HEDONIC PROPERTY VALUATION USING GEOGRAPHIC INFORMATION SYSTEM IN HONG KONG

by

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ABSTRACT

Hedonic Property Valuation With Geographic Information System in Hong Kong

Housing, as a complex issue, has drawn prolific literature from various disciplines of which the most popular area lies in property valuation with a well-established hedonic price methodology. Though other housing problems in Hong Kong have been addressed by many scholars, studies focusing on the spatial importance of property price determination and the patterns of private dormitories development are scanty. This research is a prototype study using Geographic Information System (GIS) to improve the conventional hedonic price methodology in Hong Kong. Therefore, this research has two major foci : (1) to explain the new residential development with respect to urban plans and (2) to identify the variables that affect property valuations. While the former objective is achieved through cartographic analyses, the latter is fulfilled statistically. GIS is important to the real estate database construction of this research. The derivation of proximity measurements and overlay functions have facilitated an efficient and accurate association of each price records with its parameters. Nevertheless, its superiority in presentation and integration of data and results should not be neglected.

Housing development has corresponded with the peaks and troughs of the investment environment. Floor space has experienced a continual decline while the property price continued to soar across the years. Spatially, new residential

development has shifted towards the new towns in the form of medium-sized, comprehensively designed estates. In response to the increasing volume of trade with China, future plans have targeted for these new towns where land resources are readily available. Relative importance among them hints the different stages of development in which they are at. Balanced with this new town residential development are pencil-typed buildings and comprehensively designed estates at the urban core. While the previous examples are evidences of fragmented, small-scale urban renewal, the latter one involves the conversion of land use which is owned by a single entity. Another interesting pattern of housing supply is noted - dominance of a particular district in different years as a result of the 'stage-wise' selling practice among developers, which is similar to agglomerative economics.

Hedonic price studies have been used to examine the consumers' willingness to pay for diverse parameters, in both pooled and submarket levels. Selected variables were chosen to represent the structural, locational and neighborhood traits for the hedonic price models in 1991. The overall results confirmed the non-linearity of the hedonic price function. At the pooled market level, landuse characteristics and socioeconomic descriptors are significant to explain 43% of the property price variability while the submarket results have proved similar importance of employment potentials, school quality, landuse and socioeconomic variables with the explanatory power ranging from 0.46 to 0.75. It is apparent that both locational and neighborhood parameters dominate in the hedonic price models in Hong Kong market.

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CHAPTER I

INTRODUCTION

1.1 Problem Statement

It is a common consensus that mankind need shelter. Housing provision is the obligation of a government or the involvement of private sector is needed to widen the variety in terms of quality. Being an important item on the national agenda of all countries, it has caught much academic attention over the years.

Housing constitutes a diverse study area for researchers. It is exactly because of its multi-dimensional and heterogeneous nature that has drawn prolific studies on the issue. One of its most popular area of investigation is housing price analysis. Hedonic price study aims at disentangling the possible effects certain parameters have on property valuation. Numerous achievements have been noticed from the sea of literature which will be examined in detail in Chapter II. They succeed in finding out the implicit valuations consumers put upon the structural, locational and neighborhood traits of a property. The hedonic price function is able to single out the effects of selective variables in accordance with the theme of each research. More advanced analyses involve the comparisons among different groups of premises or users (submarkets). On the whole, the model is based on the rationale that housing, being physically immobile, is bound to capture the utility or characteristics from its surroundings - physical, social, economical or even locational settings which are all

crucial in affecting the property price. It is noticed that the locational characteristics or even the residence neighborhood in which the building is located render a geographical perspective indispensable to housing price studies.

Hong Kong is famous of her congested living conditions. As will be demonstrated, it is not really a shortage of land that forms the packed city structure; rather, restricted by its rugged relief, not much suitable land can be used for accommodation. What makes the housing problem more imperative is her success of being an international financial and commercial center. Urban activities have been, and will be, in intense competition for land with residence according to her rapid pace of urban expansion. Thus, the property value in the territory is sky-rocketing across years which portrays the real estate sector a rewarding investment arena. Thus, the urban plans or activities have been believed to exert influence on the type, locational pattern and attributes of housing development.

Housing studies concerning the affordability or impacts of fiscal policies have been continually explored (eg. Chou & Shih 1994). Works ranging from the evaluation of public housing policies or their spatial impacts, historical account of residential development or even, squatter clearance implications have been done by geographers who are more concerned with the spatial effects of different forms of residential development (Drakakis-Smith 1973; Wong 1978; Pryor 1983; Smart 1992). Certainly, the interesting topic of housing price studies has also been studied. Even though hedonic price model has been widely applied with much success (eg. Michaels & Smith 1990, North & Griffin 1993), not much has been done in Hong

Kong. Mok, Chan & Cho (1995) have only performed analyses on the overall hedonic price for existing premises. There has been no attempt to provide an explanation of how the provision of housing in space change with time. Furthermore, it seems that the locational importance of hedonic price study has not been studied in great detail. Submarket level analyses are missing too. Therefore, this research attempts to conduct a more holistic approach to the housing provision in Hong Kong in two major aspects. First, hedonic price analysis is performed on both pooled and submarkets sector. Second, residential development in terms of spatial pattern on location and attributes of newly constructed premises in a dynamic urban setting are studied. While the first attempt can fill up the gap in hedonic price studies in Hong Kong, the latter one provides a critical examination on the relationship of housing and urban development.

To find out the implicit valuations of the end-users, only the newly issued premises from 1991 to 1994 and their price are used for analysis so as to avoid any speculative impacts from the second hand market. Furthermore, it is these new residential development that react or respond towards the future trends of urban development.

1.2 Role of GIS in Housing Price Study

Even though the statistical technique concerning hedonic price studies is quite well-established, there is not much attempt in applying GIS in related studies. GIS is an excellent tool for hedonic price anlaysis with its ability to integrate and derive a

large bulk of structural, locational and neighborhood variables associating with housing price. While direct associations with manual effort are prone to unnecessary errors, the overlaying function of GIS improves the situation by relational joining, generating clear linkages and new information. Specifically, its flexibility in data association and retrieval facilitates the database constructions from which statistical analyses are performed. Apart from efficient database constructions, its ability in map generation also helps in revealing patterns or results for qualitative discussions. Cartographic analyses on the spatial or temporal variations on one or more variables are possible which helps us to ask relevant questions and depict distinctive findings.

1.3 Research Objectives

The goal of this research is to study hedonic property valuation in Hong Kong using GIS techniques from which an understanding of housing development can be enhanced. Specifically, this study carries the following foci :

(1) to construct a real estate database for spatial analyses in Hong Kong;

(2) to reveal the pattern of housing locations in relation to urban development;

(3) to study the relation of residential price with a number of predictors (overall) and

(4) to examine if there are any differences among groups of premises (submarkets)

1.4 Significance

Even though conventional hedonic price methodology is well-established, this research is a first attempt that tries to incorporate the use of Geographic Information System (GIS) into hedonic price studies in Hong Kong, demonstrating an alternative approach to study the issue in a more efficient and accurate manner.

This research also initiates to uncover the spatial and temporal patterns of housing stock and its attribute changes in Hong Kong within the year 1991 to 1994. It also tries to ascertain the impacts of urban development on residential development. Through examining the pattern of newly issued residential premises rather than existing ones, it is intended to show how they react towards urban development trends or planning rationale of the government. This research not only provides an urban perspective on the issue but also the importance of private and public sectors in housing provision is made known. Possibly, the locations or attributes of private dormitories are much more affected by the private developers.

Moreover, hedonic price analyses lead to the identification of factors affecting different type of residential premises. Since the type of users (end-users and investors) and developers (large versus small) in this local market is more complicated than those in the west, it is expected that the hedonic price models developed should be different. That is to say, some proven variables may be suppressed while new sets of relationships may be revealed under different market conditions.

1.5 Methodologies

Uncovering the knowledge on the above-mentioned objectives requires both qualitative and quantitative analyses to be used in this research. It is of utmost importance to have a spatial database for all analyses to perform. Hedonic price studies involve not only the attributes of housing but also its locational and neighborhood parameters. Each record of the database comprises residential price and its floor size, distances to the railway networks, recreational facilities and cemeteries, employment attraction of the property, the *in situ* socioeconomic status, landuse mix and finally, the school quality of the neighborhood. While some of these variables are at hand, many more have to be derived or measured with models. GIS does offer an advantage in derivations and associations among variables. For instance, proximity measurements are carried out with ease; relational join among records or parameters are well-defined. Therefore, the construction of database for statistical analysis can be achieved efficiently with the help of GIS.

To reveal the pattern and direction of residential development in Hong Kong, it is better to rely on qualitative analyses. With GIS, simple descriptive statistics and maps depicting the locational pattern render cartographic analyses possible. It reveals the temporal and spatial variations of housing stock and its attributes. To determine which factors are affecting the price variation among premises, hedonic price function is the principal technique employed. It is a regression model that relates price with its structural, locational and neighborhood attributes. Through this technique, relative importance of significant factors can be identified.

1.6 Organization of Thesis

The coming 6 chapters are going to examine the theoretical background, methods, results of using GIS in hedonic price studies in Hong Kong.

In Chapter II, the theoretical base of housing research is discussed. Then, illustrations of past efforts in model-building with various variables and controversial issue like functional forms are provided. The scale of analysis is just as crucial and hence, the importance of submarket analyses and its delineation rationale are briefly discussed.

In Chapter III, the general information on the real estate sector in Hong Kong is introduced, pointing out its relative importance in housing provision for her population. After that, residential development in terms of type, location, pattern, price and floor space are described. It gives a general impression of the market situation in Hong Kong and the changes occurred in time and space. Guided by voluminous literature, the research methodologies are ascertained and reported in this chapter.

In Chapter IV, the details of data collection and input are reviewed. Particular reference is made to the derivation and manipulation of variables used in this research which facilitates later interpretation on results and discussions. It is demonstrated that with the use of GIS, it is possible to build up the statistical and attribute database for further spatial analyses.

In Chapter V, the representation of raw data by GIS is shown with brief description on each variable. Temporal pattern of housing development, its provision and characteristics are then described. After this section, with the help of maps and descriptive statistics, the locational pattern of residence, spatial differences in property price and residence type are revealed with explanations from an urban perspective.

In Chapter VI, the hedonic price function is adopted for examining the factors affecting property price at the pooled and submarket levels. For each case, the performance of the models are compared and examined if the model can be applied successfully in all markets.

Chapter VII is a concluding section. It will first summarize the major findings in this research. Then the limitations are outlined and suggestions for further studies are provided.

CHAPTER II

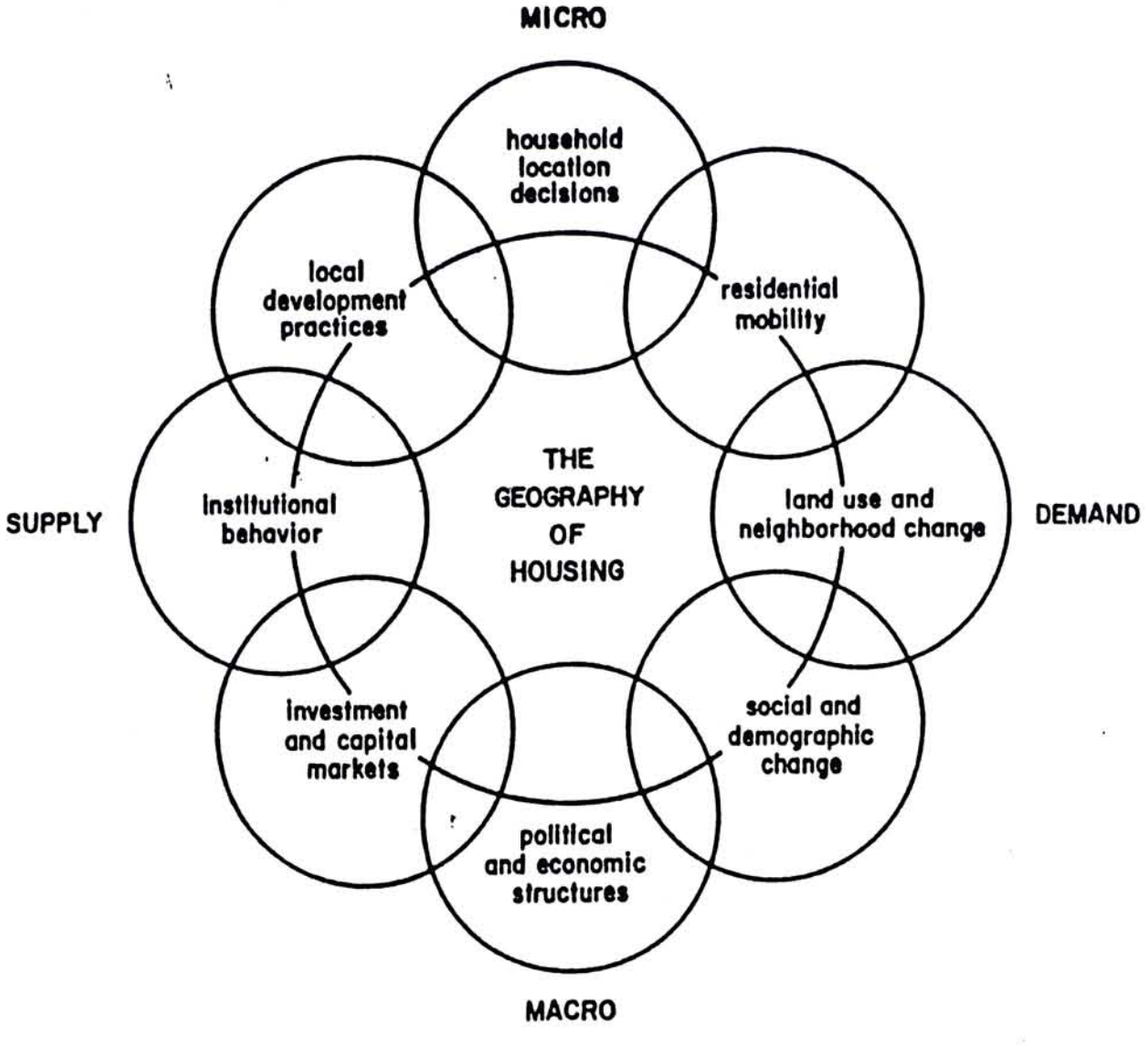
LITERATURE REVIEW

2.1 Introduction

In this chapter, previous attempts in housing geography are presented where the complexity of housing is highlighted. Then the second part deals with housing price studies in which the hedonic price methodology is commonly applied. The variables and its functional forms are discussed. It then proceeds onto the discussion of submarket analysis. Therefore, the final section deals with an introduction to GIS and its adoption in real estate sector, with special reference to hedonic price analysis.

2.2 Geography of Housing

Geography of housing can be approached in various scales with diversed interests of researchers. Different areas of interests are interwoven as depicted in Figure 2.1. All these spheres are of unequal importance to different disciplines. While investment market is the major concern of economists, they have addressed issues ranging from investment cycle in shaping the rise and fall of construction cycles to the cost of infrastructure affecting housing supply (Stover 1986, 1987; Follain 1979; Nellis & Longbottom 1981; Hajdu 1994).



source : Bourne (1981) p.10

Figure 2.1 Interwoven spheres of studies of the geography of housing

To geographers, various urbanization levels are associated with different economic structures. Spatial substitution between core and peripheral areas is one of the many outcomes being studied (Rima, Van Wissen & Nijkamp 1987; Leushacke & Wegener 1987). Geographers also take a social perspective in housing provision analyses. There are works that evaluate government housing policies and its implications. Possible social segregation is visualized in distinct residence neighborhood. Badcock (1994) examines the transfer of housing wealth in relation to social equity among regions. Knox (1995) also approaches housing problem along similar line of thoughts.

While the above issues are more macro in scale, housing can be dealt with in a more detail manner. There are abundant literature investigating life-cycle stages with residential mobility (Engelhardt & Poterba 1991; Myers 1990; Davies & Pickles 1985). Social trend like unbundling of households and female labor participation in the work force also has implication on housing type (Clapp 1987; Rudel 1987). For example, the demand for smaller-sized apartments rather than detached units will increase. Thus, all spheres of study are inter-related and the ultimate outcome of these interactions give rise to another area of research : housing price study (Bourne 1981) which has drawn voluminous literature.

2.3 Housing as a Research Question

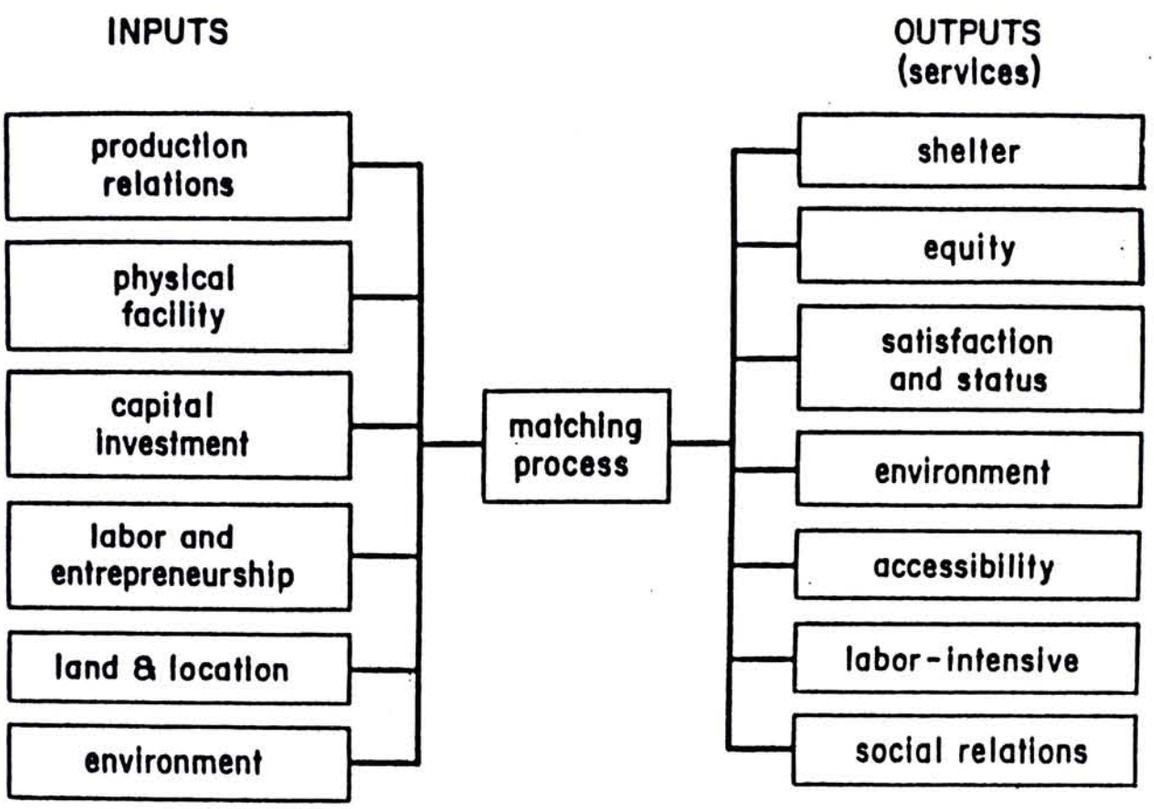
Housing is both as simple and as complex for one to understand. In daily conversations, it is referred as 'shelter' in its simplest connotation (Kemeny 1992). In

this case, it entails a stock concept. However, consumers do not just purchase the 'bricks and mortar' but also derive utilities from it. Housing then becomes something non-physical. Pozdena (1988) adds that housing can be treated as a continuous flow of 'services' to its users (Figure 2.2). From utilizing and owning the housing structure, psychological importance of 'wealth' (Rothenberg, Galster, Butler & Pitkin 1992; Bourne 1981; Smith 1970) and privacy (Smith 1970) are ascertained. Thus, possession of a dormitory also reflects the quality of life as well as the socioeconomic status of the users. That is why housing means more than just residence.

Researchers have to admit that in terms of structural parameters, housing is already a heterogeneous commodity. Since it is fixed in location, it then postulates interwoven spheres of influence between the house and its surroundings - locational and social settings (Pozdena 1988; Kemeny 1992). Complex as it may seems, the problem is further complicated by the fact that it is rooted within the institutional framework and economic arena in which the housing market is operating (Bourne 1981). This definition further hints the relationship of housing and its surroundings, the latter renders a geographical perspective in housing studies.

2.4 Housing Services and Housing Price

Housing is well-recognized as a heterogeneous commodity that comprises bundles of site and residence attributes, producing services to different groups of occupants (Megbolugbe 1989; Mehta & Mehta 1989). There are attempts to simplify what housing is and there is a consensus that "..... housing ..... (is) an irreducible



source : Bourne (1981) p.15

Figure 2.2 The flow of housing services

"vectors of attributes" ..... describing the dwelling's structural, quantitative and qualitative features, neighborhood attributes, public services and accessibility " (Rothenberg, Galster, Butler & Pitkin 1991 p.14)

The property price that consumers paid reflects their implicit valuation or willingness to pay on these attributes. Therefore, the traits of structural, locational and neighborhood are related to property price valuation which then form the basis for statistical analysis (e.g. hedonic price methodology) to apply.

2.5 Property Price Valuation

To reveal implicit valuations consumers place on these attributes, different researchers employ different techniques. For instance, Mozolin (1994) first runs a regression of dwelling value on accessibility. The residual of the equation and the socioeconomic status of neighborhoods (derived from factorial ecology) are then undergone a correlation analysis. It then confirms part of the explanation of price differences is attributed to socioeconomic constituents. Finally, mapping the overpredicted and underpredicted areas of residual reveals that the rest of the housing price differences is accounted by the impact of amenities.

In another attempt to study the intra-metropolitan price changes over time, Cadwallader (1993) employs a combination of techniques like correlation analysis, discriminant analysis and finally, models the inter-relationships between characteristics of cities and housing values through simultaneous equation model.

Other than those described, Follain and Jimenez (1985) have taken stock of literature and examine the common estimation techniques in analyzing housing price. They identify five major categories : simple hedonic approach, two-step approach, bid-rent approach, index approach and finally, discrete choice approach; each having its strengths and flaws. Among them, the most frequently used methodologies are the simple hedonic and index approach.

2.6 Hedonic Price Function

Hedonic price modeling is potentially applicable to any commodities that can be differentiated in the eyes of the users (Kulshreshtha & Gillies 1993). Housing is regarded as a goods that can be differentiated by vectors of attributes and thus, application of this technique is not uncommon.

Housing, as redefined, consists of a bundle of utility generating attributes rather than a single-attribute commodity. In order to reveal the underlying valuations of consumers, multivariate regression technique is sought. Thus, to regress the housing value on its structural, locational and neighborhood bundles of traits is commonly referred as the 'hedonic price analysis' (Goodman 1978; Linneman 1981; Gatzlaff & Ling 1994). The general form of hedonic price model is

$$P = f(S, L, N) \qquad (2.1)$$

where P = dependent variable, price

S = vectors of structural variables

L = vectors of locational variables

N = vectors of neighborhood variables

The coefficients derived from the hedonic equation is referred as the 'hedonic price' and interpreted as the 'shadow price' (Heikkila, Gordon, Kim, Peiser, Richardson & Dale-Johnson 1989).

2.6.1 Dependent Variable - Property Price

In principle, the dependent variable of the hedonic function is property value. However, different research propose different forms of 'price' in their analyses. Its choice depends mainly on the data quality and availability. A common representation is the sales price of a property as it is also the most easily available measure. Sometimes, land price is used while at other times, rent is usually consulted when the submarkets are stratified into renters and owners (Jud & Watts 1981; Linneman 1980). Where a change of residence indicates additional price consumers paid for upgrading housing service quality, concepts like 'premium' has been used as the dependent variable (Smith 1978).

2.6.2 Independent Variables Affecting Housing Price

Since not a single variable is sufficient to act as an explanatory factor towards price, lists of variables have been complied for real estate practitioners in property appraisals (Clapp 1987; Unger 1982). Yet, they fail to point out an important aspect that governs housing price differences - location. Locational differences in terms of scenery, topography and other elements are apparent. It is the consumers' perceived importance among these elements that gives forth to a range of property values.

Price is usually decomposed into two categories of factors : spatial and aspatial. By aspatial, it has nothing to do with the site or location of the premises. For example, economic variables, legal factors or even the structural characteristics of housing and many others, belong to this group. These factors apply to all premises, irrespective of their locations. However, the other grouping definitely is location-specific. This includes locational variables and its surroundings, more commonly known as neighborhood characteristics.

2.6.2.1 Aspatial Factors

There are many aspatial considerations that influence housing price. The most frequently quoted variable is economic or fiscal policies (Chou and Shih 1994; Engelhardt and Poterba 1991). It associates housing price with lending rates and mortgages availability. It affects the supply of monetary support to home-buyers and developers which then induces changes in demand or supply and hence, fluctuation of

market price and construction cycles. Equally important is the fact that housing cannot be divorced from its legal arena. Thus, it is not surprising that legal forces like zoning restrictions (Unger 1982) can be a modifier to property price. The restrictions, like building height and density, are critical to lower property values (Buttler 1981). Not only does legal rules lower the price of premises but are also barriers to housing innovations as explicitly argued by Ritzdolf (1984). Yet, Unger (1982) would rather believe that it is the nature of tenancy that brings forth such an outcome. He believes that as rental users are not secured with home-ownership rights, they are less inclined to invest on the premise. Either explanations mean the same outcome : structural quality of a premise is adversely affected while property price decreases.

Therefore, it is evident that the structural characteristics also shape the property value. These characteristics refer to the appearance, size, age, materials used and other intrinsic facilities available in the premise. Most literature include a combination of indicators presented in Table 2.1 (Waddell, Berry & Hoch 1993a &b; Mok, Chan & Cho 1995, Mozolin 1994, Daniere 1994). Theoretically, the more 'equipped' the structure, the higher the willingness to pay. Better landscaping around the premise also adds value to a property (Chan 1988).

2.6.2.2 Spatial Factors

Property price is also under the influence of spatial variables as it is physically immobile. For consumers, structural variables become parenthetical when evaluated against the location and its surrounding facilities.

Structural Variables	
age of building	living space
air-conditioning sytem	lot size
attached or detached unit	number of bathrooms
balcony	number of bedrooms
cable television	number of stories
electric wiring	roof/wall type
fireplace/heating system	sauna
garage	swimming pool
kitchen area	wetbar

Table 2.1 Conventional structural indicators for housing studies

Locational Properties

The conventional parameters used are summarized in Table 2.2. They include proximity to workplaces, accessibility and employment accessibility.

Distance decay mechanism, under the assumption of a central business district (CBD), states that land value declines for all types of landuse (Alonso 1964). One of the shortcomings of monocentric theory is the underestimation of land value between centers; thus yielding a wider residential zone than it should have (Romanos 1977). Equally unrealistic is the assumption that all work trips are destined to a particular working center (eg. CBD). First, there should be more than one center of employment; second, the nature of trips are very different (eg. trips to school) and should gear towards multi-centres. These criticisms induce a lot of research to focus on the enhancement of the monocentric model to policentric studies. They believe that the distance to working centers are influential to property valuation (Heikkila , Gordon, Kim, Peiser, Richardson and Dale-Johnson 1989; Dubin and Sung 1987; Waddell, Berry and Hoch 1993a, 1993b; Hoch and Waddell 1993; Greene 1980; Mozolin 1994; Romanos 1977; Richardson 1977, Jackson 1979; Mok, Chan & Cho 1995; Gordon, Richardson and Wong 1986). With policentric assumption, rather than decreasing monotonously from the CBD, housing price around secondary employment centers should form 'peaks'. It hints that the nearer it is to the work places (both CBD and secondary centers), the higher the property price.

Locational Traits	
Traits	*Way of measurement*
Proximity to workplaces	distance to CBD/secondary centres
Accessibility	nearest subway station proximity to freeway/highways proximity to major trunk routes
Employment Potential	employment accessibility index

Table 2.2 Conventional locational traits for housing studies

However, a deeper thought into the question leads one to ask : if it is located geographically near to an employment center, would employment opportunities for a particular household exist ? Therefore, it is necessary to take into the account of employment vacancies in a particular center. Employment accessibility index is a common indicator of such likelihood by using gravity models (Smith 1978; Bender & Hwang 1985; Mehta & Mehta 1989). Much of these research aims at modeling this attribute with a single index. Yet, it is rational that different centers are serving different functions : a financial center with a lot of tertiary jobs may not have adequate industrial vacancies. So, not only is the number of vacancies important, but also the type of job consumers are engaging in. Hence, it may be more realistic to calculate the employment accessibility index for different kinds of jobs. If the distance to the center and the nature of jobs (also, the vacancies) coincide with the buyer, then he is more willing to pay for this premise.

Finally, the prominent factor - accessibility of a premise - is included in most research works. Clapp (1987) notes that different types of landuse require different levels of linkage. For residential landuse, street transport or intra-city rail are of greater importance. So, much of the research focuses on the effects of proximity to road network or highway on housing price (Jackson 1979; Bajic 1983; Dubin and Sung 1987; Waddell, Berry and Hoch 1993a). Theoretically, the more accessible the location, the higher the price fetches. However, some of the findings confirm that the result is of an inverted-U shape as proximity to these networks induce certain level of noise pollution. Thus, its effect remains a controversial issue.

Neighborhood Characteristics

Nearly all literature include neighborhood characteristics in their housing price analyses. In addition to individual impact of each indicator, some of these works compare the relative importance among categories of parameters (Dubin & Sung 1990). Where direct measures are not possible, proxy variables are used. Unfortunately, there seems to be no consensus on a complete checklist of variables. The chosen factors are quite case-dependent. Major categories grouped under this label are : public facilities, environmental amenities and, socioeconomic status (Table 2.3) which are briefly discussed below.

In general, proximity to public facilities like parks, golf courses, entertainment facilities, sports facilities, shopping malls, fire/police stations and so on are measured (Bartik 1988; Jackson 1979, Dubin and Sung 1987; Mozolin 1994; Waddell, Berry and Hoch 1993b; Mok, Chan & Cho 1995). They are related to the 'convenience' that the household is able to get in possessing a unit. Thus, the nearer the unit to these facilities, the higher the property value - except public school. Even though proximity to school is frequently measured, Smith (1970) criticizes that families are also concerned about the quality and prestige of a school. Therefore, school quality is measured with different definitions. The most common ones are test or achievement scores of students (Jud & Watts 1981), pupil-teacher ratio (Michaels & Smith 1990) or teacher experience (Dubin & Sung 1990). Better quality schools enhance the price of residential flats. Research exploring the effects of universities or colleges on price

Neighborhood Measures	
Traits	*Way of measurement*
Socioeconomic Status	% of professional jobs average living area gross rent paid household size income % of population below poverty line education level crime rate % of black % of hispanic
Public Facilities	entertainment/sports facilities school/university/college parks/golf course/bicycle trail retail mall hospital fire stations police stations
Environmental Amenities	landuse mix congestion/noise level around airport air pollution proximity to ocean (proxy for air quality/recreation)

Table 2.3 Usual neighborhood measures in housing studies

are done along similar line of thinking (Waddell, Berry and Hoch 1993b; Dubin and Sung 1987).

Environmental quality of an area is also influential to price. Usually, high pollution level becomes a discount to residence value as frequently expressed in terms of air quality and noise level (Murdoch and Thayer 1988; Freeman 1971, 1974, 1979; Meiszkowski & Saper 1978). Catastrophes like earthquake or landfill sites with hazardous waste are also regarded as something negative. The perceived risks of the consumers proved to have adverse impacts on property value (Murdoch, Singh & Thayer 1993; Michaels & Smith 1990). Another measure of living environment is the landuse mix. Principle of Conformity (Unger 1982) states that mixed landuses tend to downgrade the value of residence. Consumers are also more aware if there is another incompatible use nearby (Thibodeau 1990; Smith 1978).

In developing countries like the Philippines, access to public or private water source varies with housing price (North and Griffin 1993). However, in more affluent cities, 'water' is of aesthetic and recreational value. It is not uncommon to notice that houses near the ocean, sea, beaches or even rivers are more popular in demand. So, some of the research will focus on the effect of 'water view' on price (Mok, Chan & Cho 1995; Kulshreshtha and Gillies 1993). Thus, it is quite interesting that even the same attribute is applied, it represents different interpretations. On the whole, it can be generalized that being nearer to positive amenities adds value to a property while the relationship is reversed for negative amenities.

Socioeconomic status is a rather abstract concept to define. Very often, proxy variables are employed. Crime rate, racial composition and other demographic variables are popular proxy variables for this measure (Waddell, Berry and Hoch 1993b; Dubin and Sung 1987; Thaler 1978). As the socioeconomic status of a neighborhood is more prestigious, the housing commands a higher price in the market (Mozolin 1994; Waddell, Berry and Hoch 1993b). Variations in perceived prestige in residential areas proved to be an influential factor not to be overlooked in explaining residential mobility. Continual efforts in exploring the spatial cognition are abundant (Aitken & Pross 1990; Lee & Schmidt 1985; Lee & Schmidt 1986; Schmidt & Lee 1987; Louviere & Timmermans 1990; Sidorov 1992).

2.6.2.3 Evaluation on Importance of Parameters

Conventional variables of structural, locational and neighborhood traits are quite well-established. Tables 2.4 & 2.5 present a content analysis of 22 papers on hedonic price methodology. While Table 2.4 presents those variables which are statistically significant, Table 2.5 shows the variables that have been commonly used. For structural trait, age of building, living space and number of bathrooms or bedrooms are common indicators; distance to CBD is a popular index for locational characteristics; racial composition seems to be used frequently for neighborhood measures.

Even though the variables discussed are by no means exhaustive, they are adequate to point out the reality that, many indicators or proxy variables can be

	Hoch & Waddell (1993)	Heikkila et.al (1989)	Jackson (1979)	Bajic (1983)	Mok, Chan & Cho (1995)	Butler (1982)	Smith (1978)	Michaels & Smith (1990)	Murdoch, Singh & Thayler (1993)	Megbolugbe (1989)
R square	**0.90**	**0.50**	**0.93**	**0.97**	**0.76**	**0.72**	**0.56**	**0.68**	**0.79**	**0.84**
Structural										
age of building	*	*	*	*		*		*	*	
air-conditioning sytem										
attached or detached unit/ no. of bldg.	*	*								*
balcony										
cable television	*									
electric wiring/plumbing						*				*
fireplace/heating system								*	*	
garage					*			*		
kitchen area										
living space	*	*	*		*			*	*	
lot size				*					*	
number of bathrooms	*		*	*	*					
number of bedrooms	*				*	*				*
number of stories/view	*	*		*				*	*	
material of bldg. (stone/brick)					*			*	*	*
roof/wall type	*									*
sauna/hot water								*		
swimming pool	*								*	
wetbar										
tennis court	*									
weight room	*									

* denote significant predictors

Table 2.4 Content analysis on selective literature (significant predictors)

	Hoch & Waddell (1993)	Heikkila et.al (1989)	Jackson (1979)	Baijic (1983)	Mok, Chan & Cho (1995)	Butler (1982)	Smith (1978)	Michaels & Smith (1990)	Murdoch, Singh & Thayler (1993)	Megbolugbe (1989)
Locational										
time for commuting					*					
dist to CBD/sec. centres	*	*	*			*	*	*		
nearest subway station										
dist to freeways	*			*						
proximity to trunk routes	*						*			
employment access.index				*			*			
Neighborhood										
hazardous waste/earthquake/floodplain										
public water/sewage/road maintenance								*	*	
% owner/renter (tenure security)							*			*
homogeneity measure				*						
% pop. 64+				*						
% of professional jobs										
average living area			*							
gross rent paid										
household size										
income										
% of population below poverty line			*							
education level										
crime rate										
							*		*	

* denote significant predictors

Table 2.4 (cont'd)

	Hoch & Waddell (1993)	Heikkila et.al (1989)	Jackson (1979)	Baijic (1983)	Mok, Chan & Cho (1995)	Butler (1982)	Smith (1978)	Michaels & Smith (1990)	Murdoch, Singh & Thayler (1993)	Megbolugbe (1989)
Neighborhood (cont'd)										
% of white							*		*	
% of hispanic			*							
entertainment/sports facilities	*	*								
school/university/college	*	*					*		*	
parks/golf course/bicycle trail	*									
retail mall	*									
hospital										
fire stations										
police stations										
landuse mix	*						*			*
congestion/noise level around airport										
pollution							*		*	
proximity to ocean / beach (proxy for air quality/recreation)	*		*						*	
visibility										
pop/housing density									*	

* denote significant predictors

Table 2.4 (cont'd)

	Murdoch &Thayler (1988)	Dubin &Sung (1987)	Bender & Hwang (1985)	Waddell, Berry & Hoch (1993a)	Waddell, Berry & Hoch (1993b)	Linneman (1980)	Mehta & Mehta (1989)0	Dubin & Sung (1990)	Meiszkowski & Saper (1978)	Thaler (1978)	Thibodeau (1990)	Cassel & Mendelsohn (1985)
R square		**0.87**		**0.89**	**0.88**	**0.78**	**0.71**	**0.78**	**0.90**	**0.62**	**0.88**	**0.56**
Structural												
owner												/
age of building	/	/	/	/		/	/				/	
air-conditioning sytem		/		/	/	/		/				
attached or detached unit/ no. of bldg.		/		/			/	/	/			
balcony												
cable television									/			
electric wiring/plumbing						/	/					
fireplace/heating system	/	/		/	/			/	/			
garage		/	/	/		/		/	/		/	
kitchen area						/						
living space	/		/	/	/		/	/	/		/	/
lot size								/	/			/
number of bathrooms	/	/	/	/	/	/		/	/		/	/
number of bedrooms		/	/				/	/	/			/
number of stories/view	/	/				/		/	/			
material of blgd. (stone/brick)			/				/		/			
roof/wall type				/	/							
sauna/hot water				/	/							
swimming pool	/	/			/			/			/	
wetbar					/							
tennis court												
weight room												

/ denote used predictors

Table 2.5 Content analysis on selective literature (used predictors)

	Murdoch &Thayler (1988)	Dubin &Sung (1987)	Bender & Hwang (1985)	Waddell, Berry & Hoch (1993a)	Waddell, Berry & Hoch (1993b)	Linneman (1980)	Mehta & Mehta (1989)0	Dubin & Sung (1990)	Meiszkowski & Saper (1978)	Thaler (1978)	Thibodeau (1990)	Cassel & Mendelsohn (1985)
Locational												
time for commuting										/		
dist to CBD/sec. centres	/		/	/	/		/	/				
nearest subway station												
dist to freeways					/							
proximity to trunk routes					/							
employment access.index							/					
Neighborhood												
hazardous waste/earthquake/floodplain				/	/							
public water/sewage/road maintenance						/	/			/		
% owner/renter (tenure security)							/			/		
homogeneity measure												
% pop. 64+	/									/		
% of professional jobs												
average living area				/	/							
gross rent paid												
household size												
income	/											/
% of population below poverty line		/						/				
education level		/						/				/
crime rate	/	/				/		/		/		

/ denote used predictors

	Murdoch &Thayler (1988)	Dubin &Sung (1987)	Bender & Hwang (1985)	Waddell, Berry & Hoch (1993a)	Waddell, Berry & Hoch (1993b)	Linneman (1980)	Mehta & Mehta (1989)0	Dubin & Sung (1990)	Meiszkowski & Saper (1978)	Thaler (1978)	Thibodeau (1990)	Cassel & Mendelsohn (1985)
Neighborhood (cont'd)												
% of white		/						/				
% of black		/	/	/	/					/		
% of hispanic				/	/							
entertainment/sports facilities										/		
school/university/college			/	/	/	/		/			/	
parks/golf course/bicycle trail											/	
retail mall				/		/				/		
hospital				/								
fire stations												
police stations												
landuse mix				/	/					/	/	
congestion/noise level around airport												
pollution			/			/			/			/
proximity to ocean / beach (proxy for air quality/recreation)	/											/
visibility	/											/
pop/housing density	/			/			/					

/ denote used predictors

Table 2.5 (cont'd)

included to analyze property price. What makes it more complicated is the diverse market situation in which the research is done. It should not be neglected that the preference of the researcher can also affect the choice of variables. Therefore, the choice of variables are always case-dependent. It is a pity that there is no standard theory that guides the choice. On the contrary, it is equally beneficial without such theory because different market situations are bound to exist. While the above-mentioned variables are the most frequently used ones, the importance among them is hard to define. Therefore, only the general conceptual framework can be ascertained : structural, locational and neighborhood traits are influential on top of aspatial factors. What kind of variables and how many of them should be used to measure either of the three categories are not constrained, so long as the researcher finds them appropriate, available and manageable.

