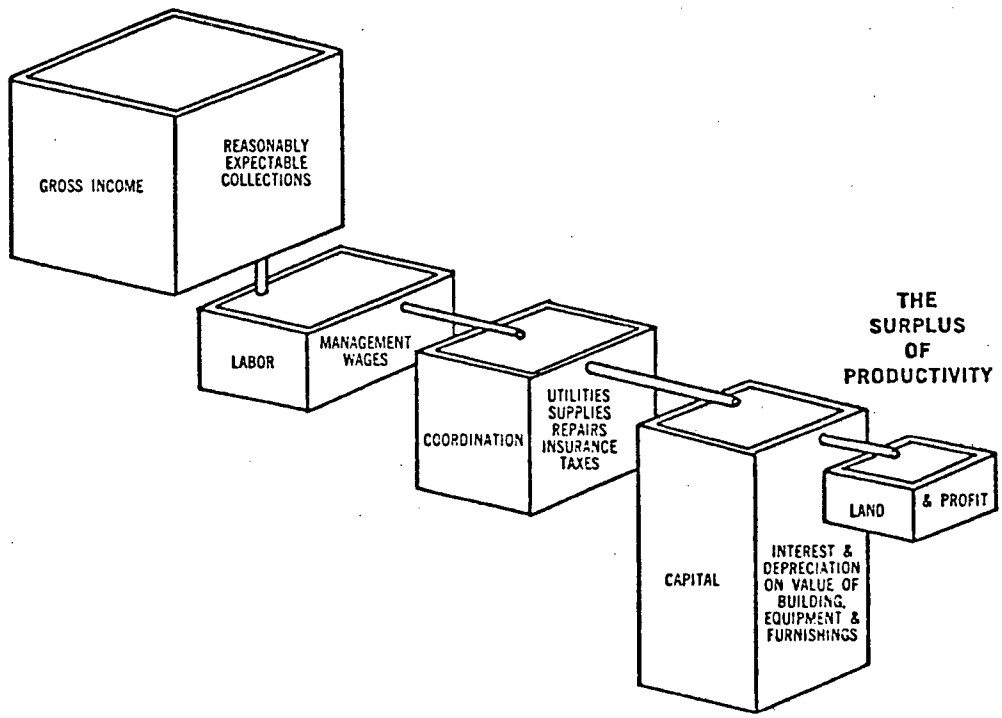
> ... the mere presence of rises in the value of land awaiting development to a higher use should not automatically be interpreted as speculative gains, rather, an increase in the value of such land is inherent in the process of capitalization. More properly only "windfall" changes in the value of land, which arise from imperfectly foreseen events that affect future development potential, should be considered speculative gains. (1970: 43-44)

A similar analysis Shoup's, was later provided by Capozza (1974). Not examined very closely, it might be summarized in the following conclusion.

> Given the rate of appreciation of the developed land, ..., speculators with perfect foresight will bid up the price of land until appreciation is equal to holding costs. That is, if land is rising rapidly in price, speculators can make capital gains by buying and holding until appreciation plus rental from undeveloped ... use no longer offset interest expenses ... and taxes. If a sufficient number of speculators are active in the market, prices will rise to the point where the current rentals plus appreciation, minus taxes afford only a normal rate of return on capital. ... Present value is maximized when the land is held until appreciation of the developed value is equal to interest plus taxes, minus undeveloped rentals. (1974: 416)

The emphasis by Shoup and Capozza is on the supply side of the land market. Very little attention is given to behavior on the demand side of the market, as in the works by Ratcliff (1949) and Turvey (1957). The 'principle of surplus productivity', as articulated in a manual of the International Association of Assessing Officers (1974), reflects a conventional view of the demand side. This simple principle asserts that some combination of factors or agents will achieve the highest value for land and, with reference to the illustration below,

> The costs of these agents must be satisfied in the order named, from the income of the property. Labor costs must be satisfied first, coordination second and capital third; whatever income is left then goes to land. As a result, it can be said that the land is valuable according



> to the surplus productivity imputable to it. (1974: 14-15).

Profit and land are shown in the same receptacle on the assumption that the entrepreneur owns the land. Before he buys the land and begins the project, he must deduct his desired profit to determine how much he can pay for land. Alternatively, he might deduct the asking prices for land to see how much profit is possible. Typically however, land is the final cost to be determined but it is the first that is incurred. Profit is whatever is left over at the finish and sale of the project.

A more vigorous definition of this principle and some indication of its application is to be found in any number of real estate appraisal textbooks. One good example is Paul F. Wendt's discussion of the "residual approach to valuation" in his appraisal text.

> In the so-called land-residual method, the appraiser assumes that the building has a value based upon its replacement cost and assigns returns to the building by applying a selected capitalization rate to the replacement (or construction) cost of the building. These returns subtracted from (expected) total net income to the property yield residual returns to the land, which are capitalized as a perpetuity to yield land value. (1974: 154)

Wendt cautioned however that while the land-residual technique has applicability in determining the use and value of vacant land, "the method must be used with extreme care because of the large differences in land value which may result in small changes in estimated total income to land and building combined," (1974: 157-158). This is especially the case when land makes up a very relatively small component of the total development cost of the property.

In 1974 and 1975, Hamilton published a number of studies which offered a far more comprehensive view of land market operations than his more limited earlier endeavor. In the following statement, he offers a tangible illustration of the 'principle of surplus productivity',

though he didn't refer to it as such.

> Assume in year one, a developer decides that the optimal house to build is one which will sell for $40,000. Building costs are estimated to be $29,000 and the developer expects to receive a profit of $1,000. Therefore, the developer can afford to bid up to $10,000 for the lot, which is assumed to be sufficient to acquire the number of lots required. In year two house prices have increased by 10 per cent to $44,000. At the same time, building costs have increased by 5 per cent to $31,500, including the developer's profit of $1,000. In the second year, the developer can afford to pay $12,500 maximum to acquire the land, but this represents a 25 per cent increase in land values.

	Year 1	Year 2	% change
House price	$40,000	$44,000	10%
Building Costs & Profit	30,000	31,500	5%
Maximum Land Price	10,000	12,500	25%

> As may be seen from the above illustration, land prices ought to change proportionately more than housing prices, given the leverage created by a smaller change in building costs. Only in the case when building costs increased at the same rate as housing prices, all other factors assumed constant, would land prices increase by the same amount. (1974: 5-6)

Hamilton notes that "even if the developer managed to acquire land for less than $10,000, he would have no incentive to sell for less than $40,000. The 'savings' on the acquisition of land would merely increase developers profit" (1974: 6). At a broader level he echoes propositions presented earlier by Ratcliff and Pennance.

> A developer looks to the current level of prices (standing stock) and in the light of current building costs simply decides whether they can profitably develop at the land price they must pay for suitable building lots. ... Land prices are

> determined by house prices rather than the other way around. (1974: 5).

He therefore takes issue with those scholars who would reverse this thinking, such as Schmid (1970), whose empirical work is reviewed in the following section. Schmid's contrary view is expressed in this way:

> A valid argument can be made that this land price increase is partly responsible for difficulties in selling new homes. It is the price of land which determines the sales price of units to be built. An average $4,567 lot would most likely mean a home selling for $22,500-$25,000. ... So the increase in the cost of land is a factor in pricing much of the public out of the (housing) market. (1970: 3-4).

It could be suggested however that these apparent differences of opinion are simply due to differences in the type of land market being studied, or in different assumptions about the conditions that prevail in land markets. Hamilton, like Pennance, appears to adopt a rigidly 'classical' approach by assuming a market in equilibrium where current prices are what matter, as well as current costs, in determining the level of production in the next period. Perhaps this assumption is simply a convenience for Hamilton did acknowledge in his earlier work (1970) the role of expectations. Even in the present analysis he noted that "land owners' expectations are influenced by other than current housing prices. ... (their) expectations concerning future house prices, and the supply of competitive land, may be such that they expect to gain more by withholding now and selling later. If the costs of withholding (opportunity costs and out-of-pocket costs) are less than the expected increase in land prices, land owners will withhold". (1974: 5-6)

In a review of the operation of real property markets with David Baxter, Hamilton presented a more complete and definitive expression of this theory (1975: 4-14). Beginning with a description of

the relationship between the 'stock' of existing housing and the 'flow' of new units, they then proceed to describe housing development in the following manner.

Figure 3: LAND DEVELOPMENT PROCESS

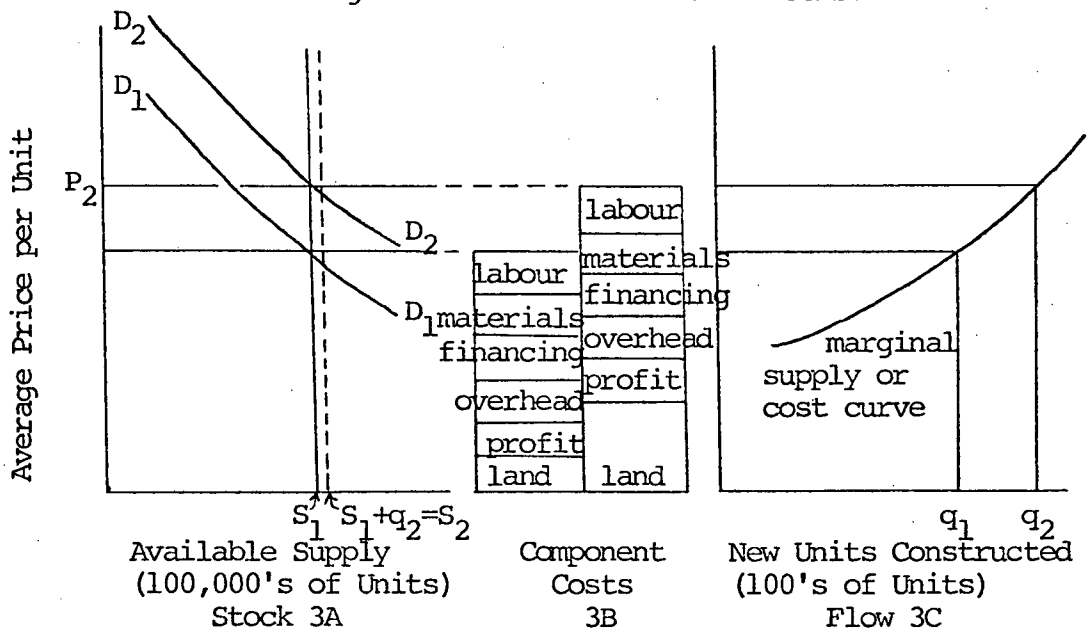


Figure 3 provides an illustration of the relationship between the market prices for finished realty and the market for land. An individual developer will take the (prevailing) market price of existing units (in any given location) and based upon this price, determine his bid price for raw land. Given the expected sales price of a new unit (determined from the price of existing comparable units), the developer subtracts his construction costs, financing costs, overhead, and required or desired profit to arrive at a bid price for land (Figure 3-B). Competition for labor, materials and financing will establish a market price for each of these. Similarly, competition amongst builders for labor, material and land will keep developers' profit at a reasonable level. Developers, having

completed such an analysis, will bid for land. If land is forthcoming at those bid prices, new units will be added to the stock (Figure 3-C).

The lower the price paid by a developer for any one of the five inputs to the production process, the greater the profits when the units are sold at the prevailing market price. However, competition for inputs sets the market price for each of these. Individual developers, through their competition in the various input markets, must act as price takers for the collectively determined prices. They do not exercise any oligopolistic control in either resource or sales markets. As the market price of property increases, assuming constant prices for labour, materials, financing and overhead, developers will bid up the price of land and hence, their profits will be maintained at a normal level. Similarly, as the demand for housing drops as the result of high mortgage interest rates and scarcity of funds, the price of housing stabilizes: given the increased cost of interim financing, developers must reduce their bids for land.

Important consequences follow from the operation of the price mechanism to determine the price and number of units added to the stock of real property. The most important conclusion to be drawn is that none of the costs of development or construction can materially effect the current level of prices for developed properties (e.g., housing). Developers look to the current level of prices and, given the current costs of subdivision and building simply decide whether or not they can profitably develop. The current cost of land, labour, materials, financing, overhead or developer's expected profits do not effect the price of the finished realty: they determine the rate at which new units are added to the stock at the current level of prices. Only slowly over time, as new construction occurs and the standing stock increases <u>relative</u> to demand will prices decline.

> A second consequence of this stock-flow relationship is its influence on the interaction between market values of usable real property (i.e. the value derived from both the investment and the flow of services produced by the real property) and the price paid for land suitable for development. Because the costs of materials, labour, financing, overhead and developers' expectations of profits are determined not only through competition amongst developers, but also by competition between the real property market and other uses for these resources, the price of land is a residual price derived from the prevailing market prices for real property. (1974: 7-8)

In this statement Hamilton and Baxter appear to offer a fairly complete model which addresses the central topic of this thesis, namely, the process by which residential land prices are determined, how these prices change over time, and how they influence or are influenced by house prices. It is characterized by strong assumptions of static equilibrium and perfect competition in land and housing markets.

The usefulness of this model appears to be severely restricted by these assumptions. Only when empirical conditions conform to the assumptions will the model offer a workable description of markets. The conformity between empirical conditions and theoretical ones is not treated by Hamilton and Baxter. This is a characteristic of several other works but it becomes most significant when the proposed explanation of market operations is based upon 'classical' assumptions.

Robert L. Bish and Hugh O. Nourse (1975) conducted an examination of the spatial pattern of cities which included a discussion

of the operation of property markets. They indicate that their understanding of urban property values is derived from Ralph Turvey's analysis.

An especially useful and indeed critical observation made by them is that "... land price is more often a decision variable than an actual transaction price..." (1975: 95). This point has rarely been made, and certainly not in any direct way, in the literature. What it says is that the prices observed in the land market are not necessarily the prices that buyers and sellers might have preferred given their calculations. Earlier in this review, the terms 'bid price' and 'reservation price' were used to denote these preferred prices for buyers and sellers respectively. Bish and Nourse, utilizing a different terminology, present a detailed exposition of the nature of market price. (1975: 80-81)

> There are two prices for the rights to any property -- a ceiling price and a floor price. The ceiling price is the maximum that a buyer will pay for a particular right. The floor price is the minimum that the holder will take to give up his rights. The actual selling price for any right must lie between these prices as long as the ceiling price is higher -- otherwise no exchange will take place.
>
> The ceiling price is the present discounted value of the earnings expected from use of the property.

$$V = \sum_{i=1}^{n} \left[\frac{-C_i}{(1+r)^i} + \frac{(R_i - O_i)}{(1+r)^i} \right]$$

where
- V = ceiling price of property.
- n = life of property, or investment period within which capital is to be recaptured.
- R_i = receipts, which include rents received and expected value of property when sold in n years.
- O_i = maintenance costs, taxes, insurance, and provision of services. Depreciation is not included.

r = the opportunity cost of capital, the rate of return on alternative, equally risky investments.

An illustration may help explain the formula. Consider the following case. It takes one year to build an improvement, and all payments for its construction are made at the end of the first year. Construction costs $100,000. Annual receipts from rental will be $40,000 and operating costs including maintenance, insurance, and taxes will be $30,000. The opportunity cost of capital is 6 per cent. The above figures, of course, are expected values, and are expected to remain the same over the forty-year life of the building. No scrap value is expected.

$$V = -\frac{100,000}{(1.06)} + \frac{10,000}{(1.06)^2} + \frac{10,000}{(1.06)^3} + \cdots \frac{10,000}{(1.06)^{40}}$$

$$= -94,300 + 140,570$$

$$= \$46,270$$

The ceiling price is the maximum amount that the investor would be willing to pay for the bare site. If there were a building already on it, he would have to include, in the cost of construction, the cost of demolishing the old building and preparing the site for constructing the new building. If a building desired by the buyer was already on the site and suitable for use, then the ceiling price would be for the rights in the property and the cost of construction would be zero. The floor price is determined in the same way, except that it includes the cost of moving from the site plus the present value of alternative properties that will serve the purpose of the present occupant of the property. (1975: 80-81)

Having defined and illustrated the concepts of ceiling and floor price, and having noted the role of interest rates and construction costs as well as the way that land value is estimated, Bish and Nourse then put all of the elements together to show how market prices are

established.

> For a particular urban area, divide the area into land parcels, or sites, on which there may or may not be buildings. Each user would be able to indicate a ceiling price for each and every parcel. Occupants, of course, would have floor prices, but would also bid ceiling prices on all other parcels. Those users bidding the highest price for a parcel would obtain it. If parcels change hands, the exchange is a result of a transaction between individuals and will only occur if the buyer believes that he is gaining more than the money given up, and the seller believes that he is gaining more in price than the expected value of holding ownership on the parcel. Thus, although the language used in explaining the market appears to discuss only demand, there are supply prices -- the floor prices of those occupying parcels and the ceiling prices of all bidding on the parcel are all opportunity costs to the eventual owner of a parcel.
>
> One way of envisioning the urban-property market is to draw up a table listing parcels of property across the top as headings to each column, as in Table 4-1. The rows are labeled for each of the bidders on property. Across each row we could insert the ceiling prices that each user, say user one in row one, would bid for each parcel in the area during some specified time period. If the user occupies a site, the bid on that site will be a floor price. Floor prices are shown in parentheses in the table. The highest relevant bid on each parcel is indicated by an underline. For example, user one in this time period occupies parcel six for which his floor price is $7, while that same user would be willing to pay a ceiling price of $10 on parcel five. Since the current occupant is user eight and his floor price is $5 and he will be willing to pay a ceiling price of $10 for parcel six, the two will benefit from exchanging places.

Occupants in parcels two, three, and four have floor prices that prevent anyone else from buying those sites in this time period. Users five, six, and seven, however, would be better off with a three-way trade. User five occupies parcel eight, but will be the highest bidder on parcel one, and user seven will be the highest bidder on parcel seven. User six, like the poor, gets what is left over. Parcel seven is bid away, and user six has the highest bid on parcel eight. Why should that be, since user eight's ceiling price is only $3, which is obviously less than many other bids on that parcel? The reason is that the higher bids on parcel eight are made by persons with still higher bids on other parcels for which theirs was the highest bid. Thus $3 is the highest relevant bid. Parcels three and four are not occupied by the highest bidder for the same reason.

The final market prices are the highest relevant bids on each parcel, since everyone would be better off if he made the trades indicated. Thus, the underlined prices in Table 4-1 are the resulting market prices in this time period. (1975: 84-85)

Table 4-1 Demand Matrix of Price Bids, Urban Property Markets*

	Parcels							
Users	1	2	3	4	5	6	7	8
1	$5	$2	$1	$4	$10	$(7)	$1	$2
2	9	5	(7)	4	8	7	2	6
3	8	(10)	3	9	1	6	4	3
4	3	5	6	(8)	4	1	4	7
5	10	3	6	2	5	3	8	7
6	5	2	1	4	4	5	(3)	3
7	(5)	7	6	6	2	8	10	4
8	6	2	8	1	(5)	10	2	9

*Parentheses indicate floor prices by occupant of parcel. Underlined prices are the highest prices offered for a parcel and indicate market price.

Bish and Nourse proceed from this point to discuss the spatial equilibrium in urban land use and related subjects, of no immediate relevance to our topic. An interesting observation raised by them is the difficulty posed for empirical investigation by the notion that market prices may be neither the ceiling prices calculated by potential buyers nor the floor prices calculated by owners and potential vendors. Instead, market prices lie somewhere in between as a result of negotiations. This would make it difficult to empirically examine the land price behavior of buyers and sellers for all that can be objectively observed is the end result of their interaction.

If Bish and Nourse gave considerable attention to the interaction and adjustments between the suppliers and demanders of residential land, it is attention to the equilibrium aspects of the residential land market that characterizes Ann Dryden Witte's derived demand model for the determination of residential site prices. Witte (1975) sought to understand 'the factors which determine the cost of sites for housing construction'. On the basis of the work by Maisel, Gottlieb, Muth, and others, she specifies the following model.

> The price of building sites is a function of the supply and demand for these sites,
>
> (1) $$P_S = f(Q_D{}^S, Q_S{}^S)$$
>
> where P_S = price of sites,
> $Q_D{}^S$ = quantity of sites demanded, and
> Q_S = quantity of sites supplied.
>
> The demand for sites, in accordance with a derived demand model, is a function of the demand for housing services and the supply of inputs other than sites necessary to provide housing,
>
> (2) $$Q_D{}^S = g(Q_D{}^h, Q_S{}^c)$$

where Q_D^H = quantity of new housing services demanded and
Q_S^c = quantity of other inputs supplied.
Substituting Equation (2) into Equation (1), one obtains

$$P_s = H(Q_D^h, Q_S^c, Q^s) \quad (3)$$

According to the above model, differences in the price of residential sites among urban areas may occur because of differences in demand for housing, differences in supply of other inputs, or differences in the supply of residential sites. (1975: 353)

The dependent variables, Q_D^h, Q_S^c, and Q_S^s, are then further specified in terms of the many variables which influence them. Substituting these many variables into equation (3) yields this equation,

$$P_s = n(\Delta HH, \Delta HH_t, Y, Y_d, \Delta Y, E, E_L, A, P_{cmp}, T, EX_p, P_{sub}, H, H_c, P_m, P_k, P_L, P_{e\&0}, P_{rl}, P_i, SS),$$

where
ΔHH = change in the number of households,
ΔHHr = change in the type of households,
Y = average level of income,
Yd = distribution of income,
ΔY = rate of change in the average level of income,
E = pattern or employment,
El = level of emplyment,
A = level of liquid assets and housing equities held by the population,
P_{cmp} = price of goods that are complimentary to housing, i.e., mortgage costs, hazard insurance, heating, etc.,
T = a measure of the housing preferences of the population,
EXp = a measure of the population expectation of future prices and incomes,
Psub = relative price of goods which are close substitutes for single damily housing, i.e., apartments,
H = measure of the sufficiency of the existing housing stock,
Hc = measure of the condition of the existing housing stock,
Pm = price of materials,
Pk = price of capital equipment,
Pl = price of labor,
Pe&o = price of entrepreneurship and organization,
Prl = price of raw land available for residential development,
Pi = price of improvements, and
ss = size of site. (1975: 355)

This last equation constitutes the 'reduced form' of Witte's model. Unlike Muth's analytic model for example, no implications are derived by Witte from her model. Her sole interest lies in identifying the association of various factors with the price of sites and she undertook a valuable empirical study in this regard. Insofar as her model is concerned, it represents a slightly more sophisticated attempt than those of Maisel and Gottlieb to describe the structure of the residential land market. Its weakness lies in lacking a behavioral content which would say something about the process or mechanism by which that long list of independent variables really affects land price.

David M. Nowlan (1976, 1977) offered some additional considerations on the determination of land prices. Nowlan addresses the issue of the private market's ability to efficiently allocate resources in land. His model of land market operations is brief and though no explicit references are made it is based upon several core propositions that have repeatedly appeared in the literature thus far. The capitalization of expected future net income to land plays a central role in Nowlan's description of land value determination as it has in most other arguments.

Something which had a bearing on this study is his observation that of the two important functions of the land market -- the allocation of land uses over space and the transition in land uses over time -- the first is much better understood than the second. The reason for this, he says, is

> the inordinate focus in analytical literature on timeless, long-run equilibrium situations. Once the focus is shifted from this timeless equilibrium, a whole new world is opened up, one with shifting land uses, moving land values and changing impacts of public decisions on surplus value. This is the real world, where policy actually has to be

> made, and where the simple-minded concepts of site value, or public versus private value, come to grief. (1976: 16)

Or as Oxley (1975) remarked, 'in the real world disequilibrium is the rule, not equilibrium'. Clearly if the land market's failures or undesirable consequences arise out of disequilibrium situations, an 'equilibrium economics' has limited application as a description or explanation of the world that is. Instead it can only be a gauge against which the nature and consequences of disequilibrium can be measured. On such grounds the classical formulations and premises of several theoretical models examined so far should be so regarded in the absence of confirming empirical evidence. In this light a proposition which says that builders look to the current level of selling prices for new houses and the current level of construction costs and profits to find the price they can afford to pay for land is a poor approximation of what actually occurs. Even when the role of expectations is acknowledged so that builders are argued to look at expected price and cost levels rather than current ones, few theoretical analyses surveyed have suggested how expectations and reservation prices are formed.

Nowlan does not appreciably advance theory in this regard but suggests the following.

> With time introduced (more) explicitly into the analysis of land value, some common misperceptions about price rises ... (might) be dispelled, and perhaps more reasonable guidance provided to policy-makers. (1976: 16)

He also suggests, 'provocatively', he says, that "a large number of what are typically said to be allocatively inefficient distortions in the market -- such things as rising land values ... are actually quite expected manifestations of an efficient allocation of land over both space and time" (1976: 16). It could be said to be a measure of a successful

land price theory that it can logically and empirically confirm or reject such a proposition.

J.R. Markusen and D.T.Scheffman (1977) offer a theoretical and an empirical analysis of the competitive residential land market. Their empirical study is treated in the subsequent section.

Since a static model can give 'only limited insights into the working of the land market', Markusen and Scheffman "develop a simple intertemporal general equilibrium model of the land market" (1977: 19). They do so "by constructing a two-period model in which a fixed stock of land held by developers is prepared for residential construction and sold to consumers over two time periods". Initially, perfect certainty is assumed such that developers and consumers are able to predict future prices with considerable accuracy (1977: 21). The model is therefore to be interpreted as a long-run equilibrium model. The assumption of two time periods -- the present and the 'future' -- is adopted for clarity of exposition but the authors judge that the conclusions would be valid in a 'multi-period model'.

Without reviewing the features of the model in detail, the price equations might be noted.

$$p_O = p_1(1 + r)^{-1} + q + [s - s(1 + r)^{-1}] ,$$

$$p_1 = p_O(1 + r) - q(1 + r) - rs.$$

where p_O and p_1 are the price of undeveloped land at time T=O and T=1 (the present and the future respectively), where q is the rent for land in an alternative, agricultural use, s are the costs of development per unit of land, and r is the rate of return on assets equivalent to land in matters like risk and uncertainty (1977: 26).

The equations are interpreted in the following manner:

> For low levels of demand, a competitive development industry will supply developed land at a price equal to the present value of agricultural returns plus development costs. For higher levels of demand for land in fixed supply, developers will supply land such that the price of developed land appreciates at a rate equal to the developer's discount rate, r, less an amount relating the opportunity costs of land development to current developed land prices. (1977: 36)

Markusen and Scheffman then extend their analysis to include the role of uncertainty and the characteristics of speculation. The mathematics employed defy a summarization of the analysis. Some significant observations can nevertheless be made.

The authors indicate that uncertainty in the land market arises from two sources: the uncertainty of future prices and the uncertainty about future technology. By technology is meant not just physical production but institutional phenomena such as subdivision plan approval. Expectations are included in the model by a rewriting of the firm's profit-maximizing objective:

> There is some difficulty involved in building a simple model of a developer, since there is no agreement in the economics literature on what an intertemporal firm's objective should be in an environment of uncertainty. For simplicity we will assume that the firm's objective is to maximize expected discounted profits. (1977: 48)

Markusen and Scheffman develop their model as an extension of the 'Capital Asset Pricing Model', a model of the determination of values of assets traded on the stock exchange. Land value is viewed as the sum of the net revenues of undeveloped land in an agricultural use and the net income from building lot sales minus the amount of expenditure in the approval process. The developer is assumed to know the current prices of undeveloped and serviced land but is uncertain about future

prices and about the amount of undeveloped land which will be approved for subdivision. Expectational variables in the model include land price and the rate of lot price appreciation (1977: 48-49). The rate of price appreciation is also a rate of desired return or discount rate, as in the present value formula seen earlier in the literature.

Markusen and Scheffman observe that expectations can have curious effect on the land market's operation. For example, if there is an increase in expected future price, then current price will increase. This will slow down the rate of development and reduce the supply of serviced land, given no change in other conditions. The authors note that

> It is very important to understand that this is not the result of market power being exercised by developers. Rather, it is due to a shift of the competitive supply function because of revised expectations. ... Thus we see that expectations are very important in determining price in the short run, and of course in determining the short-run dynamics of the model (1977: 51)

Such a proposition is also very important for, if valid, it may explain those 'unwarranted', speculative increases in land value which Henry George, Clawson, Smith and others find so objectionable.

There are two characteristics of Markusen and Scheffman's analysis which deserve special note. First, unlike Muth (1961, 1971) and like Wingo (1964), they view the demand for land as a final consumer demand. They largely ignore the role and behaviour of house-builders. Coupled with their emphasis on the supply side of the land market, this characteristic limits their model's ability to provide a comprehensive explanation of land price increases.

A second characteristic of note is the incomplete treatment of how land price expectations are formed. This inadequacy is, however,

overcome by a demonstration that, however these expectations are formed, it will be the case that a lot developer will sell lots when the current appreciation in lot prices is equal to the rate of expected appreciation, for at that point the developer has no incentive to defer sale.

A.J.Harrison (1977) offered an overview model of the land market's operation. It includes the familiar propositions that the demand for land is derived and therefore that its value is residually determined.

> In the calculation of developers bidding for land, the price of land is a residual element, after all other costs of construction have been allowed for. The demand for and value of land is derived from the markets for goods and services which require land for their production. Thus for the urban economy as a whole, land rents do not determine prices in that evonomy, but are determined by them. (1977: 58)

Harrison also examines the market's operation in relation to its functions, namely the allocation of resources.

> ... the price of land performs an economic function like any other market price, guiding decisions of all the participants in the market for it. It will only do this, however, if the participants in the land markets are themselves well informed. The prices they are prepared to bid and supply reflect estimates of rents obtainable now and in future years. When these are correct the price of land is an accurate guide to the way in which different sites should be used. (1977: 58)

Harrison's discussion is especially relevant for his observation that explanations based on simplifying assumptions require several qualifications if they are to be applied to real-life situations. One of these empirical situations is differences in expectations:

> ... if landowners have a different set of expectations about future values from other parts of the urban economy (i.e. if judgements on the future aren't shared), they may not be prepared to supply (land) at the prices at which developers are prepared to bid. (1977: 59)

Such real-life qualifications should thus 'be borne in mind when interpreting real-life phenomena' by means of simplifying theories. With respect to his own generalized model, Harrison asserts that

> ... there is a fair amount of empirical work available which suggests that it does have considerable relevance to real-world conditions. (1977: 60)

The purpose of the model then is to provide a framework which sets out how land markets work generally.

> ... if in any given economy, private markets in land and production exist, they will tend to work in the ways analyzed above, although to analyze a real-life situation it would be necessary to take into account a large number of the factors which we have assumed away ... (1977: 61)

Unfortunately, Harrison did not explore any empirical material to see how well they supported the tendency which he saw in the operation of the land market, although his bibliography, replete with a score of suitable references, is referred to.

Gordon W. Davies (1977a, 1977b) whose empirical work examined in the next section offers what may be the strongest evidence in support of any land price theory, was for this reason selected as the last work to be reviewed in this section. Chronologically speaking it is also the most recent to appear. Davies' objective is to better understand the process of inflation in the market for urban single-detached dwelling lots in most North American cities in recent years. He observes

that few studies have empirically examined this process. He cites the one by Milgram, et al, as having come "closest to estimating a dynamic model of urban land market inflation". He notes the effort by Ingram, et al, (1972) to develop a "sequential model of spatial variations in property prices" but whose emphasis on spatial price differentials limits its potential for explaining intertemporal price variations.

Davies develops a dynamic, short-run, 'macro-model' in which

> ... builders augment the stocks of housing units of each type in response to changes in the profitability of constructing the units and to changes in the mortgage rate, after appropriate information and construction lags. ... The price of lots changes in response to changes in the stock of lots per household (i.e. the supply of building lots relative to existing stock), in the expected profitability of constructing single-family detached units, and in the prime rate of interest. (1977a: 394-5)

His first postulate is that the price of building lots is related to the availability of lots, the expected profitability of construction, and builders' discount rate.

> Our specification of a lot price equation recognizes that builders buy lots from developers, construct houses on these lots and then sell these lots and finished houses with the intention of realizing a profit which may have a capital gain component applying to the land or house, or both. The expected profitability of building and selling houses therefore affects the builders' offer price for land. We define the expected rate of change of profitability as
>
> $$\dot{ph}_t^e - \dot{rc}_t^e$$
>
> where $\dot{ph}^e$ is the expected rate of change in house prices and $\dot{rc}^e$ is the expected nominal rate of change in the labor and materials construction cost

index. Since a builder has alternative investments open to him, we use the expected relative change in profitability from building and selling houses, which is the above nominal rate divided by rd, the rate on chartered bank 90-day deposit receipts, i.e. the relevant independent variable is

$$(\dot{ph}_t^e - \dot{rc}_t^e)/rd_t$$

A builder's bid price will also be related to the financial cost of holding the land until he begins construction and can obtain mortgage financing. We therefore postulate that the price for land will be negatively related to the prime rate of interest, rp. Whether a builder may borrow at this rate will depend on the size of his operation and his credit worthiness, but at least some builders will be considered prime borrowers by financial institutions and, for those who are not, the rate at which they may borrow will be related to the prime rate.

The formulation written in general functional form is therefore

$$PL_t = l(KL_t/hh_t, (\dot{ph}_t^e - \dot{rc}_t^e)/rd_t, rp_t)$$

where PL is the median sale price of vacant lots, and hh the number of households (and KL is the number of vacant, single-family detached lots). (1977a: 248)

His hypotheses were that an increase in the expected relative change in the profitability of dwelling construction, a decrease in the availability of building lots, and a decrease in interest rates will increase the bid and observed average price of building lots.

In one version of his model (1977b), Davies included five more postulates which specified in further detail the operation of the markets in new and existing housing.

Davies' formulation demonstrates a significant advance over previous efforts by its specification of some behavioral elements of the residential land market's operation. The lot price equation comes closest of any proposition yet seen in this review embodying in the functional form the residual approach by building firms to lot value determination.

Davies' model bears major criticism in one respect. It seems to imply an equality between the bid price for building lots and the observed market price for lots. It ignores the asking price for building lots, a subject treated by Markusen and Scheffman. Unlike Witte's model which fully specifies the forces which jointly determine market price (although at a very general level), Davies' model is incomplete by its emphasis on the demand side of the market. If Witte's model is more complete, it fails to incorporate a significant behavioral content as does Davies'. Both fail to allow for disequilibrium adjustment -- bid prices and asking prices which don't match, with consequent effect on quantity of lots transacted. While Davies' model formulation does not adequately address this topic, the potential is there.

Davies' significant theoretical contribution lies in his explicit incorporation of a behavioral content in a model of the residential land market's operation which is designed to explain land price changes. A further contribution is the dynamic or inter-temporal character of this content, relating current pricestoprevious values of some variables, as well as to expected values of others.

Davies' work is the most recent to be captured by the large and wide net which was cast by this survey over an extensive literature. The aim of the survey was to identify theoretical propositions on the subject of inter-temporal variation in residential land prices. Comprehensiveness in coverage has been an impossible ideal. The subject of cross-sectional variation in land prices, as studied by Brigham (1965),

Hushak (1975), and Romanos (1976), was not surveyed. A much larger literature on land speculation is to be found than was reviewed here. There are also many works on the subject of builder and developer behavior which were examined but not included in the survey. These include Weiss (1966), Kaiser (1964, 1968), Price (1970), Moore (1972), Goldberg (1972), Chamberlain (1972), Goldberg and Ulinder (1976).

The survey has accomplished a chronological identification of theoretical works, both major and minor, which pertain most directly to the causes and processes by which the level of residential land prices changes over time. The survey has also achieved a summary of the relevant theoretical works, noting their substantive nature and related characteristics.

It would have been fortunate to find a body of theory providing an adequate framework for the analysis of forces affecting inflation in residential land markets and the processes underlying these inter-temporal price variations. Instead, the theoretical work surveyed does not form a coherent and internally-consistent body of theory. It does not yield a widely-accepted 'paradigm', characterized by Thomas Kuhn (1970) as a dominant explanation of a problem, including a definition of what orders of data are relevant to it and what methods of research validation it calls for.

The survey indicates that there is no dominant theory explaining the determination and inter-temporal variation in land prices. Instead there are several major theoretical works, utilizing different sets of concepts and variables, different theoretical orientations and underlying assumptions. Consequently, a significant amount of theoretical dispute is to be observed.

Nevertheless, some repeated propositions and variables are to be found which bear upon the causes of residential land price changes

over time, and the process by which these changes occur. Changes in population numbers, household incomes, interest rates, land supply and house prices were some of the variables proposed as the major causes by Witte (1975), Hamilton (1970), and Maisel (1963a, 1963b), for example.

The process by which these variables actually transmit their influence to residential land prices has received attention from Ratcliff (1949), Wendt (1957, 1958a), Turvey (1957, 1962), Barlowe (1958, 1972), Pennance (1969, 1974), and Harrison (1977). In these works, the value of land is seen to be established by the builder as the present value of the residual or difference between the expected selling price of dwellings and construction costs. Others, notably Shoup (1970) and Capozza (1976), have proposed that the value of land to its suppliers is the net present value of expected future market value, adjusted for interim revenues and holding costs.

There is a third set of propositions pertaining to determination of the market price of land through the interaction of builders and lot sellers. On the one hand, the works of Clawson (1962, 1971), Adams, et al (1967), and Milgram (1968a), suggest that at least in some markets, supply forces play an overwhelming role in determining market price. Others, such as Turvey (1957, 1962), Pennance (1969, 1974), Hamilton (1970, 1974, 1975) have emphasized that land prices are by and large demand-determined. Still others, like Bish and Nourse (1975), Nowlan (1976, 1977), and Harrison (1977) have proposed that they are jointly determined by both forces.

Insofar as the establishment of land price is concerned, little theoretical dispute is to be found though there are some differences in the formulations proposed. However, no more than half the theoretical works surveyed addressed this matter and few of these have explicitly considered land valuation by both the mand and the supply side

though the work by Bish and Nourse (1975) comes close.

The disputes or differences as to the roles of supply and demand in determining price are difficult to characterize. In part they are empirical insofar as the validity of assumptions about market characteristics is an empirical matter. On the other hand, the dissimilarities in the way one set of assumptions are justified over another suggest theoretical differences about the source and role of assumptions. For example, Clawson's assumption about an imperfect suburban land market are based on the scarcity characteristics of land and disorganized nature of the market, while Pennance's assumption of a perfect market is contingent on the evidence that there are many buyers and sellers of land, too numerous to affect price individually. In some works, assumptions about market organization are implicit or don't play a strong role. This is especially so in those theoretical analyses that are accompanied by an empirical investigation, such as Witte's and Davies'. In Markusen and Scheffman's work, assumptions are a matter for empirical verification.

Since there is no strong theoretical statement about inter-temporal price variations to emerge from this survey, some lines of future study emerge. Until the available empirical evidence is examined, it can only be suggested that the main propositions as to land valuation by suppliers and demanders of lots need to be joined more explicitly to a proposition dealing with the determination and inter-temporal variation of land price levels. It is also suggested an emphasis be placed on the behavioral process by which land prices are changed over time.

2.2 EVIDENCE

The survey of empirical investigations undertaken in conjunction with or in relation to the theoretical analyses reviewed in the preceding section follows the same chronological approach. The

relevant empirical studies are fewer in number than the theoretical writings on the subject of the determination and inter-temporal variation of residential land prices.

One of the earliest empirical studies of urban land values was undertaken by Richard Hurd (1903). He sought to describe the relationship between city population and the frontage values of business and residential properties based on property values from twenty American cities. This cross-sectional, inter-metropolitan study was rather elementary by contemporary standards and of a descriptive character. Hurd's proposition was confirmed in a general fashion within the limitations of his approach.

