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Impacts of the New Basel Accord on Housing Finance Market in Korea

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Abstract

Our paper analyzes the macro economic consequences of a housing finance system in response to various aggregate shocks. The current housing finance system in Korea mainly consisting of short-term bullet mortgage programs is in good contrast with the long-term amortization mortgage system prevalent in the US. Our paper is purposed to compare the relative performances of two systems in the advent of income shocks as well as interest rate (or housing price) changes. The risk weight on LSRP (Loans Secured by Residential Properties) of 50% set under Basel I, is anticipated to be lowered to 35% under standardized method of Basel II. The lowered LSRP, reflecting on the past experiences of financial intermediaries, may result in the raised LTV. Thus our paper compares the impact of levying higher LTV on the residential collateral under the two different housing finance systems (bullet type loans versus amortizing ones).

1. Introduction

Our paper analyzes the macro economic consequences of a housing finance system in response to various aggregate shocks. The current housing finance system in Korea mainly consisting of short-term bullet mortgage programs is in good contrast with the long-term amortization mortgage system prevalent in the US. In this context our paper is purposed to compare the relative performances of both systems in the advent of income shocks as well as interest rate (or housing price) changes.

Accepting the presence of borrowing constraints in the form of Loan-To-Value (LTV) ratio, it is intuitively believed that the bullet mortgage system, which requires periodic payments of interest accruals before the maturity, is less vulnerable to income shocks whereas it is more so to housing price fluctuations. It is because under the bullet mortgage system banks tend to enforce the LTV criterion for their household loans collateralized by residential properties. On the other hand, the US-type long-term mortgage system is known to have relative edge against price fluctuations.

The risk weight on LSRP (Loans Secured by Residential Properties) of 50% set under Basel I, is anticipated to be lowered to 35% under standardized method of Basel II. The lowered LSRP, reflecting on the past experiences of financial intermediaries, may result in the raised LTV. Thus our paper compares the impact of levying higher LTV on the residential collateral under the two different housing finance systems (bullet type loans versus amortizing ones).

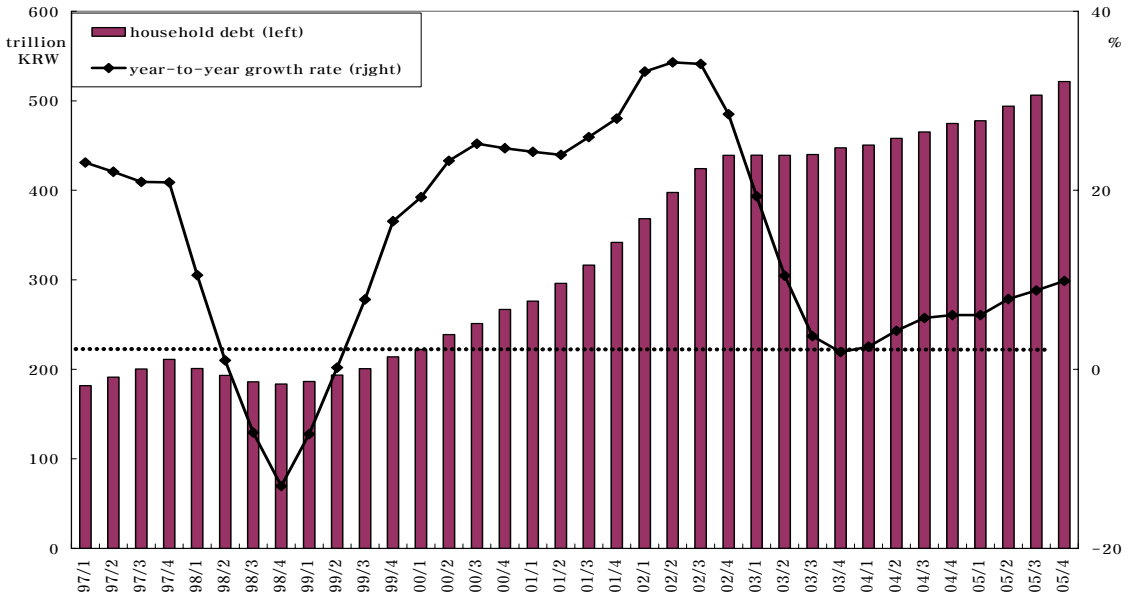
As an analytical tool, we adopt a 10-period partial equilibrium OLG economy, in which only two goods are available-nondurable consumption and durable housing. In this economy, consumers of each generation search optima of consumption and housing schedules across time and states. Exploring how the individual consumption-savings decisions respond to the variations in income, housing price, interest rate and LTV ratio, we compare the robustness of the two existing housing finance systems. Though absolute advantage of one over the other may not be sustained, we still can come up with the conditions, under which one outperforms the other and vice versa.

2. Housing Finance in Korea

2.1. Trend in household debt in Korea

While showing a sign of stabilization recently, household debt in Korea has grown significantly since the economic recovery following foreign exchange crisis in 1997. According to <figure 1>, there seems to exist three distinguished phases in development of household debt market in Korea since the foreign exchange crisis. The first phase is the pre-booming period before 2000. Household debt that had shown very strong growth in response to robust economy crisis was hit hard by foreign exchange crisis and decreased during subsequent severe depression in 1998. It was not until 2000 that the slumping household debt fully recovered up to the pre-crisis level and gained a momentum for explosive growth for the next three years that constitute the second phase. During the booming-period between 2000 and 2002, average annual growth rate of housed hold debt was 27.1%, which significantly exceeded the average income growth rate of 5% during the period. As a result of rapid increase in household debt, main indicators for household's ability to repay the debt significantly deteriorated. Debt-to-income ratio[1] increased by 49.4% points, from 63.8% at the end of

