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THE EFFECTS OF HOUSING POLICIES ON LIFE-CYCLE HOUSING CHOICE OF SINGAPORE HOUSEHOLDS

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NATIONAL UNIVERSITY OF SINGAPORE

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SUMMARY

Housing consumption is not only determined by a household's income, but is also affected by its life-cycle and other households' demographic factors. In an efficient housing market, households adjust their housing consumption according to the different needs across the life-cycle. Government's housing policies can have distortional effects on households' life-cycle housing choices. Few extant housing policy studies examined the distortional effects on the life-cycle choice behavior. This study explores the life-cycle housing consumption choice of Singapore households. In particular, we will focus on the public housing policy effects on life-cycle housing choice.

Singapore public housing market is characterized by the existence of two sub-markets, the new-flat market and the resale market. The resale market was liberalized in late 1989, since then the HDB owners can resale freely at the resale market subject to a minimum occupancy regulation. The minimum occupied period is five years for the new-flat owners, but only two and half years for the resale owners. Under this regulation, housing adjustment cost would be higher for new buyers than for resale buyers. The higher housing adjustment cost would motivate the new-flat buyers to choose flat size according to their longer-term housing needs in anticipation of longer occupancy period. In addition to the minimum occupancy regulation, there is an income ceiling to restrict higher income households to buy new flats. The desire to receive housing subsidies would encourage young professionals to purchase large new flats sooner before they reach their income potential to avoid the income ceiling constraint. These regulations distort the households' housing consumption choices. Our empirical analysis aims to measure the difference in life-cycle housing choices between new-flat buyers and resale buyers.

Our data source is Household Expenditure Survey (HES) conducted by Department of Statistics during 1997 and 1998. For the purpose of this study, our sample includes those households who purchased their flats since 1990 soon after the liberalization of the resale market.

We estimate the housing choice model using two housing consumption measurements, one continuous measurement based on Net Assessed Value (NAV) and one discrete measurement based on flat types. With the continuous measurement, we estimate the model using linear regression. With the discrete measurement, we estimate the model using ordered-choice method. The empirical results, however, are quite similar.

Our empirical analysis shows an inverted U-shape life-cycle housing consumption pattern. This is consistent with the hypothesis of life-cycle consumption profile that housing demand would increase with the age of household head till certain life stage and then decrease as the household size changes over the household life cycle. We also observe a difference in life-cycle housing choices between new-flat buyers and resale buyers. The housing consumption for new-flat buyers appears to shift forward in anticipation of longer-term housing needs and possible income ceiling restriction. The difference is larger for households with higher permanent income, who would have greater demand for housing adjustment over the life cycle and would more likely face potential income ceiling restriction.

Our estimates of the shift in life cycle housing choice between new-flat buyers and resale buyers, although consistent with our prediction, are statistically not very significant. Two limitations of our data contribute to the low accuracy of the estimates. First, the sample size is relatively small because we only focus on the households who purchased flats during 1990 to 1998. Second, we do not observe directly whether a flat was bought in new or resale market. We use the purchase price relative to the prevalent resale market price as an indicator to differentiate the new flat and the resale flat.

Our empirical findings suggest that government regulations on housing market can distort households' life-cycle housing consumption choice. With the higher adjustment cost due to the longer minimum occupied period, households would compromise their housing choice between short-term needs and long-term needs, which results in a welfare loss. The welfare loss would be more significant for households with higher permanent income, whose life-cycle housing choice pattern differ more pronouncedly between the new-flat market and resale market.

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CHAPTER ONE

INTRODUCTION

1.1 Research Motivation

Housing is one of the important goods that Singapore households consume. Since housing is a complex and expensive good that usually require the down payment as well as mortgage financing, households may adjust their housing consumption in the different life stages of household members. Basic life-cycle model suggests an inverted U-shape of household income and consumption pattern over individual life cycle that is also supported in Browning and Crossley (2001). Needs adjusted consumption should be maintained [Crossley and Ostrovsky(2003)]. Thus life cycle models make predictions about the life-cycle pattern of housing consumption. For example, some retirees, when their children move out, may cash in by changing to smaller houses.

In an efficient housing market, households adjust their housing consumption according to the different needs across the life cycle. Government's housing policies can have distortional effects on households' life-cycle housing choices. To our knowledge, few extant housing studies examine the distortional effects of housing policies on the life-cycle choice behavior. This study aims to examine the life-cycle pattern of housing

consumption choice of Singapore households. In particular, we will focus on the public housing policy effects on the life-cycle housing choice.

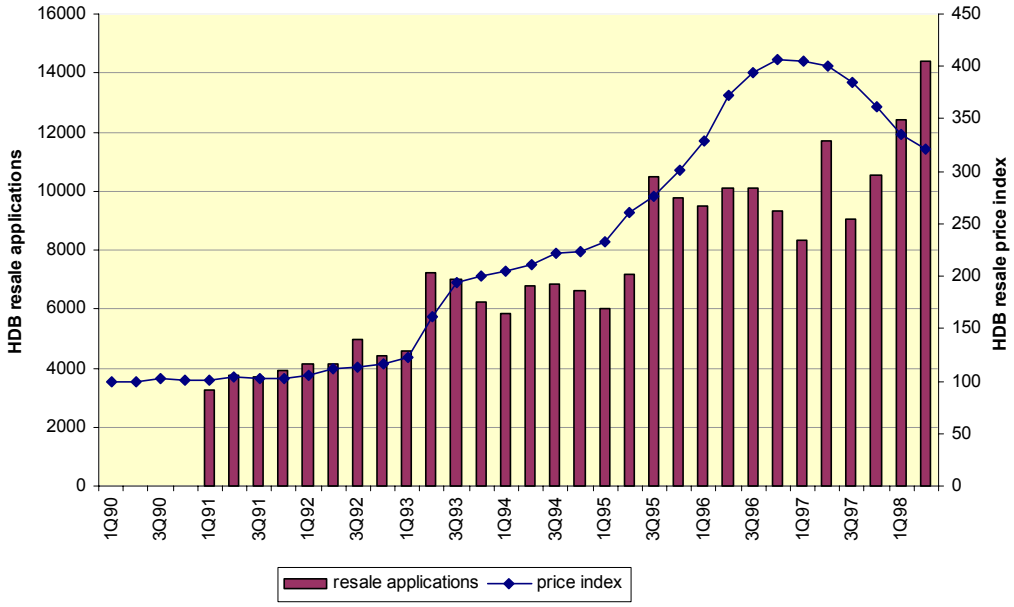
Singapore public housing system has developed well through a series of government's housing policies as well as CPF[1] schemes. The public housing market in Singapore is characterized as two sub-markets, the new HDB[2] flat market and the resale market. The resale market was liberalized in late 1989, since then Singapore permanent residents and those households whose income exceed the income ceiling for the entry of new HDB flats can buy public flats from the resale market [Bardhan et al.(2003)]. The HDB resale application increased steadily during 1990~1998 and the resale price rose dramatically in the early half of 1990s, then followed by a market downturn in 1997 and 1998 (see Figure 1.1).

In the resale market, the HDB home owners can sell their flats (either new or resale flats) subject to the minimum occupancy regulation. The minimum occupied period is five years for the new-flat owners, but only two and half years for the resale owners. With the rapid escalation in resale prices in early 1990s, the price differential between new flats and resale flats became large. More and more households choose to buy new HDB homes directly from government and the queue for the new flats was long. Under this situation, the CPF cash grant scheme was launched in 1994. The eligible first-time home buyers

[1] Central Provident Fund (CPF) is a comprehensive pension fund contributed monthly by both employers and employees. It takes care of its members' needs for retirement, homeownership and healthcare. CPF board was established in 1955 to administer the CPF operation system and preserve the values of savings.
[2] Housing Development Board (HDB) was set up in 1960 to provide affordable public homes, as well as mortgage loan financing at interest rate that are lower than commercial banks.

can get a lump sum cash grant (S$30000~S$50000) from the government if they choose to buy in the resale market. The minimum occupied period is five years[3].

Figure 1.1: HDB Resale Applications and Resale Price Index (1990~1998)[4]



Considering the minimum occupancy rule and the queuing time for HDB new flats, housing adjustment cost would be generally higher for new buyers than for resale buyers. The higher housing adjustment cost would motivate the new-flat buyers to choose flat size according to their longer-term housing needs in anticipation of longer occupancy period. A welfare loss may occur when households compromise their housing choice under the high adjustment cost.

[3] To our knowledge, the home purchase under this scheme was popular in 1996 & 1997 when the queue for the new flats was very long. In fact, the lock-in time for new-flat buyers would include both the minimum occupancy period (5 years) and the queuing time (from registration for purchase to the possession of the flat), which is longer than the lock-in time for resale even with the grant.

[4] The resale HDB application data is only available since 1991.

In addition to the minimum occupancy regulation, there is an income ceiling to restrict higher income households to buy new flats. The desire to receive housing subsidies would encourage young professionals to purchase large new flats sooner before they reach their income potential to avoid the income ceiling constraint. These regulations distort the households' housing consumption choices. For example, some young professional couples would have incentive to buy larger units than their housing needs at the time of home purchase in order to lock in the benefits of housing subsidy for the new flats.

Housing demand and housing choice behavior based on individual data have been extensively researched in many countries, while similar studies have not received serious attention in Singapore. With micro household data from Household Expenditure Survey[5] (HES) as well as other relevant market data, our empirical analysis aims to examine the life-cycle pattern of housing consumption of Singapore households. Government regulations in the new flat market can have distortional effect on the life-cycle housing choice. Thus our empirical analysis also measures the difference in life-cycle housing choices between new-flat buyers and resale buyers.

1.2 Thesis Organization

[5] Housing Expenditure Survey (HES) is conducted y Department of Statistics of Singapore once in every five years to collect detailed information on the latest consumption expenditure of private households.

The next chapter introduces more details about Singapore housing system and the CPF schemes. Chapter 3 reviews the international and local literature on housing studies. Chapter 4 describes the data and the sample definition. The hypothesis of empirical models and the empirical model specifications are elaborated in Chapter 5 & 6. Regression results using OLS and ordered-choice model are presented in Chapter 7. Chapter 8 summarizes the key findings, data limitations and policy implications.

CHAPTER TWO

SINGAPORE HOUSING SYSTEM AND THE CPF SCHEMES

2.1 Singapore Housing System

The structure of Singapore housing system is diagramed in Appendix 1. The Singapore housing system is separated into public housing sector and private housing sector. In year 2000, 88.8% of households dwell in public flats (Table 2.1 provides the structure of household dwellings in year 2000). HDB housing units dominate the housing sector. 88% of households dwell in HDB housing in which 93.2% are owner occupied. The households from low income to upper middle income who meet certain criteria can buy HDB housing units (see Appendix 2). The HDB executive condominium sector differs from other HDB flat sectors since it is a link of public housing to private housing. The executive condominium scheme was introduced in 1995 and it provides properties with comparable designs and facilities to private condominiums. It aims to meet the housing needs of the upper-middle-income families whose income level is close to but greater than the limits for purchasing the HDB flats. Public rental housing is either rented by government to the lowest income families or catered to 'transitional' families waiting for their home ownership flat as well as foreign workers in Singapore [Phang (2001)]. Private housing sector provides high quality of dwellings to the upper income families.

The private housing is mainly categorized into the non-landed property sector which includes private apartments and condominiums and landed property sector. Owner occupied private housing dominate the both sectors. The private rental sector mainly caters to the expatriate population in Singapore.

Table 2.1: The Structure of Household Dwellings in year 2000

(%)

Tenure type / Dwelling type	Own	Rent	Others	Total
HDB dwellings	93.2	6.0	0.8	88.0
Other public flats	88.6	9.2	2.2	0.8
Condominium and private flats	82.8	14.1	3.1	6.0
Landed properties	90.3	6.3	3.4	5.1
Others	45.5	44.4	10.1	0.1
Total	92.3	6.6	1.1	100
Households	852,483	61,061	9,780	923,325

Source: Census of Population in year 2000[6]. Calculated by author.

With the rapid economic growth, households' demand for housing consumption has increased steadily[7]. Since establishment in 1960, the HDB has continually and progressively built larger and better public housing (from 1- or 2-room flats to 3-, 4-, 5-room and executive flats) to provide spacious living environment for the most of

[6] Official census data refers to Singapore Residents Population only (i.e. Singaporeans and Permanent Residents) and the non-residents were excluded. The data on rental sector may underestimate the real market occupancy rate of the rental housing in the whole housing market in which foreign tenants are included.

[7] From Report on the Household Expenditure Survey 1997/1998, distribution of expenditure on housing is 15.6%, 16.5%, 17.5%, 21.9% and 21.6% for 1978, 1983, 1988, 1993 and 1998 respectively.

residents. Of the households dwelling in HDB housing, 94% live in 3-room flats and above, while 65% and 27% live in 4-room flats and 5-room flats and above, respectively[8]. All types of HDB flats are constructed similarly in high rise and high density development with 99-year land leases. In the private housing sector, 54% households live in condominiums and private flats, while 45% households live in landed private properties[9]. Private properties are identified in various types of dwelling product groups with different land leases from 99 year or 999 year-leasehold to freehold [Neo et. al (2003)].

In terms of different housing types, we observe the structure of a housing ladder from the small HDB flats to the higher end private landed properties (see the Appendix 1). With the fact that the majority of households have benefited from accessing the ownership of affordable public housing and more than 90% of households own at least one piece of residential property [Phang (2001)], the Singapore housing system is recognized as a successful case in the Asian region .

2.2 The CPF Schemes

As a Singapore social security system, the Central Provident Fund (CPF) provides retirement fund, healthcare needs, home ownership, family protection, asset enhancement, education fund, etc. The monthly compulsory savings contributed by both employees and

[8, 8] Source: Census of Population in year 2000. Calculated by author. The executive condominiums are not counted separately, probably because of the latest development and a small share in the market.

employers at certain percentage of employees' gross salary go into the three CPF accounts of each member, ordinary account, special account and medisave account[10] in the proportion determined by the CPF board.

From the beginning of the CPF in 1955, more and more CPF schemes have evolved that the CPF has developed from a simple saving plan to the current comprehensive saving and investment schemes. The theoretical implication of the CPF that people accumulate wealth during working life and dis-save in later life (Basic Life-cycle Model Hypothesis) make itself go beyond its original objective to be a social security for the retirees [Low and Aw (1997), Crossley and Ostrovsky (2003)].

The introduction of Public Housing Scheme in 1968 that allows members to use their CPF savings to pay the HDB housing purchase encouraged Singaporeans to own their dwellings.

A similar scheme called Residential Properties Scheme (RPS) applied to private housing in 1981.

In 1986, the CPF was further used in the purchase of Non-Residential Properties (called Non-Residential Properties Scheme, NRPS).

