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Evaluating Borrower's Net Yield in Long-Term Fixed Rate Mortgage Loans in Korea

Seungryul Ma†

A B S T R A C T

The Korean government has tried to change the structure of residential mortgages in Korea from the short-term variable-rate non-amorting loans to the long-term fixed-rate amorting loans since the early 2000's. This study examines he borrower's net yield from that new type of loans, which is defined as the difference between the lender's yield out of the borrower's repayment and the borrower's yield from the expected gain on the portion of housing equity funded by cosnumer. The main hypothesis tested is that the borrower's net yield will be affected by the time of loan origination and the level of mortgage interest rate charged because the future fluctuations of housing values and that of market interest rates are expected to be key determinants. The results confirm the hypothesis in that borrower's net yields show positive or negative values according to the time of loan start, the level of fixed loan rates, or home regions. The results documented can offer a useful information as to the financial consumers'decision on loan amount and the timing of loan application considering the housing and mortgage market condition, which in turn can provide policy implication to regulating the maximum loan-to-value (LTV) ratio regulations.

Keywords: net yield, long-term amortizing loan, housing value, market interest rate

Ⅰ. Introduction

The mortgage market in Korea has been expanded rapidly in the 2000s. Most of the mortgage loans consisted of short-term variable rate loans and the entire principal must be paid by the borrower as a lump sum at the loan's maturity date. Related to this, several efforts were made to alleviate the risks which could be caused by the fluctuation of interest rates and borrower's repayment burden under interest-only loan. For the purpose of risk management, Korea government tried to change the loan structure from short-term variable rate loans to long-term fixed rate loans as well as from interest-only loan to amortizing loans. In 2004, the KHFC(Korea housing finance corporation) launched a new mortgage loan(called as "Bogeumjari loan") which was the start of a long-term amortizing fixed rate loan in Korea(Korean Association for Housing Policy Studies, 2016). With this opportunity, borrowers could realize their dream of owning their homes with fraction of the price of their homes(e.g. 30%). Since the sale of the Bogeumjari loan, Korea has had the opportunity to build a more advanced housing finance system which provides long-term amortizing fixed rate loans.

There were several researches focusing on the choice problem between fixed rate mortgages(FRM) and adjustable rate mortgages(ARM) as we could see in the Dhillon et al.(1987), Sa-Aadu and Sirmans(1995), Campbell and Cocco(2003), Coulibaly and Li(2009), and Mugerman et al.(2013), etc. Dhillon et al.(1987) confirmed that pricing

† Director, SonSa Research Institute, 135-402, 174 Solsaem-ro, Gangbuk-gu, Seoul, 01192, Korea
samhan12@hanmail.net

variables play a major role on the selection of FRM or ARM but, borrower's characteristics generally do not affect significantly on the selection of FRM or ARM. Sa-Aadu and Sirmans(1995) confirmed that the selection of short-term or long-term loan period usually depends on borrower's characteristics and at the time that the future interest rates are expected to be increased, the selection of ARM would be reduced. Campbell and Cocco(2003) showed that mortgage contract types could affect borrower's wealth significantly. They showed that FRM could expose borrower's household to wealth risk and ARM could expose borrower's household to income risk. They insisted that inflation-indexed FRM could be a more superior product in the aspect of managing wealth risk and income risk simultaneously.

Coulibaly and Li(2009) confirmed that pricing variables and maturities were important considerations to select the products and risk aversion borrowers prefer FRM. Mugerman et al.(2013) have focused on the behavioral aspects of the decision making mechanism between FRM and ARM and pointed out that the final choice of interest rates between FRM and ARM does not fit well with the findings of the theoretical literature. They confirmed that changes in the short term interest rate might play an important role for the individual decisions.

In Korea, Min et al.(2012) analyzed the factors of mortgage borrower's selection between FRM and ARM and confirmed that interest rate spread, income, and the type of households were main factors of determination. Ahn(2015) also analyzed the factors of mortgage borrower's choice between FRM and ARM. To increase the ratio of FRM, he insisted that it is necessary to recognize the risks due to future fluctuation of interest rates and to narrow the spread between fixed and adjustable rates and to raise the lender's ability regarding interest rate risk management. On the other hand, Ma and Kim(2010) compared the money's worth between FRM and ARM and confirmed that money's worth in FRM was larger than that in ARM in the view point of borrowers.

