AN ASSET-BASED THEORY OF HOUSING CHOICE UNDER CREDIT CONSTRAINTS: THE CASE OF KOREA

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ABSTRACT

In many developing countries, housing has been one of the easily available investment alternatives under high inflation and rapid urbanization; however, formal housing credits are usually limited. Thus, the scarcity of credit has created various forms of institutional adjustments in the housing market such as Chonsei rental system in Korea.

After the literature survey, a three-sector (homeownership, Chonsei, monthly rental) model is proposed to analyze the urban housing tenure market in Korea. The equilibrium prices in this model are theorized by the user-cost approach and tested with empirical data. The opportunity cost of capital in the curb market and the rate of housing appreciation are the two critical elements in the model.

A theoretical relationship between housing demand and credit constraints is analyzed in a static framework in chapter IV. The model shows two different solutions based on the binding credit conditions. For the credit-bound group, the level of accumulated asset is the most critical determinant in the housing decision by constraining them to be at the corner solution. For the non-bound, both income and the level of assets are important in housing choice by making it possible for them to be at the point of global solution. This model is empirically tested in chapter V with various estimation techniques to reduce the simultaneity and truncation problem.

In chapter VI, a dynamic life-cycle simulation model is formulated to show that credit constraints and subsidized formal mortgage result in a non-trivial loss in consumers' welfare by inducing them to save excessively at the early stage of the life cycle. It also shows that the waiting time for first homeownership and the difference between the levels of housing consumption before and after homeownership can be reduced through the expansion of the housing credit and the elimination of subsidies to the formal housing loan.

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GLOSSARY

Asset
In this study, we use the term asset (or assets) to represent the non-housing assets net of real estate holdings unless noted otherwise.

Chonsei
One of the most popular rental arrangements in Korea. Under this rental arrangement, renters do not pay monthly rent. Instead, renters make a lump sum deposit of Chonsei (key money) at the beginning of occupancy which is fully refunded at the end of the contract period without interest. At each renewal of contract, the owner of the house usually increases the Chonsei deposit. As a rule of thumb, the imputed rent of Chonsei is equivalent to the curb market interest rate (3 percent per month) on the Chonsei deposit.

Curb Market
Informal financial market in Korea. The interest rate is determined strictly by supply and demand depending upon the urgency and amount of loan. Usually a 3% per-month rate is applied, and borrowers usually pay only interest during the loan period. Most of the lendings are made on a person-to-person basis. Collateral requirements can be exempted when the loan amount is small and when the borrower is well known to the lender. The loans in the curb market are usually short-term, for less than a year.

Declining Chonsei
One of Chonsei rental arrangements. Under this arrangement, a tenant makes a one-time deposit from which a certain amount is deducted every month. The remaining deposit will be repaid to the tenant at the end of his lease.

Exclusive Chonsei
A special type of whole Chonsei where the tenants use the dwelling unit exclusively without sharing the unit with the landlord or other tenants. [See Whole Chonsei.]
Housing Tenure

There are three tenures of housing: homeownership, Chonsei rental, and monthly rental. In this study, unless noted otherwise, homeownership includes owner-occupancy and landlordship regardless of the sharing status of the dwelling unit. Chonsei rental includes whole and partial Chonsei without monthly rental payments. Monthly rental includes declining Chonsei and monthly rental with or without deposit. Those excluded from this classification are free housing dwellers and street-sleepers, accounting for less than 3% of the total households.

Monthly Rental with Deposit

This is the same as that in western countries. However, the deposit requirement is rather high—usually more than one year's rent. The monthly renters usually share a dwelling unit with the landlord or other tenants.

Partial Chonsei

One of the most popular rental arrangements in Korea. Tenants of this type of rental arrangement rent part of a dwelling unit—usually some rooms and kitchen—from owner or whole Chonsei renter.

Pyong

Unit in measuring area. One pyong is equivalent to 3.3 square meters or 35.5 square feet.

Whole Chonsei

Tenants of this type of rental arrangement lease the whole dwelling unit. Then the tenants may use the whole unit or may sublet a part of dwelling unit to other tenants, usually in the form of partial Chonsei or monthly rental.
CHAPTER I

INTRODUCTION

1.1 Definition of Problem

Housing has many special properties as a consumption good: durability, locational fixity, indivisibility, linkage with public utility service, and large transaction costs.

In spite of these common characteristics, housing situations can vary widely. The housing situation in developing countries is quite different from that in developed world. For example, high urbanization, high inflation, and severe credit constraints¹ are more common in developing countries than in developed ones. Thus, the dynamics of income and population change do not create surpluses of low-income housing in developing countries; rather, there is a chronic shortage throughout the whole quality range of housing stock [Mills and Hamilton (1984), p. 379]. Similarly, various institutional factors such as rationing credits and resources [Wheaton (1981)] and dual financial structure [Struyk and Turner (1986)] are directly or indirectly involved in the housing market in developing countries.

Traditional studies and theories on housing--mostly from the developed world--should therefore be applied with caution in the housing analysis of developing countries. The single most important aspect of the traditional
housing studies is that they are based on the assumption of flexible capital market, where a significant portion of the housing price can be financed through housing mortgages. Each household, therefore, can adjust its housing consumption to its lifetime earnings or permanent income [Fisher (1930), Friedman (1957), Muth (1960)]. As a housing mortgage is relatively easily accessible, and as its costs maintain a balance with the rental costs, housing choice in developed countries is closely related to the consumer's ability to make constant payments on the basis of stable employment. Because of diverse investment alternatives and stable housing prices, the weight of housing equity in any household portfolio in developed countries may be lower than that in developing countries.²

In Korea, as formal mortgages are very limited,³ the ability to become a homeowner depends more directly on the level of accumulated assets of the household than on the level of household income, although the process of asset formation may largely be dependent upon the household income. However, existing studies on housing demand [KRIHS (1983), Lim et al. (1984)], by simply following the traditional framework of permanent income hypothesis and flexible capital market, ignore the specific impact of credit constraints on housing demand and the importance of the household assets in housing decision.

This study posits a different causal relationship from the permanent income hypothesis.⁴ In the permanent-income framework, lifetime wealth is easily converted into permanent income which, in turn, determines the level of housing consumption. This symmetrical conversion is possible because of
the flexible capital market. Under credit constraints, however, income initially determines wealth, and the level of wealth determines (or constrains) the level of housing consumption because the availability and amount of housing loans are closely related to the level of household wealth. In this context, this dissertation specifically deals with the housing market under credit constraints where the level of household assets, and not only income, is one of the most critical determinants in housing decision.

The relationship between household income and assets is a complicated one in Korea because of the diversified housing tenure and quality. Tenants' housing decision includes whether they choose monthly rental (with or without a deposit) or Chonsei (partial, whole or declining Chonsei). Because each rental option offers a different profile of deposit requirements and rent levels, the specific tenure decision affects the residual asset level and non-wage income (from asset) flows after a specific rental commitment. The owners' housing decision also profoundly affects their future asset positions because the housing equity is a substantial part of their portfolios and because a significant portion of their income flows depends on the capital gains from housing. In addition to this, owners may use their houses for income-generating purposes in Korea. That is to say, they may use part of the house for domestic manufacturing or for shops. They may even rent out part of the dwelling unit to the partial Chonsei tenants or monthly renters. This partial room-renting is also one of the convenient ways of financing the homeownership. Therefore, housing choice in Korea should be viewed as a dynamic process where income level and wealth position not only determine,
but also are affected by the housing choice.

In traditional studies, these two variables—income and assets—are treated at the same level so that the long-term relationship between them is considered symmetrical. That is to say, the estimation of housing (consumption or tenure) choice usually includes both variables (or perhaps only income) and shows that income—mostly permanent income—is more significant than the level of household assets in housing choice. At best, it shows only the complementary role of assets to income in housing choice. To our best knowledge, there are no empirical studies in the U.S. on housing demand using assets, perhaps because of the limited availability of data and the irrelevance of assets under flexible capital market.

Even though asset data are available in Korea, there are not many studies that treat the level of assets as one of the important factors in housing decision. And among those studies with assets, the behavioral relationship between housing choice and the level of assets is reversed. That is to say, the current level of assets would determine the next housing choice not the present housing choice which has already been made.

For the level of household income, this difference in time reference—whether it is before or after the housing decision—may not be a major problem if there are no significant variations in non-wage incomes. For the level of assets, especially when formal housing finance is limited, the difference in time reference may be a serious problem. As the present level of assets is recorded "after" (not "before") the housing choice has been made, the present level of assets is only a residual from the previous housing decision, not the predictor of the next housing decision.
It may be argued that, therefore, the permanent income hypothesis may fit this situation better. Our position, however, is that the permanent income hypothesis is only relevant when credit constraints are not so severe. According to the permanent income hypothesis, any variations in income are transformed into lifetime wealth, so that the level of consumption can be smoothly adjusted through the perfect capital market.

Under credit constraints and imperfect capital market as in Korea, the permanent income hypothesis may not be able to explain the asymmetric and dynamic relationships among income, assets, and housing. Therefore, we need an alternative theory of housing choice and demand based upon the level of assets if the credit market is imperfect. In particular, the pooled estimation of the credit-bound and non-bound groups in such a situation may result in a serious bias in estimating the income and asset effects on housing decision.

1.2 Objective and Scope of Study

In view of the distinctive characteristics of the Korean housing market such as diversified rental tenure, limited formal financing, high urbanization, and housing shortage, the primary objective of the present study is to formulate and empirically test a model of housing choice and demand with the level of household assets as one of the major variables used to explain the consumer's behavior of housing choice under credit constraints. By recognizing the level of assets as one of the critical determinants of housing
demand, we are able to explain several critical aspects of the housing market in Korea: 1) the diversification of housing tenure, 2) the differential behavior of housing choice among demanders, and 3) the impacts of credit constraints on the consumers' welfare.

There are three critical questions posed in this study. First, are Chonsei renting prices related to what the economic theories say they should be? Second, if the price relationship of the three-sector (homeownership, Chonsei rental, monthly rental) are determined in that manner, and strong credit constraints exist, how should estimations of housing demand be derived to accommodate the impacts of level of assets and credit constraints? Third, as a consequence, how much do credit constraints affect the consumer's lifetime profile of housing consumption and welfare?

The first question, in fact, calls for a comprehensive market analysis including supply and demand of housing; however, our analysis for this question will take a comparative static framework only from the viewpoint of housing demand because our focus is on the asset's role in the housing decision. The limitation of housing credits may also affect the behavior of housing suppliers; however, in Korea, the supplier's burden of credits during housing construction is almost always transferred to the demanders. That is to say, supply credit is usually tied to real assets (housing). Thus, with the sale of housing, the responsibility of repayment is automatically transferred to the final demanders.

The major reason for posing the first question is to see how the diversified
tenure market works; that is, how much existing economic theories can (and cannot) explain this special market. Thus, the role of assets in the housing decisions is analyzed in the form of user cost of capital and housing price appreciation. Although the assumptions are very restrictive and the analytical model is very simple, we believe that this is the first step toward a comprehensive understanding of the housing market under credit constraints.

The second question is the main focus of this study. A theoretical static model is formulated in order to identify the behavioral and structural differences between the credit-bound and non-bound groups in housing decision.

With this theoretical model we are able to answer several critical questions: 1) Who is bound by credit constraints? 2) What are the conditions of binding credit constraints? 3) How do the levels of income and assets determine housing choice with or without binding credit constraints?

An empirical test of this model calls for the data on the level of assets before the housing decision. Because of the time gap between the survey and previous housing decision, it is usually necessary to estimate the before-purchase level of assets.

The third question calls for a comprehensive dynamic analysis. The analytical model for this question is constructed in order to draw practical policy implications. The model consists of various controllable and
uncontrollable parameters. Loan-to-value ratio and mortgage interest rates are chosen as the critical policy parameters. We also analyze the impacts of the changes in these policy parameters in three aspects: 1) welfare impacts, 2) housing consumption changes between before and after homeownership, and 3) tenure choice impacts.

The conceptual framework utilized to answer the three basic questions is largely based on the microeconomic principle of maximization of utility subject to various constraints. Although we recognize the importance of the interactions between supply and demand in the housing market, this study focuses mainly on the demand side because analysis of the supply side at the same level of detail as the demand side is too great a task and risks loss of important details in aggregation of both sides. However, the results of the analysis will be discussed in the broad context of the total (aggregate) housing market, including the supply side.
1.3 Methodology and Organization

1.3.1 General Methodology

Econometric analysis and simulation are the two major methodologies employed in this dissertation. Micro demand (and choice) behavior of the household is the main focus of our analysis. The supply side of housing is not rigorously investigated, nor have the legal and social aspects of housing been extensively considered. However, several analyses will focus on the macro impacts of micro choice behavior.

Data for the empirical analysis are based on the 1982 Korea Housing Demand Survey [KRIHS(1983)]. This includes 4,750 households selected at random from 11 cities throughout the country. [See Appendix.] The instrument used for the survey is a personal interview for each household. The data provide considerable detail with respect to household characteristics, dwelling values and financing, and current and past dwelling attributes. Our empirical studies are mostly based on a subsample of 1540 residents in Seoul.

All subsequent analyses and tables presented in this study are derived from this subsample, unless indicated otherwise. In some cases the analyses are based on observations only for recently-moved residents and/or those with past housing records. Estimated regression coefficients are recorded in the tables, and relevant t-statistics are recorded in parentheses below each coefficient.
The unit of measurement for income, assets, house value, Chonsei, and monthly rent is 10,000 won -- about US$ 14 in 1982 prices -- unless noted otherwise.

1.3.2 Organization of Study

The study will be composed of three main parts: chapters II and III, chapters IV and V, and chapter VI. Chapter II is a critical evaluation of existing empirical studies, which are mostly based on the permanent income hypothesis. A survey and classification of a wide variety of theoretical studies is attempted along the lines of cross-section and time-series studies in order to identify the underlying logic of the permanent income hypothesis.

Chapter III formulates the relationship between Chonsei, rent, and house value under a static equilibrium framework. Here, assets are converted into the user-cost concept through opportunity costs and returns on housing capital in the determination of equilibrium prices. This static model is then tested with survey data by employing hedonic regressions. In particular, the hedonic regression is needed to control for the housing quality in three sectors. These empirical prices in the three sectors are compared with the theoretically expected values.

Chapter IV formulates an explanatory model of consumer behavior under
binding and non-binding credit constraints. The model is based on the principle of utility maximization subject to the credit constraints at the time of the housing decision. The conditions of binding credit constraints and the expected theoretical coefficients of income and asset are derived. Chapter V tests the empirical relevance of the theoretical model formulated in chapter IV. In particular, different housing demand patterns are identified between households for which the credit constraints are binding or non-binding. Various technical issues are explored in order to correct the simultaneity and truncation problems. The endogeneity of the previous level of assets in the empirical tests requires more stringent techniques other than ordinary least square (OLS) methods: thus, we use reduced-form and two-stage OLS in order to correct for simultaneity. Also in order to correct for the truncated nature of the data between the credit-bound and the non-bound, we employ an advanced estimation technique, the Tobit.

Chapter VI attempts to integrate various issues and problems raised in the static analyses through a dynamic optimization and to assess the simulated impacts of credit constraints on the level of consumers' welfare and housing decision. Various socio-economic parameters are considered in the building of the life-cycle savings and housing consumption simulation model.
1. In this study the term credit constraints usually refers to the various economic and non-economic barriers which prohibit housing loans. In Korea, loans are usually collateralized by real assets. Accordingly, each household should always maintain non-negative wealth. This kind of constraint is usually referred to as a liquidity constraint.

2. It is very difficult to get the relevant information for comparison; however, an Australian survey [Pugh (1980), p. 4] shows that one's own home is about 60% of total assets among households with low and modest accumulation of wealth. In Korea, the ratio is more than 70% for households with low and modest wealth--i.e., less than W10,000,000--based on our survey data.

3. In Korea, the mortgage market is quite underdeveloped. According to our survey, the proportion of homeowners who purchased the house without outside financing is almost 80% of the total homeowners, and the average loan-to-value ratio is around 20% among homeowners with outside financing. The reasons of this underdeveloped mortgage market are two: 1) Government's strict control of credit in favor of the manufacturing industries 2) The (risky) curb market's inability to offer long-term loans.


5. Because a one-time full-cash payment is required in the housing transaction, and because loan availability is very limited, the owner's equity in housing is almost the same as the purchase price except when one purchases a house with partial Chonsei. In the latter case, the owner's equity is the full housing price net of Chonsei deposit from the renters.

6. See Appendix for sample design and questionnaire.
7. In terms of household distribution by tenure, this subsample overrepresents the homeowners and underrepresents the Chonsei renters. [See table below.]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeowners</td>
<td>60.0</td>
<td>44.5</td>
</tr>
<tr>
<td>Chonsei renters</td>
<td>25.8</td>
<td>37.9</td>
</tr>
<tr>
<td>Monthly renters</td>
<td>14.2</td>
<td>16.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
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8. See Appendix for more information on this subsample.
CHAPTER II

LITERATURE SURVEY

Since housing choice under credit constraints can be different from that in a perfect capital market, in this chapter we will survey the existing studies and extract relevant ideas for the housing analysis under credit constraints in countries like Korea.

The empirical literature on housing demand and choice can be classified into two major categories\(^1\): cross-section and time-series studies. The cross-section studies focus mostly on demographic effects and cross-sectional variations of the housing demand. The time-series studies, on the other hand, emphasize financial and mortgage questions, and the user-cost of capital. While cross-section studies consist mostly of static analysis, time-series studies deal with inter-temporal dynamic aspects of the housing demand.

As the existing studies on housing demand show great diversity in their area of interests, we will focus only on how these studies define and analyze the effects of the user costs on the housing choice, and on how they deal with imperfections in the credit market and with the role of assets in estimating housing demand.
2.1 Cross-section Studies

In cross-section studies, inter-temporal variations of demographic and macro-economic parameters are fixed. Therefore, longitudinal variations in household-specific variables such as income, age, household size, and education are assumed not to be changed substantially. Inter-temporal variations of macro-economic variables such as (nominal) interest rates, mortgage terms, and taxes are analyzed only in a static framework. By static we mean that the process of inter-temporal adjustments or resource allocations in response to the changes in macro variables are not rigorously considered. However, the time-horizon of the study can be either long-run or short-run.\footnote{In other words, the housing stock can be either malleable and mobile (long-run), or durable and immobile (short-run).}

The representative long-run models are the studies by Muth (1969) and Mills (1967). An application of these models in Korea is attempted by Follain, \textit{et al.} (1980). Based on Muth's model (1969) of long-run equilibrium, Follain \textit{et al.} (1980) estimate the level of rent with income, price, housing shortage, household size, and travel time. Using consumption expenditure as a proxy for permanent income, they find that housing demand is more elastic with respect to permanent income than to the current income. Similar results can be seen in other studies [KRIHS (1983)]. However, credit constraints and household's asset changes are not considered in any of these studies.

Short-run models are developed to accommodate the durable nature of housing. In this framework, the distribution of housing stock with various
mixtures of the housing attributes is an important determinant in explaining cross-sectional variations of housing choices. Following the theory of hedonic goods [Rosen (1974), Cassel and Mendelsohn (1985), and Diamond and Smith (1985)], Sweeney's discussion of hierarchical choice (1974), Quigley's logit analysis (1973), and NBER Detroit Model [Kain (1971)] all treat the demand for housing as a short-run exchange process, in which the levels of rents for each type of housing adjust to equate units chosen with fixed supply.

Wheaton (1977) has developed a comprehensive model of short-run housing demand based on the bid-price (bid-rent) notion of Alonso (1964). The bid-rent theory is generally based on three important assumptions. First, housing is treated as a heterogeneous commodity that is indivisible, so that households purchase a bundle of spatial and physical housing characteristics by paying a single rental or purchase price for the housing unit. Second, households are assumed to bid for the existing housing stock of an urban housing market so that all households of similar income levels and preferences obtain the same level of utility. Third, housing prices within the urban market vary so that the equal-utility condition is maintained. Because the bid-rent equation contains a utility variable which is not usually measurable, division of the sample into subgroups with similar demographic characteristics including income is necessary. The underlying hypothesis for this is that income may be highly correlated with economic background factors such as class, family wealth, and education. Wheaton (1977) estimates the equation for five household strata based on age, size, and income from data for the San Francisco Bay Area.

Following this study, Follain et al. (1982) have estimated the willingness to
pay for additional space in Korea using cross-section data. In the bid-rent approach of their study, permanent income (consumption expenditure as a proxy) is used to control for the imperfect stratification. Recently Zorn (1985) has applied this bid-rent approach in an explanation of the flight of the higher-income households from the central city.

One thing that should be addressed in the bid-rent approach is the user costs of homeownership. Unlike renters, owners do not actually pay rent. In many studies, the user costs for owners are defined as the sum of opportunity interests on housing equity, mortgage interests⁴, maintenance costs, and property tax; net of income tax deductions on mortgage interest payments, and (expected) housing price appreciations.

An effort to link the hedonic theory⁵ and the bid-rent approach can be found in the study by Ellickson (1981). In his study, extreme value distribution (which is the essence of bid-price model) naturally justifies the use of the standard logit model. The question on which he focuses is the probability that a certain type of household will occupy a particular type of housing instead of the probability that a certain type of housing will be occupied by a particular type of household.⁶

Many studies have shown a variety of applications of the logit (or the probit) model in relation to the housing tenure choice. In particular, a study by Ihlanfeldt and Silberman (1985) is notable in that the authors recognize the importance of prior homeownership and human capital in housing tenure choice. In other words, the importance of assets in housing choice is identified through a proxy variable, prior homeownership.

A study by Li (1977) also employs logit analysis. It is very illuminating in
that the effects of the binding credit (in his term, budget) constraint, life-cycle, and wealth are identified for a particular household. His logit model of homeownership is to examine interaction effects among age, income, size, and race of household using Baltimore and Boston data. By examining the logit of each income category by household size, he identifies the more binding budget constraints for large families. From the age-size interaction, the logit shows an inverted U curve indicating the life-cycle effects. The wealth effect can not be observed in the age-income interaction; that is, the logit is continuously increasing with age for all groups of income categories. However, it is not at all clear in his study how wealth has been accumulated and what kind of credit constraints are binding.

As a part of a methodological development, many studies [Lee and Trost (1978), Follain (1982), Ozanne and Thiboudeau (1983), Gillingham and Hagemann (1983), Kent (1983)] have attempted to integrate housing tenure choice and consumption choice into a simultaneous model. Their common conclusions are two: 1) There is a statistically significant simultaneity between housing tenure choice and housing demand. 2) Changes in per capita income, (expected) price (appreciation), inflation, and other demographic variables such as household formation have differential impacts on tenure choice and level of housing consumption. For example, Kent (1983), based on the cross-section data, has found that the income elasticity of the per capita demand for owner-occupied housing is 0.80, household formation 0.18, and tenure choice 0.20.