2.7 Functional Form of Hedonic Price Models

The proportion of variance explained (R square) by the hedonic price models ranges from 0.5 to over 0.9 (Table 2.4 & 2.5). It shows that it is a valid model but there are continuous debate on the correct functional form of hedonic regression. Nearly every paper that deals with hedonic price function admits the difficulty in deciding the 'correct' functional form. There are two main streams of doing it : (1) through a comparison among conventional specifications (2) application of Box-Cox technique.

2.7.1 Conventional Specifications

Many, if not all, of the literature compares the performance of the following four specifications in terms of explanatory power :

(a) linear : both dependent and independent variables are not transformed

(b) semi-log : logarithmic transformation to continuous independent variables only

(c) exponential : logarithmic transformation to dependent variable only

(d) double-log : logarithmic transformation to both dependent and independent factors

Linearity of equation suggests the ability to consume bundles of attributes in discrete units (Kulshreshtha & Gillies 1993). However, Jud & Watts (1981) criticize that housing attributes cannot be untied and repackaged at will. Rothenberg, Galster, Butler & Pitkin (1991) share the same idea that components of housing are essentially complementary to each other. Production of certain attribute is also dependent on the quantities of other attributes consumed. This has an important implication for which functional form the hedonic regression should be. Linearity may not be the correct specification, while non-linearity is expected. Surprisingly, many of the studies prove that linear specification performs the best.

2.7.2 Box-Cox Transformation

Where researcher may or may not have justification for the use of some of the specifications, many prefer to adopt the flexible Box-Cox transformation (Box & Cox

1964). It is a technique that estimates λ, the transformation measure, for dependent, independent or both types of variables. It hopes to determine the specification with best fit in terms of log likelihood (Linneman 1980). λ can also be interpreted as how constrained a housing market is (Megbolugbe 1989; Mok, Chan & Cho 1995). Many research limits the search between linear to logarithmic transformation.

2.7.3 Conventional Specification versus Box-Cox Transformation

Though Box-Cox approach is highly flexible, it suffers from drawbacks discussed in Cassel & Mendelsohn (1985). The approach is not suitable for data that has dichotomous or negative figures. Very often, the transformation is applied to the dependent or continuous variables in the data set which is believed to introduce measurement bias in one way or another.

The more complex the power transformation, the more difficult the interpretation of the coefficients and relationships. It is often found out that researchers applied the transformation without much theoretical backup. They change the data for the sake of obtaining a higher explanatory power.

While Rothenberg, Galster, Butler & Pitkin (1991 : chapter 13) scrutinize the amount of specification errors with empirical examples, Butler (1982) best evaluate the cost incurred in applying complicated transformation against simple specifications. His work serves as a very good guidance for the specification issue. He firmly believes that none of the specification is the most appropriate form simply

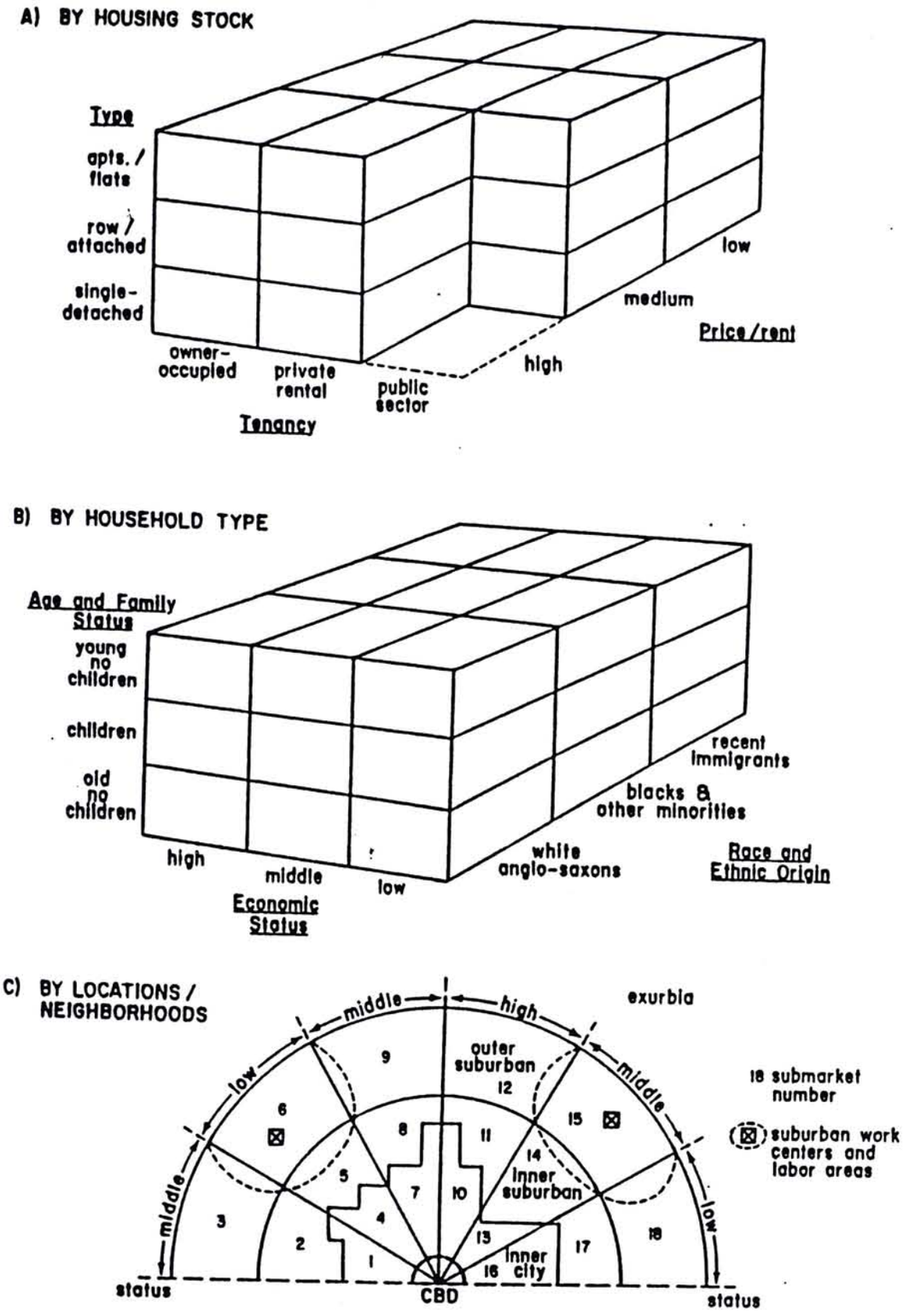
because hedonic relationship is too complex to be modeled. Furthermore, while some independent variables are included for analysis, many more have been left out. Thus, in one way or another, the hedonic function is bound to be 'misspecified'.

In short, while the impacts of bias due to misspecification proved to be smaller than expected and complicated transformation brings forth negligible improvement in either explanatory or predictive performance, it is not unwise to stick to the general rule of evaluation among simple specifications. It is essential for researcher to strike a balance on appealing statistical equation and those that are able to reflect the real situation of the problem.

2.8 Submarket Analysis and its Delineation

There are quite different arguments from literature on whether the market should be analyzed as a single arena or it should be decomposed into separate submarkets. As housing is a heterogeneous commodity, they form different 'populations' for statistical techniques to apply. Thus, submarket level analysis is a reality (Rothenberg, Galster, Butler & Pitkin 1991) and they are differentiated with various definitions.

Submarkets are delineated according to different kinds of theory or belief. It can be classified by a single trait, given the a priori knowledge the researcher has on the market For the previous, the segmentations are captured in Figure 2.3. For instance, Mehta & Mehta (1989) analyze the market with reference to tenure (renters



source : Bourne (1981) p.89

Figure 2.3 Intra-urban housing submarkets : traditional definitions

versus owners) while Megbolugbe (1989) defines it according to the type of houses (single versus multi-family). A lot of research prefer to stratify the market with municipal boundaries (eg., Bender & Hwang 1985) assuming constant service quality within each submarket. However, it is unlikely to stand because close substitutes may not be found in the same or nearby sites (Rothenberg, Galster, Butler & Pitkin 1991).

Therefore, there are efforts to define submarket with bundles of characteristics - hedonic index approach (eg. Michaels & Smith 1990). It is a way to translate the housing characteristics into a scalar representation of quality (Rothenberg, Galster, Butler & Pitkin 1991). Coefficients of the hedonic regression are used to construct a weighted sum of various traits - hedonic index. Where non-linearity exist, it is the partial derivative of the hedonic equation with respect to an attribute that serves as the weights (Megbolugbe 1989). Samples are then arrayed according to the hedonic index and stratified. Nevertheless, this approach suffers from the criticism that index is essentially arbitrarily defined (Follain & Jimenez 1985).

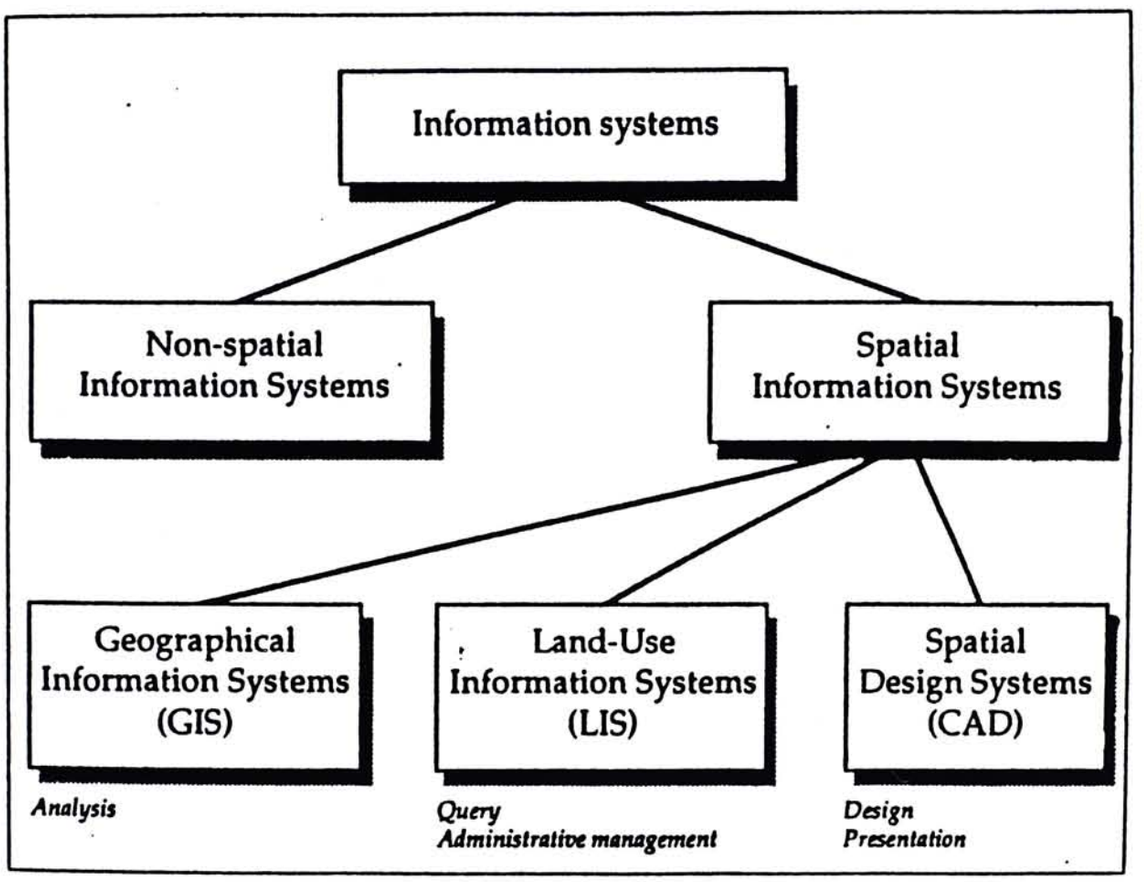
In fact, different approaches have their pros and cons, directing to suit various needs of research. While stratification by political jurisdiction is accused of neglecting various housing service quality, index approach also suffers from its arbitrary definition. There is no theoretical requirement on how submarkets should be designated. Afterall, the aim of submarket analyses is to reveal practical situation in a market; whichever method is able to fulfill this objective, it should be adopted so long as the data and assumptions are not violated.

2.9 Geographic Information Systems

Geographic Information Systems (GIS) is similar to any other information system that helps to improve one's ability to make relevant decisions. Yet, it is distinguished from others in its ability to handle 'spatial data' (Figure 2.4). In particular, it is referred as handling the geographic data with the help of digital computer, which also includes basic analytical tools to perform spatial analysis, modeling and policy evaluation functions (Goodchild 1995; Worrall 1990). To mapmakers and landuse planners, GIS is a flexible 'plotter' or map-generating tool. It can also represent proximity and topological relationships effectively (Freeman 1993; Castle 1993; Gurd 1990). Maffini (1991) comments that, to businessman, it is the new information derived that adds value to GIS. GIS provides the link between location and its attributes (non-spatial elements), which in turn generates new information for decision makers and makes it an invaluable tool for geographical studies.

2.10 GIS in Real Estate

Real estate market is not a monolithic industry which comprises different players. It is the interactions among them that contribute to numerous market niches (Castle 1993). Applications of GIS in these market niches have been on an increase because of the intrinsic nature of real estate sector.



source : Worrall (1990) p.15

Figure 2.4 A classification of spatial information systems

Every property is unique in terms of both location and its characteristics (attributes). It refers not only to the location of the property but other spatial factors that influence its value as well (Francica 1991; Court 1992). Castle (1993) emphasizes that whoever captures the most about a property has the best chance of making money and thus, real estate industry is essentially a game of information arbitrage. Somehow, the data are abundant, intensive and dynamic in nature. The integration of all these databases has to be efficient and no other database management system technology comes close to being such a 'universal solvent' as GIS (Castle 1993). It is the nature of real estate business that requires GIS.

Real estate is a high-risk high-return type of investment, information is vital for decision-making. Gurd (1990) points out that the aggregate demand and supply of a market is not sufficient and detail enough to reach a decision; rather it is the sub-market level information that counts. Therefore, cross-referencing among piles of files in detail is critical which renders GIS a desirable tool (Juhl 1992).

Finally, data from different sources have to be integrated for further analyses. At times, external supporting systems are needed to facilitate meaningful analyses. This kind of storing, retrieving and updating information is indispensable to real estate professionals and is another justification for the use of GIS.

2.11 Present Adoption of GIS in Real Estate

It is increasingly common for GIS to apply in two major aspects of real estate : (1) pragmatic usage for sales purposes, site selection or property management (2) research purposes.

2.11.1 Commercial Applications

The most popular use of GIS is to assist the sales of property (Gill 1991). The system is expected to match the demand from customers with the information on properties. GIS mainly performs the query function. If multi-media is employed, the vendor may even demonstrate a 'walk through' of the relevant property for potential buyers (Gill 1991; Juhl 1992). In a way, a lot of transaction costs is saved which is vital in business world.

GIS is also applied to solve the questions of 'site in search of a use' and 'use in search of a site' (Gurd 1990). For the former, it determines what is the most appropriate use for a given site under certain conditions. Yet, the latter application seems to dominate in most cases. It involves seeking an optimal location for an activity. Store location is an example of such (Collins 1989). Furthermore, it is a desirable tool for property acquisition or disposal (McNamara 1991; MaCartney & Thrall 1991; Peterson 1993;. Whitley, Xiang and Young 1993). Such decision-making process involves the incorporation of GIS with other systems (eg. spatial decision support system - SDSS) in order to act as a signal flag so that the company is

able to perform rightsizing, outsourcing or even strategic asset management (Castle 1994; Cullen 1992).

2.11.2 Research-wise Applications

On top of business applications, there are other areas that government or scholars can make use of it. Property appraisal is one of the many examples that is plausible with GIS application. Longley, Higgs and Martin (1994) believe that similar properties in an area attract similar values. Therefore, it is a powerful means to define the clusters of similar capital values. Through mapping of discrepancies between the observed and predicted tax on the appraised properties, any mismatch can be detected. It helps the government in terms of policy formulation and which renders social geographers to study the issue on equity in terms of housing wealth more efficient (Figneroa 1995). Furthermore, GIS also facilitates landuse planning (Rahman, Younes, Omsi 1995). Other than all these, application of GIS in housing price analysis is increasing.

2.12 Hedonic Price Study with GIS

While hedonic price methodology has been heavily consulted since 1960s, the integration of GIS in this field is rather recent. GIS is able to store locations and boundaries of properties or neighborhoods. For the previous, the location of premises can reveal the pattern or trend of development in an area. However, more advanced works have demonstrated that it is also efficient to develop proximity measures

among premises and its surrounding activities (Hoch & Waddell 1993; Waddell, Berry & Hoch 1993a). This is of importance to hedonic price analysis because many of the variables are just measuring the physical distances. With the application, the data can be done more accurately and efficiently.

Furthermore, overlaying procedures are adopted to identify areas under environmental threats like flooding (Waddell, Berry & Hoch 1993b). The effect of land use on housing price can also be revealed (Wang & Bian 1995). Can (1993) makes use of GIS to extract data from attribute tables to construct and evaluate residence quality indices. Generalized concordance analysis and spatial autocorrelation are integrated into ARC/INFO using macro language which add to the analytical power of GIS. The results are mapped and neighborhoods of similar residence quality are defined. Although these are only illustrations, it is sufficient to point out that rather than relying on manual search, the association of parameters to properties can be done with greater accuracy and the process is less time-consuming.

The advantages of incorporation of GIS are further confirmed if submarket analyses are adopted. This is because the associations among parameters, premises and submarkets' boundaries will become increasingly complex. To identify the relevant cases manually are too tedious and it is likely that errors happen easily. However, the relational join and overlaying capabilities of GIS can alleviate all these problematic issues.

2.13 Conclusion

In this chapter, an attempt is made to examine the nature of housing. There is a consensus that it is more than just residence (stock concept) for it also generates utilities and services to its occupants (flow concept). Thus, being physically immobile, the premise is in interaction with its social, economic, legal and locational settings. It is the locational and neighborhood characteristics in which the premise acquired that geographers are in an appropriate position to scrutinize the issue.

Since the property value is determined by its structural, locational and neighborhood traits, property valuation methodologies are applied to disentangle their effects. Of particular interest is the hedonic price model which has been in used over years. The methodology, its variables as well as function forms are discussed here. Finally, the submarket level analysis has been proved to be important and necessary. Hence, the submarket delineation methods have been dealt with.

After having an understanding into the nature and methods of housing price analysis, it has been demonstrated that GIS could be incorporated into the hedonic price function which leads to a more efficient way for analyses as well as data manipulations.

The following chapter is going to take an account on the real estate market condition in Hong Kong. Its importance and housing developments are also included. It hopes to demonstrate that the residential developments, in terms of location and

attributes, are largely responses towards urban development. Furthermore, the details and methodologies adopted in this research to study the property market in Hong Kong are to be provided.

CHAPTER III

THE STUDY AREA AND RESEARCH METHODOLOGY

3.1 Introduction

The first part of this chapter is going to point out the importance of private property sector in Hong Kong, in terms of economic aspects and housing production. Then, a section on relating urban development with housing is given. Urban renewal and comprehensive housing estates are the two major streams of development in the territory. This further illustrates the importance of public and private involvement in new town housing supply, in terms of their importance at different stages of development. After that, a brief description on housing price changes across time and space is given. Guided by voluminous literature on the subject matter and the background information of Hong Kong, the research details and methodologies are then discussed in the final section of this chapter.

3.2 Real Estate Sector in Hong Kong

Real estate industry is an important sector in Hong Kong. Its performance serves as a 'thermometer' of the local economy and its most crucial role is to house Hong Kong's population.

3.2.1 Importance to Local Economy

One of the popular indicator of the importance of real estate sector is its contribution towards the gross domestic product (GDP) of an area. According to the *Hong Kong Annual Report* in 1995, the proportion of GDP contributed by tertiary sector had been on a steady increase from 60 % in 1970 to 77 % in 1993, within which the finance and real estate alone covered 26 % of the contribution. Between 1984 to 1993, a robust annual increase of 20 % was recorded for the sector. The *Hong Kong Annual Report* stated that it was also the second largest employer of the tertiary sector (20 % as of 1992). Under conservative estimates, it also represented 45% of the stock market capitalization (Walker 1990). Thus, private property sector is regarded as an indicator for the performance of the local economy.

3.2.2 Importance to Housing Production

Despite continual efforts spent by the government in public housing constructions, it is fair to acknowledge the role of private sector in housing provision as well. Statistics show that in terms of housing units, the private sector contributed about 53 % from 1990 to 1994 while the remaining share was taken up by the government (Table 3.1). Equally evident was the fact that 46 % of the population was housed in private housing units (Table 3.2).

Apart from the contribution towards housing stock, private sector offers more choices for middle to higher income families. The government aims at providing low-

Year	Public Sector*		Private Sector	
	Absolute Numbers	*%*	*Absolute Numbers*	*%*
1990	791300	47.0	892800	53.0
1991	809200	47.0	912900	53.0
1992	850200	47.1	952900	52.9
1993	858900	46.1	984800	53.4
1994	899500	47.3	1003400	52.7
Mean		46.9		53.1

** includes all public rental and sales unit, plus government quarters*

source : Appendices of Hong Kong (1991 to 1995)

Table 3.1 Number of quarters supplied by public and private sectors (1990-1994)

Year	Public Sector*		Private Sector		Temporary Housing
	Absolute no.	*%*	*Absolute no.*	*%*	*%*
1990	2822900	49.1	2605800	45.3	5.6
1991	2758400	48.9	2661300	47.2	3.9
1992	2944100	51.2	2617600	45.5	3.3
1993	2935100	50.2	2720300	46.5	3.3
1994	3029100	51.1	2729400	46.0	2.9
Mean		50.1		46.1	3.8

** includes all public rental and sales unit, plus government quarters*

source : Appendices of Hong Kong (1991 to 1995)

Table 3.2 Estimated persons accommodated by public and private sectors (1990-1994)

cost housing of size less than 700 square feet for the lower income bracket households. On the contrary, the private sector offers a wider variety of housing units, ranging from 400 to over 1600 square feet (Table 3.3). Depending on the location and facility provisions of the housing projects, the price range offered by the private sector is larger than that of the public sector. The price range is further complicated by the fact that unlike public units, private properties are traded freely in the market. It possesses an investment element which is generally welcomed by consumers.

3.3 Urban Development and Housing in Hong Kong

3.3.1 Land Availability and Landuses

It is not really a shortage of land that makes Hong Kong one of the most crowded city in the world; rather it is because over 80% of the land are too rugged and hilly for any development to take place. That explains partly why urban activities are packed onto strips of land along the water front.

Between 1991 to 1994, land allocated for non-residential use was steadily increasing from 8.9% to 9.6% while a stable supply of 4.5% of total land area was designated for residential usage (Table 3.4). As Hong Kong undergoes her economic restructuring phase, commercial and financial activities certainly are hunger for space. Nevertheless, residence is something that cannot be do without. It is not easy to accommodate urban development and housing under such a congested setting.

Year	Public Sector* %		Private Sector %				
	A	*B*	*A*	*B*	*C*	*D*	*E*
1991	63.8	36.2	49.3	43.6	2.2	2.6	2.3
1992	64.7	35.3	68.1	24.5	2.5	1.3	3.5
1993	43.6	56.4	72.4	21.4	2.7	0.8	2.7
1994	51.8	48.2	72.5	19.1	4.3	1.5	2.6

** includes all public rental and sales unit*

Key : A = under 400 ft^2 B = 400 - 699 ft^2 C =700 - 999 ft^2
D = 1000 - 1599 ft^2 E = 1600 ft^2 or above

source : Hong Kong Monthly Digest of Statistics, various issues

Table 3.3 New residential units completed by sector and by floor size (1991-1994)

Type of Usage	1991	1992	1993	1994
	Percentage of total land area			
Developed Land				
Residential	3.6	3.8	3.7	3.8
Public Rental Housing	0.8	0.8	0.9	0.9
Subtotal of permanent residence	**4.4**	**4.6**	**4.6**	**4.7**
Temporary Housing Area	*0.2*	*0.1*	*0.1*	*0.1*
Non-residential	*8.9*	*9.3*	*9.4*	*9.6*
Non-built-up	*86.4*	*86*	*85.9*	*85.6*
Grand total land area (m^2)	*1075*	*1076*	*1076*	*1078*

source : Appendix 35, Hong Kong Annual Report (1992 - 1995)

Table 3.4 Land usage in Hong Kong (1991-1994)

3.3.2 Housing and Urban Development

As buildings are physically immobile, their location embodies information of the past history : either political, economical or even developmental policies adopted. For instance, the age of the building in the city center is older than those in the fringe because that is the way how the city develops. Thus, to a certain extent, such rationale hints us to relate the locational development of housing with urban development.

3.3.2.1 Early Period of Industrialization

Manufacturing sector was important to Hong Kong after 1949 and remained so until the 1970s (Lo 1992). Housing conditions at that time were intolerable and congested. Owing to her laissez faire philosophy, the government was reluctant to improve the housing quality. It was not until the fire at Shek Kip Mei in 1953 that the government intervened in housing provision (Pryor 1983; Lo 1992). By the 1970s, all possible sites near the urban areas were filled up. Simultaneously, urbanization and industrialization started to take off at an incredible speed. All these activities asked for space. Squatter areas located near the urban fringe hindered the engulfment of land by urban activities. Pressurized with the pressing need for land, there was no alternative for the government except to intervene in urban development. To accommodate these activities, new town development was one of the possible solutions. While people were moved towards new towns to free land for other

activities, squatter clearance went along with such move to further improve the situation.

3.3.2.2 Phase of Economic Restructuring

Since the late 1970s till now, tertiary activities became dominant in the local economy. Hong Kong emerges as an international center for commerce and finance, urban development tends to agglomerate in urban cores again in which highly accessible and better facilities are utilized. These activities require the prime location at the urban core. Thus, land price is pushed up while not much supply is available. Profitable as it is, many of the buildings have been converted to commercial use.

Nevertheless, it is economically inefficient to rely on the demolition of existing buildings or urban renewal to release room for residence. Only pencil-typed residential premises dominated the space in the urban core. As land price at the urban core is excessively high for comprehensive housing projects (which also requires large piece of land), it is more pragmatic for developers to implement these projects on new sites.

3.3.3 Urban Renewal

Since there are substantial demand for land in urban areas for non-residential activities, many of the residential development have to give way to them. However, employment opportunities, schools' quality and other facilities are well-provided in urban cores, it is not surprising that urban residence is still in great demand (Yu

1995). Despite the fact that land value is highest in these urban districts, considerable new housing stock is supplied as a result of urban redevelopment. For instance, Mongkok, Sham Shui Po or Wan Chai, Kennedy Town, the West are districts that have undergone much changes. Pun (1986) has ascertained the need and advantages of urban renewal projects. It is reasonable for small developers to participate in this type of projects. Much of the land redemption is made possible when it involves smaller land lot. This is because urban households are fragmented and if the land lot is smaller, it then reduces a lot of monetary and time cost during negotiations. Therefore, these newly built urban residences are bound to be smaller in floor size, uncoordinated or random in locations since it depends solely on the developers' decision.

3.3.4 Comprehensive Housing Projects

As comprehensively designed housing estates are more spacious with better facilities provisions, it seems to be the trend in housing development. While this type of projects involve more financial, personnel and technological support, only large developers have the ability to build them. Therefore, apart from the small-scale pencil-typed residence, some of the urban districts are able to supply medium-sized flats with better landscape, for instance, districts like Shek Kip Mei, Ap Lei Chau and Hunghom. These land lots are larger in area and held by large developers. Since the land lot is owned by a single entity, the redemption of land is not as difficult. Thus, instead of piece-meal redevelopment, the whole land parcel is converted to residential use. This renders large scale housing estates to develop. Examples include Whampoa

Garden, South Horizons, Laguna City. Along similar line of thought, large developers can also obtain large land lots at cheaper price in the New Territories. Thus, comprehensive housing programs are also a common feature for new town residence.

3.4 New Town Housing - Public or Private-Led

It is a well-established phenomenon that new towns are public-housing led, yet more and more comprehensive housing estates are supplied by the private sector. As a matter of fact, the government is recognizing the role of private developers in new town development (Table 3.5). New towns in the late 1970s to early 1980s proved that the government decided to let the private sector assume a larger part in new town housing development. Not only does private participation help to increase housing stock but also realize planning objectives.

The underlying planning rationale in Hong Kong follows the concept of 'balanced' community (Philips & Yeh 1987). Not only does landuse mix balance, but also aims at a social class balance. To achieve this aim, it is a common strategy for the government to house lower-income group in public housing and at the same time, encourage private developers to start off residence for higher-income households. There are high-density residence (eg. public or private apartments) and low-density ones (eg.luxury flats/houses). As a matter of fact, the new town housing development can be split up into several stages, indicating the relative importance of public and private participation.

Year of Designation	New Town	Public sector (%)	Private sector (%)
1961	Tsuen Wan	62	38
1965	Tuen Mun	61	39
1965	Shatin	63	37
1978	Yuen Long	38	62
1979	Sheung Shui/Fanling	58	42
1979	Tai Po	61	39
1982	Tin Shui Wai	51	49
1982	Junk Bay	58	42

source : Bristow 1989, Appendices

Table 3.5 Public and private sector housing provisions in new towns of Hong Kong

Since the Ten Year Housing Program in 1973, the government was conscious to fulfill her ambitious targets. One of the ways to meet the target was by massive government input in housing. In due regard, that required land and it was only rural New Territories that could afford the supply (Lo 1992; Pun 1987). Therefore, a number of new towns designated in the 1960s were filled with public housing. Many, if not all, of the scholars would argue for a 'public-housing led' new town development in Hong Kong (Pun 1986; Yeh 1987; Castells, Goh & Kwok 1990). However, the public housing only accommodates low-income groups which contradicts with the 'balanced' principle. Therefore, private sector housing is greatly encouraged, particularly to new towns designated in the 1980s, partly because of the fulfillment of planning rationale, partly because of the tight financial constraints of the government (Bristow 1989).

It is apparent that after the building of public housing, private developers then follows. This type of cyclic pattern is common to many of the new towns. A typical case of Ma On Shan is used as an illustration (Table 3.6).

In the mid-1980s, public housing predominated the housing market; not much private support could be found. However, starting from 1992, private developers joined in the housing stock supply. There seemed to be a time-lag of 5 to 6 years after which the public housings were in full swing. This is logical because the government will implement supporting services like schools, hospitals and so on only after the people move into the public housing (Lo 1992). Private developers will only join in the market after certain level of serviced land is completed (eg. road connections).

Name of Building	Year of completion	Private (v) / Public (c)
Fu On Garden	1986	v
Kam On Court	1987	c
Hang On Estate	1987	c
Yiu On Estate	1989	c
Kam Hay Court	1990	c
Kam Ying Court	1991	c
Kam Lung Court	1993	c
Lee On Estate	1993	c
Sunshine City	1992	v
Villa Athena	1993	v
Ma On Shan Centre	1993	v
Bayshore Garden	1994	v
Saddle Ridge Garden	1994	v
Fu Fai Garden	na	v
Fok On Garden	na	v

na = not applicable

Table 3.6 Private or public residential development in Ma On Shan

Therefore, it seems to suggest that while new towns are in its initial stage, public investment is dominating. During its mature stage, both public and private sectors play a role in housing provision. However, at its later stage, private investment will surpass that of the public sector.

To sum up, while it is true that new towns are mostly public-housing led, many of the new towns in the 1990s are developed with both public and private efforts. Certainly, public-housing predominates in the initial start. Once basic facilities have been provided by the government, private sector joins in the provision. As a matter of fact, increasing private input is expected. For example, Tin Shui Wai is largely a private-sector built 'new town' (Bristow 1989). Therefore, it is explicit that new towns are expected to rely less on public input at the later stage while public-housing led argument still holds at earlier stage.

3.5 Hedonic Price of Private Dormitory in Hong Kong

As outlined in the previous section, there is a marked difference between public and private housing. Even within the private property market, price fluctuates with time and location. This gives rise to the temporal and spatial variations of hedonic price for us to scrutinize.

3.5.1 Temporal Change in Property Price

The escalating hedonic price is best reflected in the property price index (Table 3.7) where the index has almost tripled within five years from 1990 to 1994. Figure 3.1 illustrates the steep gradient of increase during the early 1990s. This can be attributed by the favorable investment environment pertaining that time frame (Yu 1995). The inflation rate hovered around 10% with occasional climax of 12% from 1989 onwards. Saving deposit interest rate dropped from 3.5% to 1.5% (Ho 1993) indicating that consumers were unable to safeguard themselves from inflationary impact through deposits. Owing to the linked exchange rate system, a downward trend of interest rate in the United States caused the best lending rate to fall from 8.5 to 6.5% (Ho 1993) in the local economy. With a negative lending rate, it was advantageous for investors (Table 3.8) to invest, particularly in real estate sector as it proved to be a rewarding kind of investment.

An average of 25% increase in overall property price a year was recorded (Wong & Staley 1992). Despite the market response to upsurge of unexpected political events, the adverse effects to the property market were only temporary (Lo 1992). For instance, the market recovered to pre-crash level in six months after the June Fourth incidence in 1989 and similarly, despite uncertainty during the Gulf Crisis in 1991, there was still a 15% increase in property price (Wong & Staley 1992).

To conclude, under a favorable investment environment, both end-users and investors help boost up the price of the private property market. Yet, where to find an

Year	Overall Property Indices
1984	43
1985	48
1986	53
1987	65
1988	79
1989	100
1990	111
1991	153
1992	215
1993	237
1994	291

source : Hong Kong Monthly Digest of Statistics, various issues

Table 3.7 Indices reflecting the property price fluctuation in Hong Kong (1984-1994)

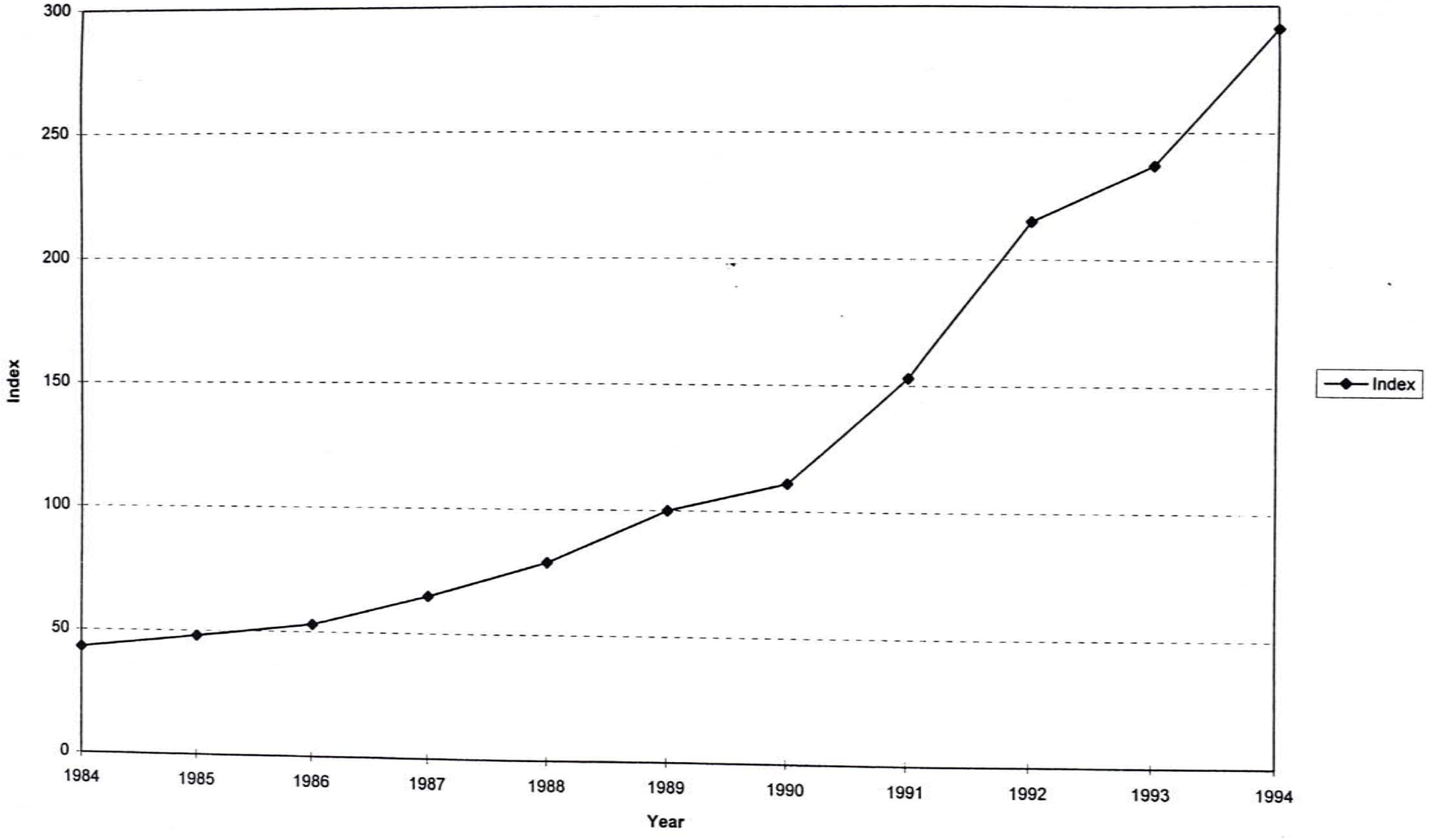


Figure 3.1 Temporal change of property price indices

Year/Quarter	Inflation#	Best lending rate*
89Q1	10.65	0.85
89Q2	10.96	0.04
89Q3	11.04	-1.04
89Q4	11.10	-1.10
90Q1	10.92	-0.92
90Q2	11.27	-0.27
90Q3	11.46	-0.96
90Q4	11.54	-1.54
91Q1	12.26	-2.76
91Q2	10.93	-0.43
91Q3	10.15	-1.15
91Q4	10.03	-1.53

\# *measured by the Hang Seng Consumer Price Index*
* *calculated by the Hongkong Bank best lending rate minus Inflation*

source : The Other Hong Kong Report 1992 p.324-325

Table 3.8 A persisting negative lending rate in Hong Kong (1989-1991)

accommodation and when to invest become interesting questions for either group of consumers to consider.

3.5.2 Spatial Variation of Property Price

Private residential use can be roughly categorized into high density or low density areas (Lo 1992). In urban areas, low density residential areas are usually those situated in a higher elevation from the coast with a better view over the water front. These prestigious areas are also where better schools are found. On the Hong Kong Island, the Peak District, Repulse Bay, Stanley, Shouson Hill, Jardine Lookout and Happy Valley are examples while in Kowloon, the most noticeable evidence is Kowloon Tong. Other than these districts in the urban area, Sai Kung , areas near Clear Water Bay and the strips of land near Sham Tseng are new areas outside the urban core that developers intend to build low density high class residence. They all share the common attributes of having spacious floor area with high property price.

Urban comprehensive housing estates are commonly found in districts like Ap Lei Chau (South Horizons), Shek Kip Mei (Yau Yat Chuen), Yau Tong (Laguna City) or Hunghom (Whampoa Garden). These estates are well-planned with recreational facilities, they are less polluted and more spacious in landscaping. Thus, with better estates management and located in urban arena, these properties command quite high a price although it is still incomparable to the prestigious zones.

The remaining urban districts are mostly pencil-typed residence with mixed landuse. The living condition is congested and quite polluted. Yet, the employment opportunities tend to agglomerate there. Furthermore, they are usually places with great convenience and hence, better re-sale potential. Thus, premises situated in prime metro area have higher property value than those in the New Territories.