It would be almost twenty-five years later before the next significant study of land value appeared. Arthur Mertzke (1926) tested the proposition that land values fluctuated over time in direct proportion to population growth. He used assessment data for land values in thirty-seven Wisconsin cities over a twenty-year period. He did not find a very close relationship between the two variables and concluded that land value trends were affected by many factors in addition to urban population growth. Mertzke also observed that there were different rates of increase between commercial, industrial, and residential land values.

In the early thirties several studies were stimulated by the rapid development of land economics theory. Spengler (1930) studied land value trends over a twenty-four year period in New York City. He dwelt primarily upon geographic variations and with respect to time found no causal factors. Not long after was published Harland Bartholomew's (1932) extensive compilation of urban land data for major U.S. cities. Not an empirical investigation in the conventional sense, Bartholomew's data-collection no doubt facilitated later studies and contributed to the

thinking of theory-builders.

Homer Hoyt's study (1933) referred to earlier found that land values in Chicago over the 1840-1900 period rose at a rate which was quite similar to the City's population growth. Over the 1910-1933 period, the relationship was no longer so close and in the last five-year period the Depression created its havoc on land values. Hoyt noted divergent trends in land price changes between land use types and between different parts of the city. He attempted to relate land value trends to interest rates but with no conclusive result.

In 1957 appeared the first of several studies by Paul F. Wendt (1957, 1958a, 1958b). Examining commercial and office land value trends in San Francisco, Oakland, and four surrounding cities over the period 1925-1955. Wendt found that

> Fundamentally, the value trends noted reflected changes in expected incomes and capitalization rates. The subjective nature of both of these factors makes the task of assessing their relative influence highly difficult. (1958a:268)

He nevertheless concluded that there was no simple relationship between interest rates and capitalization rates. In the forties, when interest rates were at an all-time low, investors were observed to capitalize net real estate incomes at higher rates than in the twenties. Wendt was therefore critical of Hoyt's analysis, as well as Dorau's view, that capitalization rates for real estate investments would equal or fluctuate directly with mortgage interest rates.

Wendt also found support for his own theory (1957, 1958a) that urban land value trends were influenced by many factors. Wendt was not able to test that theory directly. Measurement problems had posed considerable difficulty because although many of the elements in the equation were established independently of investors and could be

objectively observed, the equation contained expectations about the future values of some variables. Since these expectations are subjective in nature and influenced by many other variables, Wendt had to limit his evidence to a descriptive analysis of data rather than attempting an estimation of the postulated relationship. Wendt commented that current trends in land values themselves may be one of the factors influencing expectations by varying the optimism in revenue and cost estimates by means of the risk factor contained in the capitalization rate.

A comment made by Wendt seems still apt today. In his critical examination of economic theories and hypotheses on the relation between transportation and land values (1957),

> ... it was concluded that some of these hypotheses represented sweeping generalizations based upon unrealistic assumptions and wholly inadequate evidence, ... and that a careful review of urban land value studies was needed in order to test existing and develop new hypotheses. (1958a:252-253)

Ralph Turvey (1957, 1962) did not conduct any empirical studies but a comment he made is of significance here. Summarizing the state of much land economics research up to his time, and noting that he had incorporated very little in his analysis in the way of empirical observations, he stated

> (While) it would be desirable to cite case studies in order to test, to quantify or to exemplify the analysis ... the sad fact is that information is difficult to obtain ... (1957: 1-2)

He further remarked that where descriptive material was available it was accompanied by little deductive analysis.

In the early sixties we see a remedying of the empirical problem in land economics research. Richard Muth (1960) undertook an empirical investigation of the demand for housing. He found that 'an

understanding of the conditions of supply of housebuilding' to be essential if the response of new residential construction to changes in demand for housing was to be interpreted. Employing some data at the national level and for the pre-war years, Muth found that factor prices (for labour and materials) did not vary systematically with the output of the housebuilding industry.

To explore this observation further, Muth undertook a regression analysis to compare the variables in the supply function for new housing: the value of total new residential construction, the price of housing, the index of building-material prices, the wages of unskilled workers and the ratio of the wages of skilled to unskilled workers. He found that only 10 per cent of the variation in new construction could be explained by these variables. On the other hand, 80 per cent of the variation in price could be explained by the cost and wage price variables although the quantity of new construction was not an explanatory variable. All of the data were expressed in the form of first differences, or annual changes.

Muth concluded this particular analysis to the effect that the supply of new housing is highly elastic.

> The evidence presented in this section ... strongly suggests not only that the supply of new housing is highly elastic in the long run but also that over short periods of time there is a high degree of mobility of resources into the home-building industry. (1960: 42)

And further,

> While the profit data considered above indicate that, in the short run, prices may show minor fluctuations with changes in the rate of new construction, the evidence is impressive indeed that, in the long run, the price of housing is substantially independent of the scale of the home-building industry. (1960: 46)

Still a part of this study, is a further investigation by Muth of the role of expectations as a determinant of new construction:

> ... the rate of home-building can be related to the ratio of rent to price and the rate of interest. This follows because increases in the demand for housing cause (housing) rents to rise, since stock momentarily remains fixed. The rise in rent makes investment in new housing profitable (but depending on the rate of interest). (1960: 58)

A regression for the period 1922-1941 showed, as hypothesized, that

> ... new construction varied directly with the ratio of rent to price and inversely with the rate of interest ... in accord with a priori expectation. (1960: 59).

Together the two variables explained about 70 per cent of the variation in new construction relative to the existing stock. But Muth took this analysis a substantial step farther

> Since housing is a very long-lived asset, we might expect that investment in housing depends not only upon the current profitability of housing, the ratio of rent to price, but also upon investor's expectations about its future profitability. Looking at this a little differently, the current ratio of rent to price is a measure of the position of the desired stock-demand schedule relative to the actual housing stock. It seems not unreasonable that investment in housing depends not only upon the current demand for housing but also on investor's expectations about housing demand in the future. If this hypothesis is correct ... we need a measure of investor's expectations about the profitability of investment in housing. (1969: 59)

He therefore hypothesized that the rate of change in the expected ratio of rent to price is proportional to the difference between the current ratio and the expected ratio. Further, the expected ratio would be a weighted average of the current ratio of rent to price for eight years, with

exponentially declining weights as we go back in time. Two alternative methods of estimating these expectations were tried. By either method it was found that by

> ... taking account of expectations about the future profitability of housing explains a significantly larger fraction of the variation of new home-building. Both methods imply that new construction is considerably more responsive to changes in the expected rent-price ratio than the current ratio. Likewise, taking expectations into account increases the coefficient (of correlation) of the interest rate. (1960: 62)

One important implication which Muth derived from these results was an explanation for the lag with which new construction responds to changes in demand.

> ... the lag in the housing stock behind changing demand conditions may result partly from the lag in adjustment of investor's expectations about the future profitability of housing. (1960: 63)

Muth's investigations will be returned to on later occasions in this review for its implications and complexity cannot be adequately dealt with here against a meagre background of other studies.

Sherman Maisel was one of the first close investigators of value trends in residential land. In 1963 he published three studies in this regard. In another study that will not be reviewed here he examined fluctuations in the level of new construction. In the first study to be considered here, Maisel (1963a) assembled data on the movement over time in the cost of land used for building single-detached housing in California. The time period was twelve years.

Noting that the average lot price of Federal Housing Act-insured new homes in California rose two and a half to three times over the 1950-1961 period, Maisel studied close to 200,000 lots over the

1950-1962 period and found that while consumer prices rose 11 per cent and residential construction costs rose 17 per cent, lot prices increased between 100 and 250 per cent! He further noted that the price of the average new house rose about 109 per cent between 1950 and 1960 while site value (raw land price) rose 150 per cent. Lot size increased about 20 per cent and house size 13 per cent. Lot development costs were also observed to have increased.

Maisel judged that an increase in lot size and development cost would account for some of the price increase in finished lots. He calculated that increased cost and quality of development contributed almost 28 per cent to the increase in lot price, lot size accounted for 22 per cent of the increase, while about half was due to increases in the value of raw land.

With reference to the third factor affecting the cost of developed lots, namely the price of raw land, Maisel suggested that because of the building boom, land was probably not supplied at a rapid enough pace, creating a relative shortage. While one possible cause of this shortage was a lag in the provision of public facilities and transportation, another was speculation.

> A clear possibility is land held back because of speculation. If owners expect prices to rise rapidly, it will pay them to hold off sales, or to demand a higher price now. (1963a: 258)

Maisel argued that if population was expected to increase, densities lowered, and incomes to rise, present owners would clearly judge it worthwhile to withhold land.

> They may calculate that a delay in development or sales will be more profitable. Interestingly enough, in a dynamic system the degree of disequilibrium of movement away from real values may increase. Owners withhold land. Prices rise. Thus expectations are justified.

> They withhold more. Prices rise still more in a vicious circle. There is no certain end to the spiral. If it occurs, however, expectations may collapse and what may have appeared to have been real values will burst like the South Sea Bubble. (1963a: 2)

In a second study, Maisel undertook a cross-sectional analysis of land price increases over the 1950-1961 period in 86 U.S. metropolitan areas using F.H.A. data (1963b). Maisel noted the less-than-ideal nature of the data with the most serious flaw being the lack of control for lot size, location, amenity and development. Most importantly, he noted that since the data pertained to metropolitan areas rather than individuals or firms, the data might explain inter-metropolitan variations in rates of change according to such factors as density, average income, and population, without explaining the behavior of firms and individuals in land and housing markets (1963b: 50-51).

Through stepwise multiple regression analysis, Maisel found the highest simple correlation between change in the prices of houses and their land cost. While the relationship was not a constant one over all areas,

> ... as amounts spent for housing increased, expenditures on sites rose nearly twice as fast as those on buildings. (1963b: 54)

The regression results for 1960 cross-sectional data show a significant relationship between lot values and farm land values, new house prices, and population density. Regression results for 1956-1960 data show that changes in land values were significantly related to changes in house prices, land values, and incomes. Changes in population density were no longer significant. Results also showed that the first difference equation would have been a better predictor of 1960 site costs than the use of independent variables in 1960. Residuals were almost random in

all cases. When the equations were tested for earlier and later periods, the correlations remained significant and the regression coefficients remained approximately the same. Maisel concluded that these many tests

> ... appear to support the conclusion that a dynamic model can be constructed to explain the varying urban land values which prevail among United States cities. (1963b: 58)

None of Maisel's equations were able to explain more than half the variation in site cost levels or changes. This did not surprise him as he didn't expect otherwise.

> If the form of the city remained oriented towards the center, rents and therefore land values will rise as the city grows and as incomes go higher. These future increases in rents will be discounted back to the present to affect present values. The amount spent for urban sites will be a function of their expected future returns. ... The rate at which land will be made available to the market depends not only on actual increases in demand, but also on the expectations of land owners as to future demand and on the future costs of holding land compared to present offers. (1963b: 58-59)

As a consequence of these expectations land may be brought into urban use at a rate which lags behind its demand. Therefore,

> builders and developers will be forced to pay scarcity prices to move suitable building sites out of the hands of those who can afford to hold them for future increments in value. (1963b: 58)

The reason then that the model could not fully explain inter-temporal or inter-metropolitan variations, apart from inadequate data, was due to the intractability of expectations.

With Maisel's considerable empirical research, the con-

stellation of influences on land value trends theorized and explored by Wendt and previous writers, were more rigorously examined than ever before. The propositions about land valuation put forward in appraisal theory, and by Ratcliff for example, do not yet shape the specific statistical analysis undertaken but they do direct the reasoning and research.

The next study of land value trends was undertaken by Manuel Gottlieb (1965). This study of the rise in residential land values was closely based upon Maisel's research. Gottlieb tested the influence of five possible explanatory variables. First he examined them against the average value in 48 states of the site values of new F.H.A.-insured dwellings. Second, he did so against the mean value of all vacant lots sold in each of these states. Site (or raw land) values were of significance to those merchant builders operating largely on the urban fringe while building lot values were of significance to all construction at all urban locations. Gottlieb expected lot values to be more sensitive to speculative influences than site values.

The five independent variables identified and studied by Gottlieb were: level of income as measured by statewide median family income, supply of vacant lots relative to the total number of improved properties, economic growth as measured by the five-year increase in the number of urban employees, favourable tax assessment as indicated by the ratio of assessed to sales value of residential property relative to vacant lots, and finally statewide per acre value of farmland.

Gottlieb's regression results showed site values being only slightly related to lot supply while lot values were substantially and inversely related to the relative supply of lots. Median family income was found to influence site values but the size of the upper income group was a predominant influence on lot values. Economic growth and assessment biases had little detectable influence on site values but

appreciable effect over lot values. Farmland values were found to have limited and irregular influence on lot and site values.

Gottlieb judged his analysis to be no more than a tentative investigation in the nature of a 'preliminary clarification'. He concluded that the regression model as stated failed to isolate all the factors which might explain variations between States and over time in lot and site values, as well as those factors which might specifically reflect speculative activity in land.

In a major study of land price trends, published in several articles and reports, G. Adams , Grace Milgram and others more fully and explicitly than Maisel and Wendt a few years earlier, joined a closely-reasoned theoretical analysis to a very extensive and in-depth empirical analysis of urban land value trends (Adams, et al(1968), Milgram(1968a,1968b).

Employing data they had collected for a study of the process by which land is put into urban use and of the factors influencing the rate of development, they studied the movement of prices over time at the micro level. The data consisted of 1,111 land transactions carried out over a seventeen-year period in Northeast Philadelphia. Such an approach differs significantly from the work of Maisel and Gottlieb that was based on macro data -- average prices by metropolitan area of lots used in F.H.A.-insured dwelling construction. It also differs from Wendt's work which relied upon property tax assessments as a measure of land value.

Adams, et al, note that over time "the recorded prices of land transactions reflect an intermingling of various influences" (1968:248). Two sets of factors were argued to operate simultaneously. First, the characteristics of the land being sold are likely to change over time. Second, interest rates, general business conditions, real estate market

conditions, and construction activity are likely to affect the capitalization of expected returns of land. The researchers were therefore concerned to sort out the cross-sectional determinants of land values from the time path of land value changes. This was done by pooling all transactions to estimate a price equation that included year of sale as a variable and that distinguished the various characteristics of each piece of land.

Residential land prices were found to have risen at a rate of 14.5 per cent annually over the seventeen-year period studied. When cross-sectional land characteristics such as travel time to downtown, lot size, and distance to closest public transportation are held constant, the annual growth rate was reduced to 9.7 per cent (in real terms), and 7 per cent after real property taxes.

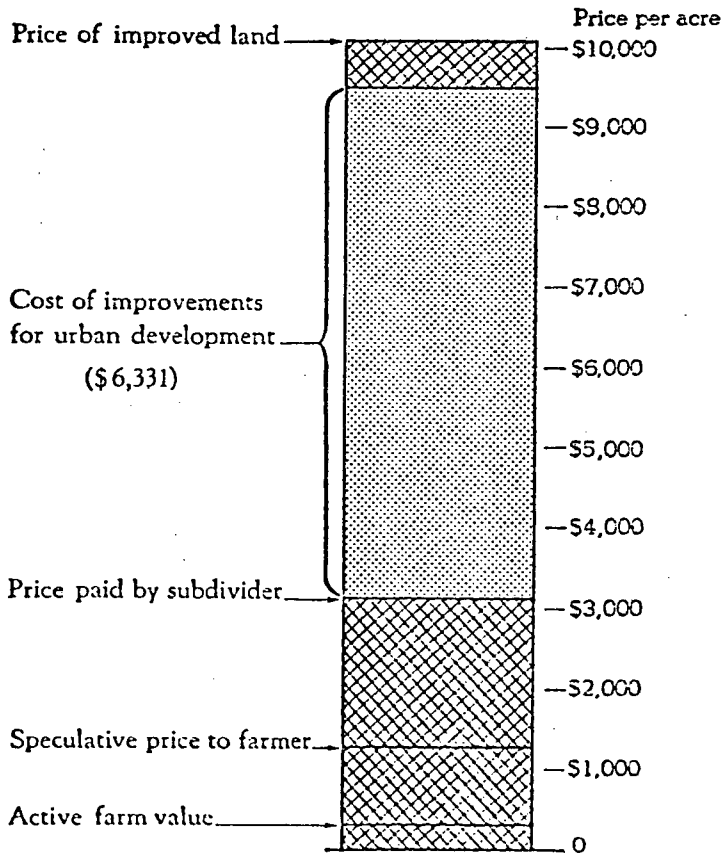
The residuals from the time path of residential land prices were then examined in relation to macro-economic variables such as housing starts (a positive relationship was found but with a one-year lag), interest rates (an inverse relationship was observed), and capital utilization (gross private domestic investment was positively related but with varying lags). A suggestion for further research was noted about the re-computation of the price equation that took these macro-economic variables into account.

It was concluded that the empirical anlysis of land prices tended to support their theoretical reasoning. The long run trend in prices for residential lots (a net annual return in constant dollar terms of 7.7 per cent) was judged to be close to normal investment returns, differing from the normal rate of capitalization due to the risk, illiquidity, property taxes, and transaction costs unique to real estate. Deviations from the trend conformed to expectations, moving inversely to the interest rate and positively with construction activity and general business conditions.

The research by Milgram and her colleagues represents a considerable advance over the explorations by Wendt, Maisel and Gottlieb. Among other accomplishments they were able to sort out the cross-sectional factors from the inter-temporal ones. Most importantly, their evidence of price movements over time lent support to the capitalization theory as the value-generating process underlying the valuation of land.

A. Allan Schmid (1968) made a study of the prices of lots for new single-family housing in more than 200 American cities in 1964. He summarized by means of the following diagram the price increases in residential land which occur over the course of the conversion process.

Land-Price Stages in the Conversion Process



> For an acre of farm land valued at $300, the farmer might receive about $1,332. The active developer-builder might pay about $3,030 (to an intermediate owner of that land) and add $6,331 in improvement costs. If the finished lots sold at about $10,072 per acre, the appreciation would be $3,441 per acre. (1968: 25).

Schmid identified a very high level of price appreciation, 34 per cent, between the farm value of land and its value as a finished building lot. He did not claim that his data provided a valid statistical summary but that it represented an average case. However, on the basis of this 'tentative first approximation' he judged that public policy attention to the matter was deserved.

It should be noted that Schmid doesn't appear to have closely considered the interim costs and revenues of land holding. The former would include property taxes and the opportunity costs of land investment, while the latter pertain to revenues from interim land uses such as grazing or recreation.

In the second part of his study, Schmid sought to analyze the components of land price appreciation and the factors associated with their variation between cities. Using a capitalization model similar to Milgram's, he attempted to relate increases in land value to capitalized expected time savings in travel. He found that this could not account for the full appreciation in land value. He did find, however, in a comparison of 1950 lot values with 1960 F.H.A. sites known to have an average age of 10 years, that 1960 lot prices exceeded the estimated 1960 value capitalized in 1950 prices though the data didn't permit firm conclusions on this score.

A third subject treated by Schmid was the set of public factors such as the availability of utilities and services, and the supply of

amenities. He argued that the first can artificially restrict the supply of building lots while the second provides benefits at no cost to the builder or developer which he can nevertheless capitalize into land values. A fourth set of factors possibly affecting values were private supply restrictions. While Schmid could find no published evidence of widespread monopolistic or oligopolistic practices (1968: 39), he argued that widely-held, uninformed, optimistic (or even pessimistic) expectations could have the same real effect as monopolistic behavior. Still other factors were discussed before selecting proxies for them and conducting an empirical test to explain inter-metropolitan variability in price increases.

For the interval 1950-1960, Schmid found a strong positive simple correlation between city population change and appreciation in raw land prices. A strong positive relationship was also found between these prices and growth in residential land area. The relationship with median family income was also positive. In a sample of the 130 largest cities, multiple regression analysis produced a multiple correlation coefficient of 0.41 with population change having the greatest effect on inter-metropolitan variability in lot price increases. Schmid found that the population change in the urbanized area rather than the central city population was negatively related to price appreciation. For reasons such as this, he judged his analysis to be tentative and exploratory. He identified a broad range of areas for further research. One topic to which he attached considerable importance was the optimistic expectations of future value increases that find their way into current prices. The possibility that these prices exceed a more realistic present value of expected future returns to land would affect the rate of sale and development of building sites and their future price thus becoming self-fulfilling. For this reason, research was said to be needed on how expectations are formed and on whether prices represented the true present value of

generally expected future values.

In a later article (1970), Schmid noted that the index of average price of sites for F.H.A.-insured dwellings doubled over the 1956-1966 period while the general price level increased by 20 per cent. "Obviously there is more at work than inflation", he remarked. He suggested that speculation was to blame and explained the speculative process in this way:

> ... future expectations are reflected in present prices. However, as with any speculative process, expectation can feed upon itself. If an owner expects higher prices tomorrow, he is in no hurry to sell raw land today -- unless the holding costs, including costs of foregone opportunities, are a problem or burden. If this optimism is widely shared, owners hold back selling their land even though prices from builders and home buyers are well above the agricultural value holding costs, and development costs. The rise in price signals a demand for a change in land use, but it may be ignored and the land held unused. If many owners hold out for still higher prices, they will observe that prices do in fact increase, in part because of their withholding action. This bolsters the sellers' view of the future even more and higher prices are asked, and the process goes on until the bubble breaks.
>
> No one can prove today that these future expectations are overly optimistic. However, there is some evidence to suggest that present land prices have lost touch with what can be reasonably expected of future values. (1970: 40)

Schmid offers this definition of the economic problem in land appreciation.

> In a society organized by market institutions, demand for changes in resource use are signalled by a change in relative prices. For most goods, a small increase in prices bid will

> divert resources to their production. Yet, in converting land from rural to urban use people are used to large price changes. ... It is clear that the rural to urban land conversion is of a different order than that involving shifts among uses of most other resources. The former produces value changes much larger than what is needed to simply motivate owners to change uses. (1970: 38-40)

It must be agreed that a very different order of magnitude is involved, but Schmid fails to indicate why land owners 'need' less than they now obtain to be motivated to release their land for urban use. The evidence brought forward by Schmid in either of his studies is largely of a descriptive nature and cannot be said to have verified any significant proposition about land price determination and inter-temporal variation.

M. T. Rancich (1970), undertook a descriptive study of the trend between 1956 and 1966 in the price of vacant land in a 4,300-acre area in the Seattle urban fringe. His primary objective was to graphically illustrate how public investments as well as major private expenditures affect both land values and the spatial pattern of urbanization. He completed such an illustration but the absence of a theoretical model or statistical analysis limit the application of his results.

Howard Clonts (1970), whose study was reviewed earlier, undertook an empirical study in connection with his theoretical analysis. Like several others whose models could not be operationalized, Clonts was unable to test his 'income expectations' model directly. Unable to find data with which he could demonstrate that the capitalization process yielded observed market prices for land, he used the model's concepts to select variables which would influence expectations and indirectly affect price. He therefore did a cross-sectional examination of land value differentials. By distinguishing land in various stages of urbanization he was able to suggest that differences in land value reflect, for other-

wise similar tracts of unimproved or agricultural land, different expectations for future development.

Stanley W. Hamilton (1970), in a study reviewed earlier, sought to explain price movements in undeveloped land with reference to variables which were considered to influence values at the time of development and those that influence the discounting process. The nature of the investigation was premised on the observation that "improved data are required if any meaningful empirical research is to take place" (1970: 43).

A sample of 776 residential building lots from the Municipality of West Vancouver 1969 tax assessment roll was obtained. Transaction of these lots, or the larger properties from which they were subdivided, were studied for the eighteen-year period, 1949-1967. A stepwise regression analysis was undertaken to measure the influence of several factors upon the average annual price of transacted lots. The regression results showed that population growth and rising per capita income were most strongly correlated with land price increases while rising housing starts and mortgage interest rates played a lesser role.

On the evidence of his tentative results of this investigation into the inter-temporal aspects of land value trends, Hamilton concluded that a better understanding of the factors influencing land values was obtained.

> Concerned authorities argue that land values are an input into the production of shelter and any increases in land values will simply be reflected in the market price for new housing. This argument is at best incomplete and probably incorrect. ... The fact that land values in a given area are increasing simply reflects the increased demand exerted on a limited supply of accessible land. (1970: 142-3)

Hamilton also noted that a better study would result from the combination of cross-section variables with inter-temporal ones, with the land prices of individual lots as the dependent variable. Furthermore, study should be extended to the whole of a metropolitan area if it is to provide meaningful results for policy purposes.

Several aspects of the land market's operation are left unanswered by Hamilton's investigation. Most of all there remains some question about how housing demand factors influence lot prices. On the one hand it could be that they are the indicators which land owners use to form expectations about future house prices and future residual lot values. On the other hand, the observed relationship may be a structural rather than behavioral one, signifying that in the long-run and at the composite level, the line of causation is, as Pennance suggested, from the existing housing stock, to new houses, to lots, to undeveloped acreage. Hamilton's research by itself does not clearly show which of these, or whether both, might be the case.

Richard F. Muth (1971) did some research to estimate a demand function for land. In his earlier work (1969) he did not have the data so that he might subject to empirical test the notion that land is an input to the production of housing rather than a commodity demanded by housebuyers directly. Using data on the characteristics of new single-family homes financed by F.H.A.-insured mortgages in 1966 in the U.S. he found agreement for his hypothesis. What he did was to specify a model of the way in which land entered into the production of housing in terms of its elasticity of substitution, that is the rate at which its utilization will change given price changes. He found that the ratio of site and dwelling expenditures was related to the ratio of unit land price and square foot construction costs in the manner expected. The ratio of expenditures on factors, the elasticity of substitution, was found to be 0.50. The factor price ratio alone was found to explain

70 per cent of the variation in the ratio of site to dwelling expenditures.

The practical significance of Muth's results is that they indicate how builders will respond to an increase in the price of land relative to house prices and construction costs, i.e. price increases which do not match their planned bid price. The response involves a more intensive use of land relative to the size of the dwelling but more is spent on land relative to expenditure on the structure. If land price increases 5 per cent, let us say, the builder will cut back on lot size with the result that lot price will increase $2\frac{1}{2}$ per cent only. The manner in which Muth reported results did not indicate how dwelling size would have been adjusted, since the practical interpretation assumes a constant selling price and constant square foot construction costs.

One of the limitations in Muth's analysis is that it is based upon cross-sectional evidence. Any understanding which it sheds upon the temporal aspects of land prices is gained by inference. In other words, the real results of the study are, with reference to the preceding statement, that houses with a land price 5 per cent greater than the average tend to have a smaller lot size and a lot price which is $2\frac{1}{2}$ per cent greater than the average.

L. B. Smith undertook two large macro-economic investigations of the supply and demand forces operating in the housing and residential construction markets Compared to his later study (1974), there is not much in this first investigation that bears upon our topic (1971). However, attempts were made to assess the implications of price expectations and land prices.

> The hypothesis being tested by the inclusion of distributed lagged price variables was that housing starts vary with price and cost expectations formulated on the basis of past variations in housing prices, rents, the general

> price level, or construction costs. This hypothesizes that past inflation is extrapolated into the future, causing an acceleration of purchasing and construction plans before prices and costs (actually) rise. (1971: 60)

However, Smith found little support for this view as the expectational variables played an insignificant role in the regression equations, although they were of the correct sign. Smith suggests that the results are not disturbing.

> Despite the lack of success with expectational variables, we cannot conclude that inflationary expectations (or normal expectations!) play little or not role in the residential construction market. Our formulations were extremely elementary and our estimation period when only (from 1954) to the end of 1967, so that only a few observations at the end reflect unusually high inflationary rates and these may be insufficient to generate or detect the anticipated behavior. (1971: 60)

With regard to land prices, it was found that if they rose by 10 per cent, total construction cost (including land) was seen to increase 1.1 per cent while the level of output was seen to decline 3.3 per cent. No comment was made here about causal relationships between these events.

In a later study (1974), Smith estimated an equation to explain the trend in land costs over the 1954-1967 period. His analysis and results are reproduced here.

> Land costs, measured as an index of the cost of land used in the construction of new NHA single detached dwellings, are assumed to be determined by the demand for residential land.[18] The cost of land (L), therefore, is thought to vary directly with population (POP), permanent real disposable income, and expectations as to future land prices (where expectations are extrapolative and represented by past changes in land prices), and inversely with the size of the existing housing stock. (1974: 51)

$$L = -84.1 + 0.022\ POP + 0.028\ YD - 0.081\ SH + 0.65\ \triangle L.$$
$$(4.16) \quad (4.38) \quad (4.93) \quad (3.29) \quad (5.43)$$

where L is an index of land costs on land used for new N.H.A. single detached dwellings, POP is population in thousands, YD is permanent real disposable income in millions of constant dollars, SH is the total stock of housing units in thousands, and $\triangle$ L is the quarterly change in the land cost index.

Smith obtained an extremely high coefficient of determination ($R^2 = 0.96$) for the relationship between land costs and the explanatory variables. This would appear to provide all the evidence that might be needed to confirm the hypothesis of this study. Yet, as will be discussed in subsequent pages, Smith's results have more limited application.

Michael Dennis and Susan Fish (1972) conducted a brief empirical analysis as part of their study of Canadian housing policy. This analysis of data on N.H.A.-financed residential construction was completely descriptive in nature. Yet it is concluded and strongly asserted throughout the rest of their study that "the prices of new houses dominate the markets for all houses" (1972: 78). The following reveals the evidence upon which their assertion is based:

> The average price of NHA houses produced in 1961 was $14,800. The median value reported in the census for houses built 1960-61 was $14,200, and for houses built 1945-59, $13,200. At the same time, the average price paid for existing houses sold under the Multiple Listing Service in Canada was $14,900. These figures bear a close relationship to each other. Apparently they move together.
>
> On the basis of those relationships, it appears that the costs of new houses are a major

> influence on the prices of houses in general, despite the fact that they represent a very small increment in the total stock. (1972: 77)

Their evidence that land prices, in combination with construction costs, determines new house prices is of comparable approach.

The work by Dennis and Fish does accomplish one thing, however, and that is to indicate the intuitive interpretation of readily available data against which the results of the test of more reasoned hypotheses may appear to be counter-intuitive.

Peter Spurr (1976) later conducted an investigation of broad trends in the Canadian residential land market including special studies of six metropolitan areas. Recognizing several shortcomings in his methods of analysis, Spurr emphasized the factual base that his study could contribute to analyses of the land price problem.

Spurr provides a 'theoretical rationale' for lot price increases which derives from many of the propositions reviewed in the literature.

> Most people consider that lot prices are independent of house prices and thus high land prices are determinants of high house prices. Certainly the cost of land and other production costs constitute the minimum price a builder would charge for a house. Moreover, as both house and lot prices are increasing quickly and the proportion of total housing price which pays for the lot is also climbing, it seems evident that the lot prices are pushing up the price of housing. ... it becomes logical to conclude that lot producers (land developers) and the lot production process (involving producers and many government bodies) can control lot prices by direct manipulation and supply manipulation, respectively. (1976: 21-22)

But Spurr does not accept this cost-push argument. Rather, he accepts that builders will determine an acceptable price for lots to be used in

the building process by means of the 'land residual technique' of site valuation.

> This is a practical application of the principle of Surplus Productivity, or the Doctrine of the Agents in Production by which the income remaining to land from the projected highest and best use indicates the value of that vacant site. (1976: 23)

Consequently, the land value depends on the market value of the developed property.

> The lot price is a function of total housing price. This answer to the causation question must be remembered in all policy questions concerning land price as it is apparent that any policy which considers land to be independent of, or causative of housing prices is constructed on weak foundations. (1976: 24)

Spurr then undertook several descriptive analyses of some facets of this phenomenon (1976: 51-56). In particular he provided a rough illustration of the residual pricing mechanism that inter-relates raw acreage prices to house prices. For Canada's major urban centres in the year 1971, he examined the selling price and cost data for N.H.A.-insured single-detached dwellings. By subtracting dwelling construction costs and his estimates of lot servicing costs, he estimated the residual value of the lots used in building (including an allowance for land profit of 15 per cent!). Spurr did not use actually observed land costs in his analysis. This severely limits his illustrative and descriptive study, but provides a tangible demonstration of how the residual land pricing mechanism is hypothesized to work in a competitive market. Spurr makes the following strong conclusion not entirely justified by his analysis.

> When house prices rise, lot prices are elevated commensurately, as the market values of lots are a direct residual function of the value of the housing they may support. Similarly, the value of raw residential land is a function of the value of the lots it may yield. Thus while it is not inaccurate to regard high land prices as the outcome of an imbalance between supply and demand, ultimately, they are caused by the inflated prices at which urbanites buy and sell houses. (1976: 395)

Begun under contract for Central Mortgage and Housing Corporation, Spurr's study was not accepted by them for publication. His spurious conclusions no doubt contributed to their rejection of his work. Spurr's study remains relevant to this investigation insofar as he states a central proposition that has strong theoretical support but no direct empirical evidence that would confirm it.

Witte's study (1975) involved the testing of a theoretical model of the derived demand for land for the determination of residential site prices. Witte hypothesized that site prices were determined by the influence of 21 demand and supply factors. The data used to test the hypothesis were for U.S. metropolitan areas and for the 1966 to 1969 time period. Measures, often indirect, were found for all but three of the variables, notably a measure of the 'population expectation of future prices and incomes'.

> To summarize, it was found that inter-urban differences in residential site prices are determined primarily by the average size of sites in various urban areas (SMSA's), two indirect measures of the price of raw land, the current annual family income of the urban area, and the rate at which the population changed, and hence by implication households, in the urban area. These five factors explain 78 per cent of the difference

> in site prices among urban areas for the 1966 to 1969 time period. (1975: 356)

Multiple regression equations were developed for each year in the sample as well as for the pooled data. No inter-temporal implications were drawn, that is Witte did not explicitly consider what effects upon price were made by changes over time in the values of the independent variables. These must be drawn by inference from the cross-sectional evidence.

Witte's study differs little from other previous ones such as Maisel's in particular. But a significant aspect of Witte's work is its more comprehensive and rigorous nature and thus its more significant results.

> The current study tried all of the independent variables found to be significant in previous studies which could be justified on the basis of the derived demand model being tested and for which data could be obtained. It only found those variables reported in the empirical results above to be statistically significant. In general, the regression coefficients of the present study are much more significant and of more stable effect than those of previous studies. (1975: 361)

On the evidence of Witte's work it would appear that further investigation of a replicative nature is not a first priority as compared to other empirical gaps identified so far.

John R. Ottensmann (1977) undertook a study which addresses one of these gaps, namely the role of expectations. He argued that "when expectations about future development potential are high, more land will be withheld from development, land values will be higher, and the densities in developed areas will be higher". Since no data could be found that was relevant to the first prediction, Ottensmann limited his analysis to the last two hypotheses.

> The hypotheses yielded two equations for the prediction of land price and density of development. Land price is seen as a function of expectations (measured by population changes) and other variables (population and income); density of development is seen as a function of land prices, expectations, and other variables. (1977: 395)

While Ottensmann was interested in expectations from the point of view of their influence upon variations in inter-urban patterns of residential growth, any evidence on this score would of course have applications to inter-temporal variations. However, the expectations that Ottensmann considered were of a very limited kind. They pertained to expected future residential demand. Like Hamilton and L.B.Smith, he saw them to be related to the rate of urban population growth.

> The initial supposition was that the level of a metropolitan area's population growth just prior to and during the period of development considered would most directly influence landowner expectations. However, should landowners exhibit rather more prescience than is expected, the rate of population growth in a future period would be a more appropriate measure of those expectations. Tests with alternative population growth measures failed to support any claim for any special powers of prediction by landowners. The rate of population change from 1940 to 1950 was the best predictor of 1950 land values, while the 1950 to 1960 change best accounted for variation in the 1960 and 1964 land values. (1977: 394-5)

The results of Ottensmann's empirical tests confirmed his original hypotheses.

> The rate of population change positively affects the levels of land values, while these two variables in turn clearly and positively affect the densities of residential development. ... The models account for approximately half the variation in the

> dependent variables in all but a few of the tests. (1977: 398).

Ottensmann concluded that his theoretical account of the role and importance of landowner expectations in the residential development process were confirmed by his empirical model.

He also went so far as to compare his results with Witte's.

> She has achieved higher coefficients of determination but only at the expense of considering a greater number of independent variables. The simple, straightforward model tested here, with but three independent variables, must be considered a valid alternative. (1977: 398)

Validity is a matter of empirical evidence (statistical validity) as well as theory (logical validity). Ottensmann's empirical model may have a statistical validity that is comparable to Witte's but no special claim can be made for the logical validity of the theoretical analysis provided by either of them. Both are lacking in a meaningful behavioral content that logically demonstrates the process which would generate the observed facts. The same criticism applies here that was made earlier with reference to Hamilton's study. A similar criticism applies to L.B.Smith's results (1971, 1974) though in his case the objectives were quite different.

Markusen and Scheffman (1977) had as a central empirical question whether or not there was sufficient ownership concentration of undeveloped land in the urban fringe to constitute market power. Their empirical analyses involved an examination of land ownership in the undeveloped land around Toronto. They concluded that there is insufficient concentration to allow for market power to be exercised.

> The results of both empirical studies (undertaken) suggest that the structure of the Toronto land market is consistent with the version

> of our theoretical models in which (a) the land market is competitive, and (b) there is a high degree of uncertainty. (1977: 123).

In their view, this conclusion justified the use of a competitive market model in analyzing the effects of public policy alternatives. Other investigators, such as Hamilton and Ratcliff (1974), and L.R.G. Martin (1976, 1977) come to similar conclusions in their own empirical studies of related subjects. The significance of Markusen and Scheffman's work lies in their considerable amount of theoretical analysis. Among other things, they demonstrated how an unco-ordinated, decentralized land market with imperfect information flows will result in its operating less efficiently than a well-organized one. Among their empirical results it was shown

> ... that expectations about future prices and the approval process and the expectations-formation mechanism can have significant effects on price and the rate of development in the short run. Therefore incorrect expectations can greatly impair the efficiency of allocation in the short run. (1977: 123)

Their empirical study quantified this aspect of the analysis insofar as it was observed that prices paid to the owners of raw, undeveloped land in agricultural use showed a high degree of variance when controlling for differences in relevant characteristics. This suggested the presence of significant uncertainty in the market. Such variance would not be expected in a market with perfect information, whether perfectly competitive or otherwise.

Gordon W. Davies (1977a, 1977b) developed and estimated a dynamic model which embodied important inter-relationships between land and housing markets. Emphasis was given to an analysis of the effects on these markets of changes in the supply of building lots.

Specifically, Davies formulated a model of the inflation in lot prices, as was reviewed earlier.

The regression equation which best fitted Davies' specifications was the following one (where the symbols of the equation were defined in the earlier summary of Davies' model) (1977a: 251).

$$
\begin{aligned}
PL_t = {} & \underset{(9.70982)}{8{,}232.80} + \underset{(15.0515)}{2{,}164.56dp_t} - \underset{(-3.82611)}{118{,}618(KL_{t-4}/hh_{t-4})} \\
& + \underset{(2.62258)}{857{,}320(KL_{t-4}/hh_{t-4})^2} \\
& + \underset{(2.50040)}{15{,}215.0((ph_{t-4}-ph_{t-5}0/ph_{t-5})-((rc_{t-4}-rc_{t-5})/rc_{t-5}))} \\
& - \underset{(-1.30752)}{91.0710rp_t} \qquad /rd_{t-3}
\end{aligned}
$$

Using monthly data for the 1966-1973 period, and aggregate or macro-data for observations, Davies obtained an R^2 of 0.83, with all coefficients being significant at the 10 per cent confidence level. Davies concluded that

> Based on these results, builders appear to form their expectations about future prices and costs primarily on the basis of the rate of change in the profitability of building and selling houses four months prior to the current period. The corresponding lag on the rate of return on an alternative investment, rd, is three months. On the other hand, the cost of borrowing, rp, acts without a lag. (1977a: 251)

Davies found that his estimated model generated a time path in lot prices which was quite close to actual prices.