[10] The savings in Ordinary Account can be used to buy a home, pay for CPF insurance, investment and education. The savings in Special Account are for old age, contingency purposes and investment in retirement-related financial products. The savings in Medisave Account can be used for hospitalisation expenses and approved medical insurance.

At the same time, the Approved Investment Scheme (AIS) was introduced. Thereafter the Basic Investment Scheme (BIS) and Enhanced Investment Scheme (EIS) came out in 1993.

Being consistent with government's intention for Singaporeans owning their dwellings and being share owners and stake holders of the Nation, these CPF schemes also imply that members have greater control over what they want to do with their own funds.

Besides the use of the CPF in the home ownership and investment purposes, the CPF also provides health/education fund and insurance premiums with relative schemes. After the set up of Medisave account in the CPF savings in 1984, Education Scheme started in 1989 and allows CPF members to finance their own or children's tertiary education with the CPF savings. The period for the repayment plus interest is 10 years beginning from one year later after Graduation.

Changes of CPF schemes on housing since 2002 have made the use of CPF savings more flexible in home purchasing. Half of the down payment for private housing, now 5% of the price, can be paid by buyer's CPF savings. With effect in 1 July 2005, the Minimum Lease Period (MLP) is lowered from 60 to 30 years[11]. Lowering the MLP thus gives members this flexibility so that more funds can be set aside to meet their retirement expenditure. In this way, both their housing and retirement needs are better met. Another scheme with effect in July 2005 is that all non-related singles (unmarried, divorced or

[11] Minimum Lease Period (MLP) refers to the length of lease remaining below which CPF cannot be used to purchase private residential properties

widowed) will be allowed to use CPF to jointly purchase their only residential properties. There is no age restriction. This change will give singles more housing options and is aligned to the HDB's Joint Singles Scheme where singles aged 35 years and above can jointly buy HDB flats[12].

On the other hand, CPF withdrawal for residential property beyond 100% Valuation Limit (VL[13]) is subject to the lower of Available Housing Withdrawal Limit (AHWL[14]) and 150% of VL. The 150% cap will be reduced gradually from 150% of VL in 2002 to 120% of VL in 2008. Meanwhile, some restrictions on Use of CPF to purchase Multiple Properties will be effect from July 2006. This policy supports the objective of retirement adequacy. It would ensure that CPF members set aside at least the Minimum Sum cash component for retirement before investing in the second and subsequent properties.

The Non-Residential Properties Scheme will be phased out from 1 July 2006. The CPF Board will not accept any applications under the Scheme from 1 July 2006. Members who are using CPF to service their non-residential properties before 1 July 2006 will not be affected by the policy change.

[12] Source: HDB website, www.hdb.gov.sg
[13] The VL refers to the value of property at the time of purchase or the purchase price, whichever is lower.
[14] For CPF members aged below 55 years, the AHWL is the available Ordinary Account balance after setting aside the Minimum Sum cash component. For CPF members aged 55 years and above, the AHWL is Available Ordinary Account balance less the Minimum Sum cash component shortfall.

CHAPTER THREE

LITERATURE REVIEW

There have been a large volume of studies on housing demand for the past four decades. Most of the international literature of housing study we have reviewed uses the individual household data (micro data) in United States, e.g. the American Housing Survey (AHS), Retirement History Survey (RHS), Federal Housing Administration (FHS), etc. A few articles also use the micro data from U.K., e.g. U.K. Family Expenditure Survey [Browning and Crossley (2001)], or from Canada [Crossley and Ostrovsky (2003)], or from China [Fu et. al (2000)], etc. On the other hand, local researchers base their housing study mostly on aggregate data sets. Available data source includes Urban Redevelopment Authority (URA[15]) statistics. A special review on the Berge and Turner (1991) is single out as we observed the Swedish housing market some similar to the Singapore housing market in the structure of housing system. It is found in this paper that the income redistribution effect induced by housing subsidiary policies is little, quite opposite the policy intention.

3.1 International Literature Review

[15] The Urban Redevelopment Authority (URA) is Singapore's national land use planning authority. URA prepares long term strategic plans, as well as detailed local area plans, for physical development, and then co-ordinates and guides efforts to bring these plans to reality. Prudent land use planning has enabled Singapore to enjoy strong economic growth and social cohesion, and ensures that sufficient land is safeguarded to support continued economic progress and future development. Source: www.ura.gov.sg

In the economics of housing demand, researchers often concern the income elasticities and price elasticites [Goodman (1982, 1984, 1988 and 2002), Hansam et.al (1996), Hausman and Wise (1980), Henderson and Ioannides (1986), Hoyt and Rosenthal (1990), Rosen (1979), Mayo (1981), Ioannides and Zabel (2001)], the appropriate functional form for housing demand equations [Mayo (1981)], the role of demographic variables [Mayo (1981), Goodman (1984, 1988)], and the dynamic aspects of housing demand [Goodman (1995)].

3.1.1 Measured Income & Permanent Income

The difference between the measured income (current income) and the expected income (permanent income), when estimating housing demand function, was earliest recognized in 1960 [Olsen, (1987)]. With Individual household data available, permanent income is estimated by using household demographics including human wealth and non-human wealth variables [Goodman and Kawai (1982)]. Measured income is separated into permanent income and transitory income that is the residual of the permanent income estimation. In Goodman and Kawai (1982), the measured income Y is expressed as sum of permanent income and transitory income: $Y = Y^P + Y^T$, where Y^P depends on individual's human wealth and nonhuman wealth: $Y^P = \phi H + \psi N$. Human wealth H is related to the household's demographic factors such as education level, age, etc. Nonhuman wealth N includes previous wealth accumulated, car owned, etc.

3.1.2 Income Elasticities and Price Elasticities

In the literature of housing studies, income elasticities and price elasticities are less than one in absolute value [Olsen (1987)]. It means that housing demand is income-inelastic and price-inelastic [Henderson and Ioannides (1985)]. The characteristics of housing commodity result that most households do not move in response to small changes in income or housing price [Goodman (2002)]. The marginal exception is observed in Goodman (1982), that the income and price demand elasticities derived from linear regression results are some higher/lower than +1/-1 but quite close to +1/-1.

With individual household data available, the estimates of income elasticities are improved, as the permanent income estimated from these data are included in the housing demand equation [Goodman and Kawai (1982 & 1984)]. In Goodman and Kawai (1984), median permanent income elasticities in all selected metropolitan areas are 77% higher than median current income elaticities in the same areas. The exception is, in Goodman and Kawai (1988), that current, rather than permanent income provides better results in the demand estimates.

Income elasticities and price elaticities between owners and renters are studied in Mayo(1981), Goodman and Kawai (1984 and 1988) and Hansen et. al (1996). Similar regression results are obtained from housing demand equations. Housing demand of owners is more income elastic than that of renters [Hansen et. al (1996)]. However, the price elasticities of owners is substantially lower (in absolute value) than those of renters [Goodman and Kawai (1984)]. Mayo(1981) explains that a large fraction of the observed

owner-renter differences in income elasticities could be accounted for by income difference alone. Income elasticities rise and price elasticities fall with incomes when linear demand functions are used. Goodman and Kawai (1984) recalculate these elasticities based on the income of the other tenure. Results show that values of elasticities calculated with tenure-specific incomes overstates the differences between housing tenures.

An interesting paper that explores the neighborhood effects on housing demand by Ioannides and Zabel (2001) found that the elasticities of individual housing demand, with respect to the mean of the neighbors' housing demands, range from 0.19 to 0.66. And, the elasticities of individual housing demand, with respect to the mean of neighbors' permanent incomes, range from 0.17 to 0.54.

3.1.3 Discontinuous Budget Constraints and Housing Demand

Household choice behavior is often presented in terms of preferences and possibilities [Deaton and Muellbauer (1980)]. Individual choices are often characterized by economists as resulting from maximization of an implicit utility function subject to a budget constraint [Hausman and Wise (1980)]. In the theory of economics and consumer behavior, the simple linear budget constraint is a basic assumption for a great deal of consumer demand analysis, while nonlinear budget constraints arise frequently in practice [Deaton and Muellbauer (1980)].

Government programs account for many nonlinearities in budget frontiers [Olsen (1987)]. Hausman and Wise (1980) proposes a general method of the estimation based on the experimental data which included "housing gap" subsidy plan that effectively created discontinuous individual budget constraints. With the same "housing gap" schemes data, Venti and Wise (1984) analyze the magnitude of transaction costs and their implications for the effects of government subsidy programs. Discontinuous budget constraints with capital gains tax are also introduced in Hoyt and Rosenthal (1990). The estimates of the elasticities are improved with modeling the capital gains tax even though the coefficient difference is not statistically significant.

Earlier studies on the nonlinearity in the budget constraint caused by moving costs are reviewed in Olsen (1987). Moving costs, especially of a non-monetary nature, are emphasized in these studies. In addition, households with lowest moving costs would more likely response their housing consumption to changes in their budget space [Venti and Wise (1984)].

3.1.4 Functional Forms of Housing Demand Equations

Mayo (1981) reviews different functional forms in housing demand estimation. Log-linear demand equations are evaluated first, with the hypothesis that elasticities of demand do not respond to the changes of either income or price variable. The log-linear specification is convenient because the coefficients on income and price provide direct estimates of the price and income elasticities of demand [Rosen (1979), Hoyt and

Rosenthal (1990)]. Mayo(1981) then evaluates the linear demand equation that may derive from the Stone-Geary or "displaced Cobb-Douglas" utility function. Linear demand equation permits that price and income elasticities vary with both prices and income. It also provides an explanation of why elasticity estimates differ between renters and owners [Goodman and Kawai (1984)].

3.1.5 Demographic Effects in Housing Demand

Demand for housing is determined not only by income and housing price but also by other household characteristics [Goodman (1982)]. Demographic effects in housing demand are reviewed in Mayo (1981). Typically, demographic variables include age of household head, household size, numbers of children, educational level and occupation category of household head, race and sex of household head, which are either added to demand equations in a linear additive way or used as category variables.

In Mankiw and Weil (1989), cross-sectional data are used to examine the link between age and housing demand. It is found that individual generates little housing demand until age 20. Housing demand rises sharply between ages 20 and 30, and remains flat after age 30. Housing demand appears to decline after age 40 by about one percent per year.

We have noticed, from the literature, that demographic effects are difficult to be compared in different studies. For instance, age has a negative and significant impact in Goodman (1988), while it has positive effect on housing demand but not very significant

in Rosen (1979). Similarly, the female head of household has positive and significant on quantity of housing services in Rosen (1979) and the male head, however, has positive but insignificant effect in Goodman (1988).

Besides the demographic factors, some non-human wealth variables, e.g. equity, car, etc., are also included in the housing demand equation [Goodman (1982)]. However, the inclusion of these wealth variables reduces the effect of permanent income.

3.1.6 Household Mobility Behavior, Life-cycle Effects

Besides household income as an important determinant of the housing consumption, life cycle (age), as well as other demographic factors, also has influential effects. It is clear that the demand for housing services, the housing consumption, changes significantly over the life cycle of any individual household [DiPasquale and Wheaton (1996)].

Venti and Wise (1984 and 1990) are among the first researchers to study residential mobility of focusing on housing consumption disequilibrium and (psychic) moving transaction cost. The disequilibrium occurs when housing consumption and housing demand do not match. However, the disequilibrium in housing demand may persist if this disequilibrium is not severe enough to overcome the sizable transaction costs that moving entails. Venti and Wise (1990) find that moving decision with respect to elder people is usually triggered by the changes in retirement, marital, or health status. In such situations, the families have much lower (psychic) transaction costs.

Households adjust their housing consumption through housing mobility behavior. Generally, households' housing mobility behavior is tenure related household mobility. Ioannides(1987) found that personal wealth, housing prices, as well as socioeconomic characteristics explain households' tenure choice and mobility behavior simultaneously. In Ioannides and Kan (1996), households' financial wealth level does not affect the mobility behavior, while demographic factors such as age of household head do have significant effect on the mobility behavior. With tenure choice and residential mobility as a joint decision, one of the two models in Ioannides and Kan (1996) provides more details for explaining households' decision to move and whether to rent or own after moving. It was found in Ioannides (1987) and Ioannides and Kan (1996) that higher mobility for renters and lower for owners. This point has been widely recognized.

A tenure choice model is also used in Rosenthal (1988) that explores the impacts of changes in housing tax policy by accounting for the moving process of households. Besides economic and demographic factors, residence times are found to be an important consideration in household tenure choice, through their influence on the discounted value of legal and realtor fees paid by homeowners.

With a comprehensive model considering both households housing consumption decision and investment decision, Berkovec and Fullerton (1992) found that demographic characteristics are primary determinants of tenure choice, whereas taxation factors help to determine the size of each owner-occupied house.

The tenure choice is also affected by households' financial status. For example, Brueckner (1986) analyzed the role of the down-payment constraint in housing tenure choice. The paper explains that households need to sacrifice initial consumption for accumulating down-payment, but eventually enjoy the homeownership benefits, resorting to long term, relative low risk investment. Johnson (1981) found that household income, expected duration of occupancy, liquidity and inflation expectation is the determinants of the financial benefits of owning a home.

As above, tenure related mobility serves a personal investment purpose, but it also symbolizes the changing of households' social status [Neo et. al (2003)]. Those with higher income, younger household head, senior managerial or professional jobs and those who are not be able to access public subsidized housing like to buy commercial homes or upgrade to better housing [Fu et al. (2000) and Tu et al. (2005)].

On the other hand, some researchers studied household mobility related to housing location choices. White (1977) presents a model showing that households' housing and non-housing consumption pattern determine their location choices. In Curran et al. (1982), it was suggested that the number of workers in a household and the employment locations of the workers do affect residential households' location decisions. In particular, Freedman and Kern (1997) explains that women's earnings opportunities and commuting burdens influence on her husband's job site as well as the household's location choice.

Thus, the socioeconomic factor changes of members in a household may affect a household's housing location choice.

In recent studies, the traditional life-cycle model of consumption and saving has been applied to examine the life-cycle effects (or age effects) when households make housing consumption decisions [Börsch-Supan and Pollakowski (1990), Sweet (1990), Crossley and Ostrovsky (2003)]. Modigliani (1986) explains that permanent income model differ from life-cycle model in that it assumes that life is indefinitely long. By recognizing the finite life of households, life-cycle model allows systematic variations in income and in "needs" which occur over the life cycle. Life-cycle model also takes into account bequests and the bequest motive. In the situation that the life-cycle framework is held in increasing disrepute with in the economics profession, Browning and Crossley (2001) provides a defense of the life-cycle framework as a source of models that can be taken to the data. The distinction between the life-cycle framework (or tradition) and particular life-cycle models with empirical content are emphasized in their paper. It also comes out some ideas for the future research for the life-cycle model by looking at specific features of goods, for example, housing.