Perhaps, the price range offered in the new towns is comparatively cheaper than those in the urban core. Yet, marked differences among them are still quite evident. For example, since new towns in the eastern New Territories are served by the railway which links to the urban districts, they are usually more expensive than their rivals in the west which do not enjoy such factor. The western part seems to be quite mixed in price ranges. While areas like Tuen Mun suffers from the traffic congestion induced by commuters who have job mismatch problems, property price is lowered. However, in areas like Sham Tseng where better residential environment is provided, the price is a lot higher.

Thus, it is safe to conclude that, in general, properties in the New Territories are cheaper than those in the urban core. Property price of new towns in the east surpass those in the west. However, it should be borne in mind that special cases like Sham Tseng may not comply with the general pattern.

3.6 The Research

After considerable literature review on the nature of housing, hedonic price methodologies and the background information on the study area - Hong Kong - it is appropriate at this stage to ascertain the details of this research.

Since not all of the conventional variables fit the market condition in Hong Kong, some of them are discarded. For instance, ethnicity is not a big consideration in property valuation; fire places at home simply does not seem to exist. Thus, the conceptual framework of studying the relationship of property price to its locational (L), structural (S) and neighborhood (N) parameters are adopted. The intended variables for the database consists of floor size indicating the structural importance (S), proximity to major railways and employment potential for service, distribution and industrial activities for locational traits (L), socioeconomic status as reflected by the demographic indicators, landuse mix as well as the district school quality are used to capture neighborhood characteristics (N).

3.6.1 Cartographic Analysis

To reveal patterns of residential development and attribute changes through time and space, maps are more appealing than text or figures. Therefore, different sets of maps are generated. To name a few, locations of newly constructed premises by year or by district, the price density or employment density maps and even the school

quality maps are produced to depict interesting findings that worth further investigations by statistical methods.

3.6.2 Hedonic Price Model

The conventional definition of hedonic price model as expressed in equation 2.1 can be adopted using the asking price per square feet to represent the housing price. As hedonic price function is a multivariate regression model building technique, the model can be rewritten as :

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + e \qquad (3.1)$$

where
- Y = dependent variable, price of premise
- β_0 = regression constant
- $\beta_1 ..... \beta_n$ = regression coefficients to be estimated
- $X_1 ..... X_n$ = independent variables X_1 to X_n of S, L, N
- e = error term

3.6.3 Dependent Variable

First of all, rather than having detached units for sale in Hong Kong, most of them are apartment units. Therefore, except the structural differences (eg. view, storey etc.), the locational and neighborhood for each unit in the same building should

be the same. Thus, the property price used refers to the average price of all units in a particular building.

Unlike most studies that quote the transacted price, asking price of a premise is adopted as the dependent variable. It should be noted that the asking price for newly released premises is equivalent to the transacted price in the first hand market. Especially in Hong Kong where speculation is vigorous, the final transacted price of a unit or premise can never be known for sure as second-hand market exists and that price intrinsically captures the impact of speculators. Hence, by using sales price from newly released premises as an alternative, it guarantees, to a large extent that, they are valuations of the end-users.

3.6.4 Independent Variables

It should be noted that although structural differences among apartment units exist, it is not the focus of this research to examine their effects on price. Therefore, except floor space, most of the used variables are locational and neighborhood measures which then comply with the aspect of geography of housing. While S, L, and N in equation 2.1 are defined by vectors of attributes (X), they are summarized in Table 3.9. The procedures involved in derivation of the variables will be discussed in Chapter 4.

	Name of Variable	*Descriptions*
Dependent Variable	PRICE	asking price per square feet
Independent Variables		
Structural (S)	AREA	physical floor size
Locational (L)		
Accessibility	SQ_RAIL+	distance to major railway
Employment Potential	V_DIS	employment potential of distribution sector
	V_SER	employment potential of service sector
	V_IND	employment potential of industrial sector
Neighborhood (N)		
Socioeconomic Status*	FAC1	purchasing power
	FAC2	household size
	FAC3	labour participation rate
	FAC4	economic independency
	FAC5	crowdedness
Landuse Mix	RES	% of residential landuse
	COM	% of commercial landuse
	COM_RES	% of commercial-residential landuse
	IND	% of industrial landuse
	INST	% of institutional landuse
	OPEN_SPACE	% of open space
Municipal Services/Amenities	SQ_REC+	nearest physical distance to recreation facilities
	SQ_CEM+	nearest physical distance to a cemetery
School Quality	D_SCORE	school quality index for a district

+ variable is expressed as the reciprocal of its square of measured distance in accordance to the distance decay theory

** 24 initial variables collapsed to 5 constructs after factor analysis*

Table 3.9 List of dependent and independent variables used in this research

3.6.5 Chosen Functional Form in this Research

Since there seems to be little consistencies on the appropriate functional form of equation 2.1. Box-Cox flexible transformation is not consulted in this research. Thus, the project simply compares the four conventional specifications, that is (1) linear (2) semi-log (3) exponential (4) double-log, and evaluate the performance of each in terms of explanatory power.

3.6.6 Submarket Analysis in Hong Kong

The hedonic regression model is applied to both pooled and submarket level. After having an understanding on the overall market situation, it is then stratified into submarkets. Since in Hong Kong, whether flats are luxury or not depends on both its price and floor size, delineation of submarkets follow this rationale. It is intended to see how well the hedonic price modeling are fitted into different groups of premises (submarkets).

3.7 Conclusion

Private property sector is just as important as the public sector in housing provision to the population in Hong Kong. With a variety of alternatives offered and its re-sale potential, more affluent households are attracted to private dormitories.

Residential development does echo with urban development. Nevertheless, both urban renewal projects in urban districts and comprehensively built housing estates in new towns are the two major trends in the territory.

In order to uphold the planning rationale and increase the housing supply, the government admits the increasing importance of private sector. Public housing is still the dominant means at initial stage of new town development. However, it is demonstrated that at later stages, private involvement are inevitable.

All these help to shape the temporal and in particular, spatial variations of housing stock supply in terms of location and attributes in Hong Kong. This chapter introduces the rationale and general design of this research and its methodologies. To study the issue in detail, a lot of variables and indicators are indispensable. Thus, they are to be dealt with in Chapter IV.

CHAPTER IV

DATABASE CONSTRUCTIONS

4.1 Introduction

The purpose of this chapter is to take an account of the procedures adopted in building a spatial database for analyses. After a brief introduction, the main content are split up into four parts (1) data collection (2) data input (3) data editing and conversions and (4) data pre-processing and manipulation. Finally, a short conclusion is given at the end of this chapter.

4.2 Data Collection

In the previous chapters, the theoretical rationale and basic parameters have been dealt with already. They are collected from various sources in different formats (Table 4.1). To reiterate, the variables can be grouped as follows :

(i) price and attributes of housing stock

(ii) neighborhood characteristics : landuse mix, socioeconomic status, school quality, proximity to municipal services

(iii) locational variables : accessibility, employment measures

Variables	Source	Format	Remarks
Basemaps Hong Kong	TPU maps (PD/T/TS S/LAN/10 Figure 2.1 to 2.4)	A/D[+]	1:50000 for New Territories 1:15000 for Kowloon and Hong Kong
Location of premises	property journal, TPU maps	A	
Atributes of premise	property journal	A	
Landuse mix	Planning Department, OZP	A	
Accessibility	Land Information Centre	D	1:20000
Employment measures	official statistics	A	gravity model
Socioeconomic status	official statistics	A	factorial ecology
Municipal services	TPU maps	A	
School Quality	Questionnaire	A	

\+ : *analog maps facilitate digitizing while the TPU boundaries are already in digital format*
Key : *A = analog* *D = digital*

Table 4.1 Summary of data sources and their formats in this research

4.2.1 Base Maps

The set of tertiary planning unit (TPU) map is chosen because it is detail enough to show the major buildings, streets and municipal facilities of the territory. All these facilitate the digitizing procedures that follow. Other cartographic maps include the 1:20,000 digital maps from the Land Information Center from which major rails are extracted for accessibility measures.

4.2.2 Housing Stock and its Attributes

The elementary information of newly developed residential premises (hereafter referred as premises) in Hong Kong is gathered from *Hong Kong Property Journal*. Attributes of each residential building are summarized in the monthly report. These include : date, name of premise, exact address, floor size, price per square feet (hereafter known as price), number of units, move-in dates, percentage of units sold and the real estate agent responsible for all transactions.

4.2.3 Official Statistics

Various government publications are heavily consulted. *Hong Kong Population Census (1991)* is the basic reference for all demographic variables. *Employment and Vacancies Statistics* reveals the employment levels of the territory. Actual figures concerning the landuse mix in each TPU are supplied by the Planning

Department and in case there is missing information, the Outline Zoning Plans[1] (OZPs) are consulted as reference.

4.2.4 School Quality

The official classification of school quality (known as 'band' ranging from 1, being the best, to 5 being the worst) done by the Education Department is confidential. In order to take this variable into consideration, it is essential to seek professional advice (ie. experienced teachers) through questionnaire.

A complete list of secondary schools, grouped according to their respective district, is compiled from the *Hong Kong Education Handbook 1994.* Teachers were asked to judge which of the school(s) can be best described as 'Band 1' (academically sound), based on their own perceptions. This information is used for calculation of a district school quality score. A total of 30 questionnaires are distributed and the response rate is 96.67% (29 out of 30).

[1] The OZP records the planned landuse mix of an area

4.3 Data input

4.3.1 Graphical Input

4.3.1.1 Base Maps

The base map of Hong Kong is digital in nature and is ready for use at the Department of Geography, Chinese University of Hong Kong. It consists of 474 polygons and grouped under 285 TPU which allow easy dissolve for later analysis.

4.3.1.2 Line Data

The mass transit transportation systems in Hong Kong includes (1) the Mass Transit Railway (MTR) which runs through the major urban areas on Kowloon Peninsula and Hong Kong Island; (2) the Kowloon-Canton Railway (KCR) which links up the Kowloon urban cores with new towns in the New Territories and (3) the Light Railway Transit (LRT) which serves the flow between Yuen Long and Tuen Mun New Towns.

Digital maps at 1:20,000 from the Land Information Center are used to form the railway coverage. Using the *append* function of ARC, railway elements of 16 map sheets are matched to become a complete railway network for the territory. These networks are modeled as arcs.

4.3.1.3 Point/Polygon Data

Efforts have been spent on locating the premises manually. With the exact address given, and the *Hong Kong Directory 1995* (where details of nearly every building is shown), the premises are plotted onto the TPU maps before digitizing. All premises are depicted as points with unique ID attached. Unfortunately, some of the addresses only give the lot number. If the name of the premise can be found on the directory, the site is known; otherwise, approximation is employed to mark them.

It should be noted that this process can be much improved if address-matching could be done with the aid of a network coverage of road centerline. However, such kind of data is not available for the entire territory of Hong Kong.

Schools, urban parks, cemeteries, public swimming pools and sports grounds are landmarks which can be easily identified on TPU maps. They are manually plotted and then digitized. While schools are strictly point features, municipal services are represented as polygons which are converted to points later for the generation of proximity variables.

Employment and Vacancies Statistics reports aggregate employment levels of 19 districts. They are described in terms of three major categories : industrial, distribution and services (Table 4.2). Geographic locations of these three centers are not the same and it is essential to identify each of them separately. The general rationale in picking them are summarized in Table 4.3. In sum, since similar type of

Category	Sector	Descriptions
Industrial	2	Mining and Quarrying
	3	Manufacturing
	4	Electricity, Gas and Water
Distribution	6	Wholesale/Retail, Import/Export trades, Restaurants, Hotels
Services	7	Transport, Storage and Communication
	8	Financing, Insurance, Real Estate and Business Services
	9	Community, Social and Personal Services

source : Employment and Vacancies Statistics

Table 4.2 Description of different employment sectors and their components

Category	Guidelines
Industrial	Centre of the largest patch/block of industrial building
Distribution	Centre of the largest patch/block of shopping mall or hotel
Services	Centre of the largest patch/block of office building or bank headquarter

Table 4.3 General guideline in locating employment centres for each district

industry tend to agglomerate, they form patches on maps. Thus, the center of the largest patch or block is chosen and represented as point features.

4.3.2 Attribute Data Input

Data entry and storage of attributes and statistics are managed as spreadsheets in Microsoft Excel. However, it is worth noting that these raw data have to be re-grouped and re-calculated before they are attached to the maps. Data editing and conversions are discussed in subsequent sections.

4.4 Data Editing and Conversions

4.4.1 Graphical Data

4.4.1.1 Standard Coverage Editing Procedures

After digitizing the required elements, it is of utmost importance to check their data quality. It should be free of spatial errors. Thus, standard coverage editing procedures are employed to each of the digital maps wherever suitable.

It is important to ensure that arcs are correctly represented : nodes are placed where necessary, lines are logically joined or split. The location of points deserves much attention. It is essential to check that non of the points falls into water bodies. Once detected, the labels are removed and re-digitized. Line joining, line cleaning

and polygon closure are basic editing procedures for polygon coverages. The assignment of a unique number to map elements is crucial for database construction and is applicable to all coverages. No feature should have more than one label as identification.

4.4.1.2 Specific Coverage Editing Procedures

Some of the digitized maps need further editing and amendments. These include 3 major operations.

Appending of Coverages

The major railway networks of Hong Kong is appended from 16 map sheets. Edge-matching has been performed. Unfortunately, the rails are represented as dotted lines. A lot of effort is spent in transforming the broken line segments into continuous arcs. Line joining and cleaning are indispensable in order to facilitate later proximity measurements.

Polygon Dissolve Procedure

Originally, tertiary planning units (TPUs) are the intended spatial units for analyses. However, it is too fragmented to generalize meaningful interpretations. As a result, the TPUs are merged to form 42 districts through polygon *dissolve* procedure. The TPUs are grouped into their respective district according to the official

classification in census report. A simple macro-language program (AML) is used for such classification.

Ungenerate polygon coverages to point coverages

Municipal amenities are presented as polygons. However, it is the physical distance between a building and its surrounding amenities that matters. Therefore, the label of each polygon is moved to the centroid through *centroidlabel.* Then they are *ungenerate*d to become point coverages so that proximity measurements are possible.

4.4.2 Attribute Data

As TPUs are grouped to become 42 districts, data have to be regrouped in order to uphold the integrity principle. Furthermore, some of the raw data are measured in absolute figures which have been converted to percentages or indices for analyses. Other adjustments are applied wherever necessary.

4.4.2.1 Housing Attributes

The units supplied are usually described in terms of minimum and maximum floor space in square feet. For ease of interpretation, mean of floor space is used for analyses.

To study the temporal and spatial variation of property price from 1991 to 1994, they need to be comparable and thus, standardized. It is a well-known phenomenon in Hong Kong that property price soared several times more than inflation. If the adjustment is made with the Consumer Price Index[2], not all of the price increase is discounted. Therefore, the property price indices are consulted for adjustments (Table 4.4). The price is adjusted as follows :

$$AP_i = \frac{P_i Y_n}{Y_j} \qquad (4.1)$$

where AP_i = adjusted price of premise record *i*

P_i = original price of premise record *i*

Y_j = price index of year *j*

Y_n = base year *n* price index

i = premise records (1 to 187)

It should be noted that 1991 was also a year when speculative activities were rigorous. Property price in January was not directly comparable to that in December. Thus, it is also necessary to adjust the price for this inflationary impact as it will be the elementary statistical database. Quarterly indices are used to standardize the price (Table 4.5) in a equation similar to (4.1).

[2] Consumer Price Index (CPI) is the popular indicator for inflation in Hong Kong

Year	Property Price Index
1991	153
1992	215
1993	237
1994	291

source : Hong Kong Monthly Digest of Statistics (various issues)

Table 4.4 Property price index

1991	Quarterly Index
1st Quarter	124
2nd Quarter	141
3rd Quarter	164
4th Quarter	183

source : Hong Kong Monthly Digest of Statistics

Table 4.5 Property price quarterly index in 1991

4.4.2.2 Landuse Mix

The raw data from the Planning Department describes the landuse mix in hectares for each TPU. They are divided into 31 categories. Since some of the categories are redundant for this research, they are intentionally discarded. For the remaining ones, they are further grouped into 6 major categories as listed in Table 4.6. Each category of landuse is expressed as a percentage of total district area in hectares (excluding roads).

It is not surprising that there are missing data from the Planning Department. Table 4.7 shows the districts when the landuse data are not available. To compensate for this shortage, the Outline Zoning Plan (OZP) is used. It is understood that the OZP is the planned landuse mix rather than the actual figure. Since landuse plans are more adhered to in new towns, data from OZP are reliable enough to supplement the missing figures.

However, the 1991 OZP for Tuen Mun and Junkbay are not available. It has to be assumed that the landuse mix will not change significantly with a year of difference and the data are adopted from adjacent years. Tuen Mun Other Areas and Tai Po Other Areas are the two cases which cannot be resolved. Fortunately, in 1991, no record are found in Tuen Mun Other Areas; for Tai Po, there are 5 records which are to be discarded before performing statistical analyses.

Grouped Category	Descriptions on Landuse
Residential	Private Residential Government Quarters Public Housing including Housing Society
Commercial-Residential	Commercial-Residential
Commercial	Commercial / Business and Office
Industrial	Special Industrial General and Heavy Industrial Light and Service Industrial Warehouse and Storage
Institutional	Private and Subsidized Educational Government Educational Private and Subsidized Institution and Community Government Institution and Community
Open Space	Private Local Open Space Public Local Open Space Private District Open Space Public District Open Space

source : Planning Department

Table 4.6 Descriptions on landuse categories and their constituents

District	Year of OZP used
Tuen Mun New Town	1990
Yuen Long New Town	1991
Junkbay	1992
Tai Po New Town	1991
Tuen Mun Other Areas	na
Tai Po Other Areas	na

na = not applicable

Table 4.7 Outline Zoning Plans (OZPs) used for missing data

4.4.2.3 Socioeconomic Status

Twenty-four demographic variables are chosen to indicate the socio-economic characteristics of each district (Table 4.8). These variables are expressed either as indices or percentage. Factorial analysis is applied in which they are transformed to 7 constructs. The factor scores derived are then used for statistical analyses. Procedures and results are to be discussed in later sections.

4.4.2.4 Employment Figures

Number of persons engaged in different sectors are gathered from the *Employment and Vacancies Statistics (Detailed Tables)* reports. In 1991, figure for service sector is missing. To resolve this problem, it is assumed that employment level is in a linear relationship with time (expressed as years) and the miss out figure is interpolated from 1992 and 1986 as

$$S_{91} = (\frac{(S_{92} - S_{86})}{6} * 5) + S_{86} \qquad (4.2)$$

where S_{86} = service employment in 1986
S_{91} = service employment in 1991
S_{92} = service employment in 1992

Employment potential indices are calculated from modified gravity model which will be reported in coming sections.

Variables	Descriptions
B0-14	percentage of population aged between 0-14
B15-39	percentage of population aged between 15-39
B40-54	percentage of population aged between 40-54
B55+	percentage of population aged 55 and above
ELEM_ED	percentage of population having no schooling to primary school education standard
SEC_SCH	percentage of population having lower, upper and matriculation secondary education level
TER_ED	percentage of population having tertiary education
F_LAB	female labor participation rate
M_LAB	male labor participation rate
BOTH_LAB	labor participation rate of both sexes
PROF_LAB	percentage of working population who were managers, administrators, professionals and associate professionals
SEC_IND	percentage of working population in secondary sector
TER_IND	percentage of working population in tertiary sector
INCOME	median monthly household income
HH_1	percentage of household with 1 person
HH_2	percentage of household with 2 persons
HH_3	percentage of household with 3 persons
HH_4	percentage of household with 4 persons
HH_5	percentage of household with 5 persons
HH_6+	percentage of household with 6 or more persons
OWNER	percentage of household being an owner of their living quarters
MARRY	percentage of people being married
POP_DEN	population density of the district
SEX_RATIO	number of male to per 100 female

source : Hong Kong 1991 Census Report

Table 4.8 Chosen demographic variables for factor analysis

4.5 Data Pre-processing and Manipulation

Some of the variables are still inappropriate for scrutiny. Thus, using models to extract relevant information is inevitable. Such derivation may or may not involve the use of GIS. The following discussions focus on the details and justifications for further data manipulation.

4.5.1 Employment Potentials

To geographers, flows of goods, information and human activities are termed as spatial interaction. The spatial interaction models originate from Isaac Newton's law of gravitational attraction. Fundamentally, the model postulates that the force of attraction is directly proportion to the product of the masses of two bodies but inversely related to the distance between them (Thomas & Huggett 1980; Carrothers 1956; Haggett 1967) which are represented by the familiar equation :

$$F = k\frac{m_i m_j}{d_{ij}^2} \qquad (4.3)$$

where F = force of attraction

k = constant

$m_i m_j$ = mass of centres *i* and *j*

d_{ij} = distance between centers *i* and *j*

The equation can be interpreted as the movements between any two regions. The mass variable can be considered as the population size or the capacity of a region to generate or attract movements while the distance can be measured in physical terms or some other indicators such as time or monetary cost (Thomas & Huggett 1980). As early as 1950s, it has already been well-recognized that gravitational model can be applied to diverse phenomena in geography (Carrothers 1956) which include migratory study, retail gravitation and journey-to-work pattern.

Housing price is believed to embody the utility derived from its proximity to employment centres. In hedonic price studies, gravity model is used to capture such utility (Mehta & Mehta 1989; Smith 1978). Similarly, the employment potentials in this research are calculated from the following equation, adopted from Carrothers (1956) where he measures the potential interactions of populations :

$$V_i = \sum_{j=1}^{n} \frac{E_j}{d_{ij}^2} \qquad (4.4)$$

where V_i = employment potential at premise i

E_j = employment level at center j

d_{ij} = distance between premise i and center j

n = number of centres (19)

i = premise record (1 to 187)

Monocentric Versus Policentric Employment

Traditional analyses believe that measuring the distance between premise and central business district (CBD) is sufficient enough to reveal employment utility. Unless primate city is dominating, such monocentric assumption is not convincing. By and large, cities are usually policentric in structure.

Employment opportunities in Hong Kong clearly do not just cluster around a single center; rather they are dispersed over the territory. Thus, policentric assumption is ascertained.

Distances among premises and centres are derived directly from *Pointdistance* command of ARC which computes distances between point features in one coverage to all points in another coverage within a specified search radius. The results are

stored in an INFO text file which is exported to Microsoft Excel for computations with equation (4.4). For each premise, it has separate employment potential index for industrial, distribution and services sectors.

4.5.2 Socioeconomic Variables

To generalize the complex urban structure, the most efficient way is to employ the factorial ecology analysis. It is now the preferred approach in handling socio-spatial differences in urban setting (Knox 1995). Simply stated, factorial ecology is the application of factor analysis on urban ecology (Davies & Herbert 1993) through which a number of demographic descriptors are collapsed into factors.

In this study, the 24 demographic variables have been described in previous section. They have undergone the Barlett's sphericity test which rejects the null hypothesis that the variables in the population correlation matrix are uncorrelated. Thus, it is rational to believe that they are correlated among themselves and share common factors.

Factor rotation aims at further cleaning up the factor structures so as to identify the factors to become interpretable (Shaw & Wheeler 1994). In deciding whether the factors should undergo orthogonal or oblique rotation, it is believed that these new hybrids of factors are somehow correlated among themselves. Thus, an oblique rotation is employed. Twenty-four variables are transformed to form 7 factors

which explain 89.1% of the total variance (Table 4.9). The variables and loadings for each construct are summarized in Table 4.10 and properly labeled in Table 4.11.

Another important output is the factor score matrix which provides a measure of relationship between each observation (Shaw &Wheeler 1994). The scores on each areal unit reflect the combined influence of the highly loaded variables. In plotting such factor scores, one is able to compare, in case-wise, the factors measured in terms of several variables simultaneously. The factor scores derived are presented from Plate 4.1 to 4.5 and they are used for further statistical analyses.

4.5.2.1 Interpretation

Factor I (Table 4.10) is quite well-defined. It is heavily loaded in variables representing if people are engaging in tertiary or secondary employment. It is somehow related to their income and whether they are professional or not. All of which are measures of their *purchasing power*. Variables measuring the *household size* are loaded consistently with factor II and is thus named. Factor III deals with whether both husband and wife are income-earning. It is related to the *labor participation* of a household. Factor IV is interesting enough to be loaded on whether people are married or not, the dependency of children and elderly. It is believed that those who are married with children are financially more burdened than those who are married without children or remained as single. Thus, this factor reflects the *economic independence* of households. Finally, the population density and large household size (over 6 persons) are converged as factor V in which they represent the

Factor	Eigenvalue	Pct of Variance	Cumulative Pct of Variance
1	7.21622	30.1	30.1
2	5.50439	22.9	53.0
3	2.82249	11.8	64.8
4	2.16659	9.0	73.9
5	1.39794	5.8	79.6
6	1.25630	5.2	84.8
7	1.02519	4.3	89.1

Table 4.9 Summary statistics of 7 constructs

	Factor I	Factor II	Factor III	Factor IV	Factor V	Factor VI	Factor VII
SEC_IND	**-0.94604**	0.17305	0.09372	0.08773	0.01622	-0.08273	-0.05500
TER_IND	**0.92342**	-0.06807	0.03251	0.00825	-0.11578	0.07409	0.01035
INCOME	**0.85721**	0.21766	0.09583	0.06299	0.10598	-0.08075	-0.00508
PROF_LAB	**0.68340**	0.16403	-0.08086	0.09871	-0.04727	0.28174	-0.25509
F_LAB	**0.65435**	0.05092	0.36441	0.20339	-0.05112	-0.11923	-0.24871
HH_5	0.05598	**0.87685**	-0.00421	-0.01220	0.28976	-0.04036	-0.08711
HH_1	-0.01321	**-0.85873**	0.11028	0.07390	-0.13090	0.21298	0.21759
HH_4	-0.01676	**0.85366**	0.01038	-0.34173	-0.18371	-0.05087	0.09567
HH_2	0.04475	**-0.82456**	-0.14317	-0.02462	-0.25612	-0.24053	-0.34457
HH_3	0.03455	**0.81605**	-0.03038	-0.08092	-0.54370	-0.10848	-0.13369
M_LAB	-0.06694	-0.02857	**0.96168**	-0.28439	0.03296	0.05994	0.05936
BOTH_LAB	0.27188	-0.07678	**0.89255**	-0.00033	-0.02274	-0.02470	-0.04739
MARRY	-0.13265	0.00979	0.21110	**-0.89728**	-0.10721	0.08114	-0.14461
B0-14	-0.10435	0.36603	0.00284	**-0.79336**	0.13344	0.01902	0.20452
B55+	-0.06862	-0.24802	-0.05722	**0.74320**	-0.05719	0.33119	0.15373
HH_6	-0.08116	0.23145	-0.07677	0.25367	**0.85347**	0.03418	-0.00230
POP_DEN	0.02791	0.04780	0.01787	0.26696	**-0.75759**	0.22842	0.23848
B15-39	-0.02750	-0.02612	-0.14145	-0.09396	0.06882	**-0.89749**	0.05051
OWNER	0.13470	-0.06384	-0.22165	-0.20629	0.00045	**0.61055**	-0.26205
SEX_RATIO	-0.4240	-0.32079	-0.08812	0.03553	-0.21213	-0.15802	**0.79931**
TER_ED	0.20379	-0.14195	0.10306	0.03909	0.09950	0.15530	**-0.79018**
ELEM_ED	-0.23452	0.11284	0.18283	0.38439	0.08944	-0.00197	**0.71403**
B40-54	0.25612	-0.14552	0.19031	0.17579	-0.16741	0.28674	**-0.54068**

Table 4.10 Summary on the variables and their loadings on different factors

Factor	Label
Factor I	Purchasing Power
Factor II	Household Size
Factor III	Labor Participation Rate
Factor IV	Economic Independence
Factor V	Crowdedness

Table 4.11 Labels for the collapsed 5 factors

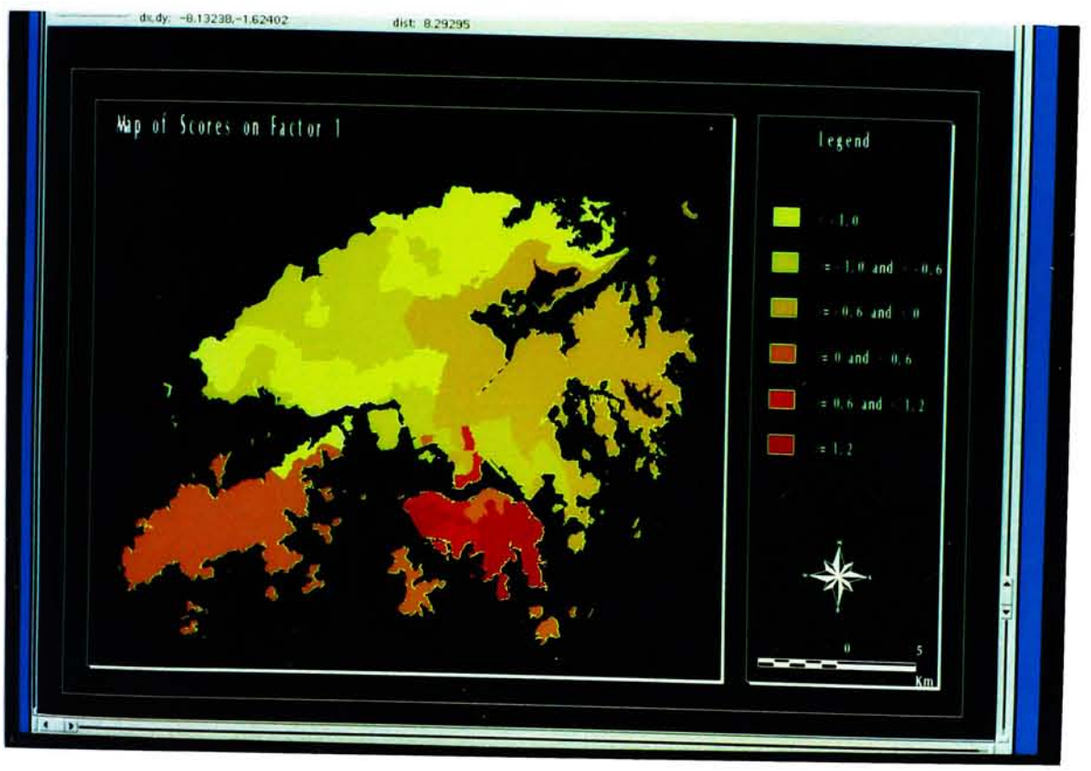


Plate 4.1 Map of scores of factor I (purchasing power)

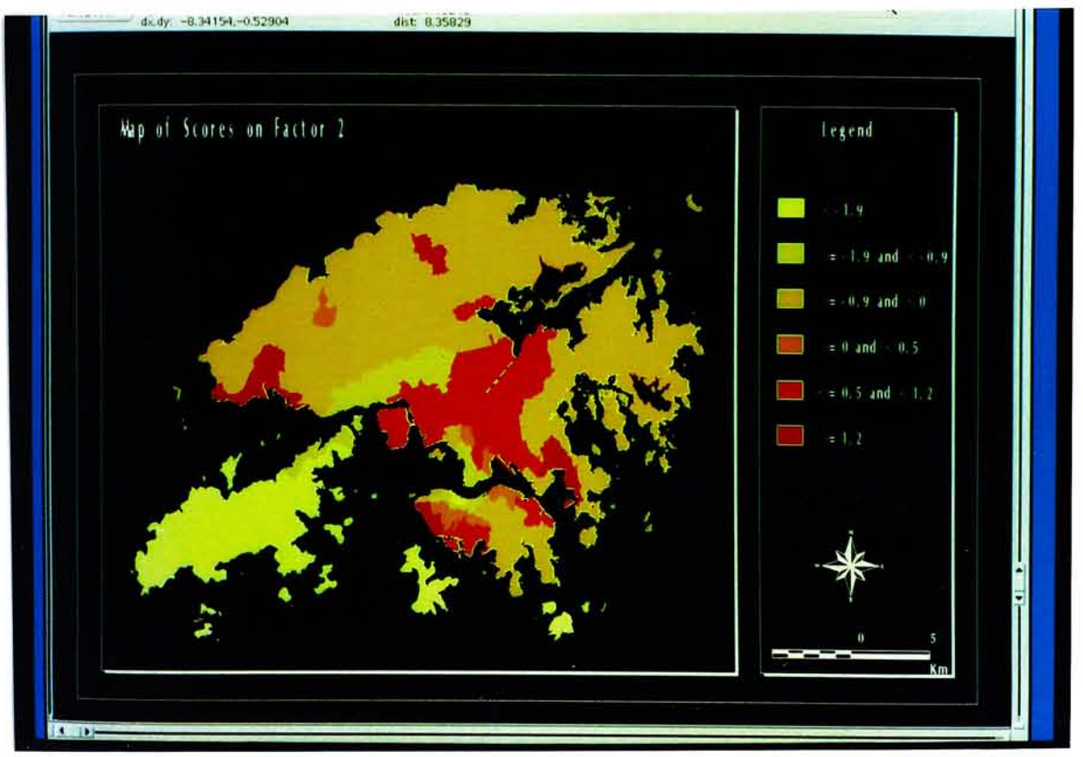


Plate 4.2 Map of scores of factor II (household size)

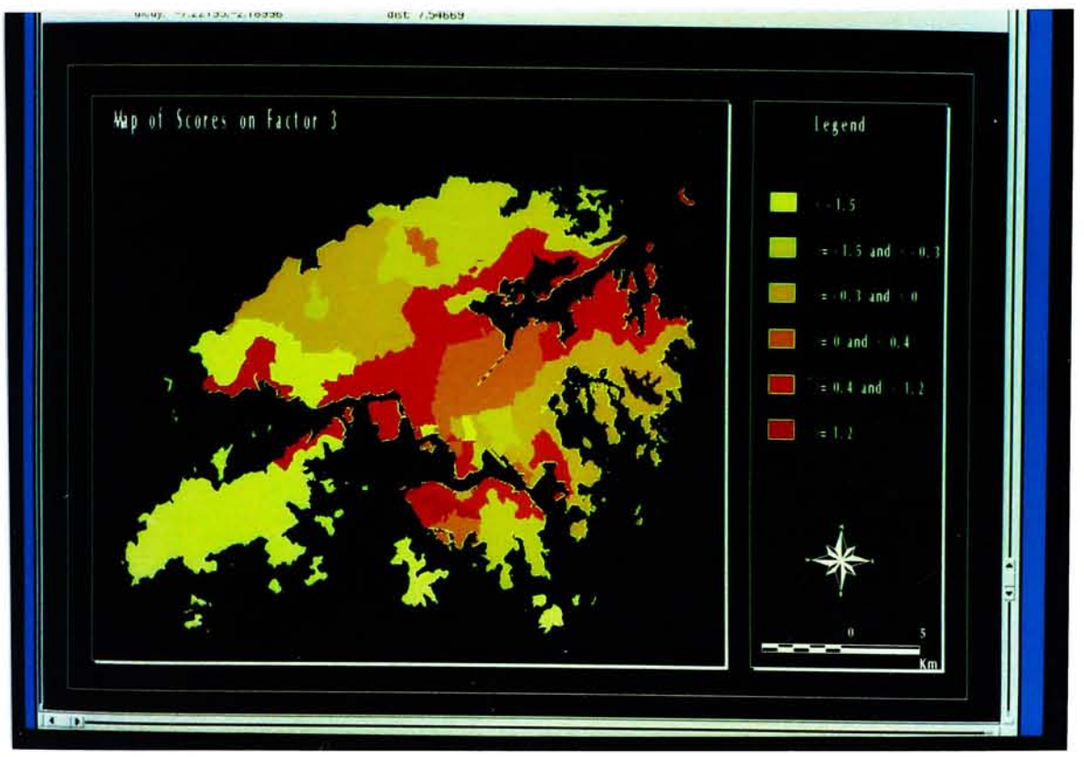


Plate 4.3 Map of scores of factor III (labor participation)

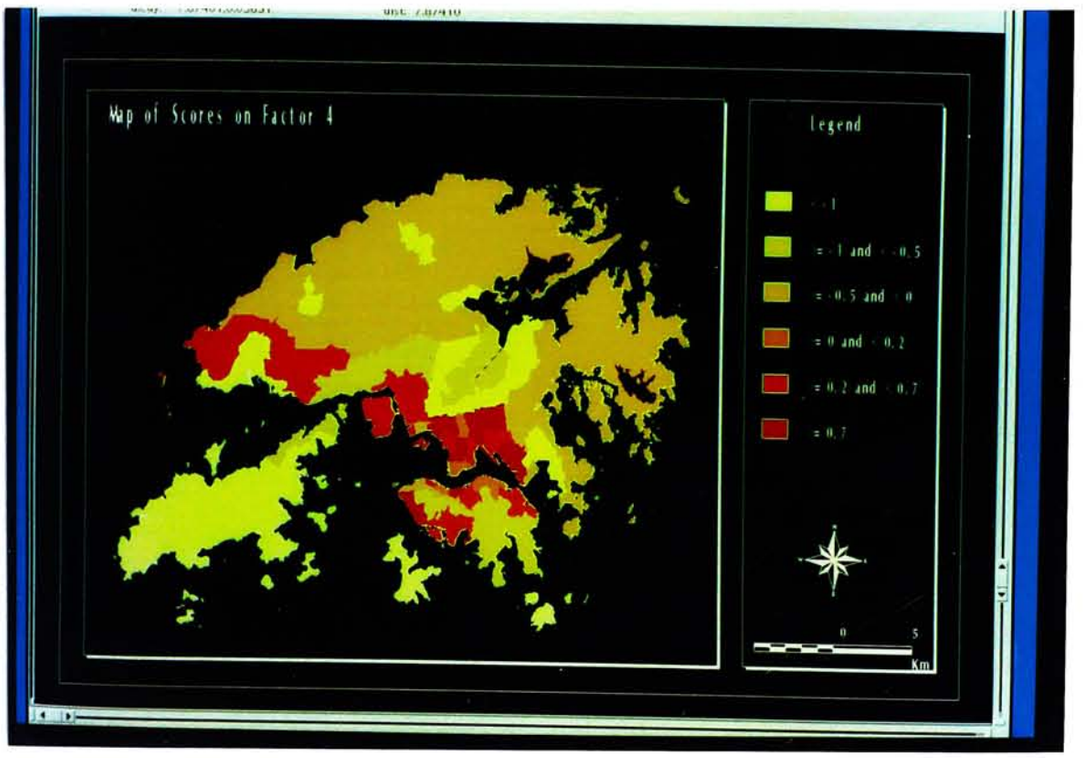


Plate 4.4 Map of scores of factor IV (economic independence)

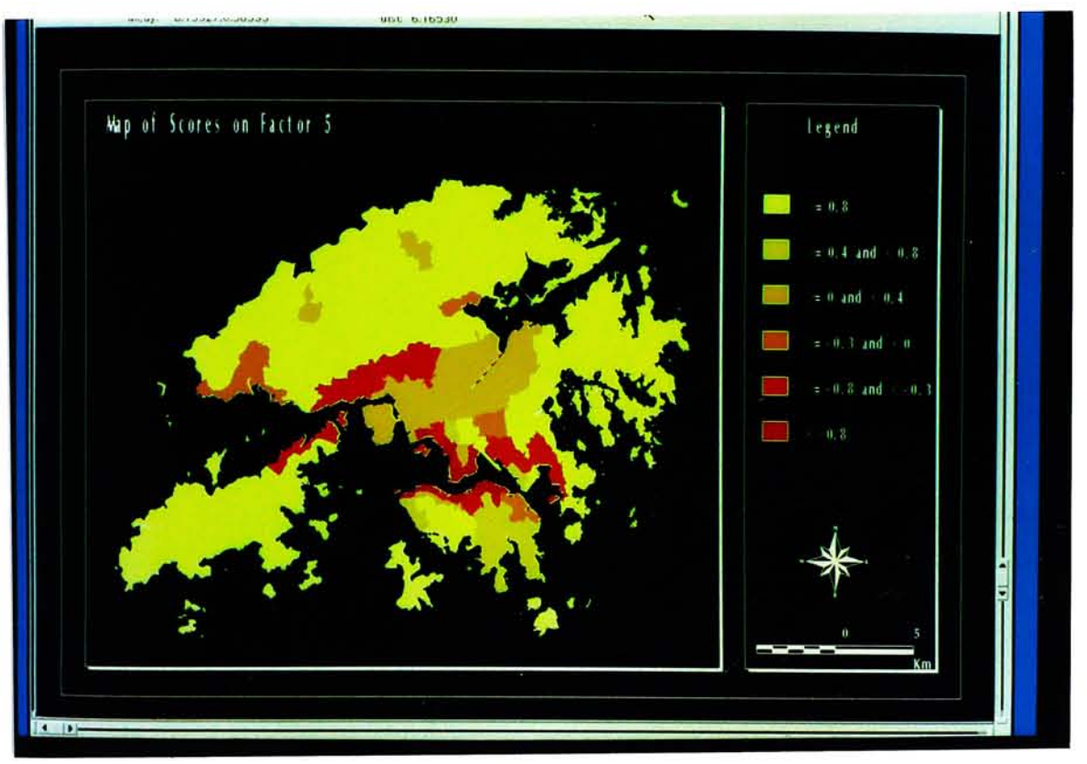


Plate 4.5 Map of scores of factor V (crowdedness)

crowdedness of an area. As the sixth and seventh factors are too vague to interpret, they are not included for further analyses.