We could confirm the degree of qualitative improvement in the structure of household's debt due to the introduction of FRM if we check the changed annual ratio of FRMs or ARMs and that of amortizing loans or interest-only loans. According to the BOK(Bank of Korea), the ratio of FRMs has increased from 0.5% at the end of 2010 to 44.6% at the end of third quarter of 2017 and the ratio of amortizing loans has increased from 6.4% at the end of 2010 to 49.1% at the end of third quarter of 2017. These phenomenon shows that the structure of household debt is improved greatly through the introduction of long-term amortizing fixed rate loans.

However, due to the continued low interest rates since global financial crisis in 2008, it appears that the size of household debt has sharply increased. As of the end of second quarter of 2017, overall household debt in Korea was 1,388 trillion won and 54% of debt consisted of mortgage loans. Under this circumstance, the government is trying to lower the speed of ever increasing amount of debt through toughening the regulations of LTV and DTI ratios and helping borrowers to maintain the capability to repay their debts by using long-term amortizing fixed rate loans(Ministry of Strategy and Finance(2017)).

Kang and Lee(2012) found that the amount of loan would increase if the future housing market was expected to be positive by analyzing borrower's characteristics who used long term mortgage loans. They showed that the borrowers who used mortgage loans under the expectation that the future housing prices would be increased steadily could have financially negative result according to the market environment. Kim and Lee(2016) analyzed borrower's characteristics regarding repayment methods and showed that the selection of long-term amortizing method was mainly influenced by the level of borrower's income and interest rate. Moon and Kim(2015) analyzed the effect of LTV regulation on the banking institutional soundness and showed that tightening the LTV regulation could aggravate the soundness of financial institutions unlike policy maker's intention. Choi and Park(2015) studied whether macro-prudential tools such as LTV and DTI ratios served to achieve micro-prudential purposes to prevent default risk at an individual mortgage level and found that the transition from interest-only bullet loans to amortizing loans and from variable rate loans to fixed rate loans tended to lower the default rate.

The previous studies related to mortgage loans mainly focused on the borrower's choice between fixed rates and variable rates, analysis on characteristic of borrowers in mortgage loans, determinants of demand in mortgage loans, and the effect of LTV or DTI regulations on the housing finance market. Beside these previous studies, judging from borrower's viewpoint, one of the most useful information will be borrower's yield in mortgage loans. Nevertheless, it is difficult to find an analysis which dealt with the subject of borrower's yield in mortgage

loans. So, in this analysis, we are going to conduct an analysis to confirm the borrower's net yield focusing on the borrowers who use long-term amortizing fixed rate loans.

Because borrower's net yield will be affected by the fluctuation of future housing values and market interest rates, borrower's net yield on housing asset will be affected by the time of loan origination and the level of fixed loan rate determined at that time loan was originated. In addition, since housing prices will vary from region to region, the borrower's net yield will also depend on residential area. It is expected that the results of this analysis could give a useful information to the borrowers to make a decision of loan amount and the timing of applying for a loan. In the aspect of housing policy, the results of this analysis could be used for improving the system related to LTV regulation.

The remainder of this paper consisted as follows: section 2 presents an overview of mortgage loans we want to analyze, section 3 presents a methodology and data we use in our analysis, section 4 reports the results of the analysis, and section 5 presents our conclusions.

Ⅱ. Overview of Mortgage Loans

A. Mortgage Loans for Analysis

We will analyze borrowers' yields according to the home regions and time of loan origination. In this paper, we focused on Bogeumjari loans, the most representative long term fixed rate mortgage loans which have more than 10 year maturity in Korea. Table 1 shows a brief information about eligibility to apply for Bogeumjari loans.

B. Cash Flow of Nest Loans

In this analysis, we focused on the borrowers who selected CPM as repayment method in nest loans. The cash flow of CPM in nest loans is as follows:

$$I_t = L_{t-1} \times i, \tag{1}$$

$$A_t = P - I_t, \tag{2}$$

$$L_t = L_{t-1} - A_t \tag{3}$$

Where, I_t: interest owed in period t, L_t: outstanding loan balance after the period t payment has been made, i: fixed interest rate, A_t: principal paid down in the period t payment, P: amount of the loan payment.