Simple life-cycle models predict that housing wealth should be dis-saved in later life, and housing consumption should also fall as needs diminish (with declining household size). The empirical findings in Crossley and Ostrovsky (2003) mildly support this prediction of simple life-cycle models. It was found that home ownership declines at older ages, but not steeply. Average housing equity declines as well, but more slowly than ownership. In

Börsch-Supan and Pollakowski (1990), the estimated age effects indicate that elderly households downgrade dwelling size without change tenure.

On the other hand, Venti and Wise (1989 and 2001) argue whether the elder people perceive the housing equity as a source of funds for general consumption as they grow older. In Venti and Wise (1989), it is observed that the elderly typically do not use saving in the form of housing equity to finance current consumption when they aged, that is contrary to the usual life-cycle theory. Also, Venti and Wise (2001) find that households are unlikely to discontinue home ownership when they become aged. Based on the empirical estimation with different sources of data, they find that housing equity either increases with age or declines somewhat.

3.2 Local Studies Review

As above, housing demand and household choice behavior have been extensively researched in United States and some other countries, e.g. U.K., while similar studies have not received serious attention in Singapore. In Singapore, housing studies more focus on the private housing market trends with available data source, Urban Redevelopment Authority (URA) statistics [Lum (1996), Ho and Cuervo (1999), Sing (2001), Tu (2004)]. The resale market analysis for public housing has also appeared in recent studies [Tu and Wong (2002), Edelstein and Lum (2003), Ong, Ho and Lim (2003)]. Moreover, researchers have done extensive studies on the impacts of

government policies on housing price dynamics in private property market [Phang and Wong (1997), Sing (2001), Lum (2002),] and in public housing market [Tu and Wong (2002)], or on the upward mobility from public housing to private housing [Ong (2000), Tu et al.(2005)].

Relating to the main objective of this study that is to understand housing consumption demand structure in Singapore, as well as to investigate the life-cycle effects on household housing consumption, the previous studies on Singapore housing market are believed to bring forth our vision. We will review some articles relevant to our research in more details.

3.2.1 Housing Demand and Household Mobility Behavior

The specific structure of housing system in Singapore determines that most of the population lives in public housing subsidized by government. Households from low income to upper middle income groups usually choose to live in public housing because of the down payment constraints and the affordability of the mortgage debt, while the smaller groups of households with higher income are accommodated in private housing. This leads the residential housing market in Singapore to be viewed as a pyramid with the largest stratum encompassing households owning and living in low-end public housing [Bardhan et al. (2003)]. Above that, in ascending order are the larger and newer public units, executive condominium, entry-level private housing, medium level private housing and finally, luxury units, and landed properties.

In recent years, the issues related to the upward mobility behaviour of households have attracted the attention of many local researchers. In contrast to international experiences, Singapore observes a special type of housing related mobility where its public homeowners continually seek to upgrade to private housing (Tu et al., 2005). They explained that the rising trend of such mobility is driven by the desire of households for an image of higher status and the increased accessibility to private housing constrained by the large amount of down payment. Regression results show that an existing Singapore public homeowner, if the household head is at younger age, or he has the limit to access to another public housing unit, but has stable and higher income or smaller household size, as well as owns a larger public housing unit, is likely to upgrade to private housing. The impacts of household characteristics on the upgrading mobility from public flats to private properties are also highlighted in the study by Thang & Ong (2001). The study reveals that younger professionals, executives or managerial staffs are more likely to upgrade, which is consistent with the latest findings (Tu et al., 2005). Ong (2000) indicates this kind of upgrading phenomenon in Singapore supported by the general upward trend in the ratio of private to public housing stock. Through the affordability and upward mobility model, empirical tests are conducted in Ong (2000) and the results imply that the ability to upgrade from public to private housing depends to a large extent on legislative and financing regulation. Upward mobility is also reflected by the theoretical, then the actual private property price movement, for example, a sharp decline in the theoretical property price (that is predicted by the upward mobility model) in the second half of 1996 when the anti-speculation regulation introduced, means that public

homeowners find it harder to upgrade. Ong & Sing (2002) point out that the private housing price volatility is significantly affected by the rising trend of such upward mobility.

Upward mobility from public housing to private housing is highly related to the public resale market movements. Capital gains from resale of HDB units may be an important determinant of upgrading mobility (Bardhan et al., 2003). In this paper, the number of new private housing transacted is estimated, depending on three macro economic factors, public resale prices and an interaction term, modeling the linkage between the public and the private housing markets. The growth in wealth, as well as capital gains in the public sector is found to generate upward mobility of households. The link between the public resale market and the private housing market is also probed by Tu (2003). She explains that the resale market was originally aimed at facilitating consumer housing choices and harnessing the greater efficiency of market mechanism in the delivery of public housing. However, it has also become a vehicle for many Singapore households to upgrade to private housing.

As well-known, the ability to afford/own private housing in Singapore is limited by the scarcity of land and understandably, high prices (Ong, 2000). Hence, owning a private property has become “the Singapore Dream”. The accepted wisdom is that the path toward ownership of private property is to purchase a HDB flat first, and to upgrade subsequently (Lum, 1996).

In a government study on household mobility during the 1991-1995, upgrading refers to a HDB/HUDC resident private household which had shifted from a lower category to a higher category of dwelling unit during the 1991-1995, while downgrading refers to a resident private household which had shifted from a higher to lower category of dwelling unit during the 1991-1995. It is found that majority of households which upgraded were headed by younger married males, had larger household size and higher household income. Conversely, downgrading households tend to be older households with smaller household size and lower household income.

3.2.2 Government Policies and Housing Mobility

As mentioned earlier, almost every study on housing market in Singapore does include the impacts of government policies. In fact, housing mobility behavior is interacted with housing price movements. For instance, the price appreciation in both public and private housing markets enhances household upward mobility behavior. The reason may be that households expect more capital gains by purchasing larger housing units. We could say any government policies that have impacts on housing prices would influence the housing mobility behavior.

In Phang and Wong (1997), the impacts of government policies on private housing prices were empirically analyzed and the results revealed that the timing of government policies relating to the use of compulsory savings for private housing finance, the liberalization of rules on public housing ownership criterion as well as for the change in maximum HDB

loan amount have significant impacts on private housing prices. On the other hand, Tu and Wong (2002), in their study on "Public Policies and Public Resale Housing Prices in Singapore", selected ten major public housing policies between 1990 and 2003 and found that the prices of public resale housing are largely determined by public policies rather than by economic variables. Out of all the public housing policies, the HDB Liberalization of Finance Terms policy issued in April 1993 appears to have strongest impacts on public resale housing prices. Tu (2003) further extended the study by empirically testing how the public resold dwellings impact on private housing prices. She found that the public resale housing market is relatively self- determined mainly driven by public housing prices, while the private housing market, to some extent, depends on the performance of the public resale market. In particular, the HDB Liberalization of Finance Terms policy made significant contributions to the boom of both the public resale and the private real housing prices in the mid of 1990s. The rising public resale housing prices further increased a public homeowner's capital gain at the time of sale, and hence increasing the accessibility to private housing. Lum (2002) also included this policy variable in her study. It is found that the package of deregulatory measures in the public housing market was an important determinant of the price adjustment process.

The impacts of anti-speculation measurements issued in May 1996 were tested in several studies [Ong (2000), Sing (2001), Tu and Wong (2002) and Tu (2003)]. Under this rule, a "Stamp Duty" was made payable on transactions of both public and private housing units [Tu and Wong(2002)]. Moreover, purchases of private property have to pay a minimum of 20% of the property price in cash (previously 10% of price). It means that HDB flat owners would find it harder to upgrade (Ong, 2000). Understandably, this policy,

together with the increment of the supply of residential lands was found to be effective in dampening condominium prices (Sing, 2001). The impact of anti-speculation measurements is much higher on the private housing market than on the public resale housing market because the public resale homebuyers are regulated by the minimum occupancy period (Tu, 2003).

The recent study by Neo, Lee and Ong (2003) explored the change in Central Provident Fund (CPF) policy on 1 September 2002, on household mobility in general and on the affordability and accessibility of potential home-buyers in particular. They found that the improvement in accessibility by allowing the use of CPF for down payment may stimulate demand at the cost of higher financial risk to home-buyers and mortgage lenders, considering the reduced affordability by the imposition of a limit on the use of CPF for up to 150% (reduced to 120% in five years at 6% per annum).

3.2.3 Summary

In a whole, researches on Singapore housing market, according to available literature, are based on aggregate data sets. Completed topics mainly focus on the price movement in private and public resale housing markets as well as the government policy effects. Upward housing mobility behavior from public flats to private housing are explored and the bulk proceeds from selling public flats with high subsidies in the resale market provide the large amount of cash down payment for the upgraders.

To our knowledge, there are few papers from micro perspective with individual household data that examine the housing consumption behavior and how the market constraints or policy restrictions affect households' housing consumption choices.

3.3 Housing Subsidy Program – A Swedish Case Review

We summarize the main points of the study by Berger and Turner (1991) talking about Swedish housing market and housing subsidy program as follows. As we observed, Swedish housing system is similar to the Singapore housing system in some aspects. From this study, we see that the government intention of redistribution of income through housing subsidy program have little effect.

3.3.1 Housing Tenure Forms

There are three tenure forms in Swedish housing sector. 43% of the dwellings belong to a rental sector, split into private and municipal rental sub-sectors of approximately equal size. Rents are fixed by a "Fair Rent System", which means that a user's value, decided on administrative grounds, determines the rents. It sometimes coincides with a market value, but will more often create excess demand for centrally located dwellings and excess supply of built dwellings during the late 1980s'. Regulated allocation of rental dwellings is also available to cater the families who have children and those who have

spent a long time in the rental queue, though part of the rental market is open to the landlord's own decisions on whom to accept as a tenant. On the other hand, the ownership sector, which occupies 42% of the dwellings, is free to let sellers determine the prices and choose future owners. In the end, the cooperative sector contained 15% of dwellings (534,000 of total 3,670,000) in 1985.

3.3.2 The Cooperative Sector

The cooperative sector is a substitute for the rental sector when the housing consumption aspect is important. The cooperative sector on the other hand is a substitute to the ownership sector for those households where the investment aspect of housing is apt to be important. Some aged owners in the ownership sector like to downsize to the cooperative dwellings from their single-family housing either for living or investment purpose. Such kind of demand for the cooperative dwellings may explain part of the high price inflation of well-located cooperative dwellings.

The term, the cooperative, can be explained that, when a building project is finished, a tenant-owner cooperative is established. Members in the cooperative association make an initial down payment in the case of a new cooperative dwelling and own the estate collectively. Then members pay a "rent" for living, which corresponds to the sum of maintenance costs and historically determined capital expenditure on loans issued to the cooperative on a collective basis. The down payment for a cooperative dwelling is set on an expenditure basis, irrespective of the (implicit) market price. Besides the way of

obtaining a cooperative dwelling in new construction as discussed above, households also can buy used dwellings in a free market where all units are bought and sold with a transaction price determined by market conditions. The transaction price usually exceeds the down payment so substantial gains accrue to those achieving a dwelling through the queue.

3.3.3 Windfall Gains & Policy Intention

The existing windfall gains create an incentive to queue for a cooperative dwelling. Queuing is open to all households, whether or not they already have a cooperative dwelling. The queuing time, however, is quite long. Especially in certain areas, the queuing time may be above ten years.

The close interaction with other housing markets explains why excess demand for cooperative dwellings arises. For the interest of the cooperative companies' behavior, it is safer to satisfy a part of the queue and maintain a situation with excess demand. Thus, the risk of creating vacant dwellings will be minimized since losses due to vacancies are a heavy burden on the cooperatives.

Capital gains taxation is implemented to prevent households from a speculative selling of the dwelling immediately after a purchase. The capital gains tax decreases with the length of the occupation.

Which households will receive these windfall gains? Using a logit regression analysis, Burger and Turner (1991) found that the probability of acquiring a dwelling through the queue, and thus capturing the windfall gain, is positively correlated with income and family size. Therefore, the cooperative queues do not have a redistributive effect on wealth in society, quite opposite the housing policy intention upon which the Swedish cooperative movement was found.[*]

[*] Besides the cooperative dwellings we discussed, there is also an interest subsidy given to the recent built cooperative dwellings and to all other tenure form in Sweden. So the interest subsidy system is complex and generous, and available across tenure forms and households in different income brackets.

CHAPTER FOUR

DATA SUMMARY

4.1 Introduction

The Singapore Department of Statistics (DOS) conducts the Household Expenditure Survey (HES) once in every five years since 1972/73. Our data source is the seventh HES in the series that was conducted by DOS from November 1997 to October 1998.

The main objective of the HES is to collect detailed information on the latest consumption expenditure of private households. The HES also obtained additional data on the demographic and socio-economic characteristics of the households, as well as the ownership of consumer durables, investments and assets among private households in Singapore[16].

The data collected in the 1997/1998 covers 5555 households in which only 41 households are headed by foreigners and 342 households are headed by Singapore Permanent

[16] Reference: Report on the Household Expenditure Survey 1997/98, ISSN 0217-9563. Department of Statistics, Ministry of Trade & Industry, Republic of Singapore

Residents[17]. In this section, we explain briefly the variables extracted from the survey that may affect households' housing consumption behavior and do summary statistics.

4.2 Households' Housing Types and Tenure Structure

The HES data have detailed households' housing type information. A large proportion of the households who live in HDB 3-room flat and above, or private housing own their dwellings. For the households who owned their dwellings during the survey period, only 23 of them are headed by foreigners, in which 19 households lived in public housing. One possible reason is that the MIE of these 19 households married Singaporeans so they can own public housing at the time. The ownership rate of HDB 1- and 2-room flats is the lowest. It may be explained that HDB 1- and 2-room flats are mainly rented to the poorest families. The type of "Others" includes shop houses, labor quarters, non-HDB public flats and attap houses. As our empirical study focuses on homeowners, we exclude the small number of households living in HDB 1- and 2-room flats as well as "Others" housing types.

[17] In this study, we define household head as the Main Income Earner (MIE) of a household. MIE is defined as the household member with the highest personal income.

Table 4.1: Home Tenure Rate by Housing Types

Housing Type	Ownership		Rental		Others	
	% owned	No. of owners	%rented	No. of renters	%others	No. of others
Others	64.0%	32	36.0%	18	0	0
HDB 1-2 room	8.9%	20	90.7%	205	0.44	1
HDB 3 room	96.5%	1503	3.4%	53	0.13	2
HDB 4 room	98.6%	1913	1.3%	25	0.15	3
HDB 5 room & Executive flat	98.9%	1190	0.83%	10	0.25	3
Private[18]	93.4%	539	4.7%	27	1.91	11
Total	93.6%	5197	6.09%	338	0.36	20

Source: Housing Expenditure Survey in 1997/1998. Calculated by author.

