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Teck Kian Tan
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LA THÈSE A ÉTÉ MICROFILMÉE TELLE QUE NOUS L’AVONS RECUE
ANALYSIS OF THE SINGLE-FAMILY DETACHED HOUSING MARKET IN WINDSOR

by

Teck Kian Tan

A Thesis submitted to the Faculty of Graduate Studies through the Department of Geography in Partial Fulfillment of the requirements for the Degree of Master of Arts at The University of Windsor

Windsor, Ontario, Canada

1982
ABSTRACT

ANALYSIS OF THE SINGLE-FAMILY DETACHED HOUSING MARKET IN WINDSOR

by

Teck Kian Tan

During the last decade a considerable number of empirical studies concerning the determinants of urban house prices have been carried out, particularly in Britain and United States. Surprisingly, there have been few studies done in Canada with regard to the micro aspects of urban housing market. This work attempts to examine the relationship between house price and selected housing and neighbourhood attributes in Windsor and to determine the factors that account for spatial variations of house prices in Windsor during a three month period, January-March 1979, when the local housing market was still booming.

A multiple regression analysis is used in this study to measure the impact on house prices of various attributes. It was found that all the variables were moderately correlated with house price and have the hypothesized regression coefficients. The findings substantiate conceptualized theories and methods employed in previous housing market analysis. Results from the regression analysis showed that space as measured by lot size and number of bedrooms, and
social-economic status of the neighbourhood were found to be significant factors accounting for variations of house prices in Windsor. Moreover, this study revealed that an aggregate model is the more appropriate method for the analysis of housing prices in Windsor.
To my mother and late father
who sacrificed so much for
my education.
ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

A study of the housing market is a study of the most complex of all the commodities traded in the economy. What makes houses so distinctive is attributable to the peculiar characteristics of them when viewed as a commodity. The main reasons responsible for the complexity of housing market analysis are: (1) housing is the single most expensive consumer good which a household will purchase, (2) it is highly durable, (3) it is extremely heterogeneous, and (4) it is fixed in location. Thus, housing is not a single product but a complex bundle of services provided by the dwelling, its location, and its environment.

Previous research on house price studies have been undertaken for a variety of purposes. Those studies, as

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1Further discussion on those features pertaining to housing as an economic commodity is notable in Berridge (1971) and Quigley (1978).

2For instance, (1) to examine from which attributes of housing the consumer derives utility by looking at the valuations of the attributes expressed by the consumer in the market - see Carvalho et al. (1976), Kain and Quigley (1970), Nelson (1978), and Ridker and Henning (1968); (2) to
Maclennan (1977) notes, have consistently used a common set of underlying theoretical assumptions to fill empirical voids, although estimation methods and research purposes vary significantly. In general, most empirical studies are based on hedonic price technique\(^3\) in which the implicit price of various attributes was estimated in an attempt to explain urban house prices. It should also be noted that the majority of the analyses are in linear, semi-log or logarithmic form, presumably on grounds of convenience and without rigorous statistical experimentation as suggested by Quigley (1978).

Many empirical studies, however, have been based on aggregate data in which the dwelling units are not the unit of analysis. Areal units such as census tracts were frequently used as a surrogate in which the dependent variable reflects an average of prices for many types of housing or combination of both owner and rental units. The value of such study is therefore reduced due to the incapability of highly aggregate data to describe local

test the hypothesis that urban housing markets are segmented by race, political boundaries, or geographical areas - see Kain and Quigley (1975), Straszheim (1974), Palm (1978), and Schnare and Struyk (1976); (3) to test theories of residential location - see Evans (1973), and Richardson, Vipond, and Furbey (1975); and (4) to derive demand functions for housing - see Apps (1974).

\(^3\)The hedonic price technique is a common tool of housing market analyses and it can identify those components of the housing bundle that contribute to market value. For a general discussion of this technique, see Griliches (1971) and Van Lierop (1980).
phenomena. Moreover, most studies focused their analyses on a broad area corresponding to the city in general. Those studies thus reflect a generalization of urban house prices. Some studies, nevertheless, attempt to analyze the spatial segmentation of urban housing markets but their findings have not been comparable. The difficulties involved in specifying appropriate submarkets for the study of housing are alluded to in numerous studies in which submarkets have been variously defined, as in Bourne (1978), Palm (1978), Grigsby (1963), and Kain and Quigley (1975).  

The price of housing has increased dramatically throughout Canada in the last several years. This concern is manifested in several government and individual reports. Surprisingly, there has been little research done in Canada to study the micro aspect of urban housing market. In view of residential development, greater understanding of the housing market is needed for the formulation of housing policy in accordance with the peculiar needs and characteristics of

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4 According to Caruso and Palm (1973, p. 221), "Although geography is often referred to as a discipline which is defined by its perspective of spatial organization, there is no unanimous opinion as to what the concept of 'space' is." The problem has been in finding a unified 'agree-upon' concept of urban social space. This results from the inconsistencies in definition which the concept itself has acquired.

specific areas. Moreover, models of this kind would be invaluable to a city in assessing property tax and other purposes.

Windsor was experiencing economic growth at the time this study began in 1979. This growth was precipitated shortly after Ford's announcement of its $533 million new engine plant in Windsor in 1978. The local housing market was among those which benefitted from the booming economy. This was evident in the Canada Mortgage and Housing Corporation (1979) record which showed that by the end of 1978 dwelling starts for both single family housing and apartments in Windsor were at a record high, 715 units and 1393 units respectively. Though the present economy is in a slump, this study of housing market reflects prices at the time of a healthy economy, particularly during the first three months in 1979.

The study in Windsor focuses on the demand aspects of housing with particular emphasis on the determinants of house prices. In order to avoid some of the defects cited earlier, this study will analyze the market value of house prices on individual dwellings. However, subsequent aggregation of individual units to an areal level is required to provide further insight into the spatial impact of the process. Different house price categories will also be analyzed in an attempt to demonstrate the important of
"submarket" analysis in future research.

It is understood that the size and the nature of the city are in themselves major factors, and that perceptions of desirable neighbourhoods and housing choices develop through time in any community.

Scope of the Study

This study attempts to reinforce our understanding of how various attributes of housing are valued by the consumers in the urban housing markets. Specifically, it has two major objectives. First, the purpose of this study is to examine some of the factors that account for varying house prices in Windsor. This is to be evaluated by testing the existence of relationships between observed house prices and selected housing and neighbourhood attributes; second, to demonstrate the value of certain attributes accounting for house prices in an overall housing market in Windsor and in different house price markets within urban areas.

It should be noted that the present study will be limited to single detached houses sold by realtors in Windsor. The reasons for selecting this type of housing are: (1) Single detached houses are the most desirable form of housing in Canada. As Lorimer (1978) notes, numerous studies of people's housing preference have shown that people generally like
living in the suburbs in single-family homes over any other alternative, (2) Windsor is a largely home ownership area with 66 percent of the total dwellings owner occupied and of the total dwelling types, about 63 percent are single detached homes, and (3) single detached houses account for approximately two-thirds of all the residential houses sold in Windsor housing market by the realtors.

Study Area

The area under study is arbitrarily confined to the City of Windsor (Figure 1), located in southwestern Ontario at the tip of the Essex peninsula bounded by Lake St. Clair, the Detroit River, and Lake Erie.

Windsor has been a manufacturing center for more than a century and the original Ford automotive plant was first established in 1904. A period of industrial expansion followed, until the depression year in the 1930's. However, with the outbreak of World War II, the industrial plants were converted to produce war material for the Allies. After the war, Windsor's plants reverted to peacetime production at record levels (City of Windsor, 1977; Ontario Housing Corporation, 1966).

In 1958 Ford moved to Oakville, Ontario, and Windsor experienced other economic difficulties (Nixon and Campbell, 1972). The economy was revived by the implementation of the Canada-United States automotive agreement in 1965, and the industry grew rapidly (Ministry of Treasury Economics and Intergovernmental Affairs, 1978).