The amount of loan payment($P_t = P$) in the CPM can be calculated using the annuity formula as below(Geltner and Miller, 2001).

$$P = L_0 \Big/ \sum_{t=1}^{N} (1+i)^{-t} = L_0 \Big/ \left\{ \frac{1}{i} \left[1 - \frac{1}{(1+i)^N} \right] \right\} \tag{4}$$

Where, N: the period until maturity

Table 1. Outline of Bogeumjari loans

Standards for Application	• Non-homeowner or homeowner who own a home temporarily • Income of married couple less than 70 million won
Interest Rate	• Fixed rate for the entire period
Target Housing	• Houses involved on record and valued below 600 million won
Support Limit	• Within 70% of housing price but, applied differently by home regions
Loan Period	• 10-year, 15- year, 20-year, or 30-year
Repayment Method	• Constant-payment mortgage (CPM), • Constant-amortization mortgage (CAM) • Graduated payment mortgage (GPM) ※ Not allow interest-only periods

Source: Korea Housing Finance Corporation (https://www.hf.go.kr)

Ⅲ. Methodology and Data

A. Evaluating Borrower's Net Yields

To calculate borrower's net yield(y) on the portion of housing equity which was funded by Bogeumjari loan, we evaluated ① borrower's yield($y^{(*)}$) on the portion of housing equity which was funded by loan and then evaluated ② lender's yield($y^{(**)}$) on the amount of borrower's repayment using trial and error method respectively. After evaluating the values of $y^{(*)}$ and $y^{(**)}$, we can evaluate the borrower's net yield(y) on the portion of housing equity which was funded by Bogeumjari loan. In this analysis, we evaluated borrower's net yield(y) by substracting lender's yield on the amount of borrower's repayment($y^{(**)}$) from borrower's yield caused by the increase in the price on the portion of housing equity funded by loan(y^{*}).

B. Borrower's Yield on Housing Equity

First, we could evaluate borrower's yield (y_n^*) at time t=n caused by the increase in the price on the portion of housing equity which was funded by Bogeumjari loan using the equation below.

$$E_0 = E_n/(1+y_n^*)^n \quad (5)$$
$$\Leftrightarrow (H_0 \times LTV_0) = (H_n \times LTV_0)/(1+y_n^*)^n$$

But, $H_n = H_0 \prod_{t=1}^{n}(1+g_t)$

Where, E_0: portion of housing equity which was funded by Bogeumjari loan at t=0(i. e., $E_0 = H_0 \times LTV_0$), E_n: portion of housing equity which was funded by Bogeumjari loan evaluated at t=n(i. e., $E_n = H_n \times LTV_0$), H_0: initial housing value at t=0, H_n: housing value at t=n, LTV_0: loan to value ratio at t=0, y_n^*: borrower's yield(or the internal rate of return) on housing equity evaluated at t=n, g_t: housing appreciation rate at t.

C. Lender's Yield from Borrower's Repayment

Second, we could evaluate lender's yield (y_n^{**}) derived from the amount of borrower's repayment at t=n using the equation below.

$$L_0 = (FVCP_n + L_n)/(1+y_n^{**})^n \quad (6)$$

But, $FVCP_n = \sum_{t=1}^{n-1}\left[P\prod_{\alpha=t}^{n-1}(1+r_\alpha)\right]+P$

Where, L_0: the initial loan balance(i. e., $L_0 = H_0 \times LTV_0$), $FVCP_n$: cumulative future value of repayment at t=n, L_n: outstanding loan balance at t=n, y_n^{**}: lender's yield(or the internal rate of return) evaluated at t=n, r_α: risk-free interest rate at t=α[1].

D. Borrower's Net Yield

We can see that the value of E_0 is exactly equal to the initial loan balance (L_0), that is $E_0 = (H_0 \times LTV_0) = L_0$. But, the value of E_n is expected to be totally different from the combined value of cumulative future value of repayment and outstanding loan balance at t=n ($FVCP_n + L_n$). That means $E_n \neq (FVCP_n + L_n)$.