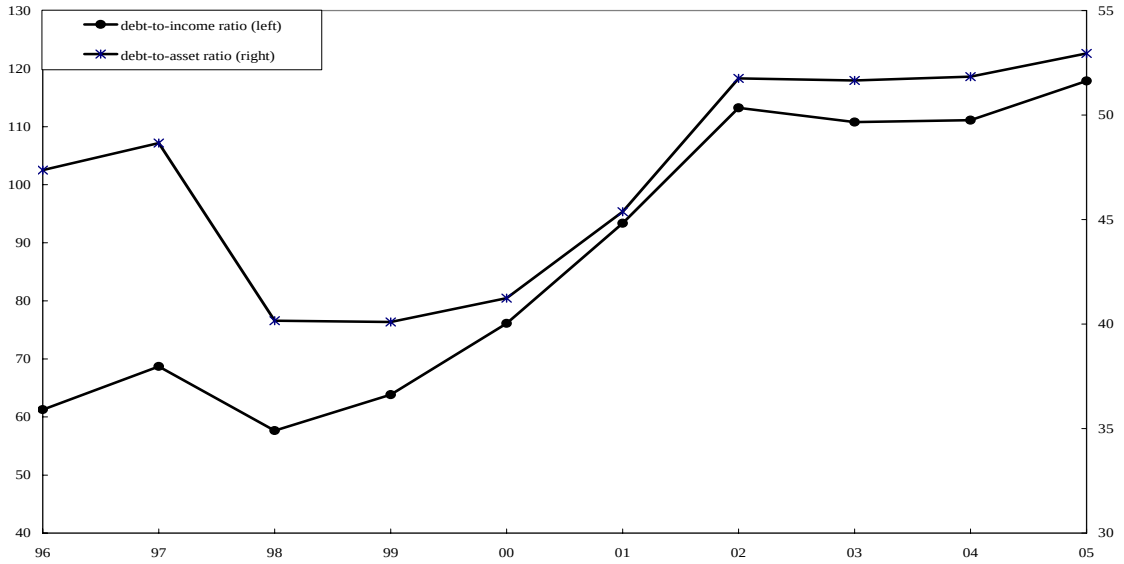
<Figure 1> Household debt in Korea: 1997 ~ 2005



1. Growth rate is the yearly percentage change from the same quarter of the previous year.
Source: Bank of Korea

[1] The measure is defined as the ratio between total household debt and national disposable income for households and private unincorporated enterprises.

<Figure 2> Trend in ability-to-repay indicators: (debt/income) and (debt/asset)



1. Debt-to-income ratio is the ratio between household debt and household disposable income.
2. Debt-to-asset ratio is the ratio between individual debt and asset in Flow of Funds Table.
Source: Bank of Korea

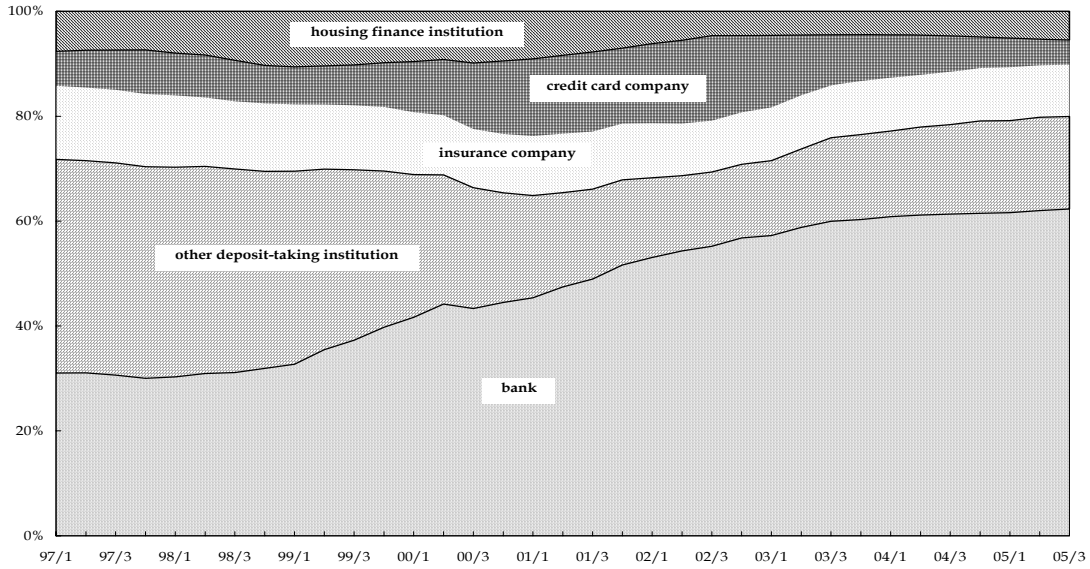
1999 to 113.3% in 2002. Moreover, debt-to-asset ratio[2] that is said to be an indicator for ultimate ability to repay the debt rose considerably from 40.1% at the end of 1999 to 51.8% in 2002. Rapid growth in household debt invited serious concern on the soundness and sustainability from both regulatory body and the market. Banks and credit card companies started to tighten the credit screening process to curb additional credit supply to household sector. Alarmed by unprecedented loan increases, regulatory authority also took various measures to control the household debt and sustain the stability of financial system. As a result of harmonized efforts though somewhat hurried, the lion was finally led to the cage. From 2003, annual growth rate of household debt stayed below 8% that is widely thought to be sustainable in long term perspective. The cost was dear. The biggest credit card company went bankrupt and financial market was in turmoil during 2003 and 2004.

Banks and credit card companies led the trend. Bank's weight in lender composition jumped by 17% points from 1999 to 2002 and continued to increase to reach 62% at the end of 2005. Proportion of credit card companies fluctuated severely. Loans by credit card companies constituted only 8.4% at the end of 1999 but explosive increase brought

[2] It is defined as the ratio between total individual debt and total individual asset in Flow of Funds table published by the Bank of Korea. The individual sector in the table includes private unincorporated enterprises and various non-profit organizations as well as households. Therefore, household debt in <Figure 1> does not coincide with individual debt in Flow of Funds table. The change of basis is unavoidable since information on aggregate asset holdings by households is not available.

the weight to 16.25% at the third quarter of 2003. Rapid increase in default rate and drastic regulatory measures forced credit card companies to take measure to curb loan growth and the proportion of household loans by credit card companies has shrunk to reach less than 5% at the end of 2005.