In Hong Kong, continual comparisons and explanatory account of the change in ecological urban structure is prolifically written. Detail qualitative and quantitative methodologies have been applied to study the ecological types in the territory (Lo 1975; 1981; 1986; 1992). Demographic characteristics of the population (eg. education, economic, ethnicity, age, sex) and their residence (eg tenure and housing conditions) are used to perform cluster or factor analyses which form typological types in Hong Kong. Comparisons among 1961, 1966, 1971, and 1981 illustrate the increasingly diversed residence segregations. Yet, it is an evidence of economic segregation rather than ethnicity. Furthermore, a mixture of concentric, axial and nuclei urban form is demonstrated with the latter ones being more apparent.

Although this research is not a direct attempt in defining ecological types, integrating the 5 factors also provide some insight into similar issue. In urban cores, family size are usually smaller (Plate 4.2). Economically, they are less burdened (Plate 4.4) with children and both male and female family member are income-earning (Plate 4.3). These households should be more affluent. This point is further confirmed in the purchasing power factor (Plate 4.1). They are usually engaged in professional or tertiary activities with higher income. A look at the crowdedness further breaks down the classification : northern belt on Hong Kong island are higher-density, middle-class residence; in the Southern part of the island are lower-density, high-class residence; except Kowloon Tong, the peninsula is dominant with higher-

density, middle to lower-class residence. This resembles the general results done in the past. It is particular relevant that clusters of high-class residence continue to be suggestive of economic segregation.

Similarly, household size in the New Territories are larger (Plate 4.2). Usually, they are financially burdened with children (Plate 4.4). In order to take care of them, it seems less desirable for both parents to go working (Plate 4.3). All these lower their household income. As revealed from their purchasing power (Plate 4.1), they are not as affluent as those in urban areas. It should be noted that it is more difficult to generalize clusters of residence because new towns are filled with public and private dormitories that house lower to middle-class population. Thus, the socioeconomic status is not as 'distinct' in classification.

It should be borne in mind that the census data used for factor analysis is 1991. At the time of writing, a lot of distinct residence neighborhoods have already been shaped by private developers in various patches of the New Territories. This being the case, the interpretation of socioeconomic status in areas of the New Territories should be flexible instead of definite neighborhoods.

4.5.3 School Quality

After the score for each school is obtained from the questionnaires, they have to be converted to an index that describes the overall quality of schools in a certain

district. At this stage, both GIS and other software have to be used. The procedures are summarized in Figure 4.1.

The point-in-polygon overlay allows the location of schools to be attached to its relevant district. From the new database, the total number of schools in a district is available. Also, the total score attained by these schools (in each district) is captured. All these are necessary for the calculation of a district school quality index as represented by the following equation :

$$Q_i = (\frac{TS_i}{n_i * m}) * 100 \qquad (4.5)$$

where Q_i = school quality index of district *i*

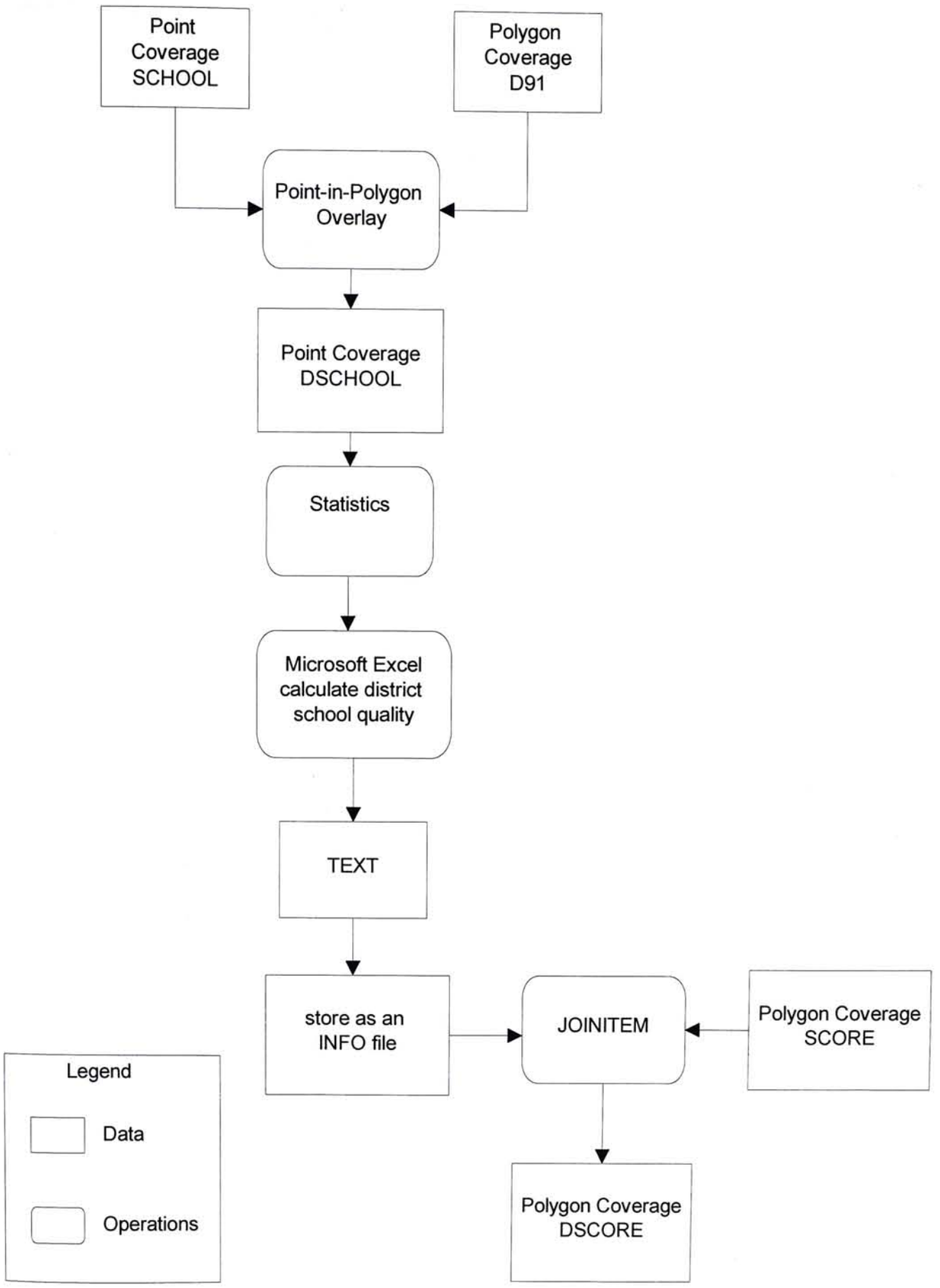
TS_i = total score attained by n schools in district *i*

n_i = number of schools in district *i*

m = total number of respondents (29)

i = district (1 to 42)

After deriving the district school quality index, it proceeds onto the attachment of this information to the final coverage.



Note :

D91	a coverage containing the information of 42 districts only
SCHOOL	a coverage with the location and attributes of each school
SCORE	a coverage with 42 districts (similar to D91)
DSCORE	final coverage with attributes & location of schools attached to respective district

Figure 4.1 Flow diagram showing the derivation of district school quality

4.5.4 Proximity Measurements

Distance between each premise to its nearest railway is used to measure accessibility while the proximity of premises to its surrounding amenities (ie. municipal services) are also important to property valuation. These distances are measured accurately with GIS and the procedures involved are summarized in Figure 4.2.

The *Near* command of ARC computes the distance from each point (premise) in a coverage to the nearest arc (rail), point (amenities) or node in another coverage. The resultant coverages capture the attributes of the input coverage as well as the generated distance. The identification number of each premise and its associated distances can be directly *unload*ed as text from the Tables module of ARC/INFO.

4.5.5 Final Step of Association : Overlay Operations

After integrating attributes from various formats and sources, overlay operations is used at this stage. Overlay refers to buffer generation, coverage updating, feature extraction and most important above all, spatial join among feature attributes. Spatial join operations aim at merging feature attributes (ESRI 1994). The spatial locations as well as their attributes are merged to form new data relationships in the output coverage. Specifically, the point-in-polygon operation is the most frequently used operation in this research. It is a convenient and accurate way to associate all parameters to price records. A lot of errors can be minimized. Standard

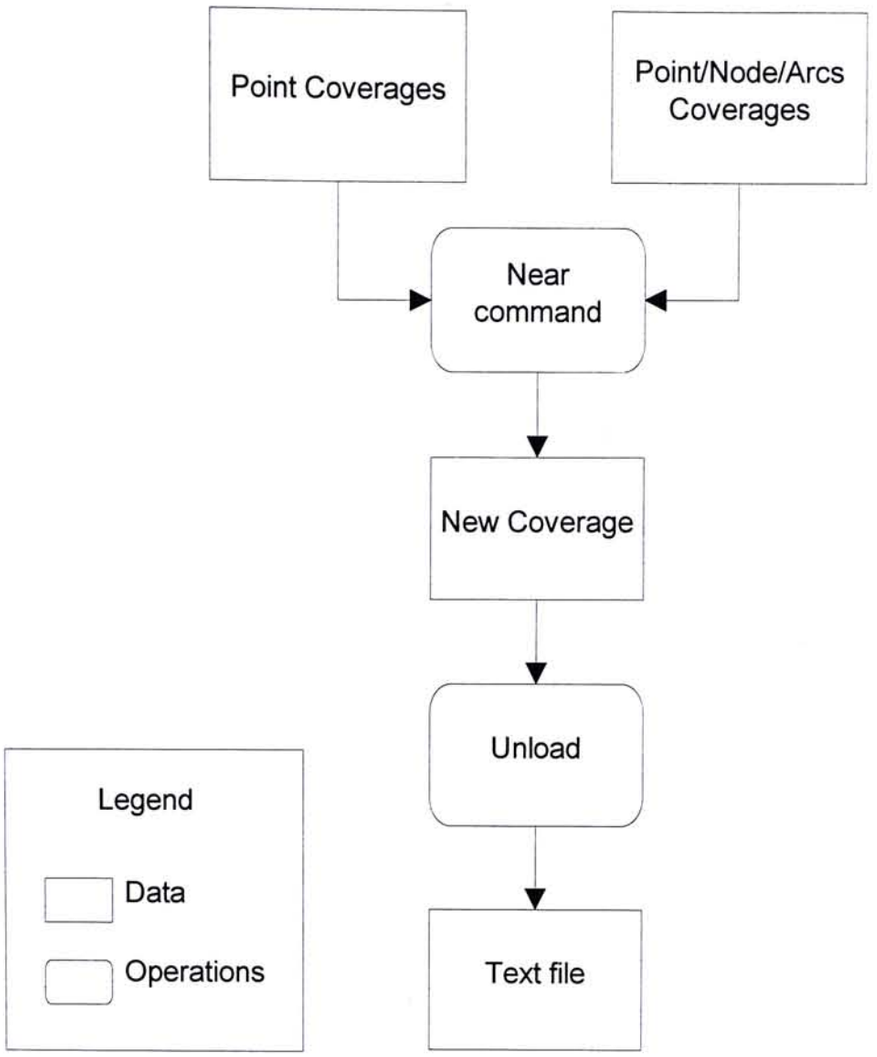


Figure 4.2 Flow diagram of proximity measurements

procedures are described in a flow chart (Figure 4.3) and they are now ready for statistical analyses.

4.6 Conclusion

This chapter has made an effort in reporting how the raw data are being handled. It is a challenge to integrate data from various sources and in different formats. With GIS, the task is done with greater accuracy and efficiency.

As this chapter presents the derivation of variables, such an understanding helps us to interpret the results presented in Chapter 5 and 6, the cartographic and statistical findings respectively.

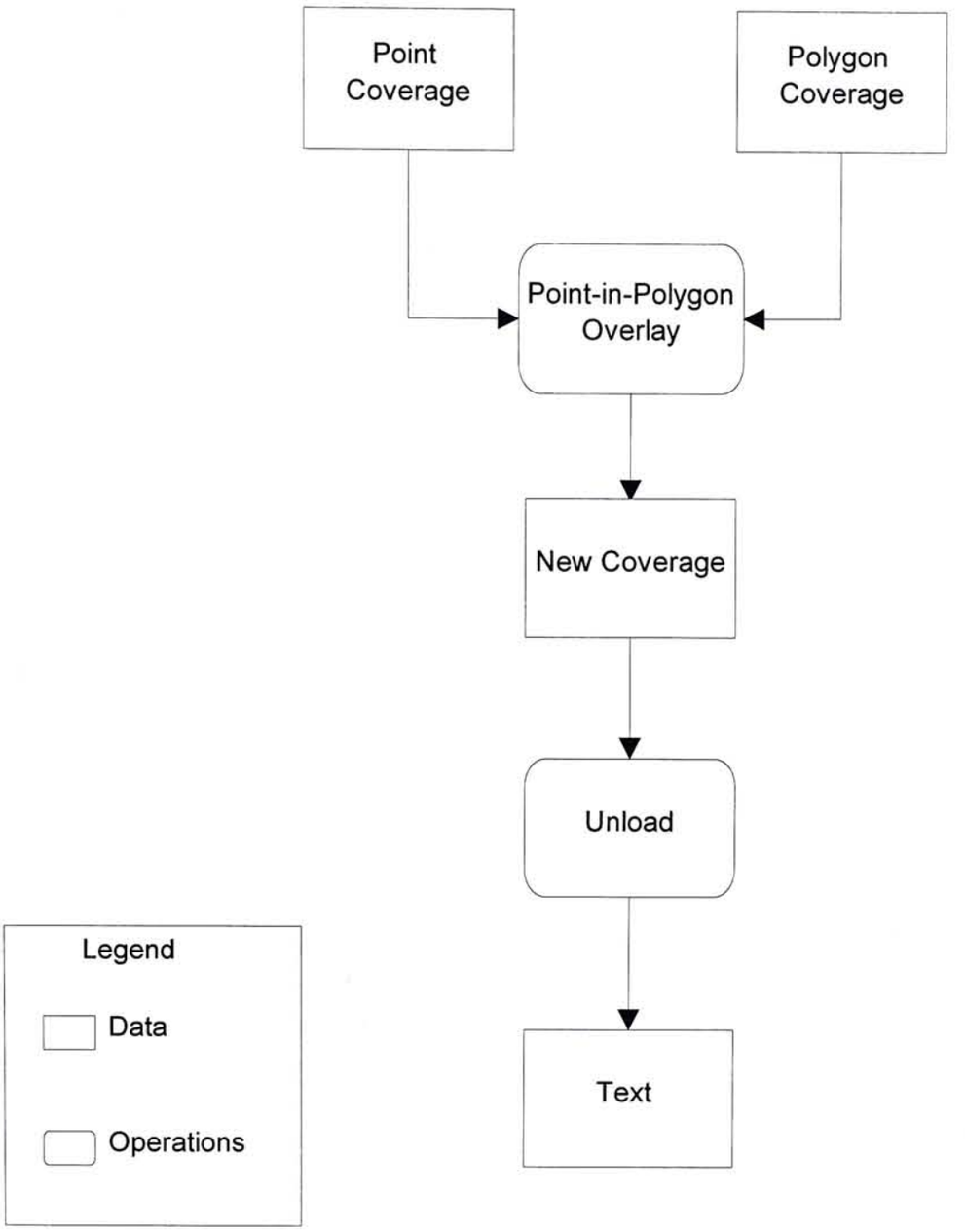


Figure 4.3 Flow diagram for general point-in-polygon overlay

CHAPTER V

CARTOGRAPHIC ANALYSIS

5.1 Introduction

This chapter aims at revealing the use of GIS to describe both data and results. In the first part, general background of the data set is briefly introduced with the help of maps. For the second section, it proceeds onto the discussion of temporal and spatial variation of housing provision in terms of location and attributes. While temporal variations rely heavily on simple descriptive statistics generated from GIS, spatial variations are better visualized with maps. All these qualitative analyses help to study the spatial pattern of housing in association with urban development.

5.2 Representation of Data

5.2.1 Location of Premises

A general impression of the newly issued premises in Hong Kong is shown in Plate 5.1. There were two major patterns in the New Territories. Clusters of housing estates were found in third generation new towns like Sheung Shui, Fanling, Tai Po and Yuen Long (Plate 5.2 & 5.3). Their locations reflected the planning rationale - development around market towns (Lo 1992). Another type of residential development was found along the coast near Sham Tseng and Sai Kung where good

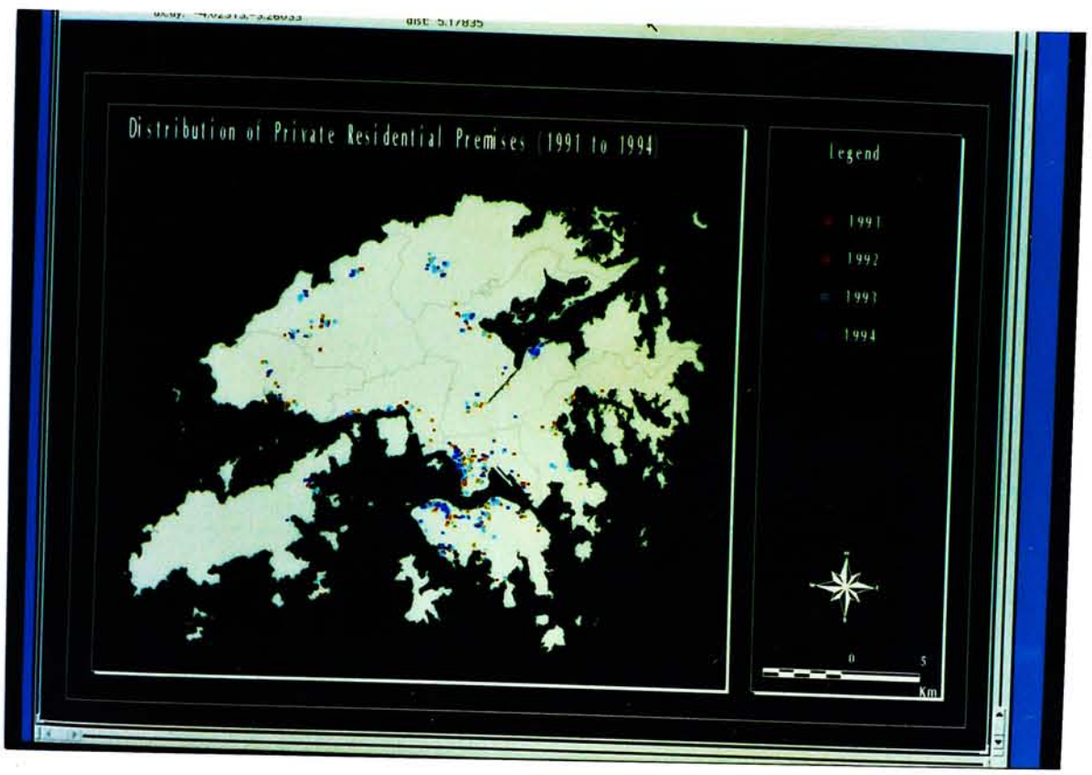


Plate 5.1 Distribution of private residential premises (1991-1994)

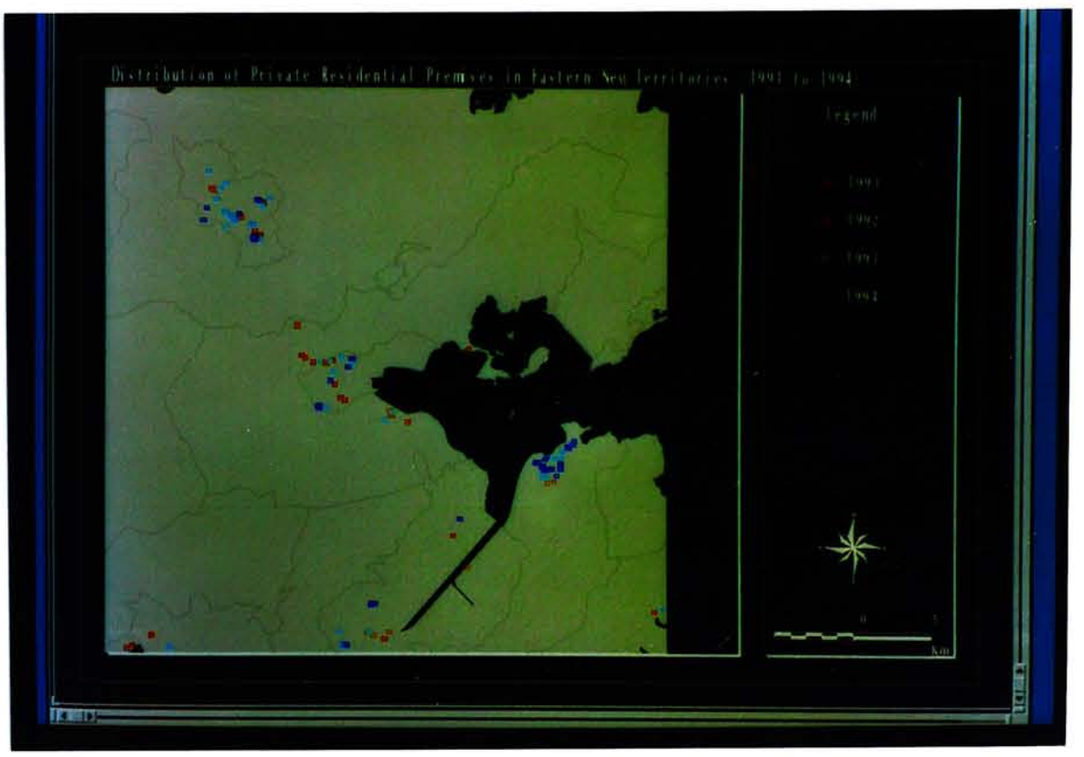


Plate 5.2 Distribution of private residential premises in Eastern New Territories (1991-1994)

Plate 5.3 Distribution of private residential premises in Western New Territories (1991-1994)

scenic views were offered. Housing development was concentrated on the northern coast of Hong Kong Island (Plate 5.4) and along the flanks of Kowloon Peninsula (Plate 5.5). It reflects the fact that, other than new town residence, urban districts are still areas of attraction to developers because of their convenient locations.

5.2.2 Proximity

Distances between the premises and their surrounding facilities are better presented with the use of buffering function of GIS (Plate 5.6). For example, around 64% (87 out of 135 cases) of the buildings in urban core were found along the MTR within a buffer zone of 1 kilometers (Plate 5.7 & 5.8). Similarly, in the New Territories, developments are found along the LRT in the west and KCR in the east (Plate 5.9 & 5.10). Approximately, half of the cases (26 out of 52 cases) are found within a buffer of 1 kilometers. All these figures may perhaps hint the importance of accessibility (Clapp 1987; Jackson 1979).

5.2.3 School Quality

The location of schools displayed distinctive pattern (Plate 5.11). They were primarily located in urban districts which more or less indicated the extent of urban area. In the New Territories, they clustered around existing market towns which were similar to the locations of residence. Yet, location of schools was not the principal concern of users. Rather, it was the school quality in each district that mattered (Plate 5.12). It was evident that better school zones were found in urban districts (Table 5.1)

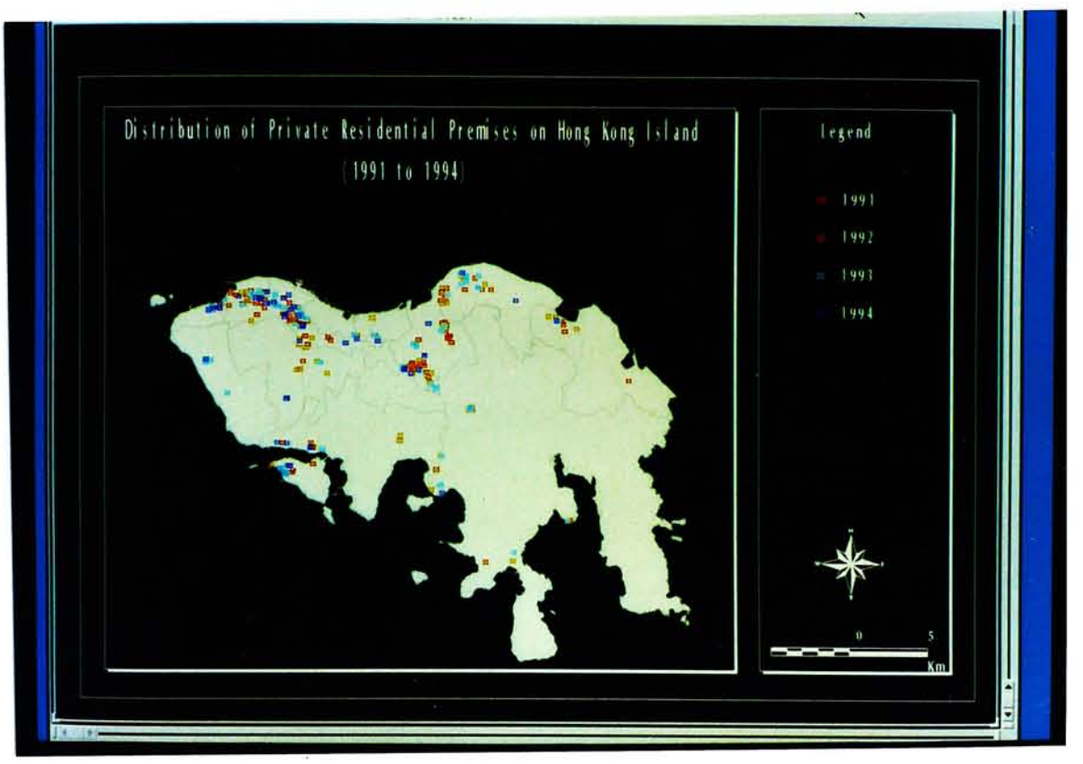


Plate 5.4 Distribution of private residential premises on Hong Kong Island (1991-1994)

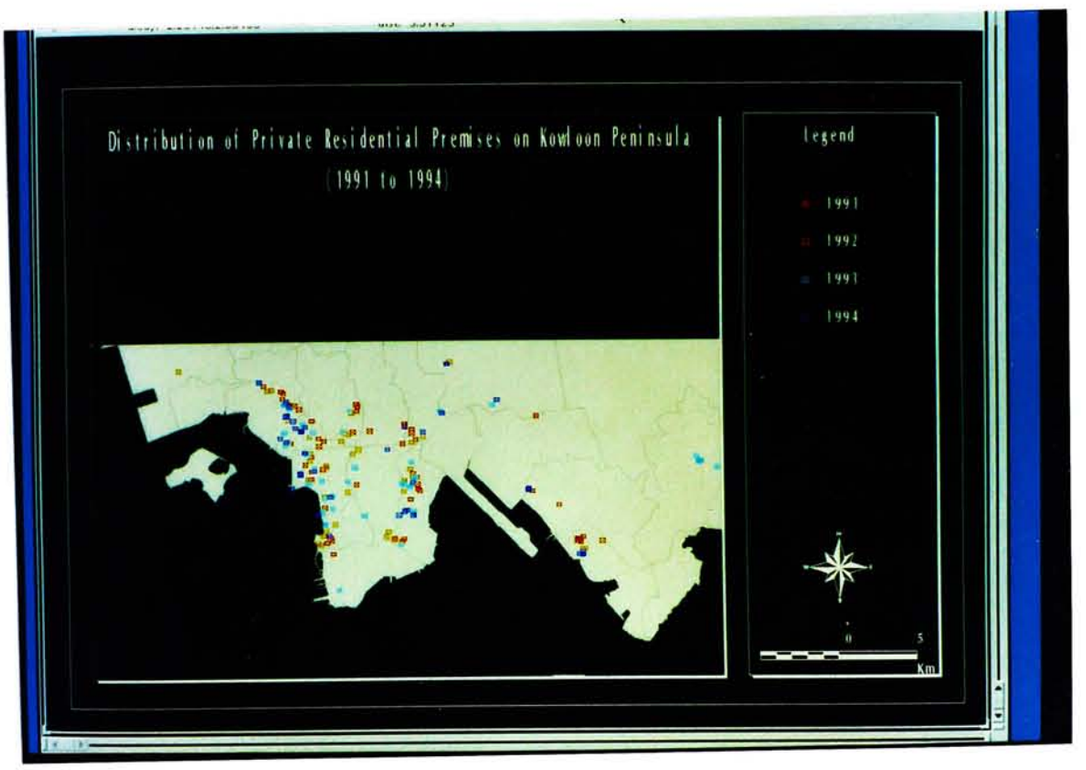


Plate 5.5 Distribution of private residential premises on Kowloon Peninsula (1991-1994)

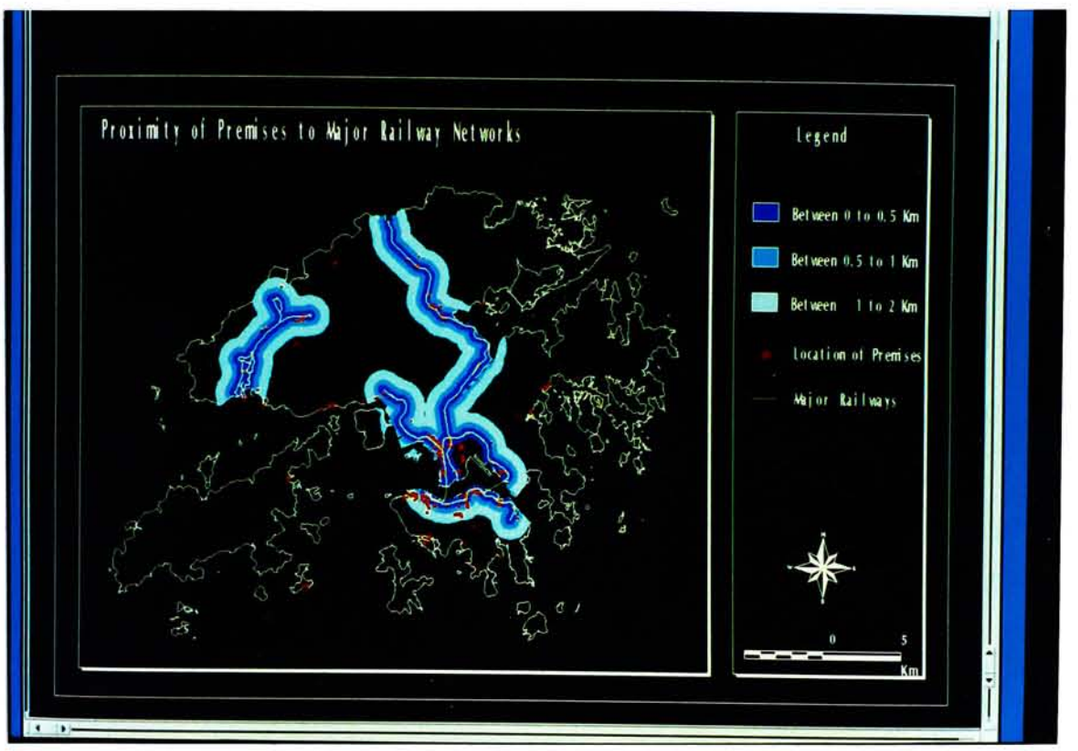


Plate 5.6 Proximity of premises to major railway networks

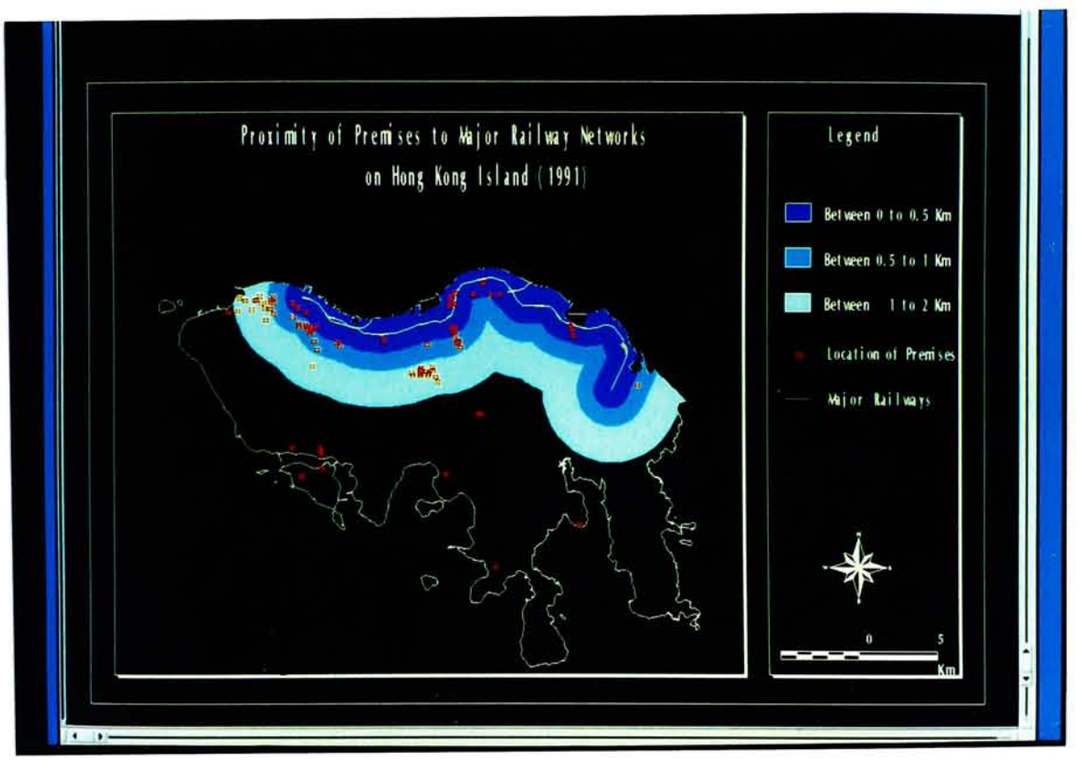


Plate 5.7 Proximity of premises to major railway networks on Hong Kong Island (1991)

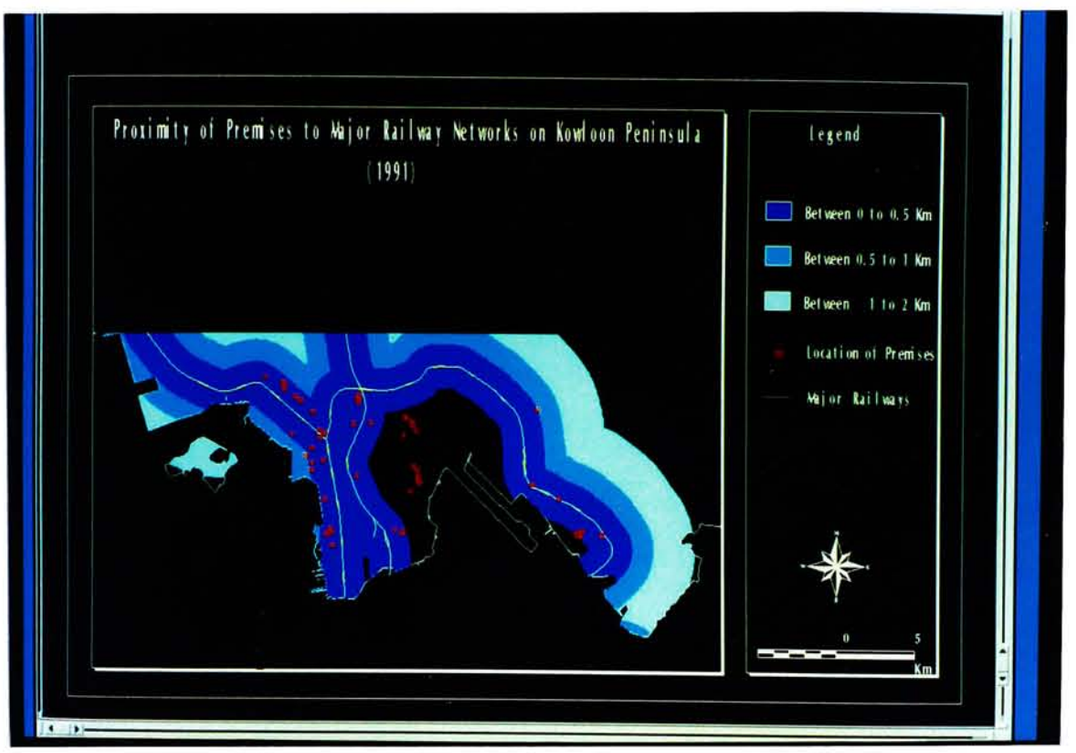


Plate 5.8 Proximity of premises to major railway networks on Kowloon Peninsula (1991)

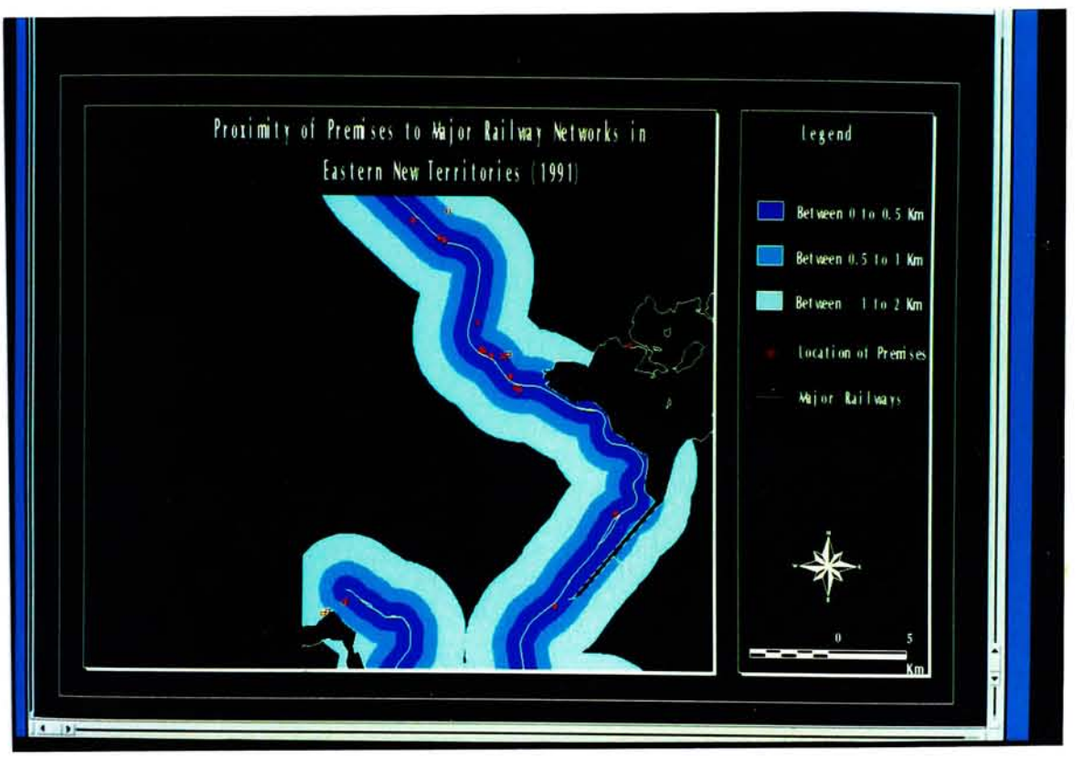


Plate 5.9 Proximity of premises to major railway networks in Eastern New Territories (1991)