So, if we could evaluate the borrower's yield caused by the increase in the price on housing equity (y_n^*) and lender's yield derived from the amount of borrower's repayment (y_n^{**}) respectively, we could get borrower's net yield (y_n) on the portion of housing equity which was funded by Bogeumjari loan as follows.

$$y_n = y_n^* - y_n^{**} \quad (7)$$

We can see that if y_n>0, then the borrower realizes net profit from using long-term amortizing fixed rate loan. On the contrary, if y_n<0, then the borrower realizes net loss from using amortizing loan.

E. Data

Because the borrower's yield will be affected by the fluctuation of future housing values or market interest

[1] In this analysis, because we analyse long-term mortgage loans, we used risk-free interest rate in the calculation of future value of long term cash flow to avoid the application of subjective risk premium in the course of calculation. If we consider the aspect of risk premium, the value of borrower's net yield could be relatively lowered than our anlysis.

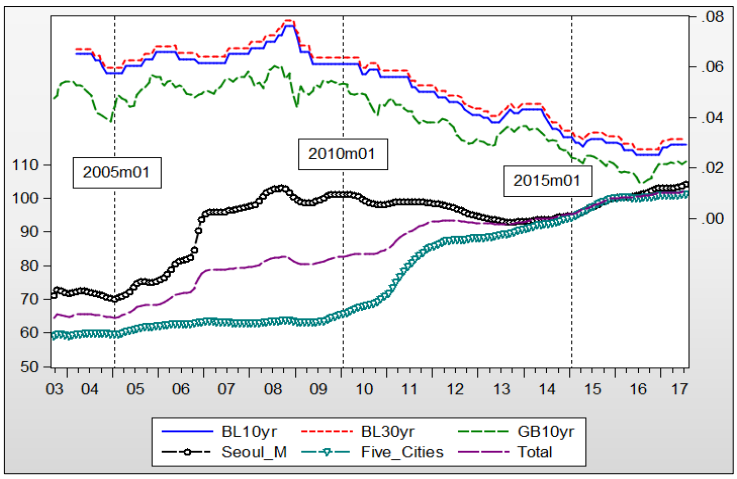

Figure 1. Trends of Interest Rates and Housing Prices

(Note) 1. BL10yr: 10-year nest loan rate, BL30yr: 30-year nest loan rate, GB10yr: 10-year government bond yield
2. Seoul_M: housing price in Seoul metropolitan area, Five_Cities: housing price in five big cities, Total: housing price in whole country.

rates, the borrower's yield in Bogeumjari loan will be affected by the time of loan origination or the level of fixed loan rate determined at the time loan was originated. The borrower's yield also will vary with home region because the housing values vary by regions even though the condition of mortgage loan contract such as the level of loan rates is same. In this analysis, we classified borrower's home region into three areas as follows.

① Total (whole country)
② Seoul Metropolitan (Seoul, Incheon, and Gyeonggi)
③ Five Big Cities (Busan, Daegu, Daejeon, Gwangju, and Ulsan)

As proxy variables of housing prices, we used regional housing price indexes from KB Kookmin Bank. And then, we used the yield data of 10-year government bond as a proxy variable of risk-free interest rate. Figure 1 represents the trends of interest rates and housing prices.

The rate of Bogeumjari loan was higher than that of government bond when we compared it during the same time period. Between 10-year and 30-year nest loans, the yield of 30-year was a little higher than that of 10-year Bogeumjari loan[2].

[2] The maturity of Bogeumjari loan is classified into 10-year, 15-year, 20-year, or 30-year. But, we analyzed only 10-year and 30-year loans in this paper because KHFC has not released the time series of 15-year and 20-year loan rates since its introduction. Although we did not analyze the effect of 15-year or 20-year Bogeumjari loans, we think that there would be no bias in the interpretation of the results in this paper.

F. Level of Repayments According to the Time of Loan Start and Loan Period

Considering the distinctively different characteristics of time series, we assumed that the loan started at January 2005, January 2010, or January 2015 respectively in 10-year Bogeumjari loan. Regarding the reason why we assumed the time of loan start like this, we explained more concretely in Table 2. On the other hand, in 30-year Bogeumjari loan, we assumed that the loan started at January 2005 or January 2015 respectively.