In response to world-wide inflation during the 1970's, housing questions began to focus on the effects of inflation on housing demand. As a
A comprehensive theoretical study of housing tenure choice has been done by Henderson and Ioannides (1983). Their analysis is based on comprehensive static framework, focusing on the difference in user costs between renters and homeowners. The rationale of the advantage to owning over renting, however, is different from other studies. Their rationale is that there is a "fundamental rental externality" from maintenance problems: renters do not pay the social marginal costs of their utilization of housing stock because the rent cannot cover these costs of externalities. In their analysis, capital market imperfections are defined as those constraining consumers not to borrow against future income for current consumption but allowing them to borrow to purchase housing which can be offered as
collateral. Under this condition, owning is less attractive than renting since owning is a risky investment when either dissavings are desired (to increase consumption) or savings in the safe asset are desired (but prohibited).

Inherently the cross-section data have no variations in mortgages or general inflations. The only thing that varies across cities is the rate of housing price appreciation. In fact, we have differential rates of mortgages and effective interest rates across cities in addition to the inter-temporal variations of them.

2.2 Time-series Studies

While cross-section studies focus on socio-economic effects, time-series studies focus on pricing and financing effects on housing choice. As time-series studies need more extensive data over a long period of time than cross-section studies, there are not many empirical studies available.

The first comprehensive time-series study has been done by Muth (1960). He estimates stock-demand elasticities for non-farm housing from time-series data in the United States from 1915 to 1941. The fundamental demand for housing is assumed to be related to rent, income, and other variables. Recognizing the lag in adjustment of actual to desired stock, he suggests that the actual housing demand function lies on a path of dynamic adjustments to the long-run equilibrium stock level. Income elasticities for
stock demand obtained in his study are about unity without substantial variations over time. He argues from this evidence that the preference for housing relative to other consumption goods has not changed.

The first comprehensive time-series study of tenure choice based on the concept of user costs has been done by Rosen and Rosen (1980). The relative prices of owning and renting and their impacts on homeownership are empirically analyzed using time-series data in the U.S. In their study, the logarithmic proportion of households that desire to own housing in a particular year is estimated as a function of the relative price of owning and renting, real per capita disposable permanent income, credit conditions (the real growth rate in deposits at thrift institutions), and other demographic variables. Because of the low significance of the credit variable, although it is positive, he concludes that the impact of credit rationing and the supply of mortgage funds on housing decisions can not be strongly supported.

The most extensive form of time-series studies is that using panel data where each household is traced over time. In the panel data, longitudinal analysis provides added variation in explanatory variables. This is particularly important for price and age variables. Housing prices per unit of housing services vary only slightly across markets in a cross-section. However, time provides for substantive price variation, and the recent time period provides us with a dramatic change in the relative price of housing versus other goods as well as in the relative user-costs of owning versus renting. Boersch-Supan and Pollakowski (1985) analyze the panel data of households rather than of dwelling units. By dividing the data into three periods and examining the changes in housing tenure and consumption for
each period, they find that housing choices are intertemporally correlated, and that this correlation must be accounted for to provide a consistent estimate of structural housing demand parameters from panel data. In particular, they find that elderly households downgrade dwelling size without changing tenure.

Housing choice in terms of lifetime portfolio considerations in a time-series context can be seen in recent studies [Kearl (1979), Schwab (1982), Dougherty and Van Order (1982), Wheaton (1985)]. In particular, housing as an asset as well as a consumption good is well discussed in the study by Kearl (1979). Since housing services are also acquired by owning the asset, a variance of income and the illiquid nature of the asset may affect demand on the part of certain individuals. He argues that the demand decision is based on opportunity cost of housing capital relative to returns from assets in consideration of real interest rate, depreciation, and anticipated housing price appreciation.

The other critical finding of Kearl's study (1979) is that the terms of housing credit can lead to distortions in the housing market in the face of anticipated inflation. This distortion can result in a significant loss of housing stock because the estimated price elasticity of demand is as elastic as -1.5 while the implied income elasticity of demand is about 0.25 under anticipated inflation. He finds that the influence of nominal interest rates has been strong on the relative price of housing independent of real rate influences. Therefore, given market imperfections and the traditional mortgage instruments, anticipated inflation can affect the relative price of housing.
In an attempt to understand better the microeconomic foundations of Kearl's empirical result, Schwab (1982), and Dougharty and Van Order (1982) have developed Fisher-type models of intertemporal utility maximization, which include a housing consumption choice. Using a simulation model, Schwab finds that the demand elasticity for housing is (three times) more sensitive to the real rate than to inflation expectations. He concludes that, with a perfect capital market, inflation should induce no distortions in housing consumption decisions. Based on user cost and time-series estimation between 1968-1980, Dougherty and Van Order (1982) argue that with interest deductibility from income taxes, inflation reduces the "after tax cost of housing capital," and thereby increases housing demand.

Based on Schwab (1982), Wheaton (1985) rephrases the Fisher model into a continuous life-cycle model and examines two kinds of credit market constraints: those requiring liquidity and those prohibiting all forms of borrowing. He argues that, depending upon the nature of credit constraints, the impact on housing demand can be different.

2.3 Review of the Theories

The studies on housing demand reviewed thus far indicate various important points: 1) Housing demand is closely related to the price (in terms of the user cost) and income. In addition, this effect can have different impacts on households with different characteristics. 2) Housing demand is also dependent on credit terms and institutional aspects such as income tax
deductions.

With respect to the first point, there are great variations in estimated elasticities. [See Table 2.1.] Even in one country such as in Korea, very different estimation results can be obtained. The most striking difference in Table 2.1 is in price elasticities: in Korea, they are much lower than in the U.S. This might be due to the difference in the degree of credit constraints between the two countries.

**TABLE 2.1**

**INCOME AND PRICE ELASTICITIES OF HOUSING DEMAND FROM VARIOUS STUDIES**

<table>
<thead>
<tr>
<th>Type</th>
<th>Cross-Section</th>
<th>Time-Series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KRIHS</td>
<td>Kearl</td>
</tr>
<tr>
<td>Author</td>
<td>Follain</td>
<td>Schwab</td>
</tr>
<tr>
<td>Data</td>
<td>Seoul</td>
<td>US</td>
</tr>
<tr>
<td>(Year)</td>
<td>(1982)</td>
<td>US</td>
</tr>
<tr>
<td>Dependant</td>
<td>Housing Price</td>
<td>(14-41)</td>
</tr>
<tr>
<td>Variable</td>
<td>Imputed</td>
<td>(61-73)</td>
</tr>
<tr>
<td></td>
<td>Floor Rent</td>
<td>Simul-</td>
</tr>
<tr>
<td></td>
<td>Space Quantity</td>
<td>lation)</td>
</tr>
<tr>
<td></td>
<td>Stock</td>
<td>'41)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income</th>
<th></th>
<th>Time-Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>0.1 0.11 0.23</td>
<td>- - -</td>
</tr>
<tr>
<td>Permanent</td>
<td>0.24 0.09 0.51</td>
<td>0.39 0.25 1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price</th>
<th></th>
<th>Time-Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Cost</td>
<td>-0.07 -0.16 -0.12</td>
<td>- -0.97 -</td>
</tr>
<tr>
<td>Price Index</td>
<td>-0.07 -0.17 -0.73</td>
<td>- 0.90 -</td>
</tr>
</tbody>
</table>

| R²          | 0.66 0.84 0.45 | 0.96 - 0.62 |

**NOTE:** 1) SF: Single-Family Housing  
2) MF: Multi-Family Housing
As Tobin (1972) has suggested, liquidity constrained households do not alter current consumption in response to the marginal changes in capital gains and other macro economic variables.

Overall, the demand elasticities of permanent income are higher than those of current income: however, they show large variations in magnitudes. With the exception of Kearl (1982), it is generally recognized in many other studies that the permanent income elasticity for housing in the U.S. is higher than 0.5 or even close to unity. As we can see in Table 2.1, it is usually much lower than 0.5 in Korea, where credit constraints are severe. Therefore, in order to accommodate correctly the asset effects on housing choice, we need an alternative model where the asset-accumulation process can be effectively accommodated.

In chapter III, we begin the analysis by examining the prices of three types of tenure--homeownership, Chonsei, and monthly rental. In chapters IV and V, based upon the implications of price behavior in chapter III, we construct an asset-based theory of housing choice under credit constraints. And finally, in Chapter VI, we develop a comprehensive dynamic simulation model.
ENDNOTES OF CHAPTER II

1. Other classifications may be possible depending on the focus of the research. For example, a classification into positive and normative theories may be possible for the pure academic research. Since our study revolves around the static and dynamic aspect of the effects of assets and credit constraints, the distinction between cross-section and time-series is considered to be relevant.

2. An intermediate-run might be the most realistic horizon for the housing studies. Because of its highly realistic nature, there are not many studies with intermediate horizon. We present only the two extreme cases with the hope that the intermediate-run model may fall between them.

3. The bid-rent model is derived from the maximization of the utility function under budget constraint. The final form will be:

$$\ln(y-t-r) = x(u_0,z) = a_1\ln(u_0) - a_2\ln(z_1) - a_3\ln(z_2) - \ldots$$

where, $y$ is income, $t$ is travel cost, $r$ is rent, $u_0$ is utility for certain group, and $z$'s are housing attributes.

From this, we can calculate the maximum bid of a certain group on each housing attribute. By dividing into homogeneous groups, we do not need to calculate the actual utility levels; that is, in the above equation, the utility is embedded in the constant term.

4. Mortgage rates are usually assumed to be the same as market rates in the cross-section studies.

5. One of the major flaws in hedonic theory is that the estimation of hedonic price functions provides little information about consumer behavior. However, Lerman and Kern (1983) found the potential estimation of the willingness to pay for housing and neighborhood attributes by integrating the random bidding process into the theory.

6. By running the usual logit estimation in reverse, he is able to connect the logit analysis to the bid-rent theory. That is to say, in the usual logit
estimation the random disturbance should be assumed to justify the Weibull (extreme value) distribution; however, in the reversed logit estimation as in Ellickson's, these extreme values are considered to be the highest bids.

7. This general trend was obtained by tracing the logit of each age for various household-size groups. The logit of homeownership is increasing up to the age of 40 and decresing afterwards.

8. It implies that declines in the after-tax: user cost of capital do not necessarily lead to increased housing demand.

9. In fact their analysis is a Fisher-type two-period model. In this respect, their analysis could be a time-series study; however, their analytical framework is comparative static rather than dynamic.

10. An owner-occupier (and a tenant) gets the housing service by increasing (but marginally decreasing) the utilization ratio of the housing capacity. But a landlord can collect from the tenant only part of the variations in the total utilization costs which is increasing (and also marginally decreasing) with higher utilization rates because tenants are charged only for obvious damages. In other words, the marginal costs of increased breakdowns and wear and tear caused by increased rates of utilization can not be fully charged to the tenant.

11. Recognizing the huge variation among dwelling units as to size, type of construction, floor space, and other characteristics to which consumers attach value, he defines the housing stock not in terms of the dwelling unit, but in terms of the current value deflated by the price of the standard house.

CHAPTER III

RENT, CHONSEI, AND HOUSING PRICE IN KOREA

In the previous chapter, we have surveyed the existing literature on housing choice. In most of the literature, the analyses are based on the assumption of perfect capital markets, and therefore the central focus is only on income and price variations. In this chapter we survey the background information related to the Korean housing market. In particular, we explore the financial structure and the development of Chonsei tenure. This will be followed by a theoretical modelling which explains the static relationship of prices of the three-tenure sectors: homeownership, Chonsei, and monthly rental. The theoretical relationship is then tested with empirical data.

3.1 Financial System and Housing Market in Korea

3.1.1 Credit Constraints in the Housing Market

Traditionally, the flow of funds between saving and investment sectors in Korea is facilitated by a range of public institutions. The financial system in Korea is dominated by the banking system, supplemented by new
institutions designed to engage in specialized activities. The entire system--both the allocation of funds and their costs--is controlled in some detail by the government. The allocation of credit to favored industrial sectors is accomplished through the control of entry into the financial industry, and by a specialization of functions laid down for institutions by the government [Struyk and Turner (1986), p. 190].

Under these conditions, formal mortgage lending is allocated to only a couple of institutions, the Korea Housing Bank (KHB) being by far the most important. In addition, the volume of funds raised by these few institutions for investment in mortgages is closely regulated. The Korea Housing Bank, for example, routinely uses a significant share of the funds at its disposal for investment in sectors other than housing.

Although the government heavily controls the formal financial sector, the informal sector or "curb market"\(^1\) has remained outside most government control. Three attributes of the informal sector are worth noting. It is large, equal to as much as one-third of the outstanding domestic credit of the formal banking system.\(^2\) Second, unlike the formal financial sector, interest rates in the curb market are determined strictly by the interaction of supply and demand. Third, the curb market functions as a genuine complement to the formal system, serving as an intermediary between household depositors and borrowers which have included large corporations as well as small firms and individuals.

The share of assets represented by housing mortgage investments gives an idea of the denigration of housing in the financial sector. Rough calculations indicate that in Korea mortgage investments made up only about eight-tenths
of one percent of aggregate financial assets in 1980. For the total cost of new housing nationwide in 1983, public financial sector funds occupied only 26.4%, and the rest was from the private sector. Of the formal housing funds, only half were bank funds considered to be long-term mortgages.

Table 3.1 illustrates the recent importance of Korea housing Bank (including the National Housing Fund) by reporting the number and value of units financed as a share of the number of units constructed from 1977 to 1982.

In 1980 and 1982 the number of loans increased, covering the majority of new units and about one-quarter of their value. Note that most loans could be for recently built units.

### TABLE 3.1

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of New Units (1,000)</th>
<th>Value of New Units (Billions of Won)</th>
<th>Number of Loans (1,000)</th>
<th>Value of Loans (Billions of Won)</th>
<th>C/A</th>
<th>D/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>203</td>
<td>723</td>
<td>56</td>
<td>77</td>
<td>0.28</td>
<td>0.11</td>
</tr>
<tr>
<td>1978</td>
<td>300</td>
<td>1,363</td>
<td>71</td>
<td>120</td>
<td>0.24</td>
<td>0.09</td>
</tr>
<tr>
<td>1979</td>
<td>251</td>
<td>1,615</td>
<td>86</td>
<td>195</td>
<td>0.34</td>
<td>0.12</td>
</tr>
<tr>
<td>1980</td>
<td>211</td>
<td>1,980</td>
<td>88</td>
<td>281</td>
<td>0.42</td>
<td>0.14</td>
</tr>
<tr>
<td>1981</td>
<td>150</td>
<td>1,754</td>
<td>127</td>
<td>532</td>
<td>0.85</td>
<td>0.30</td>
</tr>
<tr>
<td>1982</td>
<td>190</td>
<td>2,597</td>
<td>117</td>
<td>662</td>
<td>0.62</td>
<td>0.25</td>
</tr>
</tbody>
</table>

According to our survey data, less than 20% of the total households are financed by outside funds from formal and informal sources. Therefore the average loan-to-value ratio among the total (financed and non-financed) housing stock would be less than 5%.

The only truly private mortgage lending in Korea is done by insurance companies [KRIHS (1983), pp. 238-40]. These private lenders generally limit loan terms to ten years, and require very high building standards. At these terms, private financing institutions simply do not address the housing finance needs of most moderate- or middle-income households. Korea also has an extremely well-developed informal financial market. Typically, loans in the curb market carry very high interest rates (3 or 4 percent per month) and short terms, reflecting inflation prospects, the riskiness of the loans, and scarcity of funds. Hence, although the curb market is a private-market alternative, its loan structure is not at all well matched with the needs of home purchasers.

The strategy of attracting funds in public financial institutions has been the guarantee of mortgage loan when a saving contract has been fulfilled. The government, while holding the structure of interest rates low, also has subsidized interest rates on long-term deposits not tied to housing. The Korea Housing Bank (KHB), the National Housing Fund (NHF), and the Citizens National Bank (a state-operated commercial Bank) all implement variations on this basic strategy for raising funds for home mortgages. As of 1983, the Korea Housing Bank's savings deposit plan, for example, paid low interest rates but awarded subscribers eligibility for loans up to 10 million won
(U$14,300), or for up to 70% of purchase price whichever is smaller with a 10-percent interest rate for as long as twenty years. As the number of subscribers to these plan increases, there is no guarantee for obtaining a loan in any specified period of time. Thus, subscribers tie up significant resources at below-market rates in order to obtain a housing loan.

Many of the housing loans managed by KHB are made under the Long- and Medium-term Housing Installment Savings Deposit Plan. This plan matches a subscriber's monthly deposit with a loan agreement. Loan amounts are limited to 15 million won (U$21,400), and the dwelling units to be purchased should not exceed 25.7 pyongs (85 square meters).

The Korea Housing Bank also manages the National Housing Fund. The fund does not rely solely on the deposits of subscribers; it also raises money by means of National Housing Bonds and deposits by government pension funds. A household can obtain a priority ranking for a loan by participating in the National Housing Pre-emption Subscription Deposit Plan. Depositors must contribute at least 20,000 won (U$29) monthly for an established contract period. They then become eligible for a loan of up to 6 million won (U$8,600) with interest rate as low as 4 percent per year for some subscribers. This plan is generally limited to first-time house buyers. The subscribers of this plan are also eligible for publicly supplied (low-cost) housing. The maximum dwelling unit size, however, is again restricted to 25.7 pyongs--85 square meters. All of the dwelling units financed by the National Housing Fund are quite small. This has had the effect of

40
concentrating purchasers in the twenty-fifth to fiftieth percentiles of the urban income distribution.

The determination of interest rates and the allocation of financial resources in Korea, reviewed thus far, have been under strict control by the government in favor of the non-housing sectors. In spite of their low interest rates and guaranteed high loan-to-value ratio, the formal mortgages have not been available for most of the households primarily because of the scarcity of the financial resources for housing.

3.1.2 Comparison of Yields Among Investment Alternatives

During the rapid economic development in Korea, the yield structure has been advantageous to the informal financial markets and real asset markets because of the inflexible formal interest rates and pervasive inflation. This has profoundly changed the investment behaviors of business and households. [Cole and Park (1980), pp. 272-74.]

First, the reduction in the real interest rates on bank deposits has driven savers away from the banking institutions to the markets for equities and real estates—in particular, land, apartments, and houses—for speculation, and to the informal credit institutions.

Second, the high rate of return to equities that has been maintained by the government in order to cultivate capital markets succeeded in bringing large numbers of savers in the urban areas into those markets. But few firms were willing to raise funds through the equity markets beyond the amounts
required by government because of the low fixed selling price and high financing cost of new issues.

Third, because the banking institutions have not been able to mobilize adequate financial savings to meet the growing demand for bank loans, small and medium firms had to turn to the informal credit markets or to large exporters.

Fourth, large corporations with access to international money and capital markets have been borrowing heavily from abroad, even though they were the relatively favored borrowers at domestic financial institutions. Excessive foreign-capital inflows have played havoc with short-term monetary management and accelerated inflation, which in turn, depressed the real interest rate further and consequently heated up real-estate speculation.

In terms of statistics, Table 3.2 shows that during the years between 1963 and 1981 wholesale prices increased by 14.9% per year while the average formal interest rate (for time deposits in formal sector) was 18.8 percent. In comparison with the 48.1 percent of annual average interest rate in curb market during the same period, this formal interest rate barely covers the inflation rate.

The highest interest rate of saving in formal institutions is for Worker's Asset Formation Deposits, which bears an average 22-percent interest rate per year. The incentives for saving come from the unique advantage of each type of savings. For example, the National Housing Pre-exemption Subscription Deposit Plan is required in order to buy publicly-supplied low-cost housing.
### TABLE 3.2

**MAJOR ECONOMIC INDICES IN KOREA (1963-81)**

<table>
<thead>
<tr>
<th>Year (19')</th>
<th>Wholesale Price Increase (% Increase) (A)</th>
<th>Annual Interest Rates (%)</th>
<th>Annual Growth (%)</th>
<th>Annual Mortgage Int. Rates (H)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal (B)</td>
<td>Real (C)</td>
<td>Curb Market Real (D)</td>
<td>GNP Real (E)</td>
</tr>
<tr>
<td>63</td>
<td>18.6</td>
<td>15.0</td>
<td>-3.0</td>
<td>52.4</td>
</tr>
<tr>
<td>64</td>
<td>30.0</td>
<td>15.0</td>
<td>-11.5</td>
<td>61.4</td>
</tr>
<tr>
<td>65</td>
<td>9.5</td>
<td>18.8</td>
<td>7.8</td>
<td>58.8</td>
</tr>
<tr>
<td>66</td>
<td>8.6</td>
<td>30.0</td>
<td>19.7</td>
<td>58.7</td>
</tr>
<tr>
<td>67</td>
<td>6.2</td>
<td>27.6</td>
<td>19.6</td>
<td>56.4</td>
</tr>
<tr>
<td>68</td>
<td>8.1</td>
<td>24.0</td>
<td>14.7</td>
<td>55.9</td>
</tr>
<tr>
<td>69</td>
<td>6.2</td>
<td>22.8</td>
<td>15.6</td>
<td>57.2</td>
</tr>
<tr>
<td>70</td>
<td>8.7</td>
<td>22.2</td>
<td>12.4</td>
<td>50.8</td>
</tr>
<tr>
<td>71</td>
<td>8.4</td>
<td>15.7</td>
<td>6.7</td>
<td>46.3</td>
</tr>
<tr>
<td>72</td>
<td>12.9</td>
<td>12.6</td>
<td>-0.3</td>
<td>38.9</td>
</tr>
<tr>
<td>73</td>
<td>6.7</td>
<td>14.8</td>
<td>7.6</td>
<td>39.2</td>
</tr>
<tr>
<td>74</td>
<td>35.1</td>
<td>15.0</td>
<td>-14.9</td>
<td>37.6</td>
</tr>
<tr>
<td>75</td>
<td>23.6</td>
<td>15.5</td>
<td>-6.6</td>
<td>41.3</td>
</tr>
<tr>
<td>76</td>
<td>11.4</td>
<td>16.2</td>
<td>4.3</td>
<td>40.5</td>
</tr>
<tr>
<td>77</td>
<td>8.5</td>
<td>16.7</td>
<td>7.6</td>
<td>38.1</td>
</tr>
<tr>
<td>78</td>
<td>11.1</td>
<td>16.5</td>
<td>4.9</td>
<td>41.7</td>
</tr>
<tr>
<td>79</td>
<td>17.2</td>
<td>18.6</td>
<td>1.2</td>
<td>-</td>
</tr>
<tr>
<td>80</td>
<td>32.9</td>
<td>23.0</td>
<td>-7.4</td>
<td>-</td>
</tr>
<tr>
<td>81</td>
<td>20.3</td>
<td>19.3</td>
<td>-0.8</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>(63~81)</sup>

<table>
<thead>
<tr>
<th>Avg.</th>
<th>14.9</th>
<th>18.9</th>
<th>4.0</th>
<th>48.1</th>
<th>8.7</th>
<th>30.4</th>
<th>22.3</th>
<th>18.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SD)</td>
<td>(9.3)</td>
<td>(4.8)</td>
<td>(10.0)</td>
<td>(8.5)</td>
<td>(4.7)</td>
<td>(15.2)</td>
<td>(9.9)</td>
<td>(3.0)</td>
</tr>
</tbody>
</table>

<sup>(72~81)</sup>

<table>
<thead>
<tr>
<th>Avg.</th>
<th>18.0</th>
<th>16.8</th>
<th>-0.4</th>
<th>39.6</th>
<th>8.0</th>
<th>22.6</th>
<th>22.3</th>
<th>18.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SD)</td>
<td>(9.9)</td>
<td>(2.9)</td>
<td>(7.3)</td>
<td>(1.6)</td>
<td>(6.0)</td>
<td>(15.2)</td>
<td>(9.9)</td>
<td>(3.3)</td>
</tr>
</tbody>
</table>

**NOTE:**
3. Real interest rates (C): 100[(100+B)/(100+A)-1].
4. Land prices (F): (for major cities)
   *KRIBS, Housing Data Hand Book*, pp. 362-94.
The combined effect of rapid urbanization and income growth without proper investment alternatives results in pervasive housing and real estate speculation. Thus, real estate has been one of the most profitable investment alternatives.\(^5\) During the latter half of 1970's when housing speculation has been at its peak in many cities, housing prices increased more than 40% per year [KNHC Survey]. In spite of the housing boom in response to the exploding speculative demand in the late 1970's, the homeownership ratio did not catch up with household formation and in fact deteriorated in terms of homeownership ratio.\(^6\) [See Table 3.3.]