Today, Windsor is a leading automotive center in Canada with a population of about 200,000 people. The ratio of industrial workers to total local employment is one of the highest in Canada. The highly unionized and relatively high wage structure of Windsor workers has encouraged the ownership of single-family residences. The city has only a little more than one percent of Canada's population but it has fifteen percent of the nation's tool and die makers (Windsor Chamber of Commerce, 1979).

**Organization**

The organization of this study is as follows: Chapter II is a review of literature which presents a summary view of theoretical work on urban spatial structure and some empirical findings on house price studies as well as segmentation of urban housing markets. Chapter III describes the method of analyzing spatial variations of urban house prices adopted in this study and also presents the hypotheses to be tested, the operational definition of the variables and
their rationale, data sources, unit of analysis, and verification procedure. Results of the analysis are presented in Chapter IV. This study concludes in Chapter V with a summary of the findings, followed by a discussion on the limitations of the study and suggestions for future research.
CHAPTER II

REVIEW OF LITERATURE

Empirical studies concerning the determinants of urban house prices have accumulated extensively over the past decade, particularly in the social science disciplines, such as economics and geography. This chapter reviews relevant literature pertaining to urban land use, housing markets and house price studies.

The traditional concepts of urban form and models of city structure will be reviewed first, in order to present the patterns of urban land use. This is followed by the review of urban land rent theory to examine the processes which have given rise to these patterns. Then the house price studies will be reviewed to highlight the significance of various factors in determining house prices. Finally, a review of housing submarkets is presented to show the problem of identifying submarket areas per se and the value of stratified and unstratified data analysis.

Models of City Structure

Among the earliest descriptive frameworks, there are
three classic concepts of spatial organization: (1) concentric zone theory, (2) sector theory, and (3) multiple-nuclei theory. As Chapin, Jr. and Kaiser (1979, p. 32) have noted, the first and last of the above concepts deal with the entire pattern of use areas, whereas the sector system of explanation was developed primarily to explain the structure of residential area. The zonal and sector theories are used to describe changes in the basic arrangements of land use patterns, whereas the multiple-nuclei approach is primarily a description of the structural form of the urban land use pattern at a point in time.

Concentric Zone Theory

Burgess's concentric zone model was developed in the early 1920s to explain the growth of the city. Using Chicago as an example, his approach was based on the ecological process of invasion and succession whereby he conceived the city as a series of five concentric zones differing in physical appearance and social-economic characteristics.

In light of Burgess's (1925) conception, the five concentric zones are: (1) central business district, (2) zone of transition, (3) zone of workingmen's homes, (4) zone of better residences, and (5) commuter's zone. Thereupon, Burgess's model was used in a variety of empirical studies,
and, in spite of some warranted criticism by Davies and others, was generally accepted into the literature on urban residential patterns (Johnston and Herbert, 1978, p. 19).

**Sector Theory**

A second model of the changing spatial structure of the city was formulated by Hoyt (1939) and is known as the wedge or sector theory. On the basis on an intensive study of property inventories in 142 American cities, Hoyt asserted that different income classes occupied distinct subareas of the city and that these were not aligned concentrically about the city but, rather, distributed in a sectoral fashion.

Hoyt's model is known to provide a more detailed explanation of residential patterns of land use than that set forth in the concentric zone formulation, particularly in the more discriminating way in which it deals with the dynamic growth process (Chapin, Jr. and Kaiser, 1979, p. 36). Dickey (1975, p. 155), however, points out that Hoyt's view of the city is at best partial, constrained by his narrow focus of interest on housing characteristics in general and on rent in particular. He gave little consideration to the characteristics of the inhabitants who occupied the structures.

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*For a review, see Johnston (1971).*
Multiple-Nuclei Theory

A third model, multiple-nuclei theory, was first suggested by McKenzie (1933) but the concept was later expanded and modified by Harris and Ullman (1945). They argued that the land use pattern of a city does not grow from a single center but from many distinct nuclei. In some cases, the nuclei have existed from the origin of the city, but others may develop as urbanization proceeds.

It has been noted that the multiple-nuclei structure is a better approximation of reality, particularly in the contemporary metropolitan area land use patterns (Getis, 1972; Chapin, Jr. and Kaiser, 1979). Though the multiple-nuclei concept has been applauded, it has not been followed up to any large extent. The problem, as Getis (1972, p. 55) notes, "Empiricism based on multiple-nuclei approach is difficult of application." Chapin, Jr. and Kaiser (1979, p. 37) shared the same view and in their own words, "It needs study, elaboration, and probably modification based on empirical investigations of the kind undertaken by Hoyt before it can become operationally useful framework for describing urban land use, and it requires clearer differentiation between factors explaining the structure and dynamics of changes."

Although the generalization of the three classic models do not conform to the reality of any city, many elements
of each model are present in large and medium-sized American cities. Thus, they are not mutually exclusive. As Jackson (1973, p. 128) concludes, the traditional models do have a value, but only when superimposed and integrated with each other. Accordingly, Nelson (1969) states, they remain as valuable conceptual tools for analysing the modern city, and provide a basic for cross-cultural urban comparisons.

Urban Land Rent Theory

The early theory of rent and location dealt primarily with agricultural society. Brodsky (1966), however, points out that although land rent theory is at least as old as the works of Ricardo (1817) and Von Thünen (1826), the concept of land rent has only recently received formal and detailed application in urban situation.8

In 1817, Ricardo developed the first agricultural rent model in which he paid particular attention to the quality (site) differentials of land and he recognized the locational advantages as well. His model suggested that variation in soil fertility of agricultural land resulted in land rent differentials.

The theory of location differential rent was

8See Alonso (1960, 1964); Kain (1962); Moses (1962); Muth (1961); and Wingo (1961).
Developed more fully by Von Thünen in his classic work on the location of agricultural land-use zones, *Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalekonomie*, published in 1826. He emphasized the importance of accessibility as a determinant of land rent. Von Thünen's model suggests that rent at any location is equal to the value of its product minus production costs and transportation costs. Although his isolated state is modeled on the agricultural patterns of 19th century Mecklenburg in Germany, Haggett (1972, p. 267) notes that Von Thünen had not only laid the foundation for refined analysis of agricultural location but stimulated interest over a much broader area of locational analysis.

A more complex approach in dealing with urban land values was initiated by Hurd (1903) in *Principles of City Land Values*. His model is similar to that of Von Thünen for agriculture but with a different emphasis. According to Hurd, desirability differential among various locations in a city is the determinant of urban land values. That is, the value of land depends on nearness to city centre. Hurd's work suggests that besides economic rent, there are other factors accounting for house prices. However, he deliberately overlooked residential land because he believed that the basis of residence values was social and not economic.

Another theory of urban land values was developed by Haig (1926) and it is not much different from that of Hurd's.
Haig's work is based on the concept of 'friction of space' whereby the principal determinant of land rents or values is the cost of transportation. The underlying assumption is that the better the transportation, the less the friction, thereby minimizing transportation costs. Thus, the minimization of cost of friction and the accessibility to the city centre are the prime considerations of a consumer in selecting housing services. Haig, however, failed to include the size of residential lot in his model. For instance, a consumer may prefer a larger lot in the periphery than a smaller one in the centre at a lower cost of friction.

Alonso (1960, p. 149), however, criticized both Hurd and Haig theories of urban land, "Their approach copied the form rather than the logic of agricultural theory, and the resulting theory can be shown to be insufficient on its own premises. In particular, the theory failed to consider residences which constitute the preponderant land use in urban areas."

In a critical review of housing market studies, Kirby (1976) notes that the most influential of the economic models of the housing market has been that of Alonso (1964) who develops a model of the interaction of urban land values and land uses. The main contribution in Alonso's work is the demonstration that the poor tend to live in the central location on expensive land and the rich move to the periphery
on cheaper land. He concludes that the rich are price-oriented, whereas the poor are location-oriented.

Although Alonso's model is a normative model compared against certain aspects of reality, Kirby (1976) points out that the economic approach has often been employed as an explanation of reality. Moreover, Kirby cites that the verification of this point may be found in Ball's (1973) review of various house price studies in which he suggests that a positive regression coefficient for the distance function has the 'wrong sign'. As a result, Alonso's model has been applied extensively to explanations of residential behaviour and it is discussed further in the next section.