<Figure 3> Lenders to household sector



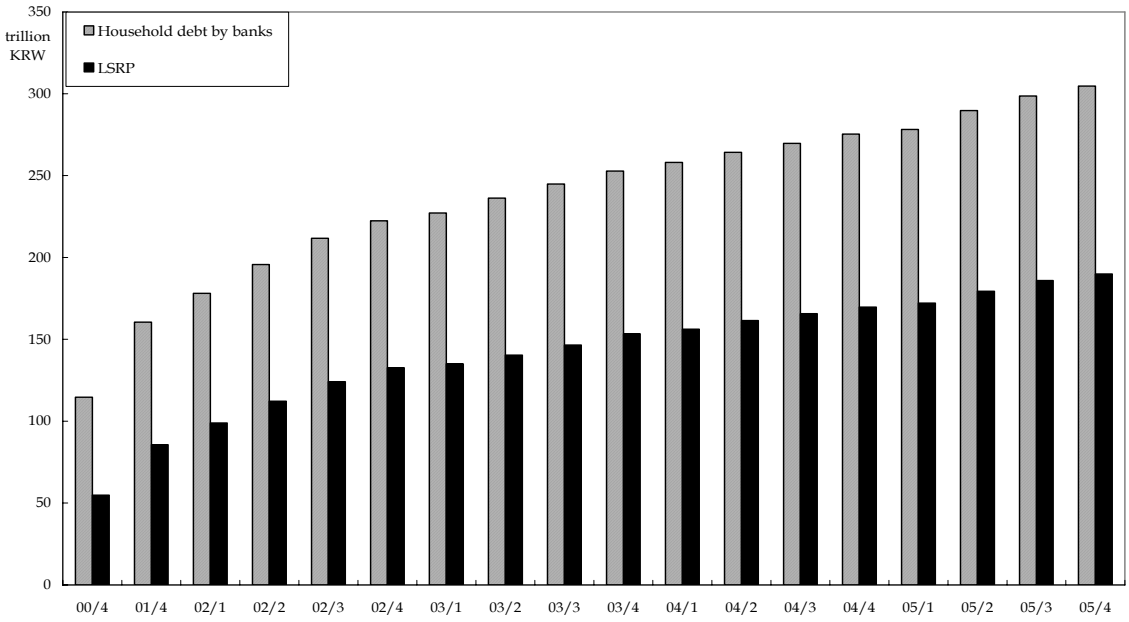
1. Housing finance institution includes Korea Housing Finance Corporation and National Housing Fund.
2. Other deposit-taking institution includes savings bank, credit unions and mutual saving cooperatives.
Source: Bank of Korea

2.2. Loans to Households Secured by residential properties in Korea

2.2.1. Recent trend in loans to households secured by residential properties in Korea

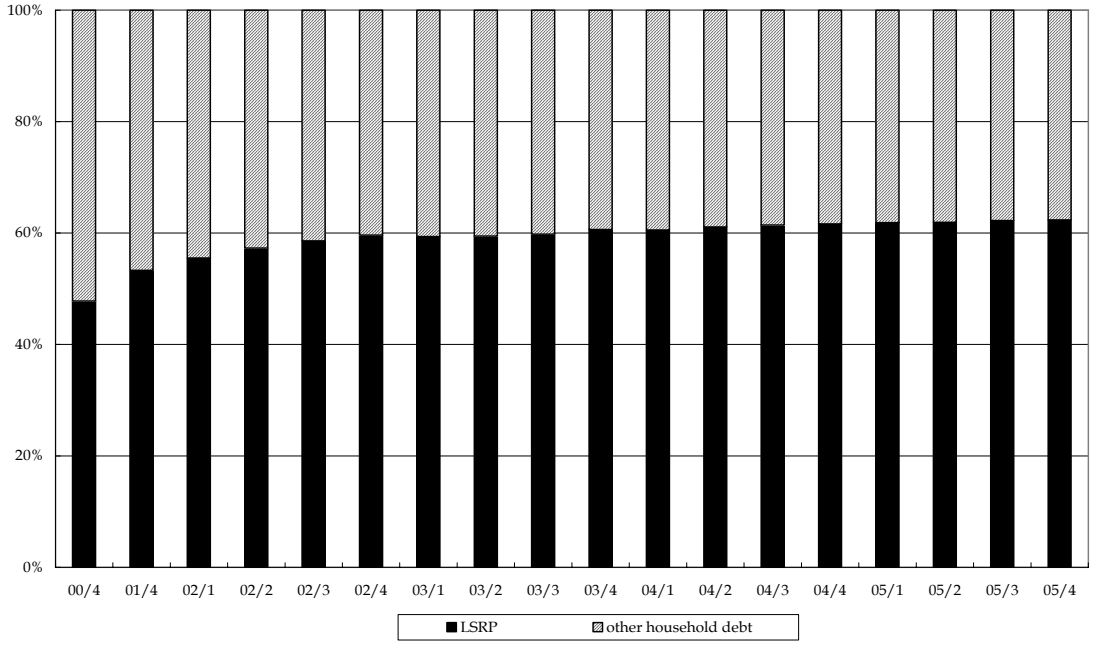
In the previous section, we show that one of the main driving forces behind the explosive growth of household debt between 2000 and 2002 was the increase in credit supplied by banking sector. Loans to households secured by residential properties (LSRP) supplied by banks also increased rapidly as the household debt by banks increased. As shown in <Figure 4>, LSRP quadrupled in five years during which total loan to household by banks tripled so that the proportion of LSRP in household loan by banking sector rose from 58.1% in 2001 to 62.4% in 2005. The pace of LSRP growth in the booming period between 2000 and 2002 was especially spectacular with annual growth rate exceeding 50%.

<Figure 4> Loans to household



1. LSRP is the loans to household secured by residential properties.
2. Note that end-of-the-year balances are presented for 2000 and 2001 due to lack of data.
Source: Bank of Korea

<Figure 5> Composition of loans to household by banking sector



1. LSRP is the loans to household secured by residential properties.
2.Other household debt includes credit card debt issued by banks, individual loans with credit line, and non-secured loans.
Source: Bank of Korea

2.2.2. Characteristic features of contract: bullet mortgage

LSRP in Korean housing finance market is a very special form of mortgage loan. There are three distinguished characteristics in LSRP in Korea compared to typical mortgage loan: short maturity, no amortization of principal, and low loan-to value (LTV).

LSRP has a very short maturity structure. A typical LSRP matures in 3 years and the maturity is shortened further when conditions in credit market deteriorate. According to a survey by Financial Supervisory Service (FSS) in 2005, 47.6% of LSRP have the (original) maturity no longer than 3 years, 21.4% for 3 to 5 years. In other words, more than two-thirds of total LSRP matures in 5 years. On the other hand, LSRP with maturity longer than 10 years occupies 25.3% of total LSRP and the weight increased by 15.7% points compared to the previous survey in 2003. The rapid increase is mainly attributable to the establishment of Korea Housing Finance Corporation in 2003[3] in the wake of rapid increase in LSRP and rising concerns on its long-term stability. According to <Table 1>, all countries surveyed by BIS other than Korea have long-term mortgage with maturity no shorter than 10 years as the main player in housing finance market.