However, the number of total households in 1980 is larger than that in 1970 by 36.4% (nation) and by 68.5% (Seoul), respectively. Therefore, the primary reason for the housing shortage is the rapid household formation partly due to the baby boom after the Korean War (1950-53) and partly due to the high rate of rural-to-urban migration.\(^7\) These newly formed households usually have little wealth, so they have mostly settled down in the rental sectors.
TABLE 3.3

HOUSEHOLD DISTRIBUTION (%) BY TENURE (1970, 1980)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner Occupier</td>
<td>63.5</td>
<td>58.7</td>
<td>46.0</td>
<td>44.5</td>
</tr>
<tr>
<td>Chonsei</td>
<td>17.4</td>
<td>23.9</td>
<td>38.5</td>
<td>37.9</td>
</tr>
<tr>
<td>Monthly Renter</td>
<td>15.6</td>
<td>15.5</td>
<td>13.8</td>
<td>16.7</td>
</tr>
</tbody>
</table>

(Households: 1,000) (5,863) (8,000) (1,097) (1,848)


3.1.3 Impacts of Financial Structure on Housing Markets

Under rampant inflation and housing price appreciation, housing has been one of the best investment alternatives. As the formal credits for long-term mortgage are limited, one-time full-cash payments are usually required in housing transactions. For an ordinary household to accumulate such a huge asset requires a long time.

The average house-value-to-annual-income ratio is almost five [See Appendix 3] for the homeowners in Seoul. As the formal credits are limited, partial Chonsei renting becomes an important part of the funding for
homeowners in Seoul. As the formal credits are limited, partial Chonsei renting becomes an important part of the funding for homeownership. When one decides to buy a house with Chonsei financing, he usually rents out (in the form of Chonsei) in advance the whole or part of the house to a Chonsei tenant. Among the owners who rent out whole or part of the dwelling unit, the Chonsei deposit from the renters accounts for as much as 57.2% of the purchase price. [KRIHS (1985), p. 233.] By securing ownership, owners can get two benefits: capital gain from housing price appreciation and a hedge against inflation. Landlords who rent out whole or part of the dwelling units with the Chonsei rental arrangements for the purpose of extra income usually take advantage of high interest rates in the curb market. In this case, landlords' risk in the curb market is partially compensated for by housing price appreciation and partially by low vacancy rate in the Chonsei market. When the Chonsei tenants move out, the landlords do not have to call the loan that they have lent in the curb market with the tenant's Chonsei deposit: because of the low vacancy rate, the landlord can easily find another Chonsei tenant who will make another Chonsei deposit.

For the renters, the Chonsei deposit is a relatively safe and high-yielding investment. It is safe because the return of the original deposit is almost guaranteed as long as there are other Chonsei demanders. And, by the Tenants Protection Law of 1981, the Chonsei deposit is legally protected and must be returned prior to other debts. Although they do not actually receive any yields, the Chonsei tenants do not pay the monthly rents, either. Because of the limited credit on housing and high yield on rental deposit, the owner (and the landlord) seems to accept the role of a middleman between Chonsei
tenants and informal financial market.

3.2 Static Equilibrium Prices in Three-sector Tenure Market

As mentioned in the previous section, the Chonsei price is mostly determined by informal loan interest rates and by the rate of housing price appreciation. In this section we will formalize the price relationships in the three-sector tenure market.

3.2.1 User-Cost Approach

Housing differs from other commodities in a number of important ways. The most salient feature of housing is its multi-dimensional nature. A housing unit is a bundle of attributes. These attributes are largely composed of structural characteristics and localization attributes. The structural characteristics are building types, building materials, utilities such as hot bath, flush toilet, piped water and so on. Even with the same structure, the layouts may be different. Localization also includes the quality of neighborhood as well as accessibility to desired trip-destinations. Actual household search and transaction behavior strongly suggests that even modest differences in attribute mixes are important to demand evaluation.

As such, without control for the housing attributes, price comparison may not be meaningful. Thus, in order to compare the prices among three-tenure
sectors, first we need a strong assumption that all dwelling units are homogeneous as to quality. The second assumption we need to make is that the levels of housing consumption utilities for these dwelling units are the same for all tenure types.

The third assumption is that there are no housing price appreciation, depreciation of dwelling units, taxes, or inflation. The opportunity cost of capital is then assumed to be equivalent to curb-market interest rate.9

Now, in our highly abstracted world, each household faces three tenure options: homeownership, Chonsei, and monthly rental. Then, in equilibrium, consumers would be indifferent between owning and renting the house if the user costs of them are equal. Therefore, for a certain period of time horizon--let us say, "n" months--the user costs should be equal among the three tenure choices. For the sake of convenience, the user costs are transformed into the value at the end of the terminal period.10

Between homeownership and monthly rental options, the cost of owning is the opportunity interests on housing investment and should be equal to the opportunity interests on monthly rental payments. Formally,

\[ V(1+ic)^n - V = R(1+ic)^{n-1} + R(1+ic)^{n-2} + ... + R \]

where \( V \) is the value of the house,
\( R \) is monthly rent,
i\( c \) is (nominal)11 curb market interest rate (i\( c \)>0).
\[ \Rightarrow V[(1+ic)^n - 1] = \frac{R}{ic} [(1+ic)^n - 1] \]

\[ \Rightarrow V = \frac{R}{ic} \] \hspace{1cm} \text{equation (3.1)}

By the same reasoning for Chonsei and monthly rentals,

\[ \frac{R}{ic} \] \hspace{1cm} \text{equation (3.2)}

where \( C \) is the amount of Chonsei deposit.

From equations (3.1) and (3.2), house value \( (V) \) should be equal to the amount of Chonsei deposit \( (C) \). However, this is not true in reality. The current level of Chonsei is smaller than the house value, the maximum of which is around 75\% of the market value of the house. As stated in the previous section, this is believed to be due to the capital gains from housing investment accruing to the house owner but not to the Chonsei depositor.

Now let us relax the initial assumption and allow housing price appreciation. Then the left hand side of the equation (3.1) includes the capital gains:
\[
V[(1+ic)^n - 1] - V[(1+ih)^n - 1] = \frac{R}{ic} [(1+ic)^n - 1]
\]

\[\Rightarrow V = \frac{R}{ic} \frac{[(1+ic)^n - 1]}{(1+ic)^n - (1+ih)^n} \text{ ........................................(3.3)}\]

where "ih" is the rate of housing price appreciation."^{12}\]

By using the Taylor series, we get from equation (3.3);

\[
V = \frac{R}{ic} \frac{(1+nic) - 1}{(1+nic) - (1+nih)}
\]

\[\Rightarrow \frac{R}{ic - ih} \text{ .........................................................(3.4)}\]

Between Chonsei and monthly rental, equation (3.2) still holds. From equations (3.2) and (3.4), we have three unknown variables: V, R, and C. If the market value of housing is given, say it is equal to construction and land costs, the following relationships hold:

\[V \equiv \text{Construction and Land Costs} \text{ ........................................(3.5)}\]
\[ R = (ic - ih) V \]  \hspace{1cm} (3.6)

\[ \frac{R}{ic} = (1-h/ic) V \]  \hspace{1cm} (3.7)

The equations from (3.5) to (3.7) mean that the levels of rent and Chonsei deposit should decrease by housing price appreciation. Although these relationships are derived from a long-run perspective, they also imply an instant moving equilibrium.\(^{13}\) The relationships in equations (3.5), (3.6), and (3.7) will be tested with our survey data in the following sections.

3.2.2 Hedonic Estimation of the Prices

In order to test empirically the relationship among rent, Chonsei, and house value established in the previous section, we need first to control for the housing quality. It may be asked why we do not use average prices of the housing in each sector. As we can see in Appendix 3, there are great differences in the average attributes among the three sectors. Therefore, we need hedonic equations to control for the housing quality.

Because of the high costs of transforming housing bundles, the prices of individual attributes vary jointly in a nonlinear way. Indeed, in the housing literature there has been a great deal of attention paid empirically to the joint pricing problem, and the literature on hedonic housing prices is voluminous. [Quigley (1982)]. The correct interpretation of these hedonic functions was
widely misunderstood until the work of Rosen (1974) appeared. Rosen's study makes a rigorous analysis of the relationship between the offer functions of suppliers, the bid functions of the demanders and the hedonic structure of prices. Rosen suggests an empirical procedure for estimating the compensated demands of consumers.

One major criticism is that it is uncertain whether a hedonic price function represents the demand or supply function. Since neither supply nor demand curves are observable, the estimated hedonic price is usually interpreted as the path of market equilibria. Regarding the functional form of hedonic equations, Cassel and Mendelsohn (1985) argue that leaving out the interaction terms from the Box-Cox formula, as almost all hedonic studies do, would give misleading information about the true functional form of the model. However, they recognize the difficulty in estimating the traditional Box-Cox functional form due to the non-linear transformation. Because of this non-linear relationship, the functional forms chosen for estimating supply and demand relationships must be consistent with an explicit production function of producers or with a utility function of consumers in order to make any quantitative statements about market behavior [Murray (1983)].

Diamond and Smith (1985) also assert that because of non-linearity the hedonic price function for housing is not properly estimable even with the method suggested by Rosen (1974).

Keeping in mind the controversies over the functional forms of hedonic equations as discussed above, we perform the linear regressions of prices (housing price, Chonsei, and monthly rent) of the three-tenure sectors against
various housing attributes, depending upon data availability.

As a representative of the structural quality of housing, we have included five explanatory variables: number of bedrooms, number of living rooms, modern kitchen, hot bath, and flush toilet.\textsuperscript{15} The last four variables are dummy variables. As for the location of the housing, we have included two explanatory variables: new development area (dummy) and time-distance to bus stop or subway station.\textsuperscript{16}

Declining Chonsei renters are classified as monthly renters because monthly rent is deducted from the original Chonsei deposit. The overall fit of the regression seems to be good. [See Table 3.4.] The signs of the coefficients are generally as expected. But the coefficients of the number of living rooms and the flush toilet for the monthly renters are somewhat puzzling. By examining the simple correlations between each of these independent variables for the monthly renters, we find that hot bath shows high correlation (about 0.6) both with number of living rooms and with flush toilet. Therefore, the unexpected sign might be related to this multicollinearity.

Also notable in Table 3.4 are the magnitudes of difference in coefficients across tenure types although the dependent variables are not the same: one is housing price and the others are Chonsei and monthly rent.
### TABLE 3.4

**HEDONIC REGRESSION (LINEAR): SEOUL (1982)**

<table>
<thead>
<tr>
<th>Model Independent Variables</th>
<th>Exclusive Owner (t)</th>
<th>Chonsei Renter (t)</th>
<th>Monthly Renter (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-487.9</td>
<td>75.34</td>
<td>5.430</td>
</tr>
<tr>
<td></td>
<td>(-5.15)</td>
<td>(6.03)</td>
<td>(7.66)</td>
</tr>
<tr>
<td>Number of bedrooms</td>
<td>583.2</td>
<td>134.6</td>
<td>0.6434</td>
</tr>
<tr>
<td></td>
<td>(24.70)</td>
<td>(19.39)</td>
<td>(1.32)</td>
</tr>
<tr>
<td>Number of living rooms</td>
<td>199.2</td>
<td>6.848</td>
<td>-0.6713</td>
</tr>
<tr>
<td></td>
<td>(2.60)</td>
<td>(0.62)</td>
<td>(-1.57)</td>
</tr>
<tr>
<td>Modern kitchen</td>
<td>72.03</td>
<td>70.04</td>
<td>1.361</td>
</tr>
<tr>
<td></td>
<td>(0.93)</td>
<td>(5.23)</td>
<td>(1.34)</td>
</tr>
<tr>
<td>Hot bath</td>
<td>127.5</td>
<td>7.689</td>
<td>9.819</td>
</tr>
<tr>
<td></td>
<td>(1.76)</td>
<td>(0.67)</td>
<td>(14.46)</td>
</tr>
<tr>
<td>Flush toilet</td>
<td>310.7</td>
<td>33.71</td>
<td>-0.9020</td>
</tr>
<tr>
<td></td>
<td>(8.14)</td>
<td>(3.99)</td>
<td>(-1.84)</td>
</tr>
<tr>
<td>New development</td>
<td>-315.4</td>
<td>-64.49</td>
<td>-1.536</td>
</tr>
<tr>
<td></td>
<td>(-6.79)</td>
<td>(-6.49)</td>
<td>(-3.34)</td>
</tr>
<tr>
<td>Distance to bus or subway</td>
<td>-12.87</td>
<td>-0.8132</td>
<td>-0.09894</td>
</tr>
<tr>
<td></td>
<td>(-2.77)</td>
<td>(-0.75)</td>
<td>(-1.78)</td>
</tr>
<tr>
<td>R²</td>
<td>.75</td>
<td>.73</td>
<td>.86</td>
</tr>
<tr>
<td>(No. of observations)</td>
<td>(398)</td>
<td>(353)</td>
<td>(51)</td>
</tr>
</tbody>
</table>

**NOTE:**
1) Modern kitchen, Flush toilet, and New development are (1,0) dummy variables.
2) Hot bath: 2-hot, 1-cold, 0-none
3) For declining Chonsei, the imputed rent is established as R = Sum[(A-Dt)i+D]/t,
   where A is original deposits and D is monthly deductions. (i=0.03).
3.2.3 Comparison of Theory and Empirical Results

Although there are many problems in direct interpretation of the individual coefficients of the estimated results in Table 3.4, we are interested only in the overall goodness of fit so that we can compare the housing prices among three tenure types. In order to compare the prices correctly, we need to control the quality of housing because of the difference in average housing qualities. By the examination of Appendix 3, we can recognize the systematic difference of the housing quality in the three sectors. That is to say, the average quality of owner-occupied housing is higher than that of Chonsei, and the average quality of Chonsei is higher than that of the monthly rental. Thus, for the correct comparison, we need to have a typical house with standard attributes.\(^1\) In the construction of a standard house we try to make it close to the average quality of Chonsei rental housing so that the errors in the other two sectors can be minimized. The standard house is therefore defined as having the following attributes:

\[(\text{Attributes of Standard House})\]

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bedrooms</td>
<td>1.7</td>
</tr>
<tr>
<td>Number of living rooms</td>
<td>0.5</td>
</tr>
<tr>
<td>Modern kitchen</td>
<td>0.3</td>
</tr>
<tr>
<td>Hot bath</td>
<td>0.6</td>
</tr>
<tr>
<td>Flush toilet</td>
<td>0.4</td>
</tr>
<tr>
<td>New development</td>
<td>0.5</td>
</tr>
<tr>
<td>Distance to bus (minutes)</td>
<td>10</td>
</tr>
</tbody>
</table>

55
### Table 3.5

**ESTIMATED AND THEORETICAL PRICES: ic=0.033, ih=0.0186**

<table>
<thead>
<tr>
<th></th>
<th>Estimated Prices (SE)</th>
<th>Theoretical Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>V (Housing Price)</td>
<td>539.1 (414)</td>
<td>701.9</td>
</tr>
<tr>
<td>C (Chonsei Deposit)</td>
<td>306.3 (83)</td>
<td>306.3</td>
</tr>
<tr>
<td>R (Monthly Rent)</td>
<td>10.37 (1.24)</td>
<td>10.12</td>
</tr>
</tbody>
</table>

**NOTE:**
1) SE: Standard errors of estimations.
2) Estimated values are fitted values of the standard housing in Table 3.4.
3) Theoretical values are from equations (3.6) and (3.7).
4) All prices are in 10,000 won.

Estimated and theoretical prices of this standard housing for each tenure are presented in Table 3.5. The estimated prices are obtained by substituting the values of the attributes of the standard housing into the regression equations in Table 3.4. The theoretical prices are calculated from equations (3.5) and (3.6) using parameter values based upon Table 3.2: ic=0.033 and ih=0.0186. As our standard housing is set close to the average quality of housing for the Chonsei renters, we calculate the housing price and the rent level by considering the Chonsei price as given from the estimation.

The theoretical rent shows a surprisingly small difference from the estimated (empirical) rent, while the two (estimated and theoretical) housing prices are rather far apart: a 30% difference from the estimated value. With a close examination, however, we can find that the theoretical housing price is
still within the range of standard error.\textsuperscript{19}

In spite of its static nature and high level of abstraction, our theoretical model is quite relevant in explaining the empirical results. What is important is the direction of the estimated housing price for the homeowners; that is, the empirical price is smaller than the theoretical one. There can be various explanations for this result. The primary reason for this might be our restrictive assumption of equal utility among three tenure types. Because the utility level is fixed regardless of tenure, would-be homeowners may not be willing to pay as much as the theoretical equilibrium price. The second reason may be the credit constraints. The credit constraints, and the associated high threshold between rental and homeownership sector, may enhance the privilege of homeownership.\textsuperscript{20}

To sum up, we have found two important facts from our empirical tests: 1) The housing prices among three tenure sectors in Korea are largely determined by (housing and non-housing) capital costs. 2) Chonsei deposits and monthly rents are well based upon the economic principles, while the homeownership prices are based upon other institutional factors as well as economic principles.

3.2.4 Aggregate Interpretation and Further Questions

In spite of the limitations of the various simplified assumptions and abstractions from the supply side, the model shows a good empirical
relevance. By restricting our attention to the demand side we are actually attempting to suggest that the demand side is imprinting itself upon the observed market. It may be argued that, where the housing market is wildly changing as shown by Table 3.2, the equilibrium prices may not be very meaningful. However, we can recognize that there does seem to be a dependable relationship among the three tenure markets based on the difference in the user-cost of capital. In a situation of the chronic shortage of housing stock and rapid urbanization, housing prices would be primarily determined by the force of demand. The supply of rental housing--partial Chonsei or monthly rental--is more flexible than that of owner-occupied housing because, with or without minor conversion of the existing houses, partial room-renting is always possible. Therefore, the changes in aggregate demand and supply of owner-occupied housing have a ripple effect on the rental market where a disequilibrium can be adjusted through the more flexible supply of rental housing.

Thus far, we have treated the housing market under equilibrium price conditions. Two questions may be raised. First, if the housing market is governed by these equilibrium prices, why do some households choose ownership while others choose Chonsei or monthly rental? The answer seems to lie in the random variations in utility of each household, in differential access to credit, and in the differential rates of housing price appreciation. Second, why is there a strong preference for homeownership in Korea? This is largely related to the owner's flexibility in consuming the housing services, as well as in the formal right to make various tenure contracts, conversions, and partial room-renting.
These questions will be dealt with in the dynamic framework of life-cycle housing consumption in chapter VI.

3.3 Summary

Housing credit in Korea has been constrained and is not easily accessible by most households. In comparison with other investment alternatives, investments in curb market and in housing have been most profitable. However, because of limited long-term formal mortgages, normal households need to pay the full price of housing at the time of purchase. Through the Chonsei system, prospective homeowners can easily mobilize the funds for the purchase of housing, and renters can pay the (imputed) rent by investing the Chonsei in the curb market through their landlords.

After the survey of the existing financial systems and the explanation of the development of Chonsei in Korea, a static relationship among the prices in the three-sector market was established by employing the curb market interest rate and the rate of housing price appreciation. The empirical tests involved use of an hedonic regression to control for the housing quality. The tests fairly supported the relevance of the theoretical model. Interpretation of our model in the aggregate housing market has been that the housing price is primarily driven by the changes in the aggregate demand from the rapid increase in income and in the level of urbanization. It was also argued that any disequilibrium that may exist in the owner-occupied sector
can be adjusted in the rental sector by a more flexible supply. Although our study, in this chapter, indicates the importance of the capital costs in housing decision, the actual threshold of homeownership is still high because of credit constraints and limited wealth of the newly-formed households. In the next chapter we will explore the question of how the credit constraints affect the housing demand behavior among two groups of demanders: the credit-bound and the non-bound.
ENDNOTES OF CHAPTER III

1. The unregulated financial markets in Korea are divided into five types. Most of the time, the curbmarket is used interchangeably with unregulated market. The five types are: 1) Rudimentary private credit market  2) The Kye market (the rotating credit club) 3) Informal bill (commercial paper) market 4) Curb market (large-scale informal credit broker's market) 5) The private financial companies for consumers and small enterprizes.


5. As of 1983, housing yields 23.3%, gold 11.0%, stock 8.0%, and holding of other goods (CPI) yields 4.8% per year: KRIHS, Housing Policy Development Study, Korea National Housing Corporation, 1983, p. 125.

6. In spite of the housing boom during the 1970's, total housing supply was slowed down by the large-scale demolitions of existing housing stock for infrastructural development and by the strict restriction on land conversions.

7. When people migrate from rural areas to the cities, they usually leave their parents and younger siblings behind, and thus form new households in the cities.

8. For extensive discussion, please refer to:

9. By this we mean an abstraction from any risk factors. This abstraction
may raise a serious bias; however, later we also assume that the housing price appreciation rate is known with perfect certainty. To the extent that these two are competitive in investment decisions, we hope that the risk and uncertainty facors would control each other.