**House Price Studies**

In recent years there have been many studies on the determinants of relative urban house prices and they shed some light on the empirical validity of the standard theories of residential location. The approach in all studies has been to investigate the valuation of various housing attributes by the consumer in the housing market. It should be noted, however, problems do arise in identifying and quantifying some of the attributes associated with environmental quality in both physical and social contexts. Ball's (1973) article, *Recent Empirical Work on the Determinants of Relative House Prices*, is noteworthy.
Basic theory of urban land value is the assumption that location rent declines as accessibility (particularly accessibility to work places) declines. The distance variable thus plays an important role in studies of relative house prices and in many theories of residential location. In spite of different types of distance measurement, the choice of distance measure was found to make little difference (Lowry, 1964).

Most of the studies found the distance variable to be significant. Wabe (1971), nevertheless, in his study on the determinants of average house price for each borough in London, found that the correlations do highlight the fact that rail travel time and cost to the central business district (CBD) enter the housing market consideration in a more complex way than just the accessibility/lower house price tradeoff. However, in a similar study in London but with fewer variables, Evans (1973) demonstrated that distance from CBD alone explained almost three-quarters of the variation in asking price of the house. Apps' (1971) study of Reading also indicates the significance of distance as an explanatory factor by using accessibility to employment and schools. Although several studies have recognized that accessibility to employment goes far to explain residential location (Wingo, 1961; Kain, 1962; Getis, 1969; and Straszheim, 1973), Moriarty's (1970) analysis reveals that urban residential decision makers as a whole exhibit more preference for
accessibility to compatible friends and neighbourhoods than for closeness to employment opportunities. Other studies which show distance as an important variable are also reported in Wilkinson (1971), Ridker and Henning (1967), Brigham (1965), Anderson and Crocker (1971), and in a recent M.A. thesis on Locational Determinants of Apartment Rent in Windsor by Risk (1980).

On the contrary, Maclennan (1977) argues that distance to the CBD is not a general measure of access for households. In his words (p. 70), "Access, in so far as it affects house prices, is now difficult to measure. Currently not enough is known about household preferences and activities and the decentralised provision of employment, schools, etc. to utilise an aggregative approach." This view is also supported by Thomas (1973).

Several studies have also indicated that housing and neighbourhood related attributes were significant in explaining relative house prices. The most provoking findings are those of Cubbin (1970), and Massell and Stewart (1971) that although they did not consider the distance variable, they still obtained high $R^2$. This raises the possibility that locational factors may not be the only determinant of house prices. Kain and Quigley's (1970) study is even more disturbing in that their regression analysis revealed the complete insignificance of the distance parameter even though St. Louis is a large
industrial and commercial town. Instead, their study highlights the importance of quality variables in the determination of house prices.

Among the house related variables, dwelling size in terms of floor area and other surrogate measures such as number of rooms and bedrooms indicated that space is a major factor in the determination of house prices. These variables were found to have a significant positive impact in numerous studies (Cubbin, 1970; Wilkinson, 1971, 1973, and with Archer, 1973; Lane, 1970, Kain and Quigley, 1970; and Van Lierop, 1980). Other variables which were found to be significant were lot size (Carvalho et al., 1976; Massell and Stewart, 1971; and Grether and Mieszkowski, 1974), garage (Cubbin, 1970; Wilkinson, 1971), and age of structure (Schnare and Struyk, 1976; Straszheim, 1974).

Other studies demonstrated that environmental attributes or neighbourhood considerations are more important than the considerations of accessibility in residential site choice (Stegman, 1969; Richardson, 1971). That is, by itself, the relative balance between these favourable and unfavourable environmental attributes of the neighbourhood in which the houses are located stratifies them by price. Empirical findings with regard to environmental quality and several of its proxies have been found significant. A dummy variable indicating a proximity to greenbelt (Wabe, 1971), an absence
of industry in the neighbourhood (Richardson, Vipond and Furbey, 1974), and a variable measuring the degree of amenity (Harris, Tolley and Harrel, 1968) were found to have significant positive coefficients. The study on the effect of air pollution on house prices revealed a significant negative impact by Ridker and Henning (1967), Anderson and Crocker (1971), and Nelson (1975). Risk (1980) findings also confirmed the significance of air quality as determinants of apartment rent in Windsor.

Social-economic status of the neighbourhood has also been found to have a positive impact on residential property values. A common measure for this attribute is usually the mean or median income level of the neighbourhood. Average family income has been employed in several studies and was found to have a significant positive effect on house prices (Brodsky, 1966; Schnare and Struyk, 1976; Carvalho et al., 1976; Ridker and Henning, 1967; and Anderson and Crocker, 1971). Other studies include social-economic indices and their findings supported the positive impact on house prices as well (Wabe, 1971; and Wilkinson, 1971). Moreover, Archer (1975) examines the correspondence between social status and urban residential distribution by using occupational scale. His research supports the findings of earlier studies concerning levels of residential segregation in relation to

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9 Neighbourhood is usually being defined as the areal unit of school district or census tract.
occupational rank (Duncan and Duncan, 1955; and Wheeler, 1968).

Other researchers have also indicated that variables associated with crowding such as population density (Wabe, 1971) and residential density (Richardson, Vipond and Furbey, 1974; Wilkinson, 1971 and with Archer, 1973; and Rider and Henning, 1967) have a significant negative impact on house prices. Likewise, the low quality of structure in the neighbourhood has also been found to have the effect of lower housing values by Kain and Quigley (1970), Grether and Mieszkowski (1974), Anderson and Crocker (1971), and Van Lierop (1980).

Richardson, Vipond and Furbey (1974), however, demonstrated that indirect testing of alternative residential location theories do not lend strong support to any single residential location theory. They suggested that the determinants of urban house prices include housing characteristics, general spatial variables, accessibility and environmental quality considerations. Moreover, they conclude that there is a need both for a more inclusive behaviourist theory and microeconomic data, particularly individual household income and expenditure patterns, that would allow such a theory to be tested directly.

**Housing Submarkets**

The problem concerning market disaggregation is
mainly "The aggregate estimation procedure for the implicit price of a housing attribute or set of attributes requires and assumes that the house prices observed are generated within the same housing market." (Maclellan, 1977, p. 63). He points out that disaggregation of a housing market into submarkets could raise the possibility of differential disequilibrium and generate the possibility of different degrees of seller's monopoly.

Straszheim (1975) recognizes the difficulty generated by housing market compartments. The major problem is that of excessive aggregation which he notes (p. 70) is due to "pooling over many submarkets when the underlying parameters differ by submarket; thus aggregation implies one price structure when in fact submarket price structures may differ significantly."

Nevertheless, Straszheim (1974, 1975) argues that whether urban housing markets are in "equilibrium" or not, the central problem in estimating hedonic equations involves the delineation of homogeneous submarkets. He points out that past studies concerning the size and direction of beta coefficients for such variables as racial composition and air quality failed to delineate meaningful submarkets. He demonstrated that market disaggregation by geographic areas in San Francisco Bay Area accounted for a significant reduction in the sum of squared errors. Thus, he suggested that proper
geographic disaggregation in cross-section estimation is required in order to obtain meaningful estimates of the spatial variation in current housing market prices.

However, in a study by Schnare and Struyk (1976), a hedonic regression technique was also used to test for segmentation in urban housing markets for thirteen suburban municipalities in Boston. The test for significant differences in the parameters was based on stratified and unstratified samples. The stratification included two neighbourhood attributes, average family income for census tracts and accessibility to employment centers, and one structural attribute, average number of rooms in the dwelling unit.

They found that the stratified model produced significant differences in the prices of the individual housing attributes but these differences were small when compared to the overall variation in housing prices. Thus, they concluded that because the stratified model involved loss of data and reduced the reliability of its estimates, and because the predictive power of the two models was essentially the same, their findings supported the continued use of an unstratified model in house price studies.