<Table 1> Contract Features in Selected Mortgage System

Country	Usual length of contract (years)	Estimated average LTV ratio (new loans)	% of owner-occupiers with mortgages
Australia	25	60-70%	45
Belgium	20	80-100%	56
Canada	25	75-95%[1]	54
France	15-20	78%	37.5
Germany	20-30	80-100%; 60% for Pfandbrief	na
Italy	5-20	80%	na
Korea	3-20	56.4%; max 70%	na
Japan	20-30	na[2]	na
Luxembourg	20-25	80%	na
Mexico	10-15	80-100%	na
Netherlands	30	87%; max 125%	85
Spain	15-20	70-80%	na
Sweden	30-45	80-95%	na
Switzerland	15-20	Max 80%; 65% for Pfandbrief issuance	na
United Kingdom	25	70%	60
United States	30	Typically about 85%	65.1[3]

[1] 75% for conventional (non-insured) mortgage loans and 95% for insured mortgage loans. [2] The Government Housing Loan Corporation discloses the average LTV ratio for the underlying mortgages of its MBSs. The ratio has been around 70-80% from the first issue in March 2001 to date. [3] 2001 Survey of Consumer Finances, Board of Governors of the Federal Reserve System.

Source: BIS(2006)

[3] KHFC started to sell long-term mortgage loans from March, 2004.

The second feature of LSRP in Korea is that borrowers are not required to repay the principal till maturity. Borrowers pay only interest on regular basis[4] and the loan is rolled over unless serious problems happen such as delayed interest payment, default, and sharp decrease in housing value[5]. Literatures call this type of mortgage loan as bullet mortgage to convey the feature that the principal is carried to the maturity without amortization and borrowers are required to pay very large amount of money when maturity arrives. According to FSS survey in 2005, 70.5% of LSRP are contracted as bullet mortgage loans but the proportion of bullet mortgage declines very fast[6]. Reflecting the burden of principal repayment at maturity, LTV for a bullet mortgage loan is set at relatively low level compared to long-term mortgage with amortization. It is know that the current average LTV for LSRP in Korea is well below 60%. In most of the countries with usual mortgage system, LTV are set at the level higher than 70% when the loan contract originates (See <Table 1>).

3. Basel II and Loans Secured by Residential Properties

3.1. Basel II on household debt collateralized by residential properties

The New Basel Accord (Basel II) suggests two different approaches to the treatment of the credit risk in LSRP. Under standardized approach, all eligible LSRP are charged with 35% risk weight, a considerable reduction from 50% under Basel I. For the banks opting to Advanced Internal Ratings-Based (A-IRB) approach, the formula for capital requirement for one unit of LSRP is given by

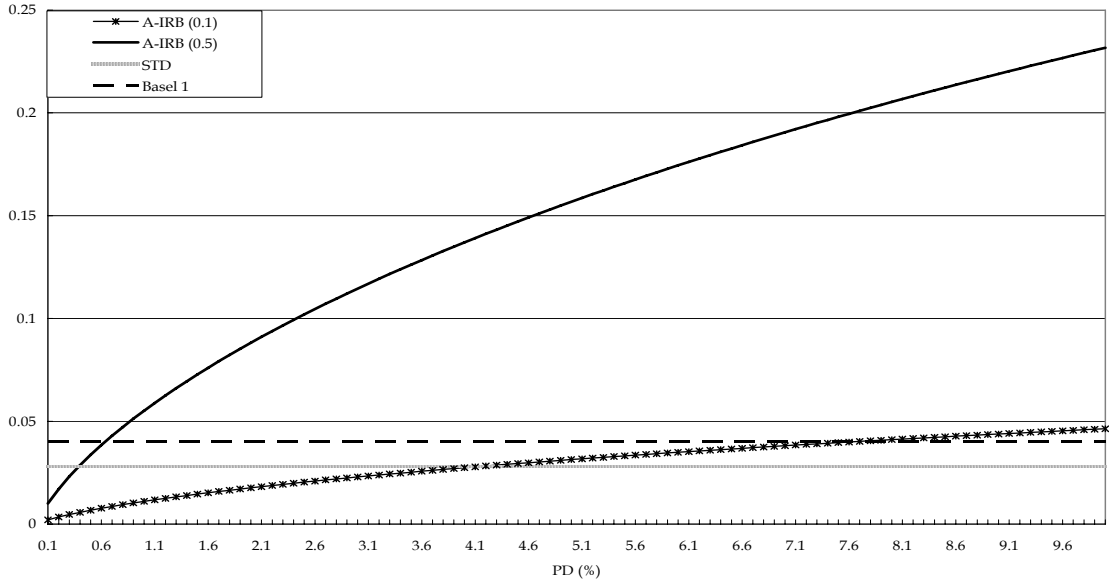
$$K = LGD \times \Phi\left((1-\rho)^{-0.5} \times \Phi^{-1}(PD) + \left(\frac{\rho}{1-\rho}\right)^{0.5} \times \Phi^{-1}(0.999) \right)$$

where K is the capital requirement, LGD loss given default, PD the probability of default, ρ the credit correlation. $\Phi(\cdot)$ is the cumulative distribution function of a standard normal random variable and $\Phi^{-1}(\cdot)$ its inverse function. The Basel committee recommends $\rho = 0.15$. Estimating LGD and PD based on its own historical data, individual bank obtains customized capital charge for eligible LSRP.
For comparison's sake, we illustrate capital requirement for one unit of eligible LSRP

[4] Monthly interest payment is the usual arrangement.
[5] In some cases, borrowers are asked to pay very small portion (typically less than 5%) of the principal as a precondition for roll-over of the matured loan.
[6] The proportion of LSRP with amortization doubled in 2 and half years. It was only 14.1% in 2003 but rose to 28.3% in May, 2005.

under different regimes of credit risk assessment in <Figure 6>. First thing to note is that Basel II treats LSRP very favorably. Under standardized approach, one additional unit of LSRP requires only 0.028 unit of capital charge, a significant reduction from 0.04 unit under Basel 1 for the same category of loans. For the banks adopting A-IRB approach, burden of capital requirement lessens if the probability of default is no higher than 7.7% assuming loss given default is 10%. It is highly unlikely that banks obtain average default rate for LSRP exceeding 7% from historical data. The average default rate for household loan for the last five years is 1.64% with the highest rate at 2.4% in 2001. The default rate for household loan by banks did not exceed 8% even during the economic turmoil following foreign exchange crisis. It is known that the default rate of LSRP is somewhat lower than other types of household loan due to high cost of foreclosure to borrowers. Under both options available to banks under Basel II, LSRP are likely to be treated more favorably than under Basel I. Additional thing to note from <Figure 6> is that capital requirement under A-IRB approach is very sensitive to the assumption on LGD. If we assume that LGD is 50% instead of 10%, capital requirement under A-IRB exceeds that under the current regime for the default rate higher than 0.7%. To be sure, it is unlikely for LGD of LSRP to reach as high as 50% and one can write down the scenario as unfounded concern. However, any regulator in charge of maintaining system stability should not totally exclude the possibility of extreme tail event in asset market.