10. Monthly rents are assumed to be paid at the end of each month. In fact, we are also asssuming that consumer's subjective rate of time preference has neutral effects on our model.

11. We have chosen nominal rates for our empirical analysis because the rental contracts are usually made on a nominal basis and because nominal data are easily available without any modifications.

12. In chapter VI, we use the parameter "b" for the real rate of housing price appreciation.

13. The rent equation (3.6) also can be derived by applying continuous growth rates in a continuous time dimension:

\[
V(T) = \int_{T}^{\infty} p(t) H'[K(t)] \exp\left[-\int_{T}^{t} r(z) \, dz\right] dt
\]

where, \( V(T) \): present value of future imputed rental income from \( T \)
\( p(t) \): price of a unit of housing service at \( t \)
\( H'[K(t)] \): (\( =dH/dt \)) stream of housing services with varying \( t \)
where \( K(t) \) is housing capital, and \( H(t) \) is the level of housing services
\( r(z) \): interest rate at time \( z \).

\[\Rightarrow \quad V(T)H'[K(T)] = [r(T) - p/p] V(T)\]

\[\Rightarrow \quad \text{rent} = [ic-ih] V \quad (\text{with the notations used in the text}).\]

Therefore, the equation (3.6) is also interpreted as a moving equilibrium at any instant time \( T \).
14. The formal Box-Cox model is as follows:

\[ V(a) = c + d_i z_i(b) + \sum_{j \neq i} f_{ij} z_i(b)z_j(b) \]

where, \( V \) : housing price
\( a, b \) : parameters
\( c, d, f \) : coefficients
\( z \) : housing attributes.

If we leave out the interaction term (the third term of above equation), the function can be linear, semi-log, or double-log forms:

\[
\frac{V^{a-1}}{a} \quad \text{if } a \neq 0, \\
\frac{z^{b-1}}{b} \quad \text{if } b \neq 0, \\
V(a) = \ln(V) \quad \text{if } a = 0. \\
z(b) = \ln(z_i) \quad \text{if } b = 0.
\]

15. It is regrettable not to be able to use living space as one of the independent variables. Such data do not exist for Chonsei and monthly renters.

16. These may not be complete in terms of socio-economic neighborhood character; however, the newly-developed areas in Seoul are substantially different from the already developed areas in terms of infrastructure and mixture of housing types—for example, less paved road and more apartments.

17. Because of the uncaptured attributes of housing in the model, we must admit that there are variations in price even for this standard housing.

18. The value of "ic" was obtained by dividing the average curb market interest rate during 1972-81 (Table 3.2, column D) by 12 months, and the value of "ih" was from the average housing price appreciation rate during 1972-81 (same table column G).
19. Please note that these are standard errors of regression, not the prediction errors. As the predicted values are rather far apart from the mean values (own: 1832, renter: 5.78), the actual prediction error will be greater than these values. For the technical details about prediction errors, please refer to: R. Pyndick and D. Rubinfeld, *Econometric Models and Economic Forecasts* (2nd ed.), New York: McGraw-Hill, 1981, pp. 203-15.

20. In chapter VI, we integrate this price gap into a dynamic simulation model in the form of premium of rental costs over ownership.

21. Other parameters such as consumer's subjective discount rate and bequest motives may be also critical in housing tenure choice. [See chapter VI.]

22. Rothenberg, *op. cit.*, 1977. He includes this special consumption utility of homeownership in his analysis.
CHAPTER IV

A THEORY OF HOUSING CHOICE UNDER CREDIT CONSTRAINTS

In the previous chapter, we established the static relationship between Chonsei, monthly rent, and the house value. The major tenet of the analysis was that the equilibrium prices of the three sectors are based on the opportunity capital cost and housing price appreciation. In this chapter, we formalize the relationship between assets and housing choice under credit constraints.

4.1 Basic Arguments and Questions

One of the fundamental features of housing is that it costs a lot to own. In the absence of credit constraints, each individual who wants to own a home does not have to pay the full amount of housing price at one time. A large portion of the housing price can be financed based on the past credit history and the prospective earnings of the individual, with the house itself as collateral. Under this circumstance, housing choice can be directly geared to the flow of income and the level of accumulated assets. Thus, correct estimates of housing demand with respect to income and assets may be obtained.
Under credit constraints, however, housing choice undergoes a different process: housing loans are not easily obtained, or they cover only a small portion of the purchase price. Under the credit constraints, households can be divided into two groups: those for whom credit constraints are, or are not, binding. If the optimum level of (homeownership) housing price is smaller (larger) than the sum of accumulated assets and available credit, then the credit constraints are binding (non-binding) for that specific household. For those who are credit-bound, the credit constraints force them to choose either a non-ownership tenure or homeownership with lower-than-optimum level of housing consumption. Since, for this group, housing choice is influenced by the level of accumulated assets, it is not difficult to obtain meaningful behavioral implications for them.

Non-bound households, however, can choose an optimum level of housing, and the behavioral implications in response to the changes in income and assets can be obtained effectively. The critical questions are: what is the optimum level of housing consumption, and when it is bound by the credit constraints? In order to answer these questions, we construct a static model of housing demand under credit constraints and test it with empirical data. Our model in this chapter is based upon a static optimization framework and will be further extended to inter-temporal dynamic optimizations in chapter VI.
4.2 The Model

From the time of housing choice, the budget condition is given by the following equation:

\[ y + i(A-H+D) - rD = c \] ..................................................(4.1)

where \( y \): income
i: return on assets
r: interest rate on housing loan
A: total accumulated assets at the time of housing decision
H: housing price
D: housing loan
c: non-housing consumption.

Here, we are abstracting from the rate of consumer's time preference or the rate of housing price appreciation. Housing overconsumption is penalized by the interest on debt and under-consumption is rewarded by the return on assets: these effects are assumed to cancel each other so that the relationship of (4.1) holds in the long run.

For the sake of simplicity, let us assume that the lending and borrowing interest rates are the same: \( i = r \). Then equation (4.1) becomes:

\[ y + i(A-H) = c \] .................................................................(4.2)

Under this budget condition, the problem is to maximize the utility of housing and non-housing consumption under credit constraints:
\[ \text{Max } U(H,c) = \text{Max } U[H, y+i(A-H)] \]

subject to

\[ H \leq A + D_{\text{max}} \]

where, \( U \): consumer's utility
\( D_{\text{max}} \): Maximum available housing loan.

The available housing loan is usually closely related to the house value. Therefore it would be more realistic to assume that the maximum available loan-to-value ratio is "a."

Therefore (4.4) can be transformed into:

\[ H \leq A + aH \]

\[ \Rightarrow H \leq A / (1-a) \]

where \( a \) is maximum available loan-to-value ratio.

Equation (4.5) says that, if there are no credit constraints \( (a=1) \), then a household can choose any amount of housing services (and thereby prices) that maximizes the utility function; if the credit constraints are absolutely binding \( (a=0 \text{ and } A \text{ is small enough}) \), then the household has to settle at a level of housing price (of ownership consumption) that is equal to the amount
of accumulated assets.

Our problem is to maximize (4.3) subject to (4.5). Graphically the feasible region can be shown as the shaded area in Figure 4.1, where H* represents the optimum point without binding credit constraints and Hc is the corner solution with binding credit constraints. If the constraints are binding (H*≥Hc), then the corner solution (Hc) is optimal. If not (H*<Hc), then the global optimum (H*) can be obtained.

![Figure 4.1 Feasible Region of Housing and Non-housing Consumption](image)

Figure 4.1 Feasible Region of Housing and Non-housing Consumption
4.3 Comparative Static Analysis and Its Implications

With a positive change in the loan/value ratio—that is, from "a" to "a+da"—the feasible region expands upward because it affects only the constraint (4.5). [See Figure 4.2.] Therefore the chance of getting optimum (H*) is obviously increasing.

\[ H = \frac{y}{i} + A \]
\[ \frac{dA}{(1-a)^2} \]
\[ H^* \]
\[ \rightarrow Hc' \]
\[ Hc = A + D_{max} = \frac{A}{(1-a)} \]

Figure 4.2 The Effect of Positive Changes in Loan-to-Value Ratio (a)

With a positive change in assets—that is, from "A" to "A+dA"—the feasible region expands to the right-upward direction because it affects both (4.3) and (4.5). [See Figure 4.3.] Thus, the chance of getting a new optimal solution (H*) is increased.
With a positive change in income—that is, from "y" to "y+dy"—the feasible region is expanding only to the right because it expands only the budget frontier of equation (4.3) while leaving the credit (and asset) conditions of equation (4.5) unchanged. [See Figure 4.4.] Note that we are not assuming any meaningful relationship between income and assets in this static model: income and assets are independent of each other in our model here. This major weakness will be overcome later in chapter VI. Under the assumption that the level of assets is not entirely dependent on the level of income, our theoretical model implies that the chance of getting a global optimal solution is decreasing by the positive change in y.
The major implication of this comparative static analysis is that, at a given level of accumulated assets, higher income people have a higher chance of being bound by credit constraints than do lower income people. This might explain why the income elasticity of housing consumption is less than unity in the usual estimations.

From the examination of the graphic analysis, one may quickly notice that the constraints may not be binding, depending upon the level of the loan/value ratio (a). That is to say, if the value of $A/(1-a)$ is bigger than the highest possible level of housing price, namely the value of $(y/i+A)$ given budget conditions, then, the constraint is simply non-binding. [See Figure 4.5.] Let us call the minimum value of "a" which makes the corner solution...
(Hc) the same as (or above) the intercept of vertical (housing consumption price) axis by the budget frontier as the higher bound of non-binding credit constraints.

\[ \text{Hc} = A + D_{\text{max}} = \frac{A}{1 - a} \]

\[ y - iA[a/(1-a)] \quad y + iA \]

Figure 4.5 Non-binding Condition: Higher Bound of "a"

Formally, the credit constraints are non-binding if:

\[ \frac{A}{1 - a} \geq \frac{y}{i} + A \]

\[ \Rightarrow a \geq \frac{y}{y + iA} = \frac{1}{1 + i(A/y)} \]

Note that the higher bound of non-binding credit constraints is dependent upon the interest rate and the asset/income ratio. Table 4.1 shows the values of the higher bound of the loan/value at various interest rates and
the asset/income ratios. Figure 4.6 also shows the shifts of the higher bound curve in response to the changes in the interest rates.

**TABLE 4.1**

<table>
<thead>
<tr>
<th>A/y Ratio</th>
<th>i = 0.05</th>
<th>i = 0.1</th>
<th>i = 0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>1</td>
<td>0.95</td>
<td>0.91</td>
<td>0.83</td>
</tr>
<tr>
<td>5</td>
<td>0.8</td>
<td>0.67</td>
<td>0.5</td>
</tr>
<tr>
<td>10</td>
<td>0.67</td>
<td>0.5</td>
<td>0.33</td>
</tr>
<tr>
<td>20</td>
<td>0.5</td>
<td>0.33</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Figure 4.6 Higher Bound of "a" and A/y Ratio

Table 4.1 is based upon the annual interest rate and annual income. Note that in Table 4.1 the variable y (income) and the variable i (interest rate) should be based upon the same time period. Thus, in Table 4.1, if the
annual interest rate is 10%, then for the households with the asset-to-annual-income ratio of 5, the higher bound is 0.5. That is to say, if the loan-to-value ratio is greater than half of the desired housing (consumption) price, then these households can choose the global optimum level of housing consumption.

4.4 Specific Solutions for Empirical Tests

In this section we will derive specific solutions for (4.3) and (4.5) and determine the lower bound of the binding credit constraint. Without losing generality, let us assume a Cobb-Douglas utility function. Now, the utility function of (4.3) can be rewritten into explicit forms:

$$\begin{align*}
\text{Max } U &= \text{Max } (\alpha \log H + \beta \log c) \\
&\quad \text{s.t. } H \leq A/(1-a) \\
&\quad \text{and } c \leq y + i(A-H)
\end{align*}$$

where, $\alpha$ : marginal utility of housing consumption

$\beta$ : marginal utility of non-housing consumption

The relevant Lagrangian can be expressed as follow:

$$L = \alpha \log H + \beta \log c + \lambda_1[A/(1-a) - H] + \lambda_2[y + i(A-H) - c]$$

where, $\lambda$ : Lagrange multipliers.
The relevant Kuhn-Tucker conditions are:

\[ \frac{\partial L}{\partial \alpha} - \frac{\partial L}{\partial \lambda_1} - \frac{\partial L}{\partial \lambda_2} i \leq 0 \quad \text{........................................................................................................(4.11)} \]

\[ \frac{\partial L}{\partial \beta} - \frac{\partial L}{\partial \lambda_2} \leq 0 \quad \text{........................................................................................................(4.12)} \]

\[ \frac{\partial L}{\partial \lambda_1} = \frac{\partial L}{1-a} - H \geq 0 \quad \text{........................................................................................................(4.13)} \]

\[ \frac{\partial L}{\partial \lambda_2} = y + i (A-H) \geq 0 \quad \text{........................................................................................................(4.14)} \]

\[ c, H, \lambda_1, \lambda_2 \geq 0 \quad \text{........................................................................................................(4.15)} \]

\[ \frac{\partial L}{\partial H} = \alpha - \lambda_1 H - \lambda_2 i H = 0 \quad \text{........................................................................................................(4.16)} \]

\[ \frac{\partial L}{\partial c} = \alpha - \lambda_2 c = 0 \quad \text{........................................................................................................(4.17)} \]

\[ \lambda_1 [A/(1-a) - H] = 0 \quad \text{........................................................................................................(4.18)} \]

\[ \lambda_2 [y + i (A-H) - c] = 0 \quad \text{........................................................................................................(4.19)} \]
From the equations (4.16) to (4.19), we get;

\[
\alpha \frac{\beta \text{i}}{H} \frac{A}{y + \text{i}(A - H)} \frac{1}{1 - \text{a}} = 0 \quad \text{..................................................} \quad (4.20)
\]

Therefore, the solution is either

\[
H_c = \frac{A}{1 - \text{a}} \quad : \text{Corner solution} \quad \text{..................................................} \quad (4.21)
\]

(Binding)

or \[H^* = \alpha \frac{\beta \text{i} + A}{\text{i}} \quad : \text{Global solution} \quad \text{..................................................} \quad (4.22)
\]

(Non-binding)

Keeping in mind that these solutions will be tested in the next chapter, we examine the partial derivatives of the two solutions with respect to assets and income.

For the corner solution of (4.21), we get;

\[
\frac{\partial H_c}{\partial A} = \frac{1}{1 - \text{a}} \quad \text{..................................................} \quad (4.23)
\]
\[ \frac{\partial H_c}{\partial y} = 0 \] .................................................................(4.24)

In the empirical test we expect that the coefficient of the asset is close to unity for the credit-bound group because the partial derivative of housing demand with respect to asset in equation (4.23) will approach unity as the loan-to-value ratio (a) is very small in Korea. The coefficient of income is expected to be very small for the credit-bound group as represented by equation (4.24).

For the non-bound group (global optimum), we obtain the following partial derivatives:

\[ \frac{\partial H^*}{\partial A} = \alpha \] .................................................................(4.25)

\[ \frac{\partial H^*}{\partial y} = \frac{\alpha}{i} \] .................................................................(4.26)

What is interesting in equation (4.25) is that the partial derivative with respect to asset is the same as the marginal utility of housing consumption (\( \alpha \)). The partial derivative with respect to income in (4.26) is simply the ratio of marginal utility of housing consumption to the market interest rate. We also can see the particular relationship between the two partial derivatives;
that is, by dividing equation (4.25) by (4.26) we get;

\[
\frac{\partial H^*}{\partial A} \div \frac{\partial H^*}{\partial y} = i \tag{4.27}
\]

In the empirical test for the non-bound group, we expect that the ratio of coefficients of assets and income to be close to the market interest rates.

Now we are at the position of deriving the lower bound of "a" where credit constraints are non-binding. The credit constraints are non-binding if the general solution is smaller than the corner solution. [See Figure 4.7.]

![Diagram showing Hc Corner and H* General (Global) solutions.]

Figure 4.7 General (global) and Corner Solutions
Formally, if (4.22) < (4.21), then the credit constraints are non-binding:

\[
\frac{\alpha(y + iA)}{i} < \frac{A}{1-a}
\]

\[
\Rightarrow a > \frac{\alpha - (A/y)i(1 - \alpha)}{\alpha[1 + i(A/y)]} = \frac{1 - (A/y)i(1/\alpha - 1)}{1 + (A/y)i}
\]

We will call "a" of equation (4.28) a lower bound of non-binding credit constraints. Table 4.2 shows the lower bound of "a" when the marginal utility of housing consumption (\(\alpha\)) is equal to 0.33. As we can see in Table 4.2, if the asset-to-income ratio is more than 10, then the household does not bound by the credit market conditions.

**TABLE 4.2**

LOWER BOUND OF "a": \(\alpha = 0.33\)

<table>
<thead>
<tr>
<th>(A/y) Ratio</th>
<th>i= 0.05</th>
<th>i= 0.1</th>
<th>i= 0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0.5</td>
<td>0.93</td>
<td>0.86</td>
<td>0.73</td>
</tr>
<tr>
<td>1</td>
<td>0.86</td>
<td>0.73</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>0.73</td>
<td>0.5</td>
<td>0.14</td>
</tr>
<tr>
<td>5</td>
<td>0.4</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Perhaps the most important fact from Table 4.2 is the opposite direction of the movements between interest rate and loan-to-value ratio. In other words, if the interest rate is high, then the loan-to-value ratio needs not to be high in order to avoid the credit constraints.

4.5 Summary and Further Questions

A theory of housing choice under credit constraints was constructed based on the maximization of the consumer's utility subject to housing credit constraints. The comparative static analysis implies that the credit constraints are more binding with the increase in the level of household income especially when the level of asset is not proportionally increasing. The conditions for non-binding credit constraints were derived with respect to the level of the interest rate and the asset-to-income ratio.

The specific solutions provided the theoretical values of the coefficients of income and assets for the credit-bound and the non-bound groups. This static theoretical model showed the specific expected values of, and relationships between, income and assets in the empirical tests. To be sure, there is a basic difference in housing demand behaviors between the two groups; that is, the credit-bound are critically dependent upon the level of accumulated assets and credit availability (such as loan-to-value ratio), while the non-bound are dependent upon the level of income as well as assets maintaining close relationship with the market interest rates.

Several questions about this model may be raised. First, there might be a difference between the interest rates of borrowing (r) and lending (i).
Second, there are likely to be substantial capital gains on housing. Third, the level of assets (A) might be related to the level of income (y). Finally, the time dimension is ignored; that is, if the corner solution is expected at a certain point in time, a household may defer housing purchase until it accumulates enough assets not to be bound by the credit constraints. These questions will be extensively dealt with through a life-cycle model in chapter VI. At hand, however, we will test our theoretical model formulated in this chapter with our empirical data.
1. In Korea, even if a housing loan is available, the loan is actually given to the borrower after the title has been secured. Therefore, if one has insufficient assets for the purchase of housing, he needs to borrow the deficit from curb market to buy the house. But, for the purchase of newly-built housing, one does not have to find such short-term finances because the developer usually arranges the loans.

2. Note that we are using housing price as a proxy for housing consumption. If there are significant housing price appreciations this symmetry will not hold. In chapter VI, we use the size of dwelling unit as a proxy for housing (service) consumption.

3. In chapter VI we assume that these two rates are not equal.

4. This higher bound (i.e., weak conditions) will be lowered later to lower bound (i.e., strong conditions).

5. The other corner, namely the intercept of horizontal (non-housing consumption) axis by the budget frontier may be also optimal depending upon the functional forms of the utility. In this case "a" should be equal to 1: the perfect capital market conditions.

6. The lower bound for these households, as we will discuss later, is in fact zero; that is, they are not bound by any credit conditions.

7. If we regress housing price with the level of assets for the credit bound group in linear form.
CHAPTER V

EMPirical Analysis of Housing Choice Under Credit Constraints

In the previous chapter, we argued that, under credit constraints, the housing choice among credit-bound and non-bound households would show different behavioral patterns. Therefore, it was suggested that special care should be taken in the interpretation of a pooled regression. In this chapter we will examine the empirical relevance of our theoretical model formulated in chapter IV. As argued, empirical tests call for a division of samples into credit-bound and non-bound groups. It was also suggested that we should use the "before-purchase" level of assets with respect to the time of housing decision.

5.1 Sample Selection and Division

Our sample for the empirical study in this chapter is limited to recently-moved first-time homeowners in Seoul. The constraint of recently-moved households is necessary for three reasons. First, the data record respondent's current demographic and economic characteristics.
Because our interest is in the attributes of households at the time of home purchase, we must limit ourselves to the subset of respondents for whom current attributes are most likely to approximate attributes at the time of home acquisition. Second, these households are most likely to provide accurate information on housing prices, financing resources, and loan terms. Third, government policies with respect to housing finance have recently changed considerably in Korea, so by limiting our analysis to recent homebuyers we are examining reasonably current institutional arrangements and financing terms.

The reasons for the \textit{first-time} home buyers are two: first, our survey data record the detailed financial sources\textsuperscript{1} including family assistance only for the first-time home buyers. Second, formal housing credit is mostly restricted to the first-time buyers who have been the primary target group of public housing policy in Korea.

Of the 1,419 residents surveyed in Seoul, first-time buyers are 544 households. Of these first-time buyers, 137 households have bought their house within previous two years (June 1980-June 1982). Of these first-time homeowners, 124 households have specific informations on financial resources used for their first homeownership. The resulting size of this subsamples is quite small, especially when we consider the further division of them into credit-bound and non-bound groups.\textsuperscript{2} However, they offer a fair representation of various socio-economic groups in terms of the distributions of occupation, income, wealth, and education level.

In the further division of the subsamples of recently-moved first-time homeowners into credit-bound and non-bound groups, we use a criterion of the size of residual assets (RES) just after the housing purchase. One may question why we do not use the theoretical conditions of binding constraints
formulated in the previous chapter. Indeed, they are meaningful if we know
the true credit conditions that each household may face. However, we do not
know the true variations in credit accessibility that each household might
have faced. That is to say; the loan information recorded in our survey data
may not reflect the true credit availability because of the difference between
the possible and the realized amount of housing credits. The easiest way to
overcome this problem is to see whether the amount of all the possible
financial resources was greater than the actual housing prices that they have
paid. Therefore, we have adopted the criterion of residual assets for the
division of samples into credit-bound and non-bound groups.