If we assume that all the initial housing prices are 100 million won regardless of the time of loan start or loan maturity, the amount of monthly repayments in loans according to the time of loan start, maturities, or the LTV ratios will be as in Table 3.

G. Forecasting Model of Stochastic Variables

1. Stochastic Models for Forecasting Housing Prices

In the long-term amortizing loan, it is necessary to forecast long-term stochastic processes of housing prices to calculate borrower's net yield. To generate future processes of housing prices through Monte Carlo simulation, we used GBM(Geometric Brownian Motion) model in our analysis. We can generate housing price at $t+\triangle t$

Table 2. Beginning of Loan Period and Maturity in Bogeumjari loans

Loan Start	10-year Maturity	30-year Maturity	Characteristics of time series
01. 2005	① 01.2005 -12.2014	④ 01.2005 -12.2034	After 01. 2005, Seoul metropolitan area showed continuous and fast pace of increase in the housing prices but, 5 big cities showed little change
01. 2010	② 01.2010 -12.2019		After 01. 2010, Seoul metropolitan area showed little change or decrease but, 5 big cities showed continuous and fast pace of increase in the housing prices
01. 2015	③ 01.2015 -12.2024	⑤ 01.2015 -12.2044	After 01. 2015, both Seoul metropolitan area and 5 big cities show continuous increase in the housing prices

(Note) When we analyzed the borrower's net yields, we used forecasted values of housing prices after 11.2017 in addition to the original data from 01.2005 to 10.2017.

Table 3. Amount of Monthly Repayments in Bogeumjari loans (unit: won)

Maturity		10-year			30-year	
Time of Loan Start		01.2005	01.2010	01.2015	01.2005	01.2015
Fixed Loan Rates		5.75%	6.10%	3.20%	5.95%	3.45%
Monthly Repayments	LTV: 70%	768,385	780,663	682,407	417,438	312,381
	LTV: 60%	659,615	669,140	584,920	357,804	267,755
	LTV: 50%	548,846	557,617	487,433	298,170	223,129
	LTV: 40%	439,077	446,093	389,947	238,536	178,503
	LTV: 30%	329,308	334,570	292,460	178,902	133,877

(Note) 1. Initial housing prices: 100 million won
2. Repayment method: CPM(not allow interest-only periods)

Table 4. Results of Parameter Estimation for the GBM Model (09.2003-10.2017)

Region	μ_H	σ_H
Total	3.36	1.71
Seoul Metropolitan	2.93	2.77
Five Big Cities	3.91	1.62

(Note) 1. Seoul Metropolitan area: Seoul, Incheon, and Gyeonggi area
2. Five Big Cities: Busan, Daegu, Daejeon, Gwangju, and Ulsan

using the GBM formula as below(Charnes, 2012).

$$H_{t+\triangle t} = H_t \cdot exp\left[\left((\mu_H - \frac{\sigma_H^2}{2}\right)\triangle t + \sigma_H \varepsilon_t \sqrt{\triangle t}\right] \quad (8)$$

Where, H_t: housing price at time t, μ_H: the average growth rate of housing price stated on an annual basis, σ_H: the volatility of the housing price, ε_t: a standard normal random variate.

Table 4 shows the results of parameter estimation for the GBM model using regional housing prices data from September 2003 to October 2017.

As we can see in Table 4, the average growth rate of housing price(μ_H) in five big cities was larger than that in Seoul metropolitan area. But, the volatility of the housing price(σ_H) in five big cities was smaller than that in Seoul metropolitan area[3].

2. Stochastic Models for Forecasting Interest Rates

We used Vasicek model in our analysis to generate future processes of interest rates through Monte Carlo

[3] The estimated parameters in Table 4 could be changed if we use different period of time series. Plus, although the magnitude of volatility in Seoul Metropolitan area was estimated larger than Five Big Cities in our analysis, but in the future, the magnitude might be reversed because the past data does not always explain the future situation similarily.