4.3 Owner Occupied Housing: Purchase Year Distribution

Demand for home ownership increased significantly after 1968 when the CPF was allowed to purchase public homes. As the CPF was liberalized to purchase private properties in 1981, as well as the CPF contribution rate reached the peak from 1984 to 1986, the trends of demand for home ownership proceeded continually. In our sample, 85.9% of the owner occupied houses were purchased during 1980~1998. Another 12.2% are purchased from1971 to 1979. Only 1.9% of owner occupied houses were purchased before 1970. Respectively, 86.1% of HDB flats, 83.9% of private houses and 90.6% of other types of houses were purchased during 1980 and 1998.

[18] Private dwelling includes private apartment, privatized HUDC, private condominium and landed housing.

Table 4.2: Owner Occupied Housing purchased by Year Interval and by Types (HDB flats, private houses or other houses)

Obs. / year interval	HDB				Private	Others	Total
	1-or 2-room	3room	4room	5room & executive flats			
1950~1959	0	1	0	0	15	0	16
1960~1969	2	40	1	0	39	0	82
1970~1979	2	357	186	54	33	3	635
1980~1989	8	637	853	357	164	11	2030
1990~1999	8	468	873	779	288	18	2434
Total	20	1503	1913	1190	539	32	5197

Source: Housing Expenditure Survey in 1997/1998. Calculated by author.

As our objective is to explore the difference of individual life-cycle choice of housing consumption in terms of two different market constraints, we focus our empirical study on the homeowners who bought their current home since 1990. For the sample that households purchased their current homes during 1980 to 1989, we could not make similar investigation since we do not have household groups under different market constraints for comparison. As elaborated in Chapter 1, the public housing market was dominated by the new HDB housing sector before the implementation of liberalized policy for the resale market in the late 1989.

4.4 Data Limitation

As the main objective of this study is to investigate the housing consumption profile over individual's life-cycle window in terms of different market conditions, whether a home purchase is a new flat purchase directly from HDB or a resale flat purchase from the open market draws our attention in the first place. However, our data does not indicate such information. Refer to the earlier paper by Lum and Fu(2004), we calculate the purchase price of a HDB flat relative to the resale market value of the property[19], *pr_pur/valuation*. By comparing *pr_pur/valuation* with the average price of new HDB flats of the same type relative to the market valuation during the year of purchase, we identify a purchase deemed as a new HDB sale if the *pr_pur/valuation* is at or below the corresponding ratio for new HDB flats.

The new flat indicator variable calculated in this study may not reflect the real nature of each housing transaction in the market. This could bias our empirical results by some extent. Nevertheless, the indicator variable is still reliable because we carefully choose the market data used in the calculation and very cautiously discern the potential factor to cause any identification error. This is the best we can do with available data.

4.5 Sample Definition

[19] We use the average HDB resale price by region, by type, and the year as the resale market value of the property in each purchase year.

In addition, housing consumption profile of private homeowners differs from that of HDB flat owners in terms of the market conditions. This study focuses on the HDB home dwellers.

Our total sample size is 2,075 observations. According to our calculation, about 523 households bought new flats while 1550 households bought their houses from the resale market. Among our sample, approximately 61% of the new flat buyers bought 5-room flats and above, 36% of the new flat buyers bought 4-room flats and only 3% of them bought 3-room flats. Approximately 42% of the resale flat buyers bought 4-room flats and the rest of them are equally distributed to buy 3-room flats and 5-room flats (or above). Dwelling size increases with average household size. The average or median ages of household Main Income Earner (MIE) at the time of purchase[20] across housing types are also presented in Table 4.3. For each type of housing, the average or median age of MIE at the time of purchase is higher if the flat was purchased from resale market. We may infer, from this simple statistic result, that households would reach the peak of housing consumption demand at earlier life stage if they purchase homes from new HDB sub-market other than resale market.

[20] From the HES cross-sectional individual household data, we obtain the age of the households' Main Income Earner (MIE) at the time of housing purchase.

Table 4.3: Sample Profile at the Time of Purchase by Housing Types

Housing types	New flat buyers (525 observations)				Resale flat buyers (1550 observations)			
	% of sample	Avg household size	Avg MIE age	Median MIE age	% of sample	Avg household size	Avg MIE age	Median MIE age
3-room	3.24	3.35	36.7	35	28.19	3.44	36.7	36
4-room	36.19	3.95	34.3	32.5	42.39	4.0	35.0	34
5-room & executive flats	60.57	4.16	34.6	33	29.42	4.18	36.3	36
Total	100	4.06	34.5	33	100	3.89	35.9	35

(Sample includes those households who are home buyers of 3-room flats and above after the year 1990. The households with MIE aged below 21 at the time of purchase are excluded. The total sample is 2,075 observations.)

CHAPTER FIVE

HYPOTHESIS OF EMPIRICAL MODEL

5.1 Description of Households' Life-cycle Housing Consumption

Simple life-cycle models predict that housing wealth should be dis-saved in later life, and housing consumption should also fall as needs diminish (with declining household size) [Crossley and Ostrovsky(2003)]. In particular, for the owner-occupied housing, as the down payment as well as the installment may be the potential constraints for younger couples to obtain large accommodations from a free market, the housing consumption demand level is expected to increase during the earlier life stages of household head and reach the peak at certain age. The hypothesis of life-cycle consumption pattern implies that housing consumption would increase with the age of household head till certain life stage and declines thereafter. Figure 5.1 shows an expected housing consumption profile over individual's life-cycle window. A demand function with a quadrate term of the age of the household head is used to describe the housing consumption profile.

$$f(t) = a_0 + a_1 t + a_2 t^2 \qquad (1)$$

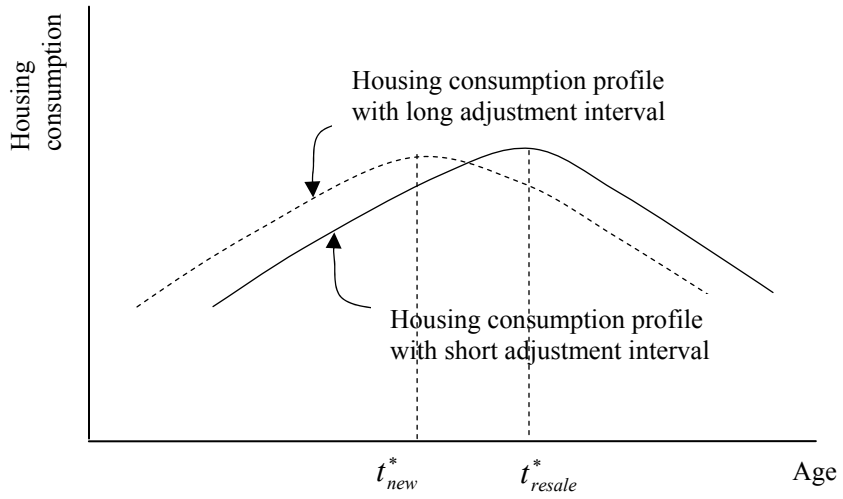
where, t is the age of the household head. The housing consumption $f(t)$ reaches the peak at certain age of the household head, t^*.

$$t^* = -\frac{a_1}{2a_2}, \quad a_1 > 0 \quad and \quad a_2 < 0 \qquad (2)$$

5.2 Housing Consumption Choice under Two Different Market Constraints

Housing adjustment process is subject to the market conditions. In a more restricted market, the housing adjustment cost is higher. Households would consider their long term needs when they make housing consumption decisions. Such households reach the peak of housing consumption at earlier life of a household head (the dashed line in Figure 5.1). On the other hand, in a more liberalized market, the housing adjustment cost is relatively lower. Households usually make housing consumption decisions by looking at the different need phases over life-cycle window (the solid line in Figure 5.1). Therefore the housing consumption profile with respect to the high adjustment cost (then the long adjustment interval) shifts.

Figure 5.1: Market Constraints and Housing Consumption



In Singapore context, the minimum occupied period is five years for the new-flat owners, but only two and half years for the resale owners. Under this regulation, housing adjustment cost would be higher for new buyers than for resale buyers. The higher housing adjustment cost would motivate the new-flat buyers to choose flat size according to their longer-term housing needs in anticipation of longer occupancy period. The above discussion implies, $t^*_{new} < t^*_{resale}$. Assume a_2 is constant for the new HDB flat market and the resale market. Then, $a_{1,new} < a_{1,resale}$. If we compare the housing consumption choice behavior between new flat buyers and resale flat buyers in the empirical analysis, we need to add a dummy for identifying any new HDB flats, as well as its interaction with t, to the equation (1).

$$f(t) = a_0 + new + a_1 t + new * a_1' t + a_2 t^2 \qquad (3)$$

Therefore, the hypothesis means that $new * a_1^{'} < 0$.

5.3 Housing Consumption under the Assumption of More Dynamic Households and Less Dynamic Households

In addition to the minimum occupancy regulation, there is an income ceiling to restrict higher income households to buy new flats. This regulation would affect households' life-cycle housing choice. Especially it would significantly affect those households with high potential growth of income. Such households usually have more dynamic housing consumption preference. From the literature, people attaining higher education qualification or with higher income are expected to have higher upgrading mobility [Fu et. al(2000) and Tu et. al(2005)]. Ioannides(1987) also explains that educated households heads are more mobile.

In general, for more dynamic household group, we expect more significant difference in life-cycle housing choice between new-flat buyers and resale buyers under the minimum occupancy regulation and the income ceiling criteria. There are two possible reasons behind this hypothesis. First, dynamic households may consider the difference of the minimum occupied period between the new HDB home buyers and the resale flat

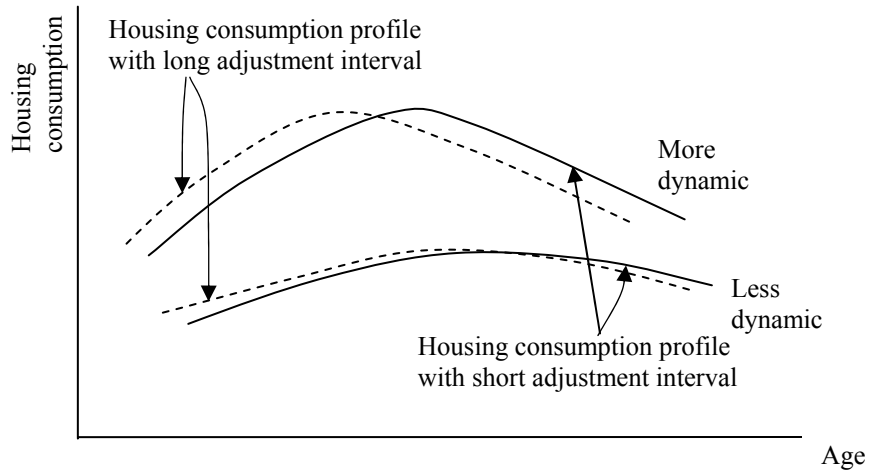
buyers[21] as a disadvantage when they are making housing consumption decisions. For the households of lower income or with less educated household heads, they reach the peak of the housing consumption at later life. The difference of the minimum occupied period is not an important factor to affect their housing consumption decisions since they live their homes usually for a long period.

Second, the income ceiling criteria for accessing to new HDB flats may arouse a high demand for large new flats from young and educated couples. The desire to receive housing subsidies would encourage young professionals to purchase large new flats sooner before they reach their income potential to avoid the income ceiling constraint. These couples consume more housing than they really need at the time.

These regulations distort households' housing consumption choices. Without the restrictions for home purchasers, a household would choose to buy a large home when they really need it, e.g., the family size gets bigger. Figure 5.2 presents an expected difference of housing consumption profile between the households of more dynamic and those of less dynamic.

[21] Referring to the footnote 3 in Chapter one, since 1994, the resale flat buyers under CPF cash grant scheme also need to occupy their dwellings at least five years. This scheme was popular in 1996 and 1997 when the queue for the new flats were very long. In fact, the lock-in time for new-flat buyers would include both the minimum occupancy period (5 years) and the queuing time (from registration for purchase to the possession of the flat), which is longer than the lock-in time for resale even with the grant.

Figure 5.2: Housing Mobility and Housing Consumption

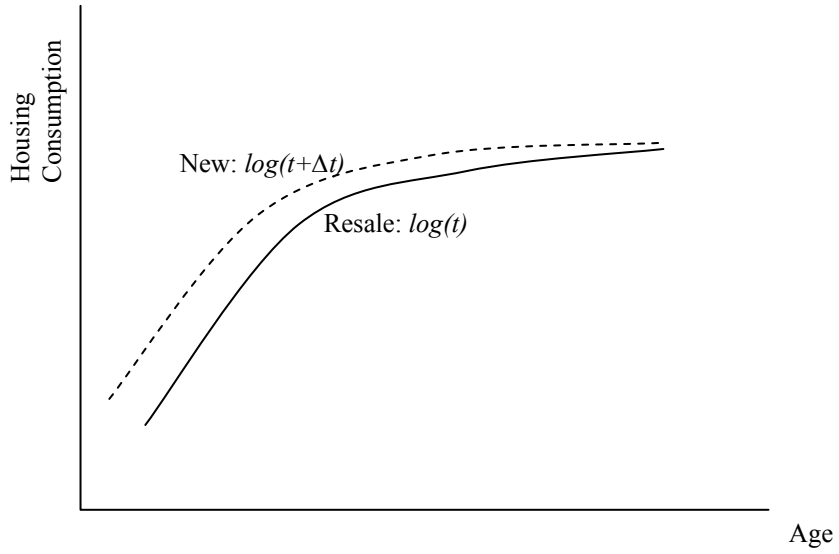


5.4 Further Hypothesis of Life-cycle Housing Consumption for More Dynamic Households

We further look at the housing consumption preference of dynamic households. With high potential growth of income, some of the households that expect their income to reach the income ceiling in a few years want to access to large new flats at earlier life. The rest, however, does not expect their income go up quickly. They show more patience in housing consumption and do not like to over consume the housing. They may choose to buy small resale flats first at favorite locations and, for a period later, move to large new units when their housing needs increase. Based on this hypothesis, we expect a quick increase in housing consumption till the peak. The housing consumption would remain at

the peak for some period as other patient households would reach the peak relatively later. We assume the consumption choice to reach a plateau and then examine whether the shift in life cycle housing choice exists between new-flat buyers and resale flat buyers. Figure 5.3 shows our hypothesis.