5.2 Estimation of the "Before-Purchase" Level of Assets

One major problem in our empirical analysis is that our survey data do
not have any records on the previous (before-purchase) level of assets for
each household. As mentioned earlier, estimations using the present level of
assets may not correctly reflect the true parameters because of its residual
character after a specific housing decision has been made. In order to
overcome this problem, we calculate the before-purchase level of assets for
each household based on the definitional identity at the time of the housing
decision: the "after-purchase" level of the housing and non-housing assets is
the same as the sum of the "before-purchase" level of the total assets, family
support, and housing debt.
Formally,

\[ H(t) + A(t) = A(t-1) + F(t-1) \]  \hspace{1em} (5.1),

where \( t \): the point of time just after the purchase of the present house,
\( t-1 \): the point of time just before the purchase of the present house,
\( H(t) \): the purchase price of the present house, \( A(t) \): the level of total non-housing assets just after the purchase,
\( A(t-1) \): the level of own assets just before the purchase which includes the rental deposit,
\( F(t-1) \): the total fund from outside the household to purchase a house such as family support and housing debt.

In equation (5.1), the values of \( H(t) \) and \( F(t-1) \) are known from the survey data. For the non-housing asset, our survey contains the data at the time of the survey \((t+1)\), not at the time of housing decision \((t)\). [See Figure 5.1.]

If we make the time-difference between the survey \((t+1)\) and housing decision \((t)\) as small as possible, the difference between \( A(t) \) and the level of assets at the time of survey \([A(t+1)]\) would be minimal. Still, there can be many sources of difference between \( A(t) \) and \( A(t+1) \) such as savings during the period, price appreciation of non-housing assets, and windfalls. Since the data record the amount of monthly savings, we can correct for that as in the equation (5.2); however, we are not able to correct for the price appreciation and windfalls.\(^5\) What we can do is to restrict the sample to the recent buyers so that the magnitude of these effects is as small as possible.
Figure 5.1 Total Asset Change

NOTE: * signifies the known variables from our survey data.

Modifying equation (5.1) by the amount of savings (S) between "t" and "t+1," we get:

\[ H(t) + A(t+1) - S = A(t-1) + F \]

\[ => A(t-1) = H(t) + A(t+1) - F - S \]

where, A(t+1) is present (i.e., at the time of survey) amount of assets, and S is the amount of savings from the time of housing purchase to the time of survey. All the variables except A(t-1) in the equation (4.28) are known from the survey data.
Regarding the criterion of binding credit constraints as mentioned in the previous section, we define a new variable, RES: the residual level of assets just after the housing decision. From equation (5.2);

\[ \text{RES} = A(t+1) - S = [A(t-1) + F] - H(t) \] .................................(5.3)

The two terms in the brackets on the right hand side of equation (5.3) represent the "before-purchase" level of assets \([A(t-1)]\) and all available outside funds, \(F\). If the sum of these two total financial resources is greater than the level of price \([H(t)]\) of the housing that was actually bought, then the household was not bound by credit constraints.\(^6\)

5.3 Non-reduced Form OLS Estimation

With the previous level of assets calculated from equation (5.2), we perform a non-reduced form ordinary least square (OLS) estimation. The dependent variable is the housing price, and the independent variables are (household annual) income, (calculated) previous level of liquid asset \([A(t-1)]\), age of the household head, household size (number of household members), and the years of education of the household head. Formally,

\[ H = f \text{[family income, } A(t-1), \text{other variab'ls]} \] ..............................(5.4)

The results of the linear regression are presented in Table 5.1. One thing that should be noted on this estimation procedure is simultaneity\(^7\); that is, the previous level of asset \([A(t-1)]\) is also an endogeneous variable in the two
simultaneous equations, (5.2) and (5.4). In other words, the \( A(t-1) \) is calculated from the equation (5.2) which contains the dependent variable \( H(t) \) of our regression equation (5.4)\(^{8} \); thus, the error term in (5.4) is not independent, a violation of one of the fundamental assumptions of OLS estimation.

Although great caution is needed in interpretation of the asset variable because of simultaneity problems, Table 5.1 shows a striking difference in the coefficients for all explanatory variables between credit-bound and non-bound groups. In particular, the magnitudes of the coefficients for income and assets for the binding and non-binding cases seem to conform to the results of our expected values based upon our theoretical equations from (4.23) to (4.26).

Table 5.2 shows the detailed information of the comparison between theoretical and empirical values. Although there are some discrepancies between the two (theoretical and empirical) values, the general trend confirms the relevance of our model. If we look at the last row of Table 5.2, we can see the ratio of the two (income and asset) coefficients is within the feasible range of interest rates.

For the credit-bound group, it might be misleading to conclude that theoretical model is wrong because of the huge difference between the theoretical and empirical values for the income variable. What we argued in the previous chapter is that the level of accumulated asset is the predominant variable in housing choice for the credit-bound group. The very high \( t \)-value for \( A(t-1) \) in Table 5.1 (for the credit-bound)--although this is greatly reduced in later estimations--implies that the level of asset is by far the most critical variable in housing demand among the credit-bound. The slight difference of the two (theoretical and empirical) values of the asset may be
<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Non-bound (RES&gt;0)</th>
<th>Credit-bound (RES≤0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.72</td>
<td>-158</td>
<td>421</td>
</tr>
<tr>
<td></td>
<td>(0.0)</td>
<td>(-0.2)</td>
<td>(1.2)</td>
</tr>
<tr>
<td>Income</td>
<td>0.793 [0.25]</td>
<td>0.561 [0.19]</td>
<td>0.736 [0.22]</td>
</tr>
<tr>
<td></td>
<td>(5.0)</td>
<td>(2.5)</td>
<td>(4.7)</td>
</tr>
<tr>
<td>A(t-1)</td>
<td>0.453 [0.36]</td>
<td>0.192 [0.20]</td>
<td>0.973 [0.67]</td>
</tr>
<tr>
<td></td>
<td>(8.9)</td>
<td>(3.5)</td>
<td>(14.6)</td>
</tr>
<tr>
<td>HHH Age</td>
<td>-1.18</td>
<td>6.67</td>
<td>-10.1</td>
</tr>
<tr>
<td></td>
<td>(-0.1)</td>
<td>(0.5)</td>
<td>(-1.3)</td>
</tr>
<tr>
<td>HH Size</td>
<td>113</td>
<td>-9.93</td>
<td>36.3</td>
</tr>
<tr>
<td></td>
<td>(1.9)</td>
<td>(-0.1)</td>
<td>(0.7)</td>
</tr>
<tr>
<td>Yrs. of Education</td>
<td>16.0</td>
<td>80.7</td>
<td>-3.17</td>
</tr>
<tr>
<td></td>
<td>(0.7)</td>
<td>(2.3)</td>
<td>(-0.2)</td>
</tr>
<tr>
<td>R²</td>
<td>0.62</td>
<td>0.61</td>
<td>0.85</td>
</tr>
<tr>
<td>(No. of obs.)</td>
<td>(124)</td>
<td>(40)</td>
<td>(84)</td>
</tr>
</tbody>
</table>

**NOTE:**
2) RES: Residual asset after homeownership. [See equation (5.3)].
3) A(t-1): Before-purchase level of assets.
4) HH: Household.
5) HHH: Head of household.
6) Housing (purchase) price, (annual household) income, previous level of assets [A(t-1)] are in W10,000.
7) Elasticities in the brackets are calculated at the mean of each variable.10
TABLE 5.2

COMPARISON OF THEORETICAL AND EMPIRICAL VALUES:
NON-REDUCED FORM OLS

(a=0.2, i=0.39, α=0.33 or 0.2)

<table>
<thead>
<tr>
<th></th>
<th>Non-bound</th>
<th>Credit-bound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theoretical</td>
<td>Empirical</td>
</tr>
<tr>
<td>Income(A)</td>
<td>α/i = 0.85</td>
<td>0.61</td>
</tr>
<tr>
<td>Asset (B)</td>
<td>α = 0.33</td>
<td>0.20</td>
</tr>
<tr>
<td>(B/A)</td>
<td>i = 0.39</td>
<td>0.342</td>
</tr>
</tbody>
</table>

NOTE: 1) Theoretical values are based upon equations (4.23)- (4.27).
2) Empirical values are the coefficients from Table 5.1.
3) Interest rate (i) is from Table 3.2, column D: Average curb market rates ('72-'81).

closely related to the large coefficient of the income variable although it should be zero for the credit-bound according to our theory; that is, the unexplained part with assets is mostly explained by income.9

Returning to Table 5.1, the non-bound group shows high coefficients for age and education while the credit-bound group shows high coefficients for the household size. On the whole this trend is maintained in later estimations. The most plausible explanations for these results may be that credit-bound households had to purchase houses because of their expanded household size, while the non-bound households were able to choose an optimal level of housing with sizable amount of assets. This latter explanation (for the

92
non-bound) is possible because in our sample the amount of assets and savings behavior are closely related to age and education rather than to household size.

5.4 Correction of Simultaneity

As mentioned before, the non-reduced form OLS estimation using the calculated previous level of assets has a serious problem, the specification error. In order to avoid this problem, we employ two different estimation techniques: reduced form estimation and two-stage estimation using instrumental variables.\textsuperscript{11}

5.4.1 Reduced Form OLS Estimation

Our estimation has been based on the following two structural equations:

\[ H = a_1 + a_2 A(t-1) \ldots \]
\[ A(t-1) = H + E \]

where \( H \) is the same as \( H(t) \), and \( E \) is the excessive assets; that is, the difference between the accumulated assets and housing price. \( E \) is also equal to \([A(t+1)-F-S]\) from the relationship in equation (5.2). These two structural equations can be written in the following reduced form by substituting \( A(t-1) \) of (5.5) with \( (H+E) \) of (5.6):
\[ H = a_1 + a_2(H+E) + \ldots \]

\[ \Rightarrow \quad H = \frac{a_1}{1-a_2} + \frac{a_2}{1-a_2} \quad E + \ldots \]

\[ \Rightarrow \quad H = b_1 + b_2 E + \ldots \quad \text{...........................................................................(5.7)} \]

Because \( E \) is a pure exogeneous variable^{12}, and thus \( A(t-1) \) is excluded in the reduced form, there will be no problem of simultaneity. However, note that the estimation results of (5.7) imply the original coefficients of structural equation (5.5). For example, the coefficient of \( A(t-1) \), \( a_2 \) in (5.5) is equal to \( [b_2/(1+b_2)] \) where \( b_2 \) is the coefficient of \( E \) in equation (5.7). The results of this reduced form estimation are presented in Table 5.3. Overall \( R^2 \) is lower than in the non-reduced form estimation, and coefficients are similar to the results in Table 5.1, except for \( A(t-1) \). The coefficient (\( a_2 \)) of the level of previous assets \([A(t-1)]\) for the non-bound group calculated from the coefficient (\( b_2 \)) of \( E \) in this reduced form estimation—-that is, \( a_2=0.0703 \)--is much lower than that (0.192) for the non-reduced form OLS results. However, the original coefficient of assets (\( a_2 \)), calculated from the estimates of \( E \) (b2) for the credit-bound group is somewhat puzzling; it is large and negative (-12.0) with high level of t-value. However, according to our theoretical equation (4.23), the coefficient (\( b_2 \)) should be negative since \( a_2 \) should be greater than unity^{13}. In fact, \( b_2 \) is right at the very sensitive region and close to -1 as we can see in Figure 5.2. A slight (leftward) change in \( b_2 \) will make \( a_2 \) very large and positive.
TABLE 5.3
REduced FORM OLS ESTIMATION (LINEAR): SEOUL (1982)

Dependent Variable: Housing Price
Coefficients [elasticities]
(t-values)
{calculated original coeff.}

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Non-Bound (RES&gt;0)</th>
<th>Credit-bound (RES≤0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-158</td>
<td>-245</td>
<td>-467</td>
</tr>
<tr>
<td></td>
<td>(-0.3)</td>
<td>(-0.3)</td>
<td>(-0.8)</td>
</tr>
<tr>
<td>Income</td>
<td>1.13 [0.40]</td>
<td>0.646 [0.21]</td>
<td>1.03 [0.31]</td>
</tr>
<tr>
<td></td>
<td>(5.6)</td>
<td>(2.5)</td>
<td>(3.7)</td>
</tr>
<tr>
<td>E</td>
<td>-0.0966</td>
<td>0.07</td>
<td>-0.923</td>
</tr>
<tr>
<td></td>
<td>(-1.1)</td>
<td>(1.0)</td>
<td>(-4.8)</td>
</tr>
<tr>
<td>{A(t-1)}</td>
<td>{-0.107}</td>
<td>{-0.09}</td>
<td>{0.0657}</td>
</tr>
<tr>
<td></td>
<td>{0.07}</td>
<td>{-12.0}</td>
<td>{-8.0}</td>
</tr>
<tr>
<td>HHH Age</td>
<td>0.107</td>
<td>6.89</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>(0.0)</td>
<td>(0.5)</td>
<td>(0.1)</td>
</tr>
<tr>
<td>HH Size</td>
<td>141</td>
<td>-12.5</td>
<td>221</td>
</tr>
<tr>
<td></td>
<td>(1.8)</td>
<td>(-0.1)</td>
<td>(2.6)</td>
</tr>
<tr>
<td>Yrs. of Education</td>
<td>46.7</td>
<td>110</td>
<td>8.33</td>
</tr>
<tr>
<td></td>
<td>(1.7)</td>
<td>(2.8)</td>
<td>(0.3)</td>
</tr>
<tr>
<td>R^2</td>
<td>0.37</td>
<td>0.48</td>
<td>0.58</td>
</tr>
<tr>
<td>(No. of obs.)</td>
<td>(124)</td>
<td>(40)</td>
<td>(84)</td>
</tr>
</tbody>
</table>

2) RES: Residual asset after homeownership. [See equation (5.3).]
3) E: Excessive assets. E=A(t-1)-H=A(t+1)-F-S.
4) The coefficients of A(t-1) are calculated from the estimates of E. [Please refer
to equations (5.5) and (5.7).]
5) HH: Household; HHH: Head of household.
6) Housing (purchase) price, (annual household) income, previous level of
assets [A(t-1)], and excessive asset (E) are in W10,000.
7) Elasticities in the brackets are calculated at the mean of each variable.
5.4.2 Two-stage OLS Estimation

Another way to correct for simultaneity is to use two-stage estimation with exogeneous instrumental variables believed to be uncorrelated with the error term but closely related to the explanatory variable $A(t-1)$. This technique, it may be noted, is often accused of obtaining consistency at the cost of high variations [Kennedy (1981)].

Instrumental variables used for the estimations are (annual) income, age of household head, household size, education, present liquid asset, housing debt, family support, savings after housing decision, and previous Chonsei. At the first stage, $A(t-1)$ is regressed against these instrumental variables. At the second stage, the predicted values of $A(t-1)$ of the first stage estimation is
used instead of the actual $A(t-1)$ for our final equation.

The results of the estimation are presented in Table 5.4. Overall the coefficients are not very different from the non-reduced form OLS results in the Table 5.1 except for the coefficients of $A(t-1)$: in the two-stage estimation (for All groups), it (0.132) is much smaller than 0.453 for the non-reduced form OLS estimation. However, the same coefficients for the credit-bound and non-bound groups do not show big differences between the two-stage and the non-reduced form OLS estimation.

5.5 Correction of Truncation and Simultaneity

The separate estimation of the credit-bound and the non-bound suffers from loss of information from the exclusion of the other group. And the pooled estimation does not reflect the truncated nature of the samples. The truncation problem usually arises when observations with values of the dependent variable above (or below) a threshold value are not included in the sample. When there is this problem, OLS estimates give biased results. In our case, the two different behavioral patterns of housing demand among the credit-bound and the non-bound raise this truncation problem.

In order to correct this truncation problem along with the problem of simultaneity, we perform a reduced-form Tobit estimation for the pooled sample.
TABLE 5.4

Dependent Variable: Housing Price coefficients [elasticities] (t-values)

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Non-Bound (RES&gt;0)</th>
<th>Credit-bound (RES≤0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-99.2</td>
<td>-190</td>
<td>387</td>
</tr>
<tr>
<td></td>
<td>(-0.2)</td>
<td>(0.2)</td>
<td>(1.0)</td>
</tr>
<tr>
<td>Income</td>
<td>1.05 [0.33]</td>
<td>0.581 [0.20]</td>
<td>0.802 [0.24]</td>
</tr>
<tr>
<td></td>
<td>(5.6)</td>
<td>(2.6)</td>
<td>(4.3)</td>
</tr>
<tr>
<td>A(t-1)*</td>
<td>0.132 [0.11]</td>
<td>0.134 [0.14]</td>
<td>0.905 [0.63]</td>
</tr>
<tr>
<td></td>
<td>(1.8)</td>
<td>(2.3)</td>
<td>(7.2)</td>
</tr>
<tr>
<td>HHH Age</td>
<td>-0.436</td>
<td>6.56</td>
<td>-10.0</td>
</tr>
<tr>
<td></td>
<td>(-0.0)</td>
<td>(0.5)</td>
<td>(-1.3)</td>
</tr>
<tr>
<td>HH Size</td>
<td>138</td>
<td>-10.8</td>
<td>51.2</td>
</tr>
<tr>
<td></td>
<td>(2.0)</td>
<td>(-0.1)</td>
<td>(0.9)</td>
</tr>
<tr>
<td>Yrs. of</td>
<td>36.5</td>
<td>91.0</td>
<td>-2.59</td>
</tr>
<tr>
<td>Education</td>
<td>(1.5)</td>
<td>(2.5)</td>
<td>(-0.1)</td>
</tr>
<tr>
<td>R² (No. of obs.)</td>
<td>0.49</td>
<td>0.59</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>(124)</td>
<td>(40)</td>
<td>(84)</td>
</tr>
</tbody>
</table>

2) RES: Residual asset after homeownership. [See equation (5.3).]
3) A(t-1)*: Predicted A(t-1) from first-stage estimation.
4) Instrumental variables: All independent variables except A(t-1), present liquid assets, debt, family assistance, savings, and previous Chonsei.
5) HH: Household; HHH: Head of household.
6) Housing (purchase) price, (annual household) income, previous level of assets [A(t-1)] are in W10,000.
7) Elasticities in the brackets are calculated at the mean of each variable.
Formally, we estimate the following equations simultaneously:

(Non-bound)
\[ H_i = a_1 + a_2 A(t-1)_i + \ldots + u_i \quad \text{if} \quad H_i^* (= \text{RHS}) < H_i \quad \ldots\ldots (5.8) \]

(Credit-bound)
\[ H_i = A(t-1)_i + E_i \quad \text{otherwise} \quad \ldots\ldots (5.9) \]

where, \( i \) : order of actual samples
\( u \) : residuals
\( H_i^* \) : unobserved latent variables
RHS: right hand side.

Therefore each observation will belong to either (5.8) or (5.9) depending upon the conditions given. However, we do not know \( H_i^* \), instead we only know the actual observation \( H_i \). By changing signs and adding \( A(t-1)_i \) on both sides, equation (5.8) and (5.9) can be rewritten as:

(Non-bound)
\[ (5.8) \Rightarrow A(t-1)_i - H_i = -a_1 + (1-a_2) A(t-1)_i - \ldots + u_i, \]
\[ \text{if} \quad A(t-1)_i - H_i^* > A(t-1)_i - H_i \]
\[ \Rightarrow E_i = c_1 + c_2 A(t-1)_i - \ldots + u_i, \quad \text{if} \quad E_i^* > 0 \quad \ldots\ldots (5.10)^{15} \]
(Credit-bound)

\[ (5.9) \Rightarrow A(t-1)_i - H_i = -E_i, \quad \text{otherwise} \]

\[ \Rightarrow E_i = -E_i \]

\[ \Rightarrow E_i = 0, \quad \text{otherwise} \quad ........(5.11) \]

where, * signifies unobserved latent variables.

Equations (5.10) and (5.11) are classical Tobit problems.\(^{16}\) Note that we are using \(E\) instead of RES because the right hand side of equation (5.10) does not have the term \(F.\)\(^{17}\) Thus we are applying a more stringent condition of binding credit constraints than in the previous estimations. In other words, the non-bound condition in our Tobit estimations is that the amount of own accumulated assets (excluding any outside finances) should be higher than the housing price.\(^{18}\)

The essence of the Tobit estimation for equations (5.10) and (5.11) is that it estimates the coefficients of the non-bound group based on the probability that a certain observation will fall into that group. Also it should be noted that the dependent variable of actual Tobit estimation is \(E\), not \(H\) in the original equations (5.10) and (5.11). Because of this we can avoid the simultaneity problems.

The Tobit estimation process will be described very briefly. The probability that \(E_i^* \leq 0\) is given by:
\[
\text{Prob}(E_i \leq 0) = \text{Prob}(u_i \leq c'x_i) = 1 - \Phi(c'x_i / \sigma) \quad \text{...........................................(5.12)}
\]

where, \(\text{Prob}:\) probability
- \(c':\) vector of unknown coefficients
- \(x: \) independent variables
- \(\Phi(\cdot):\) standard cumulative normal distribution function
- \(\sigma: \) standard deviation of error.

The conditional probability distribution of \(E_i\) given that \(E_i > 0\) is given by the following probability density function:

\[
f(E_i | E_i > 0) = \frac{f(E_i^*)}{\text{Prob}(E_i > 0)}
\]

\[
\frac{\phi[(E_i^* - c'x_i) / \sigma]}{\sigma \Phi [c'x_i / \sigma]} \quad \text{...........................................(5.13)}
\]

where, \(\phi(\cdot)\) is standard normal density function.

By substituting the standard normal distribution function of (5.13) with explicit form and by combining (5.12) and (5.13), we obtain the sample log likelihood function:

\[
\log L(c_1, ..., c_k, \sigma) = \sum_{E_i \leq 0} \log [1 - \Phi(c'x_i / \sigma)] - (1/2) \sum_{E_i > 0} \log (2\pi\sigma^2) - (1/2 \sigma^2) \sum_{E_i > 0} (E_i - c'x_i)^2 \quad \text{...........................................(5.14)}
\]
Equation (5.4) is the logarithm of joint probability that the actual observation will fall into each group; and if it belongs to the second group, it is used to calculate the unknown parameters: c' and σ. The first term of (5.14) represents the joint (log) probability of the credit-bound; and the second and third terms are for the non-bound. The difficulty in maximizing equation (5.13) occurs because of the unknown parameter σ^2. A standard computer program\(^{19}\) will provide a starting value for sigma based upon user-supplied starting values or initial regression results.