<Figure 6> Capital requirement under different regimes



1. The graph illustrates capital requirement for one unit of LSRP under different credit risk assessment regimes.
2. A-IRB(0.1) assumes that LGD is 10% and 50% for A-IRB(0.5).

3.2. What is the concern?

As discussed in the previous section, the New Accord treats LSRP more favorably than the previous accord in the sense that the cost of additional LSRP to banks are lower under the New Accord. As a consequence, one can expect LSRP to increase further driven by cheaper funding source for the loan. However, it may not be justified to allow lower capital charge for LSRP in Korean context if we take into the consideration the observation that Basel Committee's recommendation is based on the historical experience of BIS member countries with conspicuously different housing finance system as discussed in Section 2.2.

The two different mortgage systems may require different regulatory approach when it comes to aggregate stability of the financial system. Bullet mortgage system does not require amortization of principal so that it is more robust to negative income shock than the conventional mortgage system that obliges the borrowers to repay both part of principal and interest. On the other hand, the principal is carried over till the maturity in bullet mortgage system and in most cases the matured loan is rolled over as long as the collateral value of the house exceeds a certain multiple of the loan amount. Hence, bullet mortgage system is more likely to be vulnerable to negative housing price shocks relative to conventional long-term mortgage system. Therefore, it may not be a good idea to accept the recommendation based on experiences under different institutional arrangement in housing finance market. Fabozzi and Modigliani (1992) argue that US Congress enacted the National Housing Act of 1934 and established the Federal National Mortgage Association (Fannie Mae) to encourage the development of long0term mortgage market after the Great depression in response to sluggish recovery of private consumption severely hit by massive foreclosure of homes that were under the bullet mortgage contracts.

We formalize the idea in the context of choice by optimizing individuals in the following section and try to illuminate the implication on aggregate stability of the trade-off between income shock and housing price shock under different housing finance institutions.

4. The Model

4.1. The framework

In this section we introduce a T-period (T=10) partial equilibrium OLG model, which

mainly draws on Barnes and Young(2003) and Tudela and Young(2005). For tractability, we maintain the model in a simplest setup as follows:

An economy of our interest consists of consumers who can live up to *T*-periods (t=0, 1, 2, 3, …, *T*). Thus, at each period there are ten generations of consumers in the economy[7].

$$U_t^T \equiv \sum_{t=1}^{T} \beta^{t-1} \frac{1}{1-\gamma} (h_t^{\alpha} c_t^{1-\alpha})^{1-\gamma} + \beta^{T-1} \frac{k}{1-\gamma^*} bq_T^{1-\gamma^*} \qquad (1)$$

A consumer's intertemporal utility is defined to be additively time separable. The consumer's utility is derived from consumption goods ($c_t, t = 0,1,2,...,T$), housing service ($h_t, t = 0,1,2,...T$)[8] and the amount of bequest (bq_T). Among many candidates, (1) is elected because it takes after a Cobb-Douglas utility function within a period and a CRRA utility across periods. Accordingly the parameter σ commands intertemporal elasticity of substitution as well as risk aversion. On the other hand, α controls a share of spending on housing service.

Next the consumer 's income is classified into labor income (y_t) and capital income. The capital income is in turn classified in two groups by the types of asset held-financial income ($r_t a_t$, interest accruals) and gains from house sales ($q_t(1-d)h_{t-1} - q_{t-1}h_{t-1}$). On the other hand, labor income is assumed to be quadratic with respect to the age of a consumer as below[9].

$$y_t \equiv w_0 + w_1 t + w_2 t^2, t = 1,2,...,T \qquad (2)$$

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[7] Each age group in the model can be mapped to one of 5-year interval age groups between 20 and 69 in reality. For example, t=1 implies an age group of 20-25, while t=10 between 65-69. Demographic composition of these age groups will be specified later when necessary.

[8] h_t stands for the housing stock an individual holds at time t. The housing service flow is assumed to be linear with respect to the housing stock h_t. In addition it is assumed that there is no rent market for housing.

[9] Additionally, suppose $w_2 < 0$ and $w_1 > 0$. Then, the culmination of earnings in a life cycle is reached at $t = -\frac{w_1}{2w_2}$.

In terms of savings, the consumer holds two options- bank deposit (a_t) and the purchase of housing (h_t). But housing is distinguished from bank deposits in that it provides housing service while working as a vehicle of savings[10]. Considering such differences between the two types of asset, the consumer's saving equations are represented as in (3).

$$\begin{aligned} a_t &\equiv y_t + (1+r_{t-1})a_{t-1} + q_t(1-d)h_{t-1} - p_t c_t - q_t h_t, t = 1,...,9 \\ a_{10} &\equiv y_{10} + (1+r_9)a_9 + q_{10}(1-d)h_9 - p_{10}c_{10} - q_{10}h_{10} - bq_{10} \\ a_0 &= h_0 = r_0 = 0 \end{aligned} \quad (3)$$

In addition to (3), (4) is levied in order to guarantee that any consumer should not leave debt in the time of death.

$$-(1+r_{10})a_{10} = q_{11}(1-d)h_{10} \Leftrightarrow a_{10} = -\frac{q_{11}(1-d)h_{10}}{1+r_{10}} \quad (4)$$

By combining the savings equations in (3) recursively, we obtain the consumer's life cycle budget constraint of (5), which eliminates $a_t, t = 1,2,...,T-1$. (5) is consistent with economic intuition that the present value of life cycle consumption(non-durable and housing) should be equal to the present value of labor income flow and asset holding in the last period.

$$\begin{aligned} a_{10} = &\sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} y_t + \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} q_t(1-d)h_{t-1} \\ &- \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} q_t h_t - \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} p_t c_t - bq_T \end{aligned} \quad (5)$$

In the meantime, by plugging (5) into (4), we obtain (6), which becomes simpler by getting rid of a_T.

[10] Another notable point of housing as a means of saving is that it depreciates at the speed of d*100% each period

$$0 = \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} y_t + \left(\frac{1}{1+r_{10}}\right)\sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} q_t(1-d)h_{t-1} \qquad (6)$$

$$- \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} q_t h_t - \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} p_t c_t - bq_T$$

So far we haven't yet levied any restrictions on borrowing. However, considered that most household debts are collateralized by the real estate properties, the presence of credit constraints is hardly negligible. Accordingly, our model sets the upper limit of the household borrowing at a certain fraction of the collateral value, which is normally called Maximum *Loan-To-Value* (MLTV) ratio.