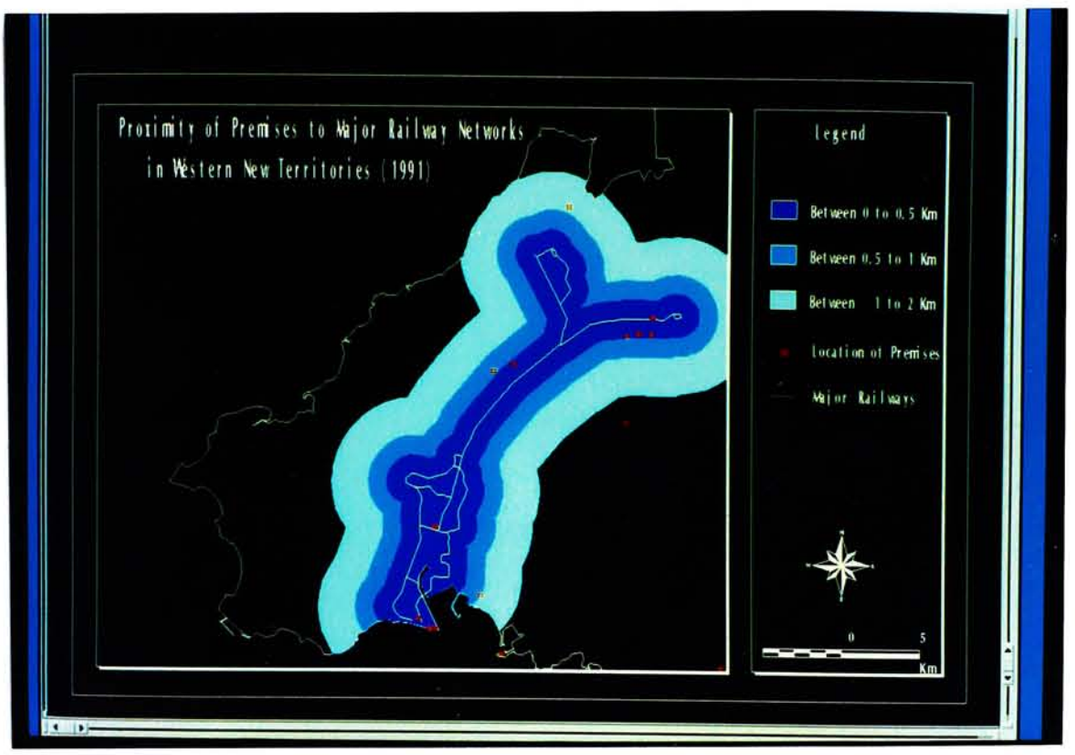


Plate 5.10 Proximity of premises to major railway networks in Western New Territories (1991)

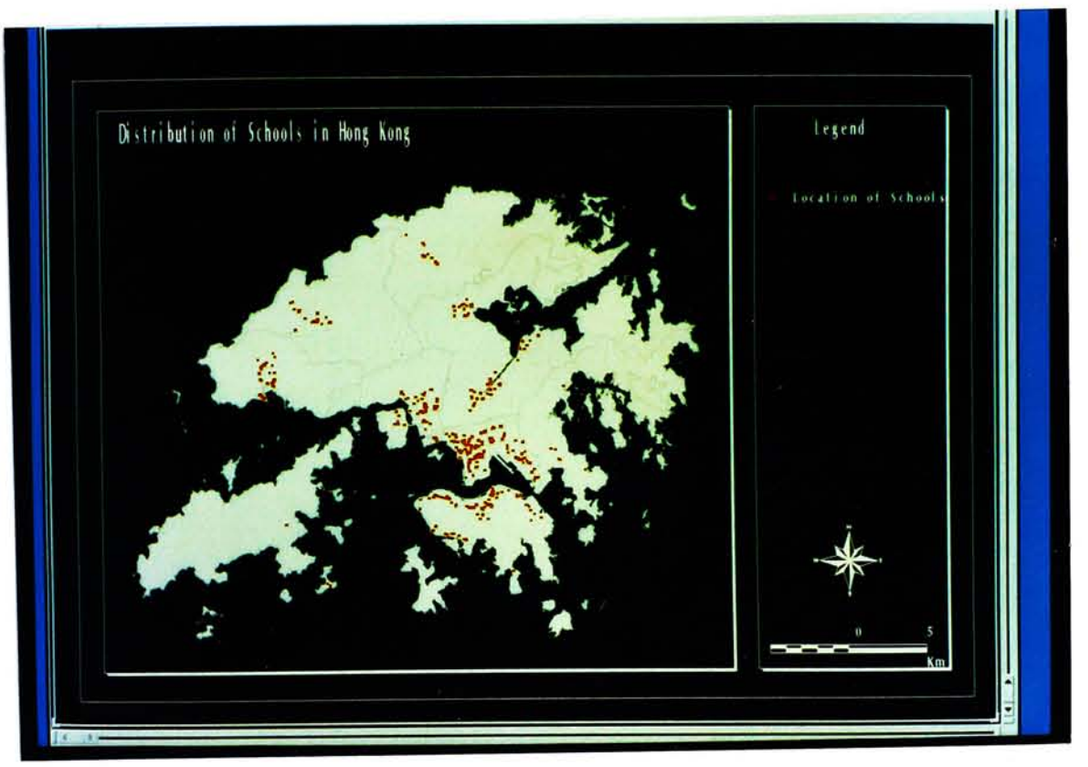


Plate 5.11 Distribution of schools in Hong Kong

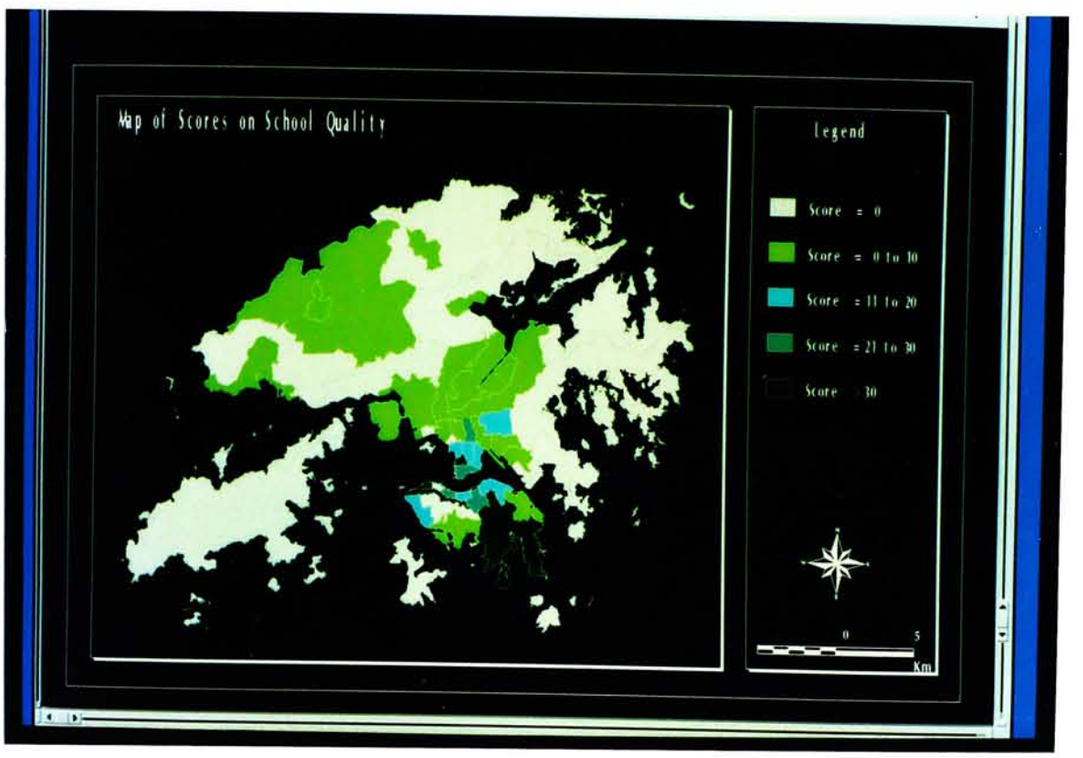


Plate 5.12 Map of scores of school quality

(1) District names	(2) Score obtained	(3) Total possible score#	(2) / (3) * 100 District School Score
central	24	87	27.5
sheungwan	0	29	0.0
west	67	203	33.0
midlevels	110	232	47.0
pokfulam	28	145	19.3
peak	0	58	0.0
wanchai	20	145	13.8
aberdeen	4	232	1.7
taihang	105	406	25.9
npointqbay	73	522	14.0
skwancwan	22	261	8.4
south	14	29	48.3
tsimshatsui	16	58	27.6
yaumatei	62	174	35.6
mongkok	45	348	12.9
hunghom	20	174	11.5
homantin	65	522	12.5
laichikok	0	145	0.0
cswan	15	261	5.7
shamshuipo	0	58	0.0
shekkipmei	33	435	7.6
ktong	78	319	24.5
kcitywtsin	5	290	1.7
twshanncwan	52	406	12.8
jvalley	15	203	7.4
kwuntong	46	638	7.2
yautong	0	87	0.0
tsuenwannt	56	1363	4.1
tsuenwanoa	0	0	na
tuenmunnt	22	870	2.5
tuenmunoa	0	0	na
yuenlongnt	13	348	3.7
tin shui wai	1	232	0.4
sshuifannt	19	232	8.2
fanlingoa	0	29	0.0
taipont	28	406	6.9
taipooa	0	58	0.0
shatinnt	55	841	6.5
ma on shan	5	261	1.9
sksouthhhau	0	58	0.0
junkbay	0	116	0.0
islands	0	87	0.0

*# express as no. of schools * no. of respondents (29)*
na not applicable

Table 5.1 District school scores in Hong Kong

which included Central, West, Mid-levels, Tai Hang and South districts on the island; Tsim Sha Tsui, Yau Ma Tei and Kowloon Tong in urban Kowloon where older and established schools were found. On the whole, the relative scores obtained in the New Territories were lower than those in the urban core. Therefore, it was probable that premises in different school zones commanded different prices (Jud & Watts 1981; Smith 1970).

5.2.4 Landuse Mix

Residential landuse could be found almost in every district (Plate 5.13). Sham Shui Po and Mongkok were the two districts that have over 40% of its area for residential purposes. A number of urban districts also had around 30% of its share used for accommodation (eg. Wan Chai, West, Kowloon Tong, Homantin). Surprisingly, the percentage in new towns was just around 10 to 20% (eg. Tuen Mun, Tai Po).

Commercial-residential landuse percentage (Plate 5.14) was highest in Tsim Sha Tsui (5.8%), followed by Central (4.0%), Wan Chai (1.3%), Mongkok (0.9%). Interesting enough, in new towns like Tai Po (2.2%) or Tsuen Wan (0.8%), mixed landuse was found usually with the existing market towns. The nature of mixed landuse in urban districts and market towns was quite different. While mixed landuse in urban districts were commonly referred as an indicator of convenience (where much of the facilities and employment are), those near old market towns conveyed the image of chaotic, polluted environments.

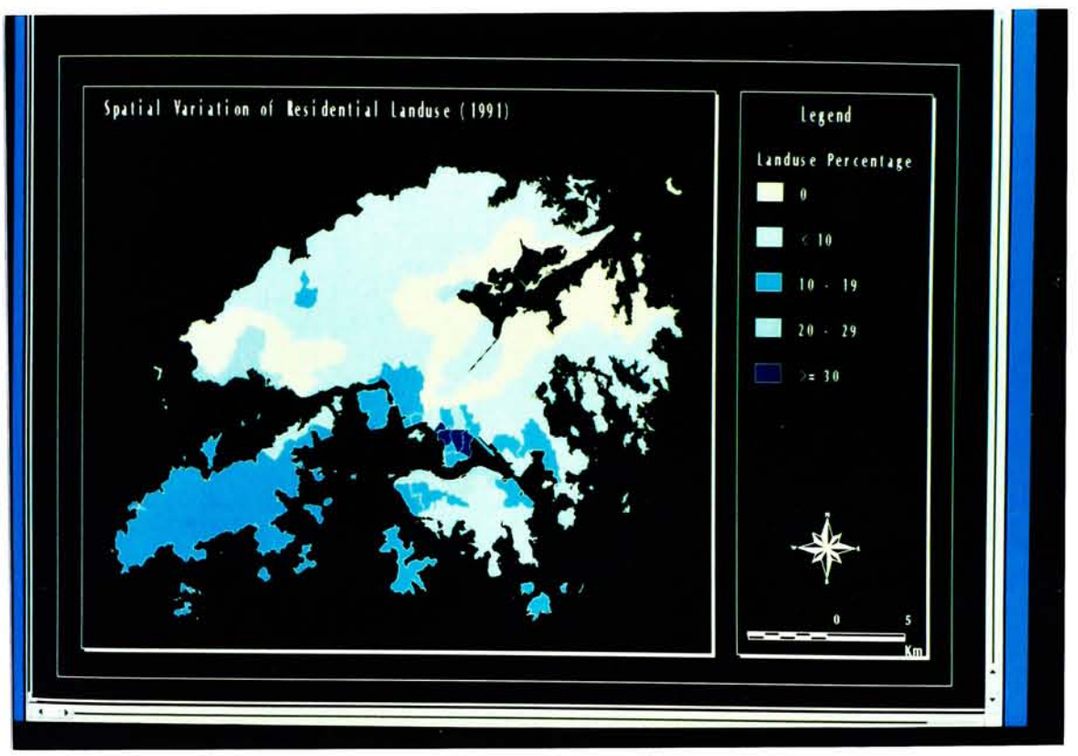


Plate 5.13 Spatial variation of residential landuse (1991)

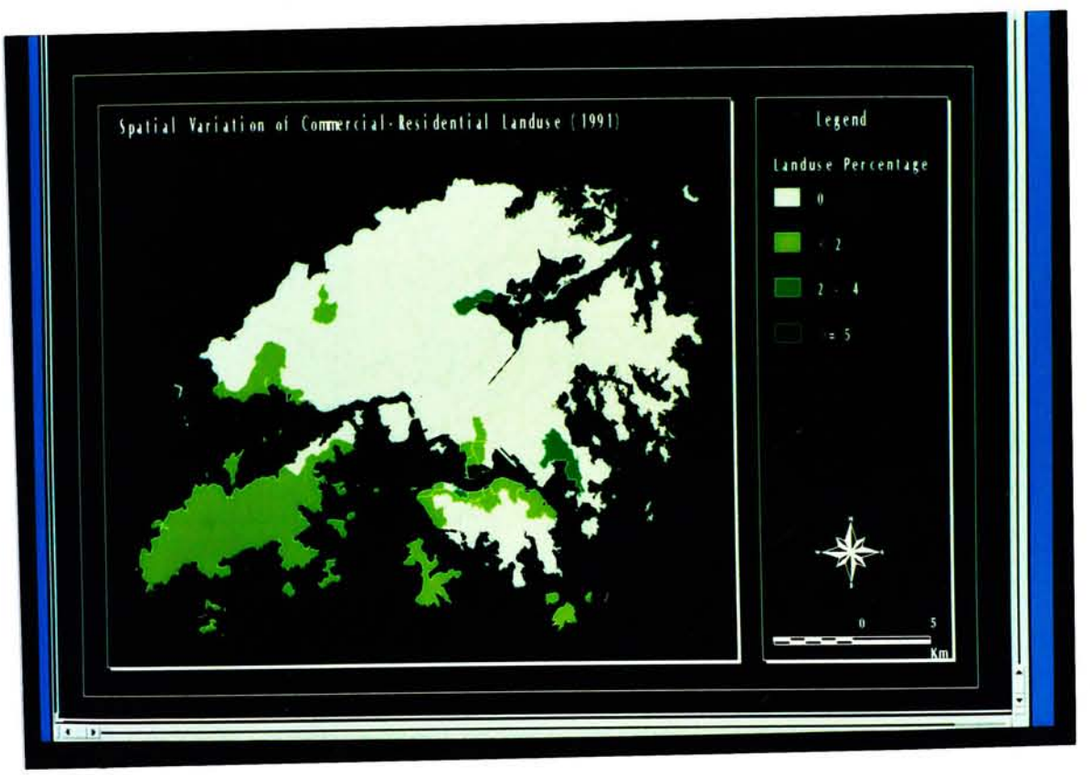


Plate 5.14 Spatial variation of commercial-residential landuse (1991)

Commerical landuse naturally agglomerated around the central business region (Plate 5.15) of Tsim Sha Tsui (13.3%), Central (24.2%), Sheung Wan (19.8%) and Wan Chai (14.5%). Commercial function was least found in new towns, except Shatin (0.5%) which was still incomparable with urban areas . Kwun Tong (13.3%) and Tsuen Wan (8.9%) continued to be major areas of industrial landuse (Plate 5.16). Yau Tong, being adjacent to Kwun Tong also had considerable share of industrial landuse (9.9%). In the New Territories, industrial landuse percentage was highest in Tin Shui Wai (12%) where the newly established Yuen Long industial estate was, with Tsuen Wan being the next (8.9%). The pattern confirmed that the industrial and commercial activities were still established around certain localities.

5.2.5 Employment

Employment was one of the proven variables that concerned consumers in residential choice (Mehat & Mehta 1989). Density surfaces of employment could be produced easily with GIS. With the centroid of districts used as the control points, density surface was generated based on the spatial interpolation of control points. The intensity of color of the surface helped identify major centres which might exert influence on housing price. A single service-employment centre was found in the west to central part on Hong Kong Island (Plate 5.17). Industrial employment concentrated in the traditional centres of Tsuen Wan and Kwun Tong (Plate 5.18). Finally, most distribution services were mainly found in the western tip of Hong Kong Island. Substantial distributional activities were also found on Kowloon with two

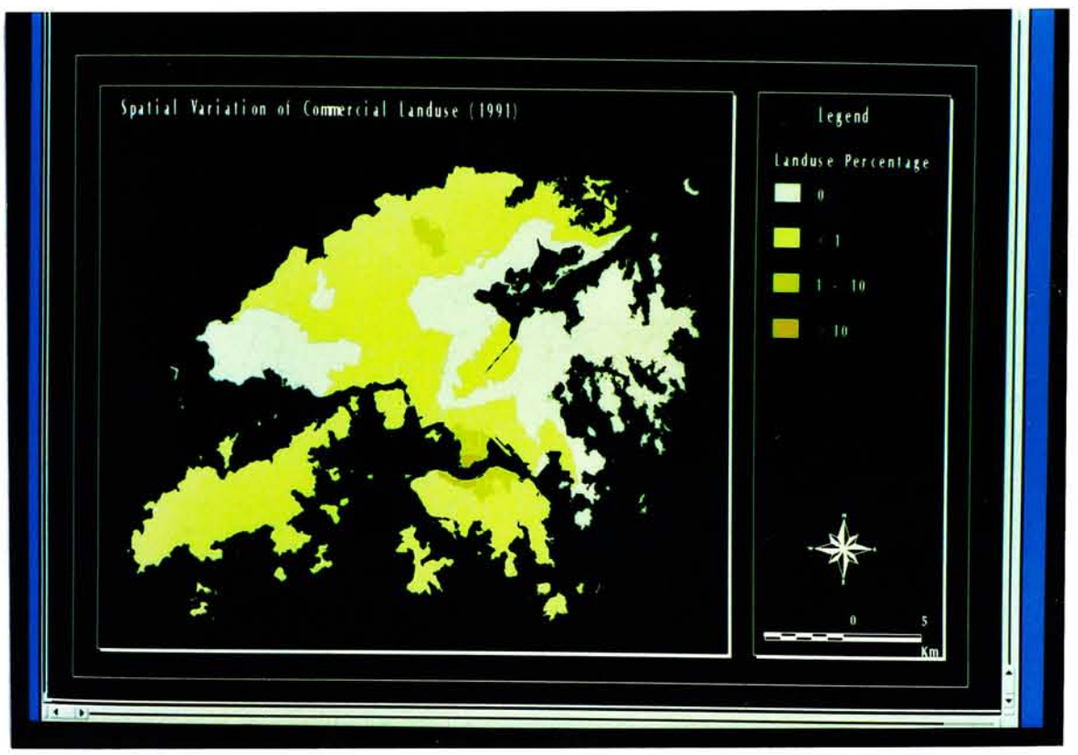


Plate 5.15 Spatial variation of commerial landuse (1991)

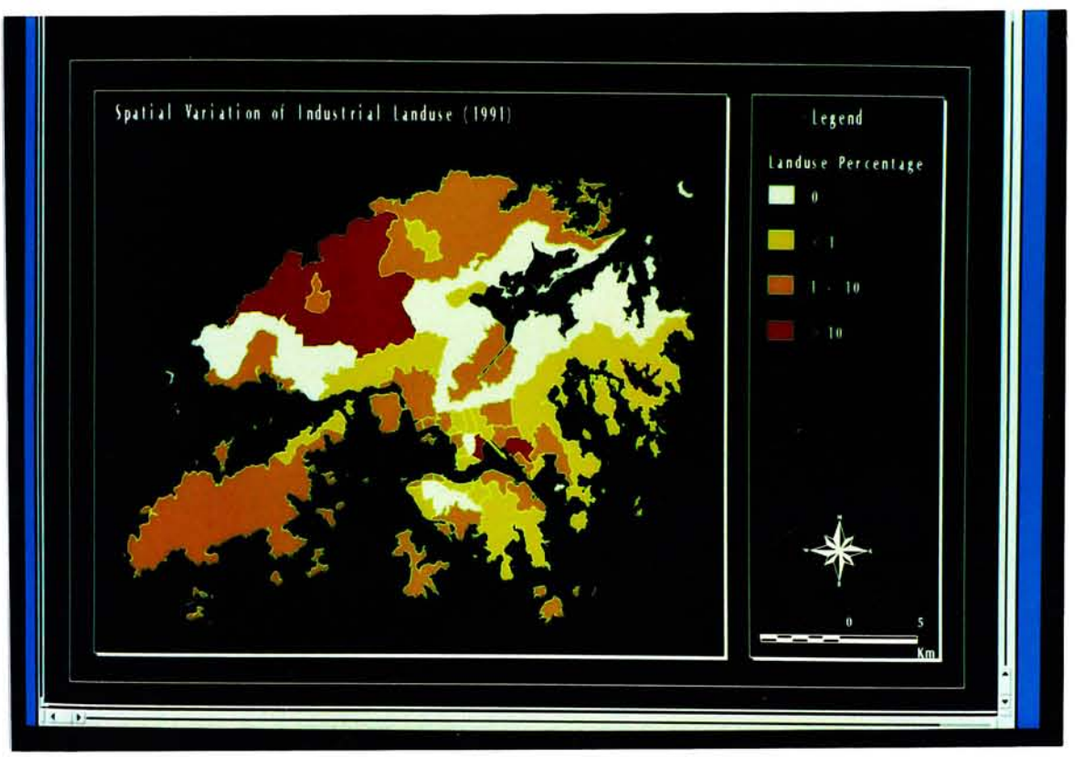


Plate 5.16 Spatial variation of industrial landuse (1991)

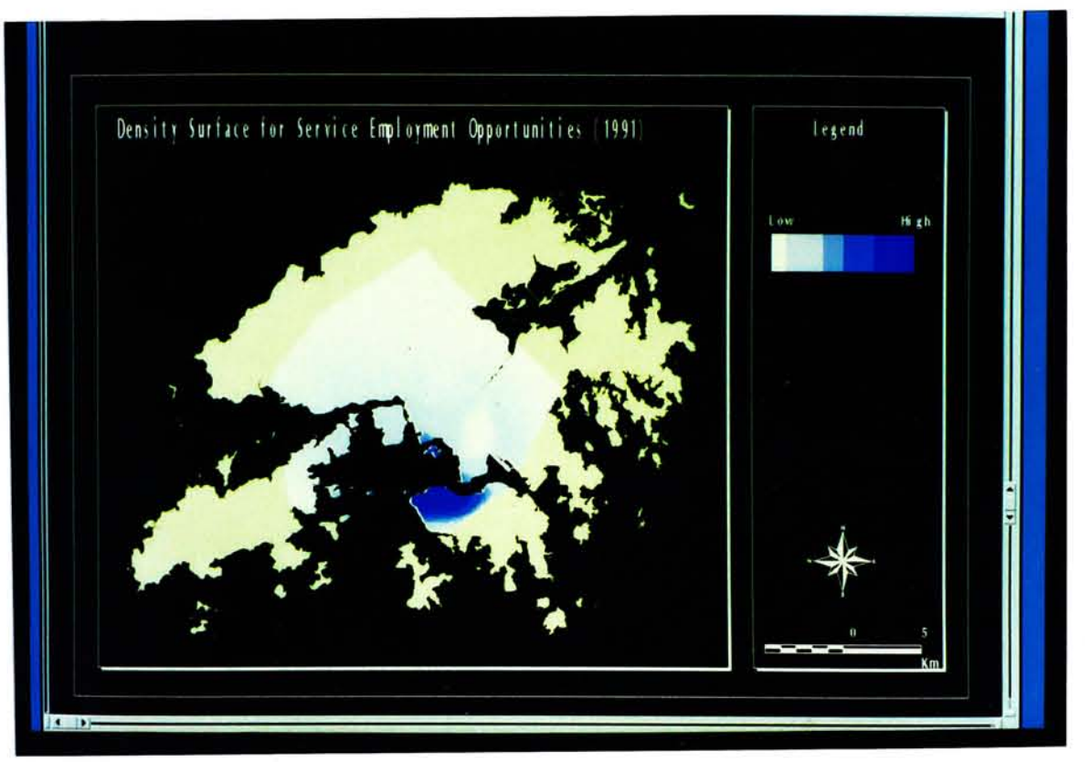


Plate 5.17 Density surface for service employment opportunities (1991)

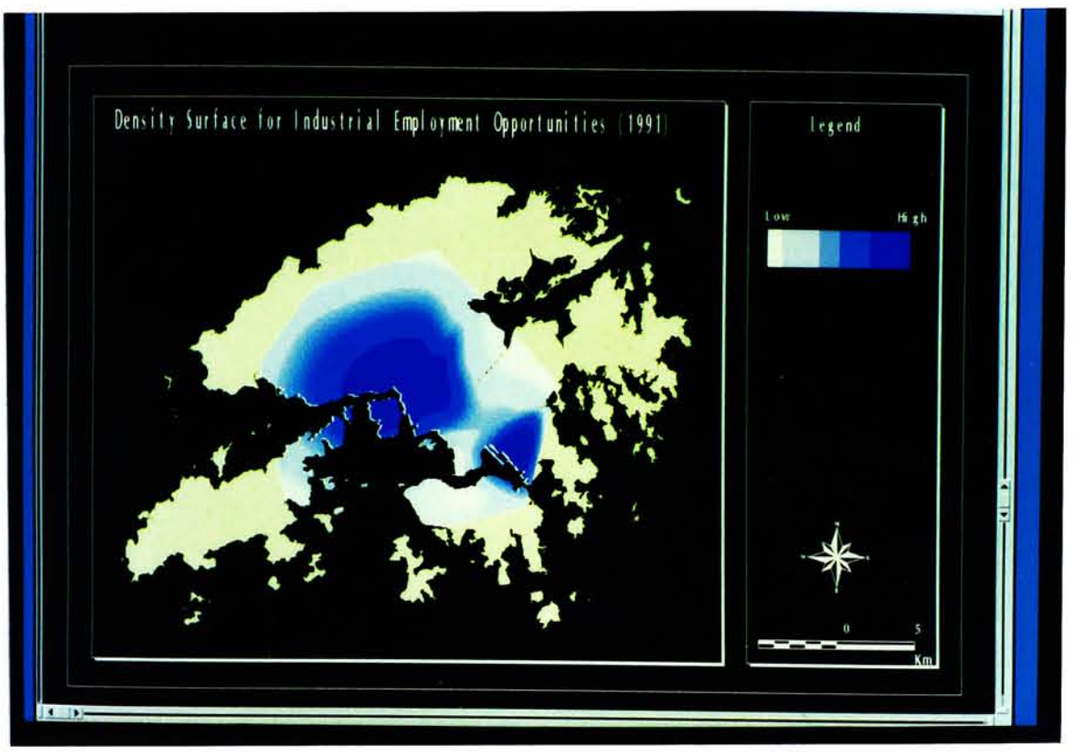


Plate 5.18 Density surface for industrial employment opportunities (1991)

patches of blue : emerging from places in Kowloon Bay in the east and Cheung Sha Wan to Lai Chi Kok in the west (Plate 5.19).

5.2.6 Property Price

The shape and intensity of colors were visually informative about the spatial variation in property price (Plate 5.20 to 5.23). Quite a consistent pattern was found among the four years except in 1992. Throughout 1991 to 1994, Hong Kong Island was usually a high-priced area with the highest price found in districts like Mid-levels and the South. Kowloon peninsula came after the Island where the highest was found in Kowloon Tong district. These districts were low-density, prestigeous areas of residence for the more affluent households. Except 1992, the eastern New Territories outbided its western counterparts. With the KCR railway, new towns in the east were linked up with the urban cores which provided better transportation to workplaces. In contrast, western New Territories suffered from notorious traffic congestion along the Tuen Mun Highway which dragged down the hedonic price there.

5.3 Results and Discussions

A preliminary analyses of the raw and derived data reveals the pattern of spatial variation of different variables, extracted from the database. It is appropriate then to study the temporal variation of housing supply and its attributes.

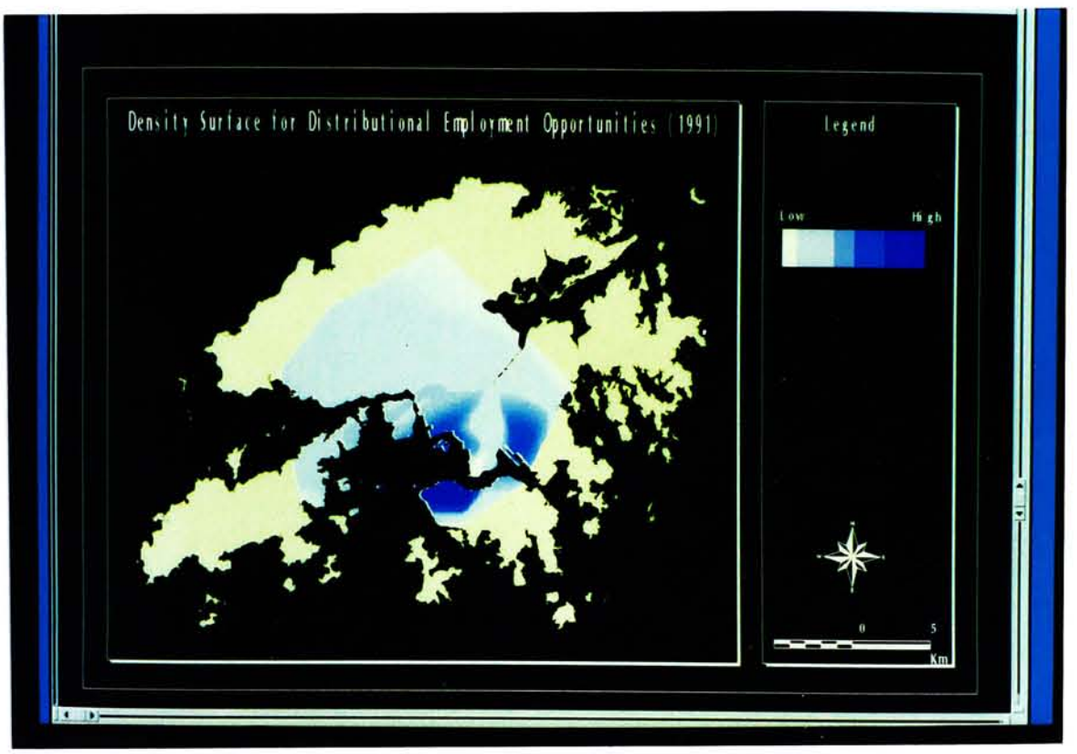


Plate 5.19 Density surface for distributional employment opportunities (1991)

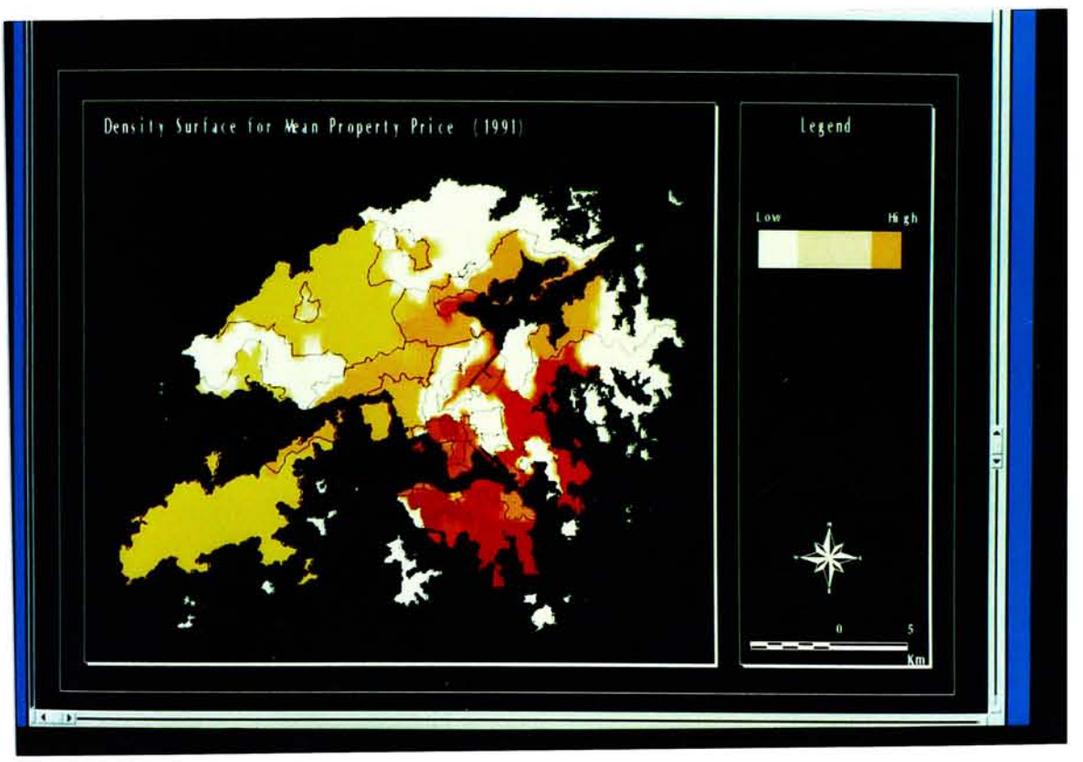


Plate 5.20 Density surface for mean property price (1991)

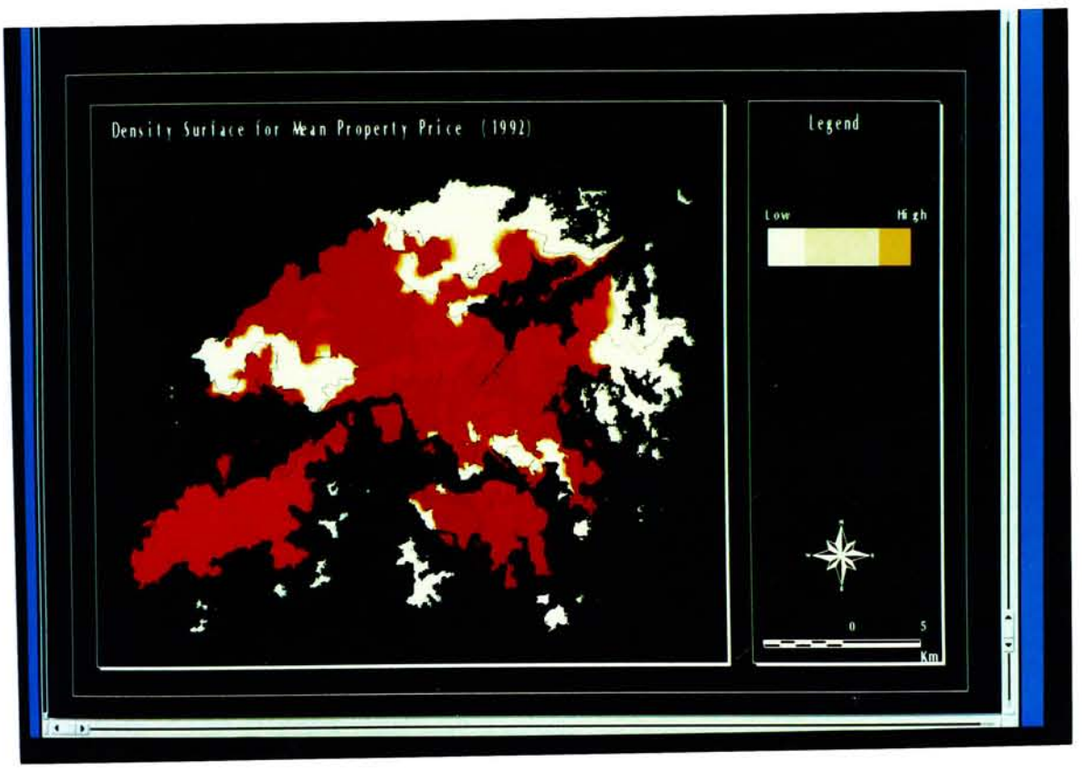


Plate 5.21 Density surface for mean property price (1992)

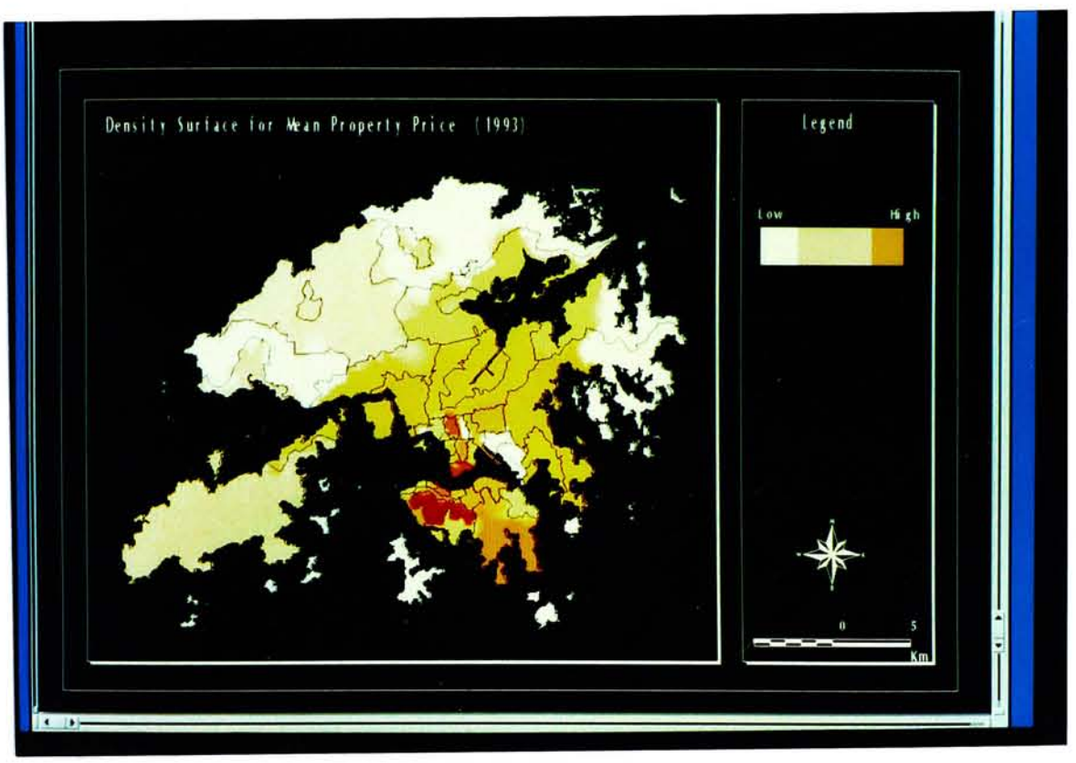


Plate 5.22 Density surface for mean property price (1993)

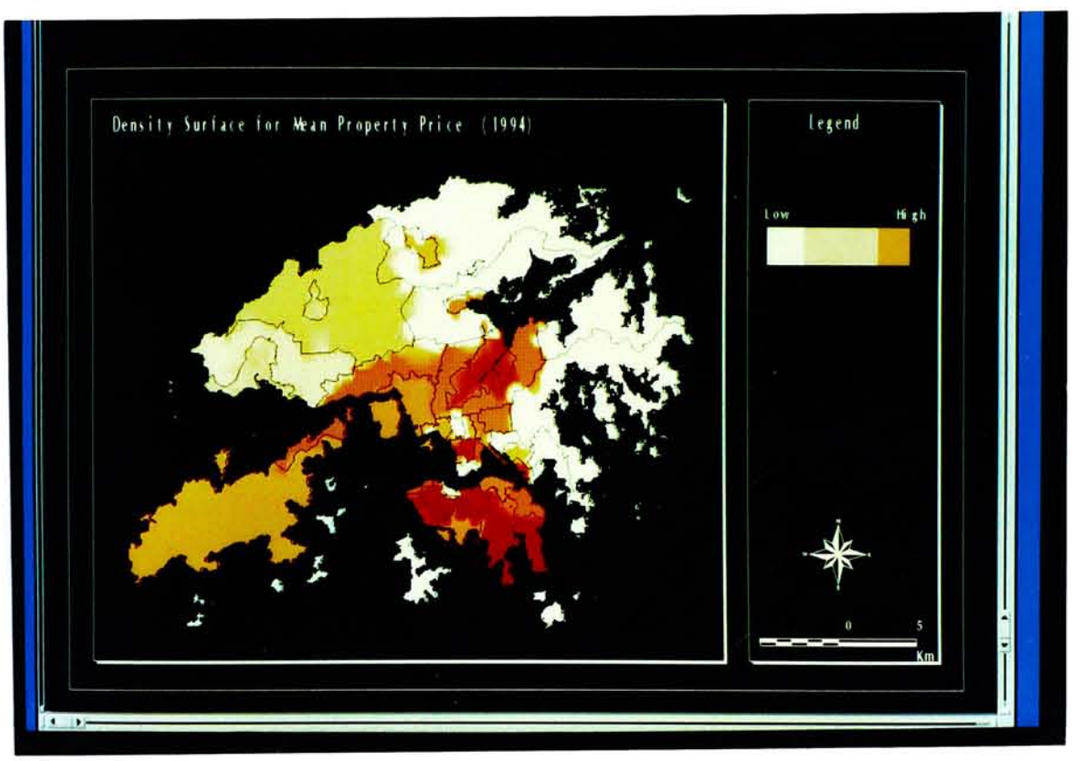


Plate 5.23 Density surface for mean property price (1994)

5.3.1 Temporal Variations on Housing Supply

Table 5.2 presented some facts about shelter provision in Hong Kong from 1991 to 1994. In terms of the number of premises, it seemed to suggest that there was a stable supply, ranging from 192 to a maximum of 204 premises. However, it was quite deceptive as the number of units supplied varied across time. A climax of 23437 units was recorded in 1991 while a significant decline of 53% was experienced in 1994 (11016 units). This fact was further amplified in the figure of total floor space supplied : the 1994 figure was only about 45% of that in 1991.