Table 5. Parameter Estimation for the Vasicek Model (09.2003-10.2017)

	α	θ	σ
10-year government bond yield	0.107	2.514	0.701

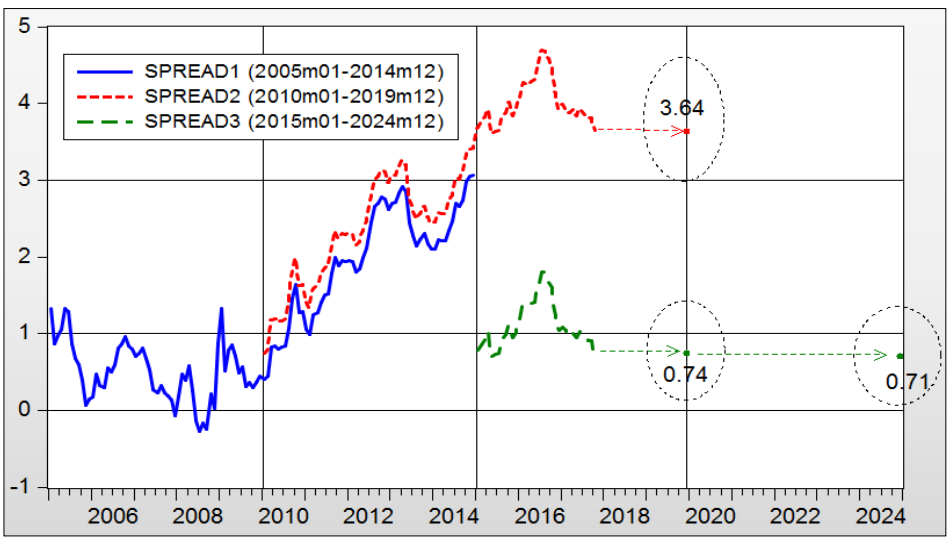

Figure 2. Spreads between Fixed Loan Rates and Market Interest Rates (unit: %)

simulation. We can generate future stochastic processes of interest rates using the Vasicek formular as below.

$$\triangle i_t = \alpha(\theta - i_t)\triangle t + \varepsilon_t \sigma \sqrt{\triangle t} \quad (9)$$

Where, i_t: interest rate at time $t(\triangle i_t = i_{t+1} - i_t)$, α: speed of mean reversion, θ: mean reverting level, σ: volatility of the interest rate, ε_t: a standard normal random variate.

Table 5 shows the estimated parameters of Vasicek model by using the maximum likelihood estimation method. We used the yield data of 10-year government bond from September 2003 to October 2017.

Ⅳ. Results of Analysis

A. Differences between Fixed Loan Rates in Bogeumjari loans and Market Interest Rates

Borrower's net yields will vary according to the residential area or the time of loan start due to the fluctuations of housing prices and interest rates. As we can see in the Table 5, the borrower who has applied to 10-year Bogeumjari loan which began from 01.2005 paid back all debts to the lender at loan rate of fixed 5.75% during 10 years and the borrower who has applied to 10-year nest loan which began from 01.2010 would pay back all debts to the lender at loan rate of fixed 6.10% until 12.2019.

In Figure 2, SPREAD 1 represents the spreads between loan rate of fixed 5.75% and 10-year government bond yields from 01.2005 to 12.2014. SPREAD 2 represents the spreads between loan rate of fixed 6.10% and 10-year government bond yields from 01.2010 to 12.2019. SPREAD 3 represents the spreads between loan rate of fixed 3.20% and 10-year government bond yields from 01.2015 to 12.2024.

In Figure 2, the spreads after 11.2017 were generated by using forecasted yields of 10-year government bond. On this occasion, we used the median values on the probability distribution of forecasted future yields of 10-year government bond at each time period created by 30,000 trials of Monte Carlo simulation[4].