Davies then used his model in a 'policy experiment' in which he altered the value of one of the exogenous variables, the stock of building lots, and traced the effect on the endogenous variables (1977b).

His results, as follows, led him to question land supply policies as a significant means of public intervention in land and housing markets to reduce the price of housing.

> Examining the initial dfiferences, we see that the policy change of 250 lots constitutes an 11 per cent change in the stock of vacant lots KI. The resulting drop in the price of land PL amounted to less than half that, about 4.5 per cent. In the short run, a change in the stock of lots therefore has a strong effect on the land market. The fall in the price of land increases the profitability of constructing single-family detached starts by 1.24 percentage points, but this change increases single starts by only 1.45 per cent in the first month in which they are affected. Single starts is a key variable in the model linking the land and housing markets, so it follows that the effect of the policy change in nl on the two housing submarkets is almost negligible. (1977b: 407)

The interpretation of Davies' results must be qualified by the criticisms made earlier of his model, namely its inadequate identification of the supply and demand sides of the land market. In effect, Davies has estimated a type of reduced-form equation that includes both supply and demand variables. His analysis is weakened by inattention, both theoretical and empirical, to the underlying supply and demand functions.

The aim of this part of the survey was to identify and characterize the evidence in support of the theoretical propositions previously reviewed. Ideally, a systematic study of these research findings should be undertaken to evaluate the evidence for and against each major proposition identified in the preceding section. However, this would be a highly time-consuming task that cannot be pursued here.

It can be concluded at this stage that no set of studies has manifestly provided confirming empirical evidence in support of a complete set of theoretical propositions explaining inter-temporal residential land price variations. The studies by Hamilton (1970), L.B.Smith (1971, 1974) and Witte (1975) offer evidence about the causes or long-run determinants of land prices, the major ones being population size and household income. The work by Muth (1960, 1971), Ottensmann (1977), and Davies (1977a, 1977b) provide suggestive evidence on the role of expectations on the demand side of the lot market while the studies by Milgram (1968), Schmid (1970), and Markusen and Scheffman (1977) offer a variety of evidence on the nature of behavior on the supply side.

Directions for further study might be discussed with reference to L.B.Smith's results (1974: 51). Smith found that the average price of land used in the construction of new N.H.A. single detached dwellings over the 1954-1970 period, "assumed to be determined by the demand for residential land", was a function of population size (+), real disposable income (+), expected future land prices (+), and size of existing housing stock (-). The signs in parentheses are Smith's confirmed hypotheses about the nature of the relationship between the respective independent variables and the dependent variable. Smith obtained a staggeringly high coefficient of determination.

Presented with such a high R^2 of 0.96, a search for confirming evidence that land prices have been established by the force of demand pressures and by expectations could end here. Smith's results might suggest that an efficient operation of the residential land market can be obtained merely by communicating to house builders information about the size of the population and the housing stock, the level of income,

and recent land prices. Builders would do the rest by digesting these data and coming up with an appropriate price which they would bid for and find building lots.

Such a conclusion is not warranted, nor was it suggested by Smith. It is instructive to consider the limitations of Smith's results. First, no potential role was given to the supply side of the land market. That market price is completely demand-determined was not fully justified by Smith and was based on the assumption of a constant supply of residential land. This seems most untenable in view of analyses by Clawson (1962, 1971) and Schmid (1971).

Second, the equation does not offer an explanation of the way in which builders decide upon land prices. Like Hamilton (1970) and Witte (1975), for example, Smith has estimated the relationship between macro-economic variables and land price. Muth (1960, 1971) and Davies (1977a) come much closer to specifying variables which builders themselves consider in their calculations as well as the arithmetic with which these variables are manipulated by builders to determine their land demand.

Directions for future empirical study are suggested by this analysis. First, average land prices over time should be seen as the consequence of the interaction between supply and demand forces. Second, land supply and demand should be specified in a behavioral form that identifies the process by which macro-economic causes or determinants transmit their influence to land prices. This process involves the formation of reservation prices, as discussed by Bish and Nourse (1975), through expectations about selling prices, construction costs, and rates of return.

The pursuit of such a study will involve prior re-consideration

It was recently asked, 'is land pricing housing out of existence?' (Flood, 1978). Flood answered that it was not, that the price of land does not determine the price of the end product, and that the high price of land does not seriously constrain the supply of housing (1978: 8). His answer appears to be based on arguments presented in theoretical and empirical analyses reviewed here. His confident reply must be questioned in view of the weak empirical evidence which is to be found in support of predominant theoretical propositions.

Our characterization of the current literature is supported by Gerecke's review of several recent works, by Bourne (1977), Hamilton, et al (1976), and others. He concludes that these works,

> ... prolong the debate (on the land question) but do not clarify it. (1977: 42)

It is further supported by the contrarity of views taken of the recent work by Markusen and Scheffman (1977). Goldberg (1978), for example, states that

> ... the present study convincingly eliminates one purported cause (of the land price boom): monopoly control and manipulation of the market. (1978: 15)

He further asks,

> In a world with imperfect information, is it really reasonable to expect even well-functioning markets with well-intentioned developers, municipal officials and consumers to act in such a way as to ensure instantaneous adjustment? I think not. (1978: 15)

Gunton (1978), by contrast, finds several deficiences in the work by Markusen and Scheffman to the extent that

> The study has numerous limitations which make its policy conclusions of dubious value. (1978: 39)

He suggests that the most serious question, ignored by the authors, is the distribution of land profits. This continuing debate can only indicate unresolved issues in the literature.

CHAPTER THREE

A THEORETICAL MODEL

INTRODUCTION

This chapter has two parts. In the first is presented an overall, critical appraisal of the theory and empirical research reviewed in Chapter Two.

In the second part of the chapter a theoretical model is developed to provide a coherent and succinct explanation of intertemporal land price variations. Beginning with a review of some practical guidelines for the statement of theory and the construction of models, the model is developed in four steps: a structural model of supply-demand interaction in the market is stated, the demand determinants are more closely specified, the supply determinants are discussed, and finally, the reduced-form of the model is obtained as well as its 'solution' or implications. The chapter is concluded with a review of the features of the theoretical model which propose to meet some of the criticisms of existing theory identified in the early part of the chapter. In Chapter Four is described the proposed empirical investigation which will subject the theoretical model to test and verification.

3.1 EVALUATION OF EXISTING THEORY

Treating the available theoretical analyses, and their supporting empirical studies, as one comprehensive body of work, it is possible

to reach some kind of judgment about its overall adequacy in explaining how residential land prices are established, how inter-temporal price variations occur, and how these are related to changes in housing prices over time.

This appraisal begins with an examination of some general criteria with which the existing body of literature might be assessed. Next, five specific criticisms of the literature are presented. These are (1) the absence of a comprehensive framework of analysis; (2) the inadequate treatment of disequilibrium situations; (3) the emphasis upon a static rather than dynamic approach; (4) a limited behavioral content; and (5) ambiguity in the "identification" of demand and supply. These shortcomings of existing analysis and research identify areas of further study for the development of a better policy-relevant understanding of the land market's operation.

Before giving attention to the explanatory power of existing theoretical analyses and the validity provided them by supporting empirical studies, it is necessary to establish some standard against which those efforts can be judged.

Eugene F. Meehan (1968) offers some practical criteria for this. He proposes that to explain is to understand past and present events, and on the basis of that understanding to generate expectations about future events and to discover ways in which future events might in principle be controlled (1968: 21). Explanation generates expectations about the consequences of specified interactions among stipulated variables; as a result, manipulation of these relations should allow control over the consequences of the interaction between the variables (1968: 23-24).

According to Meehan, explanation involves two processes. There is an empirical one that gives an observational base to the interactions or phenomena of interest. There is also a logical one which provides the reasoning by which specific occurrences are expected under specific conditions.

The logical process involves the selection or formulation of a system that can represent the structure of the empirical situation or events for which an explanation is desired. It defines the variables involved and specifies the nature and parameters of their interrelationships. The empirical process involves a test of the explanation to determine if its hypothesized or proposed predictions are found to occur in applicable empirical situations.

In practice, explanations or theories evolve through the interaction of the two processes as engaged in by numerous analysts and investigators. An explanation is finally established when "... it will explain given events with known reliability and can be used for defined purposes" (1968: 101). Such criteria are obviously consistent with the objective of the study established in Chapter One.

The first criticism of available theory and research is the absence of a commonly accepted framework of analysis. No one theory, model, or investigation surveyed fully contains a general and reliable explanation of price determination and inter-temporal price variations in the residential land market. As varied a lot as sociologists, real estate appraisers, assessors, geographers, economists, land economists, housing economists, planners, geographers, transportation economists, and regional scientists have explored the phenomenon. They have usually done so in the pursuit of individual purposes and objectives. We thus find not one theory but several -- theories of real estate

appraisal, property value assessment, residential location, urban spatial structure, housing price determinants, land use succession, and suburban land speculation. In these analyses, the treatment of land prices is often incidental to a larger objective and the relevant analysis is compromised thereby.

A consequence or characteristic of this variety is the lack of coordination between analyses of different sub-topics. For example, the analysis of land speculation makes little reference to the derived demand for land expressed in builders' bid prices for land.

A second consequence is the disjointedness in the conclusions and results achieved. This poses an obstacle to the achievement of a common and firm understanding about inter-temporal land price variations.

The second shortcoming of existing theory and research is a reliance upon an equilibrium approach, an assumption that perfectly competitive demand and supply forces are in perfect adjustment with one another, even when it is recognized that the land market is replete with disequilibrating characteristics such as imperfect information, transaction costs, and laggard price-responsiveness.

It is worth considering more closely what is meant by equilibrium. J. van Doorn (1975) defines equilibrium as 'a constellation of selected interrelated variables, so adjusted to one another that no inherent tendency to change prevails in the model which they constitute' (1975: 9).

> In other words, equilibrium is a situation related to a particular theory or model. The mere equality of any two variables in a certain period, say quantity demanded and quantity supplied, ..., does not constitute equilibrium in the above sense. It just states

> an accounting identity involving flows or stocks. Quantity demanded and supplied, ..., are not purely autonomous, but are related to various other explanatory variables such as prices and incomes ..., which themselves again depend on other values. An equilibrium only exists within a framework of relationships, which we call a model, when all dependent variables simultaneously show no endogenous tendency to change. (1975: 9-10)

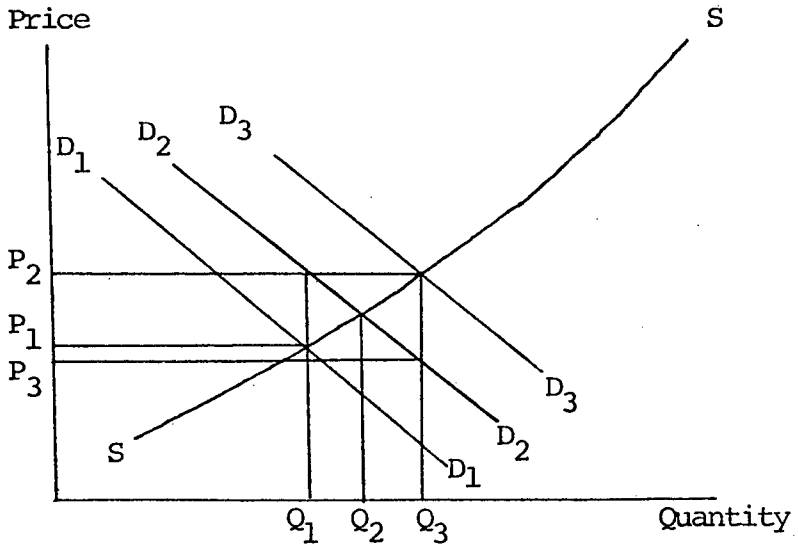
Wallace Smith (1970) concluded from a discussion of equilibrium,

> the traditional concept of 'supply-and-demand equilibrium' is not very relevant to most of the problems or issues which are associated with the housing sector of the economy. (1970: 40)

Harrison (1977) provides a very good illustration of the relationship between imperfect information and disequilibrium in property markets. In the example offered, firms respond to a widely recognized increase in the demand for office space according to the following sequence of events:

> If, in time period one, demand shifts from DD_1 to DD_2, price will rise to P_2 if supply cannot increase immediately to Q_2 because of the time required to finance, design and construct additional space. At price P_2, Q_3 could be profitably supplied and hence firms will tend to increase the volume of accommodation available in anticipation of the large profits which would be enjoyed at price P_2. However, if Q_3 is supplied then it will only be fully taken up at price P_3 which is much below the level which would justify the allocation of resources to the extra space concerned. The result in the short and medium term is a condition of 'excess supply', in which properties remain empty or prices are cut to P_3, much below the price at which any further space would be provided. The excess would only disappear if demand rose over

> time or some of the older stock, less attractive and more expensive to run, was withdrawn from the office market and converted to other uses. A good example is the recent office boom in New York which, helped by changed financial conditions, responded to pressure on space in Manhattan to the extent that a situation of over-supply was created and prices had to fall, in real and money terms, to clear the market. (1977: 72: 73)



Malton R. Strazheim (1975) notes that market equilibrium has been a theoretical cornerstone in the land economics literature

> beginning with the theory of location rent and, more recently, as represented in the closed, general equilibrium models already described (e.g. Richard F. Muth and William Alonso). ... As noted, much of it (the literature) has been directed at describing how the land market clears ... The approach outlined here suggests that classical location theory and associated models have missed many of the important factors which influence land markets. (1975: 27)

According to Straszheim many studies have avoided an 'analysis of several intermediate processes in the determination of how the land market clears', if it clears at all.

This concern is not limited to models and theories in land economics but in all economics generally. M. Ishaq Nadiri and Sherwin Rosen (1973), for example, argue that while equilibrium is possible at a moment in time, it is unlikely that it is maintained at every point in time. With reference to the micro-economic static equilibrium theory of the firm they argue as follows.

> Although estimation of long-run profit-maximizing conditions may be appropriate to cross-sectional studies, no such case can be made for time series. Given the presence of large and uncertain variations in final demand and of short-run imperfections in factor and product markets, there is no reason to expect decision makers to maintain "long-run" desired input positions at every point in time. Instead, gradual adjustment to these positions is to be expected. (1973: 1).

Richard J. Sweeney(1974) argues that both micro- and macro-economic theory commonly adopt an equilibrium approach. For example,

> Macro theory commonly takes a particular aggregated, perfectly competitive, general equilibrium system -- the Keynesian system -- and modifies it with an ad hoc limitation on its equilibrating tendencies, to induce phenomena that simulate the disequilibrium of the real world. Thus, in a macro system that would otherwise show a perfectly competitive general equilibrium, unemployment results from a liquidity trap, or rigid money wages, or money illusion, or rigid real wages, or rigid prices (take your choice). Meanwhile, all markets except the labor market are in perfectly competitive equilibrium -- ... (1974: iii)

That is to say, the analysis of disequilibrium situations involves some ad hoc tinkering with the model so that it can accommodate real-world situations. The imperfections, rigidities, and immobilities in markets means disequilibrium but the presupposition of most models and theories, including those reviewed in this study, runs counter to these pervasive

tendencies and possibly precludes an adequate explanation of the operation of these markets.

Very closely related to an inadequate treatment of dis-equilibrium situations is the emphasis on static rather than dynamic aspects of market operations. Whereas the equilibrium approach implies a perfect adjustment between supply and demand forces, a static approach implies an instantaneous and simultaneous adjustment.

Straszheim observes, in another context,

> The structure of existing general equilibrium models of urban spatial structure can be easily summarized. Their basic character is not unlike the early macro-economic models: they are closed, comparative static in nature, with no specification of the adjustment processes by which the urban area transforms itself from one state to another. (1975: 18)

Such a criticism might also apply to the land market models and theories surveyed in Chapter Two. By and large they do not address the process by which the time path of residential land prices is established.

Van Doorn indicates that the analysis of equilibrium situations has typically involved a 'static' analysis. The method of comparative statics involves the analysis of equilibrium situations at two points in time with little attention given to the processes taking place over the interval between those two points. Blalock comments that "a dynamic formulation is one in which the time factor enters into the theory in an essential way" (1969: 78). Van Doorn more specifically suggests what a 'dynamic' theory would be like.

> ... it involves variables at different points in time. ... It is not sufficient for a model to be labelled as dynamic if time is (more) explicitly introduced. What should be the case is that not all variables refer to the same time period. It will then

> be possible to trace out a self-generating -- endogenous -- time path of development. (1975: 10)

This is to be preferred to a static model whose dynamism and inter-temporal aspect lies in the ad hoc administration by the modeller of shocks, or changes in the exogenous variables, to the equilibrium and 'timeless' situation represented in the model.

We must be reminded, however, that "dynamic" does not imply "disequilibrium" any more than "static" implies "equilibrium". As van Doorn writes,

> Because static models are related to equilibrium positions does not mean that dynamic models are solely concerned with disequilibrium positions does not mean that dynamic models are solely concerned with disequilibrium positions. Dynamic models can generate equilibrium or dis-equilibrium time paths. (1975: 10)

And therein lies their obvious advantage and superiority over static models. However, there are many difficulties in formulating and estimating dynamic models. Straszheim notes that

> Most of the limitations of the closed, general equilibrium models of urban spatial structure ... are associated with the simplifying assumptions required to obtain closed form solutions.
>
> ... The combination of considering many sub-markets ... (and so on) virtually pre-cludes finding analytical solutions delineating how these many housing (and land) sub-markets are cleared or how decisions evolve over time. (1975: 21-22)

Straszheim found that by relaxing many of 'the overly restrictive and simplistic assumptions' investigators would have to forego 'an analytic solution to the problem of how all sub-markets are cleared'. They would also lose their ability 'to predict how market results would

differ if certain underlying parameters changed'. Some of the difficulties involved are analyzed by R.C.Fair and Harry H. Kelejian (1974). Sweeney, too, notes that "the theory of decision-making over time, subject to disequilibrium and error, can rapidly become so complex as to yield no results at all" (1974: iv). However, Sweeney was far less pessimistic than Straszheim about the possibilities of formulating and estimating dynamic models. The answer appears to lie in the behavioral content of the model and in the way it joins micro- and macro-processes and variables.

In Chapter Two, several studies were shown to relate cross-sectional or inter-temporal price variations to macro-economic variables such as population and income. The empirical work by Clonts, Hamilton, and Witte are examples of these. It was noted that such models lack a meaningful behavioral content. This is to say that the decision-making behavior of individual firms was not accounted for by means of variables that firms might actually consider in their decision-making. On the other hand, several studies were seen to include variables upon which builders might actually form expectations about situations confronting them in the present or in the future. The studies by Davies, Muth, Milgram, and Markusen and Scheffman are examples of these.

Nadiri (1973) comments that while the question of price expectations was seldom considered very crucial by economists, the introduction of adjustment costs and lags in a dynamic context makes it imperative to treat expectations and optimizing behavior. Van Doorn pursues this comment.

> Unlike machines, human beings do not react in a passive-mechanistic way once a disequilibrium situation has arisen. Individuals

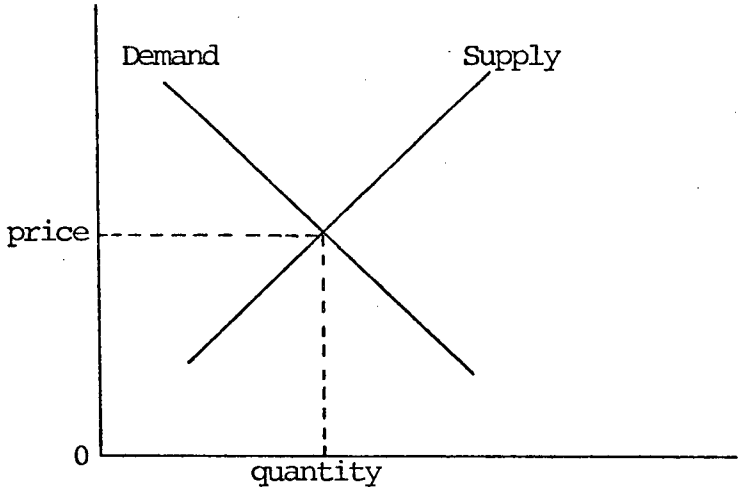
> do not base decisions on what is being observed in the market at some point in time alone. They usually have recorded past observations in their memories, and they may even think they know better than the market what future developments will be. In other words, they have anticipations or expectations about the future course of developments and may act on their belief. This will have implications for the error-adjustment process. (1975: 13).

When the role of expectations is introduced in the analysis of the land market, it is then necessary to relax the assumptions of perfect information and instantaneous adjustment of supply to demand condition. Expectations by their very nature suggest and involve lags and errors. Lags arise from the psychological inertia or slowness in response in acting on new information or revised expectations. Errors arise in the formation of expectations on the basis of incomplete or erroneous information.

A fifth and final criticism must be directed to the absence of any discussion in the literature about the "identification" problem as it is referred to in econometrics. H.H.Kelejian and W.E.Oates (1974: 244-252), J.M.Heineke (1976: 45-54) and E.J.Kane (1968: 325-329) present detailed discussion of this problem.

Several of the studies reviewed propose that land prices are either demand-determined or supply-determined. Yet, any basic microeconomics textbook, for example Lipsey (1963), Samuelson (1968), or Watson (1972), establishes as a basic economic principle that market price and quantity are jointly determined by supply and demand, as depicted in the following diagram:

FIGURE 1. Demand and Supply in Market Equilibrium



It describes a competitive market in equilibrium where the quantity of a good demanded by many buyers and the quantity supplied by many sellers will tend toward equality. The demand and supply curves represent schedules of the quantities demanded or supplied at alternative prices.

The "identification" problem in econometrics lies in correctly estimating these schedules (referred to as 'functions'). One form of problem is to be found in some of the studies reviewed. It lies in mistaking shifts in demand (or supply) as determining the movement of market price. These shifts will affect price, but not singly or totally. The following diagram depicts an observed movement in price and quantity determined by both supply and demand. To focus on demand and assume an unchanging supply curve in the following example is to conclude something quite erroneous about supply. It is to see a relatively inelastic supply curve, *Qs, when in fact it does not have these characteristics at all, but is shifting from S_1, to S_2, to S_3.

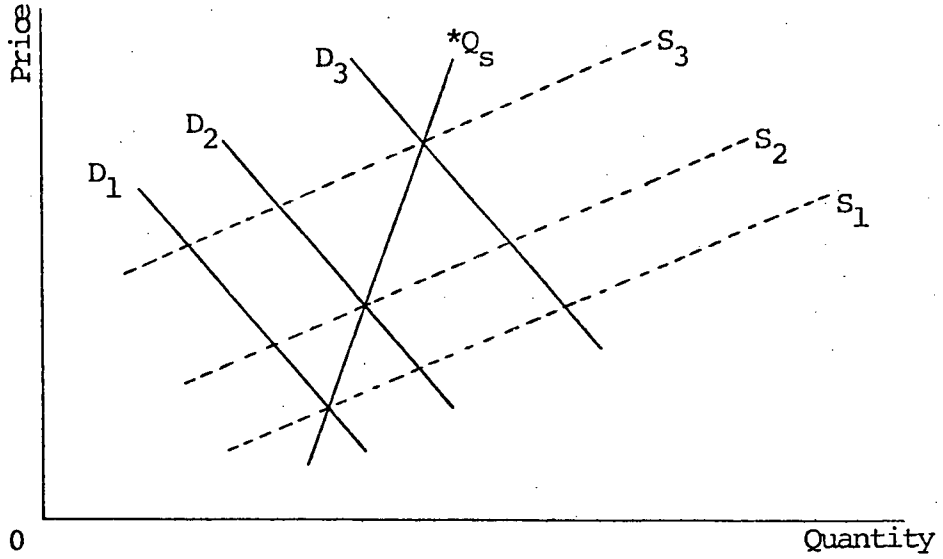


FIGURE 2. Illusory Supply Curve When Supply Shifts Are Ignored.

If it is demand which is assumed to be unchanging, price changes could easily be attributed to speculative activity on the supply side.

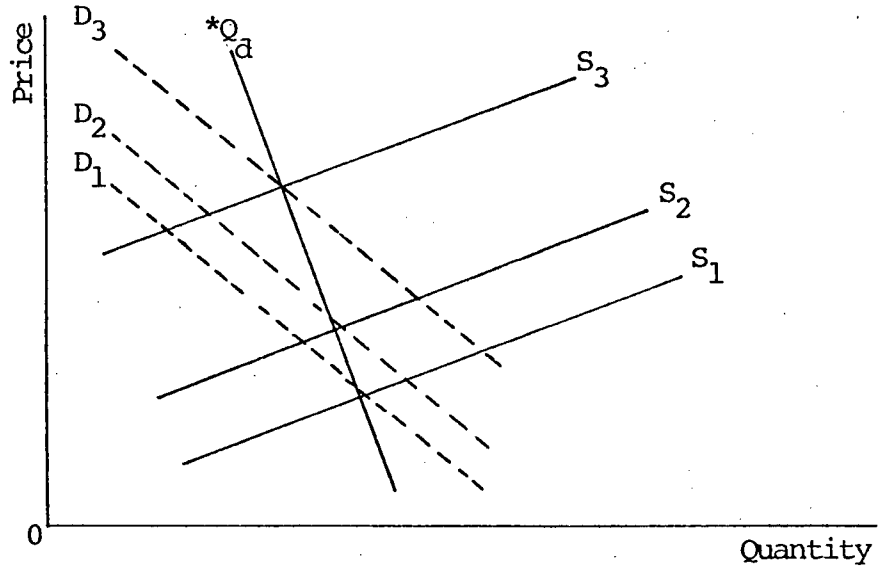


FIGURE 3. Illusory Demand Curve When Demand Shifts Are Ignored.

The diagram shows how the shifts in the supply curve all by itself could be concluded to raise price, if it is assumed that demand remains unchanged at *Qd. Only by explicitly acknowledging the role of both supply and demand will a correct interpretation have a chance to emerge. This frequent error strongly suggests that any proposition about intertemporal variation in land price should be based upon a reasonably established set of propositions about demand and supply. In so doing, much confusion about the type of market situation addressed is removed, for the specification of demand and supply equations generally fixes the degree of competition to be postulated for the demand side and the supply side.

This overall evaluation reveals that much might be accomplished, both theoretically and empirically, by a re-formulation of existing theoretical propositions which takes into account the analytical considerations raised here, and the substantive and empirical considerations raised in Chapter Two.

3.2 THEORETICAL MODEL

A three-step procedure is recommended by C.D.Harbury in the 'scientific' study of an economic or related problem (1971: 180-181). First, the problem is identified. This requires stating it in a precise enough form so that it is possible, in principle, to find facts which relate to it. In this study, the problem is the nature of the process by which residential land prices are determined, the way in which intertemporal price variations in land are generated, and the relation of these to house price levels and price changes over time.

Second, a possible explanation is proposed for the problem or phenomenon being studied. This requires that a statement be made about the potential but strictly relevant causes of the phenomenon. A quantitative form is generally used to precisely state the hypothesized causal relationship so that it can be confronted with facts. The theory formulated here is that house-building firms in the land market will have bid prices for house-building lots that are based upon the firm's calculation of the residual between expected selling price of completed new dwellings and the expected construction costs, and further that this bid price will be the discounted or present value of the residual, using the firm's opportunity cost of capital as the discount rate. The theory also postulates that landowners have asking prices, and that the interaction of lot buyers and sellers determines the market price of lots and the number of transactions over successive time periods.

In the third step of this procedure, factual evidence relevant to the problem is assembled. Facts which represent actual values of the variables in the explanation are compared against values predicted through the explanation. Results of this comparison allow a judgment to be reached about the adequacy of the theory's hypotheses and explanation. In this way, a test of the theory is performed. The empirical investigation called for in this third step is described in Chapter Four while its results are presented and evaluated in Chapter Five.

This second part of Chapter Three addresses the second step of the procedure outlined above -- an explanation of the determination and inter-temporal variation of residential land prices is proposed. Following the evaluation just completed, several desirable characteristics of the theoretical model can be identified.

First, the 'behavior' of macro-variables such as the market price of lots and the number of lots bought and sold must have an explicit micro-foundation. Changes in them, over time, must be the aggregate result of the behavior of individual decision-makers in the residential land market, i.e. house builders on the demand side, and developers of building lots on the supply side. The model must rigorously analyze the behavior of these firms and determine macro-economic results on the basis of consistent and explicit aggregation.

Second, the model must describe and analyze behavior when there is disequilibrium as well as when there is equilibrium. In particular, it must describe behavior when the asking (or bid) prices that firms confront are different from their own reservation prices, or when they cannot sell (or buy) as much as they like at going prices. That is, builders' and lot suppliers' response to disequilibrium, through price, quantity, or other adjustments, must be considered.

Third, the model must be dynamic and treat time in a realistic fashion to allow the analysis of the operation of the residential land market over time. This capability will be found in the explicit treatment of firms' expectations which pertain to a forthcoming time period and which are based on values in past periods. Such inter-temporal price 'relations' will make the model dynamic and will mean that inter-temporal price 'variations' can be explained directly by the model instead of being interpreted or deduced through an ad hoc, comparative static analysis.

Fourth, the model must explicitly consider both demand and supply and treat market variables, price and quantity, as determined by both. It should be explicit about the macro-variables which influence demand and supply through the formation of expectations and reservation

prices. It should also be explicit about the micro-variables, i.e. the reservation prices, which form supply and demand.

These four characteristics answer the major criticisms of existing theory and research raised earlier in this chapter. A satisfactory implementation of them should yield a theoretical model whose explanatory power and policy relevance will exceed the capabilities of most existing theoretical analyses.

The Nature of Theory and Model-Building

Before developing the theoretical model it is useful to consider some practical guidelines as proposed by Lowry (1965), Meehan (1968), Kane (1968), Blalock (1969), Harbury (1971), and others.

In practical terms a theory is a system of statements discussing in abstract and simplifying terms the set of facts that are to be explained. Whether or not a statement is theoretical or empirical in content depends on its generality. Generalization is a matter of eliminating the detail and heterogeneity in the class of real-world events under consideration by relating them to abstract concepts or symbols.

An important device in the statement and testing of theory is the model -- a logical, and usually mathematical, representation of whatever theory is most relevant for treating a particular phenomenon. While a theory can be said to take the form of verbal statements specifying certain patterns among real-world facts, a model usually takes on a mathematical form through a system of equations that embody theoretically-based interdependencies among empirically-identifiable variables. The approach selected here is to develop a 'theoretical model' which combines characteristics and properties of both.

A model can be defined as a representation of reality and by definition it will simplify that reality by means of assumptions and abstractions. The objective in model-building is to find what amounts to an 'optimal over-simplification' (Kane, 1968:13). This involves making its crucial assumptions and abstractions realistic while ignoring the realistic detail of the rest of the world. By 'crucial' assumptions and abstractions are meant those to which the phenomenon studied is allegedly most sensitive.

In economics, theory and models usually concern recognizable entities such as individuals, households, business firms, industries, and government agencies. These are referred to as 'decision units'. The activities of these units, such as consumption, production, exchange, and regulation, arise from their decision-making and goals. These activities generate economic processes or the interaction of decision units in what are called 'markets' where exchange takes place through the medium of price. Decisions and activities involve inputs and outputs such as information, money, goods, and services. Markets too entail inputs, such as the demand schedules or reservation prices of demanders and the supply schedules or reservation prices of suppliers (e.g. consumers and producers respectively), and outputs such as quantities exchanged and transaction prices.

The construction of an economic model involves the specification and characterization of those of the above elements and relations which can best represent the phenomenon to be explained. In so doing, an attempt is made to vigorously specify them such that a minimum of concern need subsequently be shown about elements and relations ignored.

The expression of the model -- and this may take a verbal, graphical, or mathematical form -- involves two kinds of ingredients: variables and parameters. Kane defines these terms as follows:

> Variables are economic quantities free to take on any of a number of possible values. Parameters are constants which, although not always known, are presumed to have fixed numerical values in any observation situation. (1968: 18)

Variables are of two kinds. Dependent variables are the economic quantities whose values are to be explained. Independent variables, sometimes called predictors, determinants, causes, factors, explanatory variables or causal variables, are those quantities whose values explain the values of the dependent variable. Kane notes a further, related distinction among variables.

> Some variables ... are determined within the model itself, while others ... are determined outside the model. The latter, which are termed <u>exogenous variables</u>, enter as "givens". ... (although it is definitely expected that exogenous variables will change through time. Exogenous variables bear the responsibility of making the model go -- of changing the state of the system.
>
> The other sort of variable, called <u>endogenous,</u> is defined by the condition that its value is determined jointly by the relations of the model and the values of the exogenous variables. In broad outline, exogenous variables represent outside forces which characterize the external environment and which, through the properties of the model, act upon the endogenous variables. (1968: 18)

Parameters, as defined by Kane, can be thought of as 'non-variables'. Having constant values, they tie the variables together by specifying the character of the relation among variables and, more

specifically, the nature of the causal relationship between the dependent variable and the explanatory ones.

Three types of parameters can be distinguished: behavioral, technological, and identity. Parameters are classified according to the economic nature of the relationship they embody. Behavioral parameters are used to characterize relations among variables in a statement pertaining to the behavior of decision units. Definitional relations would call for identity parameters of an accounting type. In relating outputs to inputs in the production process technological parameters are employed. These parameters also include institutional factors.

The equation, $Y = a + bX$, is a mathematical statement of the relationship between a dependent variable, Y, and an independent or explanatory variable, X. The parameters, a and b, specify that the dependent variable will take a series of values (or the values of the dependent variable will be) explained by the values of the independent variable multiplied by parameter 'b' and increased by the amount of parameter 'a'. The following diagram is a graphical illustration of this relationship. It shows the meaning of 'a' and 'b'. In this case, 'a' is the intercept of the Y-axis, while 'b' is the slope of the line relating changes in the value of Y to changes in the value of X.

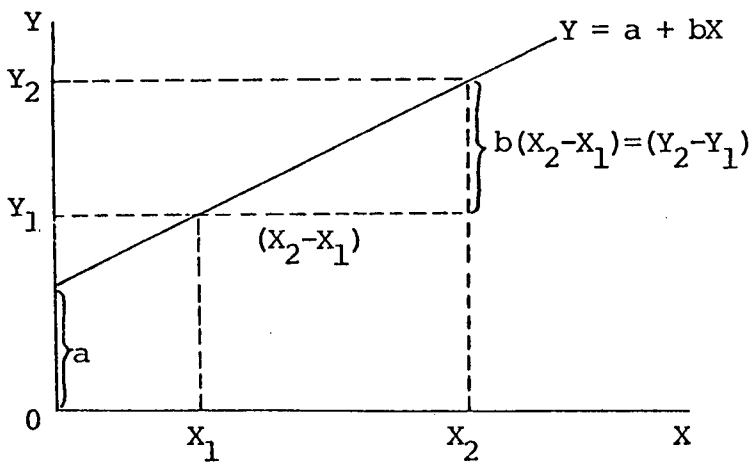


FIGURE 4. Illustrated Linear Regression Equation.

In its most general form, a model will be expressed in 'functional' terms. For example, the preceding equation can be written as $Y = f(X)$, which states that Y is a function of X. It simply means that Y is somehow, in some unspecified way, dependent on X. The model is made more specific by expressing the precise nature of the functional relationship between the dependent and independent variable(s). This requires a statement about the form of the relationship and the sign, and possibly the magnitude, of the parameter(s).

The sign of the relationship can be positive or negative depending on whether the depend variable varies positively or negatively (inversely) with the independent variable. In the preceding example, Y and X are positively related since the parameter relating them to one another is of the positive sign, +b. Graphically, this means that the line traced by various Y_i, X_i values will be upward-sloping.

The form of the relationship is specified by the configuration of the parameters (e.g., a+b, $a + a^2 + b$, b^2, ab, etc.). The magnitude of the parameters, their numerical value, also plays a significant role and the model will sometimes specify them but usually in a relative sense (e.g., smaller, than 1 or b smaller, than C).

Model construction or specification involves the expression of theory following the conventions outlined in these pages. It identifies the relevant explanatory variables and the sign, form, and relative magnitude of the parameters that describe the hypothesized relationship between explanatory variables and the dependent variable. A model is fully specified when it has a 'solution'. Orcutt explains this characteristic as follows.

> Solution of a model consists of deriving implications from it. Solutions may be more or less complete, and a wide variety of ways of solving a

> model may be possible. The various approaches to solution of social system models may be classified into three broad classes, which for present purposes will be referred to as the analytic approach, the transitional matrix approach, and the simulation approach. (1976: 9)

It is the analytic approach that is most often used, and the one which will be adopted here.

> In the analytic approach an attempt is made to deduce a relationship for each endogenous or output variable of a model that will express it explicitly as a function of initial conditions and exogenous or input variables of the model. The set of such relationships is the general solution of the model. Specific solutions of a model are obtained by evaluating these functions for specific sets of endogenous variables for specific time periods, and for given values of initial conditions and exogenous variables. (1976: 9)

The importance of a model's solution is two-fold. First, it is a source of predictions from the theory. These can be confronted with facts to test their conformity with the real-world situation. This is especially useful when for some reason the structure of the model itself cannot be tested directly. For example, it may be easier to find data pertaining to the model's predictions than to its structure. The predictions thus provide an indirect way of testing the model.

The solution is secondly a source of applications of the model to the real-world. In this regard, Kane noted that a model's variables can be classified into two policy-relevant categories.

> Policy makers prefer yet another distinction: between policy instruments (means) and targets (ends). In most models some of the exogenous variables are under direct government control. These controlled variables ... are policy instruments. Given knowledge of the economic

> structure, by varying the level of these variables governmental authorities are able to make endogenous variables equal to predetermined target levels. (1968: 18)

A further discussion of this policy approach is found in Dernburg and Dernburg (1969: 21-27).

Outline of the Model

The theoretical model is developed here in four steps. First, the structure of the model will be outlined, specifying the market determination of the market price and number of building lots transacted. Second, the determinants of demand will be more closely specified. Third, the lot supply determinants will be specified. Fourth and finally, the analytical solution of the model will be obtained by deriving the equilibrium conditions of the model and the causal relation between land prices and new house prices. To complete the development of the model some of its significant characteristics and properties will be summarized insofar as these address shortcomings in earlier investigations identified in the first part of this chapter.

Structure of the Model

Presented below is a system of equations specifying the determination of annual average price and quantity of building lots for single-detached housing. It is theorized that the market for building lots is a perfectly competitive one in which the market price of lots and the number of lots transacted in any given time period are jointly determined by the demand for lots by many builders and their supply by many

developers or land-owners. The following system of simultaneous equations constitutes the structural form of the model. It includes a demand function, a supply function, and a market-clearing equation, as follows:

$$qL_t^d = f(rL_t, rL_t^b) \quad \text{demand equation} \quad (1.1)$$

$$qL_t^s = f(rL_t, rL_t^a) \quad \text{supply equation} \quad (1.2)$$

$$qL_t^d \cong qL_t^s \quad \text{market-clearing equation} \quad (1.3)$$

where qL_t^d = builders' demand for lots in period t,

qL_t^s = developers' supply of lots in period t,

rL_t^b = builders' average reservation or bid price for lots,

rL_t^a = developers' average reservation or asking price for lots,

rL_t = average market price of building lots in period t, and

where qL_t = number of building lots transacted during period t(not shown).

An equilibrium approach is adopted here since, as will be discussed later, it is postulated that a condition of relative equilibrium will prevail over time. Short-run disequilibrium will be defined as follows:

$$qL_t^d > qL_t \geq qL_t^s \quad \text{excess demand} \quad (1.4)$$

$$qL_t^d \leq qL_t < qL_t^s \quad \text{excess supply} \quad (1.5)$$

where qL_t is the actual quantity of building lots transacted during period t. Excess demand occurs when, for a given market price, rL_t, the quantity demanded exceeds the quantity supplied with the result that the actual quantity traded will lie somewhere between the two and possibly on the supply schedule. With excess supply, the opposite situation prevails.