Figure 5.3: Housing Consumption under the Assumption of Consumption Choice Reaching a Plateau



We use the *log* term of age to describe the above housing consumption hypothesis. For the resale-flat buyers, the housing consumption with *log* term is as,

$$f(t) = a_1 \log(t) \tag{4}$$

and the for the new-flat buyers,

$$f(t+\Delta t) = a_1 \log(t+\Delta t) = a_1 \log\left[t\left(1+\frac{\Delta t}{t}\right)\right] \cong a_1 \log t + a_1 \frac{\Delta t}{t} \qquad (5)$$

when $\frac{\Delta t}{t}$ is small relative to 1.

In order to examine the difference between two types of buyers, we add the new-flat indicator variable in the equation,

$$f(t) = a_1 \log(t) + new + new * a_1' \left(1/t\right) \qquad (6)$$

The hypothesis implies, $new * a' > 0$.

In particular, the difference, Δt, can be derived from equation 5 and 6 as,

$$f(t+\Delta t) = a_1\left[\log(t) + (a_1'/a_1)\left(1/t\right)\right] \cong a_1 \log\left[t\left(1+(a_1'/a_1)(1/t)\right)\right] = a_1 \log(t + a_1'/a_1) \quad (7)$$

from the equation 5 and 7, we get Δt,

$$\Delta t = a_1'/a_1 \qquad (8)$$

CHAPTER SIX

EMPIRICAL MODEL SPECIFICATION

6.1 Two Measurements of Housing Consumption

Housing consumption measurement in this empirical study is firstly based on Net Assessed Value[22] (NAV). Log-linear regression model is used for the estimation[23]. NAV may not fully reflect the market valuation with respect to the consumption value of different flat types[24]. Alternatively, housing consumption is defined as flat types. With the ordinal nature of the dependent variable, ordered choice model is used.

6.2 Model Specifications

[22] Net Assessed Value (NAV) is the Annual Assessed Value that is determined by the Internal Revenue Authority of Singapore (IRAS) as the estimated annual rent that a house can fetch if rented out and forms the basis for property tax divided by 12. The Annual Assessed Values of HDB flats we use in this study were revised in 1990.

[23] Refer to the literature review in chapter three (3.1.4), we follow Mayo(1981), Rosen(1979) and Hoyt and Rosenthal(1990) to use log-linear regression model to estimate the housing demand equation when the dependent variable is a continuous number.

[24] The imputed rents that are measured by the annual assessed value (AAV) are underestimated in official statistics [Phang(2000)]. And, the state tends to be more conservative in ascribing AAVs for HDB flats [Lum and Fu(2004)]. The concern over the measure of housing consumption using NAV still draws our attention. The measurement could be improved if the market rentals of the owner-occupied housing in our sample during each purchase year are used. We keep this measure of housing consumption in the study at the moment because of the tight time schedule and the data collection cost as well. The regression results from this measurement are consistent with the results from ordered choice model.

We define *HC* as the dependent variable, the housing consumption based on NAV. Independent variables include permanent income (the expected household income from work) and current income (the measured household monthly total income minus net assessed value, or imputed rent), some demographic factors such as age, household size, or race. We use dummy variables for indicating the purchase year of each dwelling. These year dummies try to capture the year effects at the purchase time that may include price volatility of housing, or policy effects, etc. According to the equation (1) in Chapter five, we derived an empirical model for the housing consumption demand as,

$$HC_i = f\begin{pmatrix} p\_inc_i, c\_inc_{i,} age\_pur_i, age\_pur_i\hat{}2, Z_i, inv\_finan_i, \\ year_i\_k, p\_m_i, ex\_cons_i, DGP_i\_l \end{pmatrix} \qquad (9)$$

where, i is the cross-sectional individual. We use age of households' main income earner (MIE) at the time of home purchase,"age_pur", in the empirical model. The use of age at the time of purchase is better than current age to capture individual household's housing consumption *choice* behavior. The quadratic term, $age\_pur\hat{}2$, is used to capture the marginal age effect on the housing consumption demand. The coefficient of $age\_pur\hat{}2$ is expected to be negative, reflecting the diminishing marginal effect of age on the housing consumption demand. Z_i, represent other household demographic characteristics, including household size or race of MIE. p_m_i, is purchase price relative to market valuation at the time of purchase, capturing the individual transaction information. ex_cons, is used to reflect the income effect that is induced by housing

subsidies but is not captured by our income variable [Lum and Fu (2004)]. DGP, is a dummy variable to indicate the region[25] in which a flat is located. We include inv_finan as an independent variable to explain whether a household whose family members hold any financial assets would consume more housing services.

As we want to make a comparison of housing consumption adjustment behavior between new flat buyers and resale flat buyers, we add the new HDB flat indicator, nw_i, as well as its interaction with age_pur_i, "$nw_i * age\_pur_i$", to the equation (9). Then the housing consumption demand function is modified as,

$$HC_i = f\begin{pmatrix} p\_inc_i, c\_inc_i, age\_pur_i, nw_i, nw_i * age\_pur_i, age\_pur_i \hat{} 2, \\ Z_i, inv\_finan_i, year_i\_k, p\_m_i, ex\_cons_i, DGP_i\_l \end{pmatrix} \qquad (10)$$

As in equation (3), the hypothesis on housing consumption implies, $new * a_1^{'} < 0$. This is equivalent with the coefficient of $nw_i * age\_pur_i$ in equation (10) to be negative.

Alternatively, housing consumption demand is measured by housing types structured as a housing ladder[26]. We use housing type variable, HT, to substitute HC in equation (9)

[25] Based on the Development Guide Plans (DGP) of Urban Redevelopment Authority (URA) of Singapore, Singapore is divided into 55 DGPs, which are categorized in 5 main regions, West Region, East Region, Central Region, North Region and North East Region. Our data only indicates each of the five regions where a flat is located.

[26] See Appendix 1 for the housing ladder explanation.

and (10). For the ordinal nature of the dependant variables[27], ordered-choice model is used to measure the substituted equations.

To examine the further hypothesis of life-cycle housing consumption of more dynamic households, we derive the empirical model from equation 6 as,

$$HC_i = f\begin{pmatrix} p\_inc_i, c\_inc_{i,} \log(age\_pur_i), nw_i, nw_i * (1/age\_pur_i), \\ Z_i, inv\_finan_i, year_i\_k, p\_m_i, ex\_cons_i, DGP_i\_l \end{pmatrix} \quad (11)$$

6.4 Variable Definitions and Sample Statistics

Table 6.1 contains the definitions of the variables selected for estimating the housing consumption demand and Table 6.2 describes sample statistics of the variables.

Sample further excludes those households with MIE aged (at the time of home purchase) over 60[28] ($age\_pur_i \geq 60$). The observations for this category are relatively small, 1.0% of our previously selected sample (21 observations relative to 2,075 observations). Respectively, 0.2% of households dwelling in new HDB flats and 1.2% of households dwelling in resale flats are excluded.

[27] Housing ladder feature is, to some extent, like the ordinal nature of numbers.

[28] Those households with MIE aged over 60 at the time of home purchase are excluded because the MIE aged over 60 are less likely to buy and the real incentive for home buying can be result from other household members of the household. The concern is that some older people may downgrade their private housing and buy resale flats from the public housing market. We have taken this into consideration. The housing consumption behaviour for such category of aged people may not follow the trend we expect from the general public home owners. As the total number of households with MIE aged over 60 is quite small, the exclusion of these households will not affect the main results of this study.

Table 6.1: Definitions of Variables

Variables	Definition
HC	Housing consumption demand; the imputed rent plus the expenditure on maintenance and conservancy charges.
HT	Dwelling types indicator: 1= 1- or 2-room flats; 2=3-room flats; 3=4-room flats; 4=5-room or executive flats
p_inc	Households' permanent income: the expected household income from work
c_inc	Households' current income: current monthly household total income minus net assessed value (annual assessed value divided by 12)
age_pur	Age of households' Main Income Earner at the time of home purchase
hsz	Household size: the number of household member
race_malay	Dummy variable: 1 if MIE is malay
race_other	Dummy variable: 1 if MIE is Indians or other races (non-Malay and non-Chinese)
race_default	Default race group: MIE is Chinese
inv_finan	Dummy variable: 1 if at least one household member holds stocks or unit trusts
year_k	Dummy variable group, k indicates one of the years from 1990 to 1998 except the default year: 1 if the year of housing purchase equals k
year_default	Default year of the purchase group: we set year 1990 as default for our selected sample.
nw	Dummy variable: 1 if the property is purchased directly from HDB.
p_m	Purchase price relative to market value of the property at the time of purchase. It is same as *pr_pur/valuation* in chapter 4, "Data Summary".
hh_cons	Household total monthly expenditure minus expenditure on household durables and vehicle purchase.
ex_cons	Excess consumption: Residual of ln(*hh_cons*), see Appendix 4.
DGP_l	Dummy variable group, *l* indicates one of the five main regions of Singapore, WR, ER, CR, NR and NER: 1 if the region of a flat equals *l*.
DGP_default	Default region group: a flat is located in CR.

Table 6.2: Descriptive Statistics of the Variables

(Sample includes the households who are home buyers of HDB 3-room flats and above after the year 1990. The households with MIEs aged below 21 or over 60 at the time of home purchase are excluded. The total sample size is 2054 observations.)

Variables	Sample mean by age group at the time of purchase							All	
	21~24	*25~29*	*30~34*	*35~39*	*40~44*	*45~49*	*50~59*	Mean	Std. dev.
HC	360	405	406	398	404	422	390	401	126
HT	2.89	3.22	3.22	3.11	3.17	3.25	2.98	3.16	0.75
p_inc[29]	2,967	3,235	3,816	3,441	3,067	3,143	3,258	3,380	1,974
c_inc	4,303	5,205	5,098	4,243	3,868	4,254	3,961	4,586	3,327
age_pur	22.96	27.32	32.02	36.95	41.72	46.69	53.14	35.22	7.59
hsz	4.03	3.69	3.86	4.11	4.16	4.06	3.78	3.95	1.36
race_malay	0.21	0.14	0.15	0.16	0.14	0.16	0.16	0.15	0.36
race_other	0.078	0.073	0.12	0.081	0.10	0.17	0.20	0.10	0.30
inv_finan	0.72	0.80	0.78	0.77	0.74	0.73	0.66	0.76	0.42
year_pur	1993.4	1993.7	1994.2	1994.3	1994.3	1995.0	1994.8	1994.2	2.2
p_m	0.94	0.81	0.88	0.93	0.91	0.91	0.92	0.89	0.28
hh_cons	2,970	3,034	2,975	2,834	2,921	3,258	3,197	2,980	1,758
ex_cons								0	0.40
No. of observations	115	409	521	444	311	160	94	2054	

[29] The adjusted permanent income values are reported in Table 6.2. Please see the Chapter 7 ("Empirical Results") for the details.

CHAPTER SEVEN

EMPIRICAL RESULTS

In this chapter, we first estimate the household permanent income, as well as the excess consumption. Then we estimate individual household's housing consumption and examine the difference in life-cycle housing choice between new-flat buyers and resale buyers. For enhancing our empirical results, we use linear regression as well as ordered-choice model.

7.1 Estimation of Permanent Income

Following the earlier paper by Lum & Fu (2004), the permanent income of a household is defined as the income from work that the household expects to earn in the future given the human capital assets of its members and other selected demographic characteristics. Human capital assets mainly include the education level or the year of schooling of the household members. The HES data provides the human capital characteristics of household Main Income Earner (MIE). Sample includes all households in HES that is 5555 observations. The dependent variable, the household income from work, *inc_wk*, refers to the income contributed by all household members. Refer to HES data,

demographic factors of household MIE are used to estimate the expected household income from work. The variable definitions and sample statistics are presented in Table A3.1 (in Appendix 3).

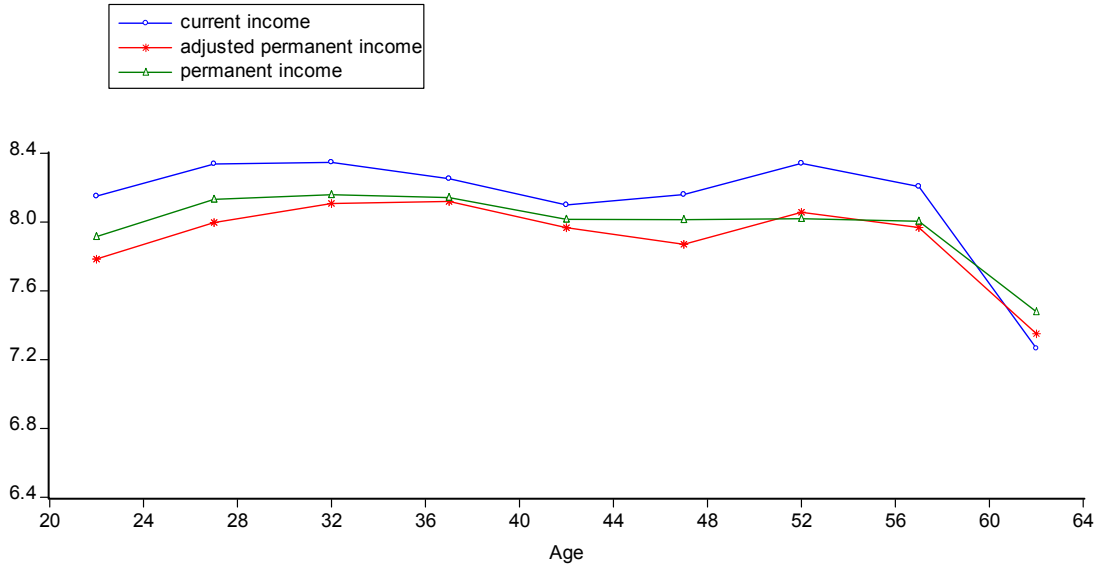
Table A3.2 reports the regression results of estimating household income from work. Education and occupation category variables have expected signs and the coefficients are significantly different from zero. The education level is represented by the highest qualification attained by Main Income Earner (MIE) of a household. Averagely, households whose MIE attained tertiary education have the highest permanent income, while those households whose MIE's highest qualification are below primary school have the lowest permanent income. Similarly, households whose MIE has managerial or professional job rank top in the range of income, whereas those with MIE as agricultural or fishery workers or production and related workers (see Table A3.1 for the variable definition) are at the bottom of income level. The age variable has the expected sign and also significant. *Age*Age* is included to capture nonlinear effect of the age variable on permanent income [Goodman and Kawai(1982)]. The coefficient of *Age*Age* is negative, reflecting the diminishing marginal age effect on permanent income. The household size significantly affects the permanent income level.

Furthermore, we think about the expectation of permanent income may be different for people who bought the property in different years as the labor productivity was rising quickly during the 1990s. That means people with same human capital are able to be more productive in 1997 than in 1990. We create an *adjusted permanent income*, equal to

the 1997 permanent income, calculated from the estimation results that are reported in the Appendix 3, multiplied by a productivity index[30].