Banks are required by the law to check whether the LTV ratio for each loan is lower than MLTV($\equiv \lambda$). Unless the LTV test passes, banks neither approve the loan nor deny its rollover (especially under the bullet mortgage system). Then, either the involved household or the bank may have to liquidate the residential property to meet the LTV restriction.

A rationale for setting the LTV ratio is that it can reduce loss probability of bank loans. However, a dilemma lies in that too low LTV may blackball too many potential home buyers from the loan market. Accordingly, banks determine the LTV ratio λ_t by compromising between the reduced loan losses and low profitability. In this section we spare a little space for discussing the processes, through which the LTV ratio λ_t is determined[11].

Aforementioned, the primary goal of this paper is to compare the performances of the two different housing finance scheme- a bullet (non-amortizing) mortgage system vs. an amortizing mortgage system. Based on the above assumptions, we represent the maximization programs for households in both housing finance systems sequentially.

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[11] Though the legal maximum may be stipulated by the law, LTV that banks apply in practice may have different values, sometimes lower and sometimes higher. In other words, the effective MLTV does hold different values in different states and time.

The effective LTV rates are to be determined at the level in which the expected revenue of a bank is maximized. Considered that the banking sector is perfectly competitive, the banks will gain zero expected rate of return at the effective LTV rate. However, in order to find the zero profit LTV rate a certain level of interest rate and a pricing kernel for human capital should be given in prior. The shape of the pricing kernel is hard to come by and the interest rate in combination with the LTV rate determines the equilibrium conditions for the previously defined economies. For these reasons, we assume that the LTV rates are given exogenously and uniformly across agents by the monetary authority.

Additionally, in order to avoid further complications, it is assumed that population does not grow. Thus, each generation of consumers take equal proportion in the total population.

4.2. Non-amortizing Mortgage program

In reality the non-amortizing mortgage system is characterized by a couple of points as follows: First, maturities of the loans are relatively short ranging from 3 years to 5 years and the loans are allowed rollovers based on the borrower's payment records and LTV ratio. Second, no principal payment is made until the maturity and only the accrued interests are paid to the banks on a monthly basis. Unless a rollover is approved at maturity, the borrower will be responsible for paying off the principle plus the interest accruals.

To epitomize the non-amortizing mortgage in the model economy, we assume that the maturity of loan is one period and it can be extended based on the LTV check. The maximization program for households under the bullet mortgage system is

$$\max \sum_{t=1}^{T} \frac{\beta^{t-1}(c_t^{1-\alpha} h_t^{\alpha})^{1-\sigma}}{1-\sigma}$$

$$0 = \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} y_t + \left(\frac{1}{1+r_{10}}\right) \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} q_t(1-d)h_{t-1} \qquad (7)$$

$$- \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} q_t h_t - \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} p_t c_t - b q_T$$

$$-a_t \le \lambda_t q_t h_t, \quad t = 1,2,...,10$$

$$a_t \equiv (1+r_t)a_{t-1} + y_t - p_t c_t - q_t(h_t - h_{t-1})$$

A consumer starts his/her life by borrowing money from a bank. Combining his initial income (y_1) with the bank loan, he purchases consumption goods (c_1) and housing stock (h_1). The size of the loan is defined to be the difference between his expenditure and the current income ($p_1c_1 + q_1h_1 - y_1$). At $t > 1$, the consumer perceives his labor earnings (y_t) and the house price (q_t). Then, he pays the interest payment ($-r_t a_{t-1}$)

and asks the bank a rollover[12]. Upon request, the bank will approve or disapprove the rollover by checking the LTV ratio of the loan ($-s_t \le \lambda_t p_t h_t$). In case either the rollover is declined or his financial status cannot afford even the interest payment, the collateral will be liquidated in the market. The proceeds from the liquidation will be used in paying off the debts as well as purchasing the consumption goods (c_t) and the new level of housing stock (h_t).

4.3. Amortizing Mortgage program

In reality an amortizing mortgage system is contrasted with the previous case on the following points: First, maturities of the loans are relatively long ranging from 10 years to 20 years. Thus, frequent rollovers are not necessary and LTV ratio is checked only once at the beginning of the mortgage[13]. Second, the borrower is responsible for monthly payment, which includes a fraction of the principal as well as the accrued interests.

Compared with the non-amortizing scheme, it is inferred that the amortizing mortgage program is less susceptible to housing price shocks, which may induce the violation of the LTV ratio. On the other hand, the monthly payment including a fraction of the principal as well as the accrued interests makes the amortizing mortgage more vulnerable to the income shocks.

Considering such differences of the two housing finance system, we construct a consumer's maximization program under an amortizing mortgage scheme as follows:

$$\max \sum_{t=1}^{T} \frac{\beta^{t-1}(c_t^{1-\alpha} h_t^{\alpha})^{1-\sigma}}{1-\sigma}$$

$$0 = \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} y_t + \left(\frac{1}{1+r_{10}}\right) \sum_{t=1}^{10} \frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})} q_t (1-d) h_{t-1} \qquad (8)$$

[12] In reality, the individual at this stage has another option, which is to declare default. Though in this model we exclude the possibility of default for simplicity, default arises more often than we might anticipate. For example, it occurs inevitably when the consumer cannot guarantee the positive consumption $c_t = y_t - rs_{t-1} \le 0$.

[13] Refinancing and prepayment risks are not dealt with in this paper.

$$-\sum_{t=1}^{10}\frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})}q_t h_t-\sum_{t=1}^{10}\frac{\prod_{t=1}^{10}(1+r_{t-1})}{\prod_{k=1}^{t}(1+r_{k-1})}p_t c_t-bq_T$$

$$-a_t \le \lambda_t q_t h_t \quad \text{for} \quad t=2,3,...,9\,,\ \text{if} \quad a_t-(1+r_t)a_{t-1}<A_t$$

$$-a_1 \le \lambda_1 q_1 h_1\,,\quad A_t=-\frac{a_{t-1}}{\sum_{k=1}^{t}(\prod_{j=0}^{k}\frac{1}{1+r_j})}\,,t=2,3,...,9$$

where A_t denotes the amount of monthly mortgage payment due at t period[14].

Unlike in the bullet mortgage system, LTV is checked only at the beginning of the mortgage in this economy ($-a_1 \le \lambda_1 q_1 h_1$), unless $a_t-(1+r_t)a_{t-1} \ge A_t$. The liquidation process begins when the borrower fails to pay his monthly dues (A_t). After the liquidation process, the consumer restarts to solve (7) with the shorter time horizon.