The specification of the model follows the conventions employed in elementary micro-economic analyses. That is, the equations embody the principle that market price and quantity are jointly determined by the demand and supply forces represented in the terms on the right-hand side of the first two equations. These terms, rL_t^b and rL_t^a, are defined here as the reservation prices of the demanders and suppliers of lots respectively. They are composite variables whose determination is theorized to result from the decision-making of builders and lot developers. All of the variables in Equations 1.1 to 1.3 are defined as the aggregation of the values which these variables take at the individual or micro level. That is,

$$qL_t^d = \sum_{D=1}^{x} qL_t^D, \text{ where } x = \text{number of builders, and } qL_t^D = \text{individual builder lot demand;}$$

$$qL_t^s = \sum_{S=1}^{y} qL_t^S, \text{ where } y = \text{number of lot developers, and } qL_t^s = \text{individual developer lot supply;}$$

$$rL_t^b = \frac{\sum_{B=1}^{x} rL_t^B}{x}, \text{ where } x = \text{number of builders, and } rL_t^B = \text{individual builder reservation price;}$$

$$\text{and } rL_t^a = \frac{\sum_{A=1}^{y} rL_t^A}{y}, \text{ where } y = \text{number of lot developers, and } rL_t^A = \text{individual developer reservation price.}$$

In both cases, $\sum$ represents a summation of individual values of the variable stated to the right of the summation sign. The quantity variable, qL, is the sum of the number of lots demanded or supplied by all participants in the lot market. The reservation price variable, rL, is the average reservation price over all lots demanded or supplied. The market variables, qL and rL, are correspondingly a sum and an average, respectively.

The supply of lots, treated in more detail below, is specified as a function of developers' desired rate of appreciation in lot prices and of recent lot prices. In other words, they have a reservation price for land, an asking price, which will be defined as follows:

$$rL_t^a = (rL_{t-1})(1+j^d)^t \qquad (1.7)$$

where rL_t^a = the current asking price for building lots,

j^d = the developers' desired rate of appreciation in lot prices, and

rL_{t-1} = the average market price of building lots in the last period, t-1, and

t = the duration of the current time period, in annual terms.

The demand for lots, also treated in more detail below, is specified in accordance with the model of derived demand for a factor in housing production. Since housing production is a multi-period activity, lot demand is expressed as a function, not of current new house prices and non-land construction costs, but of the expected values of these variables at the end of the production period. It is therefore specified that

$$rL_t^b = f(pH_t^e, mN_t^e) \qquad (1.8)$$

where pH_t^e = expected selling price of new houses at the end of time period t (H is quantity of 'housing service' and p is the unit price of housing service provided by a new dwelling), and

mN_t^e = expected non-land construction costs (N is the quantity of non-land inputs, such as labour and materials, and m is their unit cost).

This relationship is theorized to take the following algebraic form.

$$rL_t^b = \frac{pH_t^e - mN_t^e}{(1 + k^d)^t} \qquad (1.7)$$

where k^d = the builders' discount rate or opportunity cost of capital, and the other variables are as previously defined. According to this equation, it is theorized that builders' bid price for lots is a function of the difference between expected selling price of new houses and non-land construction costs, discounted to a present value according to builders' cost of capital.

Determinants of Lot Demand

The determinants of lot demand will now be specified more closely. Following the approach employed by Muth (1969) in his development of a model of the equilibrium of housing producers, a production function for housing is first expressed.

$$H = f(L, N) \qquad (2.1)$$

where H is the quantity of 'housing service' built into a dwelling unit and its lot,

L is the quantity of land input, including space or lot size, and servicing, and

N is the quantity of non-land inputs, including labour, materials, capital equipment, construction supervision or management, and interim financing.

We then write a cost equation for housing production in which total cost of production is equal to the sum of land costs and non-land construction costs.

$$gH = rL + mN \qquad (2.2)$$

where g = total cost per unit of 'housing service' in the completed dwelling and its lot,

r = unit price of land (per square foot), and

m = unit cost of non-land inputs.

Two assumptions are employed in the specification of the production and cost functions. First, it is assumed that there exists something called 'housing service' which varies with the size, configuration, and quality of a dwelling unit, and with the spatial, locational, and other characteristics of the lot. Without such an assumption, a separate production function would have to be specified for each different type of single-detached dwelling, H_1, H_2, ..., H_n. Or else it would have to be assumed that all single-detached dwellings were identical. Since homogeneity of the stock would be a totally unrealistic assumption, and since the existence of 'housing service' is theoretically justifiable, the latter assumption is made that there is a standard unit of housing service whose quantity, H, will vary between different types of units. A convenient empirical counterpart of this theoretical construct is dwelling size. We can imagine housing service as being somehow analogous to this characteristic, with a standard unit of measure conceptually similar to the 'square foot'.

Second, it is assumed that non-land inputs can be aggregated and measured according to some standard unit. This is empirically difficult given the heterogeneity of inputs, including labour, materials, equipment services, management, construction finance, and so on. For convenience, and following popular practice in the building industry,

these will be measured in terms of square foot composite costs.

In an equilibrium situation, producers' profits are at a maximum when marginal revenues and marginal costs are equal. By profits is meant normal business profit in an accounting sense. This includes the reward for the use of the firm's fixed inputs such as the expertise and management of the builder, and the capital equipment owned by the firm. In short and long run equilibrium, the following condition will hold.

$$pH \overset{e}{=} gH \qquad (2.3)$$

A profit function can be written which defines the excess profit (or the loss) obtained (or incurred) by the firm in a disequilibrium situation.

$$\pi = pH - gH \qquad (2.4)$$

In an equilibrium position the producer has no excess profit and no loss. In other words, $\pi \overset{e}{=} 0$. The derivation of these results will not be discussed. They are based upon and consistent with the conventional micro-economic theory of the firm as presented, for example, by Richard G. Lipsey (1963) and J.M.Henderson and R.E. Quandt (1971).

The model of builder behavior specifically addresses his lot valuation decision, that is, the formation of his reservation price for building lots. According to the micro-economic model summarized above, the cost of land, rL, is given by this equation.

$$rL = f\ (pH, mN) \qquad (2.5)$$

In long-run equilibrium, the cost of land inputs is given by this equation.

$$rL \overset{e}{=} (pH - mN) \qquad (2.6)$$

This is clearly an unsatisfactory specification since it assumes that production is instantaneous, current costs being equal to current market price. Housing production is a time-consuming activity and prices can change over this period. As Ratcliff, Turvey, and

Milgram have described, the builder obtains land at one moment in time, non-land inputs over subsequent successive time intervals, and sells the completed building in the final interval. For this reason, the conventional micro-economic model must be adjusted if housing production is to be adequately represented.

S. Schim van der Loeff and R. Harkema (1976) offer two models of some relevance here. According to the first model of 'deterministic profit maximization',

> the entrepreneur has full knowledge of the price schedules of the output market and the factor markets. He thus knows beforehand exactly the price he will obtain (for output) or have to pay for whatever quantity of output or factors he decides upon. (1976: 13)

A second model, 'expected profit maximization', is more suited to the circumstances previously outlined. According to this model the firm seeks to maximize the mathematical expectation of future profits.

Expected profit at the end of the forthcoming production period might be specified as follows:

$$\pi^{e}_{t} = pH^{e}_{t} - (mN^{e}_{t} + rL^{b}_{t}) \qquad (2.7)$$

The residual value of land at that time is given by this equation.

$$(pH^{e}_{t} - mN^{e}_{t}) = (rL^{b}_{t} + \pi^{e}_{t}) \qquad (2.8)$$

Builders' reservation or bid price is the present value of that residual, as follows:

$$rL^{b}_{t} = \frac{pH^{e}_{t} - mN^{e}_{t}}{(1 + k^{d})^{t}} \qquad (2.9)$$

where k^{d} is the desired annual rate of return and t is the duration of the time period in annual terms. This equation represents what might be called the 'lot bid price' function. It represents a form of the income-capitalization of expected residual land value concept seen repeatedly in the literature reviewed in Chapter Two. The residual capitalization

formula is approximately the same as a discounted cash-flow formula. More complete and detailed discussion of discounted cash flow analysis, and site valuation can be found in James W. Hughes (1977), William N. Kinnaird (1971), and James A. Graaskamp (1970).

It is useful to note Kinnaird's discussion of the use of the 'land residual technique' of site valuation.

> The income to real estate itself, especially land, is held to be residual in the sense that it has a low-priority claim on the income that it produces. ... From the point of view of economic analysis, the productive factors of labor, capital, and entrepreneurship all are mobile; they can move readily to another source of income. ... As a result, to attract and maintain the other productive resources to work in the property in question, they must be assured and receive at least a competitive rate of return for their services. Their claims must be paid first or they will move elsewhere. What is left after paying their claims is a residual income available to pay for the use of investment funds in the real estate. (1971: 239)

The present worth of this residual income is obtained by capitalizing its expected value at an appropriate market rate of discount. The present value of land to the builder is determined thereby. The equation is consistent with the principles outlined byMaury Seldin and Richard H. Swesnik (1970) and Michael D. Wilburn and Robert M. Gladstone (1972). Their works are just two examples of a plentiful 'how-to-do-it' literature in real estate investment and development which an economic analysis of the land market would ignore at its peril since the long history of this literature would suggest that its prescriptions do find their way into the decision-making procedures of even the smallest real estate entreprises.

Finally, the equation is practically identical in interpretation

to the formulae of Milgram (1968), Lean (1964), and Bish and Nourse (1975) reviewed earlier. Bish and Nourse's discussion of the determination of a ceiling price for a property comes the closest to what is attempted here.

The treatment of lot demand now turns to the formation of expectations. Herbert A. Simon (1967) states

> While the future cannot enter into the determination of the present, expectations about the future can and do. (1967: 14)

Simon further discusses how economists might address expectations.

> The classical way to incorporate expectations into economic theory is to assume that the decision-maker estimates the joint probability distribution of future events. He can then act so as to maximize the expected value of utility or profit, as the case may be. However satisfying this approach may be conceptually, it poses awkward problems when we ask how the decision-maker actually estimates the parameters of the joint probability distribution. Common sense tells us that people don't make such estimates, nor can we find evidence that they do by examining actual business forecasting methods. ... (they) have contented themselves with asking for point predictions. ... They somehow make forecasts in the form of (certainty equivalent) point predictions and act upon them in one way or another. (1967: 15)

The question is how?

> The simplest naive model is one that assumes the next period will be exactly like the present. Another assumes that the change from present to next period will equal the change from last period to present; a third, somewhat more general, assumes that the next period will be a weighted average of recent past periods. The term "naive model" has been applied loosely to various forecasting formulae of these general kinds. There is some affirmative evidence that

> business forecasts fit such models. There is also evidence that elaboration of the models beyond the first few steps of refinement does not much improve prediction; ... (1967: 16)

Economists constructing models in terms of anticipated values generally used recently realized, or lagged, values of a variable as indicators of anticipated values. As L.R. Klein writes,

> ... the immediate past level, rate of change, acceleration, etc. of prices would be a likely set of data on which to form expectations of future prices. (1972: 176).

He gives the example of the 'cob-web model' of supply-demand interaction in agricultural markets for perishable commodities.

$$q_t^s = \alpha_0 + \alpha_1 p_{t-1} + e_t \qquad \text{supply}$$
$$q_t^d = \beta_0 + \beta_1 p_t + u_t \qquad \text{demand}$$
$$q_t^s = q_t^d \qquad \text{market clearing}$$
$$e_t, u_t = \text{error}$$

> Since the commodity is perishable, by assumption markets are effectively cleared, as asserted in (3). The model states that producers supply (plant) a good (agricultural commodity) on the basis of expected price and put the whole amount (crop yield) on the market for whatever price it will fetch. Anticipated price, which forms the basis for supplier decisions, is not objectively measured, but an indicator of expected price is used instead. In the typical agricultural case, the farmer has little basis for forming expectations about price when he has to decide upon acreage and seeding. He knows the price at that time, but not at the time of marketing, because he doesn't know the volume to be marketed. In the absence of a priori knowledge about subsidies, price supports, or other price information, the best judgment about future price is last season's price. (1976: 176)

The advantage of lagged values of the expectational variables is that objective data exist for them whereas expectations are otherwise 'subjective, personal, and not easily measured for numerical statistical analysis'. Economists have nevertheless sought more realistic models of expectations formation on the premise that however subjectively expectations are formed they are based in part on knowledge of the past.

J. van Doorn (1975) provides a comprehensive but summary treatment of different models of expectations formation.

> Two naive, non-learning, hypotheses have been widely used. The first one predicts extrapolative expectations, that is to say, it predicts the next period's value of X to be the same as its current value. In algebraic form
>
> $$X_t^e = X_{t-1}$$
>
> Another expectation hypothesis that we shall, in the absence of an element of learning, also classify as naive relates the expected value of X to its value in the previous period and the direction of change in the past. Hence
>
> $$X_t^e = X_{t-1} + \beta(X_{t-1} - X_{t-2})$$
>
> where, for simplicity, it will be assumed that $-1 \leq \beta \leq +1$. (1975: 20-21)

A variation on this model, not fully treated by Klein, is the case in which it is the 'rate of change' in the current or past period which is expected to continue in the next period. We might write this model, following Klein's notation as follows:

$$X_t^e = X_{t-1} + \beta \left[X_{t-1} \frac{X_{t-1} - X_{t-2}}{X_{t-2}} \right]$$

In this case, the expected value is the past value increase by the same percentage as the past value had increased over its previous value.

A third model, identified by Simon as the 'weighted moving average model', is discussed by van Doorn.

> Instead of making expectations operational by relating them to a number of selected past observations, as we have done so far, we could construct a more general expectations hypothesis through the introduction of a distributed lag function. Hence
>
> $$X_t^e = a_1X_{t-1} + a_2X_{t-2} + a_3X_{t-3} + \ldots$$
>
> As pointed out earlier, we have to be more precise to make a distributed lag function of more practical use. The analysis will therefore be confined to those cases where all a_i's are of the same sign (non-negative), and where the weight distribution is geometrically declining, thus
>
> $$a_i = \beta\lambda^{i-1}$$
>
> where $0 < \lambda < 1$ for all i. (1975: 23-24).

It is called that 'adaptive expectations model' and reduces through algebraic manipulations to the following form,

$$X_t^e = X_{t-1}^e + \beta(X_{t-1} - X_{t-1}^e).$$

This model says that

> ... a change in expected values equals a proportion of the difference between actual and expected values in the past. The hypothesis thus implies an element of learning on the part of those to whom it applies. The new expectation equals the previous one, when the latter turned out to be correct, when no forecasting error was made. This seems plausible. It assumes people will continue their behaviour as long as it proves to be flawless. A revision for the latest expectation becomes necessary when past expectations remain unfulfilled. (1975: 24-25)

Klein (1972: 179-180), Kelejian and Oates (1974: 145-157), and J.F.Muth (1961: 316-322) offer further discussion of this model. Before we specify the form to be adopted in this model, several considerations must be discussed.

Insofar as expectations are a subjective matter, though based on objective data available to all firms, the problem of aggregate expectations arises. Sweeney would simply aggregate the expectations of individual firms to obtain average aggregate expectation. Where micro-level expectational variables are 'a kind of weighted average of how an individual firm expected relevant prices to change', at the aggregate level these are interpreted 'as an average of individual firms' indices of expected rates of increase' (1974: 23). This is similar to J.F.Muth's approach.

> Allowing for cross-sectional differences in expectations is a simple matter, because their aggregate effect is negligible as long as the deviation from the rational forecast for an individual firm is not strongly correlated with those of the others. Modifications are necessary only if the correlation of errors is large and depends systematically on other explanatory variables. (1961: 321)

J.F.Muth also found that "averages of expectations in an industry are more accurate than naive models and as accurate as elaborate equation systems, although there are considerable cross-sectional difference of opinion" (1961: 316).

Markusen and Scheffman also explored this topic for they judged the assumption of homogeneous expectations to be unrealistic. They concluded from their literature survey that it can be shown

> that if investors have heterogeneous expectations, the (expected) prices ... will be determined by a weighted average of individual depending on his relative size in the given market (1977: 44)

It would appear from these discussions that in a competitive market with many participants of insignificant size compared to the size of the industry, a simple average of individual firm expectations would generate the industry's composite expectation. Consequently, it is justifiable to adopt Sweeney's approach and take the 'representative' individual firm's formation of expectations with slightly different interpretation, to generate the industry's average expectations.

The review of the literature in Chapter Two uncovered three studies that gave explicit examination of expectations and incorporated an expectations model in their empirical analysis. The first of these was by Richard F. Muth. He used the weighted moving average method of estimating investors' expectations of the building rent-to-price ratio. Two estimating procedures were attempted: the iterative and the recursive. By the iterative method, he tested various values of the weight coefficient to find the one which produced a maximum correlation between new construction and the expected rent-price ratio. Muth found that a weight coefficient of 0.5, with weights declining exponentially over a period of eight years, such that the sum of the weights approaches 1.00, produced the 'best' expectation.

By the recursive method, the effect of expectations was taken into account by using values of the independent variables lagged one year. By this method, the weight coefficient is estimated directly according to an a priori specification. Muth found that the recursive method yielded a better result than the iterative method. This has implications for our empirical investigation which will be treated in Chapter Four.

Gordon Davies and L.B. Smith used the recursive approach in their studies. Smith includes the last quarterly change in lot prices as an indicator of

> expectations as to future land prices where expectations are extrapolative and represented by past changes in land prices. (1974: 51)

A similar approach was used by Davies. His lot price equation included as expectational variables the selling price of houses and their construction costs. He hypothesized that builders form their expectations about future rates of change on the basis of the rate of change in some past period. The specific form he used was to include the values of selling prices and construction costs lagged four quarters, or one year.

On the basis of these considerations, and so as to avoid overly complicating the model, it was decided to adopt the naive, trend extrapolation model of expectations formation.

With respect to the expected selling price of houses, the following equation is offered as a first approximation:

$$pH_t^e = pH_{t-1} \times (p_{t-1}/p_{t-2}) \qquad (2.10)$$

Accordingly, it is ventured that expected selling price is the last observed price, increased in the same proportion as that price rose over its previous value. The same approach is taken to construction costs:

$$mN_t^e = mN_{t-1} \times (N_{t-1}/N_{t-2}) \qquad (2.11)$$

In both cases, it is assumed that expectations are formed in respect of selling price and construction cost by holding constant the quantity of housing service produced and the quantity of inputs utilized (and where dwelling size is a common measure of both).

The rationale for this lies in a postulate that actual dwelling size, like the quantity of lots purchased and dwellings constructed, is only later determined through quantity adjustments made when builders cannot find their bid price in the lot market. This matter will be treated later.

The specification of lot demand specified the behavioral process characterizing the determination of reservation prices. When the same is done for the supply side, a behavioral formulation is given to the model.

Determinants of Lot Supply

The determinants of lot supply will now be examined more closely. There are three models of lot supply which might be considered to describe the 'price-taking' behavior of lot suppliers.

The first suggests that suppliers determine the asking price of lots on the basis of what they perceive builders can afford. According to this model, lot suppliers would make their own forecasts about expected selling prices for new houses and expected construction costs to determine the present value of the residual -- in other words, the ceiling price for building lots. Consequently, if lot suppliers utilized the same information and methodology as builders we would find that asking prices would be the same as bid prices. In the real world however, it is unlikely that lot suppliers' information is as complete and free from error as builders' information. Therefore their expectations would differ. Discussion of this model of developer behavior is found in James H. Boykin (1976) and R.L. Heroux and W.A. Wallace (1973).

A second model of lot supplier behavior treats suppliers as forming expectations about the future selling price of building lots on the basis of past sales. An expectations model might be used to describe the methodology employed in such forecasting.

A third model, selected here, describes lot supplier behavior in terms of the empirical findings reported in the literature to the effect that the asking price for lots is a function of recent prices and the rate

of appreciation desired by lot developers and investor-owners. This is consistent with the discussions by Clawson and Schmid and the theoretical analysis by Markusen and Scheffman who propose the following model:

> The rate of return on assets judged by developers to be equivalent to land will be denoted by r. ... If some (rather than all of the) land is sold in each period then the rate of price appreciation must be less than r, with the equilibrium rate of price appreciation being an increasing function of p_O (current prices). ... developers will be indifferent to sales in the two periods (present and future) if the difference between the present price ... and the present value of future price ... is just equal to the agricultural revenue foregone by developing ... (now rather than later) plus the burden of incurring development ... (now rather than later). (1977: 24-26)

The 'solution' or the supply of lots in the current period, therefore lies somewhere between the position of indifference and the situation where all lots would be made available. Markusen and Scheffman define it as follows:

> ... positive land sales in each period require a positive rate of price appreciation approaching r, the rate of return on equivalent assets. (1977: 26).

Alternatively expressed,

> In order for the developer to both develop some land (into lots) and carry part of his stock of approved land into the future, expected Ricardian rents must appreciate at rate δ. (1977: 50)

"δ" is the profit-maximizing firm's discount rate and will reflect not only the average cost of capital but also the 'inherent riskiness' faced by a development firm.

The works by Shoup (1970) and Capozza (1976), reviewed earlier, do not suggest any modification of this approach which can be

summarized as follows: the minimum price which lot developers and owners will accept for land is one that incorporates a rate of appreciation in lot price over the last equilibrium price rate that is equal to "the sum of the interest rate and the tax rate, minus the rate of return earned in any interim use" (Shoup, 1970: 41). The approach is adopted on the demonstration by Shoup, Capozza, and Markusen and Scheffman that it is the equivalent to the determination of present value by the capitalization of expected future returns.

On this basis an 'investment model' of the lot supply function is developed here. It assumes that lot developers and investors are indistinguishable in their method of land valuation. Our premise is that, having developed a quantity of lots, developers stand in the same position as investors, waiting for lot purchasers to present them with a price matching their asking price.

This analysis leads to the following specification for the lot supply function:

$$rL_t^a = (rL_{t-1})(1+j^d) \qquad (3.1)$$

where rL_t^a = the current asking price for building lots,

rL_{t-1} = the market price of building lots in the last period, and

j^d = the developer's discount rate or desired rate of price appreciation.

The Market

Having specified the formation of lot demand and lot supply, the system of structural equations initially presented are returned to and the determination of market price and quantity is established. This is accomplished by deriving reduced-form equations which offer an algebraic solution to the simultaneous equation system. Given known values of the

exogenous variables and given the equation parameters, it would then be possible to determine the values of the unknown or endogenous variables, rL_t and qL_t.

First, the demand and supply functions are stated in an algebraic form to make them amenable to mathematical manipulation. The following equations accomplish this by specifying the sign and form of the parameters which we theorize to underly the functional relationships stated earlier:

$$qL_t^d = a_1 - a_2 rL_t + a_3 rL_t^b \qquad (4.1)$$

$$qL_t^s = a_4 + a_5 rL_t - a_3 rL_t^a \qquad (4.2)$$

The theory embodied in these equations lies specifically in the signs of the coefficients, a_1, a_2, and so on. In the demand equation (4.1), the coefficient a_2 has a negative sign stating that the demand curve is downward-sloping. This is consistent with conventional demand theory: the higher the price, the less the quantity demanded. The magnitude of this coefficient will determine the price elasticity of lot demand. A value of 1.00 would indicate unit elasticity (an increase in price would result in a proportionate decline in demand). A value less than (more than) 1.00 would indicate elastic (inelastic) demand. The coefficient a_3 has a positive sign to indicate that quantity demanded and bid price are positively related. The magnitude of the coefficient will indicate the responsiveness of demand to exogenous factors.

In the supply equation (4.2), the coefficient a_5 has similar interpretation as in the demand case. It is substantively different, however, in that an upward-sloping supply curve is theorized -- the higher the price, the more lots would be supplied. It might be further theorized that the magnitude of this coefficient should exceed 1.00 in an equilibrium market situation in housing where land prices are hypothesized

to be determined by housing prices and the value of land being residually determined and derived from housing demand. The coefficient a_6 has a negative sign indicating that an increased suppliers' reservation price will reduce the quantity supplied of building lots.

The reduced-form of the model lies in solving the system of Equations (1.3), (4.1) and (4.2). According to Equation (1.3), the right-hand side of Equations (4.1) and (4.2) are equal to one another. This is written as follows:

$$a_1 - a_2 rL_t + a_3 rL_t^b = a_4 + a_5 rL_t - a_6 rL_t^a \tag{4.3}$$

The endogenous variable, rL_t, is isolated to one side of the equation, as follows, and then further simplified:

$$rL_t (a_5 + a_2) = (a_1 - a_4) + a_3 rL_t^b + a_6 rL_t^a \tag{4.4}$$

$$rL_t = b_1 + b_2 rL_t^b + b_3 rL_t^a \tag{4.5}$$

The other endogenous variable, qL_t, is solved by substituting the value for rL_t in Equation (4.5) in either Equation (4.1) or (4.2) as follows:

$$qL_t = a_1 - a_2(b_1 + b_2 rL_t^b + b_3 rL_t^a) + a_3 rL_t^b \tag{4.6}$$

By simplification,

$$qL_t = a_1 - a_2 b_1 - a_2 b_2 rL_t^b - a_2 b_3 rL_t^a + a_3 rL_t^b \tag{4.7}$$

$$qL_t = (a_1 - a_2 b_1) + (a_3 - a_2 b_2) rL_t^b - a_2 b_3 rL_t^a \tag{4.8}$$

$$qL_t = b_4 + b_5 rL_t^b - b_6 rL_t^a \tag{4.9}$$

The equations (4.5) and (4.9) might be re-stated in a more general functional form, as the structural equations initially were:

$$rL_t = f\,(rL_t^a,\ rL_t^b) \tag{4.10}$$

$$qL_t = f\,(rL_t^a,\ rL_t^b) \tag{4.11}$$

These two equations might have been postulated 'from scratch', without the use of the intermediary analysis and algebraic manipulations. The advantage of the simultaneous equation approach lies in the way it makes explicit the model's proposition that market price and quantity are jointly determined by the joint action of supply and demand. It also makes explicit the model's assumptions about the characteristics of supply and demand.

The algebraic expression of the reduced-form equations is as follows:

$$rL_t = b_1 + b_2 rL_t^b + b_3\, rL_t^a \tag{4.12}$$

$$qL_t = b_4 + b_5 rL_t^b - b_6\, rL_t^a \tag{4.13}$$

By substituting the exact formulations of the exogenous variables in these two equations, we obtain these precise statements:

$$rL_t = b_1 + b_2\left[\frac{pH_t^e - mN_t^e}{(1+k^d)^t}\right] + b_3\left[(rL_{t-1})\,(1+j^d)^t\right] \tag{4.14}$$

$$qL_t = b_4 + b_5\left[\frac{pH_t^e - mN_t^e}{(1+k^d)^t}\right] - b_6\left[(rL_{t-1})\,(1+j^d)^t\right] \tag{4.15}$$

The 'solution' of this model lies in deriving the effects on the endogenous variables of changes in the exogenous or independent variables. This is accomplished in two steps. First, a comparative static approach is used to make explicit the cause-effect relationships hypothesized by the model. Second, the dynamic operation of the model is made explicit.

These tasks are facilitated by Table III which describes the variables of the model.

TABLE III. Variables in the Theoretical Model

Characteristic	Symbol	Description
Endogenous	rL_t	Average price of building lots in period t.
	qL_t	Number of building lots transacted during period t.
	qL_t^s	Aggregate supply of building lots in period t.
	qL_t^d	Aggregate demand for building lots during period t.
Instrumental*	rL_t^a	Average reservation price of developers (i.e. asking price for lots).
	rL_t^b	Average reservation price of housebuilders (i.e. bid price for building lots).
Exogenous	rL_{t-1}	Average price of building lots in the previous period t-1 (i.e. a lagged endogenous variable).
	j_t^d	Average desired rate of return (or rate of appreciation) on building lots owned by developers or other non-builders.

(table continued)

	pH_t^e	Average expected selling price held by builders for newly-constructed single-detached houses at the end of period t. Its value is a trend extrapolation from values the previous periods, as follows: $pH_t^e = pH_{t-1}(pH_{t-1}/pH_{t-2})$
	mN_t^e	Average expected construction costs of new single-detached dwellings constructed during period t. Its value is based on a trend extrapolation of recent unit construction costs, and a constant dwelling size (i.e. $m^e = m_{t-1}$).
	k_t^d	Average desired rate of return (capital gain) on the purchase price of building lots held by housebuilders.

* The instrumental variables, rL_t^a and rL_t^b, are intermediaries between the model's exogenous and endogenous variables. In practical terms, they are 'exogenous' with respect to the model's endogenous variables, and 'endogenous' with respect to the exogenous variables.

The more precise nature of the exogenous variables is specified in the preceding discussions. They take the form of expectational variables and represent a composite of many other variables such as mortgage rates, the consumer price index, the residential construction cost index, and so on.

Similarly, the instrumental variables, the reservation prices of builders and developers, are composite variables based on expectations and serving to express demand or supply.

The many inter-relationships among the variables within the model here are portrayed by means of a table which shows the effects of increases in the values of the exogenous variables upon the endogenous variables. As the preceding chart indicates, there are three types of variables in the model: (a) endogenous - determined completely by the current values of the other variables in the model; (b) exogenous - determined in the current period by factors outside the model or on the basis of previous values of variables in the model; and (c) instrumental - mediating between the model's exogenous and endogenous variables, being endogenous with respect to the exogenous ones, and exogenous with respect to the endogenous ones.

The table below shows the interrelationships between the variables of the model.

	Endogenous Variables			
	Instrumental		Perfectly Endogenous	
Exogenous Variables	rL_t^a	rL_t^b	rL_t	qL_t
j^d	+			
k^d		-		
rL_{t-1}	+			
pH_t^e		+		
mN_t^e		-		
rL_t^a			+	-
rL_t^b			+	+

TABLE IV. Summary Comparative Static Results of the Theoretical Model.

The table is interpreted by reading a unit increase in the "exogenous" variable having an impact on the "endogenous" variable of the indicated sign, while holding the other "exogenous" variables constant.

This model has implications for market equilibrium which will now be discussed. In the earlier pages of this chapter, equilibrium was defined by van Doorn as existing "within a framework of relationships ... when all dependent variables simultaneously show no endogenous tendency to change" (1975: 9-10).

The following diagram depicts the equilibrium position during a given time period, t, as postulated by the model:

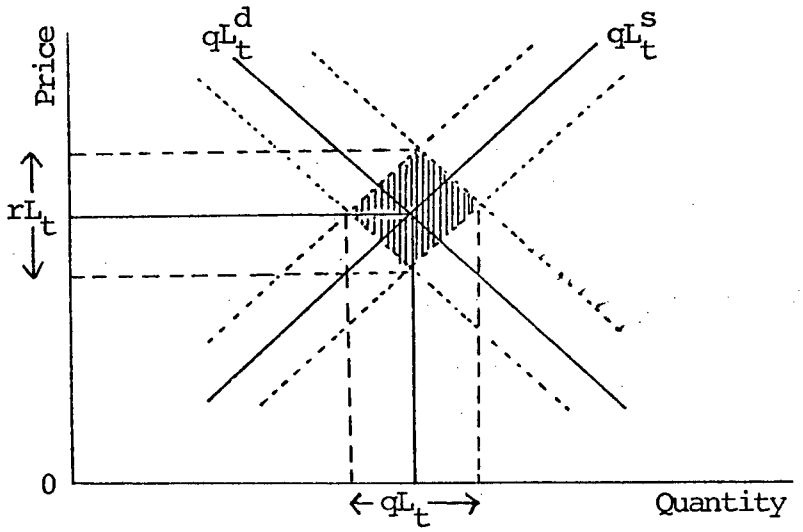


FIGURE 5. Relative Market Equilibrium.

The dotted lines illustrate how the supply and demand curves might empirically deviate from the positions specified by the supply and demand functions (Equations 4.1 and 4.2). The theoretical model has so far not specifically considered the role of market imperfections such as information costs and transaction costs. The solid lines in the diagram could be said to depict a situation given constant information and transaction costs (based on a long-run average). Since these costs might vary

from year to year in relation to factors not explicitly considered by the model, equilibrium price and quantity will lie somewhere in the shaded region of the diagram. In this sense, the model postulates a relative rather than perfect equilibrium.

This has some similarities to the approach by Kain, et al (1972: 51-59, 125-128) in a model of the housing market.

> The interaction of the supply and demand sectors in this model does not guarantee that supply will be precisely equal to demand ... during each market period. Therefore, in a strict sense the housing market is not cleared each period. The housing market is viewed as dynamically adjusting toward, but not necessarily reaching, a new equilibrium during each market period; and short-term disequilibria in housing submarkets are accepted (in the model) as a consequence of this view. (1972: 57)

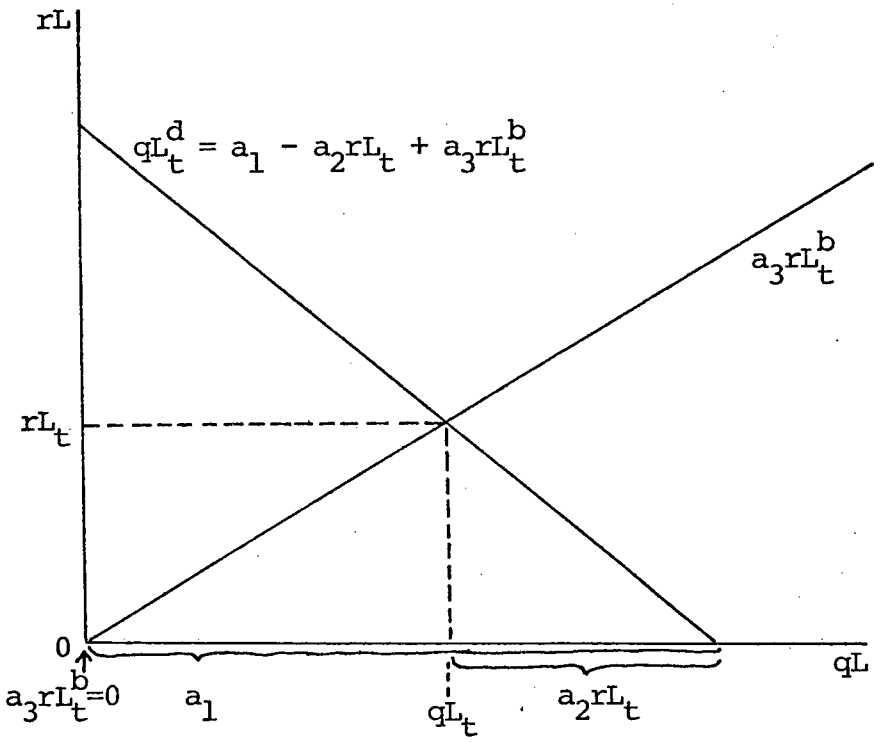
The model is felt by the authors to have a 'tentative and incomplete treatment of short-term dynamics'. This is reflected in their suggestion, not pursued, "to revise (by an iterative procedure the estimated) price expectations, until they matched market prices" (1972: 58-59). The theoretical analysis in our study would instead agree with an earlier suggestion by Kain et al, that

> A disequilibrium representation of the housing market may be a better representation of reality than one which requires that all markets adjust fully ... (1972: 57)

The second set of implications of the model pertain to its dynamic character. Successive values of the exogenous variables will generate by means of the model's propositions, a time path of equilibrium prices and quantities. To understand this feature of the model, the demand and function will be examined in detail so that both the supply and demand functions can be practically interpreted.

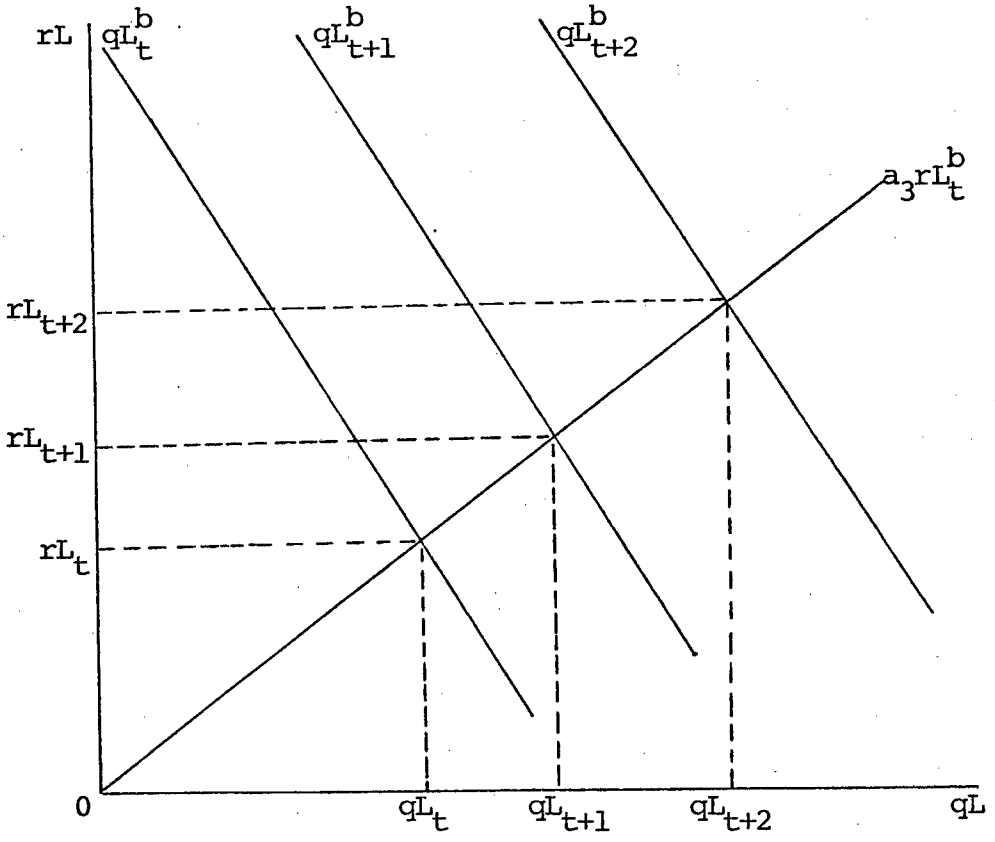
The following diagram graphically illustrates the meaning of the demand function:

FIGURE 6. Short-Run Demand Function.



The short-run demand curve is thereby illustrated. The next diagram shows how the reservation price, rL_t^b, operates as a shift parameter, moving the short-run supply curve upward as rL_t^b increases.