Figure 7.1 presents the median current (or measured) income, permanent income and adjusted permanent income across current age groups. As expected, the permanent income (or the expected household income from work) is more smoothing compared to the current income. However, households' current income and permanent income, as well as adjusted permanent income, decrease sharply after MIEs aged over 60.

Figure 7.1: Permanent Income/Adjusted Permanent Income and Current Income (logarithmic value) across Life-cycle Stages



[30] We use the manufacturing labor productivity index for Singapore (1998=1). The productivity index we used is equal to the manufacturing labor productivity index multiplied by the purchase year of housing.

7.2 Estimation of Excess Consumption

Refer to Lum and Fu(2004), we regress the total household consumption, *hh_cons*, defined as the total monthly household expenditure on consumption other than household durables and vehicle purchases on the permanent and current income, as well as a few demographic variables. Regression results are reported in Appendix 4. The residual of the regression, *ex_cons*, is to represent the income effect induced by housing subsidies.

7.3 Estimation of Housing Consumption: Life-cycle Choice under Two Different Market Constraints

As discussed in Chapter 6, housing consumption is measured either by imputed rent or the housing ladder indicators[31]. Regression results with OLS and ordered-choice model are reported in table 7.1.

7.3.1 Regression Results with OLS

The first three columns of table 7.1 reports, respectively, the regression results with *DGP_l* and *ex_cons*, or with *DGP_l*, or without *DGP_l* and *ex_cons* in the equations. The coefficients of all the age-related variables have expected signs. And also, the coefficients are significant at less than 10% level except the coefficient of $nw_i * age\_pur_i$ in the

[31] Please refer to the definition of *HT* in Chapter 6.

equation with *DGP_l* and *ex_cons*. This suggests the difference of the life-cycle housing consumption choice do exist between new-flat buyers and resale buyers[32]. In particular, the new flat buyers reach the peak of housing consumption earlier than the resale flat buyers, which is consistent with our first hypothesis.

Refer to the equation (2) in Chapter 5.1, we present the values of Δt, t^*_{new} *and* t^*_{resale} from each regression in the last three rows of table 7.1. All these values indicate the shift of the housing consumption profile of new-flat buyers, while the volumes of the difference are uncertain among the three scenarios.

We do not observe the obvious effect of the CPF cash grant scheme launched in 1994 from our regression results. The shift in the lifecycle housing choice between the new and resale flat buyers exists during 1991~19998. The lock-in time for new-flat buyers that would include both the minimum occupancy period (5 years) and the queuing time (from registration for purchase to the possession of the flat), which is longer than the lock-in time for resale even with the cash grant could explain the existence of the shift. The other possible reason is that the home purchase with cash grant was popular only in 1996 and 1997 (according to our knowledge) when the queue for new flats was very long. Thus, the effect of the scheme is not obvious in this study.

[32] The negative sign of the coefficient of *age_pur^2* in table 7.1 means that the household housing consumption profile has invert U-shape. Meanwhile, the negative sign of the coefficient of *nw*age_pur* in table 7.1 means that the $t^*_{new} < t^*_{resale}$. That is, the new-flat buyers reach the peak of housing consumption earlier than the resale-flat buyers. Refer to Chapter 5.2 for details.

With linear regression method, the results from the regression equation with *DGP_l* are shown to be more reasonable with smaller values of Δt. We do not expect two much differences between the new and resale flat buyers since the minimum occupied periods do not differ by a large extent.

Table 7.1: Estimates of Housing Consumption --- Life-cycle Choice under Two Different Market Constraints

(Sample further excludes those four households that have housing consumption not less than S$1000[33]. The total sample is 2050 observations. z statistics in parentheses for ordered probit regression equations are based on QML Huber/White standard errors & covariance. t statistics in parentheses are based on White heteroskedasticity-consistent standard errors & covariance.)

Estimation Equation	OLS						Ordered Probit					
Dependent Variable	*Ln(HC)*						*HT*					
	Coefficient(t-Statistic)						Coefficient(z-Statistic)					
Constant	3.263591	(25.6)	3.271084	(25.2)	3.377032	(30.5)						
ln(p_inc)	0.184759	(13.4)	0.185326	(13.2)	0.188237	(13.4)	0.895985	(12.1)	0.879252	(11.9)	0.887923	(12.1)
ln(c_inc)	0.078944	(7.9)	0.077410	(7.6)	0.075791	(7.5)	0.362387	(6.9)	0.348447	(6.6)	0.330565	(6.4)
age_pur	***0.018070****	**(3.4)**	***0.017440****	**(3.2)**	***0.010769****	**(2.6)**	***0.091943****	**(3.3)**	***0.088175****	**(3.2)**	***0.085844****	**(3.1)**
nw	0.118470	(2.0)	0.130215	(2.2)	0.133053	(2.3)	0.700702	(2.3)	0.728332	(2.4)	0.803780	(2.7)
nw *age_pur	***-0.002305**†***	**(1.4)**	***-0.002489**†***	**(1.5)**	***-0.002246**†***	**(1.4)**	***-0.016365****	**(1.9)**	***-0.016647****	**(2.0)**	***-0.017131****	**(2.0)**
age_pur^2	***-0.000172****	**(2.4)**	***-0.000161****	**(2.2)**	***-6.78E-05**†***	**(1.3)**	***-0.000922****	**(2.5)**	***-0.000864****	**(2.4)**	***-0.000842****	**(2.3)**
ln(hsz)	0.054657	(3.6)	0.053676	(3.4)	0.056691	(3.6)	0.310230	(3.9)	0.298148	(3.8)	0.311597	(4.0)
inv_finan	0.079633	(6.3)	0.085569	(6.7)	0.087543	(6.9)	0.429236	(6.7)	0.445113	(7.0)	0.432470	(6.8)
ln(p_m)	-0.220145	(9.7)	-0.218096	(9.4)	-0.217326	(9.4)	-1.379675	(11.6)	-1.344768	(11.3)	-1.363386	(11.6)
year_91	0.053445	(1.9)	0.058892	(2.0)	0.061434	(2.1)	0.303684	(2.2)	0.327130	(2.3)	0.350966	(2.5)
year_92	0.071603	(2.7)	0.080511	(3.0)	0.090123	(3.4)	0.484894	(3.5)	0.517795	(3.8)	0.610734	(4.5)
year_93	-0.008987	(0.4)	1.59E-05	(0.0)	0.011903	(0.5)	-0.092399	(0.7)	-0.041705	(0.3)	0.053703	(0.4)
year_94	-0.030133	(1.2)	-0.026555	(1.0)	-0.016074	(0.6)	-0.182647	(1.4)	-0.158929	(1.2)	-0.065042	(0.5)
year_95	-0.089535	(3.7)	-0.082035	(3.3)	-0.072895	(3.0)	-0.457496	(3.7)	-0.411453	(3.4)	-0.335144	(2.8)
year_96	-0.152718	(6.2)	-0.148188	(5.9)	-0.140121	(5.6)	-0.764131	(6.0)	-0.722609	(5.8)	-0.656532	(5.3)
year_97	-0.129201	(5.0)	-0.122199	(4.6)	-0.117948	(4.5)	-0.592517	(4.5)	-0.545391	(4.2)	-0.469309	(3.6)
year_98	-0.141880	(3.9)	-0.148203	(4.0)	-0.140058	(3.8)	-0.641301	(3.5)	-0.667695	(3.6)	-0.572108	(3.1)

[33] The median housing consumption of the sub-sample (purchase time after and 1990; age at the purchase time greater than 20 and less than 60) is S$355. The housing consumption that is equal or greater than S$1000 is treated as an outlier.

ex_cons	0.126543	(9.3)	-		-		0.600376	(8.5)	-		-	
DGP_ER	0.047424	(2.8)	0.048747	(2.8)	-		0.433083	(5.0)	0.428783	(5.0)	-	
DGP_NER	0.006560	(0.3)	0.002179	(0.1)	-		0.152188	(1.6)	0.125249	(1.3)	-	
DGP_NR	0.003008	(0.2)	-0.003357	(0.2)	-		0.435556	(4.3)	0.391883	(3.9)	-	
DGP_WR	0.008834	(0.5)	0.006627	(0.4)	-		0.261861	(3.0)	0.245214	(2.8)	-	
R-squared	0.416		0.391		0.374		0.248		0.231		0.224	
Log likelihood	75.69		32.96		3.63		-		-		-	
LR(d.f.)	-		-		-		1083(22)		1010(21)		979(17)	
Δt	6.7		7.7		16.6		8.9		9.6		10.2	
t^*_{new}	45.8		46.5		62.8		41		41.4		40.8	
t^*_{resale}	52.5		54.2		79.4		49.9		51		51	

*significant at 1% level **significance at 5% level ***significance at 10% level

† *p* value for the coefficient >10%

7.3.2 Regression Results with Ordered-Choice Model

Regression results from Ordered-choice model that are reported in the last three columns of table 7.1 also support our hypothesis. All the coefficients of age-related variables have expected signs and significant at less than 10% level. The values of $\Delta t, \quad t^*_{new}$ *and* $\quad t^*_{resale}$ from each regression in the last three rows of table 7.1 also indicate the shift of the housing consumption of new home buyers. Compared to the linear regression, ordered-choice model provides a little more significant results.

7.4 Estimation of Housing Consumption under the Assumption of More Dynamic/ Less Dynamic Households

We also investigate the impacts of the household permanent income as well as the education qualification of household head on households' life-cycle housing choice. *Linear regression* is used for the measurement of housing consumption.

7.4.1 Housing Consumption Estimation under High/Low Education Household Group

A household with MIE attaining school for more than 10 years (post secondary) is sorted in the high education group. The observations for this group are about one third of the selected sample (675 observations relative to 2050 observations). We estimate the

housing consumption for such household group. The coefficients of age-related variables have expected signs. However, at least one of the three coefficients is insignificant in each regression equation, while the Δt value from each regression is 6, 9 and 10 years respectively. For the low education group, the coefficients have expected signs and are insignificant. The Δt value, 5, 5.5 and 6 years are a little lower, compared to those households under high education group.

7.4.2 Housing Consumption Estimation under High/Low Income Household Group

Table 7.2 presents regression results to catch the permanent income impacts on housing consumption choices under the assumption of high income household group [34]. Respectively, the regression results with *DGP_l* and *ex_cons*, or with *DGP_l*, or without *DGP_l* and *ex_cons* in the equations are reported in separate column of table 7.2. The coefficients of all age-related variables have expected signs and are significant at less than 10% level. This suggests that the significant difference in life-cycle housing consumption choice between new-flat buyers and resale buyers exists under high income household group, which is consistent with our second hypothesis[35].

The values of Δt, t^*_{new} *and* t^*_{resale} from each regression are reported in table 7.3. All these values indicate the shift of housing consumption of new flat buyers. The volumes of the difference are still uncertain but are closer (from 11 years to 12 years) among the three scenarios under high income household group.

[34] We simply divide the household group into two category income group. The cut point is the median income of the whole households.
[35] Please refer to Chapter 5.3.

For the low income household group, the coefficients of age_pur, $nw_i * age\_pur_i$ and $age\_pur\hat{}2$ are very insignificantly different from zero. The last three rows in table 7.3 present the p-value for each coefficient of age-related variables. It suggests that there is no significant difference in life-cycle housing consumption choice between new and resale home buyers under low income household group.

7.4.3 Summary

The empirical results in table 7.2 and 7.3 suggest that the high income household group be affected significantly by the regulations in the new flat market. With relatively high income, households consider the longer minimum occupied period would be a disadvantage when they are facing decision-making in housing consumption. As elaborated in Chapter 5, young professionals access to large new flats with the incentive to receive housing subsidies and expect large capital gains.

For the low income household group, households buy large flats at older age because of the down payment constraint. After wealth accumulation through a long term working life or with more household members starting to work, such household group is able to pay the down payment of large flats. Meanwhile, they live in their homes usually for a long period without moving. The regulations in new-flat market, such as the rule of minimum occupied period or the income ceiling criteria have very limited effects on the low income household group.

Table 7.2: Estimates of Households' Housing Consumption under the Assumption of High Income Group

(We divide the selected sample into high income group and low income group at the cutting point of the median adjusted permanent income. The observations in the high income group are 1024. t statistics in parentheses are based on White heteroskedasticity-consistent standard errors & covariance.)

Dep Variable	*Ln(HC)*					
	Coefficient(t-Statistic)					
constant	3.015678	(12.4)	3.071780	(12.4)	3.064634	(12.5)
ln(p_inc)	0.183763	(6.8)	0.177134	(6.4)	0.175183	(6.4)
ln(c_inc)	0.085245	(5.0)	0.085097	(4.9)	0.085005	(4.9)
age_pur	***0.026663****	**(3.2)**	***0.025977****	**(3.0)**	***0.026895****	**(3.1)**
nw	0.266112	(2.8)	0.276433	(2.8)	0.290028	(3.0)
nw *age_pur	***-0.006064****	**(2.2)**	***-0.006235****	**(2.2)**	***-0.006467****	**(2.3)**
age_pur^2	***-0.000273****	**(2.5)**	***-0.000261****	**(2.3)**	***-0.000270****	**(2.4)**
ln(hsz)	0.096861	(4.1)	0.095307	(4.0)	0.096642	(4.1)
inv_finan	0.104569	(5.4)	0.114027	(5.8)	0.116114	(5.9)
ln(p_m)	-0.217561	(6.6)	-0.216566	(6.4)	-0.217022	(6.5)
year_91	-0.039129	(0.7)	-0.024490	(0.4)	-0.025580	(0.4)
year_92	0.000969	(0.0)	0.014786	(0.3)	0.018750	(0.4)
year_93	-0.050419	(1.1)	-0.038154	(0.8)	-0.033727	(0.7)
year_94	-0.066426	(1.4)	-0.055226	(1.2)	-0.054759	(1.2)
year_95	-0.150424	(3.3)	-0.137946	(2.9)	-0.136290	(2.9)
year_96	-0.183312	(4.0)	-0.170657	(3.6)	-0.168931	(3.6)
year_97	-0.152265	(3.2)	-0.142596	(2.9)	-0.141577	(2.9)
year_98	-0.159771	(2.6)	-0.177374	(2.9)	-0.181451	(2.9)
ex_cons	0.134569	(6.5)	-	-	-	-
DGP_ER	0.029118	(1.2)	0.025652	(1.0)	-	-
DGP_NER	0.021964	(0.8)	0.010137	(0.3)	-	-
DGP_NR	-0.002669	(0.1)	-0.014397	(0.5)	-	-
DGP_WR	-0.011588	(0.5)	-0.023806	(0.9)	-	-
R-squared	0.360		0.333		0.328	
Log likelihood	8.7		-12.6		-15.9	

*significant at 1% level **significance at 5% level

Table 7.3: The Differences of Life-cycle Housing Consumption Choices under the Assumption of High/Low Income Group

Regression		High Income			Low Income♦		
		with *DGP_l* & *ex_cons*	with *DGP_l*	without *DGP_l* & *ex_cons*	with *DGP_l* & *ex_cons*	with *DGP_l*	without *DGP_l* & *ex_cons*
Δt (years)		11	12	12	-	-	-
t^*_{new}		38	38	38	-	-	-
t^*_{resale}		49	50	50	-	-	-
p value	*Age_pur*	0.002	0.003	0.002	0.07	0.09	0.12
	*nw*age_pur*	0.028	0.027	0.021	0.71	0.77	0.70
	Age_pur^2	0.014	0.021	0.017	0.22	0.27	0.34

♦As the coefficients of a*ge_pur, nw*age_pur* and *age_pur^2* are very insignificant from our regression results under low income household group, the presence of such Δt values are not meaningful.