The shrinkage in housing stock coincided with the general investment environment at that time. The lending rate persisted to be negative and all forms of investment were boosted up in 1991. During 1992 and 1993, there was a divergence of funds from the territory to the property boom in the Pearl River Delta (Tsang 1994) and thus, the market stock started to shrink. Following the fiscal policies in the United States, mortgage interest rate was raised 4 times to 10.25 percent within 1994 which made it less affordable for consumers (Yu 1995). Further decline continued as the government introduced measures to curb speculation. Demand from end-users and speculators immediately softened. In response to their withdrawal, the developers withheld the sale of units.

Year	Number of premises	Number of units	Total floor space (sq. ft)
1991	192	23437	18125559
1992	192	15992	12338546
1993	204	19619	15078932
1994	197	11016	8177077

Table 5.2 Temporal variation on housing supply in Hong Kong

5.3.2 Temporal Variations on Floor Size

There was not much changes in the annual mean floor size, though it was evident that there was a continual decline across time (Table 5.3) from 973 in 1991 to 818 in 1994. Absolute number of cases in different categories of floor size were summarized (Table 5.4) and in terms of percentage, it reflected that most of them were of medium size. Over 50% of the stock belonged to this category. The trend was quite consistent over time with an increasing share in the market , from 53% in 1991 to 68% in 1994. Small-sized and large-sized flats experienced a steady decrease in importance to the market. For those less than 500 square feet, it took up 21% of the stock in 1991 which became 14% in 1994. Those over 1000 square feet dropped from 29% in 1992 to only 18% in 1994.

The dynamic market structure of housing stock indicated several societal changes. As private developers shifted their focus towards new towns, larger land parcels were obtained for comprehensive housing estates. Therefore, the lots were not partitioned to small apartments like those in urban cores; rather, more spacious floor space was possible. In accordance with the rising living standard of the population, the population of middle-income households were increasing. Their desire for home-ownership was made possible and easier if the sales price of a flat was not too high. Therefore, developers tended to supply medium-sized flats so that these households found them easier to afford.

Year	Mean floor area (sq. ft)	Standard deviation	Mean asking price (psf)	Standard deviation
1991	921.0	636.3	$ 2454.2	$ 724.0
1992	972.8	728.1	2485.4	570.9
1993	844.3	525.9	2417.8	691.5
1994	817.5	530.0	2711.2	1011.9

Table 5.3 Temporal Variation on housing attributes in Hong Kong

Year	Floor Area (sq.ft)						Total
	S	%	M	%	L	%	
1991	40	21	102	53	50	26	192
1992	40	21	96	50	56	29	192
1993	31	15	134	66	39	19	204
1994	28	14	134	68	35	18	197

Key : *S = < 500 sq.ft* *M = 500-999 sq.ft* *L = > 1000 sq.ft*

Table 5.4 Number and percentage of premises by floor area

5.3.3 Temporal Variations on Property Price

The overall annual mean price of the samples illustrated the volatile nature of property market in Hong Kong. Annual mean price was quite stable with less than $2500 per square feet (psf) but suddenly jumped to over $2700 psf in 1994 (Table 5.3). Over time, the market share of flats with asking price less than $1800 psf were quite stable at around 15% (Table 5.5); those fell into the price range of $1800 - $2399 fluctuated between 22% to 36%. The third group ($2400-2999) did contribute a stable share of 30%. Finally, those flats with $3000 psf or over were quite steady until 1994, an exceptionally high proportion of 29% was recorded. It demonstrated that a diversity of properties were supplied to match the varying affordability of different income-groups.

It seemed to present a contradictory picture to the investment environment : while the unfavourable economic factors should adversely affect property price in 1994, the annual mean price was the highest of all. This could be clarified because nearly one-third of the premises fell into the higher-priced category (Table 5.5). Thus, the annual mean price was biased upwards because of the intrinsic nature of the data, not attributed by economic reasons.

Year	Asking Price (psf)								
	1	%	2	%	3	%	4	%	Total
1991	36	19	51	26	69	36	36	19	192
1992	22	11	69	36	69	36	32	17	192
1993	34	17	74	36	64	31	32	16	204
1994	30	15	43	22	66	34	58	29	197

Key : *1 = < $1800*
2 = $1800-2399
3 = $2400-2999
4 = >= $3000

Table 5.5 Number and percentage of premises by price range

5.4 Locational Variations

Apart from the temporal changes in housing, the spatial patterns also reveal distinctive changes occurred over years. Therefore, the location of housing development and its attributes are discussed below.

5.4.1 Shift towards the New Towns

The emphasis of residential development shifted from urban areas towards the New Territories (Table 5.6). In 1991, the proportion of premises built in the urban core was approximately 71% while in the New Territories, it was only 27%. Situation started to change and, by 1994, the supply proportion between urban and New Territories seemed to reach a balance. Eastern New Territories, including the new towns along KCR, experienced a marked increase of 138.5% (Table 5.7), while the west also recorded a moderate growth of 21.4% with development commonly found in Tuen Mun, Yuen Long and Tin Shui Wai. Similar conclusions could be drawn when examining the number of units (Table 5.8).

Among the large-scale railway constructions spelt out in the *White Paper on Hong Kong Transport Policy (Moving into the 21st Century) (1990),* priorities were given to projects in the eastern and western New Territories. Not only did they provide better linkages with the urban core but also placed much emphasis on the newly developed centres like Tin Shui Wai in the west. Together with Yuen Long and Tuen Mun, they would serve as new centres for China trade (Wang 1995) as

Region\Year	1991	1992	1993	1994	Change*
	Percentage				
Hong Kong	44	38	30	27	-17
Kowloon	27	26	19	23	-4
Urban core	***71***	***64***	***49***	***50***	
West New Territories	14	21	20	17	+3
East New Territories	13	15	30	31	+18
New town	***27***	***36***	***50***	***48***	
Islands	2	0	1	2	0

** 1994 minus 1991*

Table 5.6 Percentage share of total premises supplied among regions

Region\Year	1991	1992	1993	1994	% change*
Hong Kong	85	73	62	54	**-36.4**
Kowloon	51	49	38	45	**-18.5**
West New Territories	27	41	40	33	**+21.4**
East New Territories	24	28	62	60	**+138.5**
Islands	5	1	2	5	**0.0**

** express as (1994-1991)/1991 *100%*

Table 5.7 Percentage change in number of premises among regions

Region\Year	1991	1992	1993	1994	Change*
	Percentage				
Hong Kong	31	27	21	21	**-10**
Kowloon	30	32	12	18	**-12**
Urban Core	***61***	***59***	***33***	***39***	
West New Territories	23	29	34	23	**0**
East New Territories	14	12	32	34	**+20**
New town	***37***	***41***	***66***	***57***	
Islands	2	0	1	4	**+2**

** 1994 minus 1991*

Table 5.8 Percentage share of units supplied among regions

further land transport (eg.Lingdingyang Bridge) and cross-border passenger service were encouraged. To the east, KCR also planned to extend railway services from Ma On Shan to Tai Wai. As the economic activities between Hong Kong and South China were bound to be rigorous in the future, areas near the border became a desirable place for residence. This called forth a quickening pace of development to commence at designated centres. It was the dynamic urban and economic setting that explained the changing emphasis of housing supply in Hong Kong.

5.4.2 Relative Importance among Districts in New Towns

In the west, Tsuen Wan lost its importance to Tuen Mun and Yuen Long in terms of share of units supplied in the region (Table 5.9). By 1994, the importance of these two centres were nearly equal in terms of regional total. In the east, the combined effect of Shatin New Town and Ma On Shan outweighed all other centres (Table 5.10). It took up an increasing share of regional supply and the figure climbed from 8% to 65% within 4 years. Junk Bay, too, had a 20% supply in 1993. The most conspicuous decline was revealed in Tai Po which dropped from a maximum of 45% in 1991 to only 7% in 1994. Other centres also experienced similar downward pattern but of a much steady pace. This pattern of changing in importance hinted the different stages of development in which new towns were at.

In the west, Tsuen Wan was the most developed new towns since 1961. With over 30 years of exploitation, much of the potentials had been tapped. Balanced with her down-turn was the recent development in Tuen Mun (1965) and Yuen Long

Districts	1991	1992	1993	1994
	Percentage of Regional Supply			
Tsuen Wan	31	25	31	11
Tuen Mun	15	58	23	48
Yuen Long/Tin Shui Wai	54	17	56	42

Table 5.9 Relative importance of supply proportions in Western New Territories

Region\Year	1991	1992	1993	1994
	Percentage of Regional Supply			
Shengshui/Fanling	39	27	38	27
Tai Po	45	19	3	7
Shatin/Ma On Shan	8	52	57	65
Sai Kung	8	12	1	0
Junk Bay	0	0	20	0

Table 5.10 Percentage share of units supplied in Eastern New Territories

(1978). It was clear that Yuen Long was at a later stage of new town development than Tuen Mun and Tsuen Wan. Thus, it had more land for development and other resources that had not been exploited. This was further confirmed in the case of Tin Shui Wai in Yuen Long which was a new town of the 1980s. Being the latest version of development, much of the focus had been put over there.

Similarly, in the east, Tai Po was designed as new town in 1979 together with Sheung Shui/Fanling. They were entering the mature stage of new town development which then explained their declining importance. On the contrary, even though Shatin entered its final stage of development, its plan was constantly under revision (Bristow 1989) in response to the increasing population. Finally, in 1988, Ma On Shan was sketched to become an extended part of Shatin New Town. Therefore, Ma On Shan was only at the initial stage of new town development; so was Junk Bay. Similar to Tin Shui Wai, much of the land was not yet serviced. Thus, it provided ample opportunities for developers to utilize the resources at much lower cost.

Witnessed from the above comparisons was the fact that, the variation of importance among districts in terms of housing provision reflected the stage of development within each new town. While Tsuen Wan was the first generation new towns that has almost been tapped, its importance has long-lost to its neighboring new towns. Tai Po, Sheung Shui/Fanling, Tuen Mun were entering the mature stage which were reflected by their declining share in supply. Even though Shatin and Yuen Long were not newly designated areas, their importance had increased because the revision of their new town plans had designated an extension for each of them, Ma On Shan

and Tin Shui Wai respectively. The latter two extensions were called the fourth generation new towns (Bristow 1989). They were essentially at a newly developing stage which echoed with the rigorous residential development to utilize their unexploited land resources.

5.4.3 Pattern of Development

5.4.3.1 Urban Core

It was apparent that residential provision continued to focus on the northern coast of Hong Kong Island (Plate 5.24) and the two flanks of Kowloon peninsula (Plate 5.25). Most of the development in 1994 were found in districts like Wan Chai, Kennedy Town and Sheung Wan instead of North Point/Quarry Bay or Happy Valley; Mongkok, Cheung Sha Wan, Sham Shui Po and Hunghom rather than Yau Ma Tei.

These new premises were usually the results of urban renewal. It was plausible that urban redevelopment was conducted in an uncoordinated manner. Their occurrence was somewhat random in pattern. While areas like North Point/Quarry Bay or Yau Ma Tei might have undergone redevelopment in earlier years, it was likely for small developers to identify new potential sites. This was particularly the case when future urban plans were announced. For instance, Tsim Sha Tsui and Hunghom would merge to become a single focus of employment when the KCR completed its extension; West Kowloon (Cheung Sha Wan/Tai Kok Tsui) was designated to play the role of terminus for rails; further west extension of the MTR

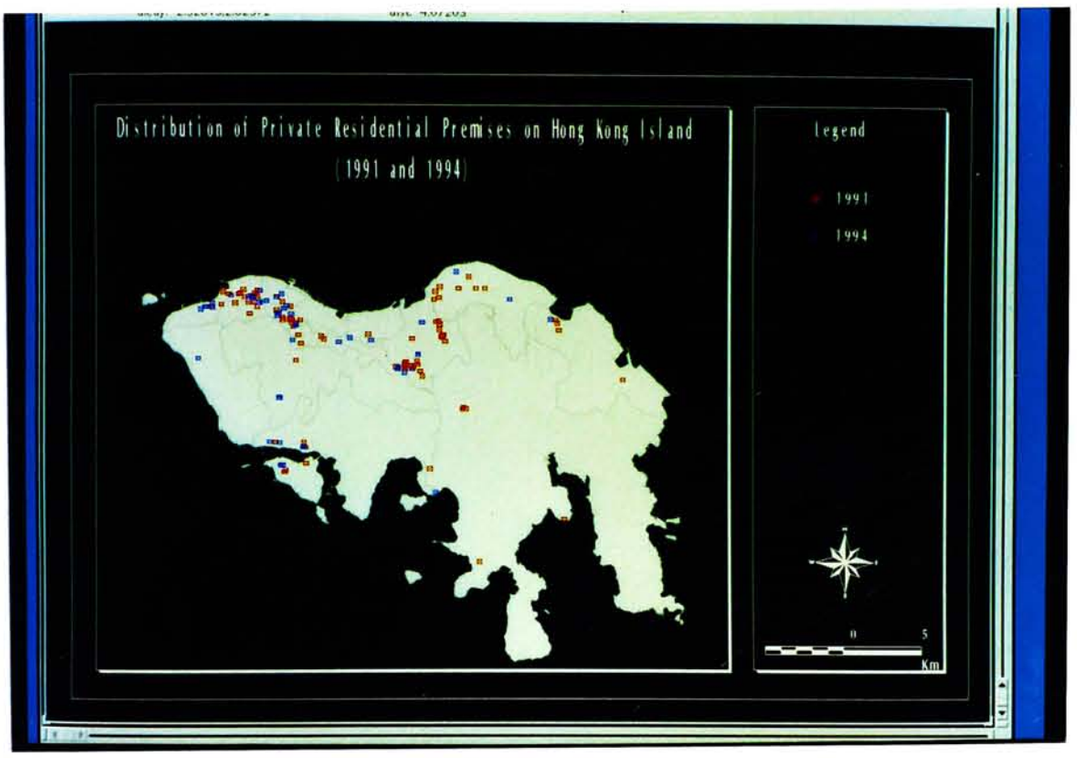


Plate 5.24 Distribution of private residential premises on Hong Kong Island (1991 and 1994)

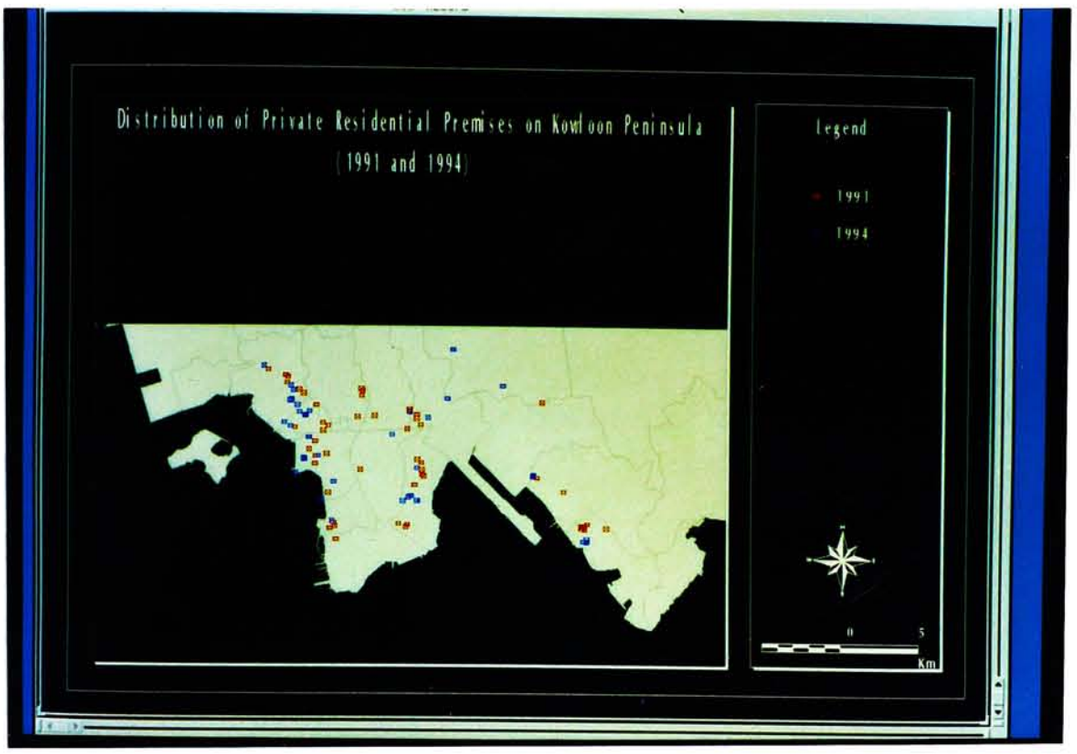


Plate 5.25 Distribution of private residential premises on Kowloon Peninsula (1991 and 1994)

was planned from Sheung Wan to Kennedy Town (Wang 1995). All these projects increased the convenience of the affected districts. That was why additional housing developments could still be found within these zones.

5.4.3.2 New Towns

Development in the New Territories was fundamentally clustering in pattern (Plate 5.26 & 5.27). It was crystal clear that one or two centres emerged as major suppliers in each year. This was reflected from the number of units supplied (Table 5.11) and reinforced by Plates 5.28 to 5.31

In 1991, Yau Tong held 18.4% of the market stock with the construction of Laguna City while in 1992, it was Tuen Mun new town which took up 16.8% of the territorial total because of the completion of Tai Hing Garden and Tuen Mun Town Plaza. As of 1993, Tin Shui Wai started emerging as an important provider of housing units in the west with the large scale Kingswood Villa while in the east, it was balanced by the Sheung Shui/Fanling development along both sides of the railway (e.g. Avon Park, Greenpark Villa, Sheung Shui Centre, Fanling Town Centre). Notice that Ma On Shan also started taking up 10.2% with the completion of Villa Athena, Sunshine City and Ma On Shan Centre. Its percentage share rose to 18.4% by 1994 with the added stock from Sunshine City and Bayshore Garden, which became the focus of housing provision that year. Junk Bay provided 6.5% of the stock in 1993 because of Finery Park and Well On Garden, with no more supply in any of the other years.

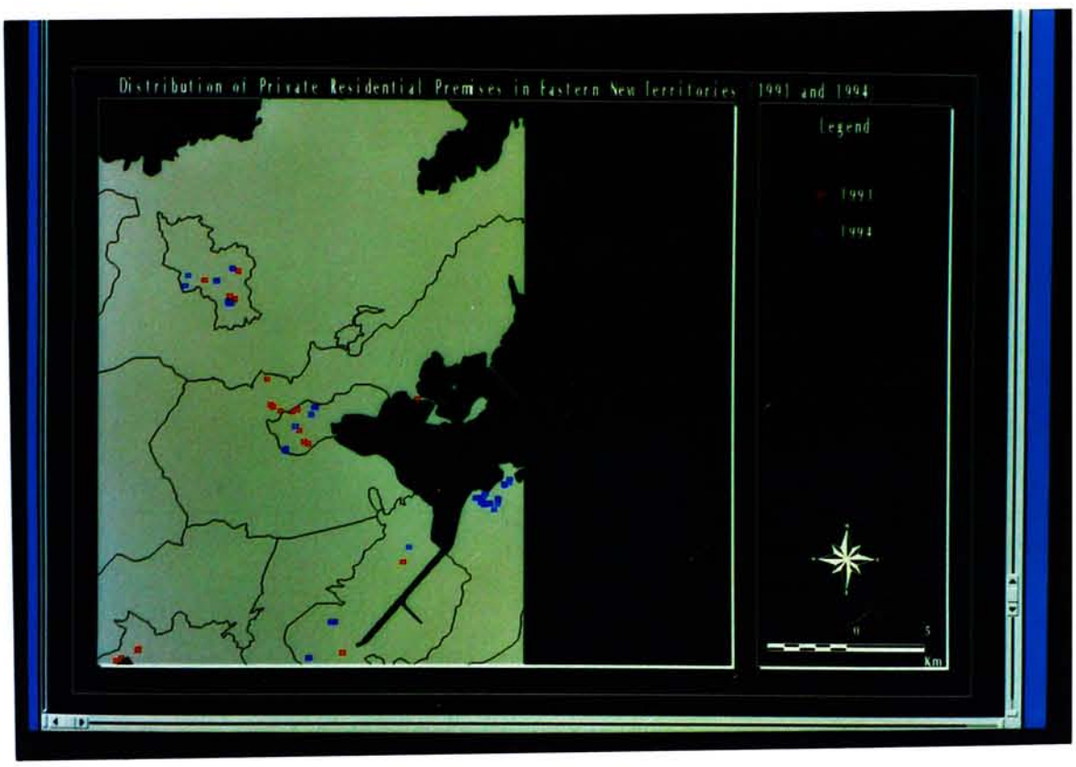


Plate 5.26 Distribution of private residential premises in Eastern New Territories (1991 and 1994)

Plate 5.27 Distribution of private residential premises in Western New Territories (1991 and 1994)

district	District Name	1991	1992	1993	1994
1	central	0.3%	0.2%	1.3%	0%
2	sheungwan	1.4	0	0.6	1.1
3	west	3.8	3.7	2.9	7.4
4	midlevels	6.8	4.9	2.1	5.6
5	pokfulam	0	0	0.6	0.1
6	peak	0	0.7	0	0.1
7	wanchai	0.1	0.5	0.8	0.6
8	aberdeen	**8.5**	4.5	8	3.2
9	taihang	5.5	1.8	1.1	1.4
10	npointqbay	2	3.6	1.8	0.8
11	skwancwan	1.8	1.1	0.4	0.3
12	south	1.2	6.2	1.3	0.2
13	tsimshatsui	0.1	0	0.7	0
14	yaumatei	0.5	5.6	0.2	0.3
15	mongkok	2.1	6.7	2.7	2.1
16	hunghom	2	4.8	2.7	3.3
17	homantin	0.2	1	0.4	0.5
18	laichikok	0	0	0	0
19	cswan	2.3	3.5	2.3	2.5
20	shamshuipo	0.5	0.6	0.6	1.1
21	shekkipmei	2.5	6.7	1	0
22	ktong	0.4	0	0	0.1
23	kcitywtsin	0.3	0.2	1.1	1
24	twshanncwan	0	0.1	0.3	1.8
25	jvalley	0	0	0	0
26	kwuntong	0.4	0	0	1
27	yautong	**18.4**	2.6	0	4
28	tsuenwannt	3	2.6	2.4	0.2
29	tsuenwanoa	4.2	4.6	4.6	2.3
30	tuenmunnt	3.5	**16.8**	7.8	**10.2**
31	tuenmunoa	0	0	0	0.9
32	yuenlongnt	3.7	3.9	6	0.7
33	tin shui wai	9	0.8	**13.1**	9
34	sshuifannt	5.3	3.2	**12.1**	**9.4**
35	fanlingoa	0	0	0	0
36	taipont	1.8	0	0.7	2.4
37	taipooa	4.4	2.3	0.3	0
38	shatinnt	1.1	1.9	1.6	3.9
39	ma on shan	0	3	**10.2**	**18.4**
40	sksouthhhau	1.1	1.4	0.4	0
41	junkbay	0	0	6.5	0
42	islands	1.8	0.5	1.2	3.9

Table 5.11 Percentage share of units supplied among disticts

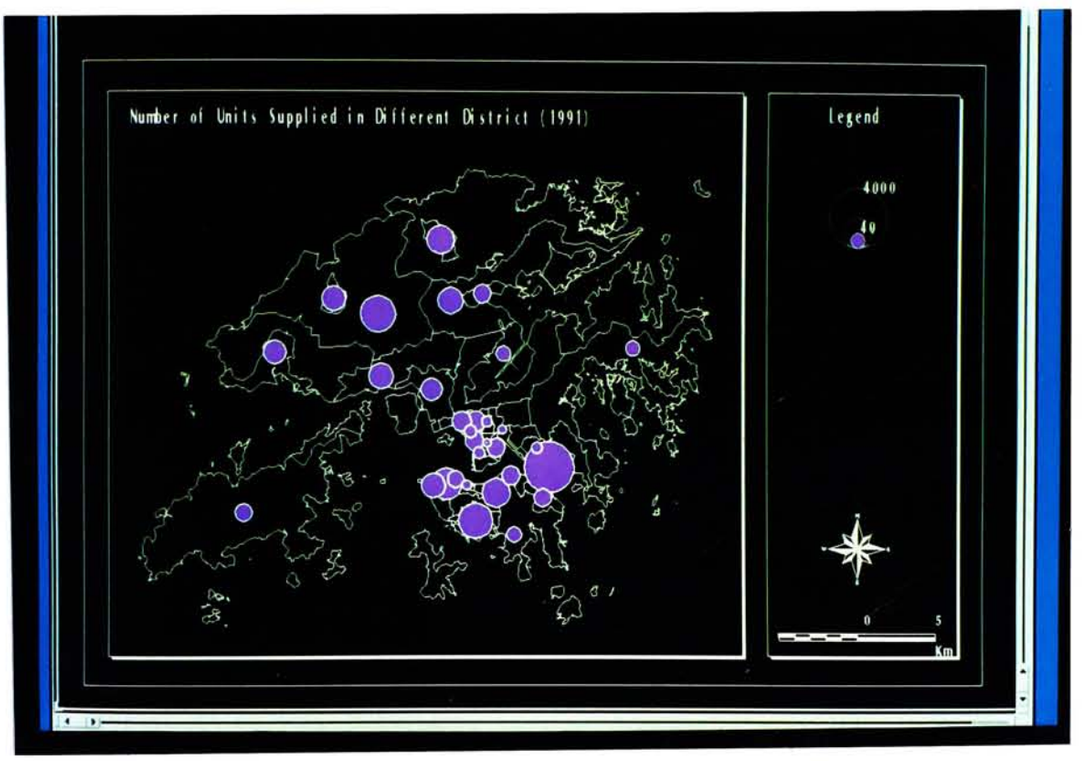


Plate 5.28 Number of units supplied in different districts (1991)

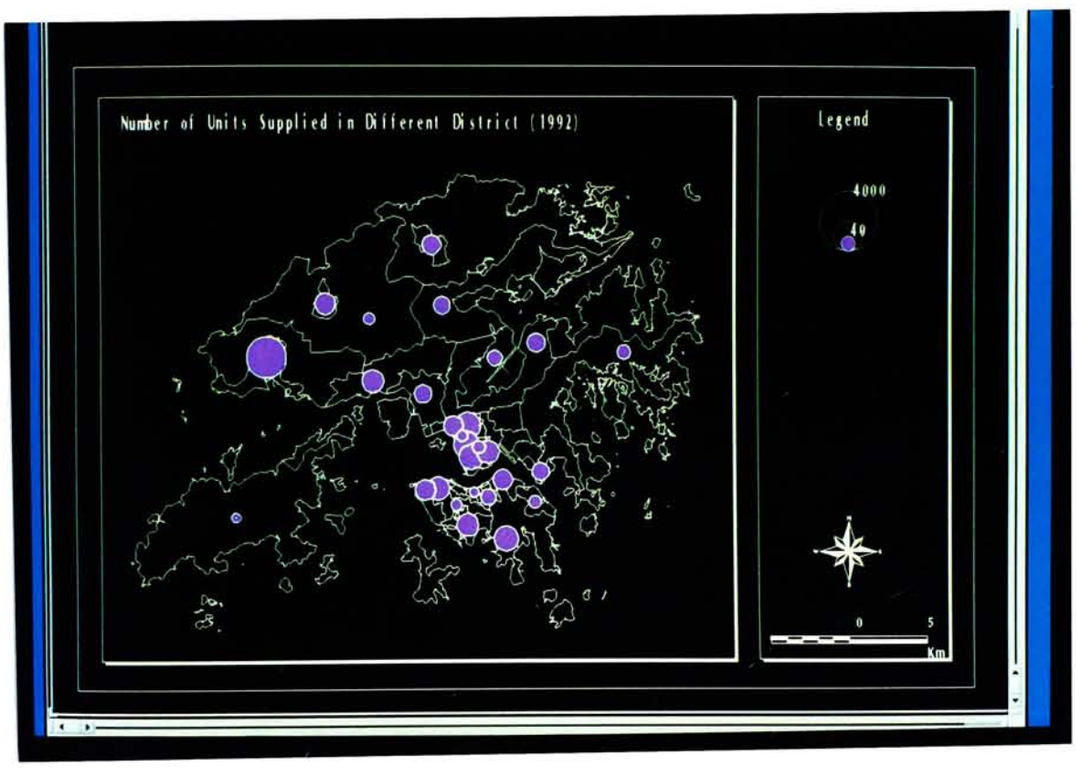


Plate 5.29 Number of units supplied in different districts (1992)

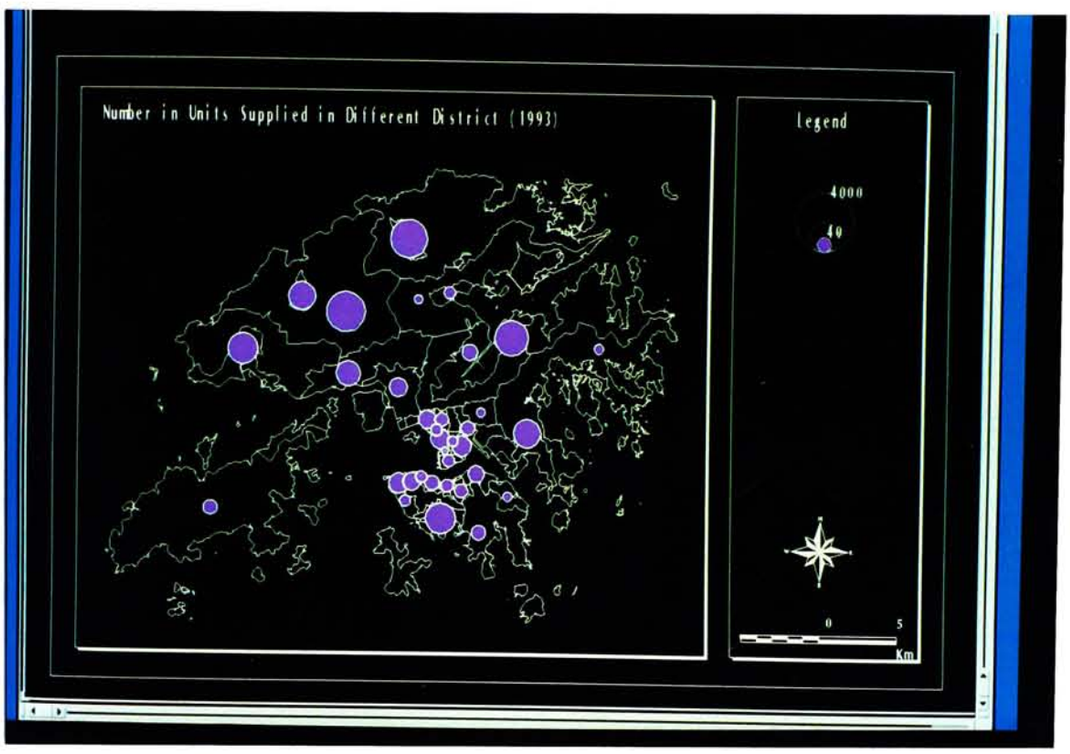


Plate 5.30 Number of units supplied in different districts (1993)

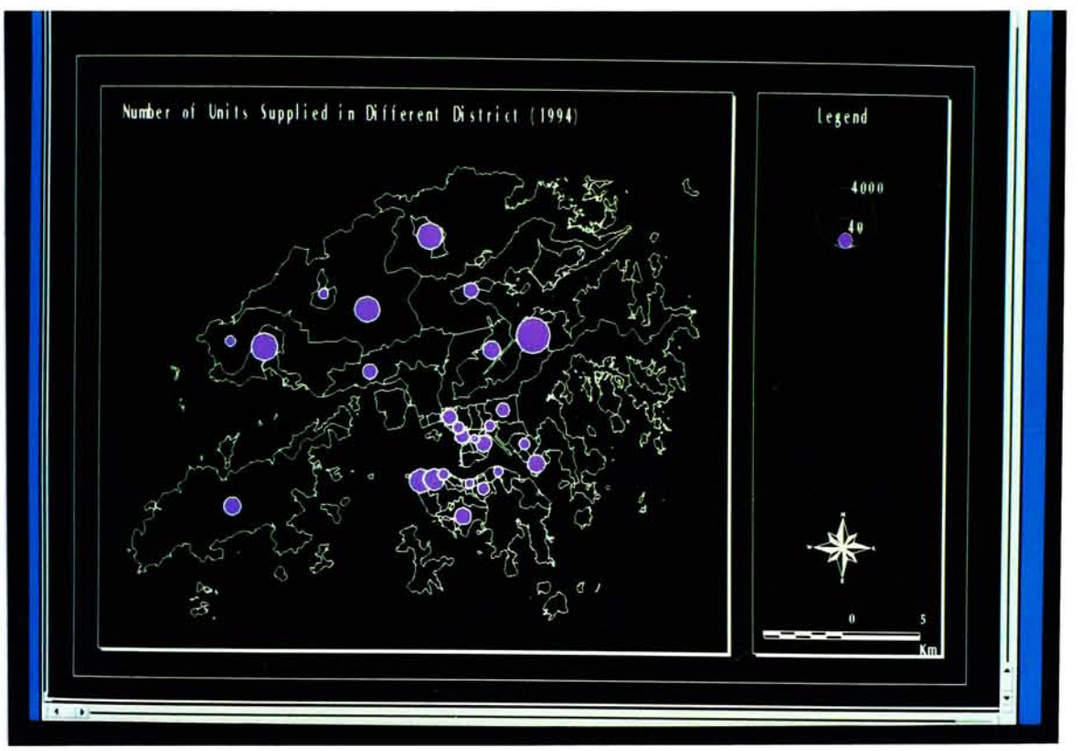


Plate 5.31 Number of units supplied in different districts (1994)

The overwhelming supply in each district at one time was quite a unique phenomenon in recent years. They sprang up under the arrangement of developers instead of a coincidence. Developers now preferred to sell the units of a comprehensive housing estate in different stages (Wong & Staley 1992). Since they were never certain at what price the unit would be sold at a maximum, it was rational for them to allocate part of the stock at a certain price in the initial stage. Immediately, the market reflected the valuation of consumers and hence, they were in a better position to adjust the sales price, mostly upward, in subsequent stages. Thus, they were guaranteed to minimize their risk of lose and to a large extent, quite certain that all of the units were going to be sold. Premises in Ma On Shan is a good case study to illustrate this point[1].

Case Study : Ma On Shan

During 1993, Ma On Shan had started to supply quite a substantial share of housing towards the market as the Sunshine City, Villa Athena and Ma On Shan Centre were completed for sale. At that time, the average price per square feet (psf) was around $4800. In October 1994, Bayshore Garden joined in the housing stock supply. Rather than asking for $4800, its average price was just $4400 and the developer allocated just 120 units for sale (total number of units = 1102). Together with its large-scale marketing strategies, the number of registered buyers was 32 times

[1] Detail descriptions can be found in various issues of Hong Kong Property Journal (94.10.1; 94.10.16; 94.11.1)

that of the total units for sale. Certainly, only 120 buyers were lucky enough to participate in the game during the first round.

The developer succeeded in conveying an impression that these units were highly attractive which then, induced a lot of demand from end-users as well as investors. The developer started to sell 442 units during the second round at $4500-5200 psf. At the initial start of the third round, it attracted over 14 times of registrations with only 56 units. Then the developer decided to add 160 units for sale. These 216 units ($4997-5400 psf) were all sold out within 3.5 hours on 24 October, 1994. The same sales practice proved to be successful again when the developer sold out 152 units at an average price of $5200 on 26 October, 1994. At each stage, the price was higher than the previous one because the market responded positively.

Not only did the developer succeed in selling all of its units in a very short time span, other developers from nearby housing estates also got the message that the 'wants' of consumers were aroused. Since the asking price of Bayshore Garden was lower than its nearby estates, other developers became increasingly worried over the fluctuation of price. Those who intended to sell units at a much higher asking price were greatly disappointed by such moves. Thus, rather than facing the uncertain price changes[2] and withdrew all sales, they preferred to sell them when the market responded favourably. In this case, Sunshine City immediately tried to sell the remaining stock after realizing the success of Bayshore Garden.

[2] It is possible that the price of property persists going downward. If that's the case, developers have to borne all financial costs with the unsold units. Furthermore, they have to worry and wait till the price is favourable which they are unable to foresee.

From this case, we are not certain if developers collaborate to arouse market demand by such 'stage-wise selling practice'. While there is no evidence that suggests 'conspiracy' among developers, it is very likely that the strategy and its effects are readily informative to each other. When the market is filled with 'consumptive actions', consumers respond favourably, hoping to grasp some gain like their precedents. Developers, too, seize the opportunity to sell the units with greater certainty and profits (price is pushed up with each successive stage). This kind of behaviour helps to attain an agglomerative economy of scale. Rather than lowering the cost of productions, the developers 'agglomerate' to disseminate advantageous information towards the market. Even though it cannot be ascertained if their costs have decreased, it is probable that their profits have increased with certainty. This behaviour adds up to the clusters of residential buildings at one time.

5.5 Spatial Variations on Floor Size

Throughout the years, the mean block size in different regions demonstrated quite a consistent pattern (Table 5.12). Hong Kong Island tended to supply larger-sized flats as confirmed by the fact that the average block size in 1991 to 1994 was over 1000 square feet (sq.ft). Those premises on Kowloon Peninsula were the smallest kind in terms of floor area, supplying flats of around 550 to 600 sq. ft. Those in the eastern and western New Territories were quite similar. They were usually flats of medium-sized (800 to 1000 sq. ft).