Ball and Kirwan (1977) conducted a similar study in Bristol area. Their submarkets were, however, predetermined
by means of cluster analysis. They found that submarket analysis lends no explanatory power to the metropolitan model because their regression equations failed to identify sharply varying attribute prices. Moreover, an F-test failed to show sufficient reduction in the error variance to reject the null hypothesis. Thus, submarkets provide no better statistical explanation of house prices than the overall market model.

Palm (1978) was particularly interested in the level of aggregation in house price studies. To test for spatial segmentation of the urban housing market for the San Francisco Bay Area, Palm employed a multiple regression technique to analyse the metropolitan area as a whole and also for submarkets defined on the basis of real estate board jurisdictions, the racial-ethnic composition of neighbourhood and the average house price of neighbourhoods.

Regression analysis revealed different patterns of collerates for the market and submarket models, and the F-test indicated that the board of realtors submarket model was superior to the other models in accounting for variance in price change. Her findings suggested that submarket models

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10 According to Ball and Kirwan (1977, p. 17), "No theoretical meaning is here attached to the technique used to identify the groupings: the only theoretical proposition which is aimed to test is that such groupings exist and that they are reflected in the structure of house prices....The technique is simply a convenient way of identifying groupings as they occur."
should be used in house price studies. However, she cautioned that it is essential to carefully define submarkets to bound areas which are likely to show discrete attribute-price structure.

Not all studies found disaggregation of housing market significantly improved their ability to explain variation in house prices. It should be noted that submarket analysis may be better applied to large metropolitan areas. One might then concur that the larger cities would tend to have greater heterogeneity of the stock and of households which reflect marked "pocket" or multiple-nuclei development and with a stronger likelihood of homogeneous racial-ethnic neighbourhoods. Furthermore, topographic variety may be a contributing factor to the occurrence of housing submarkets.
CHAPTER III

METHODOLOGY

The methodology employed in this study consists of specific hypotheses to be tested, the model, the technique, data sources, unit of analysis, and verification procedure. Earlier empirical studies on the determinants of relative house prices attempted to explain the valuation of attributes in the market by regressing house prices against a set of attributes. The present study applies some of those key attributes to the Windsor housing market and demonstrates the degree of their validity on a medium size city in Canada as compared to previous findings in United States and Britain.

Hypotheses

Based on the review of literature, field observations, and study objectives, a number of hypotheses are formulated to test the relationship between observed house prices and the selected housing and neighbourhood attributes in Windsor, and to demonstrate the valuation of these attributes in different house price markets.
Basically, it is hypothesized that house prices in Windsor are:

1. directly related to the size of the lot, in acres;
2. directly related to the number of bedrooms in the dwelling;
3. directly related to the average family income of the respective census tracts, in dollars;
4. inversely related to population density of each census tract;
5. directly related to the average family size within each census tract;
6. directly related to the proportion of children under 18 years of age in each census tract, in percentage;
7. inversely related to the proportion of elderly over the age of 65 in each census tract, in percentage; and
8. directly related to the participation rate of married female in the labour force of each census tract, in percentage.

The first two hypotheses are related to specific housing attributes, while the remaining six hypotheses are related to neighbourhood attributes. The testing of these hypotheses is performed via a model which is discussed in more detail in the following section.
The Model

The approach adopted in this study is analogous to the hedonic price technique which has been used to quantify intrametropolitan variations in house prices over the past decade (Ball, 1973; Straszheim, 1975; Schnare and Struyk, 1976; Palm, 1978; and Goodman, 1978). The basic assumption underlying this sort of analysis is that price of a given dwelling unit depends on the characteristics of the unit and its neighbourhood (Schnare, 1974). The combination of various factors, such as structural and neighbourhood attributes are found to be important in explaining variation of house prices over an urban area. The present study is based on multiple regression technique in which the valuation of various components are determined implicitly. This can be expressed in the following conceptual form:

$$ HP = a + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n + e $$

where HP (house price) is the dependent variable, X's are the independent variables, b's are the regression coefficients, a is the constant, and e the errors.

The Technique

To determine the relative importance of various factors in accounting for house prices in Windsor, a single
equation multiple regression is used with house price as a dependent variable and housing and neighbourhood characteristics as independent variables. The relationship of the general form is estimated as follow:

\[ HP = \alpha + b_1(IS) + b_2(NB) + b_3(AFI) - b_4(PD) + b_5(FS) + b_6(PU18) - b_7(P065) + b_8(MFLF) + e \]

Where:
- \( HP \) = House price;
- \( \alpha \) = Constant;
- \( b \) = Implicit price of attributes;
- \( IS \) = Lot size in acres;
- \( NB \) = Number of bedrooms;
- \( AFI \) = Average family income of each census tract, in dollars;
- \( PD \) = Population density for each census tract;
- \( FS \) = Family size of each census tract expressed as an average number of persons per family in that tract;
- \( PU18 \) = Percentage of population under 18 years old in each census tract;
- \( P065 \) = Percentage of population over 65 years of age in each census tract;
- \( MFLF \) = Percentage of married female in the labour force for each census tract; and
- \( e \) = Errors.
To demonstrate how the key attributes accounting for most of the explained variance in house price are different from one house price market to another in Windsor, a frequency diagram (Figure 2) was constructed which shows the distribution of house prices in Windsor. Subsequently, four distinct house price markets were identified: (1) Low house price – $25000 or less, (2) Medium house price – $25000 to $49999, (3) Medium-high house price – $50000 to $69999, and (4) High house price – $70000 or more. The spatial distribution of all sales of single detached houses in the overall Windsor housing market and in the various house price markets as identified above were illustrated in Figure 3, 4, 5, 6 and 7 respectively.

The above stratification scheme will allow the calculation of a set of multiple regression equations for the entire housing market and for each house price market in Windsor. Thereupon, the key attributes are identified and compared.

The Variables

The variables that are employed in the equation are defined as follows:

The Dependent Variable

The dependent variable, house price, used in the present study is the selling price of all the single detached
Figure 2

DISTRIBUTION OF SINGLE DETACHED HOUSE PRICES IN WINDSOR, JANUARY-MARCH 1979.

Source: M.E.N.S. School Corporation High School, 1979. Windsor County Real Estate Board.
houses under multiple-listing and sold by the realtors in the City of Windsor during the first three months in 1979. Only those houses that were listed in the Multiple Listing Services Sales Comparison Book\textsuperscript{11} were accounted in the study.

Independent Variables

Of the determinants of house prices, eight variables were used in the model: lot size (LS), number of bedrooms (NB), average family income (AFI), population density (PD), family size (FS), population under 18 years of age (PUL8), population over the age of 65 (P065), and married female in the labour force (MFLF). Further discussion of these variables are as follows:

\textit{Lot size} is the total parcel of land in acres on which the dwelling is sited. In the housing market, the purchase of a house - detached, semi-detached, row or duplex - generally includes a portion of land and certain rights to that land. Thus, the price of the housing unit includes the cost of the land on which it is built. It is, therefore, logical that the larger lot would cost more than the smaller one. As Ministry of Housing (1976) has demonstrated, of the total savings identified in site planning standards, approximately 75 percent of the savings can be attributed to permitting

\textsuperscript{11}This book is published by the Windsor-Essex County Real Estate Board once every three months and it contains a complete list of all the residential and commercial properties sold in the city and county during the three months span.
reduced lot sizes.

**Number of bedrooms** refers to the total number of these units in a dwelling. Due to the difficulty of obtaining appropriate data for dwelling size, the number of bedrooms is used as a measure for this attribute. Past studies have indicated that floor area and number of rooms or bedrooms are most significant in accounting for house prices. This implies that in light of house related attributes, space is the key determinant of house prices. For that reason, it is generally assumed that the larger the number of bedrooms, the larger the dwelling. Thus, one would expect that a larger house which requires more material and labour for its construction would cost more than a smaller one.

**Average family income** refers to the average of all the total family incomes in each census tract, in dollars. Family income is the sum of the income received by all member of the family 15 years and over, from all sources of each census tract.