The results of the estimation and the calculated original coefficients based on equation (5.8) are presented in Table 5.5. Note that in equation (5.10), the original coefficients have reversed signs (e.g., a_1 = -c_1) except for a_2, that is a_2 = 1 - c_2. The coefficient for A(t-1) for the non-bound group is 0.155 which is higher than the reduced-form (0.0657) or the two-stage OLS estimate (0.134); however, it is much smaller than the non-reduced form OLS estimate (0.192).
**TABLE 5.5**


Dependent Variable: Excessive Assets (E) coefficients [elasticities] (t-values)

<table>
<thead>
<tr>
<th></th>
<th>Estimated ($c_j$)</th>
<th>Original Coefficients ($b_j$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-444 (-0.4)</td>
<td>444</td>
</tr>
<tr>
<td>Income</td>
<td>-0.751 (-1.83)</td>
<td>0.751 [0.26]</td>
</tr>
<tr>
<td>A(t-1)</td>
<td>0.845 (10.7)</td>
<td>0.155 [0.16]</td>
</tr>
<tr>
<td>HHH Age</td>
<td>28.5 (1.4)</td>
<td>-28.5</td>
</tr>
<tr>
<td>HH Size</td>
<td>-449 (-2.8)</td>
<td>449</td>
</tr>
<tr>
<td>Yrs. of Education</td>
<td>-50.9 (-1.1)</td>
<td>50.9</td>
</tr>
<tr>
<td>$\sigma^2$</td>
<td>662276 (3.1)</td>
<td></td>
</tr>
</tbody>
</table>

log likelihood at convergence = -164.8
Number of observations = 124

**NOTE:**
2) E: Excessive assets for homeownership: E = RES-F = H-A(t-1).
3) Original coefficients are based on equation (5.10).
4) HH: Household; HHH: Head of household.
5) Housing (purchase) price, (annual household) income, previous level of assets [A(t-1)] are in W10,000.
6) Elasticities in the brackets are calculated at the mean of each variable.
7) $\sigma^2$: Square of standard deviation of error.
TABLE 5.6

THEORETICAL AND ESTIMATED VALUES:
(a=0.2,  α=0.33, i=0.39)

coefficients of structural equation
[elasticities]

<table>
<thead>
<tr>
<th></th>
<th>Theoretical</th>
<th>Estimated Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Non-reduced OLS</td>
</tr>
<tr>
<td>(Non-bound)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income (A)</td>
<td>0.85</td>
<td>0.561</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.19]</td>
</tr>
<tr>
<td>Asset (B)</td>
<td>0.33</td>
<td>0.192</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.20]</td>
</tr>
<tr>
<td>B/A (C)</td>
<td>0.39</td>
<td>0.34</td>
</tr>
<tr>
<td>(Credit-bound)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income (D)</td>
<td>0</td>
<td>0.736</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.22]</td>
</tr>
<tr>
<td>Asset (E)</td>
<td>1.3</td>
<td>0.973</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.67]</td>
</tr>
<tr>
<td>D/E (F)</td>
<td>0</td>
<td>0.76</td>
</tr>
<tr>
<td>(All)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income (G)</td>
<td>-</td>
<td>0.793</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.25]</td>
</tr>
<tr>
<td>Asset (H)</td>
<td>-</td>
<td>0.453</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.36]</td>
</tr>
</tbody>
</table>

NOTE: 1) Dependent Variable: Housing Price
2) Theoretical values are based upon equations from (4.23) to (4.27).
3) Estimated values are form Table (5.1), and (5.3)-(5.5).
4) a: Loan-to-value ratio.
5) Interest rate (i) used for theoritical values is from the average curb rate (72-81) form Table 3.2.
Table 5.6 summarizes and compares the theoretical and empirical estimates. For the non-bound group, direct comparison of the theoretical and empirical values is very difficult to make because the value of $\alpha$ is unknown. An easy way is to see the ratio [row C of Table 5.6] of the two coefficients. According to our theory in the previous chapter, this ratio is supposed to imply the market interest rate. From Table 5.6, this ratio varies from 10% to 34%. If we disregard the non-reduced form case which has a simultaneity problem, this ratio varies from 10% to 23%: this range is considered to be reasonable since it lies between the curb rate (nominal 39%, real 23%) and formal rate (nominal 16.8%, real -0.4%).

Interestingly enough, the empirical estimate of asset [row B], which is supposed to imply the marginal utility of housing consumption from our theory, is less than 0.2.

Regarding the credit-bound group in Table 5.6, we cannot find any consistent relationship between the two variables. One notable finding is that the ratio [row F] of them is not very different from zero even for the reduced form estimations.

Income elasticities are around 0.25 and are similar among the two groups. However, the asset elasticities for the non-bound are underrepresented in the pooled estimation [row H in Table 5.6].

The most important finding of this empirical study is the striking behavioral difference between the two groups. For the credit-bound, the most critical variable is asset. For the non-bound, both income and asset determine housing demand, maintaining a balance with credit market conditions. The behavioral difference can also be seen for other variables:
household size for the credit-bound, and age and education for the non-bound have positive and significant effects in each group.

5.6 Summary and Further Questions

Empirical tests of the theoretical model formulated in chapter IV involved the correction of two problems. The first problem was associated with the time reference of asset data; that is, the data on assets should be before the housing decision. We argued that the data on assets at the time of survey only represent the residuals after the purchase of those houses at the time of survey. In order to avoid this residual character of the asset data, we moved our time reference from the date of survey to that of the housing decision, and calculated the level of assets before the housing decision.

The second problem was associated with the correction process of the first problem. With simultaneity and truncation in the data we could not obtain unbiased estimates from the non-reduced form OLS. Various estimation methods were further employed. Overall the empirical tests showed the relevance of our theoretical model. In addition, the empirical test showed striking behavioral difference between the credit-bound and non-bound groups.

For the non-bound group, housing demand could be well explained by income and assets. Age and education turned out to have positive and significant effects on the non-bound's housing demand reflecting the importance of savings and family backgrounds.

For the credit-bound group, the level of accumulated assets was by far the most important variable; however, income was explaining most of the residual part unexplained by the level of assets. Among other variables,
household size is critical for this group.

In an attempt to synthesize and reinforce our static analyses thus far, we will formulate a comprehensive dynamic simulation model in the next chapter and draw various implications for future public housing policy in Korea.
ENDNOTES OF CHAPTER V

1. Please refer to questionnaire in Appendix 2.

2. A rule of thumb tells us that the sample size should be at least 15 times the number of explanatory variables.

3. This is especially severe for the credit-bound because they almost exhaust their assets for the purchase of their houses.

4. The only exception for this identity is the case where one buys a house with partial Chonsei. In this case, the amount of the Chonsei deposit should be added to the housing debt. However, we do not have any data on the specific amount of the rental deposit in this case.

5. Application of the wholesale price index may be suggested to correct for the price appreciation of non-housing assets; however, the composition of liquid assets may be substantially different among households. For example, some households may have more stock or bonds than gold or cash while others may not.

6. RES can be negative if a household is already in debt; that is, A(t-1)<0.

7. The simple correlation coefficients among independent variables imply that there are no other serious problems such as multicollinearity except for age and size. For these two variables, the correlation coefficient was about 0.35 which is not so serious level for multicollinearity.


9. In theory, if RES=0, assets explain the whole variations of the housing demand for the credit-bound. However, if the residual asset is negative—that is, a household is already in debt before the purchase of the house or underreports present level of assets—then, the theoretical coefficients of asset cannot be the same as 1/(1-a) and the difference may be explained by other independent variables in the regression
10. Sample means are as follows:

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Non-bound</th>
<th>Credit-bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Prices</td>
<td>1682</td>
<td>1780</td>
<td>1636</td>
</tr>
<tr>
<td>Annual Income</td>
<td>526</td>
<td>611</td>
<td>486</td>
</tr>
<tr>
<td>A(t-1)</td>
<td>1350</td>
<td>1810</td>
<td>1131</td>
</tr>
</tbody>
</table>


12. Because it is defined by the three exogeneous variables: A(t+1), F, and S. Please refer to equation (5.2).

13. If a₂>1, then A = b₂/(1+b₂)>1 => b₂<-1.


15. Please note that Eᵢ = A(t 1)ᵢ - Hᵢ, which is positive for the non-bound group.

16. This model was first studied by Tobin (1958) and was nicknamed the Tobit (Tobin's probit). Please refer to: G. S. Maddala, *op. cit.*, 1983, ch. 6.

17. The relationship between E and RES is: E = RES - F.

18. With this criterion, the number of the non-bound is only 18 compared with 40 in the previous estimations. However, the Tobit estimates are actually based on the whole sample of 124 households.

CHAPTER VI

SIMULATED IMPACTS OF CREDIT CONSTRAINTS

In the previous chapters (III, IV, and V), we examined the importance of the individual asset accumulation in the housing choice under severe credit constraints. In this chapter, we integrate the static analyses of the previous chapters into a dynamic simulation model in order to examine the magnitudes of the impacts of credit constraints. A life-cycle profile of asset (dis) accumulation and housing consumption is analyzed through the life-cycle simulation model of a typical consumer with moderate income. The analysis in this chapter is primarily based on a life-cycle theory [Wheaton (1985), Artle and Varaiya (1978), Yaari (1964), Tobin (1967, 1972), Modigliani (1954)] utilizing optimal control techniques [Sethi and Thompson (1981)].

6.1 Life-Cycle Theory and Housing Consumption

In a perfect capital market, the level of a household's wealth is defined as the sum of its nonhuman wealth, net of liabilities, and the present value of its prospective earnings from work. Within the bounds of solvency set by this concept of wealth, the household will engage in borrowing and lending in order to make its rate of consumption "more nearly uniform" [Fisher (1930),
p. 112] over time.

Modigliani and Brumberg (1954) elaborated on this idea and formulated what has since become known as the life-cycle theory of saving and consumption. A major tenet of their theory holds that an individual's current rate of consumption and saving can be satisfactorily explained, not by the current income, but by the individual's current position in a life cycle described by age and present wealth. In particular, the role of savings is to serve as a cushion against fluctuations of income during the life cycle and to provide for retirement and emergencies.

Yaari (1964) provided a more precise rule for the allocation of an individual's consumption over his or her lifetime in order for the lifetime utility function to be maximized subject to a nonnegative wealth constraint. He proved that under his assumptions the optimal plan of consumption over the life cycle is a continuous and smooth function of time.

Tobin (1967) also showed that, with a given market interest rate, an individual who behaves according to the rule of maximizing life time total utility will allocate consumption "evenly" over the life cycle. Consumer will tilt their consumption to the future (present) if the market rate of interest is greater (smaller) than the subject rate of discount as proven by Yaari [1964, p. 309] and as illustrated numerically by Tobin [1967, p. 151].

Focusing on the liquidity constraints in real life, Tobin (1972) later built an alternative theory in which an individual must maintain nonnegative assets (not total wealth) at all times. By comparing his alternative theory with pure life cycle theory, he suggested that wealth-constrained households will, while liquidity-constrained households will not, alter their current
consumption in response to marginal changes in their illiquid resources such as an increase in expected future labor incomes, improvements in prospective retirement benefits, and capital gains on houses and other imperfectly liquid assets. In the study by Tobin (1972), it was proven that, even with liquidity constraints imposed on the consumer, the optimal consumption profile is still continuous over time.

In order to attain and sustain an optimal profile of consumption of goods and services, a consumer will hold desired stocks of consumer durables as part of the individual's nonhuman wealth. To the extent that the timing of acquisition and disposition of such durables (by their indivisible nature and portfolio considerations) is sensitive to illiquidity constraints and other market imperfections, the shape of the life cycle profile may be affected. Thus, one particular component of individual wealth, namely residential housing, becomes integrated with the life-cycle model.

Artle and Varaiya (1978) analyzed the effects of housing tenure choice and timing upon the shape of the optimal profile of consumption over the life cycle. Their analysis is based on the major assumptions that income and housing price are constant and that renter's user cost is higher than the owner's. Adding bequest motives to the lifetime utility function, they proved that both the optimal level of consumption and the switch times (from rental to ownership or vice versa) are uniquely determined satisfying the non-negative asset constraint. As a result of this constraint, consumers tend to save more in the early part of the life cycle and tend to increase consumption later, leaving the consumption profile continuous but not smooth at the switch points. In the presence of credit constraints, Artle and Varaiya (1978)
further proved that the consumption and asset profiles have sudden jumps at switch times because the consumers must save enough money to pay for the required down payments of their houses. Therefore, the benefit that credit constraints may bring in lowering housing costs, in the case of homeownership, must be weighed against the loss of utility resulting from the reduction of consumption early in the life cycle—possibly not outweighed by the gain of consumption later. Hence, if the consumer's subject discount factor is sufficiently high and the consumer's income and initial assets are sufficiently low, the tenant profile would be optimal one. One crucial nature of their study is that it does not allow borrowing against housing equity. Their assumptions are also too restrictive. They assumed that every one at a given point in time and at every point over the life cycle should consume exactly the same quantity of housing, regardless of wealth, price, or temporary income differences.\(^2\)

In an attempt to understand better the microeconomic foundations of the empirical results by Kearl (1979) and Follain (1982) that housing demand is reduced by greater economy-wide inflation, Schwab (1982), and Dougherty and Van Order (1982) developed Fisher-type models of inter-temporal utility maximization which include a housing consumption choice. They concluded that, in order to explain the empirical result of diminishing housing demand by inflation, capital market imperfections should indeed exist.

Wheaton (1985), building on the study by Schwab (1982), developed a life-cycle model accommodating various credit market constraints. He rephrased the Fisher model into a continuous life-cycle model and examined two kinds of credit constraints: those requiring liquidity and those prohibiting
all forms of borrowing aside from an initial housing mortgage. Wheaton's conclusions are three. First, if the liquidity constraints prohibit borrowing against future earnings as Tobin (1972) suggested, but if borrowing is allowed against accumulated housing equity through refinancing, second mortgages, etc., then greater inflation increases housing demand. Second, when absolute borrowing constraints are present and binding—when consumers cannot accumulate assets until they pay off the housing debt—then, inflation reduces housing demand if the real interest rate is less than the consumer's rate of time preference. Third, when absolute borrowing constraints are present but non-binding, the perfect capital market results do not hold. Even if consumers are saving, to tilt their consumption stream forward, borrowing constraints allow them to dissolve their accumulated non-housing wealth but not housing equity.

6.2 A Life-cycle Simulation Model Under Credit Constraint

In an attempt to apply the life-cycle theory in Korea, we identify several important characteristics which have prevailed in Korea's housing market.

First, as seen from Table 3.2, there has been a substantial difference between the rate of housing price appreciation and general inflation during rapid economic development and urbanization. Also it is recognized that income growth has been substantial during the past few decades.

Second, the preference for homeownership over rental is very strong in Korea. The hardships of renters from doubling up with landlords and frequent
moves due to rent (or Chonsei) increases are well known.

Third, the bequest motive is traditionally stronger in Korea than that in western countries.

Finally, long-term mortgages are very limited, and a substantial amount of down payment is usually required for the purchase of a house. However, it is not so difficult for homeowners to borrow against housing equity in the curb market. Without collateral, however, it is generally difficult to borrow from the financial market, whether formal or informal.

Recognizing these special characteristics, we formulate a simulation model based upon the works by Wheaton (1985) and Artle and Varaiya (1978).

6.2.1 Assumptions

1) The model is formulated from the viewpoint of a consumer whose lifetime, initial assets, and income are all known with certainty.

2) Liquidity constraints prohibit borrowing against future earnings, but borrowing against housing equity is assumed to be easy to obtain at the market rate of interest. In other words, only borrowing against real assets is allowed. Therefore, renters can save up to the down payment of their own first house or up to an optimum level of bequests. Once they become homeowners, they can borrow against their housing equity at the market interest rate, or they can save more for later consumption.

3) Consumers can instantly and costlessly adjust their housing consumption over time. This makes sense given that individuals operate in a capital market which is fluid enough to permit borrowing against real assets.
Therefore, the appreciated housing price can be instantly liquidated through adjustments in housing consumption.

4) There are two kinds of interest rates: a market interest rate and a formal mortgage interest rate. The latter is currently publicly subsidized and substantially lower than the former. The former rate is applied to the borrowing against real assets and to the lending from an accumulated asset, while the latter applies only to the housing mortgage. The formal mortgage is assumed to be available at any time for both renters and homeowners; however, renters should have matching funds (down payments) in order for them to be eligible for the formal mortgage.

5) As a result of 2), 3), and 4) above, the renter's constraint is to maintain non-negative liquid assets while the homeowner's constraint is to maintain non-negative total net assets defined as liquid assets cum housing assets net of housing and other debt. Thus, renters can either accumulate or dissolve assets while fulfilling the nonnegative liquid asset constraints. Owners, on the other hand, can be in debt up to the level of housing equity.

6) The rental price is higher than the owner's user cost. In other words, for the same unit serviced, renters get lower utility than owners. We denote this as a premium (rate) of rental cost over homeownership.

7) The starting year in this model is assumed to be the time of marriage. All households are assumed to be renters at the very beginning. In order to become homeowners, renters must save up to the required down payment level, based on the housing price. After ownership is acquired, further change in tenure is not allowed.

8) The consumer's utility is derived from housing and non-housing
consumption, and from bequests. These utilities are discounted by the rate of
time preference. Consumers can give more (equal or less) weight to bequest
utility relative to consumption utility. In the simulation we use a
Cobb-Douglas log-linear utility function.

9) Housing price is increasing annually at a constant rate, and income is
also assumed to grow at a constant rate, both with perfect certainty.

6.2.2 Notation of Parameters, Functions, and Variables

In this chapter we use the higher case English letters for functions,
lower case for variables, and the Greek letters for parameters; however,
exceptions have to be allowed because of the large number of parameters and
variables. The subscripts of 1 and 2 are representing rental period and
homeownership period, respectively. When we refer to the actual years since
the beginning of the life cycle (after marriage), we present them in the
parentheses after each variable.

(1) Functions

U : Utility function of consumers at each time. Utility function is
defined only by two variables: consumption of housing and
consumption of other goods.

B : Bequest utility function.
(2) Variables

\( h_1 \): Consumption of rental housing in pyong.

\( h_2 \): Consumption of owner-occupied housing in pyong.

\( c \): Consumption of other goods.

\( T_s \): Switching time from rental to ownership.

\( p(t) \): Housing price per pyong at time \( t \).

\( a(t) \): Liquid asset of renters at time \( t \).

\( a(t) \): Time differentiation of liquid asset (i.e., \( \partial a/\partial t \)).

\( y(t) \): Real household income at \( t \).

\( A(t) \): Total net assets of owners at time \( t \), equivalent to liquid assets cum housing equity.

\( A(t) \): Time differentiation of total net assets (i.e., \( \partial A/\partial t \)).

(3) Parameters

\( m \): Consumer's rate of time preference.

\( T \): Terminal time of life measured in years after marriage.

\( k \): Down payment requirement for owner-occupied housing.

Consumers are assumed to get a formal mortgage of (1-k) times of housing price.

\( b \): Rate of housing price appreciation.

\( y_i \): Real rate of income growth.
\( q \) : (Premium) Ratio of rental costs to homeownership costs \((q > 1)\).\(^4\)

\( R \) : Real rental rate (not adjusted by "q")--with respect to housing price--which is assumed to be the interest rate net of the rate of housing price appreciation; that is, \( r-b \). [Please refer to Chapter III.]

\( r \) : Real interest rate

\( i \) : Real interest rate on a formal mortgages. \((i < r)\).

\( \rho(t) \): Marginal contribution of the state variable \((a \text{ or } A)\) to the objective function at \( t \).

\( \lambda(t) \): Lagrangian coefficient.

\( \delta \) : Weight of bequest utility.

\( \alpha \) : Coefficient of housing consumption in a Cobb-Douglas utility function.

\( \beta \) : Coefficient of other-goods' consumption in a Cobb-Douglas utility function.

6.2.3 The Model

The objective function of this model is to maximize present value of total lifetime consumption and bequest utility with respect to control variables, namely the levels of housing and other-goods' consumption and the switching time from rental to ownership.
\[
\text{Max}_{h_1(t), h_2(t), c(t), T_s} \left[ \int_0^{T_s} U[h_1(t), c(t)] e^{-mt} \, dt + \int_{T_s}^T U[h_2(t), c(t)] e^{-mt} \, dt \right] + B \left[ A(T) e^{-mt} \right] \]  
\text{.................................}(6.1)

subject to,

(Rental Period)

\[ a(t) = y(t) - c(t) - h_1(t) p(t) Rq + a(t) r, \quad 0 \leq t \leq T_s \]  
\text{.................................}(6.2)

\[ a(0) \geq 0 \]  
\text{.........................................................}(6.3)

\[ a(T_s) \geq k h_2(T_s) p(T_s) \]  
\text{.........................................................}(6.4)

\[ a(t) \geq 0, \quad 0 \leq t \leq T_s \]  
\text{.........................................................}(6.5)

(Homeownership Period)

\[ A(t) = y(t) - c(t) - h_2(t) p(t) [i(1-k)+kr-b] + A(t) r, \quad T_s \leq t \leq T \ldots (6.6) \]

\[ A(T_s) = k p(T_s) h_2(T_s) \geq 0 \]  
\text{.........................................................}(6.7)^5
\[ A(T) = \frac{\partial B}{\partial A} |_{t=T} e^{-mT} = \rho(T) \geq 0 \] ................................. (6.8)

\[ A(t) \geq 0, \; T_s \leq t \leq T \] ................................. (6.9).

Equation (6.2) says that the change in liquid assets at the given point in time is the sum of income and returns on accumulated assets net of the (housing and nonhousing) consumption. The third term of the right hand side of (6.2) represents rental costs with rental rate of "Rq." The corresponding capital cost for homeownership period is the third term of the right hand side of equation (6.6). The rate of capital cost here is defined by the sum of interest rate on the formal mortgages, and opportunity interest rate on housing equity net of housing price appreciation. The terminal condition of the first period, equation (6.4), signifies the required asset level for homeownership. The terminal condition of (6.8) is given from the equation (2.28) of Sethi and Thompson (1981) and the Corollary 3.1 of Artle and Varaiya (1987).

The solution of this model requires extensive calculations. Instead of direct calculation, we have built a computer-based optimization model. The calculation procedure is diagramatically described in Figure 6.1.

As we can see in this figure, the optimization requires a dynamic programming approach. With a given switching time, optimization is performed for the second period, thereby we can write the second period asset equation of motion, equation (6.6), with the function of \( \rho(T_s) \). By
substituting this into the terminal boundary condition of (6.8) we can obtain the specific value of \( \rho(T_s) \), given switching time.

Meanwhile, the same methods of optimization for the first period, under the assumption that \( \rho(T_s) \) and \( T_s \) are given, produce a specific relationship between \( \rho(0) \) and \( \rho(T_s) \).

By substituting this relationship into the first period's asset equations of motion, equation (6.2), we can determine specific value of \( \rho(0) \).

With these specific value of \( \rho(T_s) \) and \( \rho(0) \), we can calculate the optimal levels of consumption of housing \( (h_1 \text{ and } h_2) \) and other goods \( (c_1 \text{ and } c_2) \), given switching time. From these now-known variables, we calculate the present value of the utility of consumption and bequests given the same fixed switching time from equation (6.1).