Region\Year	Floor Size (sq.ft)			
	1991	1992	1993	1994
Hong Kong	1044	1173	1040	1020
Kowloon	638	609	585	553
West New Territories	950	878	839	861
East New Territories	1099	1232	818	764

Table 5.12 Average floor size among regions

The mean district floor size were classified into 3 classes and transformed to a table (Table 5.13). A highly consistent pattern was found in most districts across time. Low density residential zones continued to supply larger-sized flats (eg. Midlevels, the Peak, Tai Hang and the South) while other urban districts remained as high density residential areas (eg. Mongkok, Sham Shui Po). Medium-sized flats were found in selective districts (eg. Yau Tong, Ap Lei Chau, Shek Kip Mei). Most of the new towns supplied medium-sized dormitories except Sai Kung.

Other than those prestiguous low-density residential districts, buildings in the urban core were of smaller size and were descriptively known as 'pencil-typed' premises. These premises were largely the effort of urban renewal. Since many of these urban districts had been under intensive use for years, many of the old buildings were just a few-storey high. They were constructed under the old planning ordinances and were very inefficient in terms of land usage (Pun 1987). Furthermore, these districts were usually places with great convenience, where all kinds of facilities were well-established. In addition, employment opportunities tended to concentrate in these districts. Therefore, a continual demand for urban residence was able to sustain (Yu 1995). On the supply side, small developers preferred urban renewal projects than comprehensive ones as they did not have strong financial arrangements and expertise (Chuan 1994a). The projects were usually small-scaled and fragmented which could be completed in a shorter time span and thus, faster to realize the gain. Where in-situ redevelopment was done, the lot size was bound to be smaller. Thus, it was a usual practice for developers to partition the floor size into 400 to 500 sq.ft.

		Floor Size by Category			
district	District name	1991	1992	1993	1994
1	central	M	S	M	-
2	sheungwan	S	-	M	M
3	west	M	L	M	M
4	midlevels	L	L	M	L
5	pokfulam	-	-	L	L
6	peak	L	L	L	L
7	wanchai	M	M	S	M
8	aberdeen	M	L	M	M
9	taihang	L	L	L	L
10	npointqbay	M	M	M	M
11	skwancwan	M	M	M	S
12	south	L	L	L	L
13	tsimshatsui	S	-	L	-
14	yaumatei	M	M	S	M
15	mongkok	S	S	M	S
16	hunghom	M	M	S	M
17	homantin	S	M	L	M
18	laichikok	-	-	-	-
19	cswan	S	M	S	M
20	shamshuipo	S	M	S	M
21	shekkipmei	M	M	M	-
22	ktong	L	-	-	S
23	kcitywtsin	S	S	M	M
24	twshanncwan	-	S	M	M
25	jvalley	-	-	-	-
26	kwuntong	M	-	-	S
27	yautong	M	M	-	M
28	tsuenwannt	L	M	M	L
29	tsuenwanoa	L	M	M	M
30	tuenmunnt	M	M	M	M
31	tuenmunoa	-	-	-	S
32	yuenlongnt	M	M	M	M
33	tin shui wai	M	L	M	M
34	sshuifannt	M	L	M	M
35	fanlingoa	-	-	-	-
36	taipont	M	-	M	M
37	taipooa	L	L	L	-
38	shatinnt	M	M	L	L
39	ma on shan	-	M	M	M
40	sksouthhhau	L	L	L	-
41	junkbay	-	-	M	-
42	islands	M	M	M	L

Key : S = less than 500 sq.ft M = 500 - 999 sq.ft L = 1000 sq. ft or over
- = not applicable

Table 5.13 Summary on categories of floor size among districts

Apart from the small sized apartments, there was a tendency for developers to start building larger scale housing estates in urban districts. Developers who have more financial and expertise input were able to shoulder comprehensively designed projects (Pun 1987). Examples included projects which converted the dockyard in Hunghom to Whampoa Garden and oil tank land lot to Mei Foo Sun Chuen. For the 1990s, the most noticeable larger-scale residential developments were found in the previous power plant site of Ap Lei Chau that became the South Horizons. The Laguna City was built from redeveloping the Shell Oil Tank. Rather than redeeming large piece of land from fragmented property ownerships, they preferred a change of land use for implementation of housing projects. Therefore, they were able to offer medium-sized, high-density housing estates with less pollution and better landscaped residence for consumers.

Comprehensively planned housing estates were also a popular kind of residence in the new towns. All these projects required large land parcels. Those developers who did not have dockyard/oil tank areas to convert or, having converted them already, found it too expensive to acquire land from the urban core. This was because landuse competition was severe in metro areas, therefore, value of land parcel was incredibly high and perhaps, always escalating. Furthermore, to redeem a large piece of land from fragmented tenure was impractical because the cost of compensation and negotiation took immeasurable time and money (Pun 1987). Thus, it was more economical to develop new residence away from the core where developers had acquired larger land lot at a cheaper cost. The government, too, tended to encourage such a move by having land in the New Territories sold at

auctions (Chuan 1994b). Only consortiums or large developers having the required technology and money were able to borne such projects. They aimed at providing a spacious and 'self-contained' living environment for consumers. That explained why dormitories in new towns were usually of medium-sized.

Therefore, while pencil-typed residential buildings were largely the efforts of small developers conducting urban redevelopment, it was also common for them to build comprehensive housing estates in selected locations. For the latter type, they usually involved a conversion of usage of a large piece of land lot. That was why, small to medium-sized dormitories were found in urban districts. On the whole, these housing estates were developed to its fullest in new towns. This was made possible as land in these areas were predominantly held as 'land banks' by large developers who had the technology and monetary support to fulfill the projects. Thus, most of the dormitories in new towns were more spacious than those at the core region.

5.6 Spatial Variations on Property Price

The potential for property price increase also displayed quite an interesting pattern (Table 5.14). Hong Kong Island experienced a 25% increase in property value from 1991 to 1994 , followed by that in the Eastern New Territories (10.2% increase). Those in Kowloon and Western New Territories shared a similar magnitude of increase (8%). Properties on the outlying island like Lantau had a remarkable increase of 42.5%.

Region\Year	Price ($ psf)				
	1991	1992	1993	1994	% change*
Hong Kong	2777	2662	2862	3474	**+25.1**
Kowloon	2481	2392	2518	2686	**+8.3**
West New Territories	1626	2196	1893	1758	**+8.1**
East New Territories	2365	2636	2269	2606	**+10.2**

** express as (1994 - 1991)/ 1991 * 100%*

Table 5.14 Average price among regions

Plate 5.32 presents the district-wise changes in price and supporting figures are shown in Table 5.15. Districts with missing information were ruled out of comparisons. The most conspicuous increase was found in Wan Chai (82.8%) followed by that in Shatin New Towns (54%) . An increase of 40% or over were found either in prestiguous areas (eg. Midlevels or the South), or in the newly developed sites (eg. Sham Tseng, the Islands).

Effects of prestiguous residential areas on price were well-documented (eg. Mozolin 1994; Dubin & Sang 1987). Yet, newly developed sites bore similar increase potential. They were usually areas with better scenic views (eg. waterfront areas in Sai Kung, Sham Tseng, Discovery Bay). Through advertisements, the recreational facilities, 'hotel house-management' and the private club memberships all tried to convey the image of 'high-class residence'. Developers intentionally cultivated these residential zones as high socioeconomic neighborhoods which were similar to those prestiguous districts. Finally, the price increase was partly attributed by future urban development along these areas[3] . This enhanced the attraction of the area and thus, the property price.

A final group of price increase were areas adjacent to major employment centres (eg. Mongkok, Yau Tong). The economic restructuring in Hong Kong bore an impact on the employment distribution. Tertiary activities agglomerated at the business core while residential development geared towards new towns. Worse still,

[3] The White Paper on Hong Kong Transport Policy clearly spells out the future transportation projects in the said area

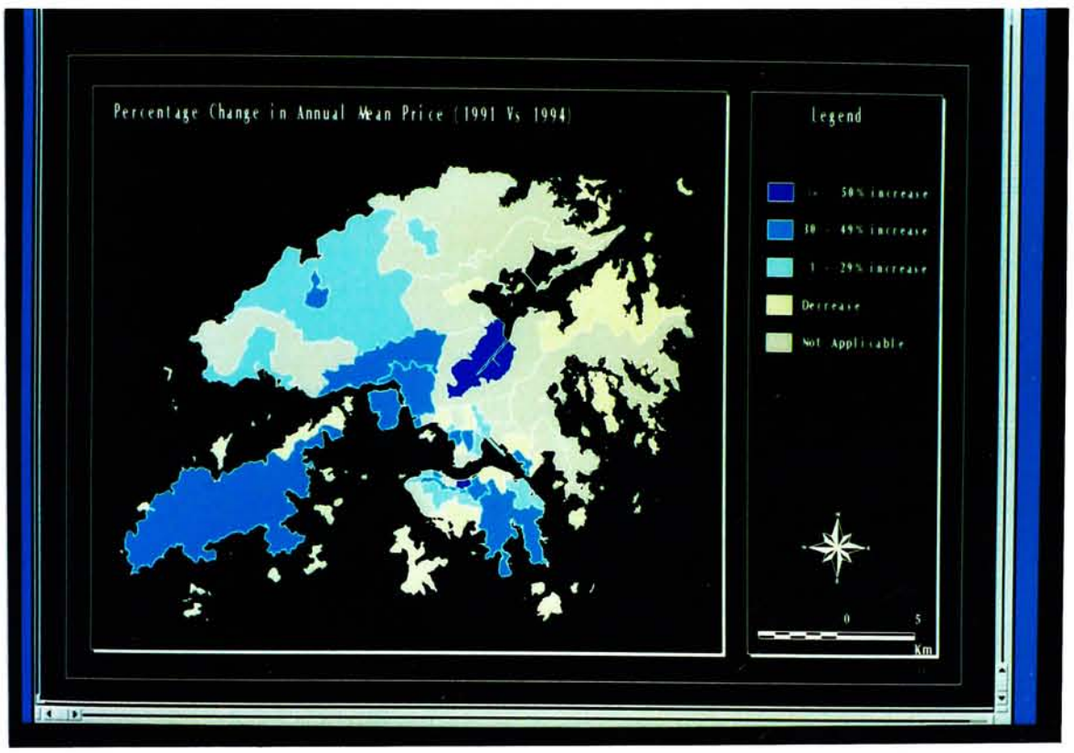


Plate 5.32 Percentage change in annual mean price (1991 versus 1994)

district	District name	Price ($ psf) 1991	1992	1993	1994	% change*
1	central	3240	2679	3408	0	na
2	sheungwan	2204	0	2783	3197	45.1
3	west	2273	2249	2207	2787	22.6
4	midlevels	2817	3041	3131	3970	40.9
5	pokfulam	0	0	2975	3481	na
6	peak	4450	2595	7101	5162	16
7	wanchai	1918	2957	2617	3507	82.8
8	aberdeen	2544	2993	2198	2538	-0.2
9	taihang	2990	2545	2915	3915	30.9
10	npointqbay	2931	2319	2810	2627	-10.4
11	skwancwan	2177	2660	2135	2798	28.5
12	south	3831	2846	3237	5482	43.1
13	tsimshatsui	2404	0	3910	0	na
14	yaumatei	2696	2284	2479	2496	-7.4
15	mongkok	2260	2389	2562	3356	48.5
16	hunghom	2344	2430	2211	2786	18.9
17	homantin	2536	2641	3114	3382	33.4
18	laichikok	0	0	0	0	na
19	cswan	2522	2340	2120	2269	-10
20	shamshuipo	2064	2344	2207	2250	9
21	shekkipmei	3679	2398	3708	0	na
22	ktong	2533	0	0	2150	-15.1
23	kcitywtsin	2393	2221	2671	2577	7.7
24	twshanncwan	0	2363	2792	2646	na
25	jvalley	0	0	0	0	na
26	kwuntong	2788	0	0	2058	-26.2
27	yautong	2258	2529	0	3206	42
28	tsuenwannt	1835	2624	2609	2426	32.2
29	tsuenwanoa	1902	2164	2417	2716	42.8
30	tuenmunnt	1475	2083	1705	1554	5.4
31	tuenmunoa	0	0	0	1264	na
32	yuenlongnt	1132	1937	1600	1545	36.5
33	tin shui wai	1666	2744	1525	1745	4.7
34	sshuifannt	1859	2817	2036	2133	14.7
35	fanlingoa	0	0	0	0	na
36	taipont	2604	0	2072	2515	-3.4
37	taipooa	1958	2264	2249	0	na
38	shatinnt	2365	2820	2486	3641	54
39	ma on shan	0	2398	2468	2679	na
40	sksouthhhau	2723	2939	2613	0	na
41	junkbay	0	0	2460	0	na
42	islands	1598	1864	1861	2277	42.5

** express as (1994-1991)/1991*100%*

na not applicable

Table 5.15 Percentage change in property price among districts

the transportation linkages between urban areas and new towns were unable to cope with the commuting traffic. As a result, job mismatch swayed the consumers' preference back to the central urban area in which transportation cost (both monetary and time) could be saved. This pushed up the property price in Kowloon and Hong Kong areas which seemed to suggest the importance of workplaces and residence relationship (Greene 1980; Mok, Chan & Cho 1995).

Relatively speaking, while some of the districts were becoming more irresistible to consumers, other districts that did not have so much future development appeared to be less appealing. Furthermore, the effects of 'stage-wise' selling practice helped to portray the districts in concern to become more attractive than others which did not have such a pattern. Therefore, while Yau Tong entailed a better living environment and boosted by marketing strategies, its adjacent district Kwun Tong appeared not as attractive.

5.7 Conclusion

It is demonstrated that the housing supply in Hong Kong is affected by the general investment environment. Nevertheless, its provision patterns are quite distinctive. The emphasis has shifted towards the new town regions rather than the urban cores in response to the future urban development. As these new towns were designated in different time periods, their housing developments are thus, different. Tsuen Wan, as a fully developed centre, is unable to offer as much opportunities for further housing developments as compared to Ma On Shan which is at its initial stage

of development. Thus, the relative importance of new towns is articulated with reference to their different stages of development.

The conspicuous supply pattern of one centre at a time is by no means a coincidence but a result from the 'stage-wise selling practice' of developers. This is a unique characteristics of Hong Kong property market.

While new towns experience robust housing constructions, urban core is still the preferred residence zone in Hong Kong. That is why, many of the pencil-typed premises are found in urban districts as a result of uncoordinated urban renewal projects of small developers. Yet, comprehensively designed housing estates are commonly found in selective urban districts and in new towns. They are either a conversion of land use or it is more economical to start in these locations.

Not only does the location of residential premises distinctive, but also its attributes. Floor size is associated highly with the type of projects in different regions (urban renewal or large housing estates). Property price continues to be highest in prestigeous zones and it is quite a recent phenomenon that new potential sites are offering similar 'high-class residence' like Sham Tseng or Discovery Bay.

All in all, through cartographic analyses, pattern of residential development and its attributes are revealed. It helps to increase the understanding of the property market in Hong Kong. Discussion on relating property price with various parameters is captured in Chapter VI.

CHAPTER VI

STATISTICAL ANALYSIS

6.1 Introduction

This chapter primarily deals with statistical results in this research. In addition to simple cartographic analyses, statistical support helps to reveal the mathematical relationships among parameters with price. Procedures involved in establishing regression models are briefly accounted for. Then it proceeds onto the discussion of the statistical results. Analyses are conducted at two levels : pooled market and submarkets which are defined by both price and floor size. An attempt is made to explain the effects of variables on price.

6.2 The Data Set

One of the important consideration in hedonic price study is the socioeconomic status which is estimated from demographic characteristics summarized by the census statistics. Since the most recent census report was in 1991, it means that demographic variables for 1992 to 1994 are not available. In that case, only the premises records (192) in 1991 can be analysed with a full set of variables. Five records are discarded before establishing the regression models as a result of missing data. Therefore, a total of 187 records of asking price (psf) of properties in 1991 are regressed upon 19 predictors with hedonic price function. In Chapter 3,

details of hedonic price methodology was discussed, its dependent and independent variables will not be repeated here. However, descriptive statistics on the dependent and independent variables are available for reference (Table 6.1).

6.3 Stepwise Regression Modeling

In addition to the forced entry of variables in regression modeling, there are three popular alternatives : forward, backward and stepwise selection, each having its own rationale. Stepwise regression technique is used here to establish the coefficients and significance of the parameters. In sum, at each stage, variables already in the equation are evaluated against the removal criterion while those not in the equation are selected with the highest partial correlation. The probability of entry (PIN) and removal (POUT) is now set at 0.05 and 0.10 respectively. Four common specifications of the regression model are examined. They are linear, semi-log, exponential and double-log approaches. Standard F-test and t-test are included to extract relevant variables for the model. Confidence level is set at 95%. The performance of all models are evaluated by the explanatory power. An R square of over 0.40 is considered reasonable while exceeding a figure of 0.70 is regarded as a well-fitted model in this research.

6.4 Correlation among Variables

A correlation matrix is able to reveal the association between dependent variable and its predictors. Since there are altogether 4 types of regression models

Number of Valid Observations (N) = 187				
Variables	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**
Predictors				
FAC5	-0.22	0.95	-1.76	1.84
FAC2	-0.20	0.85	-2.06	1.46
FAC4	-0.04	0.86	-2.29	1.48
FAC1	0.13	0.84	-1.15	2.56
FAC3	0.15	0.95	-4.30	1.79
COM_RES	0.36	0.72	0.00	5.80
SQ_CEM	1.18	4.47	0.01	57.01
COM	1.54	3.41	0.00	24.20
IND	3.29	4.06	0.00	13.30
OPEN_SPACE	8.21	7.02	0.00	32.70
INST	9.04	6.62	0.00	40.60
D_SCORE	15.77	16.13	0.00	48.30
SQ_REC	19.30	64.99	0.01	650.47
RES	19.72	12.39	0.00	49.20
SQ_RAIL	42.66	146.33	0.00	1280.17
AREA	913.20	626.24	338.00	3414.00
V_IND	77633.54	184870.71	1797.40	1680876.2
V_SER	92620.94	366266.75	1206.00	3432183.6
V_DIS	116397.66	535226.05	1640.50	6019809.8
Dependent				
PRICE	1968.71	429.02	97.00	3015.00

Table 6.1 Descriptive statistics on dependent and independent variables

used in this research, each of their correlation matrix is presented (Table 6.2 - 6.5). It is found out that price is only moderately associated with school quality (D_SCORE), purchasing power (FAC1), economic independence (FAC4) with their correlation coefficients less than 0.5 and to a lesser extent, percentage of industrial landuse (IND) and distance to cemeteries (SQ_CEM). The magnitude of correlation of these variables to property price is quite consistent across models. This suggests that these variables are more likely to be the ones which can explain price variability in latter analyses.

Theoretically, a desirable condition is obtained when the predictors correlate significantly with dependent variable but have relatively low degree of association among themselves (Stevens 1986). Although associations between dependent and independent variables are not too strong ($r < 0.5$), it is free from the problem of multicollinearity as reaffirmed from the variance inflation factor (VIF) being less than 10 (Table 6.6).

6.5 Validation of the Models

After running the models, it is essential to check if any of the assumptions are violated. In particular, errors are assumed to be independent and possess a normal distribution with constant variance (Stevens 1986). Graphical examinations on residual plots and histograms confirm that none of the assumptions are violated.

	PRICE	AREA	COM	COM_RES	IND	INST	OPEN_SPACE	RES	D_SCORE	FAC1	FAC2	FAC3	FAC4	FAC5	SQ_CEM	SQ_REC	SQ_RAIL	V_DIS	V_IND	V_SER
PRICE	1.000																			
AREA	0.231	1.000																		
COM	0.063	-0.186	1.000																	
COM_RES	-0.142	-0.046	0.336	1.000																
IND	-0.287	-0.286	0.010	-0.114	1.000															
INST	0.055	-0.131	0.429	0.388	-0.073	1.000														
OPEN_SPACE	0.093	-0.154	0.092	0.244	-0.103	0.208	1.000													
RES	0.085	-0.165	0.215	0.199	0.008	0.487	0.619	1.000												
D_SCORE	0.400	0.292	-0.034	0.030	-0.374	0.411	0.006	0.355	1.000											
FAC1	0.413	0.203	0.112	-0.056	-0.282	0.055	0.018	0.190	0.567	1.000										
FAC2	-0.107	-0.036	-0.335	0.097	0.097	-0.251	-0.022	-0.229	-0.288	-0.043	1.000									
FAC3	0.233	-0.029	0.096	-0.042	-0.068	0.103	0.099	0.186	0.248	0.011	0.147	1.000								
FAC4	0.368	-0.205	0.190	-0.341	0.265	0.113	0.217	0.049	-0.032	0.066	-0.187	0.180	1.000							
FAC5	-0.067	0.264	-0.335	-0.083	-0.168	-0.346	-0.374	-0.712	-0.237	-0.135	0.138	-0.380	-0.150	1.000						
SQ_CEM	-0.045	-0.025	-0.063	-0.040	-0.135	-0.094	-0.001	-0.089	-0.026	0.047	0.028	-0.034	0.028	0.179	1.000					
SQ_REC	0.003	-0.157	0.052	-0.075	0.159	0.016	0.121	0.141	-0.069	0.031	0.071	-0.052	0.141	-0.164	0.018	1.000				
SQ_RAIL	-0.041	-0.157	-0.018	-0.044	0.056	-0.095	0.037	-0.005	-0.143	-0.131	0.144	0.057	0.044	-0.107	-0.062	-0.020	1.000			
V_DIS	-0.010	-0.100	-0.034	-0.002	-0.096	-0.069	0.012	-0.071	-0.113	-0.139	0.166	-0.060	0.160	0.135	0.073	0.268	-0.032	1.000		
V_IND	0.013	-0.212	0.229	0.094	0.264	0.307	0.097	0.405	0.001	-0.061	-0.212	0.075	0.188	-0.357	-0.029	0.006	-0.003	0.022	1.000	
V_SER	-0.015	-0.104	-0.043	0.044	-0.096	-0.061	0.018	-0.071	-0.142	-0.162	0.203	-0.080	0.135	0.142	0.074	0.317	-0.030	0.939	0.017	1.000

Table 6.2 Correlation matrix of the linear hedonic price model

	PRICE	LOG_AREA	COM	COM_RES	IND	INST	OPEN_SPACE	RES	D_SCORE	FAC1	FAC2	FAC3	FAC4	FAC5	LOG_CEM	LOG_REC	LOG_RAIL	LOG_DIS	LOG_IND	LOG_SER
PRICE	1.000																			
LOG_AREA	0.228	1.000																		
COM	0.063	-0.225	1.000																	
COM_RES	-0.142	-0.032	0.336	1.000																
IND	-0.287	-0.279	0.010	-0.114	1.000															
INST	0.055	-0.148	0.429	0.388	-0.073	1.000														
OPEN_SPACE	0.093	-0.169	0.092	0.244	-0.103	0.208	1.000													
RES	0.085	-0.194	0.215	0.199	0.008	0.487	0.619	1.000												
D_SCORE	0.400	0.288	-0.034	0.030	-0.374	0.411	0.006	0.355	1.000											
FAC1	0.413	0.176	0.112	-0.056	-0.282	0.055	0.018	0.190	0.567	1.000										
FAC2	-0.107	-0.008	-0.335	0.097	0.097	-0.251	-0.022	-0.229	-0.288	-0.043	1.000									
FAC3	0.233	-0.044	0.096	-0.042	-0.068	0.103	0.099	0.186	0.248	0.011	0.147	1.000								
FAC4	0.368	-0.223	0.190	-0.341	0.265	0.113	0.217	0.049	-0.032	0.066	-0.187	0.180	1.000							
FAC5	-0.067	0.322	-0.335	-0.083	-0.168	-0.346	-0.374	-0.712	-0.237	-0.135	0.138	-0.380	-0.150	1.000						
LOG_CEM	0.316	-0.025	-0.024	-0.080	-0.267	0.027	0.319	0.169	0.275	0.378	0.217	0.291	0.293	-0.057	1.000					
LOG_REC	0.208	-0.362	0.197	0.056	0.010	0.289	0.348	0.441	0.181	0.142	0.190	0.369	0.369	-0.432	0.500	1.000				
LOG_RAIL	0.016	-0.300	0.182	0.217	0.097	0.287	0.254	0.282	-0.043	-0.249	0.241	0.287	0.168	-0.319	-0.056	0.460	1.000			
LOG_DIS	0.054	-0.220	0.132	0.134	-0.083	0.238	0.274	0.216	-0.001	-0.140	0.213	0.069	0.284	-0.076	0.349	0.588	0.385	1.000		
LOG_IND	0.189	-0.353	0.247	-0.016	0.217	0.408	0.229	0.476	0.118	-0.051	-0.102	0.249	0.499	-0.521	0.257	0.551	0.398	0.439	1.000	
LOG_SER	-0.029	-0.244	0.115	0.227	-0.023	0.246	0.238	0.188	-0.129	-0.248	0.294	0.029	0.153	-0.050	0.317	0.568	0.387	0.875	0.412	1.000

Table 6.3 Correlation matrix of the semi-log hedonic price model

	LOG_PRICE	AREA	COM	COM_RES	IND	INST	OPEN_SPACE	RES	D_SCORE	FAC1	FAC2	FAC3	FAC4	FAC5	SQ_CEM	SQ_REC	SQ_RAIL	V_DIS	V_IND	V_SER
LOG_PRICE	1.000																			
AREA	0.172	1.000																		
COM	0.080	-0.186	1.000																	
COM_RES	-0 152	-0.046	0.336	1 000																
IND	-0.206	-0.286	0.010	-0 114	1 000															
INST	0.051	-0.131	0.429	0 388	-0.073	1.000														
OPEN_SPACE	0.075	-0 154	0.092	0.244	-0 103	0.208	1.000													
RES	0 094	-0 165	0.215	0 199	0 008	0 487	0 619	1.000												
D_SCORE	0.326	0.292	-0.034	0.030	-0.374	0 411	0 006	0 355	1.000											
FAC1	0.363	0.203	0.112	-0 056	-0 282	0 055	0 018	0.190	0.567	1.000										
FAC2	-0 105	-0.036	-0 335	0 097	0.097	-0.251	-0.022	-0 229	-0.288	-0.043	1.000									
FAC3	0.203	-0.029	0.096	-0.042	-0.068	0.103	0.099	0.186	0.248	0.011	0.147	1 000								
FAC4	0.354	-0.205	0 190	-0 341	0.265	0 113	0.217	0.049	-0 032	0.066	-0 187	0 180	1.000							
FAC5	-0.101	0.264	-0 335	-0.083	-0 168	-0 346	-0.374	-0.712	-0.237	-0 135	0.138	-0.380	-0.150	1.000						
SQ_CEM	-0 022	-0.025	-0.063	-0.040	-0 135	-0 094	-0.001	-0.089	-0.026	0.047	0.028	-0.034	0.028	0.179	1 000					
SQ_REC	0 021	-0 157	0.052	-0.075	0 159	0.016	0.121	0.141	-0.069	0 031	0.071	-0.052	0.141	-0 164	0.018	1.000				
SQ_RAIL	-0.013	-0.157	-0.018	-0.044	0.056	-0.095	0.037	-0.005	-0.143	-0.131	0.144	0.057	0.044	-0 107	-0.062	-0.020	1.000			
V_DIS	-0.080	-0 100	-0.034	-0.002	-0.096	-0.069	0.012	-0.071	-0.113	-0.139	0.166	-0.060	0.160	0.135	0.073	0.268	-0.032	1.000		
V_IND	0.041	-0.212	0.229	0 094	0 264	0 307	0.097	0 405	0.001	-0.061	-0 212	0 075	0 188	-0 357	-0.029	0.006	-0 003	0.022	1.000	
V_SER	-0 018	-0.104	-0.043	0.044	-0.096	-0 061	0 018	-0.071	-0.142	-0 162	0.203	-0.080	0.135	0.142	0.074	0.317	-0.030	0.939	0 017	1.000

Table 6.4 Correlation matrix of the exponential hedonic price model

	LOG_PRICE	LOG_AREA	COM	COM_RES	IND	INST	OPEN_SPACE	RES	D_SCORE	FAC1	FAC2	FAC3	FAC4	FAC5	LOG_CEM	LOG_REC	LOG_RAIL	LOG_DIS	LOG_IND	LOG_SER
LOG_PRICE	1.000																			
LOG_AREA	0.165	1.000																		
COM	0.080	-0.225	1.000																	
COM_RES	-0.152	-0.032	0.336	1.000																
IND	-0.206	-0.279	0.010	-0.114	1.000															
INST	0.051	-0.148	0.429	0.388	-0.073	1.000														
OPEN_SPACE	0.075	-0.169	0.092	0.244	-0.103	0.208	1.000													
RES	0.094	-0.194	0.215	0.199	0.008	0.487	0.619	1.000												
D_SCORE	0.326	0.288	-0.034	0.030	-0.374	0.411	0.006	0.355	1.000											
FAC1	0.363	0.176	0.112	-0.056	-0.282	0.055	0.018	0.190	0.567	1.000										
FAC2	-0.105	-0.008	-0.335	0.097	0.097	-0.251	-0.022	-0.229	-0.288	-0.043	1.000									
FAC3	0.203	-0.044	0.096	-0.042	-0.068	0.103	0.099	0.186	0.248	0.011	0.147	1.000								
FAC4	0.354	-0.223	0.190	-0.341	0.265	0.113	0.217	0.049	-0.032	0.066	-0.187	0.180	1.000							
FAC5	-0.101	0.322	-0.335	-0.083	-0.168	-0.346	-0.374	-0.712	-0.237	-0.135	0.138	-0.380	-0.150	1.000						
LOG_CEM	0.303	-0.025	-0.024	-0.080	-0.267	0.027	0.319	0.169	0.275	0.378	0.217	0.291	0.293	-0.057	1.000					
LOG_REC	0.184	-0.362	0.197	0.056	0.010	0.289	0.348	0.441	0.181	0.142	0.190	0.369	0.369	-0.432	0.500	1.000				
LOG_RAIL	0.014	-0.300	0.182	0.217	0.097	0.287	0.254	0.262	-0.043	-0.249	0.241	0.287	0.168	-0.319	-0.056	0.460	1.000			
LOG_DIS	-0.038	-0.220	0.132	0.134	-0.083	0.238	0.274	0.216	-0.001	-0.140	0.213	0.069	0.284	-0.076	0.349	0.588	0.385	1.000		
LOG_IND	0.232	-0.353	0.247	-0.016	0.217	0.408	0.229	0.476	0.118	-0.051	-0.102	0.249	0.499	-0.521	0.257	0.551	0.398	0.439	1.000	
LOG_SER	-0.050	-0.244	0.115	0.227	-0.023	0.246	0.238	0.188	-0.129	-0.248	0.294	0.029	0.153	-0.050	0.317	0.568	0.387	0.875	0.412	1.000

Table 6.5 Correlation matrix of the double-log hedonic price model

Variables	Linear	Semi-log	Exponential	Log-Log
COM	2.564	2.951	2.564	2.951
COM_RES	2.172	2.123	2.172	2.123
D_SCORE	4.311	5.280	4.311	5.280
FAC1	2.704	3.675	2.704	3.675
FAC2	2.337	3.846	2.337	3.846
FAC3	1.843	2.003	1.843	2.003
FAC4	2.563	3.725	2.563	3.725
FAC5	3.082	3.553	3.082	3.553
IND	2.064	2.049	2.064	2.049
INST	2.802	2.829	2.802	2.829
OPEN_SPACE	3.076	3.381	3.076	3.381
RES	5.228	5.800	5.228	5.800
V_DIS	8.870	5.705	8.870	5.705
V_IND	1.575	2.944	1.575	2.944
V_SER	9.665	6.350	9.665	6.350
SQ_CEM	1.087	2.956	1.087	2.956
SQ_RAIL	1.126	2.272	1.126	2.272
SQ_REC	1.313	3.308	1.313	3.308
AREA	1.401	1.674	1.401	1.674

Table 6.6 Variance inflation factors for all independent variables

It is essential to detect if there are any outliers which might be influential enough to affect the explanatory power of the models. Standardized residuals and Mahalanobis' distance are measures to check for outliers on dependent variables and its predictors (Stevens 1986). Throughout the entire data set, only case 75 is an outlier. Fortunately, judged from its Cook's distance being less than 1, it is not an influential case.

Cross validity of regression models are calculated by the Wherry[1] or Stein rule (Stevens 1986, p.78-81). This test is used to check the reliability of the predictive power of regression models. Stein rule is applied instead of Wherry's rule here in which the adjusted R square should be given by :

$$1- (n-1/n-k-1)(n-2/n-k-2)(n+1/n)(1-r^2) \qquad (6.1)$$

where

n = number of cases

k = number of predictors

r^2 = explanatory power of the model

The adjusted R square should be compared with the R square to cross-validate the regression equation. If the adjusted R square is only half of the R square, then the

[1] The adjusted R square on the print-out of SPSS is calculated from the Wherry's rule

shrinkage in predictive power is great while a shrinkage of less than 20% is regarded as a good model (Stevens 1986).

6.6 Findings

6.6.1 Pooled Market Results

The overall results are summarized in Table 6.7. Explanatory power among the 4 specifications were quite close, ranging from 0.38 to 0.43. As the functional form of the equation became increasingly non-linear, the inclusion of employment potential (V_DIS, V_SER, V_IND) adversely affected the performance rather than raising it.

Semi-log function performed the best and confirmed the common belief that non-linearity of hedonic price function was not unexpected (Jud & Watts 1981; Kulsgreshta & Gillies 1993). The performance of the model was acceptable with an R square of 0.43 (F= 27.332 ; p = .000).

A total of 5 out of 19 factors were included in the final regression equation. The signs of the predictors were expected. Purchasing power (FAC1), labor participation (FAC3), economic independence (FAC4) and floor size (AREA) were in positive relation with price while industrial landuse (IND) was inversely related.

	Linear	**Semi-log**	Exponential	Log-Log
Model Performance				
R Square	0.42	**0.43**	0.38	0.39
Adj. R Square*	0.28	**0.26**	0.21	0.23
F-statistics	26.61	**27.33**	15.57	16.18
Sig. F	0.000	**0.000**	0.000	0.000
Regression Coeff.				
Constant	1917.53	**910.34**	3.27	2.97
AREA	+0.13	**+390.61**	+3.19E-05	+0.11
FAC1	+137.83	**+139.10**	+0.04	+0.04
FAC3	+63.23	**+64.43**	+0.17	
FAC4	+216.73	**+219.72**	+0.07	+0.07
IND	-27.49	**-27.19**	-0.01	-0.01
V_DIS			-1.74E-07	-0.12
V_SER			+2.28E-07	+0.07
V_IND				+0.05

** calculated according to Stein's rule, measuring the cross-validity of model to independent samples*

Table 6.7 Summary statistics of stepwise regression equations for pooled market

The relative importance among significant factors was reflected in the partial correlation coefficient (Table 6.8) which is the correlation between a particular independent variable and dependent variable when the linear effects of all other independent variables have been removed from them (SPSS p. 342-343). The results were readily interpretable : economic independence of a household (FAC4) emerged as the most important factor, followed by purchasing power (FAC1), industrial landuse percentage (IND), floor size (AREA) and finally, labor participation of the district (FAC3). Four out of 5 significant parameters were measuring the neighborhood quality of an area, with the remaining floor size being a structural significant attribute.

The results confirmed the belief that properties in higher socioeconomic status district commanded a better price (Mozolin 1994; Waddell, Berry & Hoch 1993b). Demographic indicators were used to measure if the district was prestigeous or not. In districts where the purchasing power of the people was higher (FAC1), they were less burdened with children (FAC4). Therefore, both husband and wife joined the work force (FAC3) which then brought forth a more affluent income to the family. That was why they were able to afford more spacious living units (AREA). Therefore, all these factors were positively affecting the property price.

Although consumers might not be aware of the percentage of industrial landuse, the existence of industrial buildings or the location of industrial districts were easily identified. Furthermore, as industrial development started off quite early in

IV\DV	PRICE			
	Linear	Semi-log	Exponential	Log-Log
AREA	+0.23	+0.26	+0.17	+0.22
FAC1	+0.32	+0.32	+0.28	+0.27
FAC3	+0.18	+0.18	+0.15	
FAC4	+0.47	+0.47	+0.44	+0.40
IND	-0.29	-0.29	-0.22	-0.30
V_DIS			-0.29	-0.26
V_SER			+0.26	+0.17
V_IND				+0.24

Table 6.8 Partial correlation table

Hong Kong, those areas carried the connotation of 'old and congested' working class residence which lowered property value.

Although there was only one variable, AREA, measuring structural trait, it was significant in explaining price variability just like the research done elsewhere (Mozolin 1994; Daniere 1994). The larger the flat, the higher the price, which was logical.

On the whole, neighborhood effect was proved to be the major force in shaping the market price. It was also found out that the accessibility variable did not seem to be significant in this research. It should be noted that for most research, accessibility had been proved siginificant where buyers were usually the end-users (Clapp 1987; Bajic 1983). However, the case was different in Hong Kong. When speculative activities were vigorous in 1991, much of the demand was induced by investors. As they were not really the end-users, their demand on housing attributes was suspected to be very different. Hence, for a certain attribute, while end-users were willing to pay more, investors were not and vice versa. For instance, rather than worrying the cost to work, investors were more concerned with the re-sale or price increase potential of the premise. Under this consideration, neighborhood attributes were more influential than the accessibility factor.

Where market situation was complex with speculation, some of the proven variables from other literature were suppressed. At least, in this study, it casted doubt on whether speculators and end-users pursued unique attributes in housing

consumption. Thus, if the status of the users could be identified, better model fitting and analyses were possible.

6.6.2 Submarket Level Analyses

The overall market was stratified based on two major criteria : price and floor size. Price range was splitted up into two groups using a mean value of $1965 as the divider while floor size was divided into three groups : small (< 500 sq.ft), medium (500-999 sq.ft) and large (1000 sq.ft or over). Thus, a total of 6 submarkets and the number of cases in each group were presented in Table 6.9.

Basically, the procedures followed closely with the pooled market analyses. A hedonic price function was applied to each submarket. A total of 4 functional forms were attempted and the best-fitted regression model was evaluated by the explanatory power. Standard F-test and t-test were carried out to see if the factors, taken together or individually, were significant or not. All reported variables were proved to be significant with a confidence level of 95%. Out of the 6 submakets, no model could be fitted for the larger size, low-priced submarket which was largely because of the constraint of inadequate sample size. All other submarkets produced regression models for evaluation and comparison.

Price	Floor Size		
	Small	Medium	Large
Low	19	55	17
High	21	44	31

Key :
Floor Size (sq.ft) : Small (< 500) Medium (500-999) Large (>= 1000)
Price (psf) : Low (< $1965) High (>= $1965)

Table 6.9 Six major submarkets in Hong Kong

6.6.2.1 Small-Sized, Low-Priced Flats

The best-fitted model was the exponential regression equation (r^2 = 0.75) which was satisfactory (Table 6.10). Four out of 19 variables passed the t-test and proved to be significant. They were purchasing power (FAC1), economic independence (FAC4), crowdedness of the neighborhood (FAC5) and the percentage of commercial-residential landuse (COM_RES). All of them were neighborhood measures.

The signs for socioeconomic measures were as expected. As discussed in the previous case, urban districts were usually residence for the more wealthy household. Their purchasing power was higher but economic burden was a lot less than other households in districts elsewhere. Thus, they would pay more if the district was less crowded.

Contrary to the concept of higher value for homogeneous landuse (Unger 1982), mixed landuse type were in positive relation with price. Out of the 19 cases, 16 of them belonged to the urban districts (Plate 6.1). These districts were usually filled with combined commercial activities on the ground floor and residence on the upper floors which were typical land use pattern in older districts such as Mongkok, Hunghom or Yau Ma Tei. They were exactly the same place where middle class residents preferred because of their convenient locations. This attraction dominated the undesirable impacts of mixed landuse and thus, led to an increase in property valuation.