Generally, one can argue that increases in real income will have a significant influence on the level of demand for housing. In part, according to Sharpe (1977),

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12 The total floor area for each dwelling is not recorded in the Multiple Listing Services. Although the dimension for each room was provided for each of the dwelling unit, they were found to be inconsistent.
replacement demand for new, bigger and better houses is generated by the changing tastes and rising aspirations which result from increases in real income. Many researchers have also indicated strong relationships exist between income and housing services. On the basis of this evidence, it is reasonable to assume that, other things being equal, houses located in census tracts with higher average family income have higher market values.

Population density refers to the number of persons per acre in each census tract. Many empirical studies have demonstrated that for a wide range of times and places, urban population densities decline in a negative exponential manner with increasing distance from the city center (Clark, 1951; Muth, 1961 and 1968; Newling, 1969; Berry, Simmons and Tennant, 1963). This theory is also reinforced by Alonso (1960) that the rich, in western cities, live at the periphery on cheap land and consume more land at lower densities than the poor do who live at the center. One would thus expect that house price is negatively related to population density.

Family size is the average number of persons per family for each census tract. Other things being equal, demand for space will vary according to the distribution of families at different stages in their life cycles. It has been noted that with an increase in family size the demand increases for more dwelling space (Doling, 1976; McCarthy,
1976). As a result, a larger house would tend to cost more to accommodate a larger family and one would expect that house price is positively related to family size. However, it should be noted that family size may not be a truly independent variable because if the cost of housing is too high, the expanding family might choose to double up rather than buy a bigger house, or opt for public housing.

Population under 18 is the percentage of children under 18 years of age in each census tract. Previous research had shown that increases in interior space demands are common particularly with the addition of children to the family (Michelson, 1977). Thus, the family with more children would require more space and tend to located in the suburbs. Consequently, as dwelling size increases, house price increases as well.

Population over 65 is the percentage of elderly over 65 years old in each census tract. Several studies have found that the elderly are less mobile in terms of moving their households (Carp, 1965; Golant, 1972; Doling, 1976; Wiseman, 1978). Much of the explanation for concentration patterns of the elderly, as Wiseman (1978) notes, is attributable to the process of aging-in-place combined with the out-migration of younger cohort. Therefore, it is generally assumed that with loss of income from retirement, deterioration of health, and the decrease in family size as
children leave home, thereby reducing the demand for space, and inability to pay for and to properly maintain property results. Moreover, social stigma has also added to the concentration of elderly population in a particular neighbourhood associated with cheap and older portion of the housing stock. A higher proportion of elderly people thus has a negative impact on house prices.

*Married female in the labour force* represents the percentage of the total number of married women in the labour force of each census tract. It appears reasonable to believe that a family with double income contributed from a working housewife in the labour force increases the family income and thereby increases their purchasing power. Such a family would then be able to afford a mortgage on a better quality house. For that reason, one would expect a positive relationship to exist between house price and married female in the labour force.

**Data Sources**

The data used to estimate the model in the preceding section are derived from two different sources. Individual data comprising a population of 635 single detached houses sold in Windsor during the first quarter of 1979 were gathered from the Windsor-Essex County Real Estate Board (WECREB), for all the sales listed in the *Multiple Listing Services Sales*
Comparison Book. According to the WECREB estimates, the multiple listing services accounted for more than two-thirds of the total residential housing market transactions. On the whole, in spite of the fact that a very short term data sample was utilized in this study, all census tracts in Windsor are fairly represented. This is evident in the composite map illustrated in Figure 3 showing the spatial distribution of all sales of single detached houses in Windsor during the first three months in 1979. The advantage of using such short term data in the present study is that the data reflect the price of houses during the housing boom period in Windsor resulting from the impact of new Ford engine plant.

Besides recording the address of each home sold and its selling price, two house-related variables are also recorded: lot size (LS) and number of bedrooms (NB). Since it is rather difficult to obtain information pertaining to income of a particular purchase, aggregate data on census tract level were used. Average family income (AFI) for each census tract was extracted from 1971 Census of Canada but it was projected to 1976 income level by means of a factor (1.5) as used by the Planning Department in Windsor. The remaining neighbourhood information was extracted from the 1976 Census of Canada: population density (PD), family size (FS), population under 18 years of age (PU18), population over the age of 65 (P065), and married female in the labour
force (MFLP).

Unit of Analysis

The 43 census tracts of Windsor were selected as the basic units within which certain hypotheses relating to house price were formulated and tested. It should be noted that census tracts may not be the best delineated subareas for analysis, but for the same reasons cited earlier by Dewar (1974), these were thought to be the most appropriate form of basic unit areas as follows: (1) the census tract is the smallest area for which aggregate statistics can be compared over time, since the smaller enumeration districts are continually being altered with the taking of each new census; (2) they are the geographical areas for which the greatest amount of data is readily available from Statistics Canada; (3) due to the nature of housing market and the sample size for single detached type of houses, anything smaller than a census tract would make it difficult to obtain meaningful results; and, (4) analysis by census tract allows comparisons with other studies which have generally been analyzed on the basis of similar areal units.

Verification Procedure

The standard statistical technique of correlation analysis is used to test the hypotheses between the observed
house price and a set of housing and neighbourhood attributes for the entire housing market in Windsor. In view of previous research findings in housing market analysis, a linear relationship was assumed in all cases. Since the dependent variable consists of a population (100 percent of sales), a correlation coefficient of greater than zero is considered to be statistically significant. However, to be more particular, this study would only consider r value greater than 0.2 to be significant.

A set of multiple regression equations were calculated to explain the variation of house prices for the entire housing market in Windsor and for each house price market. The SPSS stepwise regression program is used for the computation. Since not all the independent variables are measured on the same unit, beta coefficients are used to compare the relative importance of the different attributes on house price for the various house price markets in Windsor.
CHAPTER IV

ANALYSIS

In this part of the study, empirical evidence concerning the determinant of house price in Windsor will be examined. Initially, the theoretical hypotheses formulated in Chapter III will be tested, the model will then be estimated empirically using multiple regression analysis, and the beta weights for the various house price markets will be compared. Finally, the results of the analysis will be discussed and summarized.

Testing of the Hypotheses

The Pearson product moment correlation of coefficient (r) was used to test the hypotheses, and linear relationships were assumed in all cases as previously revealed by many research findings in housing market analysis. This is simply the testing of the simple associations between house price and each of the selected independent variables for the housing market in Windsor at large. The results for the variables are shown in Table 1.
Table 1: Correlation Coefficients (r) between House Price and Selected Independent Variables for Windsor.

<table>
<thead>
<tr>
<th>Variable</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$ LS</td>
<td>0.569</td>
</tr>
<tr>
<td>$X_2$ NB</td>
<td>0.321</td>
</tr>
<tr>
<td>$X_3$ AFI</td>
<td>0.533</td>
</tr>
<tr>
<td>$X_4$ PD</td>
<td>-0.256</td>
</tr>
<tr>
<td>$X_5$ FS</td>
<td>0.348</td>
</tr>
<tr>
<td>$X_6$ PU18</td>
<td>0.267</td>
</tr>
<tr>
<td>$X_7$ PO65</td>
<td>-0.224</td>
</tr>
<tr>
<td>$X_8$ MFLF</td>
<td>0.266</td>
</tr>
</tbody>
</table>

Source: Author.
Hypothesis 1. It was hypothesized that house price in Windsor varies directly with lot size (LS). This hypothesis is based on the literature which revealed that with the reduction of lot sizes in site planning standards, there is a considerable savings in cost. This implies that the larger the size of the lot, the higher the house price:

The correlation of coefficient ($r = 0.569$) is greater than $\pm 0.2$ as initially adopted and the hypothesis is therefore substantiated. That is, the strength and direction of the relationship between house price and lot size were found to be significant and positive in nature as expected. Thus, lot size does have a positive impact on real estate values in Windsor as in many major urban areas revealed by previous research.