7.5 Estimation of Housing Consumption under the Assumption of Consumption Choice Reaching a Plateau

As discussed in Chapter 5.4, households with high potential growth in income may have different housing consumption preferences. To examine the hypothesis made in Chapter 5.4, we run the linear regression with OLS based on equation 11 in Chapter 6.3. Regression results are reported in table 7.4.

The coefficients of *ln(age_pur)* and *nw*(1/age_pur)* have expected signs. The coefficient of *nw*(1/age_pur)* is positive, meaning that there is the difference in life-cycle housing consumption choice between new-flat buyers and resale buyers, while the statistical significance is a bit compromised. From equation 8 in chapter 5.4, we calculate the value of Δt as 22.9 years for the high income household group, and 12.5 years for the high education group[36].

[36] As we discussed in chapter five, the time difference of housing consumption between new & resale flat buyers is more significant for the higher income/educated households. The value of Δt in this section is also expected to be large. Compared to the results with the inverted U-shape life cycle hypothesis of housing consumption, the value of Δt *under high income household group* have increased by about 100%. This may suggest that the log specification is inferior to the quadratic specification in our study of life-cycle housing choice.

Table 7.4: Estimates of Housing Consumption under the Assumption of Consumption Choice Reaching a Plateau

(t statistics in parentheses are based on White heteroskedasticity-consistent standard errors & covariance.)

Dep. Variable	*ln(HC)*			
Household Group	High Income		High Education	
Observations	1024		675	
Indep. Variable[37]	Coefficient(t-Statistic)		Coefficient(t-Statistic)	
Constant	2.785062	(11.2)	3.155781	(11.7)
ln(p_inc)	0.189574	(7.1)	0.132233	(4.0)
ln(c_inc)	0.083575	(4.9)	0.089019	(4.2)
ln(age_pur)	***0.218776***	***(5.0)***	***0.233380***	***(4.0)***
nw	-0.087619	(0.8)	-0.031950	(0.2)
nw *(1/age_pur)	***5.015534***	***(1.5)***	***2.925067***	***(0.7)***
ln(hsz)	0.098385	(4.2)	0.083929	(2.7)
inv_finan	0.105815	(5.5)	0.131314	(5.4)
ln(p_m)	-0.210161	(6.4)	-0.220226	(5.3)
year_91	-0.032218	(0.5)	0.068817	(1.1)
year_92	0.005387	(0.1)	0.047672	(0.9)
year_93	-0.045752	(1.0)	0.005106	(0.1)
year_94	-0.061554	(1.3)	-0.028757	(0.6)
year_95	-0.146078	(3.2)	-0.113402	(2.3)
year_96	-0.178382	(3.8)	-0.163725	(3.2)
year_97	-0.147845	(3.1)	-0.126876	(2.3)
year_98	-0.155313	(2.6)	-0.173776	(2.4)
ex_cons	0.134187	(6.5)	-	
DGP_ER	0.029122	(1.2)	-	
DGP_NER	0.018710	(0.6)	-	
DGP_NR	-0.003719	(0.1)	-	
DGP_WR	-0.013552	(0.5)	-	
R-squared	0.356		0.335	
Log likelihood	5.67		-30.6	

[37] We also did several experiments with/without *DGP_l* and *ex_cons* in the equations. We present the best results we got from the regressions.

CHAPTER EIGHT

SUMMARY OF FINDINGS, LIMITATIONS AND POLICY IMPLICATIONS

8.1 Main Findings

Our empirical analysis shows an inverted U-shape life-cycle housing consumption pattern. We find that resale-flat buyers reach the housing consumption peak around 50 years old. It is about 10 years earlier for new-flat buyers. Based on linear regression that Net Assessed Value (NAV) is the measurement of housing consumption, we obtain the shifts ranging from 8 to 12 years. New-flat buyers reach the peak of housing consumption around 44 years old, while the resale buyers reach the peak of housing consumption in the range of age 53 to 56. Ordered-choice model, in which flat type is the measuring of housing consumption, provides similar results. The shift is from 11 to 15 years. New and resale buyers reach the peak of housing consumption, respectively, in the range of 37 to 39 years old and 50 to 52 years old.

As above, our empirical findings first lends support to our prediction that the minimum occupancy regulation and the income ceiling criteria in the new HDB market motivate home buyers to purchase large new units at earlier life. Then we show further evidence of the incentive by comparing the shift between high and low income household group.

Under high income household group, the shift in life-cycle housing choice between new and resale flat buyers is from 9 to 11 years. For resale buyers, the age of a household head at the peak of housing consumption is around 50 years old. For new-flat buyers, it is about 10 years earlier. Our estimates are again consistent with the prediction. As expected, no significant difference in life-cycle housing choice is observed under low income household group as the coefficients of age-related variables are statistically insignificant (as shown in table 7.3).

We also experimented with *log(age_pur)* specification to allow for the possibility of plateauing in the life-cycle housing choice for high income or high educated group. The results are qualitatively same.

8.2 Limitations

Our study is firstly limited by the small sample size because we only focus on the households who purchased flats during 1990 to 1998. Second, with incomplete household data, for example, lack of new flat indicator, we identify new flats by using relevant market data. The way we identify "*nw*" seems sensible and the best we can do with the data we have, but we know that it is not a precise measure.

Third, Net Assessed Value (NAV) may not fully reflect the market valuation with respect to the consumption value of different flat types. We use ordered-choice model to check the possible bias and we find that the results of OLS appear largely unchanged.

Although the data limitations prevent us from precisely identifying the shifts in life-cycle housing choice, the estimated sign of the shifts appears quite robust to different specifications of the model.

8.4 Policy Implications

Our empirical findings suggest that government regulations on housing market can distort the household's life-cycle housing consumption choices. With the higher adjustment cost in the new flat market caused by the longer minimum occupied period, households usually make long-term housing choice decisions. The compromise of housing consumption causes a welfare loss for individual household. The distortional effects are more significant when households have higher permanent income. Such household group may consider the difference of the lock-in time between new & resale flat buyers as a disadvantage when they are making housing consumption decisions. However, this is not an important factor for the lower income household group when they are facing the similar situations.

In addition, the income ceiling criteria for the entry of new-flat market has distortional effect on households' life-cycle housing choice. Especially, the effect is more significant

for the high permanent income households. These households choose to buy large new flats sooner before they reach their income potential to avoid the income ceiling constraint. For example, young professional couples would have incentive to over-consume housing at the time of home purchase in order to lock in the benefit of subsidy for new flats.

BIBLIOGRAPHY

1. Bardhan, Ashok Deo, Datta, Rajarshi, Edelstein, Robert H. and Lum, Sau Kim (2003), "A Tale of two sectors: Upward mobility and the private housing market in Singapore", *Journal of Housing Economics* 12, pp.83-105.

2. Berger, Tommy and Turner, Bengt (1991), "Windfall Gains on the Swedish Housing Market: The Effects of Queuing for a Cooperative Dwelling", *AREUEA Journal*, 19(2), pp.161-183.

3. Berkovec, J. and Fullerton, D. (1992), "A General Equilibrium Model of Housing, Taxes and Portfolio Choice", *Journal of Political Economy*, 100(2), pp.390-429.

4. Börsch-Supan, A. and Pollakowski, H. (1990), "Estimating Housing Consumption Adjustment from Panel Data", *Journal of Urban Economics*, 27, pp.131-150.

5. Browning, Martin and Crossley, Thomas F. (2001), "The Life-Cycle Model of Consumption and Saving", *The Journal of Economic Perspectives*, 15(3), pp.3-22.

6. Brueckner, Jan K. (1986), "The Downpayment Constraint and Housing Tenure Choice", *Regional Science and Urban Economics*, 16, pp.519-525.

7. Central Provident Fund Board, Singapore (1995), "*The CPF Story, 40 years serving Singapore*", published by Public Affairs Branch, Central Provident Fund Board, Singapore.

8. Chua, Beng Huat. "*Political Legitimacy and Housing*". Routledge, New York. 1997.

9. Crossley, Thomas F. and Ostrovsky, Yuri (2003), "A Synthetic Cohort Analysis of Canadian Housing Careers", *Research Paper* of A Program for Research on Social and Economic Dimensions of An Aging Population.

10. Curran, Christopher and Carlson, Leonard A. (1982), "A Theory of Residential Location Decisions of Two-Worker Households", *Journal of Urban Economics*, 12, pp.102-114.

11. Deaton, Angus and Muellbauer, John (1980), "*Economics and Consumer Behavior*", Cambridge, New York.

12. DisPasquale, D. and Wheaton, W.C. (1996), "*Urban Economics and Real Estate Markets*", Prentice-Hall.

13. Edelstein, Robert H. and Lum, Sau Kim (2003),"House Prices, Wealth Effects and the Singapore Macro-economy", *International Workshop* on "Housing Market and the Macro Economy: the Nexus", August, 2003.

14. Freedman, Ora and Kern, Clifford R. (1997), "A Model of Workplace and Residence Choice in Two-worker Households", *Regional Science and Urban Economics*, 27, pp.241-260.

15. Friedman, Milton (1957), "*A Theory of the Consumption Function*", Princeton University Press, Princeton.

16. Fu, Y.M., Tse, D. and Zhou, N. (2000), "Housing Choice Behavior of Urban Workers in China's Transition to a Housing Market", *Journal of Urban Economics*, 47, pp.61-87.

17. Goodman, Allen C. and Masahiro Kawai (1982), "Permanent Income, Hedonic Prices, and Demand for Housing: New Evidence", *Journal of Urban Economics* 12, pp.214-237.

18. Goodman, Allen C. and Masahiro Kawai (1984), "Replicative Evidence on the Demand for Owner-Occupied and Rental Housing", *Southern Economic Journal* 50, pp.1036-1057.

19. Goodman, Allen C. (1988), "An Econometric Model of Housing Prices, Permanent Income, Tenure Choice, and Housing Demand", *Journal of Urban Economics*, 23, pp.327-353.

20. Goodman, Allen C. (1995), "A Dynamic equilibrium Model of Housing Demand and Mobility with Transaction Costs", *Journal of Housing Economics*, 4, pp.307-329.

21. Goodman, Allen C. (2002), "Estimating Equilibrium Housing Demand for 'Stayers' ", *Journal of Urban Economics* 51, pp.1-24.

22. Greene, William H. (2000), "*Econometric Analysis, 4th edition*", Prentice Hall, New Jersey.

23. Hansen, Julia L., Formby, John P., and Smith, W. James (1996), "The Income Elasticity of Demand for Housing: Evidence from Concentration Curves." *Journal of Urban Economics*, 39, pp.173-192.

24. Hausman, Jerry A., Wise, David A. (1980), "Discontinuous Budget Constraints and Estimation: The Demand for Housing", *The Review of Economic Studies*, 47(1), Econometrics Issue, pp.75-96.

25. Henderson, Vernon and Ioannides, Yannis (1986). "Tenure Choice and the Demand for Housing," *Economica*, 53, pp.231-246.

26. Ho, K.H.D. and Cuervo, J.C.(1999), "A Cointegration Approach to the Price Dynamics of Private Housing – A Singapore Case Study", *Journal of Property Investment & Finance*, 17(1), pp.35-60.

27. Ho, K.H.D. and Tay, P.H.D (1993), "An Econometric Forecast of the Private Residential Price Index in Singapore", *Journal of Real Estate and Construction*, 3, pp.39-50.

28. Hochguertel, Stefan and Soest, Arthur van (2001). "The Relation between Financial and Housing Wealth: Evidence from Dutch Households." *Journal of Urban Economics,* 49, pp.374-403.

29. Hoyt, William H. and Rosenthal, Stuart S. (1990), "Capital Gains Taxation and the Demand for Owner-Occupied Housing." *The Review of Economics and Statistics,* 72(1), pp.45-54.

30. Ioannides, Y.M.(1987), "Residential Mobility and Housing Tenure Choice", *Regional Science and Urban Economics*, 17, pp. 265-287.

31. Ioannides, Y.M. and Kan, K. (1996), "Structural Estimation of Residential Mobility and Housing Tenure Choice", *Journal of Regional Science*, 36(3), pp. 335-363.

32. Ioannides, Yanins M. and Zabel, Jeffrey E. (2001), "Neighborhood Effects and Housing Demand", *Discussion Paper Series*, Department of Economics, Tufts University.

33. Johnson, Michael S. (1981), "A Cash Flow Model of Rational Housing Tenure Choice", *AREUEA Journal*, 9, pp.1-17.

34. Kosters, Marvin, (1990), "Schooling, Work Experience, and Wage Trends", *American Economics Association Papers and Proceedings*, 80, pp.308-312.

35. Lim, Kim-Lian (2001), "Implications of Singapore's CPF Scheme on Consumption Choices and Retirement Incomes", *Pacific Economic Review*, 6(3), pp.361-382.

36. Low, Linda and Aw, T.C. (1997), "Housing a Healthy, Educated and Wealthy Nation through the CPF", *The Institute of Policy Studies*, Singapore 1997, Times Academic Press.

37. Lum, Sau Kim (1996),"The Singapore Private Property Market – Price Trends and Affordability", *NUS Inter-Faculty Conference* on The Singapore Dream: Private Property, Social Expectations & Public Policy.

38. Lum, Sau Kim (2002),"Market Fundamentals, Public Policy and Private gain: Housing price dynamics in Singapore", *Journal of Property Research*. 19 (2), pp.1-23.

39. Lum, Sau Kim and Fu, Yuming (2004),"Examining Housing Demand with Discontinuous Housing Subsidies", *Working Paper*.

40. Mankiw, W. Gregory and David N. Weil (1989), "The baby boom, the baby bust and the housing market", *Regional Science and Urban Economics*, 19 (2), pp.235-258.

41. Mayo, Stephen K. (1981), "Theory and Estimation in the Economics of Housing Demand", *Journal of Urban Economics* 10, pp.95-116.