Small Sized, Low-Priced Type of Residence (SSLP)				
Number of Valid Observation (N) = 19				
Model Performance	Linear	Semi-log	**Exponential**	Log-Log
R Square	0.71	0.75	**0.75**	0.71
F-statistics	9.83	9.83	**11.75**	11.75
Sig. F	0.000	0.000	**0.000**	0.000
Regression Coeff.				
Constant	1646.30	1646.30	**3.21**	3.21
COM_RES	+167.79	+167.79	**+0.05**	+0.05
FAC1	+63.26	+63.26	**+0.02**	+0.02
FAC4	+152.42	+152.42	**+0.04**	+0.04
FAC5	-93.15	-93.15	**-0.02**	-0.02

Table 6.10 Summary statistics on stepwise regression equations of small-sized, low-priced units

Plate 6.1 Distribution of small-sized, low-priced flats (1991)

6.6.2.2 *Small-Sized, High-Priced Flats*

The hedonic regression was best fitted as a linear relationship (Table 6.11), explaining over 70% of the variance. Significant variables included the district school quality (D_SCORE), the employment potential for distributional (V_DIS) and service industries (V_SER). These were neighborhood and locational attributes. The signs were readily informative about their relationship with price.

Employment potentials were calculated from gravity model. A negative relationship denoted when employment attraction decreased, price increased. Attraction declined as a result of either job opportunities (E_j) decreased or the distance between premise and the employment centre (d_{ij}) increased. The opposite rationale held for a positive relationship.

While distributional job opportunities concentrated in urban districts, this type of residence were also found in nearby areas (Plate 6.2). Residents living there saved much transportation cost to work. Thus, a positive relationship existed between distribution employment potential and price.

On the contrary, where service-related job opportunities were fewer or if its centre of employment was located further away from the premise, property price increased. This was because people engaged in service sector earned more money. Even though they had to travel a longer distance to work, they were able to afford the cost. Therefore, they could choose to live in low density residential area which was

Small-Sized, High-Priced Type of Residence (SSHP)				
Number of Valid Observation (N) = 21				
Model Performance	**Linear**	Semi-log	Exponential	Log-Log
R Square	**0.72**		0.70	
F-statistics	**12.72**		11.90	
Sig. F	**0.000**		0.000	
Regression Coeff.				
Constant	**2064.89**		3.34	
D_SCORE	**+4.12**			
V_DIS	**+3.41E-04**		+9.67E-08	
V_SER	**-4.60E-04**		+1.51E-07	
IND			-0.00	

Table 6.11 Summary statistics on stepwise regression equations of small-sized, high-priced units

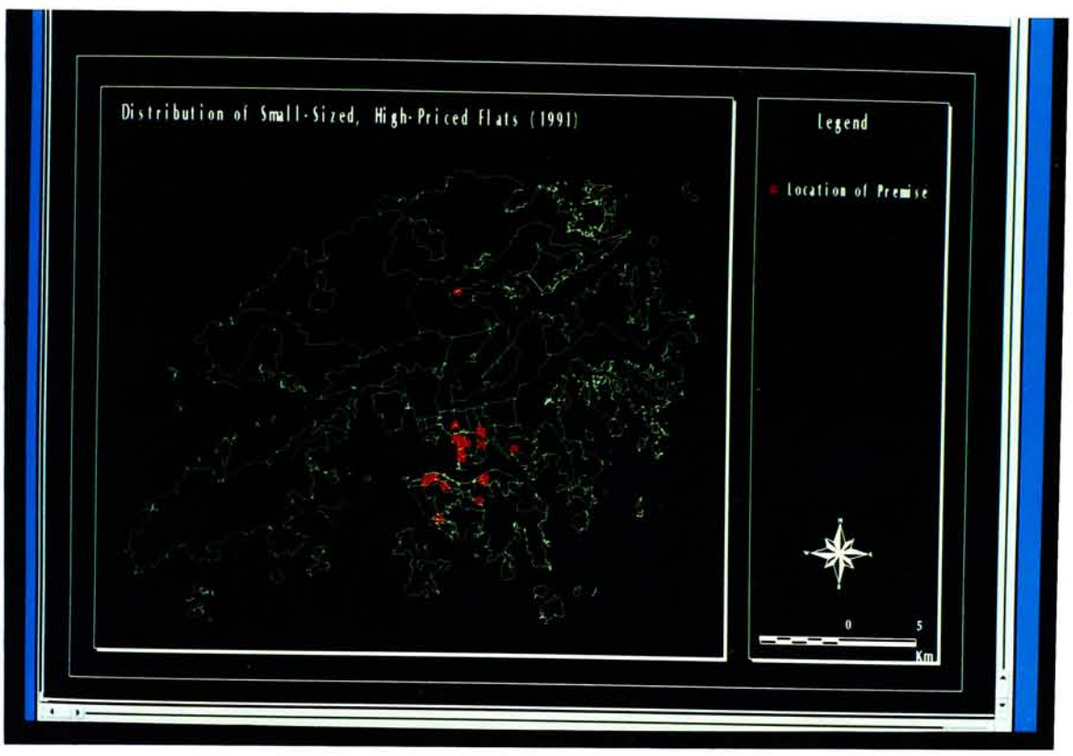


Plate 6.2 Distribution of small-sized, high-priced flats (1991)

further away from the congested CBD. The South district on Hong Kong island was a good example of such phenomenon.

Urban areas were places with better quality schools (Plate 5.12) eg. Tai Hang, Mid-levels, Yau Ma Tei. As most of these premises fell into better school zones, the price of the property was enhanced. It confirmed with other research that better school did have a positive impact on price (Jud & Watts 1981).

6.6.2.3 Medium-Sized, Low-Priced Flats

Exponential model was the best regression model judged by the explanatory power (r^2 = 0.75) in Table 6.12. This submarket was positively affected by the household size (FAC2) and employment potential for service sector (V_DIS); but negatively regressed with crowdedness (FAC5), percentage of mixed landuse (COM_RES), employment potential for distribution (V_DIS). 31 out of 55 cases were found in new town regions (Plate 6.3).

From Plate 5.2, the average household size in new towns were larger than those in urban cores. Estates built in new towns were targeted towards nucleated families. They were more stable in income earning and home ownership became a necessity. Thus, it was not surprising that this type of flats was positively regressed with household size.

Medium-Sized, Low-Priced Type of Residence (MSLP)				
Number of Valid Observation (N) = 55				
Model Performance	Linear	Semi-log	**Exponential**	Log-Log
R Square	0.68	0.36	**0.75**	0.28
F-statistics	20.84	14.65	**29.90**	10.02
Sig. F	0.000	0.000	**0.000**	0.000
Regression Coeff.				
Constant	1863.16	655.59	**3.25**	3.09
FAC2	+97.46		**+0.03**	
FAC4	+181.69			
FAC5	-71.55		**-0.04**	
IND	-27.37			
V_DIS	-9.94E-04		**-8.59E-07**	-0.11
V_SER			**+3.33E-07**	
COM_RES		-165.75	**-0.07**	
V_IND		+231.92		+0.14

Table 6.12 Summary statistics on stepwise regression equations of medium-sized, low-priced units

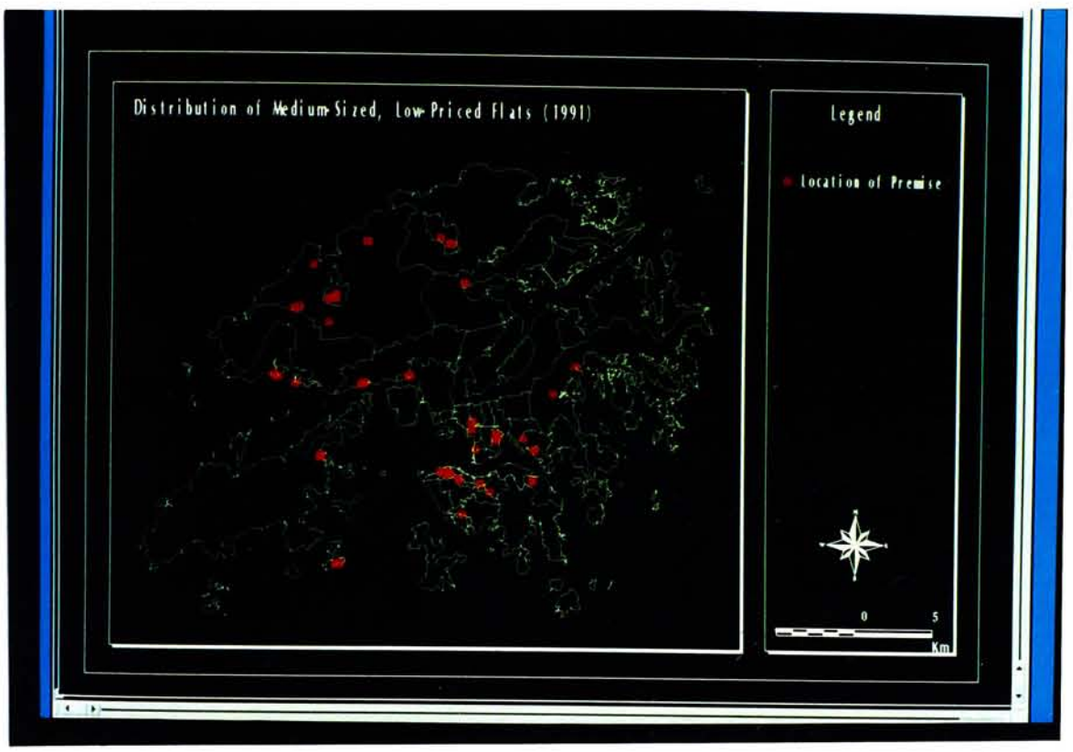


Plate 6.3 Distribution of medium-sized, low-priced flats (1991)

Unlike scenarios in urban cores, mixed landuse in new towns did not guarantee better accessibility or convenience. This was because the nature of mixed landuse was different. In urban areas, most of the mixed landuse sites were usually those with greater convenience. It was more likely to find retail shops on the ground floor and residence on upper floors. However, most of these mixed landuse was found in new town centres (Plate 5.16). This was a result from the planning rationale that, in Tuen Mun, Yuen Long and Tai Po, the new town centre should be built around the existing market town (Lo 1992). Furthermore, the general usage on the ground floor was far more than just shops; sometimes, restaurants were found. Thus, old market towns were associated with the connotation of 'shabby', 'polluted' and 'congested' living conditions. This tended to lower the property value.

Even though much of the service-related activities continued to agglomerate in urban centres, some moved out towards the non-CBD districts. An illustration of such centre was Shatin although the share of employment was incomparable to the urban core. Premises in this kind of setting were most welcome because the cost to work was minimized. Thus, property price tended to go up. On the other hand, most people had to travel back to urban centres for distribution works (eg. Kowloon Bay), they had to spend more on transportation cost. This was undesirable for residents which then explained their lower willingness to pay.

6.6.2.4 Medium-Sized, High-Priced Flats

The performance of model was reasonably fitted with exponential specification (r^2 = 0.46) as shown in Table 6.13. A different set of parameters was significant for this submarket. Economic independence (FAC4) and percentage of residential area (RES) added value to the property price of this group while industrial landuse (IND), employment for industrial sector (V_IND) and purchasing power (FAC1) were negatively related to price.

Most of these premises were found in urban setting (43 out of 47 cases), predominately on Hong Kong Island and to a less extent, Kowloon (Plate 6.4). Areas with industrial landuse or employment proved to lower the property value. Thus, consumers were less willing to pay for such living conditions (eg. Kwun Tong). This fact was further confirmed from their higher willingness to pay for districts with more residential landuse (eg. the South).

Economically independent households tended to concentrate in urban cores (Plate 5.4) where this group of flats was commonly found. With less family burden, they could afford a better dormitory with higher price. That was why, economic independence moved in the same direction with price. Unfortunately, purchasing power did not seem to support this reasoning. Thus, interpretation of this factor was ambiguous.

Medium-Sized, High-Priced Type of Residence (MSHP)				
Number of Valid Observation (N) = 44				
Model Performance	Linear	Semi-log	**Exponential**	Log-Log
R Square	0.41	0.36	**0.46**	0.36
F-statistics	6.70	7.34	**6.55**	7.64
Sig. F	0.000	0.000	**0.000**	0.000
Regression Coeff.				
Constant	2209.80	432.01	**3.34**	3.00
D_SCORE	+6.12			
FAC1	-96.22		**-0.03**	
FAC4	182.47		**+0.03**	
IND	-27.40	-21.64	**-0.01**	-0.01
RES			**+0.01**	
V_IND			**-1.16E-07**	
SQ_RAIL		+80.90		+0.02
AREA		+660.42		+0.13

Table 6.13 Summary statistics on stepwise regression equation of medium-sized, high-priced units

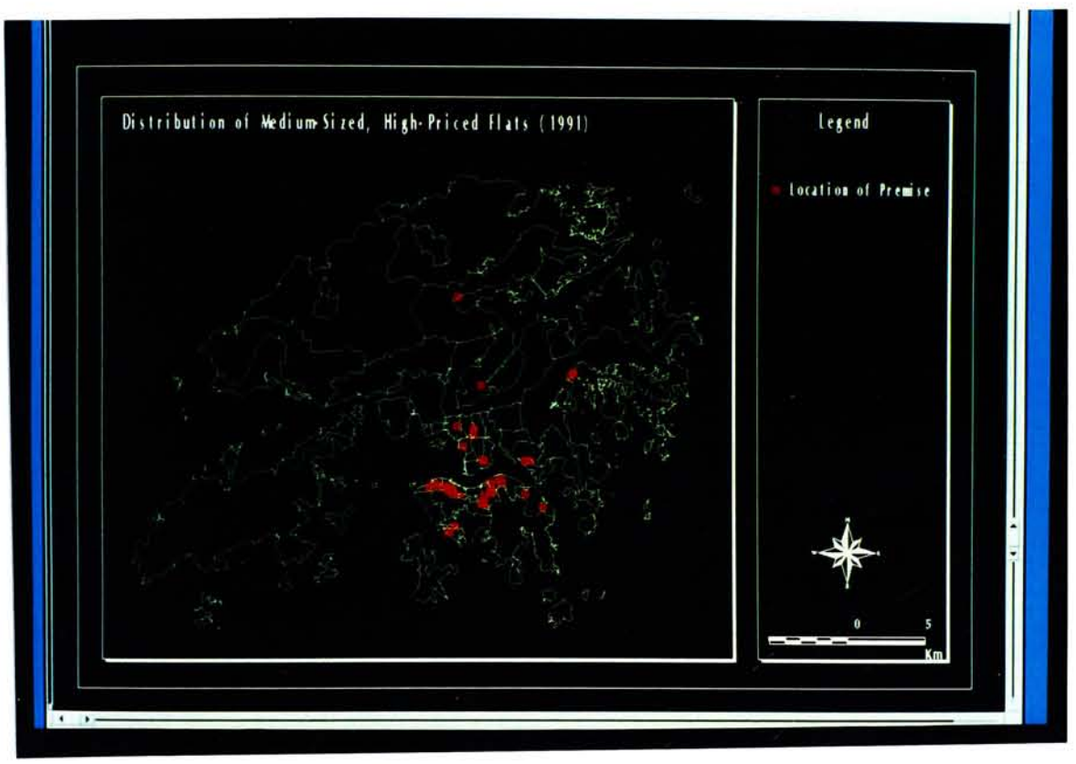


Plate 6.4 Distribution of medium-sized, high-priced flats (1991)

6.6.2.5 Large-Sized, High-Priced Flats

The best-fitted regression was semi-log with an R square of just 0.24 (Table 6.14). The performance of the model was far from satisfactory. The only significant variable was percentage of residential landuse which was negatively related to price. A more stringent confidence level would certainly rule out the variable as its signifiance is just marginal (t = -3.029 p = 0.0051). Thus, the model could be regarded as unsuccessful.

Those who were able to afford living in such spacious living environment were usually the more wealthy class. They were freed from the constraints of transportation costs, purchasing power or any other financial burden. Their choice of residence were more geared towards subjective preferences. It was possible that they bought the flat not because of objective measures like better school quality zone or recreational facilities. It was also probable that their preference was entirely different from other groupings. Variables concerning personal feelings or taste might be more influential in explaining their consumption pattern which the 19 factors failed to capture. Thus, this explained why the model was not successfully implemented in both high and low priced range of spacious dormitories.

6.7 Conclusion

The pooled market and submarkets results are consistent in proving the importance of landuse mix and socioeconomic variables in property valuation.

Large-Sized, High-Priced Type of Residence (LSHP)				
Number of Valid Observation (N) = 31				
Model Performance	Linear	Semi-log	**Exponential**	Log-Log
R Square	0.23	0.24	**0.22**	0.22
F-statistics	9.17	3.18	**6.55**	8.08
Sig. F	0.005	0.005	**0.008**	0.008
Regression Coeff.				
Constant	+2669.29	+2669.29	**+3.42**	+3.42
RES	-13.92	-13.92	**-0.00**	-0.00

Table 6.14 Summary statistics on stepwise regression equation of large-sized, high-priced units

Furthermore, the employment potentials too are able to affect price variability. Except employment potentials which are locational characteristics, others are essentially neighborhood measures. It reflects that, unlike most research that proves structural characteristics to be influential, it is neighborhood and locational traits that count in Hong Kong. Thus, it seems to suggest the dominance of neighborhood effect on property valuation in a local context. When a market is complicated by different kinds of users, their concern for housing attributes differ. Ultimately, conventional variables such as accessibility or floor size may no longer be significant in explanations.

Yet, various submarkets yield diverse results. Even the same variable appears to be significant in different submarkets, its relationship with price is not consistent. The most noticeable example here is the measure for employment potentials. The interpretation of their relationship with price depends on the availability of certain kinds of job and the type of dormitory supplied in a particular district. It is also found out that hedonic price models do not perform well in larger size units. This is because while the consumers for these units are more well-off, they do have a different set of concerns for residence. It involves some subjective preferences which the chosen parameters fail to capture.

One of the important findings is the effect of mixed commercial-residential landuse on price. The effect of mixed landuse on property valuation can be controversial depending on different local settings. In this study, where mixed landuse is found in urban areas, the convenience it carries is able to over-ride other

effects. Yet, in new towns, such kind of mixed landuse is found in the original market towns. These are usually areas where pollution and congestion drag down the property price. In this case, people preferred single land usage[2]. The nature of landuse is different in both case which gives a different relationship with property valuation in Hong Kong.

To conclude, hedonic price methodology does grant a better understanding into the market situation. However, in a perplexed property market like Hong Kong, it is reasonable that while some proven parameters are suppressed, others become significant. It is the unique local setting that brings forth interesting results which are reasonable and realistic.

[2] For instance, in the peripheral areas of new towns, comprehensively built housing estates are essentially residential zones which are more organized in spatial layout. The property price is a lot higher than those around market towns.

Chapter VII

CONCLUSION

7.1 Summary of Findings

After discussing the findings in the previous two chapters, it is appropriate at this stage to summarize the main points in this chapter so as to pave the way to identify the limitations of this research and highlight directions for further study. On the whole, the results are highly informative. Cartographic as well as statistical techniques, with the help of GIS, prove to be an ideal combination in housing research.

7.1.1 Summary on Housing Development in Hong Kong

It is more revealing using descriptive analyses for the examination of housing development patterns in this type of study. The temporal as well as spatial changes in nearly all aspects of the problem have been achieved for scrutinization.

In terms of time, from 1991 to 1994, there were quite distinctive changes in housing stock in the territory. While 1991 to 1993 were years when the general investment environment was highly attractive, both developers and users (mainly investors) had induced the property cycle to bloom. Unfortunately, as the investment

environment was adversely affected and the government introduced measures to curb speculative activities in late 1993 to 1994, the cycle immediately started to reach a trough. On top of the impacts on housing provisions, price had fluctuated in the same direction with the property market. This was logical because the property price was determined by both market forces which were quite responsive to these aspatial factors. Another point was the trend that medium-sized flats became more dominant in the market. This could be attributed by the increasing number of affluent households who could afford this type of flats, as well as the fact that comprehensively designed housing projects tend to supply more spacious dormitories which has been the common form of development these years.

Spatial patterns of residence development also displayed informative results. First of all, the emphasis of development proved to be found at new towns rather than the urban core. Even though it had been argued that insufficient land supply was the reason for this phenomenon, it seemed not convincing since newly built premises could still be found in urban districts. Therefore, it was explicit that the emphatical change could have been a response to future urban development. For instance, as the economy between Hong Kong and Southern China were bound to merge in the future, new urban projects focused on the western New Territories. Not only did future plans target there but these projects were given higher priority than plans adopted in the urban setting. To the east, future railway extension from Tai Wai towards Ma On Shan also attracted much preference from consumers. Related to this pattern was the relative importance among new towns which has been proved to be related to the planning stage it was at. The resources of first generation new towns (eg. Tsuen Wan)

had been fully utilized while fourth generation ones had plenty to exploit. Therefore, while development at the previous category became more or less static, the latter was vibrant.

There were clear distinctions on the type of residence developed at urban core and new towns. It was found that at urban districts, the development was uncoordinated. These newly issued buildings were largely the effort of urban renewal. Both pencil-typed and comprehensive housing projects were found. While the previous one was clearly the effort of small developers undertaking fragmented, small-scale development, conversion of land use was done by the larger developers for the latter group of buildings. In new towns, similar type of comprehensive housing estate was commonly found. Of particular interest was the pattern of supply. There was a clustering pattern of supply each year which could be explained by the 'stage-wise' selling behaviour among developers in order to attain agglomerative economy in scale.

Finally, the spatial pattern of property price was revealed. Prestigious areas continued to supply high-class, low-density residence. Yet, new areas like Sham Tseng or Sai Kung were able to command quite a high price and it was suspected to be under the influence of high socioeconomic residence neighborhood image, created by the developers intentionally. Other urban districts were able to remain competitive in property price owing to her convenience, especially when compared with the new towns in which the traffic load was too heavy and linkages with urban districts were not well-established. However, property price in the New Territories were not

uniform because special areas of high-priced (eg. Shatin/Ma On Shan) premises did not comply to the general pattern of price variation.

On the whole, the cartographic results were quite encouraging. Thus, it was confirmed that qualitative analyses spoke much about the relationship of urban development with residence attribute changes as well as its locational patterns.

7.1.2 Summary from Hedonic Price Models

The overall market as well as the submarkets, delineated by floor size and price, had been studied with hedonic price functions. The intention was to reveal what kind of factors were significant to explain different categories of properties.

The model was quite well-fitted in the pooled market analysis ($r^2 = 0.43$) while those for the submarkets ranged from an R square of 0.46 to 0.75. The hedonic price models were quite well-established in most cases except the high and low-priced range, large-sized premises. It was suggested that the unsatisfactory performance could be explained by the fact that those consumers who bought these type of residence were quite wealthy. Their choice of residence might not be guided by objective criteria of the hedonic price functions, rather, their personal feeling or taste might be more influential in their buying behaviour. It was proved that the 19 variables fail to capture this aspect and thus, reasonable to get such results. Apart from these two submarkets, remaining submarket and pooled market shared something similar - in terms of the category of significant variables.

In pooled market results, it was found out that purchasing power, labor participation, economic independence, floor size were positively regressed with price while industrial landuse adversely affected it. For the first three variables, they were indicators of socioeconomic status of a neighborhood; industrial landuse too was a parameter under neighborhood measures while floor size was a structural variable. It would be confirmed from this result that neighborhood effects dominated. Similar conclusion was made with the submarkets. The locational variables (employment accessibility), landuse (commercial-residential, industrial and residential) as well as socioeconomic indicators (eg. economic independence) were proved significant in one or several submarkets. The results reaffirmed the dominance of neighborhood concerns of consumers.

Hence, it led to the question about the residence traits from different type of users. Noted that the database used was 1991 and it was a year of speculation in real estate. It was probable that the end-users and speculators were engaged in this game and quite likely, the latter category dominated. Since the residence expectations of these two groups were different, their valuation on traits were bound to be unlike. For instance, speculators were concerned about the re-sale potential while end-users probably paid more attention to other factors, such as school quality zone in which the premise was located. Thus, these concepts were reflected in the property price of a premise. It was found out that in market situation like Hong Kong where end-users and speculators complicated the market forces and the fact that they demanded quite different type of residential premises or traits, it was concluded that the hedonic price

model in the territory should contrast with those done elsewhere where the market was a lot simpler to dissect and analyze.

7.1.3 Significance of GIS

The conventional hedonic price methodology has been much improved with the application of GIS. In particular, its ability in deriving different variables and direct association of price records to different traits have contributed a lot to a more accurate database for statistical analyses. Without GIS, the manual effort spent on database construction would be tedious and are more prone to error. Furthermore, GIS is flexible in handling and presenting the data and results. For instance, density surface is a rather innovative way to present variables like employment potentials. It is vivid for researchers to identify centres of influence visually. Qualitatively, trends or development patterns are revealed which also help the researchers to ask relevant questions and analyses. Therefore, introducing GIS into housing studies is highly beneficial : both statistically and qualitatively.

7.2 Limitations and Recommendations

There are several constraints in this research that worth examining. In this section, the main difficulties encountered in hedonic price model building will be discussed and remedies will be suggested if possible.

Concerning the hedonic price analyses, only the data in 1991 was chosen. It was a reality that not all districts would have newly issued premises in that particular year. Therefore, it seemed that the analyses could have been more representative if there were more data from each district within 1991. A more ideal case would be the possibility of examining the models across years. With an enlarged sample size, the performance of the model could have been better.

One of the crucial factors affecting the performance of the regression models was the suitability of the chosen indicators. This consideration would be more conspicuous when proxy variables were used. The research affirmed the impossibility to include all factors in any of the hedonic price studies (Butler 1982) but it had also encountered the problem on how these traits should be measured or represented. For example, in this research, accessibility was measured by the nearest distance to the railway system. However, other methods to derive such utility were possible, such as travel-time (which also involves the mode of transport taken) but the comparative improvement on alternative methods was not examined in this research.

Furthermore, the choice of variables in this research were made on the hypothesis that the locational or neighborhood factors were more influential. The rationale has been proved correct. However, the model failed in examining the large flats (both high/low priced ranges). Apart from its inadequate sample size, it was suspected that the personal feeling or taste of the consumers had much impact on shaping their consumption behaviour. Therefore, a comment could be drawn here : if the hedonic model were to apply in such residence type, the inclusion of some

subjective measures was needed which then, introduced a separate group of parameters into the hedonic price study.

An added point was the fact that, just like selling practice which could affect property price, one has to admit that other aspatial factors were at work. Especially in a complex market like Hong Kong where the kind of actors were diverse , it seemed inadequate to explain price variability with just a hedonic price function. Rather, it would be better if the relationships among actors (ie. users, developers, government etc.) could be studied.

A final note should be made on the submarket delineation methods. This research stratified the market with the type of residence, as defined with a combination of price and floor size. However, the model results could be improved realizing that speculative activities were rigorous in 1991 and the demand was induced by both end-users and speculators. As suspected, their preference on residence type and hence, traits were different. Therefore, submarkets could be delineated according to the type of users instead, just like those analyses on renters versus owners.

7.3 Direction of Future Research

Discussed in the previous section are the difficulties and suggestions for further housing analysis in Hong Kong. It is appropriate to elaborate them at this stage.

First of all, it should be recognized that it is just as vital to take into the account of aspatial factors in housing price analysis : economic variables are not sufficient, other things like selling practice, preferential treatment to first-home-buyers offered by developers, or even the pre-sale practice may be more informative and revealing. The land development process in the territory is shaped by the interactions among players, including the developers (production side), government administrators as well as consumers. For instance, while developers build up their land bank, they also actively decide when, where and what should be built. Therefore, their decisions can affect the location and attributes of housing development. Hence, the land development process and the interplay among actors worth detail studies in the future. The dynamics of the property market and other social processes are influential, perhaps, in a more subtle manner. It is also suggested that time series analyses on these aspects help to fill up the knowledge gap in this area.

Another aspect of the problem that needs continual effort is to conduct studies concerning the second hand market. While this research is an attempt to study the first hand market, second hand market transactions in Hong Kong are rigorous and substantial. Taking an appropriate sample size from the voluminous database, it can trace on how the price of a particular apartment changes with every transaction. It hints another type of hedonic price study to form. Perhaps, the valuations of consumers can be better reflected in this market.

As mentioned, GIS is a desirable tool in property and housing studies. Not only is it flexible and reliable but the efficiency achieved is unrivaled to that of the conventional methods. Other than those techniques employed in this research, there are several system improvements which could enhance the GIS application in this area. For instance, if the real estate database is used for sales purposes, it is suggested that an incorporation with other media is advantageous. The consumers' requirements can be matched with the existing housing stock. It is also possible to demonstrate a 'walk-through' of the residence if photos or videos are connected to GIS from which a lot of transaction costs can be saved. Data updating is just as vital since the property market is highly volatile. Thus, if real time data processing is used, the system can be improved for further real estate analyses.

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APPENDICES

APPENDIX I

District Map of Hong Kong

District Map of Hong Kong
1 to 42 District No.

APPENDIX II

List of Districts and its Components

LIST OF DISTRICTS AND ITS COMPONENTS

Region		Distict name	Descriptions
Hong Kong Island	1	central	Central, Admiralty
	2	sheungwan	Sheung Wan
	3	west	Kennedy Town, Shek Tong Tsui, Sai Ying Pun
	4	midlevels	Robinson Road, HK Zoological Garden, areas around Hong Kong University
	5	pokfulam	Wah Fu, Pok Fu Lam
	6	peak	Peak
	7	wanchai	Wan Chai, Morrison Hill, Lockhardt Road
	8	aberdeen	Aberdeen, Wong Chuk Hang, Ap Lei Chau, Shouson Hill, Ocean Park
	9	taihang	Happy Valley, Tai Hang, Causeway Bay
	10	npointqbay	North Point, Bo Ma Shan, Quarry Bay
	11	skwancwan	Shau Kei Wan, Sai Wan Ho, Chai Wan, Siu Sai Wan
	12	south	Repulse Bay, Stanley, Chung Hom Kok, D'Angular Peninsula, Shek O, Jardine's Outlook
Kowloon Peninsula	13	tsimshatsui	Tsim Sha Tsui, Tsim Sha Tsui East, Canton Road, Jordan
	14	yaumatei	Yau Ma Tei, Waterloo Road
	15	mongkok	Tai Kok Tsui, Mongkok, Prince Edward
	16	hunghom	Hung Hom, To Kwa Wan
	17	homantin	Ho Man Tin
	18	laichikok	Lai Chi Kok
	19	cswan	Cheung Sha Wan, So Uk Estate
	20	shamshuipo	Sham Shui Po
	21	shekkipmei	Shek Kip Mei, Yau Yat Chuen
	22	ktong	Beacon Hill, Kowloon Tong
	23	kcitywtsin	Kowloon City, Wong Tai Sin, Wang Tau Hom
	24	twshanncwan	Tsz Wan Shan, San Po Kong, Ngau Chi Wan
	25	jvalley	Jordan Valley, Kowloon Bay
	26	kwuntong	Kwun Tong, Sau Mau Ping, Ngau Tau Kok, Lam Tin
	27	yautong	Yau Tong

LIST OF DISTRICTS AND ITS COMPONENTS (cont'd)

Region		Distict name	Descriptions
Western New Territories	28	tsuenwannt	Tsuen Wan, Kwai Chung, Tsing Yi
	29	tsuenwanoa	Sham Tseng, Ting Kau
	30	tuenmunnt	Tuen Mun new town (around market town)
	31	tuenmunoa	Tuen Mun other areas
	32	yuenlongnt	Yuen Long new town (around market town)
	33	tinshuiwai	Tin Shui Wai
Eastern New Territories	34	sshuifannt	Sheung Shui, Fanling (along the KCR)
	35	fanlingoa	Sheung Shui, Fanling other areas
	36	taipont	Tai Po new town (around market town)
	37	taipooa	Tai Po other areas
	38	shatinnt	Shatin, Tai Wai, Fo Tan
	39	maonshan	Ma On Shan
	40	sksouthhhu	Sai Kung
	41	junkbay	Junk Bay
	42	islands	Lantau, Cheung Chau and other outlying islands

APPENDIX III

Tertiary Planning Units (TPUs) - District Conversion List

TERTIARY PLANNING UNITS (TPUs) - DISTRICT CONVERSION LIST

Region		Distict name	TPUs
Hong Kong Island	1	central	121,122,123,124
	2	sheungwan	113,114,115
	3	west	111,112,116
	4	midlevels	140,141,142,143
	5	pokfulam	171,172
	6	peak	181,182,183,184
	7	wanchai	131,132,133,134,135
	8	aberdeen	173,174,175,176,191,199
	9	taihang	144,145,146,147,148,149
	10	npointqbay	151,152,153,154,155,156,157
	11	skwancwan	161,162,163,164,165,166
	12	south	190,192,193,194,195,196,197,198
Kowloon Peninsula	13	tsimshatsui	211,212,213,214,215,216,247
	14	yaumatei	225,226
	15	mongkok	220,221,222,227,228,229
	16	hunghom	241,242,243,244,245,246
	17	homantin	231,232,233,234,235,236,237
	18	laichikok	255,256,260
	19	cswan	261,262,264,265,269
	20	shamshuipo	266,267
	21	shekkipmei	263,268
	22	ktong	271,272
	23	kcitywtsin	282,283,285,286
	24	twshanncwan	281,284,287,288,289
	25	jvalley	280,291,292,296
	26	kwuntong	293,294,295,297
	27	yautong	290,298,299

TERTIARY PLANNING UNITS (TPUs) - DISTRICT CONVERSION LIST (cont'd)

Region		Distict name	
Western New Territories	28	tsuenwannt	257,320,321,322,323,324,325,326,327,328,329,350,351
	29	tsuenwanoa	251,253,254,310,331,332,333,340,334,335,336,972,974,975
	30	tuenmunnt	421,422,423,424,425,426
	31	tuenmunoa	411,412,413,414,415,416,427,428,431,432,433,434,441,442
	32	yuenlongnt	524,527,528,529
	33	tinshuiwai	510,511,512,513,514,515,516,517,518,519,521,522,523,525,526,531,532,533,541,542,543,544,545,546,610
Eastern New Territories	34	sshuifannt	624,625,626,627,628
	35	fanlingoa	621,622,623,629,631,633,632,634,641,642,651,652,653
	36	taipont	723,726,727
	37	taipooa	711,741,712,721,720,722,724,725,728,729,742,743,744
	38	shatinnt	753,754,755,756,758,759
	39	maonshan	731,732,761,733,751,757,762,252
	40	sksouthhhu	811,812,813,821,814,831,815,832,822,823,824,825,826,827,828,833,834
	41	junkbay	835,836,837,838,839
	42	islands	911,913,912,920,931,932,933,934,941,942,943,944,950,961,962,963,971,973,976

APPENDICES

APPENDIX I

District Map of Hong Kong

District Map of Hong Kong
1 to 42 District No.

APPENDIX II

List of Districts and its Components

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	2	sheungwan	Sheung Wan
	3	west	Kennedy Town, Shek Tong Tsui, Sai Ying Pun
	4	midlevels	Robinson Road, HK Zoological Garden, areas around Hong Kong University
	5	pokfulam	Wah Fu, Pok Fu Lam
	6	peak	Peak
	7	wanchai	Wan Chai, Morrison Hill, Lockhardt Road
	8	aberdeen	Aberdeen, Wong Chuk Hang, Ap Lei Chau, Shouson Hill, Ocean Park
	9	taihang	Happy Valley, Tai Hang, Causeway Bay
	10	npointqbay	North Point, Bo Ma Shan, Quarry Bay
	11	skwancwan	Shau Kei Wan, Sai Wan Ho, Chai Wan, Siu Sai Wan
	12	south	Repulse Bay, Stanley, Chung Hom Kok, D'Angular Peninsula, Shek O, Jardine's Outlook
Kowloon Peninsula	13	tsimshatsui	Tsim Sha Tsui, Tsim Sha Tsui East, Canton Road, Jordan
	14	yaumatei	Yau Ma Tei, Waterloo Road
	15	mongkok	Tai Kok Tsui, Mongkok, Prince Edward
	16	hunghom	Hung Hom, To Kwa Wan
	17	homantin	Ho Man Tin
	18	laichikok	Lai Chi Kok
	19	cswan	Cheung Sha Wan, So Uk Estate
	20	shamshuipo	Sham Shui Po
	21	shekkipmei	Shek Kip Mei, Yau Yat Chuen
	22	ktong	Beacon Hill, Kowloon Tong
	23	kcitywtsin	Kowloon City, Wong Tai Sin, Wang Tau Hom
	24	twshanncwan	Tsz Wan Shan, San Po Kong, Ngau Chi Wan
	25	jvalley	Jordan Valley, Kowloon Bay
	26	kwuntong	Kwun Tong, Sau Mau Ping, Ngau Tau Kok, Lam Tin
	27	yautong	Yau Tong

LIST OF DISTRICTS AND ITS COMPONENTS (cont'd)

Region		Distict name	Descriptions
Western New Territories	28	tsuenwannt	Tsuen Wan, Kwai Chung, Tsing Yi
	29	tsuenwanoa	Sham Tseng, Ting Kau
	30	tuenmunnt	Tuen Mun new town (around market town)
	31	tuenmunoa	Tuen Mun other areas
	32	yuenlongnt	Yuen Long new town (around market town)
	33	tinshuiwai	Tin Shui Wai
Eastern New Territories	34	sshuifannt	Sheung Shui, Fanling (along the KCR)
	35	fanlingoa	Sheung Shui, Fanling other areas
	36	taipont	Tai Po new town (around market town)
	37	taipooa	Tai Po other areas
	38	shatinnt	Shatin, Tai Wai, Fo Tan
	39	maonshan	Ma On Shan
	40	sksouthhhu	Sai Kung
	41	junkbay	Junk Bay
	42	islands	Lantau, Cheung Chau and other outlying islands

APPENDIX III

Tertiary Planning Units (TPUs) - District Conversion List

TERTIARY PLANNING UNITS (TPUs) - DISTRICT CONVERSION LIST

Region		Distict name	TPUs
Hong Kong Island	1	central	121,122,123,124
	2	sheungwan	113,114,115
	3	west	111,112,116
	4	midlevels	140,141,142,143
	5	pokfulam	171,172
	6	peak	181,182,183,184
	7	wanchai	131,132,133,134,135
	8	aberdeen	173,174,175,176,191,199
	9	taihang	144,145,146,147,148,149
	10	npointqbay	151,152,153,154,155,156,157
	11	skwancwan	161,162,163,164,165,166
	12	south	190,192,193,194,195,196,197,198
Kowloon Peninsula	13	tsimshatsui	211,212,213,214,215,216,247
	14	yaumatei	225,226
	15	mongkok	220,221,222,227,228,229
	16	hunghom	241,242,243,244,245,246
	17	homantin	231,232,233,234,235,236,237
	18	laichikok	255,256,260
	19	cswan	261,262,264,265,269
	20	shamshuipo	266,267
	21	shekkipmei	263,268
	22	ktong	271,272
	23	kcitywtsin	282,283,285,286
	24	twshanncwan	281,284,287,288,289
	25	jvalley	280,291,292,296
	26	kwuntong	293,294,295,297
	27	yautong	290,298,299

TERTIARY PLANNING UNITS (TPUs) - DISTRICT CONVERSION LIST (cont'd)

Region		Distict name	
Western New Territories	28	tsuenwannt	257,320,321,322,323,324,325,326,327,328,329,350,351
	29	tsuenwanoa	251,253,254,310,331,332,333,340,334,335,336,972,974,975
	30	tuenmunnt	421,422,423,424,425,426
	31	tuenmunoa	411,412,413,414,415,416,427,428,431,432,433,434,441,442
	32	yuenlongnt	524,527,528,529
	33	tinshuiwai	510,511,512,513,514,515,516,517,518,519,521,522,523,525,526,531,532,533,541,542,543,544,545,546,610
Eastern New Territories	34	sshuifannt	624,625,626,627,628
	35	fanlingoa	621,622,623,629,631,633,632,634,641,642,651,652,653
	36	taipont	723,726,727
	37	taipooa	711,741,712,721,720,722,724,725,728,729,742,743,744
	38	shatinnt	753,754,755,756,758,759
	39	maonshan	731,732,761,733,751,757,762,252
	40	sksouthhhu	811,812,813,821,814,831,815,832,822,823,824,825,826,827,828,833,834
	41	junkbay	835,836,837,838,839
	42	islands	911,913,912,920,931,932,933,934,941,942,943,944,950,961,962,963,971,973,976