Hypothesis 2. For the second hypothesis, a direct relationship between house price in Windsor and the number of bedrooms (NB) of the dwelling was hypothesized. In view of the literature, it has been noted that space is the key determinant of house price and the underlying implication suggested that the larger the dwelling size, the higher the house price. This hypothesis, however, used the number of bedrooms as a surrogate measure for dwelling size and one would accordingly expect it to have a positive impact on house price as well.
The result is \( r = 0.321 \), which is well above the set criteria of \( \pm 0.2 \) and thus this hypothesis has been substantiated. Although the number of bedrooms is only a surrogate measure of dwelling size, it was found to be significant and have a positive influence on house price in Windsor.

Hypothesis 3. It has been hypothesized that house price in Windsor varies directly with the average family income (API) of the census tract. This hypothesis is introduced to measure the influence of social-economic status of a neighbourhood on house price. The literature has indicated that as the real income of a family increases, there is a significant influence on the level of demand for housing. Thus, one would expect that the higher the average income of a neighbourhood, the better the quality of the house and its surrounding environment, and subsequently the higher the house price of that area.

The calculated \( r \) of 0.533 is greater than \( \pm 0.2 \). Consequently, as in previous research, the findings revealed a direct and significant relationship between the average family income of the census tract and house price in Windsor. This hypothesis is therefore accepted.

Hypothesis 4. An inverse relationship was hypothesized to vary between house price in Windsor and the
population density of the census tract. The literature asserted that urban population densities decline with distance from the city center. Moreover, the poor were found to locate near the city core residing on expensive land but consuming little of it at higher density, whereas, the rich at the periphery, consuming more of it at lower density. In spite of the lower land values reflected by lower population density in the suburb, the house price is generally higher than those of higher density near the city center. That is, the suburban homes are mainly bigger in size, built on larger lots, relatively new, in good condition, and in good neighbourhood which are some of the factors that accounted for higher real estate values. As a result, the lower the population density of a residential area, the higher the house price of that area is expected.

The $r$ value of $-0.256$ is obtained and is greater than $0.2$. This hypothesis is therefore accepted. The findings thus confirmed the association between the population density of the census tract and house price in Windsor to be significant and inverse in nature.

Hypothesis 5. It was hypothesized that house price in Windsor varies directly with the family size (FS) of the census tract. This hypothesis attempts to examine the influence of family life cycle stages on house price. The literature has indicated that demand for dwelling space vary
according to the distribution of families at different stages in their life cycles. Thus, as family size increases, more space is required to accommodate the expanding family, and subsequently higher house price is expected.

Direct relationship is confirmed to exist between house price in Windsor and the family size of the census tract. The calculated $r$ of 0.348 is well above the set criteria of ±0.2 and the hypothesis is, therefore, considered to be substantiated.

Hypothesis 6. The hypothesis states that house price in Windsor varies directly with the percentage of children under 18 years of age (PU18) in each census tract. This hypothesis is intended to determine whether a large concentration of children in a neighbourhood has any effect on house price. According to the literature, the number of children in a family is directly associated with the dwelling size. Consequently, those findings also reflect that the larger the number of children of a neighbourhood, the higher the house price of that area.

The $r$ of 0.267 is obtained which is greater than ±0.2. This hypothesis is therefore accepted in that the association between house price and percentage of children under 18 years of age is significant and direct in nature.
Hypothesis 7. It has been hypothesized that house price in Windsor varies inversely with the percentage of elderly over 65 years of age in each census tract. This hypothesis is derived to examine the spatial patterns of elderly concentration in urban area and their influence on house price. An examination of the literature reveals that the concentration of elderly population generally associated with cheap and older housing units near the city center. A large concentration of elderly persons would therefore have a negative effect on the real estate values of that area. Consequently, one would expect that the larger the proportion of elderly in an area, the lower the house price of that neighbourhood.

Since the computed correlation of coefficient is greater than ±0.2 (r = -0.244), the relationship between house price and the percentage of elderly over 65 years of age in each census tract is considered to be significant and inverse in nature. This hypothesis is thus accepted.

Hypothesis 8. The hypothesis states that there is a direct association between house price in Windsor and the percentage of married female in the labour force of each census tract. This hypothesis attempts to reinforce the economic characteristics of a family in each census tract. It is assumed that generally a double income family supplemented by a working housewife in the labour force
would enable such a family to finance a basic shelter or even a better quality house. In this regard, one would expect that the greater the percentage of married females in the labour force of an area, the higher the house price of that area.

The result is \( r = 0.266 \) which appears to be greater than the set criteria of 0.2. It is to be concluded that the percentage of married females in the labour force does have a significant and direct influence on house price in Windsor. Therefore, this hypothesis is accepted.

The results of this investigation showed that all the variables were significantly correlated with house price and have the right sign. The findings of the hypotheses thus supported many previous research findings in housing market analysis.

**Interpretation of the Model**

The estimates obtained from stepwise regression analysis on house price for Windsor are shown in Table 2. The regression explained 54 percent of the variation in house price of all sales of single-family detached dwellings during the first quarter of 1979. All the variables are significant and nearly all of them have the expected sign. Of the eight independent variables, two house related variables associated
Table 2: A Summary of Stepwise Regression Analysis on House Price for Windsor.

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable Entered</th>
<th>$R^2$</th>
<th>$R^2$ Change</th>
<th>b Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$X_1$ LS</td>
<td>0.324</td>
<td>0.324</td>
<td>164801.70</td>
</tr>
<tr>
<td>2</td>
<td>$X_2$ AFI.</td>
<td>0.471</td>
<td>0.147</td>
<td>2.21</td>
</tr>
<tr>
<td>3</td>
<td>$X_2$ NB</td>
<td>0.532</td>
<td>0.061</td>
<td>6677.89</td>
</tr>
<tr>
<td>4</td>
<td>$X_8$ MFLF</td>
<td>0.539</td>
<td>0.008</td>
<td>279.29</td>
</tr>
<tr>
<td>5</td>
<td>$X_5$ FS</td>
<td>0.541</td>
<td>0.002</td>
<td>5159.45</td>
</tr>
<tr>
<td>6</td>
<td>$X_4$ PD</td>
<td>0.542</td>
<td>0.001</td>
<td>182.02</td>
</tr>
<tr>
<td>7</td>
<td>$X_6$ P065</td>
<td>0.543</td>
<td>0.001</td>
<td>110.05</td>
</tr>
<tr>
<td>8</td>
<td>$X_7$ PU18</td>
<td>0.543</td>
<td>0.000</td>
<td>95.34</td>
</tr>
</tbody>
</table>

( Constant ) -65181.42

Source: Author.
with space and one social-economic variable, average family income, are responsible for almost all (53 percent) the explained variance in the model.

The first variable to enter the multiple regression equation was lot size (LS). That is, the total parcel of land on which the dwelling is sited. The result is $R^2 = 0.324$, indicating that this variable alone already explained about one-third of the variance in relative house price in Windsor. Consequently, this house related variable is an important determinant of house price as previously revealed by Carvalho et al. (1976), Massell and Stewart (1971), and Grether and Mieszkowski (1974).

The average family income (AFI) of the census tract was the second variable added to the regression equation. This produced a $R^2$ of 0.471, which increases the explained variance by another 14.7 percent. The relationship has been found to be positive as expected and the social-economic status of a neighbourhood measured by the average family income variable does indeed have a significant and direct influence to the real estate values in Windsor. Hence, the first two variables already accounted for almost half of the total variance.

In the third step, the number of bedrooms (NB) of the dwelling was added to the regression equation and a $R^2$
of 0.532 was obtained. This variable adds an increment of another 6.1 percent to variation already explained by lot size and average family income. The relationship between the number of bedrooms and house price is positive as predicted, which indicates that with the increase of dwelling size reflected by the number of bedrooms, the house price increases. This variable, thus, supported past research findings that the size of a dwelling is one of the key determinant of house price (Kain and Quigley, 1970; Van Lierop, 1980).