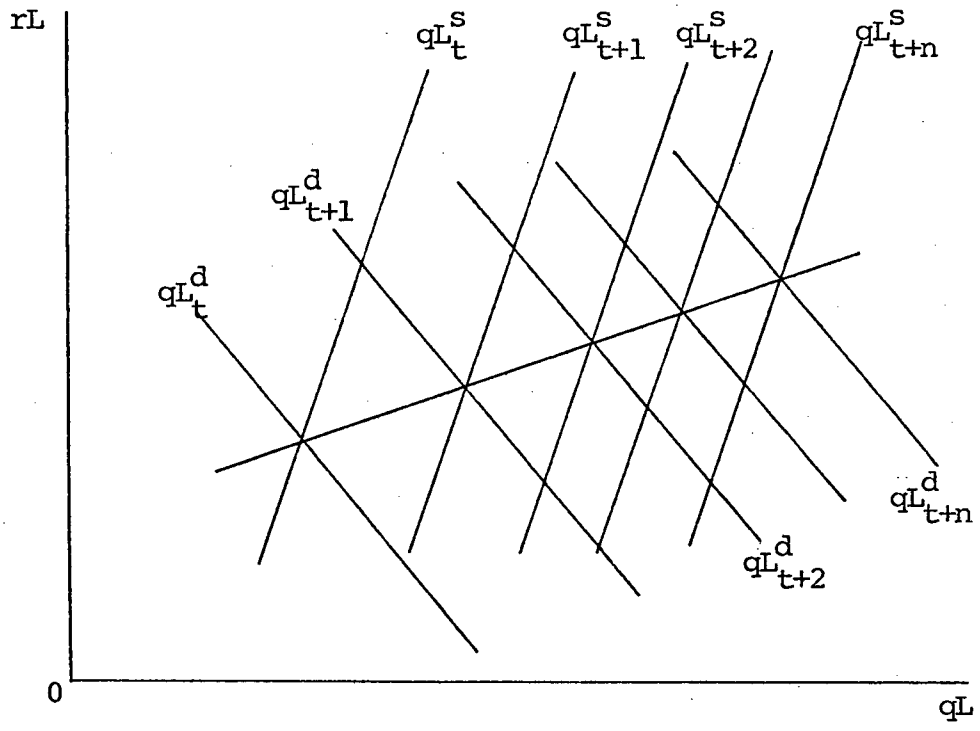
FIGURE 7. Shifting Demand Function.



The same interpretation can be made of the supply function.

The following diagram shows a timepath of lot prices and transactions generated by shifting supply and demand curves.

FIGURE 8. Long-Run Demand and Supply Equilibrium.



The actual path of equilibrium positions will depend upon the slopes of the demand and supply curves and their shifts from one time period to the next. In this diagram, supply is shown to be relatively elastic -- supply changes are quite responsive to changes in price, and the supply shifts are shown to be commensurate with the demand shifts.

The dynamic formulation of the model lies in its capacity to generate an equilibrium time path given the growth rate of the shift parameters for supply and demand, the parameters of the price and quantity equations, and initial equilibrium values of price and quantity.

The growth rate in the shift parameter for lot demand is an empirical matter which cannot be predicted by the model, but the movement of the supply shift parameter under market conditions specified by the model will be a lagged function of shifting demand.

It was earlier seen that in long-run equilibrium, builders make no excess profits. As a result

$$pH_t = mN_t + rL_t, \text{ and} \tag{4.16}$$

$$rL_t = pH_t - mN_t. \tag{4.17}$$

Lagged by one period, Equation 4.17 can be re-written,

$$rL_{t-1} = pH_{t-1} - mN_{t-1}. \tag{4.18}$$

This can be substituted in Equation 1.7, to obtain the following:

$$rL_t^a = (pH_{t-1} - mN_{t-1})(1+j^d) \tag{4.19}$$

It was earlier seen that bid price in the current period, Equation 2.9, is as follows:

$$rL_t^b = \frac{pH_t^e - mN_t^e}{(1+k^d)^t} \tag{4.20}$$

In equilibrium, the following situation will be found:

$$rL_t^b = \frac{pH_t - mN_t}{(1+k^d)^t} \tag{4.21}$$

When this equation is lagged one period and substituted in Equation 4.19, the following is obtained:

$$rL_t^a = (rL_{t-1}^b)(1+j^d)^t \tag{4.22}$$

The following equation expresses the definition of this long-run equilibrium asking price in functional form:

$$rL_t^a = f(rL_{t-1}^b, j^d) \tag{4.23}$$

This last expression indicates that the supply shift parameter is a function of lagged bid price, and the cost of capital to lot suppliers. When j = k, it will further be found that asking price will move according to movements in the bid price, but with a lag of one time period. It remains however that the level and movement of idscount rates are an empirical matter dependent upon the general cost of capital and the rate of return in alternative opportunities. For this reason, the actual movement of reservation prices cannot be postulated, nor the time path of market price and lot transactions which they will generate.

The wider implication of this, of course, is that in long-run equilibrium the inter-temporal variations in lot prices are demand-determined. They are a function of the price of houses, the costs of construction, and the cost of capital to the building industry. This means, practically speaking that the model developed here proposes that land prices are determined by house prices, rather than the other way around, as emphatically stated by Pennance (1969) for example.

However, the theoretical analysis provided here is specific about the conditions under which the central proposition will hold. Notably, it postulates a relative equilibrium rather than a classic, static equilibrium. Practically speaking, this means that the lot prices and transactions are expected to deviate in a random manner from perfect equilibrium positions. These short-run disequilibrium situations, representing an imperfect operation of the lot market, will result from market imperfections such as differences between the expectations, information, and goals of participants in the lot market.

To complete the presentation of the model, some of its properties and characteristics will be summarized. The theoretical model offers several advances over existing theoretical analyses:

(a) a more comprehensive framework of analysis;

(b) a behavioral content;

(c) a dynamic approach; and

(d) a treatment of disequilibrium situations.

Where previous studies have tended to focus upon limited aspects of the operation of land markets, the model offered here provides a comprehensive framework by treating at close quarters lot demand, lot supply and their interaction in the clearing of the market over given time periods. The explicitly derived simultaneous equation approach adopted to achieve this represents a potentially large advance over previous single-equation efforts.

An important contribution attempted by the model lies in its behavioral content. A closer consideration of this subject would be useful at this point insofar as it is the model's treatment of behavior which gives it an ability to treat disequilibrium situations and dynamic ones.

Holbrook Working (1958) suggested that economists may have been misled by Alfred Marshall's analysis of the price mechanism in a competitive market.

> Marshall simply had not set himself the task of considering market price with any great care. His concern was with what he called "normal" prices; that is, with equilibria for periods of different lengths longer than those involved in the consideration of market prices. His "illustration from a corn-market in a country town" was not primarily a discussion of the formation of market price but an illustration to develop the concept of equilibrium. (1958: 35)

According to Holbrook, Marshall did not conceive of normal or equilibrium prices as being the moment to moment market prices as precisely determined by the bids and offers that are in effect at any instant when price is formed. As a result economists have had difficulty dealing with price fluctuations and 'disequilibrium'. For, as has been said before in this text, the real-world is one of disequilibrium.

Working offered a model to give a better understanding 'of the true nature of price fluctuations'.

> The basic idea underlying the model is that it must make adequate place for expectations in the formation of demand. Prices ... such as we are discussing must be formed under the influence of expectations, and we therefore need a theory of market price founded on expectations. We are dealing with prices that must be anticipatory. (1958: 35)

Working proceeded to build a market model taking into account expectations. It is a verbal model and one that assumes supply to be fixed. Working demonstrated that in such a situation price is demand-determined, but more importantly that demand-formation requires expectations. Furthermore, "this requires that reservation prices be considered part of the demand".

By extension, when supply is not fixed, its formation too would involve expectations, and reservation prices would be considered as part of supply. Acting upon this suggestion the theoretical model developed here specifically formulated lot demand and lot supply in terms of expectational variables composing reservation prices. It is an innovation with potentially far wider application than the objectives of this thesis.

It is the behavioral content of the model, or more exactly, the way in which behavioral content has been incorporated which makes the model dynamic and able to treat price variations over time. Comparative static models are made dynamic in their application rather than in their structure. Comparative static results of an analytic model enable an investigator to draw some inferences about temporal aspects. The model developed here is specifically dynamic in that the exogenous variables involve inter-temporal price relations by which events in one period

influence those in a later period and in which expected future events influence current ones. The successive values of exogenous variables generate the time path of price fluctuations. This characteristic of the model distinguishes it from most time-series analyses in which very weak "a priori" reasoning is employed to justify relationships between successive time periods, if indeed any are hypothesized. In some studies there are none. In a study of lot prices this would mean explaining prices in successive years strictly in terms of observed exogenous variables in those years, with no foresight or hindsight credited to the participants in the market being analyzed.

Marc Nerlove (1972) presents an overview of the 'new' micro-economics which seeks to overcome the inadequacies of the statis theory and 'ad hoc macro-dynamics'. The new approach is defined in this way.

> Essentially, the basic approach of the "new" microeconomists is to try to develop aggregate dynamic relations from models of rational, optimizing behavior at the micro level in a world where information flows are imperfect, the future is uncertain, and transactions and changes of all sorts are costly and disruptive. (1972: 228).

Five approaches to dynamic model building are identified by Nerlove in his review of literature. Search models, transaction costs models, diffusion models, expectation formation models, and adjustment costs models. Examining the fertility of these approaches he argued that empirical studies of dynamic economic behavior have produced findings that are very sensitive to the period of analysis and to the assumptions concerning time-series or serial properties of the relationships being studied.

Of special interest to this project was the expectation formation model. Nerlove found in this regard that most studies incorporated it by means of 'distributed lags', that is, lagged values of the

exogenous variables according to some form or other. He argues that 'in spite of their apparent justification', lags have generally been ignored in analysis until the empirical analysis itself. In short, most investigators offer little theoretical justification for their use and for the particular form of lag distribution employed.

According to Nerlove, it is not sufficient to utilize lagged variables in and of themselves. Rather,

> The issue is whether we can in fact obtain a better and truly dynamic theory which will determine the form and perhaps even some parameters of the lag distributions encountered in empirical contexts. (1972: 227)

The demand and supply determinants proposed in the model developed here recognize this issue. The expectations and reservations approaches to the demand and supply functions yield specific forms for the structure of lagged variables utilized by the model.

The comprehensiveness, behavioral content, and the dynamic formulation of the model allow it to answer a fourth criticism of existing theory and research: its inadequate treatment of disequilibrium. Nerlove notes in this regard that

> ... we have been too bound by static concepts and ..., in particular, the concept of a long-run equilibrium towards which adjustment occurs may not be an empirically useful concept in a dynamic context. (1972: 222)

Many studies, especially those using cross-section data, suggest that significant relationships exist between the current values of the dependent variables and the current values of the exogenous variables. This is predicted by their assumption of long-run equilibrium. Statistically significant results are typically generated by such efforts but Whitehead and Odling-Smee (1975) have shown that serial correliation in

the variables studied almost guarantees such a result. As a consequence,

> Instantaneous existence of long-run equilibrium conditions can in no way be inferred from significant statistical relationships between current values. Nor may one derive the parameters of an instantaneous adjustment model from the observed statistical relationship ... in a world of lags and partial adjustment ... The most that can be concluded from observed relationships between the current values of endogenous and exogenous variables is that some of the relevant variables have been identified; the exact dynamics of their roles in the model must remain in doubt. (1975: 317)

They argue that

> ... long lags and other complexities on both supply and demand sides ensure that the housing market is hardly ever fully adjusted to exogenous changes; it is normally in the process of moving towards an equilibrium position following the last shift in an exogenous variable. Furthermore, it will probably never arrive at the optimal point because while it is on the way there will be another exogenous change, and the system will have to redirect itself towards a new equilibrium position. (1975: 315)

They propose for economic models in housing

> ... that the mechanism according to which adjustments to exogenous changes are made would be a central part of any successful model. The mechanism would include time lags, representing slow responsiveness, and threshold effects, representing the inertia associated with transaction costs ... Because such models would be set in the time dimension they can only be tested against time-series data...must therefore supplement the usual cross-section analysis. (1975: 317)

The model developed here includes such a mechanism, in the reservation price formation process, whereby lags, and expectations, present a

potential source of slow adjustment or maladjustment to changes in the exogenous variables.

To summarize, the theoretical model does not assume away, as do static equilibrium models, the many characteristics of markets which generate disequilibrium situations. In so doing, it nevertheless remains an equilibrium model for, as van Doorn (1975) has remarked, equilibrium is a relative notion and can be interpreted to include a wider range of situations than are conventionally thought of as being equilibrium positions. Specifically, the model postulates an equilibrium in the lot market in the sense that even in a changing environment, the relationships which govern the behavior of the market will be constant.

In concluding the development of the theoretical model, it ought to be remarked that while a complete specification of the operation of the lot market over time has been attempted, it does not describe what we will find in the real world. Several elements of the model are empirical matters. These include housing demand, construction costs, interest rates and alternative opportunities for developers and builders.

The model is an analytical one. It predicts the lot market's reactions to changes in exogenous variables but these predictions remain analytical ones. This means that the theoretical model is not a forecasting model and not a simulation model. As a mathematical statement of theory, the theoretical model is limited in application to the functions of theory outlined earlier. Applications, whether for policy analysis or forecasting, depend upon an empirical formulation of such a model. However, the main task of an empirical model is to more precisely specify theoretical propositions, given some known general facts about the exogenous variables and given the situation about which data are available to test the model. These matters are considered in the following chapter.

CHAPTER FOUR

PROPOSED EMPIRICAL INVESTIGATION

INTRODUCTION

In the preceding chapter a theoretical model of inter-temporal variation in the average price of building lots for new single-detached housing was developed. The model attempted to synthesize the more firmly established propositions in the literature and to overcome some of the shortcomings in the theoretical analyses and empirical studies surveyed in Chapter Two.

This chapter addresses the empirical investigation which is proposed as a test of the theoretical model. First, the data, their source and characteristics, are treated. Second, a precise empirical model to be tested with the data is formulated in light of these data considerations. Third and finally, the methodology proposed for testing the empirical model is outlined.

4.1 THE DATA

The selection of data for an empirical investigation depends upon two main factors: the substance and the scope of the study. The data obtained for this study must pertain to the variables of the theoretical model. The major variables include lot prices, dwelling prices, dwelling construction costs, quantity of lots traded and dwellings constructed, and builder profits or capital gains on building lots. Other variables are necessary in the formation of developer and builder price expectations. These include the mortgage rate, the level of consumer

prices, the level of residential construction costs, and profitability in alternative but closely comparable endeavors.

The scope of the study, outlined in Chapter One, and the subsequent development of a theoretical model direct the investigation to an examination of the operation of the lot market at a general level. The examination must therefore abstract from the particularities of time and place. For this reason, time-series data of an aggregate nature are necessary. To reiterate, the objective of the empirical study is not to explain a short (or long) history of lot price changes in a given locality but to uncover the general parameters which will show some stability over a long period of time and over many localities. In this way, the process and general causes underlying the inter-temporal variation of residential land prices might be characterized.

The main body of data used in the study is found in the table on the following page. They pertain to all single-detached housing in Canada financed through the provisions of the National Housing Act on an annual basis. The data were recorded from information contained in approved N.H.A. mortgage or insurance applications. They include an estimate of the price paid for the lot -- ignoring any subsequent servicing or financing costs. They include an estimation of the dwelling size and construction costs. Finally, there is a category of data called "other costs" which remains undefined in Canadian Housing Statistics but which is assumed here to include financial costs and capital gain. It is further assumed that builder's profit in construction is included in the category of construction costs.

The figures for 1970 and 1971 shown in Table V differ from recently published figures (see Table I). Excluded from the study's data base was $200 million of C.M.H.C. activity in those years which substantially affected costs distort the trend in normal N.H.A.-financed activity.

TABLE V. The Number and Estimated Costs and Prices of New Single-Detached Housing Financed Under the National Housing Act, Canada, 1951-1977.

Year	Estimated Land Cost	Estimated Construction Cost	Other Costs	Estimated Selling Price	Average Dwelling Size(sq.ft.)	Number of Dwellings
1951	$1,048	$ 9,568	$ 332	$10,948	1,091	16,272
1952	1,182	9,730	388	11,300	1,070	23,380
1953	1,197	10,084	457	11,738	1,092	26,615
1954	1,687	10,472	259	12,418	1,102	39,481
1955	1,819	10,777	245	12,841	1,102	54,205
1956	2,025	11,574	255	13,854	1,138	36,625
1957	2,260	11,766	252	14,278	1,137	37,333
1958	2,471	11,762	246	14,479	1,118	60,530
1959	2,533	11,946	250	14,729	1,108	48,405
1960	2,473	11,920	246	14,639	1,125	27,434
1961	2,602	12,041	245	14,888	1,154	43,172
1962	2,783	12,204	246	15,233	1,189	36,292
1963	2,973	12,448	261	15,682	1,204	40,283
1964	3,082	13,100	296	16,478	1,218	35,436
1965	3,095	13,992	315	17,402	1,226	34,189
1966	3,480	15,457	356	19,293	1,257	30,317
1967	3,580	15,669	362	19,611	1,221	29,824
1968	3,746	15,774	378	19,898	1,158	26,132
1969	4,201	17,197	462	21,860	1,179	20,559
1970*	4,258	16,904	437	21,599	1,124	25,427
1971*	4,886	17,560	466	22,912	1,116	38,825
1972	4,887	18,114	474	23,475	1,112	42,580
1973	4,673	20,359	485	25,517	1,090	26,794
1974	4,867	24,378	565	29,810	1,067	17,621
1975	7,246	27,364	882	35,492	1,072	31,809
1976	9,226	29,389	1,266	39,881	1,065	33,001
1977	10,272	30,644	1,218	42,134	1,059	25,670

Source: Canadian Housing Statistics (annual), Central Mortgage and Housing Corporation, Ottawa.

There are four drawbacks to the use of these data which require discussion to justify their use in this project: (a) the heterogeneous character of the dwellings which comprise the N.H.A. 'sample' and its changes from year to year; (b) the questionable existence of a 'national' housing market; (c) the bias of the N.H.A. sample, and (d) several measurement problems.

The first limitation in the use of national-level data on N.H.A.-financed residential construction is well-discussed by Baxter (1976) and McFadyen (1976). The aggregate data in the N.H.A. time series contain a bias insofar as they are arithmetic averages that are unadjusted for compositional changes in the individual data. Over the years the mix of housing types has changed in terms of the relative proportions of bungalows, split-levels, $1\frac{1}{2}$-storey and 2-storey houses. Insofar as these different types of single-detached houses occupy lots of different sizes, and are themselves of different sizes, both lot price and construction cost data expressed in unweighted average terms will bias the true figure.

An additional bias is introduced by changes over the twenty-seven year period in average lot size and in the amount of servicing costs included in the lot price. For example, if lot sizes have increased some of the observed lot price increase will be attributable to or associated with the lot size change. Likewise, the installation and payment of lot services by developers rather than by local governments which has been a trend in the post-war period would also tend to raise lot prices.

Finally, a bias is introduced by the mix of C.M.H.C.-assisted dwelling construction as compared to those units financed by N.H.A.-approved lenders. Since the value of housing varies considerably between the two, and since the proportion varies from year to year, the data are biased in that regard. In one special instance, the influence of C.M.H.C. activity is so large in comparison to other years that the data have been

adjusted accordingly as was explained previously.

How seriously do these biases affect the investigation? If the objective is to explain the causes of the observed increases in the price of lots for N.H.A.-financed or insured single-detached residential construction, then it would be of utmost importance to have an accurate measure of the real increase in prices, adjusted for compositional and other changes and biases. The analyses by Baxter and by MacFadyen indicate the stringent requirements that would be imposed in such an endeavor. However, when the objective is to explain the process or behavioral mechanism through which causal factors exert themselves, the requirements can be relaxed. But not without some penalty. If no adjustments are made with respect to compositional and other effects, it will probably be found that the theoretical model cannot explain all of the variation that is observed in average lot prices. The reason for this is that the model does not suggest how lot sellers and buyers might adjust their reservation prices with respect to expected compositional changes (if any are expected).

The second limitation has been frequently mentioned in the housing literature. M. Carvalho, et al (1976) write,

> Much discussion is based upon highly aggregative data since detailed figures of comparable quality are often unavailable on a local or regional basis. The examination of housing problems on a national scale is undoubtedly necessary in order to ascertain general housing conditions; but it is becoming increasingly important that more specific and local studies of housing situations be undertaken. The need for doing so is twofold. First, regions or individual cities vary greatly from one another, and general housing indicators based upon highly aggregated data are incapable of describing local phenomena. Second, national housing policies

> should be developed from knowledge of peculiar needs and characteristics of specific regions in order to design appropriate policy responses. Accordingly, housing studies of specific urban areas should constitute an important contribution for developing meaningful indicators of each unique housing market and ultimately should serve in designing a comprehensive national 'policy grid'. (1976: 190)

It was for similar reasons that Edward L. Bebee (1972) disaggregated the 'national' market into five regional markets so as to examine each one separately.

> This will allow us to look for possible differences among regional markets reflected in different responses to common influences such as monetary policy. In addition, there are factors more or less unique to a given region. (1972: 386)

Observing that several empirical studies of the Canadian housing market treated it at the national aggregative level, Bebee rightly wondered, about L.B.Smith's studies for example,

> whether or not conclusions drawn from the national aggregative studies cited above may carry over to the disaggregated regional housing markets. (1972: 386)

This matter has been satisfactorily dealt with in delimiting the scope of the study. However, it remains a quite legitimate question to ask if there is a housing market whose geography extends across the whole of Canada. A housing market is generally defined as the physical area within which dwelling units compete with one another for the house buyer or renter's dollar. In practical terms, housing markets have no fixed boundaries but tend to coincide with those of the built-up areas of metropolitan or urban centres. Within these areas, dwellings are related one to another in a 'chain of substitution' with the price effects of demand or supply changes reverberating throughout the area and generally no further.

Analytically speaking, the boundaries of a market area are relative, as discussed by Chester Rapkin , et al (1953). Their premise is the following:

> In general terms, a housing market area is the physical area within which all dwelling units are linked together in a chain of substitution. ... there is no continuum of local housing markets that would tend to make them statewide, or regionwide, or nationwide. (1953: 9).

That would appear to be the final word on the matter, but the authors are speaking in general and practical terms. Analytically, they distinguish between a market area before the housing consumer has made his locational choice and after he has made this choice. Before choosing a locality, a household will consider alternative locations in terms of job and related opportunities. Some of the dwellings in these alternative localities will be good substitutes for each other and to this extent they are in the same market. Once a locality has been selected in respect to a metropolitan area, city, or neighbourhood, the housing market area is reduced in size commensurate with the distance between home and workplace, schools, friends, and so on, beyond which the household would be reluctant to travel on a regular basis. It is also reduced to that range of dwellings which fit the household's preferences and ability to pay.

Similar considerations prevail on the supply side with the boundaries of the housing market area determined first by the alternative localities, types, and value range of residential construction which a building firm will choose from. Second, once a locality and type of housing production have been selected, the market area is determined by the physical area over which the building firm is prepared to develop a knowledge of factor and product prices, factor availability, and to apply its management expertise, financial resources and equipment.

It is obvious then that a housing market's boundaries are not simply a matter of geography but also one of time. In effect, there is a short run and a long run dimension to housing market area definition. In the short run, the locality of the housing producer or consumer is fixed. For the small housebuilder, the short run housing market will consist of all or part of a metropolitan area and one or more categories of residential construction activity. For the housing consumer, the market area will consist of a category of preferred and affordable housing within a maximum commuting territory fixed by the place of employment. In the long run, on the other hand, the locality of the housing producer is variable. So is the firm's size, goals, mode of production, and type of output. In the long run, the housing consumer's employment location is variable as well as his preferences and ability to pay.

As the long run in housing markets has been defined, its boundaries could be provincial, regional or national in extent, depending on the actual time period involved. Over a twenty-five year period, people -- whether housebuyers or entrepreneurs -- can and do move across the great length of this country. In this theoretical sense there is a national housing market and no strong obstacle is posed by the use of national data in the proposed investigation.

The third problem posed by N.H.A. data is that they provide a biased representation of the behavior of lot sellers and buyers. The table on the following page shows data on single-detached residential construction activity across the country between 1951 and 1977. NHA-financed construction over this twenty-seven year period averaged 38 per cent of all activity. Fluctuations range from a high of 58 per cent in 1958 to 14 per cent in 1974. The differences between conventionally-financed residential construction and N.H.A.-financed building are significant insofar as changing institutional factors (e.g. loan limits and lending

TABLE VI. Single-Detached Residential Construction, Canada, 1951-1977

Year	Total Starts	N.H.A.-Financed Construction		Conventionally-Financed	
		Number	Percent of Total	Number	Percent of Total
1951	53,002	16,272	30.7	36,730	69.3
1952	60,696	23,380	38.5	37,316	61.5
1953	70,782	26,615	37.6	44,167	62.4
1954	78,574	39,481	50.2	39,093	49.8
1955	99,003	54,205	54.8	44,798	45.2
1956	90,620	36,625	40.4	53,995	59.6
1957	82,955	37,733	45.5	45,222	54.5
1958	104,508	60,530	57.9	43,798	42.1
1959	92,178	48,405	52.5	43,773	47.5
1960	67,171	27,434	40.8	39,737	59.2
1961	76,430	43,172	56.5	33,258	43.5
1962	74,443	36,292	48.8	38,151	51.2
1963	77,158	40,283	52.2	36,875	47.8
1964	77,079	35,436	46.0	41,643	54.0
1965	75,441	34,189	45.3	41,252	54.7
1966	70,642	30,317	42.9	40,325	57.1
1967	72,534	29,824	41.1	42,710	58.8
1968	75,339	26,132	34.7	49,207	65.3
1969	78,404	20,559	26.2	57,845	73.8
1970	70,749	25,427	35.9	45,322	64.1
1971	98,056	38,825	39.6	59,231	60.4
1972	115,570	42,580	36.8	72,990	63.2
1973	131,552	26,794	20.4	104,758	79.6
1974	122,143	17,621	14.4	104,522	85.6
1975	123,929	31,809	25.7	92,120	74.3
1976	134,313	33,001	24.6	101,312	75.4
1977	108,403	25,670	23.7	82,733	76.3

Source: Canadian Housing Statistics (Annual), Ottawa: Central Mortgage and Housing Corporation

rates) will affect the N.H.A. sector and thus its proportionate share of total activity. Recalling the objective of the study -- to understand inter-temporal land price variation rather than to explain the history of lot price increases -- this limitation in the data should not affect the N.H.A. sample's ability to represent the behavioral process of lot price determination.

The premise underlying the use of the selected N.H.A. data is that, irrespective of locality, year, or method of financing by the house purchaser, the behavior of lot developers and of house-builders is qualitatively constant. Nothing has replaced the market mechanism as the major means of determining prices and the level of production. And nothing has arisen to suggest that entrepreneurs, like people generally, cope with uncertainty and plan for the future with something other than expectations. In other words, the behavioral postulates of the theoretical model apply to N.H.A. builders as well as non-N.H.A. builders.

There are nevertheless some significant aspects of the difference between N.H.A. and non-N.H.A. building activity which will affect the empirical investigation. Entrepreneurs are generally free to move from one area or field of economic activity to another. There is mobility of firms and resources between different types of economic activity. This means that the market in building lots for N.H.A. housing is not separate from a market for lots for non-N.H.A. housing. Similarly, housebuilders are not restricted to one or the other type of building activity. Economic theory suggests that resources that are mobile move to that endeavor which provides the greatest return. Any use of N.H.A. data to test the theoretical model developed in Chapter Three must accommodate this principle.

The movement of resources between the N.H.A. and non-N.H.A. sectors has already been indicated in the preceding table. The changing levels of construction between the two sectors have also been discussed. Differences in price levels between the two are also important. The following table contrasts dwelling prices in the two sectors.

TABLE VII. Estimated Selling Prices of New Single-Detached Dwellings, Canada, 1951-1977.

Year	N.H.A. Financed Dwellings	Other Dwellings
1951	$ 10,948	$ 8,559
1952	11,300	8,410
1953	11,738	8,298
1954	12,418	9,274
1955	12,841	11,209
1956	13,854	12,997
1957	14,278	12,895
1958	14,479	14,088
1959	14,729	15,305
1960	14,639	15,733
1961	14,888	17,228
1962	15,233	17,840
1963	15,682	17,934
1964	16,478	19,122
1965	17,402	21,144
1966	19,293	23,554
1967	19,611	25,114
1968	19,898	25,924
1969	21,860	27,472
1970	21,599	27,496
1971	22,912	28,541
1972	23,475	32,834
1973	25,517	39,104
1974	29,810	45,698
1975	35,492	51,043
1976	39,881	55,699
1977	42,134	60,004

There are no published annual data on the average price for non-N.H.A. housing. The data in the table are based upon published data on average loan amounts for conventionally-financed housing. By common experience, a 75 per cent loan-to-value ratio characterizes such mortgages. It is thus possible to estimate the full value of these dwellings.

From the table it can be determined that over the 1951-1977 period, the average unweighted price for N.H.A. housing is $20,405 and

$25,422 for non-N.H.A. housing, or 25 per cent more. On an annual basis, non-N.H.A. house prices tend to exceed prices in the N.H.A. sector by 12.8 per cent.

The ratio of relative prices has not been a constant one for non-N.H.A. house prices have risen an average of 8.0 per cent per year while N.H.A. house prices have risen an average of 5.4 per cent annually. There is thus an association of a sort between the declining size of the N.H.A. sector and the lower rate of price increases in that sector relative to the other sector. According to the theoretical model, lot prices are expected to vary with changes in house prices and construction costs. An empirical test of this proposition which uses N.H.A. data and which ignores the role of the non-N.H.A. sector will be of limited use. The empirical model must therefore take close account of the relationship between the two sectors.

There is a fourth set of limitations associated with the data. These are measurement problems. The first may be of such critical significance as to reduce the empirical study to a prima facie analysis. The reservation prices, rL^a and rL^b, are not observable or measured variables, whether at the level of the individual firm or at the aggregate level. While many of the variables which were theorized to enter into the formation of reservations and expectations are observable, the end result is not. An iterative approach by which alternative formulations of the reservation price variables were tested to see which one was most consistent with the observed market variables begs the question addressed by the study and is therefore rejected. Instead, the theorized formulation will be tested. This has important implications for the results of the study. A rejection of the hypotheses involves a rejection of the reservation price formulation without necessarily invalidating the notion that reservation prices and behavioral processes of another nature underlie the determination of lot prices and their inter-temporal variation.

A second measurement problem lies in the annual nature of the data. They pertain to the new dwellings financed through the National Housing Act each year. The available data on lot prices and construction costs are measured on this basis. Since there are inventories of unsold dwellings carried from one year to the next, the annual data are biased, since they do not represent all building lots actually constructed upon during a given year. However, since inventory is estimated to range between 2 and 5% of new construction (for single-detached and duplex dwellings in major urban centres), this carry-over is expected to have negligible effect. On the other hand, the data do not include building lots traded between investors or held by housebuilders in inventory. With respect to the latter, the assumption made in this study is that all construction of dwellings were commenced at the beginning of the year, with sale and lot purchase occurring at the beginning of the year. This is not unreasonable since a 6 to 9 month construction period is typical for single-detached dwellings, and a very short holding period for building lots normally characterizes the operations of small builders (see Richard More, 1970). The trading of building lots for investment or long-term inventory purposes is ignored at greater peril. If the lot market operates in the manner postulated, this should not have serious ramifications.

A fourth measurement problem lies in the absence of data on builder profits, whether on construction activity or on lot holding. The available N.H.A. data include an undefined component referred to as 'other costs'. This variable will be interpreted to include profit on the land component as well as holding costs such as property taxes and additional servicing costs. The published land cost data are interpreted as the average price for building lot. It is assumed that it is the actual price paid and does not include profit, and holding and servicing costs after the lot was purchased.

A fifth measurement problem lies in the absence of cost and price data for single-detached housing construction which was not N.H.A.-financed, as has been discussed above.

These measurement problems will bias the parameter estimates of the empirical analysis, and the predictive ability of the empirical model. This will confine the application of the findings and discourage the derivation of policy implications. One measurement problem, the measurement of average builder profits on lots, could potentially bias the analytical validity of the model. The reason for this is that the theoretical formulation of lot demand and builders' reservation prices makes them quite sensitive to the magnitude of profits relative to the values of the other variables. Further research beyond the scope of this particular study would be necessary to verify and improve the quanlity of these data.

The four data limitations discussed are not slight but neither are they insurmountable obstacles for the proposed investigation. The changing composition of N.H.A. activity not accounted for in the available data was argued to affect any attempt to explain the real causes of lot price increases without critically affecting an attempt to uncover the process by which lot price increases occur. Secondly, the existence of a 'national' housing market was argued on theoretical grounds. Third, the unrepresentativeness of N.H.A. data relative to non-N.H.A. activity was shown to be so significant as to require explicit consideration in the specification of the empirical model. Finally, the measurement characteristics of the data were seen to impose several serious reservations upon the interpretation and general application of results to be obtained.

4.2 THE EMPIRICAL MODEL

Only rarely do real-world measurements coincide exactly with the theoretical constructs which they are to represent and estimate. The

preceding section has shown how the data readily available for this study do not satisfy all of the requirements of the theoretical model. Since the data are otherwise quite suitable, an auxiliary or empirical model is developed to accommodate some of the peculiarities in the data which are of theoretical significance. In the process, the theoretical model is also restated in more definitive form to yield exactly-stated propositions of a quantitative nature about the theory's predictions.

There is one significant aspect of the data which requires some accommodation in the empirical model. The data represent N.H.A. activity in a market where the N.H.A. sector's activity is not isolated from or independent of the non-N.H.A. sector.

In spite of this caveat, the basic structure of the model developed in Chapter Three remains unchanged. The system of equations proposing that the market price of lots and the quantity transacted are jointly determined by aggregate demand and supply remains the same. The proposed demand and supply functions, relating demand and supply, respectively, to market price and to reservation prices, also remain the same.

The modification made is to the instrumental-exogenous variables of the theoretical model -- the reservation prices. Since developers can sell lots to both N.H.A. and conventional builders, the formation of their reservation price, rL_t^a, will not be limited to the price level, the price appreciation, and the desired rate of return in the N.H.A. sector, but will also depend on the value of these variables in the non-N.H.A. sector.

Similarly, builders are generally mobile between the two sectors of house-building activity and their activity in the N.H.A. sector must be competitive with the non-N.H.A. sector's opportunities. Lot demand and lot supply will now be more closely examined, and given a precise

empirical formulation.

Lot Buyer's Reservation Price

In the theoretical model it was proposed that lot demand takes the following form:

$$qL_t^d = a_1 - a_2 rL_t + a_3 rL_t^b \qquad (5.1)$$

In the empirical model, this demand function remains unchanged except for the addition of u_t^d, a disturbance or error term which will account for the composite effect of all causal factors other than those already in the equation, namely the market price and builders' reservation price. This would include random information errors and random variation in transaction and information costs.

$$qL_t^d = a_1 - a_2 rL_t + a_3 rL_t^b \pm u_t^d \qquad (5.2)$$

The coefficient a_2 refers to the slope of the demand curve and measures the change in quantity of lots demanded for given changes in the market price of lots. The sign of the coefficient is negative, indicating an inverse relationship between the two variables.

The coefficient a_3 is a shift parameter which measures the movement of the demand curve from one time period to another, without affecting the slope of the curve. The sign of this coefficient is hypothesized to be positive as increases in the bid price, given an unchanged market price, are hypothesized to produce an increase in the quantity of lots builders would like to purchase.

In the theoretical model, builders' reservation price is specified as follows:

$$rL_t^b = \frac{pH_t^e - mN_t^e}{(1+k_t^d)^t} \qquad (5.3)$$

where pH_t^e = builders' expected selling price of dwelling at the end of the construction period, t,

mN_t^e = builders' expected construction costs, and

$1+k_t^d$ = builders' desired rate of return.

For convenience, because the data are recorded on an annual basis, the time period, t, will be set equal to one year. It will thus be assumed that expectations are formed and lots purchased as well as construction begun near the start of a given year, while the expected values of expectational variables pertain to the end of the year when construction is completed and the sale of the dwelling is expected.

In view of the role of the non-N.H.A. sector of single-detached residential construction, the specification of the reservation price variable will be modified. The formation of expectations will be specified in terms of a naive trend extrapolation expectations model rather than the more sophisticated versions treated in the theoretical analysis. This simplification is justified on the basis of year-to-year advances in the consumer price index which would probably make irrelevant even the most sophisticated expectation based on past values of the expectational variable.

It is hypothesized that builders' expected average value of new N.H.A.-financed dwelling prices at year-end will be a function of last year's price adjusted for increases in this price and on increases in consumer prices, as follows:

$$pH_t^e = pH_{t-1} \times 0.5\left[\frac{pH_{t-1}}{pH_{t-2}} + \frac{cpi_{t-1}}{cpi_{t-2}}\right] \tag{5.4}$$

where "cpi" denotes the level of the all-items consumer price index. To take non-N.H.A. activity into account, it is hypothesized that builders also look to price movements in that sector for indications of future price

trends. As a further refinement, since house prices may increase at different rates than the prices of other consumer goods and services, the housing component of the consumer price index, might be included in the specification. The result is as follows:

$$pH_t^e = pH_{t-1} \times 0.25\left[\frac{pH_{t-1}}{pH_{t-2}} + \frac{cpH_{t-1}}{cpH_{t-2}} + \frac{cpi_{t-1}}{cpi_{t-2}} + \frac{hcpi_{t-1}}{hcpi_{t-2}}\right] \quad (5.5)$$

where "hcpi" denotes the level of the housing component of the consumer price index, and "cpH" indicates the average estimated price of new single-detached housing in the non-N.H.A. sector. A weighted average approach giving greater emphasis to the rate of change in N.H.A. house prices was not used since it is reasonably assumed that current N.H.A. price is established relative to other current prices, rather than according to its own past prices.

A further modification of the expectational selling price variable is necessary to accommodate a significant feature of National Housing Act mortgage lending and insurance activity (as discussed by Hatch (1975)). The provisions of the Act allow regulations prescribing a ceiling on the loan amount of the N.H.A. mortgage. Regulations also prescribe the maximum loan-to-value ratio. Both of these can and have changed from year to year. Both will affect final selling prices. The following table shows the relevant data for the 1951-1977 period.

Builders typically arrange financing at the start of a building project. A commitment is obtained from a lender to extend mortgage loans to approved borrowers for the purchase of the completed dwellings. When builders obtain their financing under the provisions of the N.H.A. they cannot expect finall selling prices to exceed the amount determined through

TABLE VIII. Loan Limit and Loan-to-Value Ratio Provisions of the National Housing Act, Canada, 1951-1977.

Year	Loan Limit	Loan-to-Value Ratio	Estimated Price Limit	Average Loan Amount	Actual Price
1951	10,000	0.86	11,570	7,030	10,498
1952	10,000	0.86	11,570	8,253	11,300
1953	10,000	0.86	11,570	8,502	11,738
1954	12,800	0.80	16,000	9,974	12,418
1955	12,800	0.80	16,000	10,169	12,841
1956	12,800	0.80	16,000	10,725	13,854
1957	12,800	0.86	14,850	11,286	14,278
1958	12,800	0.86	14,850	12,036	14,479
1959	12,800	0.86	14,850	12,224	14,729
1960	14,200	0.89	16,000	12,400	14,639
1961	14,200	0.89	16,000	13,343	14,888
1962	14,200	0.89	16,000	13,440	15,233
1963	14,900	0.88	17,000	13,776	15,682
1964	14,900	0.90	16,640	14,558	16,478
1965	18,000	0.90	20,070	15,120	17,402
1966	18,000	0.90	20,070	16,605	19,293
1967	18,000	0.90	20,070	16,358	19,611
1968	18,000	0.93	19,285	16,618	19,898
1969	25,000	0.91	27,500	18,377	21,860
1970	25,000	0.91	27,500	19,811	21,599
1971	25,000	0.91	27,500	19,647	22,912
1972	30,000	0.95	31,575	20,757	23,475
1973	30,000	0.95	31,575	23,064	25,517
1974	32,500*	0.95	34,200	26,746	29,810
1975	35,000*	0.95	36,800	32,862	35,492
1976	37,500*	0.95	39,500	34,910	39,881
1977	40,000*	0.95	42,100	37,796	42,134

* In 1974, N.H.A. loan regulations were amended to eliminate previously prescribed maximum loan amounts so as to permit C.M.H.C. to establish loan maxima on a regional or local basis. Loan amounts were subsequently increased to a variety of levels between $30,000 and $40,000.