By repeating the whole procedure for different switching times from 0 to \( T \), we can obtain the whole profile of lifetime utility levels for any possible Then we can choose the optimal switching time \( (T_s^*) \) when objective function is maximized.

Once the optimal switching time is determined, the final optimal levels of consumption and asset accumulation are easily derived by repeating the procedure.
Figure 6.1 The Procedure of Optimization

Optimization of Second Period w.r.t. fixed Ts

↓

Check Terminal Boundary Condition of Asset Eq. (6.8)

↓

Get $\rho(T_s)$

↓

Get $h_2(t), c_2(t)$

↓

Get Total (Consumption & Bequest) Utility by Changing Ts

↓

Find Ts that maximize Total Utility

↓

Get $\rho(T_s) \rightarrow h_2, c_2 ; \rightarrow \rho(0) \rightarrow h_1, c_1$

Optimization of First Period w.r.t. fixed Ts

↓

Check Boundary (at Ts) Condition of Asset Eq. (6.4)

↓

Get $\rho(0)$

↓

Get $h_1(t), c_1(t)$

NOTE: 1) First Period and subscript 1: rental period

2) Second Period and subscript 2: homeownership period

3) w.r.t.: with respect to

4) *: optimum values switching times from 0 to Ts.
(1) **Maximization During Second Period**

Hamiltonian:

\[ H = U e^{-mt} + \rho(t) [y(t) - c(t) - h(t) p(t) \{ i(1-k)+kr-b \} + A(t)r] \]

\[ + \lambda(t) a(t) \] \hspace{1cm} (6.11)

First-Order Conditions are\(^6\):

\[ \frac{\partial U}{\partial c} \hspace{1cm} (6.12) \]

\[ e^{-mt} = \rho(t) \]

\[ \frac{\partial U}{\partial h_2} \hspace{1cm} (6.13) \]

\[ e^{-mt} = \rho(t) [i(1-k)+kr-b] p(t) \]

\[ \rho(t) = -[\rho(t) r + \lambda(t)] \] \hspace{1cm} (6.14)

\[ \lambda(t)A(t) = 0, \lambda(t) \geq 0, A(t) \geq 0 \] \hspace{1cm} (6.15)

\[ A(Ts) = k h_2(Ts) p(Ts); A(t), A(T) \geq 0 \] \hspace{1cm} (6.16)

\[ \frac{\partial B}{\partial A} \mid t=T \hspace{1cm} (6.17) \]

\[ = \rho(T) e^{mT} \]
If we allow asset accumulation (i.e., $\lambda(t)=0$ and $A(t)>0$);

\[(6.14) \Rightarrow \quad \rho(t) = \rho(Ts) e^{-r(t-Ts)} \quad \text{..............................(6.18)}\]

\[\frac{\partial U}{\partial c} = \rho(0) \quad e^{rTs+(m-r)t} \quad \text{..............................(6.19)}\]

\[(6.12),(6.13) \Rightarrow \quad \frac{\partial U}{\partial h_1} / \frac{\partial U}{\partial c} = p(t) [i(1-k)-b+kr] \quad \text{..............................(6.20)}\]

Equation (6.19) means that the level of consumption can be slanted toward present (future) if the rate of consumer's time preference, $m$, is greater (smaller) than the real interest rate, $r$.

(2) **Maximization During First Period**

Hamiltonian:

\[H = U e^{-mt} + \rho(t) [y(t)-c(t)-h(t)p(t)Rq+a(t)r] + \lambda(t)a(t) \quad \text{.........(6.21)}\]

First-Order Conditions are:
\[ \frac{\partial U}{\partial c} = e^{-mt} = \rho(t) \] ..................................................(6.22)

\[ \frac{\partial U}{\partial h_1} = e^{-mt} = \rho(t) \left[ \rho(t) \ R_q \right] \] ..................................................(6.23)

\[ \rho(t) = -[\rho(t) \ r + (t)] \] ..................................................(6.24)

\[ \lambda(t)a(t) = 0, \ \lambda(t) \geq 0, \ a(t) \geq 0 \]

\[ a(T_s) = k \ h_2(T_s) \ p(T_s) : \ \text{Boundary condition}. \]

If \( \lambda(t) = 0 \) (i.e. \( a(t) > 0 \));

\[ \rho(t) = \rho(0) \ e^{-rt} \] ..................................................(6.25)

\[ \frac{\partial U}{\partial c} = \rho(0) \ e^{(m-r)t} \] ..................................................(6.26)

\[ \frac{\partial U}{\partial h_1} / \frac{\partial U}{\partial c} = \rho(t) \] ..................................................(6.27)

Without losing generality, let us assume the logarithmic utility functions.

As discussed before, the total utility is the sum of utilities from (housing and non-housing) consumption and from bequests (with a certain weight).
Formally, each of these two utility function is defined as follow:

(Consumption Utility)
\[ U = \alpha \log(h) + \beta \log(c) \] .................(6.28)

(Bequest Utility)
\[ B = \delta \log[A(T)] \] .................(6.29)

Then we can rewrite the housing and non-housing consumptions as follows:

\[ (6.19) \Rightarrow c(t) = \frac{\beta}{\rho(Ts)} e^{-rT_s+(r-m)t} \] .................(6.30)

\[ (6.20) \Rightarrow \frac{\alpha}{h_2} \frac{\beta}{c(t)} = \frac{[i(1-k)+kr-b]}{p(t)} \] 

\[ \Rightarrow h_2(t) = \frac{\alpha}{\rho(Ts)} \frac{e^{-rT_s}}{[i(1-k)+kr-b]p(0)} e^{(r-m-b)t} \] .................(6.31)

For the first period;
\[ (6.22) \Rightarrow c(t) = \frac{\beta}{\rho(0)} - e^{(r-m)t} \] 

(6.32)

\[ (6.23) \Rightarrow \frac{\alpha}{h_1} / \frac{\beta}{c(t)} = R \frac{p(t)}{p(0)} \]

\[ \Rightarrow h_1(t) = \frac{\alpha}{\rho(0)} \frac{1}{Rp(0)} e^{(r-m-b)t} \] 

(6.33)

Unknown variables on the right hand sides of equations (6.30)-(6.33) are \( \rho(Ts) \) and \( \rho(0) \). These four equations are then substituted into the equations of motion, (6.2) and (6.6). The resulting equations are also the functions of \( \rho(Ts) \) and \( \rho(0) \). The specific solution for \( \rho(Ts) \) is determined so that from the starting point of \( a(0) \), \( A(T) \) winds up satisfying the terminal boundary condition, equation (6.8).

Formally, by directly solving the differential equations of (6.2) and (6.6) and by substituting the values of equations (6.30)-(6.63), we obtain the following equations:
(Asset Equation for Second Period)

\[ A(t) = \frac{y(0)}{r - y_i} \left[ e^{(y_i - r)T_s + rt} - e^{y_i t} \right] + \]

\[ \frac{e^{r(t - T_s)}}{\rho(T_s)} \left[ \frac{e^{-mt} - e^{-mT_s}}{m} + \frac{k e^{-mT_s}}{i(1-k)+kr-b} \right] \]

.................................(6.34)

(Asset Equation for First Period)

\[ a(t) = a(0) e^{rt} + \frac{y(0)}{r - y_i} \left[ e^{rt} - e^{y_i t} \right] + \]

\[ \frac{e^{rt}}{\rho(0) m} \left[ e^{-mt} - 1 \right] \]

.................................(6.35)

By arranging terms among equations (6.8), (6.17), and (6.34) evaluated at T, we can obtain a specific value of \( \rho(T_s) \) with known parameters including a given \( T_s \). By fulfilling the terminal condition of (6.35) for the first period--that is, by substituting \( h_2(T_s) \) of (6.4) with \( h_2(T_s) \) from (6.31)--we
can obtain \( \rho(0) \) as a function of \( \rho(Ts) \) and Ts. The resulting equation, then is put equal to (6.35) evaluated at Ts. The only unknown variable in this final equation is \( \rho(Ts) \). Now, we can calculate the value of \( \rho(0) \) with given Ts and known \( \rho(Ts) \).

With known \( \rho(0) \) and \( \rho(Ts) \), we can obtain the specific values of \( h_1, h_2, c_1 \), and \( c_2 \) from equations (6.30) to (6.33). These values are substituted in the objective function and we can calculate the value of the objective function given the switching time. Repeating the whole procedure by changing Ts, we obtain the optimal Ts* which maximizes the objective function. Then we obtain the final optimal profiles of life-time consumption and savings for the final optimal switching time, Ts*.

### 6.2.4 Major Properties of The Model

1. **User Costs of Owning and Renting**

   The rate of user costs of owning for a given housing price (hp) is defined by; the opportunity interest rate for the own fund (kr) cum the formal mortgage interest rate \([i(1-k)]\) net of the housing price appreciation rate (b); thus, the rate of owner's user cost is \([kr+i(1-k)-b]\). The rate of user costs of renting is also defined by; the difference between the opportunity interest rate \(r\) and the housing price appreciation rate \(b\), times the premium rental rate over ownership \(q\); thus, \([r-b]q\]. These two rates of owning and renting are applied to the housing price.

   Therefore, if there is no premium of rental costs over homeownership
(q=1), the homeownership advantage in user costs to the rental is the subsidized formal mortgage interest rate; that is, (1-k)(i-r). As long as the formal mortgage rate (i) is lower than market interest rate (r), the value of (1-k)(i-r) will be negative--that is, low homeownership costs.

If there exists a premium of rental cost over homeownership (q>1) in addition to the subsidized interest rates, the user cost of homeownership becomes much smaller. Even without the subsidized credit, the cost of owning is still cheaper than the cost of renting because of the rental premium. In this case the difference is r(k-q)-b(q-1) which is negative if there is rental premium (q>1).

In short, the advantage of homeownership comes from two sources: the subsidized mortgage interest rate and the premium of rental costs over ownership. If there is no subsidized mortgages (k=1 or i=r) and if there is no premium of rental cost over ownership (q=1), then consumers would be indifferent between owning and renting.8

The magnitude of the difference in the user costs between owning and renting is also dependent upon the loan-to-value ratio, (1-k). If the formal mortgage is expanded--that is, k is smaller--without the change in the subsidized interest rate, the difference will be bigger and more advantageous to homeownership. However, if the subsidy in the mortgage interest rate becomes smaller--that is, the mortgage rates approach the market rates--then the cost advantage of homeownership will become smaller.

One of the purposes of doing our simulation is to examine the impacts of the two critical sources of capital market imperfections9: credit constraints and subsidized mortgage. Under perfect capital market conditions, we expect
that there is no down payment requirement for homeownership (k=0) and
that there is no subsidized mortgage (i=r). The levels of consumer's life-time
welfare under the present conditions and under perfect capital market
conditions are compared through simulation to infer the welfare implications
of the credit constraints.

It is expected, in the simulation, that the credit constraints will induce
renters to save a substantial portion of their income over a substantial period
in order to become a homeowner. If there are incentives such as subsidized
mortgage interest rates and premium rental costs over ownership, the
extensive savings in the early stage of the life cycle will weigh against the
higher levels of housing and nonhousing consumption after homeownership.
This high level of consumption after homeownership arises from two sources.
First, there is no further need to save to take advantage of the subsidized
mortgage. Second, the first effect is further amplified by the lower cost of
homeownership compared to rental.

The magnitude and direction of housing demand and tenure choice,
however, are also dependent upon the consumer's subjective rate of time
preference and other parameters. For example, if the consumer's rate of time
preference is low enough, then the loss of welfare from forced savings due to
the credit constraints can be smaller\(^ {10}\) because the consumers will save
anyway.

(2) \textbf{Housing Consumption}

The \textit{levels} of housing consumptions at the beginning of the
rental and at the beginning of the homeownership period are determined by
the magnitudes of $\alpha$, $R$, $q$, $[i(1-k)+kr-b]$, and $T_s$ as we can see in equations (6.31) and (6.33). From these equations, however, the rate of housing consumption is dependent upon the value of $(r-m-b)$; that is, the interest rate net of the consumer's time preference and the rate of housing price appreciation. [See Figure 6.2.] If this is negative, consumers decrease housing consumption over time. In other words, at the same level of the market interest rate $(r)$ and the consumer's time discount rate $(m)$, a high rate of housing price appreciation $(b)$ reduces housing consumption over time. This is because the consumer wants a larger house as early as possible to get the most benefit from housing price increases.

Figure 6.2 Housing Consumption over Time

NOTE: The actual $T_s$ can be different for the three cases.
6.3 Simulations

6.3.1 Explanation of Parameter Values

Parameter values used in our simulation are mostly based on the survey data used in chapters III and V. For example, the ratio of $\alpha/\beta$ was set around 0.5 under the observation that roughly one-third of household resources are spent for housing services.\textsuperscript{11}

The level of initial assets is set to W1,500,000 ($2,000) which is roughly equivalent to the Chonsei deposit of one-room renters. Initial annual income is set to the average level of income of monthly renters. [See Appendix 3.]

The real interest rate ($r$) is the most difficult one to determine as Korea has a dual financial structure: a regulated financial market (formal) and an unregulated financial market (informal). From Table 3.2 we know that the average ('63-'81) real (annual) interest rate is around 3 percent in the formal financial markets, while that in the informal curb markets is around 30 percent. From these dual interest rates, the real interest rate for the simulation is calculated as 12 percent based on the portfolio composition of individual households [The World Bank (1984), p.169].\textsuperscript{12}

The ratio ($k$) of own funds to the housing price is also difficult to set. The loan-to-value ratio of formal housing loans shows great variations depending on the size of the dwelling unit. In cosideration of the variations and the limitations of the formal credit, an 80% down payment requirement seems to be reasonable.

The real rate of housing price appreciation ($b$) which is set to 3 percent per
year seems to be rather moderate in view of the informations given in Table 3.2. However, recent experience of the low level of housing price appreciation [KRIHS (1985)] confirms that the past rate has been rather high.

The rental rate (RR or Rq) of housing price is calculated from the relationship of [r-b]q, where "q" is the premium rental rate over homeownership. The real income growth rate is set at 5 percent in view of the past performance from Table 3.2; that is, real GNP growth rate (7%) net of population growth rate (2%).

Other parameters are set for the switching time of around 10 years from the beginning of the period. In particular, the consumer's rate of time preference (m) is set so that the ratio of savings to household income is around 30 percent. The summary of parameters and standard simulation results are repoted in Table 6.1.

### TABLE 6.1
SUMMARY OF PARAMETERS AND STANDARD RESULTS

<table>
<thead>
<tr>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 = a(0): Initial Asset(W10,000)</td>
</tr>
<tr>
<td>360 = y: Initial Annual Income(W10,000)</td>
</tr>
<tr>
<td>0.12 = r: Real Interest Rate (Annual)</td>
</tr>
<tr>
<td>0.8 = k: Own-fund Ratio For Homeownership</td>
</tr>
<tr>
<td>0.03 = b: Real Housing Price Increase</td>
</tr>
<tr>
<td>0.06 = m: Consumers' Time Discount Rate (Annual)</td>
</tr>
<tr>
<td>80 = p(0): Initial Unit Housing Price per Pyong(W10,000)</td>
</tr>
<tr>
<td>10 = Ts: Switching Time to Ownership</td>
</tr>
<tr>
<td>35 = T: Total Life-Cycle Year</td>
</tr>
<tr>
<td>0.67 = β: Coefficient of Consumption in Utility Function.</td>
</tr>
<tr>
<td>0.33 = α: Coefficient of Housing in Utility Function.</td>
</tr>
<tr>
<td>5 = δ: Weight on Bequest Utility</td>
</tr>
<tr>
<td>0.05 = i: Real Annual Mortgage Interest Rate</td>
</tr>
<tr>
<td>0.099 = RR: Rental Rate of Housing Price (Rq)</td>
</tr>
<tr>
<td>0.05 = yi: Income Growth Rate (Annual)</td>
</tr>
<tr>
<td>1.1 = q: Premium Rental Rate over Ownership</td>
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</table>

(Continues)
<table>
<thead>
<tr>
<th>YEAR</th>
<th>(1) C(t)</th>
<th>(2) H(t)</th>
<th>(3) A(t)</th>
<th>(4) H(t)*P(t)</th>
<th>(5) TOTAL</th>
<th>(6) Cons.</th>
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<td>ERR</td>
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</tr>
</tbody>
</table>

**NOTE:**
1) C(t): Consumption of other goods in W10,000 at t.
2) H(t): Housing Consumption in pyong at t.
3) A(t): Total net asset in W10,000 at t.
4) H(t)*P(t): Value of housing in W10,000 at t.
5) ERR in the column (5) means that the utility level cannot be obtained because of the negative consumptions in some years.
6.3.2 Standard Results

Column 1 of Table 6.1 shows the amount of nonhousing consumption in W10,000 in each year.\textsuperscript{15} Column 2 shows the lifetime profile of housing consumption (size of the dwelling unit) in pyong. Column 3 represents the amount of accumulated assets (W10,000) at each year.

The nonhousing consumption increases due to the income growth and returns to accumulated assets. Once a consumer has accumulated enough assets [column 3 at the year 10] for the down payment (80\% of the housing price), he becomes a homeowner. After that time on, he may borrow from the curb market against housing equity or save even more depending upon the weight of the bequest utility.\textsuperscript{16} In our case the consumer continues to save for the bequests, although the rate of savings as a homeowner is much lower than that as a renter. For example, in the year 11, the housing equity is 2440 [i.e., 80\% of the housing price of column 4], and the amount of accumulated assets is 2513.38; thereby the amount of saving is about 74, the difference between 2440 and 2513.38.

Housing consumption [column 2 of Table 6.1] is increasing because the parameter values of (r-m-b) is positive. [Please refer to the equations (6.31) and (6.33).] However, there is a discontinuity around the switch time at the year 10; that is, the level of housing consumption almost doubles with homeownership from 15.31 to 27.41.

The level of asset [column 3 of Table 6.1] shows the level of net assets including housing equity. It continuously increases during the entire life cycle because of the high weight (\text{delta}=5) on bequest utility over
consumption utility. The net amount of bequests is represented by the level of terminal assets: in our case, it is 14824.32 [last row of column 3] which is roughly 7 times the amount of nonhousing consumption.

Housing prices [column 4 of Table 6.1] are obtained by multiplying the price per pyong\textsuperscript{17} to the dwelling space [column 2]. Note that the housing prices for rental period are only for reference. They are not rents.

Columns 5, 6, and 7 in Table 6.1 show the total, consumption, and bequest utilities respectively for differently given switch time, not the utility in each year. The total utility [column 5] is the highest (79.91716) when the switch time is 10, which is underlined. Note that the level of utility is measured with a logarithm. Therefore, a slight change in total utility can make a significant difference in real cash values.

The sensitivity of this standard results will be analyzed in the next section.

6.3.2 Welfare Effects and Sensitivity Analysis

Based upon the standard results in the previous section, we perform a sensitivity analysis in order to examine the welfare losses due to the credit constraints and to draw policy implications. As our major concern is on the credit constraints, parameters chosen for the sensitivity analysis are own-fun ratio (k) and formal mortgage rate (i). In addition to these two critical parameters we include two more parameters (b and q) in order to examine the specific impacts of these parameters on housing demand.
The sensitivity test has been done for the following five different cases:

CASE I : Elimination of Credit Constraints With Subsidy (k=0, i< r)
CASE II : Elimination of Credit Constraints Without Subsidy (k=0, i=r)
CASE III: Expansion of Credits With Subsidy (k=0.5, i< r)
CASE IV : Without Premium of Rental Rates (q=1)
CASE V : With Higher Rate of Housing Price Appreciations (b=0.05)

The comparison of welfare levels--in terms of total lifetime utility--will be made only for the former three cases because the latter two are based upon the changes in uncontrollable variables. The results of each simulations are summarized in Table 6.2 along with the standard results shown in Table 6.1.

(1) Welfare Impacts of Credit Constraints and Interest Subsidies

The change in the level of total utility (last row of Table 6.2) shows striking results. The elimination of credit constraints while maintaining present interest subsidy (Case I) increases the total utility from 79.92 (for Standard) to 86.52 (for Case I).18

Case II, however, shows somewhat different results: an elimination of subsidized interest rate along with credit constraints--a perfect capital market conditions--reduces the total utility from 79.92 (Standard case) to
## TABLE 6.2
SENSIVITY OF SIMULATION FOR EACH PARAMETER

<table>
<thead>
<tr>
<th>CASE Parm.</th>
<th>Standard</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
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<td>0.5</td>
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<td>-</td>
<td></td>
</tr>
<tr>
<td>i=0.05</td>
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<td>0.12</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>b=0.03</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>(0.05)</td>
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<td>-</td>
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Switch

Time (Ts) 10 1 1 6 12 16

Nonhousing Consumption (W10,000)

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<th>C(Ts+1)</th>
<th>C(T)</th>
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<td>365</td>
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<td>365</td>
<td>220</td>
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<td></td>
<td>471</td>
<td>230</td>
<td>231</td>
<td>369</td>
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<td>1986</td>
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<td>1669</td>
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Housing Consumption (Pyong)

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Total Net Asset (W10,000)

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Total Utility 79.92 86.52 79.74 80.96 80.07 79.80

NOTE: 1) Standard : With credit constraints and subsidy. [See Table 5.1.]
2) CASE I : Without credit constraints.
3) CASE II : Without credit constraints or subsidy.
4) CASE III : Expanding loan-to-value ratio.
5) CASE IV : Without premium of rental costs.
6) CASE V : Higher housing price appreciation.
79.74 (Case II). It may be argued that any market distortions or subsidy like Standard case of Table 6.2 should result in a welfare loss. However, note that we are using the consumer's welfare, not the welfare of the society as a whole. Therefore, the welfare gain by the homeowners implies a welfare loss by someone in the society. It is not hard to see which is the worst-off group from this dead weight loss: it is the renters who do not have access to the formal credit markets by various economic and non-economic lending restrictions such as legal title, age of dwellings, type of employment, familiarity with the bank clerk, etc.\textsuperscript{19}

Now we have identified the directions of welfare change with respect to our two critical parameters. That is to say, the level of consumers' welfare increases with an elimination of credit constraints and decreases with an elimination of subsidized mortgage interest rates. Then the question may be how much we should eliminate these market distortions.

Case III is an attempt to explore this question. With moderate expansion of credit from 20\% to 50\% of the housing price maintaining the interest subsidy, it shows a gain in total utility from 79.92 (Standard) to 80.96. Considering this case as a basis--since entire elimination of credit constraints will not be possible in reality--we would be able to analyze the impacts from various alternative levels of mortgage interest rates.