The remaining variables entered into the regression equation in step 4 to step 8 inclusive are: married female in the labour force (MFLF), family size (FS), population density (PD), population over 65 years of age (P065), and population under 18 years of age (PU18) respectively. However, those variables added only minutely to the increase in $R^2$ as shown in Table 2. It is, therefore, concluded that in association with the first three most important variables, the remaining variables have virtually no significant contribution to the determinant of house price in Windsor.

Consequently, the final regression equation can be reduced to consist of only the initial three variables which already accounted for almost all the variation in house price. The revised model for the estimated house price in Windsor at large is thus:
\[ HP' = -65181.42 + 164001.70 \text{ IS} + 2.21 \text{ AFI} + 6677.89 \text{ NB} + e \]

where:
- \( HP' \) = Estimated house price;
- \(-65181.42\) = Constant;
- IS = Lot size in acres;
- AFI = Average family income of each census tract, in dollars;
- NB = Number of bedrooms; and
- e = Errors.

With a similar approach as in the overall model, the results for the various house price markets in Windsor were obtained as presented in Table 3. It appears that the explanatory power for the sub-models are quite low in which the \( R^2 \) ranged only from 0.15 to 0.24.

Coefficients of determination for the stratified models were thus consistently lower than that of the unstratified model, indicating that, in general, the overall model is a relatively better device for the analysis of housing prices in Windsor.

**Analysis of the Beta Weights**

To determine the relative importance of the independent variables in varying the dependent variable for
Table 3: Regression Models of House Prices for the Overall and Different House Price Markets in Windsor.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Windsor</th>
<th>Low House Price</th>
<th>Medium House Price</th>
<th>Medium-high House Price</th>
<th>High House Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$ LS</td>
<td>164801.70</td>
<td>28010.46</td>
<td>43799.94</td>
<td>17791.42</td>
<td>40897.88</td>
</tr>
<tr>
<td>$X_2$ NB</td>
<td>6677.89</td>
<td>145.01</td>
<td>1446.70</td>
<td>1510.43</td>
<td>11612.19</td>
</tr>
<tr>
<td>$X_3$ AFI</td>
<td>2.21</td>
<td>0.09</td>
<td>1.00</td>
<td>0.24</td>
<td>0.54</td>
</tr>
<tr>
<td>$X_4$ PD</td>
<td>182.02</td>
<td>-100.50</td>
<td>169.27</td>
<td>109.30</td>
<td>840.32</td>
</tr>
<tr>
<td>$X_5$ FS</td>
<td>5159.45</td>
<td>14319.44</td>
<td>-1676.76</td>
<td>3904.47</td>
<td>9285.65</td>
</tr>
<tr>
<td>$X_6$ PUL8</td>
<td>95.34</td>
<td>-816.17</td>
<td>269.20</td>
<td>139.29</td>
<td>-615.67</td>
</tr>
<tr>
<td>$X_7$ P065</td>
<td>110.05</td>
<td>-125.01</td>
<td>58.79</td>
<td>30.15</td>
<td>-413.21</td>
</tr>
<tr>
<td>$X_8$ MFLF</td>
<td>279.29</td>
<td>152.04</td>
<td>-60.93</td>
<td>202.70</td>
<td>-214.22</td>
</tr>
<tr>
<td>Constant</td>
<td>-65181.42</td>
<td>-10954.41</td>
<td>10317.90</td>
<td>20031.67</td>
<td>26881.99</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.54</td>
<td>0.15</td>
<td>0.20</td>
<td>0.24</td>
<td>0.20</td>
</tr>
<tr>
<td>No. Observations</td>
<td>635</td>
<td>42</td>
<td>379</td>
<td>153</td>
<td>61</td>
</tr>
</tbody>
</table>

Source: Author.
the various house price markets in Windsor, the net regression coefficients are standardized. This procedure is essential because not all the independent variables have the same unit of measurements. The standardized regression coefficients would then be the beta weights and the constant term would always be zero. Thereupon, the beta weights reflect the degree to which a change in one standard deviation of the independent variable will generate a change in the standard deviation of the dependent variable.

The beta weights for the overall and different house price markets in Windsor are shown in Table 4. The results indicate a variation in the relative importance of the independent variables with respect to the various house price markets identified. The findings thus suggested that certain factors are relatively more important in one house price market than another.

In view of the overall housing market in Windsor, the beta weights indicate that lot size (LS) is the most closely associated with house price, followed by the average family income (AFI) and the number of bedrooms (NB). The remaining variables provided limited explanation to the determinant of house price.

As expected, the findings revealed that in valuation of house price, the consumers are generally most concerned
Table 4: Beta Weights for the Overall and Different House Price Markets in Windsor.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Windsor</th>
<th>Low House Price</th>
<th>Medium House Price</th>
<th>Medium High House Price</th>
<th>High House Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>LS</td>
<td>0.44</td>
<td>0.23</td>
<td>0.25</td>
<td>0.17</td>
</tr>
<tr>
<td>$X_2$</td>
<td>NB</td>
<td>0.25</td>
<td>0.03</td>
<td>0.17</td>
<td>0.16</td>
</tr>
<tr>
<td>$X_3$</td>
<td>AFL</td>
<td>0.34</td>
<td>0.05</td>
<td>0.37</td>
<td>0.15</td>
</tr>
<tr>
<td>$X_4$</td>
<td>DLD</td>
<td>0.05</td>
<td>-0.15</td>
<td>0.17</td>
<td>0.09</td>
</tr>
<tr>
<td>$X_5$</td>
<td>FS</td>
<td>0.07</td>
<td>0.84</td>
<td>-0.07</td>
<td>0.17</td>
</tr>
<tr>
<td>$X_6$</td>
<td>PUL8</td>
<td>0.04</td>
<td>-1.22</td>
<td>0.28</td>
<td>0.14</td>
</tr>
<tr>
<td>$X_7$</td>
<td>P065</td>
<td>0.03</td>
<td>-0.19</td>
<td>0.07</td>
<td>0.03</td>
</tr>
<tr>
<td>$X_8$</td>
<td>MFLF</td>
<td>0.08</td>
<td>0.16</td>
<td>-0.06</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Source: Author.
with the amount of space that they are getting both inside and outside as reflected by the lot size and number of bedrooms. The other major concern is affordability which is determined by the economic characteristic of a family in selecting a particular house associated with a desirable neighbourhood. As a result, the house related variables and economic variable proved to be the most important factors in the explanation of house price for Windsor as a whole.

In the low house price market, however, the independent variables that explained most in varying house price are different from that of the overall housing market. Population under 18 years of age (PU18) seems to carry the heaviest weight but the direction of correlation is negative which is opposite to that hypothesized. The explanation for this unexpected sign is, perhaps, that in order to support a large number of children in a family, such a family could only afford a less expensive house. In addition, the attitude toward desirable family size may have little to do with family income level.

The next most important variable is the family size (FS) which seems to conflict with the former interpretation. This could nevertheless be true if a family has sufficient income to acquire a bigger house for the large family. The size of the lot (LS) is also of prime consideration as in the overall housing market.
There are also a few less important factors characterizing this house price market and the variables concerned are the population over 65 years of age (P065), married female in the labour force (MPLF), and population density (PD) respectively. It is apparent that the population over 65 years of age is negatively associated with house price. This supported the phenomenon that concentration of elderly population are generally associated with older and cheaper houses nearer to the city center. A large proportion of married females in this house price market is expected to be in the labour force because a family in such a low house price bracket is likely to need an extra income to help subsidize payment for the house. Moreover, the population density has a negative correlation as expected.

For the medium house price market, the average family income (AFI) turns out to be the most important variable, followed by the population under 18 years of age (PU18) and lot size (LS). The other variables of less importance are the number of bedrooms (NB) and population density (PD) while the remaining of the variables are of little importance.

The results indicate that as the house price increases to the medium price range ($25000 to $49999) as identified, the economic characteristics of a family is of major consideration in light of affordability. This house price market also
reflects that as the number of children increases in a family, it would generate a desire for additional space. Consequently, lot size and dwelling size as well as the number of children in a family are vital house related and neighbourhood variables in the determinant of house price. The population density nevertheless exhibits a positive relationship with house price. The explanation for such a behaviour could be that the majority of those houses in the medium price range are located within the vicinity of the city center where they are normally zoned higher density than those in the periphery.