Equation (7) exemplifies the adjustable rate mortgage (ARM). The maximization program under ARM is used in the paper because it is easier to represent in a set of equations compared with the fixed rate mortgage (FRM)[15].

5. Simulation Result

In this section we calculate the maximization programs of (7) and (8). Due to the presence of borrowing constraints, such as LTV tests, an exact closed form solution is hard to come by. Thus, we display several numerical examples based on (7) and (8) and compare the stability of the two housing finance systems by examining both the cross-sectional and cross time patterns of housing stock held. Allowing variations in key parameters, such as LTV ratio, labor income, and interest rate, we explore how the economic decisions are affected in the two different housing finance systems.

The parameter values used in calculations are selected by the following criteria. In case they are directly observable (such as the economic growth rate, housing price growth and inflation), their long-run averages in Korea are used. On the other hand, unobservable parameters like time preference and risk aversion coefficients borrow their values from the existing literature.

The values of the key parameters are given in <Table 2>. Based on these values we

[14] Of course, the present valued sum of A_t s amounts to the current outstanding loan.

[15] In real life most common is a fixed rate mortgage (FRM), under which a mortgage holder can even opt to refinance each time lower interest rate is applicable. However, we do not analyze the FRM setup because there is no distinction between ARM and FRM in a certainty case like ours.

calculate the paths of consumption, housing stock held, and savings (or debts) for the maximization programs of (7) and (8). Repeatedly obtained for many generations of consumers, these results also demonstrate the cross-sectional feature of household behaviors.

<Table 2> Values of key parameters

Parameter	Value	Description
α	0.5	The share of instantaneous marginal utility from
β	0.904	Time discount factor
γ	4	Intertemporal elasticity of substitution or risk aversion coefficient
d	0.05	Depreciation rate of housing
λ_t	0.8	Maximum LTV ratio at t
r_t	0.37	Nominal interest rate at t
k	0.7	Preference for bequest
p_t	$p_t = 1.188 p_{t-1}$	Assuming 19% of price increase in 5 years ($p_1 = 1$)
q_t	$q_t = 1.217 q_{t-1}$	Assuming 22% of housing price increase in 5 years ($q_1 = 3$)
g_t	0.54	Nominal Economic growth

<Table 3> Labor income profile of age groups

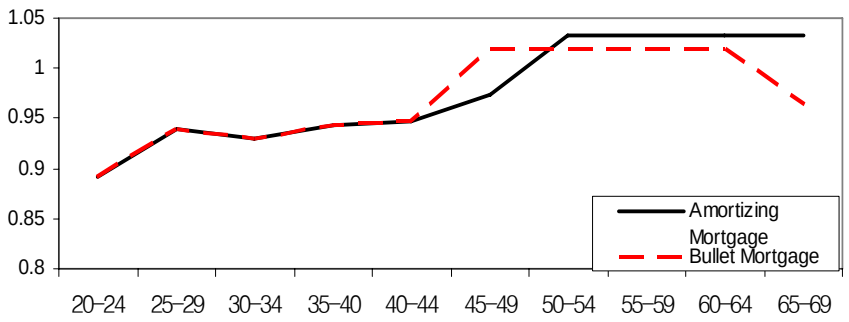
Income	NSHIE(2000)[16]	Value
y_1	84.28	0.045787
y_2	162.01	0.078375
y_3	414.71	0.178646
y_4	785.37	0.301261
y_5	1,448.32	0.494707
y_6	1,771.68	0.538869
y_7	1,599.28	0.433149
y_8	1,622.32	0.391261
y_9	1,648.36	0.353995
y_{10}	1,735.75	0.33193

The labor income profile of various age groups used in calculation is displayed in the third column of <Table 3>, which is processed from NSHIE (2000). As is guessed, the earnings profile shows the quadratic curvature.

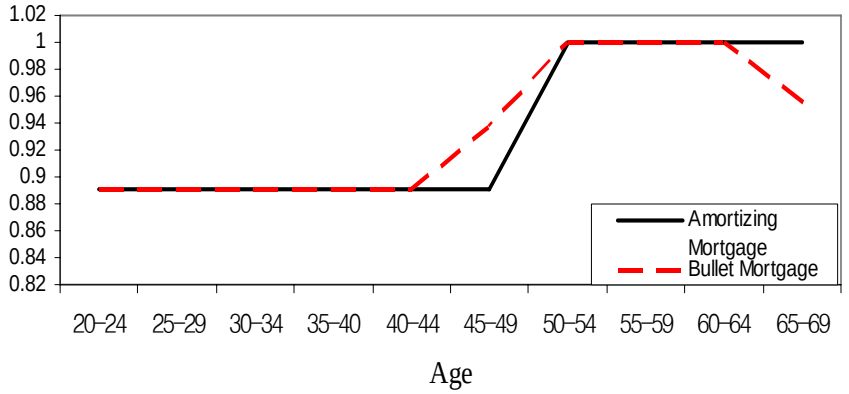
Based on the given values of the parameters and the labor income flow, we calculate (7) and (8), which constitute benchmark cases. The benchmark cases are compared respectively with the cases in which the LTV ratio is lowered from 0.8 to 0.55, or the interest rate is raised from 37% by 5%p, or the labor income is temporarily increased by 10%. From the comparisons, we could see how the housing finance systems have differential impacts on the demand for housing across time and across generations.

[16] NSHIE(National Survey on Household Income and Expenditure) administered by National Statistical Office of Korea is one of the most comprehensive cross-section household data sets.

[Fig.1] The Ratios of Housing Stock: Time Series
(LTV=0.55/LTV=0.8)



[Fig.2] The Ratios of Housing Stock:Cross-Section
(LTV=0.55/LTV=0.8)



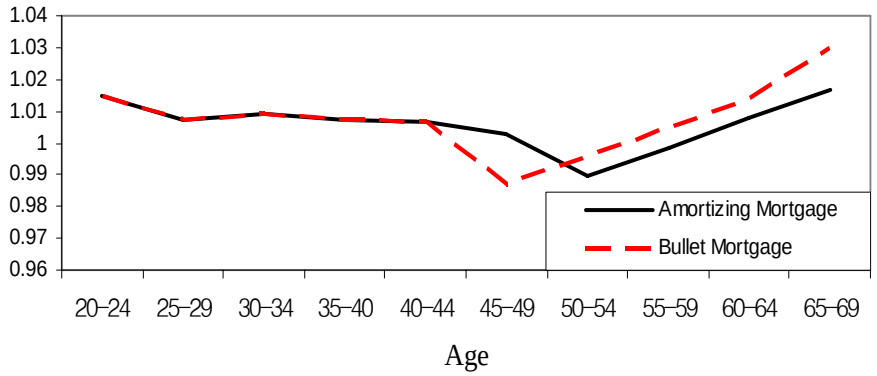
[Fig.1] and [Fig.2] plot the ratios of the housing demand when the maximum LTV ratio is 55% with respect to that when the MLTV is 80%. [Fig.1] traces the life time path of housing demand of an individual. In contrast, [Fig.2] demonstrates housing demands for various age groups at a certain point of time.