N.H.A. regulations for they limit the loan amount and loan-to-value ratio available to qualified house purchasers (Hatch, 1975: 51-55).

Another expectational variable is construction cost. The following equation represents how these expectations are hypothesized to occur.

$$mN_t^e = m_{t-1} \times N_{t-1} \times 0.5\left[\frac{N_{t-1}}{N_{t-2}} + \frac{resind_{t-1}}{resind_{t-2}}\right] \qquad (5.6)$$

where m_{t-1} = average dwelling size in the last year,

N_{t-1} = average unit construction cost (per square foot) in the last year, and

$resind_{t-1}$ = the level of the composite residential construction cost index (for labour and materials) in the last year.

This formulation specifies that builders assume a constant dwelling size, similar to last year's, and an increase in construction costs related to previous changes in actual construction costs and in the residential construction cost index. It is hypothesized that builders form these construction cost expectations as a first approximation which is subsequently adjusted once builders have acquired building lots, which may have cost more or less than was bid for them. On this occasion estimated or proposed dwelling construction costs are defined as follows:

$$mN_t^a = pH_t^e - [rL_t \times (1 + k^{d_t})] \qquad (5.7)$$

where mN_t^a = estimated or proposed dwelling construction costs, and the other variables are as previously defined.

Proposed construction costs are the difference between expected selling price and the desired future value of the building lot (purchase price, rL_t, plus a capital gain of k^d per cent).

Proposed dwelling size, m_t^a, is therefore determined in the following manner:

$$m_t^a = mN_t^a / N_t^e \qquad (5.8)$$

Proposed total dwelling construction costs are divided by expected unit

construction costs to obtain proposed dwelling size. This complete sequence of events yields the proposition that dwelling size will be increased when building lots can be purchased at a price below builders' reservation price, all other things remaining equal (i.e., expected selling price, expected unit construction costs, and desired rate of return).

One final variable which enters into the formation of the average reservation price of builders is the desired rate of return. In the theoretical model it was suggested that builders sought two types of return from their activity: (1) a builder's after-tax profit on construction activity as recompense for construction management and supervision, and for the use of builder-owned capital equipment; and (2) an after-tax capital gain on the value of the building lot as a reward for entrepreneurial activity and risk and as reimbursement of holding costs (but where the capital gain is treated by income tax authorities as business income).

It will be one of the assumptions of the empirical model that the builder's lot purchase measures his equity contribution to the project, paid for from working capital. In a study of the Vancouver housebuilding industry, Price (1970) found that while large tract builders can avoid paying cash and are able to finance their entire operations, it is usually necessary for small builders "to own the land before financial institutions will lend them money". He found that small builders typically had

> ... to invest an amount equivalent to the value of the lot and construction costs to floor level before any finance money would be released. (1970: 70)

While a basis in fact for our important assumption is not firm, it is consistent with the descriptions of builder behavior made by Milgram

(1968), and Hatch (1975: 90-94) in a Canadian context.

The assumption made here is not that the builder finances the lot purchase from his working capital, though small builders may be required to do so. Rather, it is assumed that lot value measures the builder's equity contribution. Lenders' financial arrangements with builders are usually conservative in that they lend on the basis of amount of dwelling construction completed. The lender thus assumes some of the risk on the dwelling portion of the property, leaving any riskiness in the development of the building lot to the builder. Our assumption is justified on this basis.

It remains that some builders can finance the purchase of the lot, in this case their individual business profit is reduced by the cost of the loan, without affecting the gross capital gain in the lot's value over the holding and construction period.

Builder's rate of return is defined as the rate of discount which equates the present value of a building lot at time of acquisition to its residual value at time of sale.

$$k_t = \frac{pH_t - mN_t - rL_t}{rL_t} \qquad (5.9)$$

The desired rate of return from building activity in the forthcoming year is defined in this way:

$$k_t^d = k_{t-1} \times \frac{i_{t-1}}{i_{t-2}} \qquad (5.10)$$

It is hypothesized that builders would seek an increase in their previous rate of return commensurate with expected increases in the conventional mortgage lending rate, i_t. This lending rate is used here as a proxy for the cost of capital. The mortgage lending rate is more appropriate than

the prime lending rate or the bond rate since it incorporates some adjustment for the higher risk and illiquidity in real estate investment as compared to other securities. However, builders' actual rate of return is probably higher than the lending rate for mortgages since building projects in their initial stages at least are much riskier and far less marketable than mortgages.

A further modification is added to the definition of desired rate of return due to the role of the non-N.H.A. building sector. Since the builder can choose between both sectors, profitability or rate of return should be comparable in both. If the risks are identical then the rates should be identical. Less risk is probably to be found in N.H.A.-financed dwelling construction since the less expensive housing which it produces and the more favourable loan terms are more likely to find buyers.

Since there is no direct measure of rates of return in the non-N.H.A. sector, a proxy indicator is employed. The following reformulation hypothesizes that builders look to the relative difference between expected selling prices in both sectors for an indication of relative differences in profitability. The desired rate of return is thus adjusted according to the ratio of expected price trends in both sectors.

$$k_t^d = k_{t-1} \times \frac{k_{t-1}}{k_{t-2}} \times 0.5\left[\frac{cpH_t^e}{pH_t^e} + \frac{cpH_{t-1}}{pH_{t-1}}\right] \qquad (5.11)$$

Each of the terms in the following equation has been defined:

$$rL_t^b = \frac{pH_t^e - mN_t^e}{1 + k_t^d} \qquad (5.12)$$

Consequently, the formation of builders' reservation price has been fully specified.

Lot Sellers' Reservation Price

In this empirical model lot supply is expressed in the following manner:

$$qL_t^s = a_4 + a_5 rL_t - a_6 rL_t^a \pm u_t^s \qquad (6.1)$$

Otherwise identical to the formulation in the theoretical model, a disturbance term, u_t^s, is added here as in the case for lot demand to include the influence of factors on lot supply other than those specified in the equation.

The coefficient a_5 is the slope of the supply curve which measures the change in the quantity of lots that developers will make available for sale with given changes in the market price of lots. The sign of the coefficient is positive for it is hypothesized that quantity supplied is positively related to market price.

The coefficient a_6 is a shift parameter that moves the supply curve along the quantity axis in relation to changes in sellers' average reservation price rL_t^a. The sign of this coefficient is negative according to the hypothesis that a higher reservation price, other things being equal, will reduce the quantity of lots that developers would supply. A clear comprehension of this can be had by forming a ratio of asking price to market price. The individual developer, taking the market price as a given, compares it to his asking price. If it is higher, he sells. If it is lower, he does not. When this behavior is aggregated, we obtain the hypothesis expressed. However, at the aggregate level, market price is no longer exogenous but will be determined in part by the

behavior of individual firms taken collectively. At that level of analysis, the significant ratio is formed by the reservation prices of both buyers and sellers.

Lot developers' reservation or asking price for building lots was defined in the theoretical model in the following way:

$$rL_t^a = rL_{t-1} \times (1 + j_t^d)^t \qquad (6.2)$$

where rL_{t-1} = last year's market price for building lots, and

j_t^d = developers' average desired rate of return.

The desired rate of return was not precisely defined in the theoretical analysis, except to say that it would be closely related to the return on alternative investments with comparable risk and liquidity. As in the case of lot buyers or house-builders, a base rate against which all real estate returns might be compared is the conventional mortgage lending rate.

To estimate an approximation of the desired rate of return for developers, the actual rate of return should first be defined.

$$j_t = \frac{rL_t - rL_{t-1}}{rL_{t-1}} \qquad (6.3)$$

Very simply, it is the rate of appreciation in lot prices. This investor or speculator approach to lot supply rather than a producer approach as was used for lot demand was justified in the theoretical model on the basis of literature which suggested the applicability of the approach. A more complete analysis, beyond the scope of this study, should treat lot supply from a production point of view since lot developers stand in similar relation to lot buyers as house builders stand in relation to house buyers.

The desired rate of return in lot 'investment' cannot be simply related to an extrapolation of past rates of lot price appreciation for these can be seen in the data provided earlier in this chapter to fluctuate rather widely from year to year. Since lot prices are hypothesized to be causally related to house prices in a residual manner, one hypothesis would be to state that lot suppliers look to house price increases for an indication of expected lot price increases and therefore the amount of the amount of house price increase which they would desire to capture for themselves. That is,

$$j_t^d = \frac{PH_{t-1} - PH_{t-2}}{PH_{t-2}} \qquad (6.4)$$

where PH is the average price of all housing, both conventionally financed and N.H.A.-financed.

However, the desired rate of return also depends on the cost of capital, or the conventional mortgage lending rate, i. The preceding formulation might be revised as follows:

$$j_t^d = \frac{PH_{t-1} - PH_{t-2}}{PH_{t-2}} \times \frac{i_{t-1}}{i_{t-2}} \qquad (6.5)$$

Since data on the average price of all single-detached housing are not available, and while an estimate could be developed, the price indicator that will be used is the movement of estimated prices in the sector of conventionally-financed housing, the more dominant sector. The price terms in the preceding equation can therefore be replaced as follows:

$$j_t^d = \frac{cpH_{t-1} - cpH_{t-2}}{cpH_{t-2}} \times \frac{i_{t-1}}{i_{t-2}} \qquad (6.6)$$

There is one final modification to be made to the rate of return variable. Since N.H.A.-financed housing might sometimes, if rarely, be expected to increase at a greater rate than conventionally-financed new housing, it is hypothesized that lot suppliers will look to this rate when that threshold is reached.

The other term of the reservation price equation for lot supply, rL_{t-1}, also requires modification in the empirical model in view of the relationship between the two sectors of the new housing market. It can be strongly suggested that there is only one price in the lot market and that lot suppliers do not distinguish between builders who are building for the N.H.A. sector and those that are not.

The average lot price in this single market, RL, will of course have to be estimated since there is no data which measure it. The task is simplified if it is assumed that lot suppliers ignore lot price levels in the N.H.A. sector and look instead to price levels in the conventional sector. Proceeding on this assumption, the price of building lots in that sector could be defined and estimated as follows:

$$nrL = rL \times \frac{npH}{pH} \qquad (6.7)$$

This assumes that the level of lot prices in the non-N.H.A. sector is the average price in the N.H.A. sector increased by the ratio of house prices in the two sectors. Such an assumption will in all likelihood introduce some error in the testing cf the model for there is no reason to assume that this relationship will hold on a year-to-year basis. However, on a long-term basis it is a reasonable one to make, just as the rates of return in both sectors should be the same in the long run. Indeed, it is year to year deviations from a long-run equality in these which will explain the movement of resources between both sectors, and the gradual decline in the colume of N.H.A. activity. This means that the movement

of resources out of the N.H.A. sector reflects less and less opportunity there to earn rates of return for lot suppliers, as well as builders, which are competitive with those that are possible in the conventionally-financed sector.

Each of the terms in the following equation has been defined:

$$rL_t^a = (nrL_{t-1}) \times (1 + j_t^d)^t \qquad (6.8)$$

Consequently, the formation of lot sellers' reservation price has been fully specified.

Demand and Supply

The preceding sections have specified the nature of the empirical model's instrumental variables, rL_t^a and rL_t^b, in terms of the model's exogenous variables.

In the following discussion, the demand and supply functions will be examined more closely with a view to stating some further hypotheses. As these functions were developed through theoretical anaylsis, hypotheses have been limited to the signs of the coefficients. It is possible, given the analysis underlying the theoretical model, and some of "a priori" conditions of the empirical model, to venture some hypotheses about the relative magnitudes of the coefficients.

The lot demand and supply functions were previously specified in the following manner:

$$qL_t^d = a_1 - a_2 rL_t + a_3 rL_t^b \pm u_t^d \qquad (7.1)$$

$$qL_t^s = a_4 + a_5 rL_t - a_6 rl_t^a \pm u_t^s \qquad (7.2)$$

Coefficients a_2 and a_5 are parameters of the short-run demand and supply schedules, while coefficients a_3 and a_6 are the parameters of the shift variables. Already hypothesized are the signs indicated. The signs of the constants, a_1 and a_4, and of the disturbance terms are indeterminate. An assumption necessary for the statistical estimation of these equations, to be discussed later, is that the disturbance terms, u_t^d and u_t^s, are not related to one another. Furthermore, it is assumed that there is no serial correlation in them, that is, $u_t^d \neq u_{t-1}^d$. The assumptions about the disturbance terms signify that the factors affecting demand or supply which are not specified in the terms of the equations are random in effect. They are not interrelated from one year to the next, and they do not affect demand in the same way as they affect supply. The implication is that the equations presume to explain the formation of demand and supply as much as they can possibly be explained using the indicated variables and that no variables have been left out which might be related to those that have been excluded. The basis for these assumptions is found in the theoretical analysis.

It is possible to hypothesize the relative magnitude of the coefficients of the short run and shift parameters. If market price, rL_t, is replaced in the demand and supply equations by the demand and supply reservation prices, respectively, we obtain the following equations:

$$qL_t^d = a_1 - a_2 rL_t^b + a_3 rL_t^b \pm u_t^b \qquad (7.3)$$

$$qL_t^s = a_4 + a_5 rL_t^a - a_6 rL_t^a \pm u_t^a \qquad (7.4)$$

These equations might be rewritten as follows:

$$qL_t^b = c_1 - c_2 rL_t^b \pm u_t^b \qquad (7.5)$$

$$qL_t^a = c_3 - c_4 rL_t^a \pm u_t^a \qquad (7.6)$$

These equations express the quantity of lots demanded and supplied at the demand and supply reservation prices. The coefficients c_2 and c_4 are given a negative sign to express a new hypothesis that the more that buyers and sellers are willing to pay or accept for lots relative to previous lot prices, the lower will be the quantity demanded or supplied at those new prices. This hypothesis is generated from the notion that lot buyers and suppliers have a relatively fixed amount of working capital or assets on which they seek a desired rate of return commensurate with profitability in comparable endeavors. Thus, in actuality they would seek an absolute amount of return. The higher are the reservation prices, and given an acceptable rate of return, the lower the number of purchases by builders, or sales by builders, necessary to generate that amount of return.

Empirically, however, the signs will ultimately depend on the numbers of new builders and developers attracted to the market by expected profits. The increase in the size of these two industries may erase the hypothesized effect.

The signs of the coefficients, as derived above, c_2 and c_4, enable a tentative statement about the relative magnitudes of the coefficients in the demand and supply equations:

$$-c_2 = (-a_2 + a_3)$$

$$-c_4 = (a_5 - a_6)$$

For the first of these equations to hold, a_2 must be larger than a_3. For the second equation to hold, a_6 must be larger than a_5.

The hypotheses of the empirical model about the demand and supply equations can be summarized in the following manner.

$$qL_t^d = a_1 + a_2 rL + a_3 rL_t^b \pm u_t^d \qquad (7.1')$$

where it is hypothesized that

$$a_2 < 0$$

$$a_3 > 0$$

$$a_2 > a_3$$

$$qL_t^s = a_4 + a_5 rL_t + a_6 rl_t^a \pm u^s \qquad (7.2')$$

where it is hypothesized that

$$a_5 > 0$$

$$a_5 < 0$$

$$a_5 < a_6.$$

<u>The Market</u>

The empirical model now incorporates the interaction between supply and demand to determine market price and the quantity of lots transacted. In the theoretical model, the following price and quantity equations were formulated:

$$rL_t = b_1 + b_2 rL_t^a + b_3 rL_t^b \qquad (8.1)$$

$$qL_t = b_4 - b_5 rL_t^a + b_6 rL_t^b \qquad (8.2)$$

These equations can be rewritten in the more precise form with which they will be confronted with data.

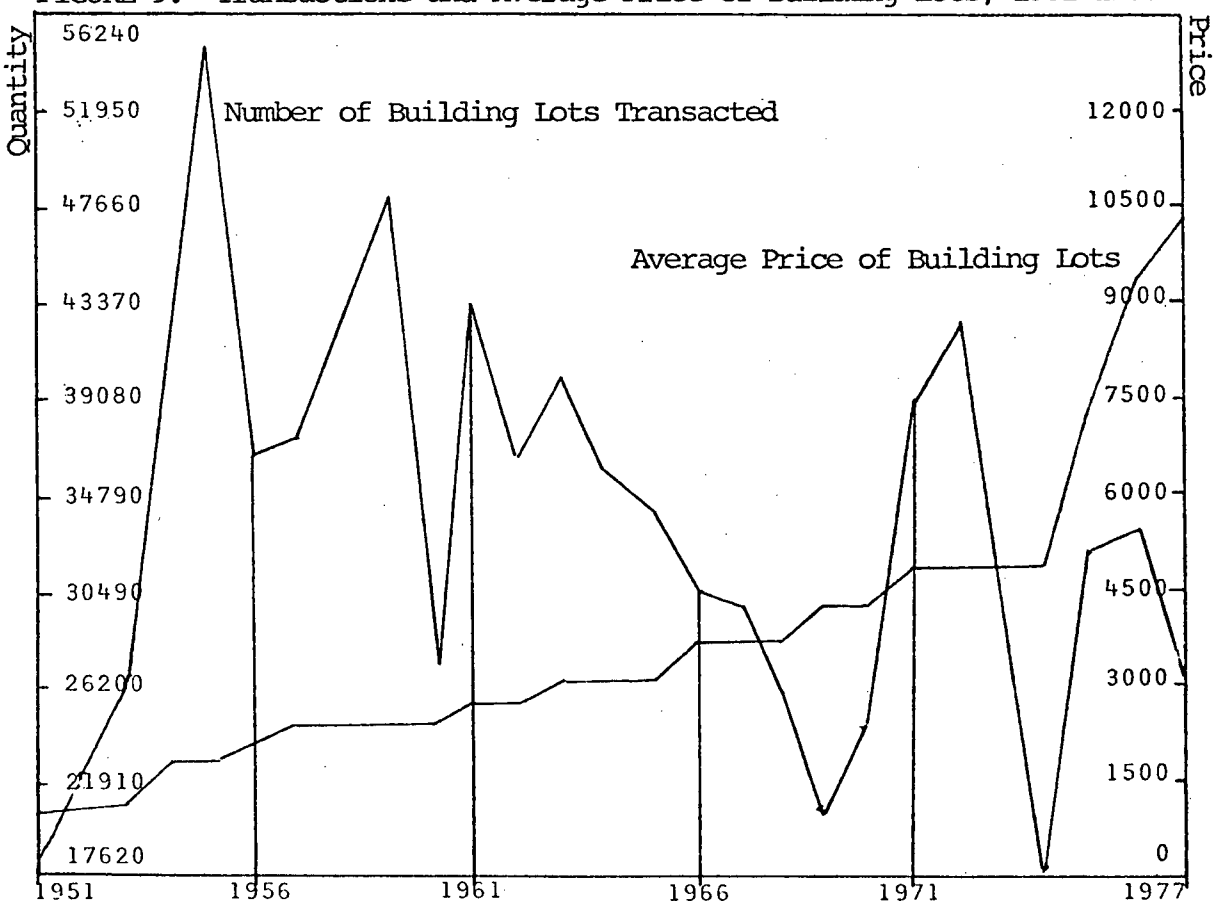
$$rL_t = b_1 + b_2 rL_t^a + b_3 rL_t^b \pm w_t^r \qquad (8.3)$$

$$qL_t = b_4 - b_5 rL_t^a + b_6 rL_t^b \pm w_t^q \qquad (8.4)$$

In the theoretical analysis it was postulated that the price and quantity equations would generate a time path of successive market prices and lot transactions according to the successive values of the reservation prices. Following the central hypothesis that lot prices are derived from housing demand, it is to be expected that the bid price for lots would be the major factor shaping the time path.

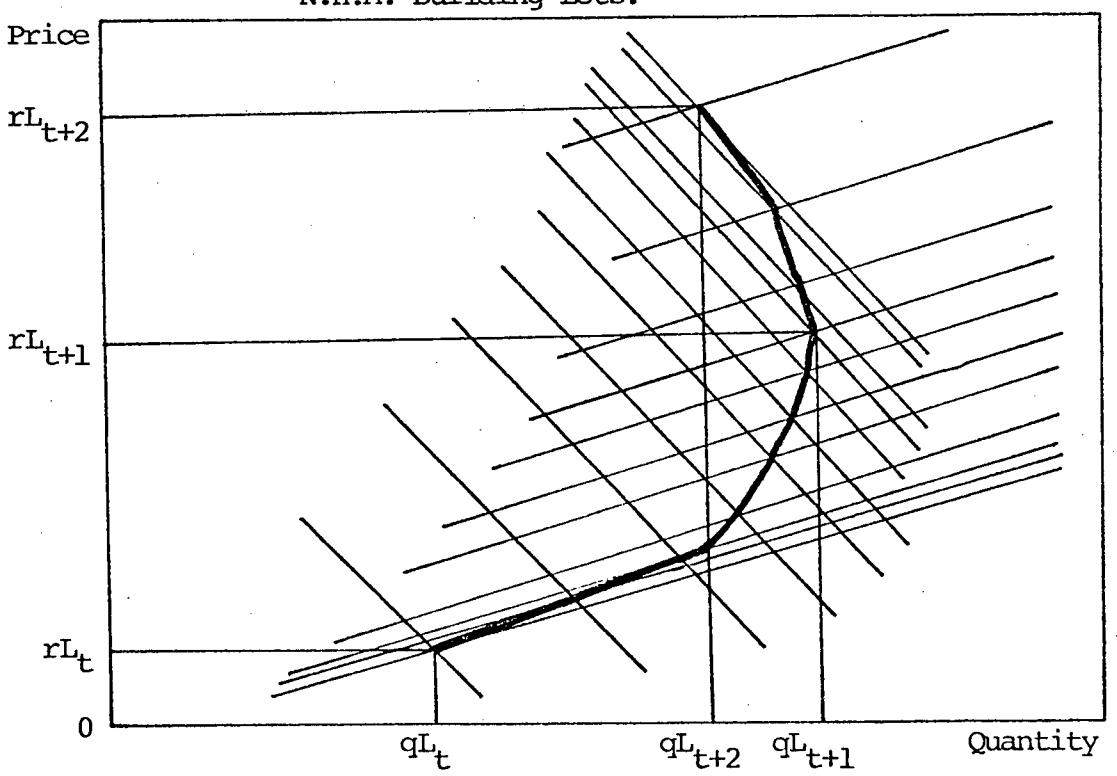
By contrast, in the empirical situation investigated here, while prices have continued to rise over the twenty-five year period, lot transactions have fluctuated and generally declined. This is depicted in Figure 9. It is therefore not expected to find empirical conditions similar to those postulated by the theoretical model.

FIGURE 9. Transactions and Average Price of Building Lots, 1951-1977.



The diagram following represents a generalized interpretation of events suggested by the empirical model and the above data. Assuming for convenience that demand and supply were in equilibrium in every time period, the following diagram shows how the short-run demand and supply curves might have shifted over time to generate the generally observed trend in lot prices and transactions. Because of rising house prices in the non-N.H.A. sector, the profitability of lot sales to that sector has increased and lot sellers' reservation prices have risen concomitantly. On the demand side, the more gradual rate of increase in the selling price of N.H.A. houses would have tempered builder rates of return, lowered their enthusiasm for N.H.A. building, and, in the aggregate, resulted in a decline in N.H.A. building activity.

FIGURE 10. Long-Run Demand and Supply in the Market for N.H.A. Building Lots.



This brief analysis indicates a further hypothesis, namely that the coefficient b_5 in the quantity equation (8.4) above will be greater than the coefficient b_6 for lot suppliers are under no compulsion to sell lots very far below their reservation price, when they can sell them at acceptable prices to non-N.H.A. builders. Insofar as asking prices exceed bid prices, the hypothesis is a safe one to make.

A hypothesis about the relative magnitudes of the coefficients in the price equation (8.3) can also be made. It is expected that the coefficient b_3 will exceed the coefficient b_2. While asking prices will probably be found to exert considerably upward pressure on N.H.A. lot prices, builders of N.H.A. single-detached dwellings are constrained in an absolute sense in the price they can afford to pay by N.H.A. lending limits. Builders are also constrained by what they would be willing to pay given the alternative of profitable activity in the non-N.H.A. sector. It is therefore expected that lot prices will increase only to the extent afforded by lot demanders.

Market Equilibrium

A final subject to be treated in the development of the empirical model is the matter of market equilibrium. Do we expect to find lot sellers being able to sell the quantity they want to sell at the price they're asking? Do we expect lot buyers to be able to buy the quantity of lots they seek to build on at the price they're bidding?

None of the preceding discussion and analysis provides a definitive answer. However, several assumptions underlie the investigation which can be relied upon to suggest what manner of (dis)equilibrium situations the empirical investigation might potentially uncover. First, it is assumed that lot developers and builders are slow in adjusting to

expectations. For caution, as well as the relative fixity of assets and skills, time is required for a revision in a firm's policies.

Second, there is no organized market in building lots nor any 'over-the-counter' or 'off-the'shelf' marketing of building lots. Builders must actively find lots. Developers must actively pursue buyers. The available stock of lots is a matter of conjecture, experience, or 'feel' rather than one of hard, published fact. As a result, bargaining and negotiations between lot sellers and buyers is an individualized and subjective matter. The aggregate effect may be a scattering of lot prices whose average is not identical to the equilibrium amount which might have been reached if an organized market had prevailed.

Third, information on which to base expectations is imperfect. For the individual participant in the market, it is typically incomplete, and possibly erroneous. If the individual builder, for example, estimates the trend in house prices on the basis of limited, personal samples, the aggregate effect of such behavior is to produce average expectations that are in error. When we see that this error is compounded by the number of expectational variables -- house prices, construction costs, rates of return, mortgage lending rates -- it is easily understood how reservation prices might be formed which result in disequilibrium market prices.

These considerations point to a hypothesis suggesting that in any given year, demand and supply are unlikely to be in equilibrium. The quantity demanded, qL_t^s, will likely exceed or be lower than quantity supplied, qL_t^s. No consistent pattern of excess demand or supply situations is expected however. This is consistent with the discussion in the latter part of the theoretical analysis.

Related to the matter of disequilibrium is the use of disturbance terms. In the estimation of the empirical model, it will in all

likelihood be found that the equations cannot explain all of the variation in the data. In other words, they may not perform very well as predictive equations. The prediction errors, referred to as 'residuals' in regression analysis, are treated in the proposed equations by means of the disturbance term. It was earlier indicated that these terms were expected to be random in effect with errors in one equation being unrelated to those of another, and with the error in one time period being unrelated to the error in a preceding or subsequent period.

A rationale for this assumption about the behavior of the disturbance terms is based on the idea that imperfect information and a disorganized market lead to imperfect and possibly erroneous expectations, and thus to imperfect reservation prices. Common sense tells us that people do not repeatedly make the same error, but by trial and error will attempt better ways of doing things. When numerous lot buyers and sellers are engaged in this searching exercise, it is plausible to expect their resulting errors to have a random character. And it is not expected that these errors might 'cancel out' in the process of aggregation. On the contrary, the influence of the media and trade associations, and the like will induce a certain conformity among lot sellers and another conformity among lot buyers or house-builders. This leads us to expect an erratic pattern of prediction errors in our estimated equations.

The development of the empirical model is completed with this discussion. The following section on the methodology pursued in the actual empirical investigation will treat the procedures adopted and the steps pursued in the empirical analysis. Also treated there are some propositions corollary to the empirical model, whose investigation will provide a more solid test of the model and of the significance of the main tests. For example, the time-series data will be partitioned into

two sub-periods with independent investigations of each to see if the parameters estimated over the entire period are stable within it. Two alternative models will also be tested for some indication of the empirical model's explanatory power relative to other potential models.

4.3 METHODOLOGY

The statistical methods used in empirical analysis serve two functions. They allow estimation of data when direct observations are not available. More importantly, they allow a test to be made of the correspondence between actual relationships between variables and those hypothesized by theory. In both cases statistical techniques offer computational methods of prediction and hypothesis-testing without which we would not know the reliability of our estimates and hypotheses. In this section, methodology will be discussed firstly with an identification of the actual techniques employed and secondly with an outline of the complete set of steps followed from the computation of reservations prices to the final evaluation of the complete empirical model.

In the analysis of data undertaken here the statistical technique utilized is regression analysis. The choice of this technique is dictated by the need to measure the amount of change in a variable that is associated with given amounts of change in other variables. Regression analysis is well-suited to this purpose. It is a method of describing and measuring the functional relationship between two or more variables measured by sample data. Given known values of the independent or causal variable(s), and the estimated parameters of the explanatory equation, this technique permits a prediction of the value of the dependent variable. A comparison of the actual values of the dependent variable

with those predicted on the basis of the hypothesized relationship between the dependent and independent variables provides a measure of the adequacy of the hypothesized relationship.

Actual computational techniques will not be discussed here. (Blalock 1972), Wynn and Holden (1974), and Cuddy (1974) discuss them in detail. The computer programs developed by N.H.Nie, et al (1975) were utilized in this study. Several statistical measures are available through their technique:

(a) the estimated coefficients of the regression equation;

(b) the standard error of each regression coefficient;

(c) the t statistic for each variable;

(d) the standard error of the estimate (s.e.e.);

(e) the coefficient of determination (R^2);

(f) the partial correlation coefficient of each regression coefficient;

(g) the significance level of the F probability for the entire equation, and

(h) the Durbin-Watson statistic.

These eight statistical measures combined permit a determination of the quality of estimated regression equations. The works by Schmalensee (1973) and Kelejian and Oates (1974) offer practical guidance in the interpretation of these statistics, each of which will now be briefly discussed.

The estimated coefficients of the regression equations are the signs and magnitudes of the parameters in the empirical equations computed in the regression analysis.

The standard error of each regression coefficient is the standard

deviation of its estimated value.

The t statistic is the ratio of the estimated regression coefficient to its standard error. Kelejian and Oates' approach to its interpretation is adopted (1977: 90-92). An absolute value of the t ratio exceeding 2 indicates that the estimate is significantly different from zero ata 5per cent significance level, or 3 and 1 respectively. When the sign of the coefficient is hypothesized, the required value falls to 1.7 at the 5 per cent level(or 2.5 at a 1 per cent level of significance).

The standard error of the estimate is the error value used to form a t statistic for the constant estimated for regression equation.

The coefficient of determination, R^2, is a measure of how well an equation explains the variation in the dependent variable. It lies between 0 and 1, and is interpreted as a percentage of the variance in the dependent variable explained by the regression equation. The adjusted R^2 is a firmer measure which takes into account the number of variables in the equation and the number of observations in the data.

The partial correlation coefficients measure the correlation between the dependent variable and each of the independent variables, while holding constant the effect of the other variables. This statistic is used to determine how much of the explained variation in the dependent variable is explained by a given independent variable.

The F statistic tests the significance of R^2. Large values of F generally indicate that all the estimated coefficients in the equation are not zeros. A probability level is usually produced along with F which indicates the significance level of the R^2 obtained.

The Durbin-Watson statistic provides a measure of the amount of correlation in the successive prediction errors of the equation. Generally, a value of this statistic inside the range 1.5 - 2.5 generally

indicates a satisfactory distribution of the errors.

While these statistics enable us to evaluate the regression equation which estimates afunctional relationship among variables, the evaluation must consider the use of the regression equation. Regression is a general statistical technique which can be used as a descriptive tool or as an inferential device (N.Nie, et al (1975)).

As a descriptive tool regression analysis can be used to find the best linear prediction equation and evaluate its prediction accuracy, or it can be used to describe the structure of linkages between the dependent and independent variables. A corresponding use as an inferential tool is to be found for every descriptive use -- whether to infer population parameters from sample data or to test hypotheses about the parameters. All of these uses are employed at some point or other in the empirical investigation undertaken here.

Of special significance is the distinction between the predictive use of the regression equation and its analytical role. Kane notes that

> It is important to realize that we may rate the performance of a regression equation either for the "light" it sheds on underlying theory or the "fruit" it yields in terms of successful forecasts. ... (1968: 354)

Thisstems from the presence of two main types of error in estimation of the regression equation: first, there is error arising from the random disturbance term representing factors not accounted for by the model in the equation; and second, there may be error in the specification of the model and consequently a mis-estimation of its parameters.

There are ways of determining the type of error in a model and therefore its analytic validity and its predictive value. Analytic validity

is usually affirmed by a high R^2 with a satisfactory significance level. If the Durbin-Watson statistic is within the acceptable range, even a low R^2 can affirm the validity of the model insofar as the model has correctly specified the amount of random error produced by the disturbance term. It is also required for analytic purposes to have individual regression coefficients that are significant.

The predictive value of the equation is not all that pertinent to hypotheses testing. However it does affect any generalization about the numerical values of the estimated parameters just as it affects the use of the equation's predictions. This characteristic of a model based on time-series data is best tested by the use of first-difference equations (using year-to-year changes in the data rather than annual values for example). A large drop in the R^2 of a level equation estimated in a first-difference form generally signifies large prediction error. Wynn and Holden (1974:4) observe that predictive accuracy is an elusive result in econometric analyses with the consequence that separate approaches are usually taken to analysis or model-testing, and prediction or forecasting.

Other tests of the regression equation's value and validity are found in 'extra sample' testing (Kane (1968: 354-355) and Cuddy (1974: 140-141)). When the time-series data are partitioned into two sub-samples of two separate time intervals, and the regression equations re-estimated, the sensitivity of the regression coefficients indicates model error while their stability confirms the soundness of the model.

This summarizes our use of regression analysis in the empirical study and our method of interpreting and evaluating its results. The hypothesis testing procedure outlined by Kelejian and Oates (1974: 77-92) is also used. Problems of multi-collinearity, auto-correlation and simultaneous-equation bias present further topics of

discussion but will be treated below.

Before the results of the empirical study are examined, in Chapter Five, the steps taken in the computational task of testing the empirical model's equations will be outlined. The strategy adopted in this study was to outline these steps before any empirical analysis was undertaken, with decision points indicated where evaluation of intermediary results could be used to determine whether or not it was feasible to proceed to the next step.

The first step involves a computation of expectations and reservation prices according to the equations of the model. This is a straightforward task requiring no statistical techniques but simply an arithmetic manipulation of the data base.

In the second step, the reduced-form market price and quantity equations (with reservation prices rL^a and rL^b as independent variables) are estimated. The overall regression results and the individual regression coefficients are evaluated against hypotheses.

A significant amount of multi-collinearity is expected to be found between the independent variables since they are combinations of related exogenous variables. According to Kelejian and Oates (1974: 184-187) this presents a problem when a high R^2 is found but the estimates of the coefficients of the independent variable are found to be statistically insignificant (as measured by their t-statistics). Otherwise, multi-collonearity does not present a problem.

Another potential problem is serial correlation in the variables, a frequent problem in time-series data. In such a situation, the values of the variables in one time period are closely related to their values in adjacent observations. The Durbin-Watson statistic provides an indication of the bias which serial correlation introduces to the equation

(Kelejian and Oates (1974: 190-207)). Some amount of it is tolerable. This statistic is not a very good indicator when lagged values of the endogenous variable are used in an independent variable. This does not occur in our equations for none of the lagged endogenous variables is used directly. The statistic is calculated from the residuals or prediction errors of estimated equations. A value of the statistic falling within the acceptable range denotes that the residuals are not significantly auto-correlated but are randomly distributed over time.

The third step involves an estimation of the reduced-form equations in terms of first differences to ascertain their predictive value. Furthermore, since the variables are standardized or reduced to a common unit of measure by the first difference transformation (i.e. annual percentage change), the practical interpretation of the reduced-form equations is facilitated by this step.

In the fourth step of the empirical analysis the demand and supply equations are estimated. Kane (1968: 313-318, 325f) and Kelejian and Oates (1974: 244-255) discuss the procedure to be used for the estimation of these in a simultaneous-equation model of the type developed in the theoretical analysis. The estimation of a single demand or supply equation with observed prices as one of the independent variables results in biased estimates of the equation since the model postulates that market price is an endogenous variable jointly determined by demand and supply. The solution proposed by Kelejian and Oates is two-stage least squares, as opposed to ordinary least squares regression analysis. Kane suggests indirect least squares.

The first operation of the 2SLS technique adopted here is provided in the second step above. It involves the prediction of market prices by the reduced-form price equations. The estimated values of

market prices (their "purged" values according to Kelejian and Oates (1974: 254)), are then used for the estimation of the supply and demand equations. These equations are then evaluated in the usual way.

The fifth step involves an estimation of the demand and supply equations in terms of first differences, for the same reason as in the third step. The first difference approach also permits an interpretation of the price elasticities of supply and demand, as discussed by Watson (1972: 39-61) for example.

In the sixth step, the temporal stability of the parameters of the reduced-form equations are estimated by sub-period regression analyses. The results of this test can be used to corroborate or qualify earlier findings.

A seventh step proposes the testing of two alternative empirical models. In the first case, a model is ventured that lot developers exert lot market power and are able to obtain their reservation price, i.e. $rL_t = rL_t^a$. Ready evidence is available to indicate that this is a probably unreasonable model: the year-to-year fluctuations in the annual appreciation in lot prices bears little relation to movements in corporate bond rates or mortgage interest rates. It is difficult to imagine why lot developers would be so erratic in their profit expectations. A second model assumes that the N.H.A. sample data pertain to an isolated lot market unaffected by non-N.H.A. activity. The performance of the empirical model relative to these alternatives can be obtained by evaluating the results of three model tests in the usual way. The relative power of the empirical model will be established by its significantly better predictive and analytical validity.

The eighth step involves the conducting of several 'ad hoc' tests of logically-derived expectations from the empirical model

pertaining to the disequilibrium-adjusting behavior of house builders. Insofar as builders do not find their bid price for lots, they should make predictable adjustments to dwelling size and level of production.

The final step of the proposed empirical analysis lies in reaching a conclusion about the overall significance of the statistical results for the tested empirical model.

CHAPTER FIVE

THE RESULTS

The empirical investigation undertaken in this study, and as outlined in Chapter Four, consists primarily of regression analyses to estimate and evaluate the equations of the empirical model. It should be remarked that a fundamental characteristic of hypothesis-testing is that propositions are never definitively proved or confirmed. At best, results might be obtained which provide evidence supporting or consistent with the hypotheses. Typically, it is null hypotheses which are tested, and evaluation lies in accepting or rejecting the null hypothesis that there is no relationship of the hypothesized form and sign, (and possibly magnitude) between the independent and dependent variables.

In the analyses reported here, all major null hypotheses were rejected. This means that no obvious reason was found to reject the overall analytical validity of the empirical model. Practically speaking, this means that the model developed in Chapter Four offers support for the theoretical model and therefore a promising and fruitful explanation of the determination of building lot prices and their inter-temporal variation.

In this chapter, the empirical and statistical results of the investigation are presented: (1) A brief review of the computed reservation prices is made; (2) the estimated reduced-form or price and quantity equations of model are presented and evaluated; (3) the estimated demand and supply equations are presented and evaluated; (4) the results of the sub-period tests and the test of two alternative models are presented; (5) a judgment is reached about the overall validity of the empirical model, with qualifications attached as necessary, and (6) the implications of the tested empirical model for the theoretical model are obtained.