42. Modigliani, F. (1986), "Life Cycle, Individual Thrift, and the Wealth of Nations", *American Economic Review*, 76(3), pp.297-313.

43. Moriizumi, Yoko (2000), “Current Wealth, Housing Purchase, and Private Housing Loan Demand in Japan.” *Journal of Real Estate Finance and Economics* 21(1), pp.65-86.

44. Murphy, Kevin and Finis Welch (1992), "The Structure of Wages", *Quarterly Journal of Economics*, pp.285-326.

45. Neo, Poh Har, Lee, Nai Jia and Ong, Seow Eng (2003), “Government Policies and Household Mobility Bdhaviour in Singapore”, *Urban Studies*, 40(13), pp.2643-2660.

46. Olsen, Edgar O. (1987), “The Demand and Supply of Housing Service: A Critical Survey of the Empirical Literature”, *Handbook of Regional and Urban Economics*, 11.

47. O'Neill, June (1990), "The Role of Human Capital in Earnings Differences Between Black and White Men", *Journal of Economic Perspectives*, 4, pp.25-45.

48. Ong, Seow Eng (2000), "Housing Affordability and Upward Mobility from Public to Private Housing in Singapore," *International Real Estate Review*, Asian Real Estate Society, 3(1), pp.49-64.

49. Ong, Seow Eng and Sing, T.F. (2002), "Price Discovery between Private and Public Housing Markets”, *Urban Studies*, 39(1), pp.57-67

50. Ong, Seow Eng, Ho, K.H. David and Lim, Chai Hoon (2003), "A Constant – Quality Price Index for Resale Public Housing Flats in Singapore”, *Urban Studies*, 40(13), pp.2705-2729.

51. Phang, Sock Yong and Wong, Wing-Keung (1997), “Government Policies and Private Housing Prices in Singapore”, *Urban Studies*, 34(11), pp.1819-1829.

52. Phang, Sock Yong (2000), “Owner-Occupier Housing Subsidies in Singapore: Implications of Transition from Supply-Side to Demand-Side Method”, paper prepared for the *Hong Kong Housing Research Network Conference* “Housing Policy and Practice in the Asian Pacific: Convergence and Divergence”

53. Phang, Sock Yong (2001), "Housing Policy, Wealth Formation and the Singapore Economy", *Housing Study*, 16(4), pp.443-459.

54. Report on the Household Expenditure Survey 1997/1998, *Department of Statistics and Ministry of Trade & Industry*, Singapore.

55. Rosen, Harvey (1979), "Housing Decisions and the U.S. Income Tax: An Econometric Analysis", *Journal of Public Economics,* 11, pp.1-24.

56. Rosenthal, Stuart S. (1988), "A Residence Time Model of Housing Markets", *Journal of Public Economics*, 36, pp.87-109

57. Sing, T.F. (2001), "Dynamics of Condominium Market in Singapore," *International Real Estate Review*, 4(1), pp. 135-158.

58. Thang, C.L.D. and Ong, S.E. (2001), "Will the Potential Upgrader Stand Up Please?" *CRESTimes*, 1(1), 3.

59. Tu, Yong (2000), "Singapore Housing Policy and Housing System", Paper at *the 5th Asian Real Estate Annual Conference*, 26-30 July 2000, Great Wall Hotel, Beijing, China.

60. Tu, Yong and Wong, Grace K.W. (2002), "Public Policies and Public Resale Housing Prices in Singapore". *International Real Estate Review*, 5(1), pp115-132.

61. Tu, Yong (2003), "The Macro Impacts of Public Resold dwellings on Private Housing Prices in Singapore". *Review of Urban and Regional Development Studies*, 15(3), pp.191-208.

62. Tu, Yong, Kwee, Lanny K. and Yuen, Belinda (2005), "An empirical analysis of Singapore household' upgrading mobility behaviour: from public homeownership to private homeownership". *Habitat International,* 29, pp.511-525.

63. Venti, Steven F. and Wise, David A. (1984), "Moving and Housing Expenditure: Transactions Costs and Disequilibrium", *Journal of Public Economics*, 23, pp. 207-243.

64. Venti, Steven F. and Wise, David A. (1989), "Aging, Moving and Housing Wealth", in *The Economics of Aging*, ed. D. Wise. Chicago: University of Chicago Press.

65. Venti, Steven F. and Wise, David A. (1990), "But They Don't Want to Reduce Housing Equity", in *Issues in the Economics of Aging*, ed. D. Wise. Chicago: University of Chicago Press.

66. Venti, Steven F. and Wise, David A. (1991), "Aging and the Income Value of Housing Wealth", *Journal of Public Economics*, 44, pp. 371-97.

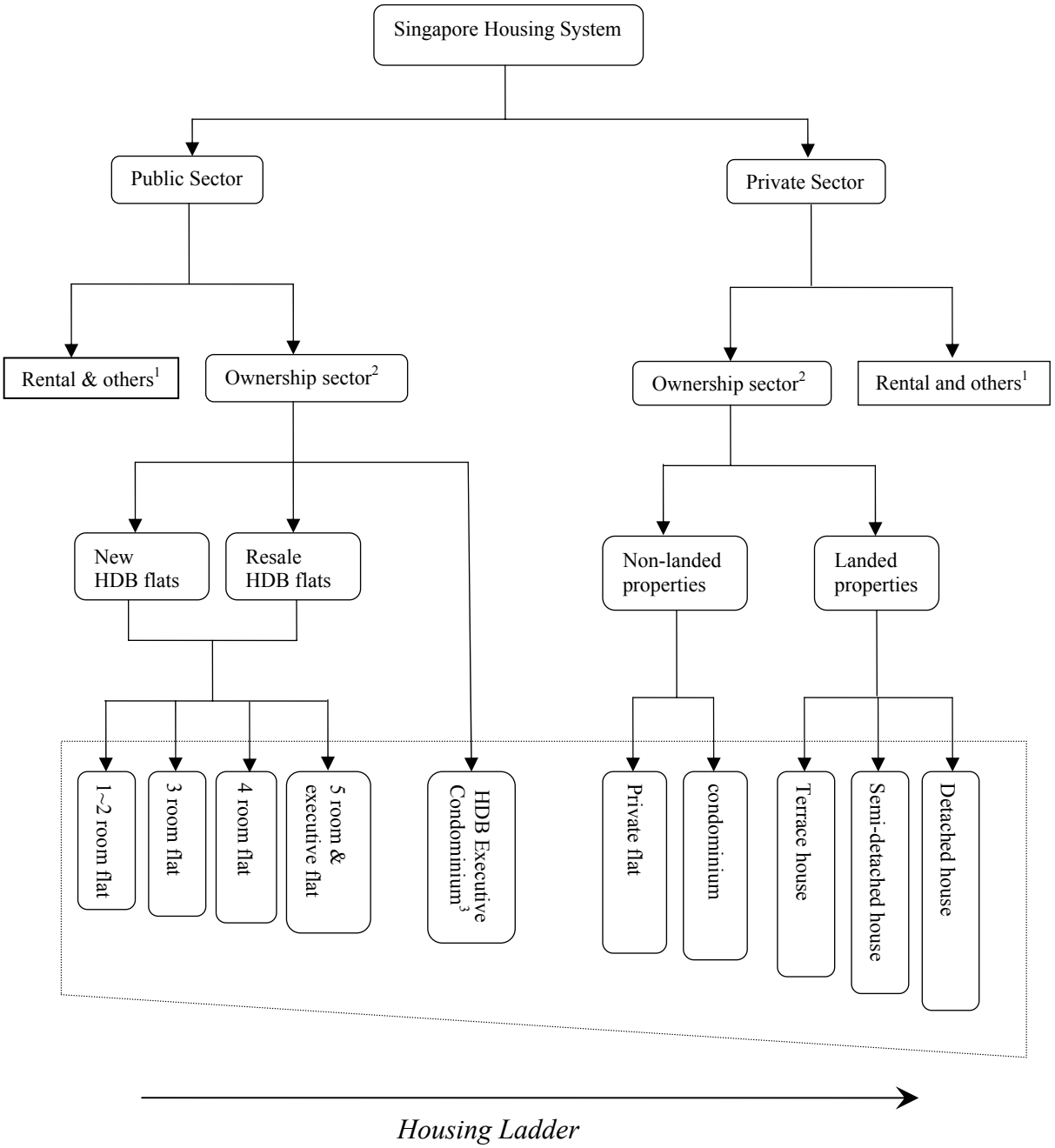
67. Venti, Steven F. and Wise, David A. (2001), "Aging and Housing Equity: Another Look", *NBER, Working paper #8608.*

68. White, Michelle J. (1977), "A Model of Residential Location Choice and Commuting by Men and Women Workers", *Journal of Regional Science*, 17(1), pp.41-53.

69. Wooldridge, Jeffrey M. (2002), "*Econometric Analysis of Cross Section and Panel Data*", MIT.

APPENDICES

Appendix 1: Singapore Housing System



[1] Other types of dwellings include the accommodation provided by employer, relative or friend.
[2] In the ownership sector, there are some other types of public and private houses not shown in the diagram chain. The percentage of those houses is very small.
[3] Executive condominium is separated from other HDB flats because EC is a link to private housing. The market for ECs is also different from that for other HDB flats.

Appendix 2: Eligibility Conditions for the Purchase of HDB Homes[38]

Buying a Flat Direct from HDB	Buying a Resale Flat on the Open Market	Buying a Executive Condominium Direct from HDB
Singapore citizen At least 21 years of age Have a nucleus family Total household income not more than S$4,000 per month. (The income ceiling was raised to S$7,000 in 1992 and S$8,000 in 1994) Must not own any private residential property (From October 1991, new HDB flat owners can invest in private property but must continue to reside in their flats.) Minimum occupancy period before HDB lessees can reapply for a new flat from HDB is 18 months. (Time bar raised to 5 years in 1992, and from 5 years to 10 years in 1997.)	Singapore citizen or Permanent Resident At least 21 years of age Have a nucleus family (Singles above 35 can purchase 3-room or smaller flats outside the Central Area from October 1991. Singles can buy any types of HDB flats from 2004.) No income ceiling Private residential property owners must owner-occupy their HDB flats. Minimum occupancy period is 2.5 years if no cash grant was given.	Singapore citizen At least 21 years of age Have a nucleus family; (2 or more related orphans, two single Singapore citizens and at least 35 years of age can purchase ECs) Total household income not more than S$10,000 per month. Ownership of private property is not allowed. Minimum occupancy period is 5 years. Only Singapore citizens and Singapore permanent residents can buy the resale ECs from the 6th to 10th year. No restrictions on resale ECs' buyers from the 11th year.

[38] Refer to Lum and Fu (2004), the third column about the eligibility conditions to Executive Condominiums is added.

Appendix 3: Permanent Income Estimation

Table A3.1: Variable definition and sample statistics (include the total sample---5555 observations)

Variables	Definition	Mean	Std. Dev.
inc_wk	Household income from work	4639	4547
age	Age of main income earner (MIE)	40.48	10.74
sch_pri	MIE of household attended primary school	0.251	0.433
sch_sec	MIE of household attended secondary school	0.288	0.453
sch_upp	MIE of household attended upper secondary school	0.083	0.276
sch_poly	MIE of household attended polytechnic	0.105	0.307
sch_ter	MIE of household attended university	0.135	0.342
sch_default	Default highest education group: the highest education attained of MIE is below primary school.		
post_sec	Dummy variable: 1 if the highest qualification of MIE is post secondary	0.323	0.468
post_upp_sec	Dummy variable: 1 if the highest qualification of MIE is post upper secondary	0.240	0.427
occup_sales	Dummy variable: 1 if occupation of MIE is service or sales workers	0.109	0.312
occup_clerk	Dummy variable: 1 if occupation of MIE is clerical workers	0.110	0.313
occup_tech	Dummy variable: 1 if occupation of MIE is technical workers	0.186	0.389
occup_admin_prof	Dummy variable: 1 if occupation of MIE is legislators, administrators, managers or professionals	0.272	0.445
occup_default	Default occupational group: agricultural, production-related workers, not classifiable		
hsz	Household size	4.01	1.40
married	Dummy variable: 1 if MIE is married	0.744	0.437
car_own	Dummy variable: 1 if the household owns at least one car	0.376	0.484
num_hp	Number of hand phones possessed	0.694	0.774
internet	Dummy variable: 1 if the household has internet access	0.241	0.428
num_pc	Number of personal computers possessed	0.581	0.647
num_motor_vehicle	Number of motor vehicles possessed, including cars, scooters and vans	0.603	0.668

Table A3.2: Estimates of Household Income from Work with OLS

(The dependent variable is *ln(inc_wk)*. Sample size is 5555. t statistics are based on White Heteroskedasticity-Consistent Standard Errors & Covariance.)

Variable	Coefficient	(t-Statistic)
c	6.440049	(48.8)
age	0.016138	(2.5)
*age*age*	-0.000172	(2.2)
sch_pri	0.124695	(4.7)
sch_sec	0.354946	(12.0)
sch_upp	0.498812	(8.6)
sch_poly	0.511419	(11.8)
sch_ter	0.735264	(16.2)
post_sec(age>=30)*	0.069587	(1.1)
post_sec(age>=40)*	-0.192810	(3.2)
post_sec(age>=50)*	0.187536	(3.7)
post_sec(age>=60)*	-0.289028	(1.6)
post_upp_sec(age>=30)*	0.101158	(1.5)
post_upp_sec(age>=40)*	0.168105	(2.5)
occup_sales	0.090135	(3.5)
occup_clerk	0.228790	(9.0)
occup_tech	0.279145	(11.6)
occup_admin_prof	0.410072	(16.3)
ln(hsz)	0.333372	(15.6)
married	0.077633	(4.1)
car_own	0.131878	(6.4)
num_hp	0.152681	(15.0)
internet	0.088032	(4.5)
num_pc	0.085009	(6.0)
Num_motor_vehicle	0.119267	(7.9)
R-squared	0.577	

Appendix 4: Estimation of Excess Consumption --- Linear Regression

(Dependent Variable: *ln(hh_cons)*. Sample includes the households who are home buyers of HDB 3-room flats and above after the year 1990. The households with MIEs aged below 21 or over 60 at the time of home purchase are excluded. The total sample size is 2054 observations. t statistics in parentheses are based on White Heteroskedasticity-Consistent Standard Errors & Covariance)

Variable	Coefficient	(t-Statistic)
Constant	3.222	(23.6)
ln(p_income)	0.292	(12.0)
Ln(c_income)	0.239	(11.0)
(age>=30 and age<40)	-0.0564	(1.9)
(age>=40 and age<50)	0.0176	(0.6)
(age>=50 and age<60)	0.117	(2.7)
age>=60	0.394	(2.5)
ln(hsz)	0.281	(10.9)
married	-0.0642	(2.3)
R-squared	0.409	