These two figures consistently show that the housing demand is reduced in response to falling LTV for the younger, that are more likely to be credit constrained. On the other hand, the housing demand is increasing for the elderly because they are relatively freer from the borrowing constraints. Furthermore, the pattern of steeper housing demand across age and age groups implies that the lowered LTV works towards fortifying the liquidity constraints.

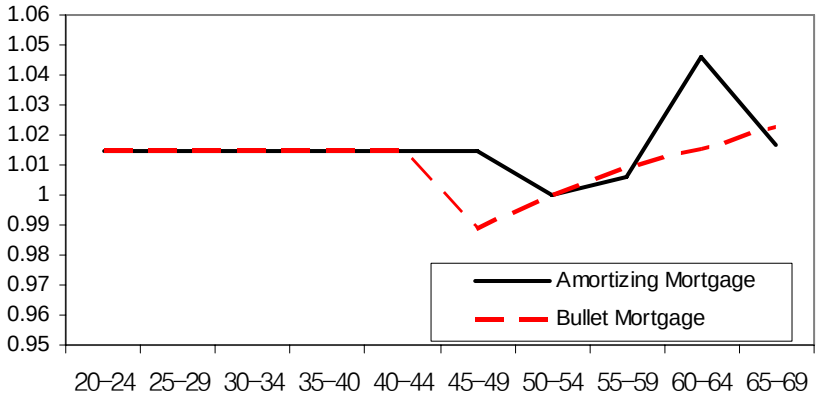
Next, [Fig.3] and [Fig.4] plot the ratios of the housing demand when the interest rate is 42% with respect to that when it is 37%. Like in the previous graphs, [Fig.3] traces the life time path of housing demand of an individual whereas [Fig.4] demonstrates housing demands for various age groups at a certain point of time.

[Fig.3] and [Fig.4] show that in the bullet mortgage system the demand for housing changes in a more volatile way than that in the amortizing mortgage. This confirms our intuition that in the bullet mortgage system borrower are more susceptible to interest risk than in the amortizing system.

[Fig.3] The Ratios of Housing Stock:Time Series (r=0.42/r=0.37)

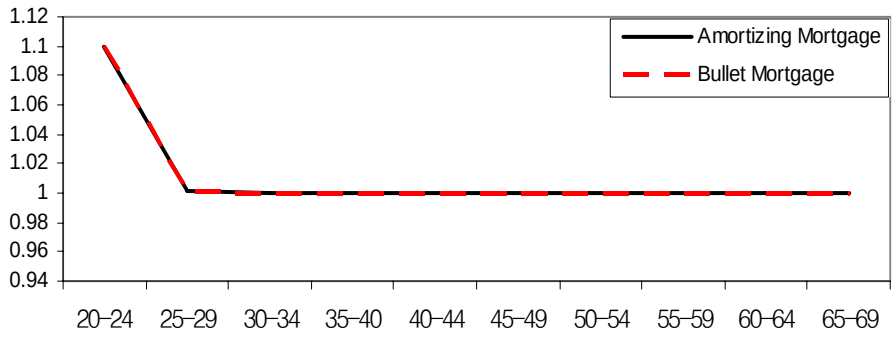


[Fig.4] The Ratios of Housing Stock:Cross-Section (r=0.42/r=0.37)

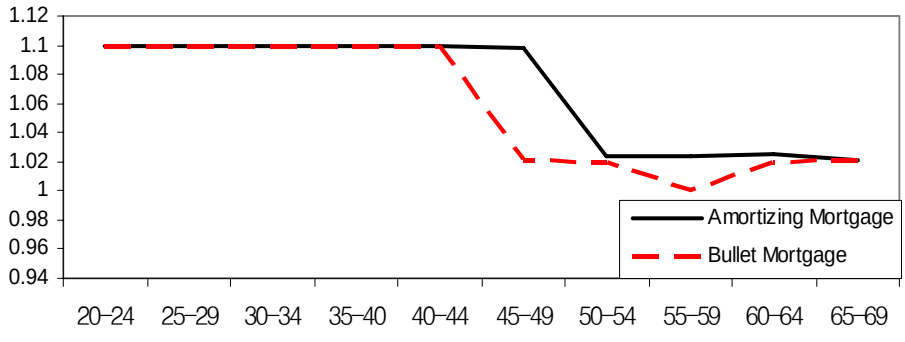


[Fig.5] and [Fig.6] plot the ratios of the housing demand when the current labor income increases by 10% with respect to the benchmark case. Both [Fig.5] and [Fig.6] demonstrate that the income increase has positive impact on the demand for housing, which is not so interesting. However, it is notable that in the bullet mortgage system the demand for housing is less volatile than that in the amortizing mortgage as shown in [Fig.6]. This confirms our intuition that the amortizing mortgage system is more vulnerable to income risk than the bullet system.

[Fig.5] The Ratios of Housing Stock: Time Series (income change +10%/ 0%)



[Fig.6] The Ratios of Housing Stock:Cross-Section (income change +10%/0%)



6. Limitations and Extensions

Our model may be criticized for its excessive abstraction of Korea housing market and housing finance system. Especially, allowing for the huge proportion of real estate in the household balance sheet, demand is high for a model, which reflects the complex structure of Korean housing market. This is, we believe, the direction our model should be improved in.

To begin with, a revised model of housing market should allow for the presence of diverse rent systems including Korea unique Chonsei system. Then, beyond merely adjusting housing stock held each period as in the above, consumers are allowed to change his residential status according to their affordability.

Next, the new model should distinguish the role of housing as a means of investment from that of housing as a direct source of instantaneous utility. In this context, we recommend that the new model should accommodate the uncertainty of housing price. By doing so, the demand for housing as an asset could be determined separately from the demand for the risk free asset.

Finally, our model neglects the production side including the determination of labor supply, which limits our model to a partial equilibrium model.. Accordingly, it can be a definitely good option for the future model to introduce a production sector and extend itself to a general equilibrium model.

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