5.1 RESERVATION PRICES

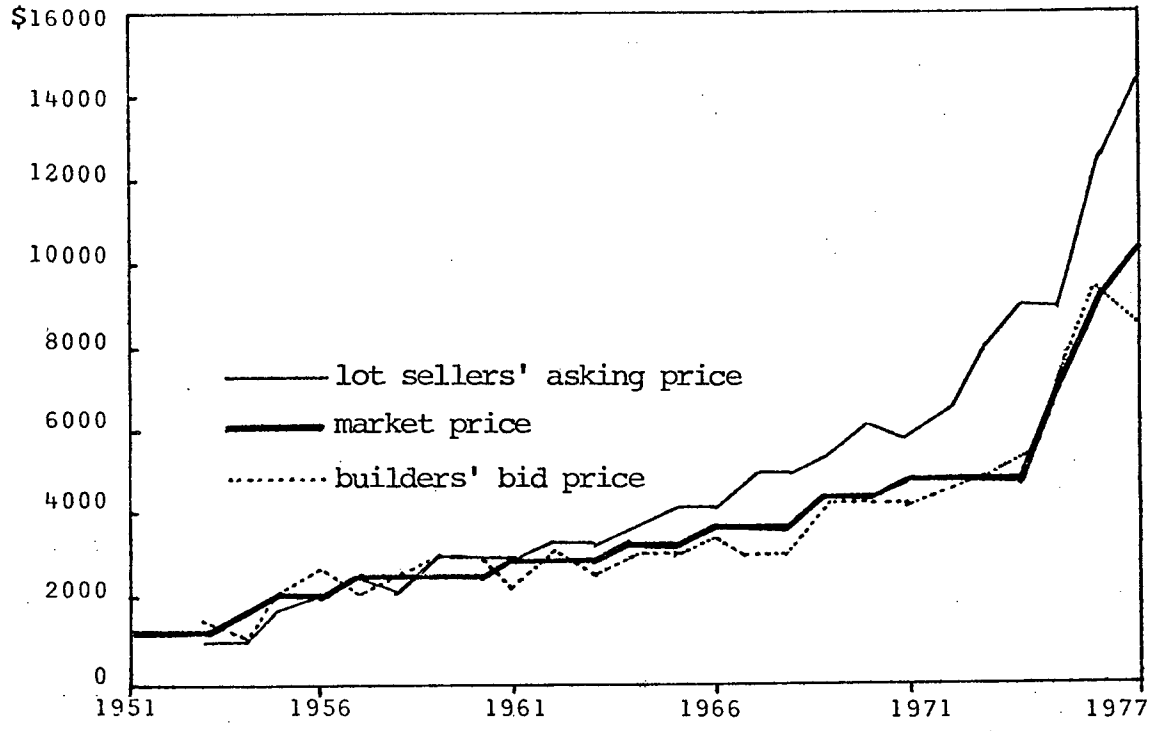
Estimates of builders' and developers' reservation prices, bid and asking respectively, were estimated according to the specifications outlined in the theoretical and empirical models. Table IX shows the results, as well as the ratio of the two reservation prices. For comparison, actual market price of building lots is also shown.

TABLE IX. Computed Reservation Prices of Lot Buyers and Sellers, Canada, 1953-1977.

Year	Actual Price	Asking Price (rL^a)	Bid Price (rL^b)	Asking Price /Bid Price
1953	$1197	$ 908	$1332	0.68
1954	1687	881	987	0.89
1955	1819	1406	2135	0.65
1956	2025	1916	2226	0.86
1957	2260	2238	2102	1.06
1958	2471	2106	2202	0.95
1959	2533	2622	2732	0.95
1960	2473	2875	2643	1.08
1961	2602	2730	2177	1.25
1962	2783	3297	2682	1.22
1963	2973	3375	2382	1.41
1964	3082	3500	2738	1.27
1965	3095	3813	2814	1.35
1966	3480	4181	3185	1.31
1967	3580	4769	2962	1.60
1968	3746	4910	2722	1.80
1969	4201	5049	4095	1.23
1970	4258	5880	4088	1.43
1971	4886	5425	4176	1.29
1972	4887	6418	4531	1.41
1973	4673	7877	4667	1.68
1974	4867	8647	5188	1.66
1975	7246	8953	6720	1.33
1976	9226	12409	9008	1.37
1977	10272	14396	8425	1.70

Figure 11 graphically illustrates the movement of these prices over time. Interestingly, in the immediate postwar years, bid prices exceeded asking prices.

FIGURE 11. Movement in Building Lot Prices and Reservation Prices, 1951-1977.



There is not too much of interest in these price movements and price levels in and of themselves. It should be noted however that the increases in these prices have not been steady. Over the twenty-five year period, there have been turning points in the movement of reservation prices, as in average lot price. Furthermore, the pattern of fluctuation differs between the three. The observation that this fluctuation differs between the asking prices and the bid prices is a rough indication that different factors have gone into their formation.

It should also be noted, as shown in an earlier table, that the quantity of building lots transacted has fluctuated quite erratically

from year to year, in comparison to the movement in prices. And whereas prices have gradually increased, the quantity of lots transacted in 1977 was about 1,000 less than in 1953. Insofar as the changing value of money may account for some of this anomaly, an adjustment of the price data by means of the consumer price index indicates a real increase in the average price of lots of 5.6 per cent annually (at a compound rate of increase). Therefore, in real terms a significant decline in the quantity of lots transacted has occurred.

5.2 REDUCED-FORM EQUATIONS

The two reduced-form equations of the empirical model which offer an explanation of the process by which average lot price and number of lots transacted are determined were estimated with the following results:

$$rL_t = \underset{(.807)}{316.69} + \underset{(2.946)}{0.296\, rL_t^a} + \underset{(3.467)}{0.593 rL_t^b} \qquad (\text{Adj.}R^2 = .969)$$

$$ql_t = \underset{(4.112)}{35491.38} - \underset{(2.474)}{5.465\, rL_t^a} + \underset{(1.911)}{7.205 rL_t^b} \qquad (\text{Adj.}R^2 = .324)$$

At the 5 per cent level of confidence, the estimated price equation is significant, and therefore the null hypothesis is rejected that the relationship specified between the variables cannot be found. A very high adjusted coefficient of determination was obtained. The coefficients for the independent variables were significant: the figure in parentheses beneath each of them is its corresponding t-statistic. Not just the signs of the coefficients but their relative magnitudes too

were statistically -- significantly -- different from that proposed by a null hypothesis.

These results are consistent with the hypotheses of the empirical model. Two notes are in order. First, there is considerable multi-collinearity between the two independent variables ($r = 0.973$). This would lead to a high R^2 in problematic circumstances, but in such circumstances it also results in very low t-statistics. When the t-statistics are significant, multi-collinearity poses a much smaller problem and the analytical significance of the equation is accepted. This has occurred in the estimation of the reduced-form equations.

Another matter of note is the Durbin-Watson statistic which measures any serial correlation among the residuals or errors of the equation's predictions. For the price equation, this statistic had a value of 1.79, which falls within the acceptable range. This suggests that the standardized residuals are approximately normally distributed around zero and insofar as their sequence is concerned may be considered to be randomly distributed. This too is consistent with the empirical model. Since there are no explicitly lagged variables in the price equation, our interpretation of the Durbin-Watson statistic is not affected.

While there is a high coefficient of determination for the equation, the constant term has a t-statistic which is quite low. This means that the errors or disturbances in the equation significantly affect the equation's predicted lot price. The practical implication is that although the interaction of demand and supply forces through reservation prices results in a set of equilibrium market prices in a manner consistent with theory, there is some factor at play which throws these forces off their equilibrium position. In the development of the empirical model, it was expected that this result would occur as the

consequence of expectational errors of a random nature. This expectation from the empirical model is confirmed here.

The estimated quantity equation was also found to be acceptable at the 5 per cent level of significance. Unlike the price equation, all three coefficients were found to be significant. All hypotheses about signs and relative magnitudes were found acceptable, with one exception. While the coefficient of the asking price is lower than the one for the bid price, as expected, the difference was not significant at the 5 per cent level. In overall terms the quantity equation was significant but the independent variables could explain only 31 per cent of the variation in the quantity variable. The Durbin-Watson statistic indicated that the residuals were of an acceptable nature.

While the quantity equation is prone to disturbances as is the price equation, it appears that some other factor, possibly associated with builders' reservation price, is affecting the dependent variable.

There is a significant difference between the two equations which was not addressed in the development of the empirical model. The equations were studied to see how the independent variables individually accounted for the explained variation in each equation. It was found that developer's asking price 'explained' 98.4 per cent of the explained variation in average lot price. On the other hand, builders' bid price explained 34.8 per cent of the explained variation in the quantity of lots transacted. The practical significance of these results appears to be that, insofar as the N.H.A. lot market is concerned, there is considerable 'cost-push' from the supply side limited by the N.H.A. loan limits constraining house builders. Alternative tests of these two equations, to which we now turn, may shed more light on these results.

Two alternative approaches were taken to the estimation of the reduced-form equations of the empirical model. The first was to use

c.p.i.-adjusted price data and thus to reduce any confounding effect introduced by inflation. The second was to use the first differences, or annual changes, in the price variables.

The results of these alternative approaches for the price equation are as follows (* denotes cpi-adjustment, and Δ, the first-difference expression of the variables):

$$*rL_t = \underset{(2.692)}{982.60} + \underset{(3.864)}{0.316}\,*rL_t^a + \underset{(2.374)}{0.399}\,*rL_t^b \quad (\text{Adj. } R^2=.876)$$

$$\Delta rl_t = \underset{(0.292)}{103.25} + \underset{(4.200)}{0.169}\,\Delta rL_t^a + \underset{(3.599)}{0.516}\,\Delta rL_t^b \quad (\text{Adj. } R^2=.656)$$

In the first instance, c.p.i. adjustment reduces the predictive power of the price equation, but not measurably. The equation retains its high overall significance, and indeed the constant term now has a significant t-statistic. The relative power of the bid price variable remains little affected.

In the second equation, the adjusted coefficient of determination, R^2, is measurably reduced but still without affecting the overall significance of the equation. The significance of the constant term is once again lost. These different observations on the constant term suggest that inflation has something to do with the error contained in the first and last equations reported. That error may lie in the way it was incorporated in the estimation of reservation prices, that is, in the way which lot buyers and sellers form expectations under inflationary circumstances. The practical implication is, inflation places a premium on the quality of information used in the formation of expectations and magnifies any error in that information. The use of a naive extrapolative model of expectations formation was predicated on such an assumption which is now supported.

A significant result to come out of the first-difference equation is that builders' bid prices account for 73 per cent of the explained variation in year-to-year changes in average lot prices. This suggests that the first equation is perhaps biased by the difference in magnitude between bid prices and asking prices. This also suggests that the thought about 'cost-push' from the supply side was a premature one. The evidence of the first-difference equation makes the suggestion no longer tenable, for it tells us 52 per cent of the change in lot price from one year to the next is accounted for by the change in the bid price, while just another 17 per cent is explained by the change in the asking price. This is consistent with the discussion in the development of the empirical model which suggested that there was an absolute limit to the prices which builders could afford to pay. The practical significance of this analysis is that, while sellers may move the level of prices, it is builders who are able to limit the pace at which that movement occurs.

This will of course have serious implications with respect to the number of lots transacted. The following two equations represent similar approaches to the quantity equation as were taken to the price equation.

$$*qL^t = \underset{(4.232)}{35449.83} - \underset{(3.065)}{5.761} *rL_t^a + \underset{(1.896)}{7.323} *rL_t^b \quad (\text{Adj. } R^2 = .363)$$

$$\Delta qL_t = \underset{(0.171)}{1949.41} - \underset{(0.801)}{1.553} \Delta rL_t^a + \underset{(1.028)}{3.161} \Delta rL_t^b \quad (\text{Adj. } R^2 = .055)$$

The first, c.p.i.-adjusted equation, is significant in all respects. Furthermore, the adjusted R^2 is improved a small amount by this transformation of the data, but not quite enough to make any significant difference. The second equation, in which the data take the form of first

differences or annual changes, was found to be insignificant in all respects. In spite of this, it was found that the signs and relative magnitudes of the coefficients conformed to the hypotheses. It was also found that sellers' asking price still accounted for most of the variation in lot quantity changes.

The general result of this part of the empirical investigation might be that it is indeed possible to explain N.H.A. average lot prices and number of lots transacted in terms of expected selling prices of houses, expected construction costs, and desired rates of return commensurate with alternative opportunities. Furthermore, these variables influence the dependent variables through the operation of instrumental variables -- the reservation prices of lot buyers and sellers. It can therefore be concluded that the empirical model appears to adequately specify and characterize the process by which lot prices and quantities transacted are determined, and the inter-temporal variation in these two variables. Finally, the results indicate that while lot price changes appear to be paced according to the reservation prices of lot buyers, the number of lots transacted is influenced by the reservation prices of lot sellers relative to those of lot buyers.

5.3 LOT SUPPLY AND DEMAND

The two reduced-form equations of the empirical model were derived algebraically from a demand equation and a supply equation. In the development of the theoretical model and in the presentation of the empirical study's methodology it was observed that these equations could not be estimated directly, since they contained an endogenously-determined variable, market price rL_t. In methodological discussion,

it was explained that the supply and demand equations can be estimated without simulatenous-equation bias by substituting the price predictions of the reduced-form price equation for actual market price. This procedure was followed and the following two equations were estimated (rL_t^* is the equilibrium price predicted by the reduced-form equation).

$$qL_t^d = \underset{(4.790)}{41348.42} - \underset{(2.474)}{18.476rL_t^*} + \underset{(2.232)}{18.163rL_t^b} \qquad (\text{Adj.}R^2 = 0.324)$$

$$qL_t^s = \underset{(3.666)}{31640.27} + \underset{(1.915)}{12.149rL_t^*} - \underset{(2.232)}{9.059rL_t^a} \qquad (\text{Adj.}R^2 = 0.324)$$

In spite of the low adjusted coefficient of determination of the equations, their analytic significance was found acceptable according to the t-statistics. All hypotheses concerning signs and relative magnitudes were met. In both cases, reservation price accounts for 52.7 per cent of the explained variation in quantity demanded or supplied.

Figures 12 and 13 graphically illustrate the slopes of the short-run demand and supply curves, as well as their shift parameters. It ought to be noted that the demand and supply equations yielded lines rather than curves since a linear formulation of the parameters as well as the variables was adopted.

The short-run curves exhibit the familiar textbook slopes. Demand is downward or negatively sloping, while supply is upward or positively sloping. The upward slope of the demand shifts is consistent with increased lot demand over time. The downward slope of the supply curve indicates a long-run decline in lot supply. This is to be expected in the empirical situation investigated. Increasingly higher lot prices in the market of lots for conventionally-financed single-detached housing has drawn lots out of the N.H.A. market.

Interpretation of the demand and supply curves is facilitated by their expression in the form of first difference equations (in which the data are expressed as annual changes). A characteristic of these equations is that it is possible to relate percentage changes in the dependent variable to percentage changes in the independent variables.

FIGURE 12. Estimated Lot Demand.

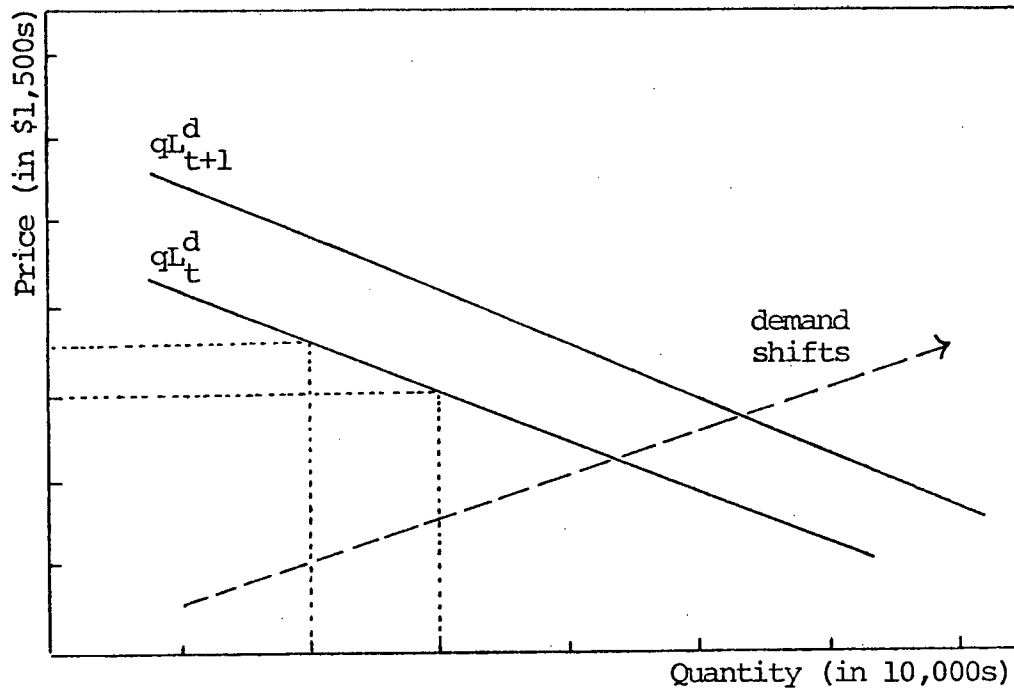
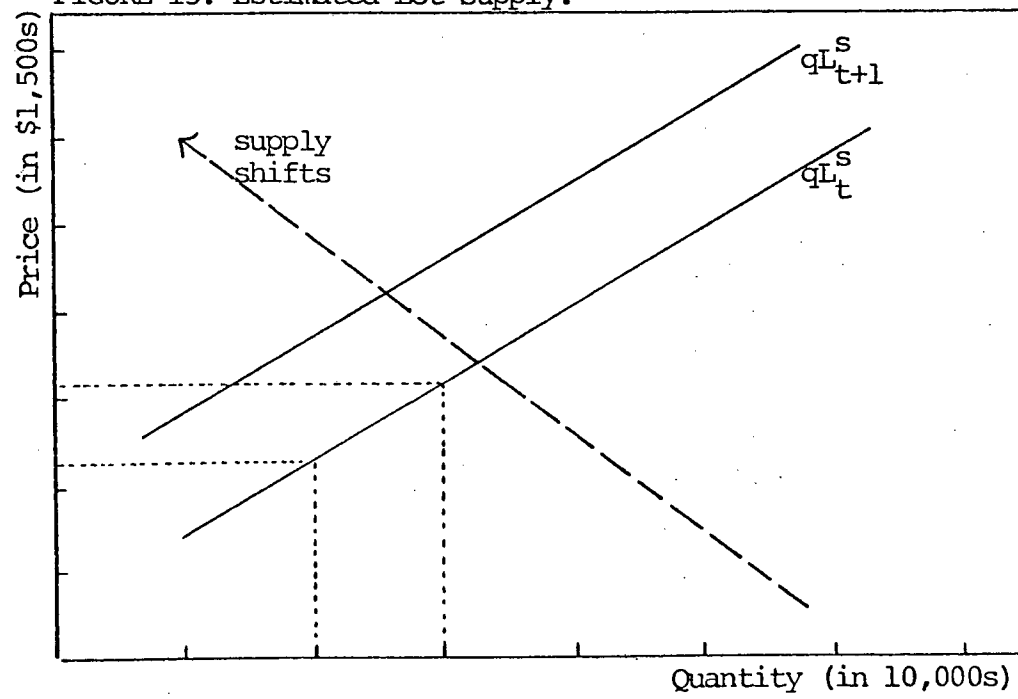


FIGURE 13. Estimated Lot Supply.



The first difference equations reported below had very low adjusted coefficients of determiniation and unacceptable t-statistics. For this reason, the evaluative statistics are not reported. Nevertheless it was found that the signs and relative magnitudes of the equations' regression coefficients were similar to those of the preceding equations.

$$\Delta qL_t^d = 0.16 - 1.39\Delta rL_t^* + 1.18\Delta rL_t^b$$

$$\Delta qL_t^s = 0.10 + 0.40\Delta rL_t^* - 0.32\Delta rL_t^a$$

In the first instance, with a negative price elasticity exceeding unity, demand is found to be extremely sensitive to variations in market price. In concrete terms, the result signifies that a 1 per cent increase in lot price will bring a 1.39 per cent decrease in the quantity of lots demanded. A 1 per cent increase in the level of the shift parameter would raise quantity demanded by 1.18 per cent.

The supply equation indicates far less elasticity, or responsiveness to price changes. A 1 per cent increase in market price would raise quantity supplied by 0.40 per cent, indicating relative inelasticity. A 1 per cent increase in the level of the shift parameter would lower quantity supplied by 0.32 percent.

The differences in the price responsiveness of supply and demand differ from theoretical postulates but are consistent with the hypotheses of the empirical model. Theoretically, in a single and perfectly competitive market, supply would normally be quite elastic to price changes. In this empirical situation, lot demand from the non-N.H.A. sector restricts the response of lot supply to N.H.A. lot demand.

Having estimated the structural(supply and demand) equations and the reduced-form(price and quantity) equations of the empirical model, and having found them to offer a valid analysis of the process underlying inter-temporal variation in lot prices, their results can be used to describe the equilibrium characteristics of the lot market. Table X

shows three ratios which can be examined to characterize the adjustment between supply and demand from one year to another.

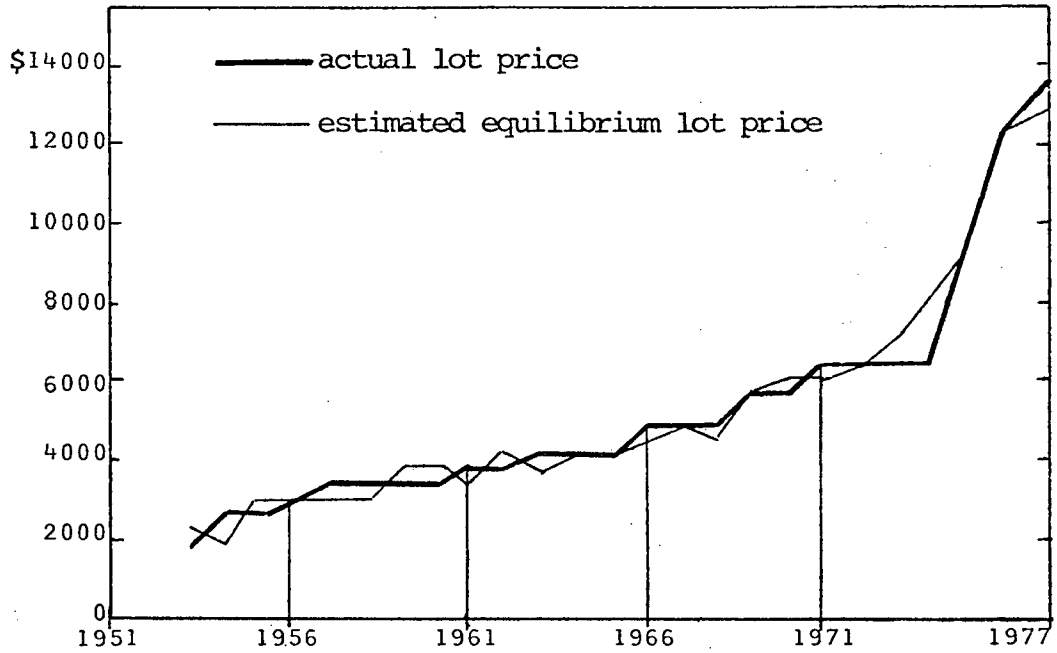
TABLE X. Disequilibrium Situations in the N.H.A. Lot Market, Canada, 1953-1977.

Year	Actual/ Equilibrium Price	Actual/ Equilibrium Quantity	Quantity Supplied/ Demanded
1953	0.87	0.66	0.87
1954	1.45	1.04	1.57
1955	0.91	1.25	0.88
1956	0.91	0.89	0.87
1957	1.01	0.98	1.02
1958	1.10	1.51	1.19
1959	0.93	1.18	0.87
1960	0.90	0.70	0.81
1961	1.07	1.19	1.17
1962	0.96	0.98	0.92
1963	1.08	1.17	1.25
1964	1.03	0.98	1.09
1965	0.99	0.97	0.98
1966	1.01	0.85	1.03
1967	1.02	0.96	1.10
1968	1.10	0.92	1.51
1969	0.99	0.54	0.96
1970	0.95	0.77	0.81
1971	1.11	1.08	1.55
1972	0.99	1.28	0.98
1973	0.86	1.02	0.42
1974	0.81	0.68	0.27
1975	1.04	0.90	1.30
1976	0.98	1.01	0.90
1977	1.07	1.46	5.67

The first two ratios, relating actual price and quantity to their estimated equilibrium values, indicate the extent and magnitude of disequilibrium situations. They reveal that the functioning of the market has been quite erratic. The severity of short-run disequilibria is indicated by occasions when actual lot transactions differed as much as 50 per cent from the equilibrium amount.

The relationship between actual and equilibrium lot price, de-

FIGURE 14. Movement of Actual Lot Price and Estimated Equilibrium Lot Price, 1953-1977.



picted in Figure 14 does not manifest the wide maladjustments that are found in lot transactions. The illustration shows graphically how there is no consistent pattern to disequilibrium situations. They appear to be quite random. This is also the case for lot transactions.

The third ratio in Table X relates lot supply to lot demand. In this ratio lies an explanation for disequilibrium situations. When supply exceeds demand there is a situation of excess supply. When the ratio is less than 1.00 there is excess demand. Not always, but generally, price and quantity are below their equilibrium values in excess demand situattions. The opposite tends to occur in excess supply situations.

In the development of the empirical model, the concept of relative equilibrium was discussed. Many of the disequilibrium situations occuring between 1953-1977 could be said to fall within an acceptable range of maldajustment, but several remain outside that range. They manifest lot prices and levels of housing production far from their desirable, equilibrium values. This is an important subject which will have to be given further discussion.

5.4 FURTHER TESTS

The evaluation of the reduced-form equations has indicated that they offer a weak but valid explanation of the process generating intertemporal lot price variations. Their weakness lies in their poor ability to fully explain trends in lot prices and transactions. The later verification of the structural, or supply and demand, equations lended support to the reduced-form equations (which were algebraically derived from the structural equations). The interdependence of these equations suggests that some additional evaluation be undertaken, although this is not strictly necessary. In the methodological discussion four tests were proposed.

The first test involves an examination of the stability over time of the estimated parameters of the reduced-form equations. Sub-period regression analyses were made, first, for the period 1953-1965, and second, for the period 1966-1977. The results are shown in Table XI.

TABLE XI. Regression Results of Sub-Period Tests.

Period	Dependent Variable	Independent Variables**			Adj. R^2
		Constant	rL^a	rL^b	
1953-1977	rL	316.69(0.807)	+0.296(2.946)	+0.593(3.467)	.969
1953-1965	rL	1052.6(6.427)	+0.603(5.966)	-0.061(0.343)	.918
1966-1977	rL	154.95(0.284)	+0.239(1.406)	+0.707(2.643)	.941
1953-1977	qL	35491(4.112)	-5.465(2.474)	+7.205(1.911)	.324
1953-1965	qL	30497(3.110)	-7.868(1.300)	+12.799(1.204)	.146*
1966-1977	qL	28060(3.975)	-3.041(1.383)	+4.722(1.363)	.177*

*These are unadjusted coefficients of determination. The adjusted ones were too small to report.

**With 9 degrees of freedom in the sub-period equations, the relevant range of significance for a one-tailed test is 10 to 5 per cent for t-statistics(in parentheses) between 1.383 and 1.833, and 5 to 1 per cent for t-statistics between 1.833 and 2.821.

In all instances, the coefficients of determination were smaller than the corresponding ones in the full-period, reduced-form equations.

While the price equations were found to be significant, the quantity equations were not, even at the 10 per cent level. All sub-period equations show the expected sign and relative magnitude in their regression coefficients, with one exception (equation 2 in the table).

This equation has a relatively higher numerical value for the constant than the other two price equations and the coefficient for the bid price shows a sign opposite from what is generally expected. Initially disturbing, the phenomenon seems to indicate a lesser influence from the non-N.H.A. sector in the early years of the study period. This is supported by the evidence of N.H.A. lot prices in the early and mid-fifties that are higher than those in the non-N.H.A. sector. What it means, however, is that builders were able to obtain lots far more cheaply than they were prepared to pay. Apart from this observation, the stability of the regression coefficients supports the analytic validity of the price equation.

In spite of the very low coefficients of determination for the quantity equations, which are expected given its low value for the full-period equation, the regression coefficients are stable in sign and magnitude. The poor performance of these equations nevertheless ruled out a closer examination of estimated sub-period supply and demand equations.

On balance, the analytic validity of the model is not rejected by the sub-period test.

The second test consisted of the estimation and comparative evaluation of two alternate models, as outlined in the previous chapter. The results are shown in this table.

Model	Dependent Variable	Independent Variables			
		Constant	rL_t^a	rL_t^b	
Main	rL	316.69(0.807)	+0.296(2.946)	+0.593(3.467)	.969
One	rL	---	---	---	--
Two	rL	168.19(0.633)	+0.373(7.151)	+0.625(3.851)	.986
Main	qL	35491(4.112)	-5.465(2.474)	+7.205(1.911)	.324
One	qL	41324(4.235)	+0.383(0.456)	-2.261(0.085)	.057
Two	qL	43265(4.561)	-2.515(0.774)	+2.415(1.306)	.109

TABLE XII. Regression Results of Test of Alternative Models.

The first alternative model is clearly out-performed by the other two such as to be totally useless. The results of its price equation are ignored since perfect collinearity between lot developers' asking price and the market price generate no useful information for the test.

The second alternative model is interesting. Unlike the empirical model, builder's bid price explained 99.1 per cent of the explained variation in lot price and 65.6 per cent of the explained variation in the number of lot transactions. The corresponding figures for the empirical model are 1.6 and 34.8 per cent. This is expected by the formulation of this alternate model.

The price equation of this alternate model was significant in the same respects as the main empirical model. Indeed, it appears to have a slightly better analytic capability with a slightly lower, but still large, prediction error. Simultaneous-equation models must be

evaluated on the basis of both equations. In this regard, the alternate model's results fall far short of the main model's. The overall significance level of the quantity equation falls to 11%, versus less than 1% for the main model. Neither of its independent variables has significant coefficients.

On this basis it can be concluded that neither of the alternate models produced results which would lead to a rejection or reconsideration of the specification of the postulated empirical model.

A final test involved the administration of four ad hoc examinations. The first three showed that builders make logically-expected adjustments in disequilibrium situations.

The first of these tests involved a regression analysis of actual dwelling size with the size expected when the builders must reduce (or can increase) their total construction costs because of lot prices which are larger (or smaller) than the prices bid. An R^2 of 0.696 was obtained, significant at the .01 per cent level. The standard error was 32 square feet on an average dwelling size of 1,139 square feet. Assuming an accurate numerical estimation, this suggests that builders would make up further adjustments in the quality of construction undertaken.

The second test was an examination of the relationship between annual changes in dwelling construction costs, and the difference between estimated or planned costs in the current year and actual total construction costs in the previous year. An R^2 of 0.487, significant at the .02 per cent level was obtained. The standard error was $770 or an average estimated total construction cost figure per dwelling of $17,082. This result dovetails with the previous one.

A third test involved an examination of the relationship

between the proportion of dwellings left unsold at year-end (estimated from data for all single-detached and rowhouse construction in urban centres) and the ratio of builders' reservation price for new houses to selling price for houses.

Just as builders have a reservation or bid price for building lots, so too as suppliers of new housing they have a reservation or asking price for newly-completed single-detached dwellings. The following equation indicates how this price is established:

$$pH^a_t = mN_t + rL_t(1+K^d_t)$$

where pH^a_{t+1} = the reservation or asking price for new dwelling.

mN_{t+1} = the actual construction costs of the new dwelling,

rL_t = the actual price of the building lot purchased, and

$1+K^d$ = the builder's desired rate of return on his investment in the purchased lot.

The builder's reservation price for the new dwelling may be more or less than his expected price, pH^e_t, depending on whether or not the price actually paid for the building lot was more or less than his bid price for the lot. A market price for lots in excess of the bid price would raise pH^a above pH^e.

An R^2 of 0.368, with a 13 per cent level of significance, was obtained for the relationship between the proportion of unsold dwellings and the ratio of asking price to selling price of new houses. The relationship is a weak one although the t-statistic for the coefficient of the independent variable indicated that the sign of the relationship was significant. Not too much can be made of this test given the proxy data used to estimate the rate of unsold dwellings.

A fourth test was based on the idea that builders would increase their level of production and thus the number of lots purchased when the expected selling price would exceed the reservation price for new houses. The following relationship was obtained:

$$\frac{qL_t^b}{qL_t} = 3.296 - 2.48 \frac{pH_t^e}{pH_t^a}$$

The R^2 for the equation was low, .056, and the significance level was 25 per cent. Both suggest an unsupported relationship. A better test would have used the ratio of initial to revised lot demand as the dependent variable. However, the sign of the estimated relationship is as expected and the equation thus serves as a useful rough approximation.

The four ad hoc tests, like the preceding tests, presented no discouraging evidence for the empirical model. Since these tests complete the empirical analysis, a conclusion will now be reached about the validity of the empirical model.

5.5 EVALUATION OF THE MODEL

The preceding analyses have offered an empirical description of the process by which inter-temporal variations in the average price of building lots are produced. They showed how supply and demand forces, operating through expectations and reservation prices, interacted to produce the movement of N.H.A. lot prices and transactions in Canada over the 1953-1977 period. Finally, empirical analysis described the characteristics of lot supply and demand, as well as adjustments in building activity made by builders in short-run disequilibrium situations.

Specifically, the empirical investigation found that N.H.A. lot prices have risen over time in close relation to the prices that builders of

N.H.A. financed single-detached houses have been able to afford, given construction costs and expected selling prices, and what they have been willing to pay, given desired profitability. Furthermore, to the extent that these lot prices have not kept pace with prices in the conventionally-financed housing sector, lot developers have supplied fewer lots to N.H.A. builders. Also, to the extent that N.H.A. dwelling construction has not been as profitable as conventionally-financed dwelling construction, N.H.A. builders have reduced the level of N.H.A. construction.

Many hypotheses were tested in the evaluation of the empirical model. Only the most practically relevant were reported in this presentation, but no hypothesis which was rejected by empirical evidence was ignored. On the basis of these many tests, a judgment can be reached about the validity of the empirical model. It is concluded, within the limitations noted in the presentation of the results, that the empirical model is not rejected by the data with which it is confronted and can be accepted as a fruitful explanation of inter-temporal variation in lot prices. This conclusion is nevertheless attached with qualifications.

Several of the model's equations had a high prediction error. This is indicated by the relatively low coefficient of determination which was occasionally obtained, especially for the quantity equations. The analytical validity of the estimated equations is not seriously affected by this however. This is due to the performance of the constant term in the equations. Generally, the numerical value of the constant term includes the disturbance or error to be found in an estimated equation. When the coefficients of the independent variables of an equation are found to be significant by an acceptable t-statistic and the constant term on the other hand has a low t-statistic, along with other indicators, it can be concluded that the equation's prediction errors are approximately distributed in a random manner around 0. This phenomenon was indeed hypothesized in the

development of the empirical model. It was suggested that information errors and imperfections, unrelated to one another over time or between demanders and suppliers, would result in significant prediction error of a random sort.

Sub-period tests weaken our confidence in the model but do not jeopardize its basic formulation. They suggest that a non-linear rather than linear form in some of the model's equations might add more temporal stability to the numerical values of the sub-period regression coefficients. Such an approach would also yield curves for the demand and supply equations rather than the lines generated here by a linear formulation of demand and supply schedules.

A further limitation of the empirical analysis stems from the measurement quality of the data. The impressionistic interpretation of some data and the use of proxy data place some doubt upon the descriptive findings of the study. Replication of the analysis with alternative interpretations and proxy data would likely result in different parameter estimates than were obtained here. These limitations will restrict specific empirical applications of the study's findings.

Theoretical applications of the study's findings are not so limited. Confirmation of the model's analytical validity justify its use in explaining the general process by which lot prices are established and change over time. The study's central objective is thereby achieved. Its theoretical implications will now be more closely examined.

5.6 THEORETICAL IMPLICATIONS

The results of the empirical analysis indicate that the observed operation of the N.H.A. lot market involves a process which is consistent with the propositions of the empirical model developed in Chapter Four.

Since this model was derived from the theoretical model developed in Chapter Three, the study provides empirical evidence in support of theory.

The empirical findings generally support the theoretical proposition that lot prices and their year-to-year variations are established through the profit-maximizing behavior of lot developers and house builders. The major long-run determinant of lot prices is the difference between the selling price of new single-detached houses and their costs of construction. In the short-run, lot prices are shaped by the profit and price expectations of developers and builders. Builders offer lot prices that are the present value of the difference between expected house selling price and construction costs. The present value of this future amount is determined by a desired rate of return competitive with alternative opportunities for builders. On the other hand, lot sellers seek prices that show a rate of appreciation which is competitive with returns in alternative and comparable endeavors. Market price and number of transactions are determined by the aggregate interaction of lot sellers and house builders.

Both the empirical model and theoretical one share the same propositions about market behavior and market operation. The models differ in their assumptions however. The theoretical model assumes that there is only one market for single-detached housing building lots. The empirical model, on the basis of a priori knowledge about the lot market's organization, recognizes the differences between the buying and selling of lots for N.H.A.-financed dwelling construction, and for conventionally-financed housebuilding. In this regard, the empirical model assumes that there are no barriers to the movement of builders and lot sellers between these two 'sub-markets'.

This difference between the two models presents the first implication of the empirical investigation for theory. The analysis demonstrates the necessity of reformulating theory in light of the empirical

circumstances which are to be investigated whether for research or policy purposes. It demonstrates that the theoretical model has limited empirical validity for its assumptions about market organization are violated by real world conditions. A practical lesson to be gained from this is the caution which must be taken in describing the real world on the basis of theory alone. This does not in any way detract from the function of theory however, since its analytical validity permits it to be reformulated in empirical terms to suit different real world circumstances.

Another important implication of the empirical investigation is its confirmation of the simultaneous-equation formulation of the theoretical model and the demand-supply interaction hypothesis it expresses. This formulation contrasts sharply with the single-equation approaches found in existing theory and research. Explicitly recognizing that market prices and quantities transacted are jointly determined by supply and demand, the simultaneous-equation approach is common in econometric studies. The investigation undertaken here demonstrates its applicability to the analysis of property market operations. To investigators not acquainted with the literature reviewed in Chapter Two, the theoretical model's system of equations will represent a rather unoriginal formulation. Its general absence in much of the land and housing literature signifies the shortcomings which are to be found in current understandings of the relationship between land and housing prices.

A further implication of the empirical investigation for a theory of inter-temporal variation in lot prices is the explanatory ability to be gained by explicitly including the role of expectations and reservation prices in the formation and expression of supply and demand. While structural and macro-economic approaches, as exemplified in the work of L.B.Smith (1971, 1974), might generate equations with little prediction error, they shed very little light on the behaviors and process which

underlie macro results. Such approaches may also be what it is that sustains the credence of market organization as the factor which explains market results. Much of the dispute in the literature about the market's operation is often argument about the monopoly, oligopoly, or competitive conditions that are to be found there. The behavioral approach taken in this study shows how the results of the market's operation are the consequence of many builders and developers seeking to maximize expected profits on the basis of imperfect information and competing alternatives. While market organization is a significant factor, as indicated in this study by the division of the lot market into two sectors, the idea of seeking a complete explanation of the market's operation in its organization, or to infer its organization from its results, is not justified.

A final theoretical implication of the empirical investigation is support for a concept of relative equilibrium. The assumption of long-run static equilibrium is neither justified nor necessary for the achievement of useful analytical results. Closely related to this matter is the necessity of a dynamic formulation over a static one. A dynamic approach is indispensable insofar as market behavior is anticipatory and reflective. Past events and expectations are joined in the minds of market actors to form decisions for guiding their present behavior. The empirical investigation has shown how theory can and should consider inter-temporal relations in and among variables.