As seen in Table 4, the medium-high house price market revealed that married female in the labour force (MFLF) to be the most important variable. This may be explained by the fact that to be able to afford a more expensive house in the $50000 to $69999 price range, a family must have substantial income to cover for the mortgage payment. Moreover, with the continuous rising cost of living reflected by today's economy, more housewives are expected to be in the labour force in order to improve or just to maintain their standard of living.

The other variables of relative importance in this house price market are family size (FS), lot size (LS), number of bedrooms (NB), average family income (API), and the population under 18 years of age (PU18).
It appears that house price in the high house price market is related primarily to the dwelling space as measured by the number of bedrooms (NB). This is quite logical that if one can afford an expensive house, it is generally the size of the dwelling that is of major concern. In another words, only the rich can afford the luxury of ample living space and they are normally located in the periphery as seen in Figure 7.

The population under 18 years of age (F18) is the second most important variable in this house price market but it has a negative relationship with house price which is opposite to that generally hypothesized. The probable explanation for this outcome may be that the consumers in this expensive housing market tend to prefer a larger house regardless of the number of children they have. Moreover, as Statistics Canada (1976) shows that the upper house price market families in the periphery have fewer children than those families in the lower house price category nearer the city center and that perhaps explained part of the negative relationship with house price.

As expected, the outside space in terms of lot size (LS) is of relative importance as well. It is probably due to the fact that lot size is closely associated with dwelling size and therefore in view of the consumer behaviours, they would generally prefer a larger lot. Although the population
density (PD) has the same beta weight as the lot size, it indicates a positive relationship with house price which is rather confusing. This finding was unexpected because of the emphasis on the early theory of urban population densities and urban land use suggesting an inverse relationship between house price and population density.

However, further analysis of the population density variable in this house price market appears to shed some light on its unusual behaviour. A probable explanation may be that a greater intensity of mixed residential land use existing on the east side of the city (CT* 18, 19, 20, 41, 42 & 43) increases its population density, thereby causing a diluting effect to the association between house price and population density which resulted in a direct relationship. This is evident in Table 5 showing the beta weights of population density for the high house price market and its subareas in Windsor. In spite of the limited importance of the population density variable in "East" Windsor, it nevertheless exhibits a positive sign which suggested that some high house price areas do indeed associate with relatively high population density as reflected by its mixed residential land use. In this regard, the relationship between house price and population density is thus deviated from the general norm.

*For reference of the census tracts, see Appendix A.
Table 5: Beta Weights of Population Density for the High House Price Market and its Subareas in Windsor.

<table>
<thead>
<tr>
<th>Area</th>
<th>Population Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>High House Price Market</td>
<td>0.14</td>
</tr>
<tr>
<td>&quot;East&quot; Windsor (CT 18,19,20,41,42 &amp; 43)</td>
<td>0.01</td>
</tr>
<tr>
<td>&quot;South&quot; Windsor (CT 1,2,3,5,6,8,10,11,13,16 &amp; 29)</td>
<td>-0.13</td>
</tr>
</tbody>
</table>

Source: Author.
On the contrary, "South" Windsor (CT 1,2,3,5,6,8,10, 11,13,16 & 29) appears to have a relatively homogeneous low density neighbourhoods. The beta weight shows an inverse relationship between house price and population density and the finding, thus, complies with the general norm as confirmed earlier in Hypothesis 4.

The less important variable in this expensive housing market is the population over 65 years of age (P065) and the rest of the variables are of little importance.

In examining the beta weights for the various house price markets in Windsor as illustrated in Table 4, it can be seen that the relative importance of various factors accounting for the variations of house prices varied from one house price market to another. However, it is worth noting that in spite of their differences, space and social-economic status of the neighbourhood appeared to be consistently more important than other variables in general.
CHAPTER V

CONCLUSIONS

In this final chapter, a summary of the findings of the present study is presented. Following this section is a discussion of the limitations of this study and finally this chapter concludes with some remarks and observations on future research.

Summary of the Findings

The first objective of this study was to evaluate the existence of the relationship between house price and a set of housing and neighbourhood attributes in Windsor. The results of the analysis revealed that all the variables were significant and have the expected sign. The following variables thus supported previous research findings in housing market analysis: (1) lot size, (2) number of bedrooms, (3) average family income, (4) population density, (5) family size, (6) population under 18 years of age, (7) population over 65 years of age, and (8) married female in the labour force.
The second objective of this study was to determine the relative importance of selected housing and neighbourhood parameters for the prediction and estimation of house price in the Windsor housing market, and to identify and compare the main features in the various house price markets. The findings of the analysis indicated that the aggregate model is capable of explaining 54 percent of the variation of house price in Windsor. However, of the eight independent variables, three already accounted for almost all the total variance (53 percent). As a result, the regression model for the estimation of house price in Windsor at large can be reduced to consist of the three variables as follows:

\[ HP' = -65181.42 + 164001.70 \times (LS) + 2.21 \times (AFI) + 6677.89 \times (NB) + e \]

where \( HP' \) is the estimated house price, \(-65181.42\) is the constant, \( LS \) is the lot size in acres, \( AFI \) is the average family income of each census tract in dollars, \( NB \) is the number of bedrooms, and \( e \) is the error term.

The stratified models for the different house price markets were found to have consistently lower explanatory power (\( R^2 \) ranging from 0.15 to 0.24) than the overall model. The findings thus supported the continued use of the unstratified model in the analysis of housing market in Windsor.
The analysis of beta weights revealed that the relative importance of various attributes varied from one house price market to another in Windsor. It should nevertheless be noted that despite their differences, the variables associated with space and social-economic status of the neighbourhood proved to be most important in the valuation of house price.

**Limitations of the Study**

This study has been an attempt to explain housing values using information on selected housing and neighbourhood characteristics in which the house is located. The empirical results on the determinants of house prices for Windsor as a whole can be considered satisfactory, particularly in the overall model whereby three variables are already capable of explaining more than half of the variability of house prices. However, it should be noted that there are still many limitations on the data. The factors involved in the explanation of house prices in the Windsor housing market can therefore be used as a guideline hereafter in selecting other variables in house price studies.

It is obvious that the variables employed in the model by no means exhaust a list of all the possible attributes. This implies that the determinants of spatial variations of house prices in this study is incomplete for it is virtually
impossible to completely specify all the factors influencing the house price. Moreover, the specification ignores the location and environmental characteristics of the neighbourhood. Hence, there is always a possibility that an important variable may be omitted from the analysis which would affect the explanation of house price in Windsor.

Another problem of this study is the aggregation of neighbourhood data at census tract level. The averaging process could easily obscure important variations because not all census tracts represent homogeneous neighbourhoods. Consequently, such study may lead to serious distortions in the research findings.

Conclusions

The results of this study indicated that the market-wide model is basically a better device for the analysis of real estate values in the Windsor housing market. The findings also reconfirmed that space and social-economic characteristics of the neighbourhood were significant contributory factors in the explanation of house price in Windsor. However, among the findings, the inconsistency of the association between house price and population density may perhaps warrant further investigation.

The availability of data is essential in future
research if the determinants of house prices are to be predicted with a certain degree of accuracy. Ideally, individual household data is preferred over aggregate data because the former yields better results. Hence, it is recommended that in future house price studies of Windsor, a sample of purchased single detached houses extracted from the multiple listing services for a particular year be used to collect individual household data through a mailed questionnaire. Such inductive approach will be able to measure the direct effect of environmental perceptions of a particular household, thereby enhancing the locational determinants of urban house prices.

An extension of this study can also be carried out to examine the behavioural and temporal factors in light of how individuals, groups of people, and institutions segment the housing market. It is hoped that further studies would assist the future development of systematic submarkets areas.

It is also felt that ongoing analysis of housing market is necessary because the perceptions and values of desirable neighbourhoods and housing choices of the population develop through time in any community.
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