(2) \textbf{Impacts on Housing Consumption and Tenure Choice}

In the rows for H(Ts) and H(Ts+1)\textsuperscript{20} in Table 6.2 for the Cases I, II, III,
and Standard case shows a sudden (almost double) increase in housing consumption after homeownership. The sources of this huge jump are two: first, there is no need to save after homeownership except for the bequests; thus, the level of disposable income for consumption is increased. Second, the lower level of user costs of homeownership over rental amplifies this effect.

Case I shows striking results: three times larger at the time of tenure change because of interest subsidy and perfect credits. The same trends of huge increase in housing consumption also can be seen in Case III. The common assumption of these three (Standard, Case I, and Case III) is to maintain the interest subsidy.

Case II which assumes neither credit constraints nor interest subsidy, shows the same discontinuity but with much reduction in housing consumption from 22.0 (before) to 14.8 (after). Interestingly enough, this size of 14.8 pyongs is roughly the size of public housing in Korea which guarantees subsidized mortgages. Although the horizontal comparison among the H(Ts+1)'s is hard to make because of the difference in switch times (Ts), the implication is clear. That is to say, present public housing policy in Korea is aiming at the results of Case II—that is, supply of small housing—with the tools of Standard case—that is, with the extensive credits and subsidized interest rates.

This might be an over-simplification because we do not consider the various institutional barriers and resource limitations. The important point, however, is the direction of impacts of these two policy parameters on the housing demand.
Case IV shows that, without the premium of rental costs, the difference in housing consumption between 19.0 (before) and 28.5 (after) is smaller when compared with Standard case. Case V which is based on a high rate of housing price appreciation shows that the rate of increase in housing consumption is low while the gap between before and after homeownership shows the same trend as standard results.

The switch time of tenure (Ts) shows great variations. A quick examination suggests that it is very sensitive to the credit availability represented by the loan-to-value ratio, (1- k). Expanding credits—with (Case I and III) or without (Case II) interest subsidy—is surely the most critical factor for early homeownership. The switch time also turns out to be sensitive to the price factors such as rental costs (Case IV) and housing price appreciations (Case V). Indeed the housing tenure choice is made in consideration of both housing and credit market conditions.

6.4 Policy Implications

One of the most important implications of the results of our simulation is that the existence of credit constraints and subsidized mortgages in Korea is forcing people to save more in the early stages of their life cycle. In particular, the subsidized mortgage rates induce greater housing consumption at the time of, and after, homeownership.

Although the exact numerical interpretation needs great caution for our
model, the direction of change is obvious. This suggests a very important implication. Thus far, the government of Korea has tried to supply public housing of small units by expanding the loan-to-value ratio while maintaining low interest rate on housing loans. In recent years, many of these units remain unsold. The simulation results can explain this: although these dwelling units are affordable for the moderate income class, they are not desirable. With the extensive public subsidy, people want to buy larger dwelling units than the size currently provided—under 20 pyongs. Therefore, the levels of subsidization and the availability of credit should be carefully weighed based upon the firm understanding of the direction of impacts on housing demand for the more effective implementation of the public housing policy in Korea. In particular, expanding the accessibility of housing loans with a careful elimination of the subsidy on loan interests seems to be one of the best alternatives that the Korean government should choose both to suppress the housing demand and to enhance the homeownership ratio.

This general direction of future housing policy in Korea should be accompanied by an effort to eliminate the visible and invisible institutional barriers in credit allocation systems. To be sure, the social costs of the subsidized mortgages are borne by the whole members of the society.
ENDNOTES OF CHAPTER VI

1. Thurow (1969) also has questioned the assumed ability of individuals to adjust their consumption to the optimum life cycle profile. By comparison of theoretical and actual values he concluded that institutional barriers that block borrowing against future income should be removed.


3. For example, variables A(t), A(t), and Ts; and parameters T, m, k, b, y, R, r, i, and q are such exceptions.

4. The real amount of rental premium will be (1-q) times the housing price. For example, if homeownership cost is 100,000 won per pyong and q is 1.2, then the rental cost will be 12,000 won per pyong with premium of 2,000 won. In the actual simulation, RR [= R(-r-b) times q] represents the rental rate per pyong.

5. Please note that we are using total net asset, A(t), for homeownership period as against the liquid asset, a(t), for rental period. The A(t) is defined by the sum of housing equity and liquid asset for the homeowners. As renters cannot be in debt we differentiate the notations.

6. For detailed discussion of these conditions, please refer to: William C. Wheaton, "Life-cycle Theory, Inflation, and the Demand for Housing," Journal of Urban Economics, 18, pp. 161-79, 1985. As our model allows the switch in tenure and bequest motives, equations (6.16) and (6.17) are needed.

7. See chapter III for the rental rate in terms of the house value.

8. However, there are many reasons for us to believe in the existence of premium rental costs over ownership: 1) The transaction costs of renters are high because they move more frequently than the owners. 2) Doubling up with landlords in the same dwelling unit intensifies the hardships of renters. 3) Command over property is inferior for renters compared with owners. 4) The rental price shows somewhat sticky behavior. In the short
run, at the time of changes in the rate of housing price appreciation, rental price does not lower but shows hesitation to move downward while owners get instant benefits.

9. It is only in the sense of housing credit. Borrowing against the future is still prohibited.

10. Because we assume a automatic shift of tenure once the renter's accumulated assets reach the down payment level, the welfare loss may be negligible if the rate of time preference is small. However, if there is a reasonable amount of rental premium, this effect vanishes.

11. According to KRIHS (1983), rates of imputed rent by tenure are 43.4% for owners, 25% for Chonsei renters, and 20% for monthly renters.

12. That is to say, about 40% of the household portfolio is composed of savings in formal financial institutions, 20% in cash, and 40% in various other institutions in the informal financial market.

13. According to our survey data, average rental period before first homeownership of housing at this income category is 9-10 years.

14. Savings ratios to household income are as follows:

<table>
<thead>
<tr>
<th>Monthly Income (W10,000)</th>
<th>0-150</th>
<th>150-250</th>
<th>250-350</th>
<th>350-450</th>
<th>450-550</th>
<th>550-650</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings ratio (% of Income)</td>
<td>24.6</td>
<td>30.9</td>
<td>29.0</td>
<td>27.8</td>
<td>27.5</td>
<td>28.0</td>
</tr>
</tbody>
</table>

15. As we have applied a continuous time framework, the numbers represent the amount of consumption at the end of each year.

16. In another simulation with delta=1, consumers dissave for more consumption.

17. The initial unit price, p(0), appreciates by 3 percent annually.
18. In money terms, the difference is 700 times of the standard case because we are using logarithmic utility functions.


20. Please note that the actual initial level of homeownership housing consumption $H(T_s)$—which is not appeared in our tables— is different from $H(T_s+1)$ because $H(T_s+1)$ is the level at the end of the year not at the beginning of the year of homeownership, $T_s+1$. However this slight difference does not make any change in our arguments.
CHAPTER VII

CONCLUSION

Since the arguments provided in this dissertation take a narrow viewpoint, namely that of the micro economic study of housing choice and demand, it would be useful to examine the arguments from a broader perspective. In particular, the results of our study will be reviewed in three critical contexts: aggregate housing market, institutions and policies, and theoretical visions.

In the first part of this dissertation, we have argued that the prices of the three housing tenure markets are based upon an important economic factor, namely the user cost of capital. The empirical tests have shown the relevance of our theoretical model. In particular, the Chonsei rental system depends on the high level of returns in the informal financial market as expected. However, the price behavior of homeownership sector shows a discrepancy (although not so significant) from the prediction of our user-cost model.

The empirical tests also imply the following critical characteristics of the Korean housing market:
1) Each tenure is specialized in housing quality and socio-economic characteristics of households.

2) Because of this specialization, improving housing quality usually requires tenure change.

3) However, there is a discontinuity in improving housing quality from rental to ownership.

4) On the other hand, the movement in the rental market is easy to make.

These four critical aspects of the Korean housing market reflect the mechanism of housing policy and institutional systems in Korea.

Specialized tenure by housing quality is closely related to various legal and institutional systems. This would not be possible without partial room-renting. This partial room-renting, again, would not have been possible if there were any legal restrictions on household density per dwelling unit or strict enforcements of restrictions on illegal expansion (or conversion) of the house. Therefore, both enforcing and raising the minimum building standards (e.g., maximum building coverage ratio, minimum lot size, etc.) would have a serious impact on the whole housing market as well as the rental sector.

Diversified tenure is closely related to the dual financial structure of formal and informal capital markets. The recent public attempts to formalize the curb market have resulted in pervasive speculations on real assets such as housing and land on the one hand, and a huge increase in Chonsei rental deposits on the other. It should be noted, however, that the financial resources are moving away from the housing sector because rental deposits are flowing into the curb markets. Therefore, public housing policies or programs should be carefully designed so that the formal resources invested in housing sector do not end up in other sectors of the economy.
One of the most important factors that cause the discontinuity between homeownership and rental markets is the credit constraints. Because of this, homeownership is available only for those with huge personal wealth. In fact, the Chonsei system has been working toward the elimination of this gap; that is, serving as a substitute for a formal housing finance system. Public policies to modernize the Korean housing finance system requires a complete understanding of the financial problems which the Chonsei system is trying to solve.

From a theoretical perspective, the first part of our study sheds light on the future development of housing studies. The common assumption of bifurcated housing tenure (into homeownership and rental) may be reasonable for the housing studies in Korea. Housing demand behavior is also quite responsive to the price signals and is approaching equilibrium even with wildly changing socio-economic environments. However, this adaptation process requires a special form of institutional apparatus, namely divisible housing consumption in such a form as partial room-renting. On the other hand, housing is still indivisible for homeownership, which requires a large amount of personal wealth. Thus, the movements between owning and renting are not symmetrical. As such, the degree of impact of any housing policies and programs aimed at the specific tenure market would have non-negligible impacts on the other tenure markets as well as on the socio-economic groups involved. Thus far, there are not many studies dealing with such cross-tenure market impacts.

In the second part of this dissertation, we have argued that the housing demand behaviors among credit-bound and non-bound households are
different from each other. That is to say, the credit-bound households are mostly dependent upon the level of own assets, while the non-bound are dependent upon both income and assets. We also argued that the degree of credit constraints is determined by market indicators such as loan-to-value ratio and interest rates as well as by household-specific characteristics such as income, accumulated assets, and marginal utility of housing consumption.

The empirical evidence of the second part of the study has shown various important aspects of the housing market, along with the relevance of the theoretical model formulated in chapter IV. The two groups (credit-bound and non-bound) are different not only in financial characteristics but also in demographic characteristics. Among the non-financial characteristics, household size and education levels are conspicuous: that is, the credit-bound had to be bound because they did not have time to wait for the sizable asset accumulation due to their expanded household size. On the other hand, the non-bound have shown positive and significant education effects on housing demand.

These aspects of the housing market bear important implications for credit ration systems. In particular, the result of the application of wrong non-economic criteria may be serious. Because of the differential degree of binding credit constraints depending upon various household-specific characteristics, the credit allocation system should be carefully designed so that the real credit-bound households can receive the loans.

From a theoretical point of view, the second part of our study makes an important departure from traditional studies. For the correct estimation of the asset's effect on housing demand, the asset data should be based on the
"before-purchase" observations rather than "after-purchase" observations because of the strong residual nature of the latter, especially when there are strong credit constraints. In estimating housing demand with correct asset data, we should be careful for the simultaneity that may arise between the asset variable and error terms of the regression. The results of the estimation among the credit-bound and non-bound groups strongly imply that the usual pooled estimation may have seriously underrepresented the credit-bound.

In the third part of this dissertation, we have examined the simulated impacts of credit constraints on consumers' lifetime profile of housing consumption. The major difference of our model from other similar studies is that we allow bequest motives, change in tenure, income growth, and housing price appreciation. The basic argument is as follows. There is an exogenous consumption advantage in homeownership over rental: because of this advantage, renters accumulate their assets over time to become homeowners. In addition to this, the government subsidy of low formal mortgage interest rates induces extensive savings with huge reductions in consumption levels at the early stage of the life-cycle.

The results of the simulation suggest a direction of future housing policy in Korea: **the expansion of loan-to-value ratio along with a careful elimination of the subsidy in formal mortgage interests**. To be sure, expanding credits facilitate the early homeownership. But at the same time, mortgage interest rates should approach the market rate in order to suppress the excessive demand for a larger owner-occupied housing. This direction toward the free capital market is especially needed to **control housing demand and facilitate**
Homeownership: the two major goals of the public housing policy in Korea.

Although we expect substantial changes in parameter values over time, especially in developing countries, the life-cycle simulation of consumption and savings turns out to be a very good tool for the analysis of public housing policy. In fact, we have assumed that the values of all parameters remain unchanged whatever the income levels may be. If we allowed different parameters by income groups, we might indeed have more realistic results.

Throughout the study, it may appear that we are trying to denigrate the importance of income in housing choice. This is not the case. Income is surely the most powerful variable to explain the housing choice behavior; however, some of its effect is indirect and through the influence on the size of asset formation.

Although there is a substantial amount of literature on life-cycle consumption processes in pure economics, most of the authors are concerned with how the level of income affects housing choice rather than the direct impacts of asset levels. This is perhaps because of data availability and variations in the time of housing choice.

Our study can be extended in various directions. The first and major extension might be toward the market interaction between demand and supply. Although we have good reasons to believe that the supply side may effectively adjust the signals from the demand side, the signals from the supply side may also affect demand. Such interaction is not addressed in our study.
The second direction might be an effort to link the level of income and assets. Through our simulation model, we have tried to explain the process of asset accumulation; however, the relationship between income and assets is determined in such a sophisticated way that we have only the results of the interaction, not the functional relationship itself. Our conviction in this study is that considering income alone under credit constraints may result in an incorrect conclusion.

The third direction might be toward the extension of the simulation model. The impact of the micro behavior of consumers can be integrated on an aggregate level with the aggregate supply model if the micro simulation of the supply model is possible from the application of the principles of our simulation model.

The final direction is toward a more comprehensive and practical model including the two important sources of market distortions: taxes and transaction costs. Our study also abstracts from the inflation effects under the common belief that basically it would give neutral effects among the economic sectors involved. To the extent that these three factors--taxes, transaction costs, and inflation--affect the housing market, our theoretical model can be refined, and empirical results can be fully explained.

It is believed that this study as it stands, however, can be applied in many developing countries where housing credits are usually limited during the process of economic development.
APPENDIX: QUESTIONNAIRE SURVEY

1. Sample Frame:

<table>
<thead>
<tr>
<th>Cities</th>
<th>No. of Samples (1982) (A)</th>
<th>Total HH (1980) (B)</th>
<th>(A/B) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Cities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seoul</td>
<td>1,540</td>
<td>1,847,877</td>
<td>0.083</td>
</tr>
<tr>
<td>Pusan</td>
<td>570</td>
<td>690,126</td>
<td>0.083</td>
</tr>
<tr>
<td>Taegu</td>
<td>300</td>
<td>364,268</td>
<td>0.082</td>
</tr>
<tr>
<td>Medium sized Cities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwangju</td>
<td>620</td>
<td>153,184</td>
<td>0.405</td>
</tr>
<tr>
<td>Daejun</td>
<td>520</td>
<td>127,431</td>
<td>0.408</td>
</tr>
<tr>
<td>Jeonju</td>
<td>300</td>
<td>72,862</td>
<td>0.412</td>
</tr>
<tr>
<td>Kangneung</td>
<td>100</td>
<td>24,353</td>
<td>0.411</td>
</tr>
<tr>
<td>Industrial Cities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulsan</td>
<td>250</td>
<td>93,705</td>
<td>0.267</td>
</tr>
<tr>
<td>Yosu</td>
<td>150</td>
<td>32,955</td>
<td>0.455</td>
</tr>
<tr>
<td>Satellite Cities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anyang</td>
<td>210</td>
<td>55,587</td>
<td>0.378</td>
</tr>
<tr>
<td>Buchon</td>
<td>190</td>
<td>51,161</td>
<td>0.371</td>
</tr>
</tbody>
</table>

TOTAL 4750

NOTE: 1) We used only Seoul data in this study.
2) Confidence levels are greater than 0.95.
3) Relative Errors are smaller than 0.1.
2. Questionnaires:

I. Basic Information on HH ...............................................................(All HHs)
   1) HH Classification: 1. Owner-occupier HH
       Rental HH: 2. Primary HH 3. Secondary HH
   2) HH Members

<table>
<thead>
<tr>
<th>HH Relation</th>
<th>Sex</th>
<th>Age</th>
<th>Spouse</th>
<th>Education</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. HHH</td>
<td>1. M</td>
<td>1. Yes</td>
<td>1. No Ed.</td>
<td>1. Yes</td>
<td></td>
</tr>
<tr>
<td>4. Grandchildren</td>
<td></td>
<td></td>
<td>4. High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Parents</td>
<td></td>
<td></td>
<td>5. Junior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Brother/sister</td>
<td></td>
<td></td>
<td>6. College</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Relatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3) Information on HHH
   . Years from marriage
   . Occupation
   . Employment status ... 1. Regular 2. Temporary

II. Basic Information on Housing .............................................. (Owner-occupied only)

                   Apt. 5. Mixed-use
                   4.Inheritance 5. Gift 6. Other
3) Purchase Price
5) Building Structure
6) Year of construction, 7) Lot Size, 8) Floor Area
9) Facilities : Room, Toilet, Kitchen, Bath, Living, Basement
10) Total Number of HHs in the Dwelling Unit
11) Total Number of People
III. Basic Information on Housing ........................................... (Renters Only)

1) Rental Tenure:  1. Whole  2. Partial  
                     with Deposit 4. Monthly Rent  5. Other  
3) House Type:  Detached, Apt, etc.  
4) Keymoney Amount, 5) Monthly Rent  

IV. Housing Conditions ...........................................................(All HHs)

1) Housing Information sources  
2) Occupied Term  
3) Exclusive Use Facilities  
4) Facility Quality & Satisfaction Level  
5) Neighborhood Characteristics:  
   Development status, Zoning, Housing Cond. & type  
6) Time Distance to Workplace & Major Trsp. Means  
7) Access to Public Facilities: Market, Hospital, School, Ward office  
8) Piped Water & sewerage  

V. Information on HH Mobility

(The 1st Home-owned)
1) Year of Homeownership: After/Before Marriage: ___ yr.  
2) Location: 1. Same Ward 2. Same District 3. Same City....  
3) Ownership Status: 1. exclusive 2. partial  
4) Housing type & Facilities 5) Lot Size, Floor Area  
6) Purchase Price  
7) Number of Moves Until Ownership after Marriage  
8) Number of Moves After Ownership  

(Rental HH only who never owned home)  
1) Number of Moves up to now After Marriage  
2) Keymoney paid to the 1st Rental house on Marriage  

(All HHs)
1) Methods of Financing the 1st Home purchase or 1st Rental  
   5. Real Estate Sale
2) Information on Past Move (Chronologically)

Most Recent  Recent  Least Recent
Tenure
Housing Type
Room Number
HH Size & Yrs. of Residence
Location & Neighborhood & Zoning
Purchase Price or Rent
Facilities & Time Distance to Work
Live-in Total HHs
Reasons for Move

VI. Information on HH Asset, Income and Expenditure

   4. Commercial Paper
Fixed: 1. Land 2. Rental Outlet 3. Bldg
   4.Second Home
Other: 1. Color TV 2. Refrigerator 3. Telephone
2) Monthly Avg. HH Income: Wage, Salary, Bonus, other
3) Monthly Avg. HH Expenditure: Savings, Food, Housing
4) Financing Information on Present Home Purchase
   Fin. Inst.  Total Amount  Lending Terms
KHB
Other Formal Inst.
Curb Money and Others
5) Financing for Keymoney: Principal & Interest

VII. Information on HH Attitude and Opinion:
1) Opinion about Homeownership
2),3),4) Opinions about Transaction, Investment, and Rental
### 3. MEAN VALUES OF SURVEY DATA (SEOUL, 1982)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Owner</th>
<th>Chonsei Renter</th>
<th>Monthly Renter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Means</td>
<td>(Standard Deviations)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HHH Age</td>
<td>46.5</td>
<td>39.5</td>
<td>37.4</td>
</tr>
<tr>
<td></td>
<td>(11.3)</td>
<td>(10.6)</td>
<td>(9.3)</td>
</tr>
<tr>
<td>HH Size</td>
<td>5.2</td>
<td>4.4</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>(1.4)</td>
<td>(1.4)</td>
<td>(1.3)</td>
</tr>
<tr>
<td>No. of Children</td>
<td>1.7</td>
<td>1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Under 19</td>
<td>(1.2)</td>
<td>(1.1)</td>
<td>(1.0)</td>
</tr>
<tr>
<td>HHHH Marriage Yrs.</td>
<td>19.3</td>
<td>12.1</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>(11.6)</td>
<td>(10.7)</td>
<td>(9.7)</td>
</tr>
<tr>
<td>No. of Bedrooms (Exclusive Use)</td>
<td>2.9</td>
<td>1.9</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>(1.2)</td>
<td>(0.9)</td>
<td>(0.8)</td>
</tr>
<tr>
<td>No. of Living Rooms (Exclusive Use)</td>
<td>0.96</td>
<td>0.61</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>(0.31)</td>
<td>(0.50)</td>
<td>(0.47)</td>
</tr>
<tr>
<td>Price of Housing (Price, Chonsei, or Monthly Rent)</td>
<td>2727</td>
<td>415.7</td>
<td>8.213</td>
</tr>
<tr>
<td></td>
<td>(1849)</td>
<td>(420.4)</td>
<td>(5.758)</td>
</tr>
<tr>
<td>Asset (Liquid and Fixed)</td>
<td>2958</td>
<td>1041</td>
<td>647.2</td>
</tr>
<tr>
<td></td>
<td>(9723)</td>
<td>(2452)</td>
<td>(1271)</td>
</tr>
<tr>
<td>Income (Family Annual)</td>
<td>716</td>
<td>502</td>
<td>352</td>
</tr>
<tr>
<td></td>
<td>(543)</td>
<td>(335)</td>
<td>(153)</td>
</tr>
<tr>
<td>Asset / Annual-income Ratio</td>
<td>3.96</td>
<td>1.98</td>
<td>1.84</td>
</tr>
<tr>
<td></td>
<td>(12.67)</td>
<td>(4.79)</td>
<td>(3.38)</td>
</tr>
<tr>
<td>House Value/ Income Chonsei/ Income Rent/ Income Ratio</td>
<td>4.55</td>
<td>0.95</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>(3.28)</td>
<td>(0.87)</td>
<td>(0.24)</td>
</tr>
</tbody>
</table>

| No. of Observations        | 750         | 331             | 60              |

**NOTE:**
1) HH: Household; HHH: Head of Household.
2) Housing price, asset, and income are in 10,000 won.
3) Samples with missing observations are excluded.
BIBLIOGRAPHY


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