The study's most significant implication pertains to the hotly debated question: do land price increases push up the price of housing or do land prices go up because house prices have increased? The analysis completed here, although not conclusive, offers strong support for the proposition that lot prices are determined by house prices. However, this relationship is neither so simple nor straightforward as Pennance (1969,

1974), Hamilton (1970, 1975, 1976), and others would suggest. The manner by which house prices shape lot prices involves a process characterized by lags and maladjustments. It takes time for house price changes to affect the expectations of builders and it takes further time for builders' reservation prices for building lots to affect the expectations of lot developers. Because of these lags and because of the imperfect information on which builders and developers base their decisions, short-run disequilibrium situations occur in which lot prices and housing production may be greater or lesser than what a fully-informed market would generate. Such failures in the lot market will have subsequent effect upon the house market. These failures represent some mis-allocation of society's scarce resources which more efficiently operating markets might avoid. This conclusion is the study's most significant finding. It identifies for further theoretical consideration a potentially serious problem in the functioning of the land market.

CHAPTER SIX

CONCLUSION

The objective of this study was to develop a better understanding of the operation of residential land markets. This was accomplished through a theoretical analysis and empirical investigation of the process underlying inter-temporal variation in the average annual price of building lots used in the construction of N.H.A.-financed housing in Canada over the period 1951-1977.

The theoretical implications of the empirical investigation have been addressed in the preceding chapter. This chapter treats the study's implications for further research as well as some implications for planning and for land and housing policy.

6.1 DIRECTIONS FOR FUTURE RESEARCH

Several avenues of further study can be identified on the basis of the study's findings. First and foremost, replication of the empirical investigation is of utmost importance. The quality of the study's analytical findings was such that it would be desirable to ascertain them. A repetition of the analysis with firmer verification of the available data, alternative interpretations of some data, alternative proxy data, and new data to replace proxy data would achieve this. As a result, firmer findings might be obtained from which empirical or policy applications can be derived.

The large prediction errors obtained in this study suggest a further avenue of research. More specific consideration of information

imperfections, errors, and costs, as well as transaction costs would be desirable. Ideally, it is preferred that some measurement of these be made. On the other hand, if some grounds can be found for considering them truly random, an attempt should be made to filter out their effect in further empirical analysis. This will obviously affect the forecasting abilities of the model, as well as its policy role. One of the most frequently ignored assumptions of the theory of pure and perfect competition is the availability of complete and perfect information. This means a situation in which all buyers and sellers are fully informed about market prices and quantities, and other data pertinent to their decision-making. The study suggests that this is a patently unreasonable assumption to make in any analysis of land or housing markets. While the study has avoided this assumption, it has not been able to replace it with a strong empirical proposition. Until one is found, removal of the model's prediction errors will be difficult.

A key assumption made in the study was that lot sellers and buyers had access to and utilized the same data as was employed in the study. This is a reasonable assumption to make insofar as N.H.A. data is published on a regular basis and with only a short time lag. However, the results show that builders and sellers probably do not use this information. This is to be expected insofar as actual behavior takes place in local markets. Notwithstanding a justification in Chapter Four for the existence of a national lot market from the point of view of universal behavioral propensities, when it comes down to a complete explanation of all the inter-temporal variation in lot prices, local characteristics will have a considerable effect. It is for this reason that the model has limited policy-relevance. Ths parameters or regression coefficients of the model's equations would play a very important role in policy analysis for they

measure the expected response in some variables to public policy induced changes in other variables. Since the parameter estimates are extremely sensitive to the data used, the model estimated here has restricted empirical application.

Further study to produce some policy-relevant findings is recommended in view of the limited capabilities of the model developed here, and in view of the market failure identified by the study. Local or regional studies should be undertaken to show how parameters might vary according to differing local circumstances of an institutional, financial, economic, or political nature. Cross-sectional studies are also recommended to develop a better appreciation of the relative significance of these factors from one locality to another.

Future research on the topic investigated here should consider a non-linear formulation of the variables in the theoretical model's equations. This is suggested by the results of the sub-period regression analyses which showed that the estimated parameters were not constant over time. Inflation, or increases in the level of consumer prices, affects the price variables and will modify the relationship between price and quantity variables. Textbook analyses of supply-demand interaction treat 'real' prices and abstract from inflationary phenomena. Analysis using 'current' prices unadjusted for inflation will yield demand and supply equations which will show more price inelasticity than equations estimated from 'real' price data. Without this transformation of the data, or a recognition of this situation in the interpretation of the findings, observed unresponsiveness to price changes by lot buyers or sellers could mistakenly be interpreted for non-competitive market behavior. The reason that unadjusted price data was used in this study was that lot buyers and sellers were reasonably assumed to use 'current' rather than

real or inflation-adjusted price information in their decision-making.

The study's findings suggest the need for further research in the area of data development. As Baxter (1976) and McFadyen (1978) have observed, the available data, both the N.H.A. time series and the housing component of the Consumer Price Index, do not accurately reflect the real movementin dwelling costs and prices. The study has shown how limitations in the N.H.A. data must be accommodated if they are to be used to understand the operation of the lot market. Account must be taken of the relationships between N.H.A. and non-N.H.A. housebuilding activity. Dennis and Fish (1972), for example, failed to consider this and interpreted the movement over time in N.H.A. lot prices and transactions as evidence that increasing lot prices were pushing up the price of houses.

This study of the lot market contains some recommendations about the study of related markets, namely the raw land market, the market for new houses, and the market for existing housing. These four markets are linked to one another through supply-demand interations which would be ignored at peril. In this study, close attention was given to the market for new houses since prices in this market were hypothesized to have a direct influence on the lot market. This conforms to a repeated proposition in the literature surveyed that the demand for lots is a derived demand -- derived from the demand for new houses. This suggests, for example, that the study of the raw land market must consider the demand for raw land as derived from the demand for building lots. It was noted earlier that Markusen and Scheffman (1977), who studied this market, did not give any intermediary role to housebuilders but viewed house purchasers as the consumers of lots.

Another desirable characteristic of investigations into these

markets is their adoption of a simultaneous-equation approach which gives a role to both demand and supply in shaping observed market prices. Single-equation studies which give an exclusive role to one or the other must be viewed as providing a limited understanding of these for, as this study has shown, observed market prices do not necessarily represent equilibrium reservation prices of sellers or buyers. The ubiquity of short-run disequilibrium situations argues strongly against the static equilibrium assumption underlying single-equation approaches.

Of the many avenues for further study identified, the last methodological consideration is of paramount importance. The impact of imperfect information on the lot market's operation and its resulting inefficiences appears to be the substantive area in most urgent need of study.

6.2 IMPLICATIONS FOR POLICY AND PLANNING

Several implications for urban planning and for public policy in housing and land can be derived from the study and its findings. However, current issues and problems in planning and policy have not been treated very closely and so the study's findings in their present form have more direct application to theory and understanding than to planning and policy action. While the study's findings promise to remove some of the confusion and argument about the lot market's operation, they do less to resolve the ongoing debate about land and housing problems.

Gerecke (1978) observed of recent studies of housing and land that they 'prolong the debate but do not clarify it'. With some further analysis, this study can avoid such a criticism. Since a basic matter under contention in the current debate is government's intervention in

land and housing markets, it would be useful if this study could suggest the relative impacts of alternative forms of government intervention on the lot market investigated.

Employing the estimated equations of the empirical model, it is possible to see what would be the result on lot prices and number of lots transacted of public policy-induced changes in exogenous variables like mortgage rates and construction costs.

A typical approach which might be followed for this purpose is comparative static analysis. By this method economists show the impact on the dependent variable(s) of a specified change in the independent variable(s) while holding constant the other variables in the equation. Another method has been proposed by Baer and Fleming (1976). They suggest 'counterfactual analysis' to explore the implications of policy alternatives.

> Through conjecture and the deliberate alteration of historical events, we can acquire an appreciation of the consequences from implementing a policy proposed for the future.
>
> Counterfactual analysis is one means of manipulating historical data for this end. Use of a counterfactual creates an event contrary to what actually happened and then speculates on what would have been the result. ... Once an alternative set of historical events has been decided, the differences in outcome between the actual and the counterfactual chain of events may be used to determine the possible impact or significance of a proposed policy...
>
> Used in this manner, counterfactual analysis can be an effective analytical tool in the planner's kit. It must be emphasized, however, counterfactual analysis cannot be used for prediction, for it is based on fiction. Nevertheless, it can serve as the basis for informed and rigorous speculation, providing both an understanding and a feel for a sequence of events. (1976: 243-244)

The approach followed here combines a comparative static analysis with the use of counterfactuals. It does not treat the full sequence of events in the manner suggested by Baer and Fleming but employs the comparative static framework to obtain a first approximation. The advantage of this modification is that it yields quick results. The disadvantage is that feedback effects over time are ignored.

All the variables in this analysis take the form of long-run, 25-year average values. Table XIII shows the effect on long-run average lot price, quantity of lots transacted (and therefore the level of house-building activity), and builders' asking price for new housing of changes in the indicated exogenous variables. The last endogenous variable, asking price for new houses, is included for it is through this variable that reverberations of events in the lot market will be transmitted to the market for new housing.

The counterfactual events considered in the analysis are of five kinds: (a) the accuracy of information used to form expectations; (b) the level of mortgage rates; (c) the level of construction costs (as affected by changes in building materials taxes, minimum wages, and employer contributions to employee benefit plans, for example); (d) the level of desired rates of return (as affected by property and income tax levels, servicing costs and development levies, builder cash grant incentives, and so on); and (e) government activity in lot development or house-building.

Table XIII clearly shows that changes of an equal percentage amount in each of the various exogenous variables generate markedly different market effects. It should be kept in mind however that the exogenous changes are not strictly comparable. Practically speaking, this means that public expenditure to produce a 5 per cent reduction in

TABLE XIII. Counterfactual Comparative Static Analysis

Exogenous Change			Instrumental Variables		Endogenous Variables		
	Exogenous Variables	Change	Lot Asking Price	Lot Bid Price	Average Lot Price	Number of Lots Traded	House Floor Price
1.1	Expected Selling Price	-5%		-25.19	-13.79	-18.57	-2.73
1.2	Expected Selling Price	+5%		+25.19	+13.79	+18.57	+3.15
1.3	Previous Lot Price	-5%	-5.00		- 1.85	+ 3.79	-0.19
1.4	Previous Lot Price	+5%	+5.00		+ 1.85	- 3.79	+0.60
1.5	pH^e and rL_{t-1}	-5%	-5.00	-25.19	-15.64	-14.78	-3.13
1.6	pH^e and rL_{t-1}	+5%	+5.00	+25.19	+15.64	+14.78	-3.54
2.1	Mortgage Rate	-5%	-1.91	+ 0.53	- 0.41	+ 1.85	-0.01
2.2	Mortgage Rate	+5%	-1.06	- 0.53	- 0.68	+ 0.42	+0.19
3.1	Construction Costs	-5%		+20.19	+11.06	+14.89	+4.20
4.1	j^d	-5%	-0.50		- 0.18	+ 0.38	+0.17
4.2	j^d	+5%	+0.50		+ 0.18	- 0.38	+0.25
4.3	k^d	-5%		- 0.53	- 0.29	- 0.39	+0.27
4.4	k^d	+5%		+ 0.53	+ 0.29	+ 0.39	+0.14
4.5	j^d and k^d	-5%	- 0.50	- 0.53	- 0.47	- 0.02	+0.23
4.6	j^d and k^d	+5%	+ 0.50	+ 0.53	+ 0.47	+ 0.02	+0.18
5.1	Lots Demanded (qL^d)	+5%		+ 2.70	+ 1.49	+ 2.00	+0.52
5.2	Lots Supplied (qL^s)	+5%	- 3.98		- 1.47	+ 3.03	-0.11

Note: The symbols pH^e, rL_{t-1}, j^d and k^d represent expected house selling price, previous lot price, lot sellers' desired rate of appreciation, and builders' desired rate of return, respectively.

builders' construction costs will be rather different than the public cost of a 5 per cent decrease in the mortgage rate.

One practical interpretation which might be kept in mind while reading the table is to view the + exogenous changes as involving a public expenditure to obtain the benefits of lower lot prices, greater housing output, and lower house prices, and to view the - exogenous changes as events which will have the indicated, generally deleterious, effects on lot prices, housing production, and house prices in the absence of government intervention. However, the first six cases must be interpreted somewhat differently, as will be discussed later.

An especially outstanding result at the outset is the minimal impact that all exogenous changes have on builders' reservation price for new houses. This situation is similar to the one illustrated by Hamilton (1974: 5-6). It is explained by land's relatively small contribution to the total cost of dwellings.

One case of special interest is the change in construction costs (3.1). It suggests that if governments could reduce these costs by 5 per cent, builders would be able to afford a 20.19 per cent higher bid for lots! The final result would be to raise lot prices by 11 per cent and the level of housing production by 15 per cent, and to reduce the asking price for new houses by 4.2 per cent. This appears to be a fairly dramatic and effective result. It should be considered however that actual market prices for new dwellings may remain unchanged since it is competition between house purchasers which is theorized to play a major role in setting house prices. The result is that builders will gain the difference and with these extra profits will bid up the price of land still more with profits eventually accruing to the owners of raw land from which lots are developed.

The last two cases (5.1 and 5.2) illustrate government's role first as a builder of housing, and second as a developer of lots. In the first instance, government demand for building lots is conjectured to raise total lot demand by 5 per cent. This is seen to raise builders' bid price for lots due to stiffer competition between them for a limited number of lots supplied. The final result is to raise the price of lots and the asking price of housing. The level of housing production is increased 2 per cent, achieving only 40 per cent of government's building target. In the second instance, government is conjectured to increase the supply of lots, through zoning, servicing, or the development of government-owned land. The effect is to lower lot prices and asking prices for new houses. Housing production is raised 3 per cent, achieving 60 per cent of government's target.

A government-induced decrease in current lot supply might also have been conjectured to represent increased zoning restrictions, higher servicing standards, or reduced provision of municipal infrastructure. In such a situation the effect would likely be an increase in lot price, a decline in housing production, and an increase in builders' reservation price for new dwellings.

Variations in mortgage rates are seen to have limited impact on the lot market. It is generally accepted that it is housing demand which is most affected by changing mortgage rates, with a lagged effect on land prices. However, the model developed here has not treated housing demand in sufficient detail to incorporate this situation.

The most significant results are to be found in the accuracy of expectations. The situations depicted in this analysis represent errors in information utilized by builders and developers. Inaccurate information about selling prices resulting in optimistic expectations for builders, generates lot prices which are 13.8 per cent higher than they ought to be,

and asking prices for new houses that are 3.2 per cent higher. There is also considerable over-building (18.6 per cent increase in housing production). Information error leading to pessimistic expectations for builders results in the opposite situation. As far as lot sellers are concerned, mistaken information about previous lot prices, used as a basis for determining expected current price, has less impact on the market than the accuracy of information available to builders. When both are considered jointly, the result is severe for all endogenous variables.

The results of the first six cases tangibly supports the proposition that imperfect information can have a disequilibrating effect on the lot market. These findings further indicate how sensitive the model is to the expectations formation behavior that the model has specified for builders and developers.

A closer examination of policy and planning alternatives should form the subject of a separate investigation. Lying within the scope of this study are the implications of its findings for the kinds of government intervention surveyed in the counterfactual, comparative static analysis.

In most general terms, the study can be said to affirm the significance of 'paradigms' and understanding in policy and planning. Alonso writes,

> ... in planning work where it is necessary to make recommendations and decisions and where things must be said even when certainty does not exist, it is necessary to develop ways of dealing reasonably with uncertainty. (1971: 172)

The way in which policy analysts and planners could be said to cope with uncertainty is through their use of some form of 'diagnostic paradigm'. By this term R.L.Warren means a thought structure which explains why something is as it is. In so doing it implies the way in which that thing

might be conceptualized as a problem, and what strategies will be used to deal with it (Warren, 1971: 472).

This particular study has achieved a conceptualization of the lot market's operation. It has identified as a significant problem short-run disequilibrium situations in the lot market in which supply and demand are imperfectly adjusted. These situations result in lot prices, levels of housing production, and builders' asking prices for land which are greater or lower than what would be found in cases of better adjustment. The study also identified a range of public actions which can affect the lot market's operations and outcomes.

Whether or not the paradigm developed here is the most appropriate one for the real social problems generated by the operation of land and housing markets cannot be determined here. However, the feasibility and necessity of making paradigms explicit and subject to verification has been illustrated. The brief analysis undertaken above clearly shows the economic character of policy and planning activities.

It is therefore desirable that planners and policy analysts develop a better understanding of the operation of property markets and the economic effects of government intervention in those markets. As L.J.Duhl (1967) has remarked in a slightly different context, 'how can planners plan if they don't know the names of the variables?' A growing literature on the 'economics of planning' should receive greater attention from planners (Lean, 1969; Bish and Nourse, 1975; Oxley, 1975; and Harrison, 1977).

Oxley has offered a very practical suggestion for the amelioration of diagnostic paradigms in the specific context of this discussion.

> Within a market-failure approach, the thoughts of an urban planner might be organised in terms of:
>
> 1. What form or forms of market failure underpin my objective and at which

level ... am I challenging the market system?

2. What forms of intervention exist and have been suggested in the economic literature to deal with this form of failure?
3. Which method is applicable in this particular case? (1975: 503)

Implications have been drawn from the study in answer to the first two questions. An answer to the third question posed by Oxley leads us to a final implication of the study for urban planning and public policy.

Imperfect information was identified by the study as a major contributing factor to failure in the lot market's efficient functioning. Several forms of government intervention were briefly examined which might be used to correct this failure. Any means of ensuring that market participants develop accurate expectations was seen to have the greatest impact. These means are also most appropriate since the other forms of intervention address the symptoms of the problem rather than the problem itself. If the problem is one of incomplete and inaccurate information signalling unnecessary or erroneous changes in supply and demand with subsequent effect on lot prices and housing production, then the obvious solution lies in better information rather than in changes to fiscal and monetary policies or local land use controls, tax policies, and capital expenditure programs.

It is recommended therefore that an informational role for local planning agencies, as an adjunct to their other activities and closely related to them, be pursued. Further study would be needed to determine more precisely what this endeavor should entail and what resources would be required for it.

As a concluding comment and in the context of the preceding discussion, this study can be summarized as having examined the

operation of the land market through an investigation of inter-temporal variation in lot prices. This variation was found to be derived from changes in housing demand. Consequently, increasing lot prices were not seen to signify a failure in the functioning or the organization of the lot market.

The study nevertheless found an inability of supply and demand to maintain a close adjustment to one another on a short-run basis. This inefficient functioning of the market was seen to result in lot prices and levels of housing production which fluctuated above or below their equilibrium levels. This market failure was interpreted to manifest a significant misallocation of resources and to form a matter for public or governmental concern. A remedy was suggested for this particular problem which involves government intervention, not in the lot market, but in the marketplace for information.

BIBLIOGRAPHY

Adams, F. Gerard, Grace Milgram, Edward W. Green, and Christine Mansfield (1968). "Undeveloped Land Prices During Urbanization: A Micro-Empirical Study Over Time", Review of Economics and Statistics, Vol. L, No.2 (May).

Alonso, William (1960). "A Theory of the Urban Land Market", Papers and Proceedings of the Regional Science Association, Vol. 6.

_____ (1964). Location and Land Use, Cambridge: Harvard University Press.

_____ (1971). "Beyond the Inter-Disciplinary Approach to Planning", Journal of the American Institute of Planners, Vol. 37, No.3 (May).

Babcock, Frederick M. (1932). The Valuation of Real Estate, New York: McGraw-Hill.

Baer, William C., and Syke M. Flemming (1976). "Counterfactual Analysis: An Analytical Tool for Planners", Journal of the American Institute of Planners, Vol. 42, No.3 (July).

Barlowe, Raleigh (1958). Land Resource Economics, Englewood Cliffs, N.J.: Prentice-Hall, Inc.

_____ (1972). Land Resource Economics (Second Edition), Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Bartholomew, Harland (1932). Urban Land Uses, Cambridge: Harvard University Press.

Baxter, David (1976). "Published Housing Data: Trends and Evaluation", in Housing: It's Your Move (Volume II, Technical Reports), Vancouver: Urban Land Economics Division, Faculty of Commerce and Business Administration, University of British Columbia.

Bebee, Edward L. (1972). "Regional Housing Markets and Population Flows in Canada: 1956-1967", Canadian Journal of Economics, Volume V, No. 3 (August).

Becker, Arthur P. (1969). Land and Building Taxes, Madison, Wisconsin: The University of Wisconsin Press.

Bish, Robert L. and Hugh O. Nourse (1975). Urban Economics and Policy Analysis, New York: McGraw-Hill Book Company.

Blalock, Hubert M., Jr. (1969). Theory Construction, Englewood Cliffs, N.J.: Prentice-Hall, Inc.

_____(1972). Social Statistics (Second Edition), New York: McGraw-Hill Book Company.

Bourne, Larry S. (1977a). The Housing Supply and Price Debate: Divergent Views and Policy Consequences (Research Paper No.86), Toronto: Centre for Urban and Community Studies, University of Toronto.

_____(1977b). "Choose Your Villain: Five Ways to Oversimplify the Price of Housing and Urban Land", Urban Forum, Vol. 3, No.1 (Spring).

Boykin, James H. (1976). "Developmental Method of Land Appraisal", Appraisal Journal, Vol. 46, No.2 (April).

Brigham, Eugene F. (1965). "The Determinants of Residential Land Values", Land Economics, Vol. 41, No.4 (November).

Capozza, D.R. (1976). "The Efficiency of Speculation in Urban Land", Environment and Planning, Vol. 8, No.4.

Carvalho, M., D. Hum, K. Sahay, and D. Falconer (1976). "On the Determinants of Residential Property Values", Plan Canada, Vol. 16, Nos. 3/4 (Sept./Dec.).

Central Mortgage and Housing Corporation (various). Canadian Housing Statistics (Annual), Ottawa: C.M.H.C.

Chamberlain, Simon B. (1972). Aspects of Developer Behavior in the Land Development Process (Research Paper No.56), Toronto: Centre for Urban and Community Studies, University of Toronto.

Clawson, Marion (1962). "Urban Sprawl and Speculation in Urban Lane", Land Economics, Vol. 38, No. 2 (May).

_____ (1971). Suburban Land Conversion in the United States, Baltimore: Resources for the Future, John Hopkins Press.

Clonts, Howard A., Jr. (1970). "Influence of Urbanization on Land Values at the Urban Periphery", Land Economics, Vol.46, No.4 (Nov.).

Cuddy, J.D.A. (1974). Quantitative Methods in Economics, Rotterdam: Rotterdam University Press.

Dalzell, A.G. (1927). Quoted in Journal of the Town Planning Institute of Canada, Vol. 7, No.3. Reprinted in L.R.G. Martin, "Problems and Policies Associated with High Land Costs on the Suburban Fringe", in The Management of Land for Urban Development, Ottawa: Canada Council on Urban and Regional Research.

Davies, Gordon W. (1976). "A Model of the Urban Residential Land and Housing Markets", Urban Forum, Vol. 2, No.1 (Spring).

_____(1977a). "An Examination of the Market for Urban Single-Detached Lots", Journal of Regional Science, Vol.17, No.2 (August).

_____(1977b). "A Model of the Urban Residential Land and Housing Markets", Canadian Journal of Economics, Vol.X, No. 3.

Dennis, Michael, and Susan Fish (1972). Programs in Search of a Policy, Toronto, A.M.Hakkert.

Dernberg, T.F., and J.D.Dernburg (1969). Macroeconomic Analysis, Reading, Mass.: Addison-Wesley Publishing Company.

Derkowski, Andrej (1975). Cost in the Land Development Process, Toronto: Housing and Urban Development Association of Canada.

Dorau, H.B., and Albert G. Hinman (1928). Urban Land Economics, New York: The Macmillan Co.

Duhl, Leonard J. (1967). "Planning and Predicting: Or What to Do When You Don't Know the Names of the Variables", Daedalus, (Summer).

Ely, Richard T., and Morehouse Edward W. (1924). Elements of Land Economics, New York: The Macmillan Co.

Fisher, Irving (1906). The Nature of The Capital and Income, New York: Macmillan.

Flood, Ed. (1978). "Is Land Pricing Housing Out of Existence?", Housing and People, Vol. 8, No. 3 (Spring).

George, Henry (1879). Progress and Poverty (1955 edition), New York: Robert Schalkenbach Foundation.

Gerecke, Kent (1977). "Three Views on Housing", City Magazine, Vol. 3, No. 2 (December).

Goldberg, Michael A. (1972). Residential Developer Behavior: Some Empirical Findings, Vancouver: Faculty of Commerce and Business Administration, University of British Columbia.

_____, and Daniel D. Ulinder (1976). "Residential Developer Behavior: 1975", in Housing: It's Your Move. (Volume II, Technical Reports). Vancouver: Urban Land Economics Division, Faculty of Commerce and Business Administration, University of British Columbia.

_____(1978). 'Book Review of Speculation and Monopoly in Urban Development by J.R.Markusen and D.T.Scheffman', in Urban Forum, Vol. 3, No. 6 (March/April).

Gottlieb, Manuel (1965). "Influences on Value in Urban Land Markets, U.S.A., 1956-1961", Journal of Regional Science, Vol. 6, No. 1 (April).

Graaskamp, James A. (1970). A Guide to Feasibility Analysis, Chicago: Society of Real Estate Appraisers.

Gunton, Tom (1978). "The Urban Land Question: Who is Right?", City Magazine, Vol. 3, No. 3 (February).

Haig, Robert M. (1926). "Towards an Understanding of the Metropolis", Quarterly Journal of Economics, Vol. XL.

Hamilton, Stanley W. (1970). Price Movements in Undeveloped Land Facing Urbanization: A Micro Study, Unpublished Doctoral Dissertation, Berkeley: University of California.

_____, and R.U. Ratcliff (1972). Suburban Land Development, Vancouver: Union of British Columbia Municipalities.

_____(1974). Public Land Banking - Real or Illusionary Benefits, Toronto: Urban Development Institute of Ontario.

_____, and David Baxter (1976). Capital Taxes Pertaining to Real Property, Vancouver: Real Estate Institute of British Columbia.

Harbury, C.D. (1973). An Introduction to Economic Behaviour, London: Fontana/Collins.

Harman, Willis W. (1972). Key Choices of the Next Two Decades: An Exploration of the Future, Unpublished Paper.

Hatch, James E. (1975). The Canadian Mortgage Market, Toronto: Ministry of Treasury, Economics and Intergovernmental Affairs.

Harrison, A.J. (1977). Economics and Land Use Planning, London: Croom Helm.

Heineke, John M. (1976). Microeconomics for Business Decisions, Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Henderson, James M., and Richard E. Quandt (1971). Microeconomic Theory, New York, McGraw-Hill Book Company.

Heroux, Richard L., and William A. Wallace (1973). Financial Analysis and the New Community Development Process, New York: Praeger Publishers.

Hoyt, Homer (1933). One Hundred Years of Land Values in Chicago, Chicago: The University of Chicago Press.

Hughes, James W. (1977). Methods of Housing Analysis, New Brunswick, N.J.: Centre for Urban Policy Research, Rutgers University.

Hushak, Leroy J.(1975). "The Urban Demand for Urban-Rural Fringe Land", Land Economics, Vol. LI, No. 2 (May).

Hurd, Richard M. (1903). Principles of City Land Values, New York: Real Estate Record Association.

International Association of Assessing Officers (1974). Assessing and the Appraisal Process, Chicago: I.A.A.O.

Ingram, Gregory K., John F. Kain, and J. Royce Ginn (1972). The Detroit Prototype of NBER Urban Simulation Model, New York: National Bureau of Economic Research.

Kain, John F. (1962). "The Journey-to-Work as a Determinant of Residential Location", Papers and Proceedings of the Regional Science Association, Vol. IX.

_____(1964). "An econometric Model of Urban Residential and Travel Behavior", Review of Economics and Statistics, (Feb.).

Kaiser, Edward J. (1968). "Locational Decision Factors in a Producer Model of Residential Development", Land Economics, Vol.44.

Kane, Edward J. (1968). Economic Statistics and Econometrics, New York: Harper and Row Publishers.

Keiper, Joseph S., Ernest Kurnow, Clifford D. Clark, and Harvey H. Segal (1961). Theory and Measurement of Rent, Philadelphia: Chilton Book Company.

Kelejian, Harry H., and Ray C. Fair (1974). "Methods of Estimation for Markets in Disequilibrium: A Further Study", Econometrica, Vol. 42, No. 1 (January).

Kelejian, Harry H., and Wallace E. Oates (1974). Introduction to Econometrics, New York: Harper and Row Publishers.

Kinnaird, William N., Jr. (1971). Income Property Valuation, Lexington, Mass.: D.C.Heath and Company.

Klein, L.R. (1972). "The Treatment of Expectations in Econometrics", in C.F.Carter and J.L.Ford (Eds), Uncertainty and Expectations in Economics, Oxford: Basil Blackwell.

Kuhn, Thomas S. (1970). The Structure of Scientific Revolutions (Second Edition), Chicago: International Encyclopedia of Unified Science, University of Chicago Press.

Lean, William (1969). Economics of Land Use Planning: Urban and Regional, London: The Estates Gazette Limited.

Lipsey, Richard G. (1963). An Introduction to Positive Economics, London: Weidnefeld and Nicolson.

Lorimer, James (1970). The Real World of City Politics, Toronto: J. Lorimer and Company.

Lowry, Ira S. (1965), "A Short Course in Model Design", Journal of the American Institute of Planners, Vol. 31, No.2(May).

_____(1963a). "Background Information on Costs of Land for Single-Family Housing", in Housing in California, Sacramento: Governor's Advisory Commission on Housing Problems, State Printing Office.

_____(1963b). "Price Movements of Building Sites in the United States - A Comparison Among Metropolitan Areas", Regional Science Association Papers, Vol. XII.

Maisel, Sherman J. (1963c). "Land Costs for Single-Family Housing", in Donal L. Foley, C.B. Wurster, and Wallace F. Smith (Eds), Housing Trends and Related Problems, Berkeley, Centre for Planning and Development Reserach, University of California.

Markusen, James R., and David T. Scheffman (1977). Speculation and Monopoly in Urban Development: Analytical Foundations with Evidence for Toronto, Toronto: University of Toronto Press.

Marshall, Alfred (1890). Principles of Economics (8th Edition, 1948), New York: Macmillan and Company.

Marx, Karl (1909). Capital: A Critique of Political Economy, Vol. III, Part VI, edited by F. Engels, translated by E. Untermann, Chicago.

Martin, L.R.G. (1974). "Problems and Policies Associated with High Land Costs on the Suburban Fringe", in The Management of Land for Urban Development, Ottawa: Canadian Council on Urban and Regional Research.

Martin, L.R.G. (1977). "Recent Land Market Activity on the Toronto Rural-Urban Fringe", Urban Forum, Vol. 3, No. 2 (June-July).

McFadyen, Stuart, and Robert Hobart (1978). "An Alternative Measurement of Housing Costs and the Consumer Price Index", Canadian Journal of Economics, Vol. XI, No. 1.

Meehan, Eugene J. (1968). Explanation in Social Science: A System Paradigm, Homewood, Illinois: The Dorsey Press.

Mertzke, Arthur J. (1926). "Land Values and Population", Land Economics, Vol. 2.

Milgram, Grace (1968a). The City Expands: A Study of the Conversion of Land for Rural to Urban Use - Philadelphia, 1945-62, Philadelphia: Institute for Environmental Studies, University of Pennsylvania.

_____ (1968b). U.S. Land Prices - Directions and Dynamics (Research Report No. 13), Washington, D.C.: National Commission on Urban Problems, U.S. Government Printing Office.

Mills, Edwin S. (1969). "The Value of Urban Land", in Harvey S. Perloff (Ed), The Quality of the Urban Environment, Baltimore: Resources for the Future, John Hopkins Press.

Moore, Richard A. (1972). A Development Potential Model for the Greater Vancouver Metropolitan Area, Unpublished Master's Thesis in Business Administration, Vancouver: Faculty of Commerce and Business Administration, University of British Columbia.

Muth, John F. (1961). "Rational Expectations and the Theory of Price Movements", in Econometrica, Vol. 29, No.3 (July).

Muth, Richard F. (1960). "The Demand for Non-Farm Housing", in Arnold C. Harberger (Ed), The Demand for Durable Goods, Chicago: The University of Chicago Press.

_____(1969). Cities and Housing, Chicago: The University of Chicago Press.

_____(1971). "The Derived Demand for Urban Residential Land", in Urban Studies, Vol. 8, No. 3 (October).

Nadiri, M. Ishaq, and Sherwin Rosen (1973). A Disequilibrium Model of Demand for Factors of Production, New York: National Bureau of Economic Research, Columbia University Press.

Nerlove, Marc (1972). "Lags in Economic Behavior", in Econometrica, Vol. 40, No. 2 (March).

Nie, Norman H., C.H.Hull, J.G.Jenkins, K.Steinbrenner, and D.H.Bent, (1975). Statistical Package for the Social Sciences (Second Edition), New York: McGraw-Hill Book Company.

Nowlan, David M. (1976). "Value and Use of Land: The Public Connection", in Urban Forum, Vol. 2, No.3 (Fall).

_____(1977). "The Land Market: How it Works", in Lawrence B. Smith and Michael Walker (Eds), Public Property?: The Habitat Debate Continued, Vancouver: The Fraser Institute.

Orcutt, Guy, Steven Caldwell, and Richard Wertheimer II (1976), Policy Exploration Through Microanalytic Simulation, Washington, D.C.: The Urban Institute.

Ottensmann, John R. (1977). "Urban Sprawl, Land Values and the Density of Development", in Land Economics, Vol. 53, No.4 (November).

Oxley, M.J. (1975). "Economic Theory and Urban Planning", in Environment and Planning, Vol. 7.

Park, Robert E., Ernest W. Burgess and Roderick McKenzie (1925). The City, Chicago: The University of Chicago Press.

Pennance, F.G. (1969). Housing Market Analysis and Public Policy, London: The Institute of Economic Affairs.

_____(1974). "Planning, Land Supply and Demand", in A.A.Walters, F.G.Pennance, et al, Government and the Land, London: The Institute of Economic Affairs.

Price, Edmund V. (1970). The Housebuilding Industry in Metropolitan Vancouver, Unpublished Master's Thesis in Business Administration, University of British Columbia.

Rancich, Michael T. (1970). "Land Value Changes in an Area Undergoing Urbanization", in Land Economics, Vol. 46, No.1 (February).

Rapkin, Chester, Louis Winnick and David M. Blank (1953). Housing Market Analysis - A Study of Theory and Methods, Washington, D.C.: Housing and Home Finance Agency, Government Printing Office.

Ratcliff, Richard U. (1949). Urban Land Economics, New York: McGraw-Hill Book Company.

Ricardo, David (1817). Principles of Political Economy (1911 Edition), London: G. Bell and Sons, Ltd.

Romanos, Michael (1976). Residential Spatial Structure, Lexington, Mass: Lexington Books.

Samuelson, Paul A. (1967). Economics: An Introductory Analysis, New York: McGraw-Hill Book Company.

Schim van der Loeff, S., and R. Harkema (1976). "Three Models of Firm Behavior; Theory and Estimation, With an Application to the Dutch Manufacturing Sector", The Review of Economics and Statistics, Vol. LVIII, No. 1 (February).

Schmalensee, Richard (1973). Applied Microeconomics, San Francisco, Calif.: Holden-Day, Inc.

Schmid, A. Allan (1968). Converting Land From Rural to Urban Uses, Baltimore: Resources for the Future, John Hopkins Press.

_____ (1970). "Suburban Land Appreciation and Public Policy", Journal of the American Institute of Planners, Vol.36, No. 1 (January).

Seldin, Maury, and Richard H. Swesnik (1970). Real Estate Investment Strategy, New York: John Wiley & Sons, Inc.

Shoup, Donald C. (1970). "The Optimal Timing of Urban Land Development", Papers and Proceedings of the Regional Science Association, Vol. 25.

Simon, Herbert A. (1967). "Theories of Decision-Making in Economics and Behavioral Science", in American Economic Association and Royal Economic Society, Surveys of Economic Theory, New York: St.Martin's Press.

Smith, Adam (1776). The Wealth of Nations, (1905 Edition), New York: Collier.

Smith, Lawrence C. (1971). Housing in Canada, Monograph 2, in Urban Canada: Problems and Prospects, Ottawa: Central Mortgage and Housing Corporation.

_____(1974). The Postwar Canadian Housing and Residential Mortgage Markets and the Role of Government, Toronto: University of Toronto Press.

Smith, Wallace F. (1970). Housing: The Social and Economic Elements, Berkeley, Calif.: University of California Press.

Spengler, Edward H. (1930). Land Values in New York in Relation to Transit, New York: Columbia University Press.

Spurr, Peter (1976). Land and Urban Development, Toronto: J.Lorimer & Co.

Straszheim, Malhon R. (1975). An Econometric Analysis of the Urban Housing Market, New York: National Bureau of Economic Research, Columbia University Press.

Sweeney, Richard J. (1974). A Macro Theory with Micro Foundations, Cincinnati: South-Western Publishing Co.

Turvey, Ralph (1957). The Economics of Real Property, London: George Allen & Unwin Ltd.

_____(1962). "The Rationale of Rising Property Values", Lloyds Bank Review, October.

van Doorn, J. (1975). Disequilibrium Economics, London: The Macmillan Press Ltd.

von Thunen, Johann H. (1826). Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie (Third Edition, 1875), Berlin: Schumacher-Zarchlin.

Warren, Roland L. (1971). "The Sociology of Knowledge and the Problems of the Inner Cities", in Social Science Quarterly (December).

Watson, Donald S. (1972). Price Theory and Its Uses, (Third Edition), Boston: Houghton Mifflin Company.

Weiss, Shirly F., et al (1966). Residential Developer Decisions, Chapel Hill, N.C.: Center for Urban and Regional Studies, University of North Carolina.

Wendt, Paul F. (1957). "Theory of Urban Land Values", Land Economics, August.

_____ (1958a). "Urban Land Value Trends", Appraisal Journal, Vol. 26, No. 2 (April).

_____ (1958b). "Economic Growth and Urban Land Values", Appraisal Journal, Vol. 26, No. 3 (July).

_____ (1974). Real Estate Appraisal Review and Outlook, Athens, Georgia: University of Georgia Press.

White, Philip H. (1963). Urban Redevelopment Policies, Occasional Paper No. 3, Vancouver: Faculty of Commerce and Business Administration, University of British Columbia.

Whitehead, C.M.E., and J.C.Odling-Smee (1975). "Long-run Equilibrium in Urban Housing - A Note", Urban Studies, Vol.12, No.3 (October).

Whipple, R.T.M. (1971). Urban Renewal and the Private Investor, Sydney: West Publishing Corp.

Wicksell, Knut (1935). Lectures on Political Economy, Vol.I, London: Routledge.

Wicksteed, Philip H. (1894). An Essay on the Co-ordination of the Laws of Distribution (Reprinted, 1932), London: London School of Economics and Political Science.

Wingo, Lowdon, Jr. (1961). Transportation and Urban Land, Baltimore, Maryland, Resources for the Future, John Hopkins Press.

Wilburn, Michael D., and Robert M. Gladstone (1972). Optimizing Development Profits in Large Scale Real Estate Projects, Technical Bulletin 67, Washington, D.C.: The Urban Land Institute.

Wirth, Louis (1925), "A Bibliography of the Urban Community", in Park, et al, The City, Chicago: University of Chicago Press.

Witte, Ann Dryden (1975). "The Determination of Interurban Residential Site Price Differences: A Derived Demand Model with Empirical Testing", Journal of Regional Science, Vol. 15, No. 3 (December).

Working, Holbrook (1958). "A Theory of Anticipatory Prices", (Reprinted, 1977), Selected Writings of Holbrook Working, Chicago: Board of Trade.

Wynn, R.F., and K. Holden (1974). An Introduction to Applied Econometric Analysis, New York: John Wiley & Sons.