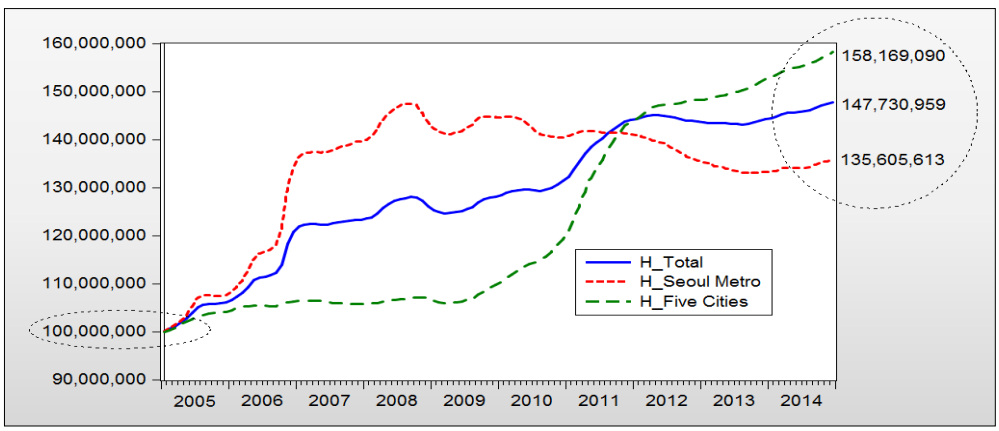

Figure 3. Regional Housing Prices (01.2005 to 12.2014)

As we could confirm in Figure 2, the borrowers who applied to 10-year nest loan which began from 01.2005 experienced the situation that the spreads(SPREAD 1) had increased until loans were terminated due to decreased market interest rates after global financial crisis. The SPREAD 1 was about 3% at 12.2014, the end of the loan period. The borrowers who have applied to 10-year nest loan which began from 01.2010 have experienced the situation that the spreads(SPREAD 2) were larger than SPREAD 1 and showed that the spread would be about 3.64% at 12.2019, the end of the loan period. On the other hand, the borrowers who have applied to 10-year nest loan which began from 01.2015 showed relatively lower spreads(SPREAD 3) compared to SPREAD 1 or SPREAD 2. SPREAD 3 showed about 1% of spread for most of the loan period and showed that the forecasted spread would be only about 0.71% at 12.2024, the end of the loan period.

The results of above spread analysis tells us that the borrowers who have applied to Bogeumjari loan from 01.2005 to 01.2010 could have net loss(y<0) because they have selected higher fixed loan rates which failed to reflect future trend of lower market interest rates. On the contrary, the borrowers who have applied to nest loan after 01.2015 could have net profit(y>0) if the future market interest rates shows upward trend continuously due to lower fixed loan rates they have selected. Of course, whether the borrower's net yield would become a negative(-) value or a positive(+) value would also depend on the future trend of housing prices until the loan is terminated.

B. Housing Appreciation Rates

If the borrowers have applied to 10-year nest loans in 01.2005, the loan period ended in 12.2014. In this case, if we assume that the initial housing prices were all the same, 100 million won, regardless of residential area and then the regional housing price indexes of past periods were utilized, we could generate the trends of housing prices from 01.2005 to 12.2014. We could also confirm the variability of housing prices by region.

Figure 3 shows the trends of regional housing prices from 01.2005 to 12.2014 when the initial housing prices in 01.2005 were all assumed 100 million won regardless of region. In 12.2014, we could confirm that the housing price of whole country was 148 million won, Seoul metropolitan area was 136 million won, and 5 big cities was 158 million won respectively. So, if we assume that all the borrowers borrowed the same amount of money from 10-year Bogeumjari loans at the same time regardless of residential area, we could guess that the borrowers whose home were located in Seoul metropolitan area would have lower profits than the borrowers whose home were located in 5 big cities.

If the borrowers have applied to 10-year loans in 01.2010, the loan period ends in 12.2019. In this case, if we assume that the initial housing prices were all the

[4] Refer to Charnes(2012) for the details of Monte Carlo simulation method.

same, 100 million won, regardless of residential area and then the regional housing price indexes were utilized, we could generate the trends of housing prices from 01.2010 to 12.2019. We could also confirm the variability of housing prices by region.

However, because we could only use data until 10.2017, to forecast future housing prices after 11.2017, we conducted Monte Carlo simulation by using GBM model. The housing prices after 11.2017 in Figure 4 show the median values on the probability distribution of forecasted future housing prices at each time period created by 30,000 trials of Monte Carlo simulation.

On the other hand, if the borrowers have applied to 10-year loans in 01.2015, the loan period ends in 12.2024. In this case, if we assume that the initial housing prices were all the same, 100 million won, regardless of residential area and then the regional housing price indexes were utilized, we could generate the trends of housing prices from 01.2015 to 12.2024. We could also confirm the variability of housing prices by region. The forecasted

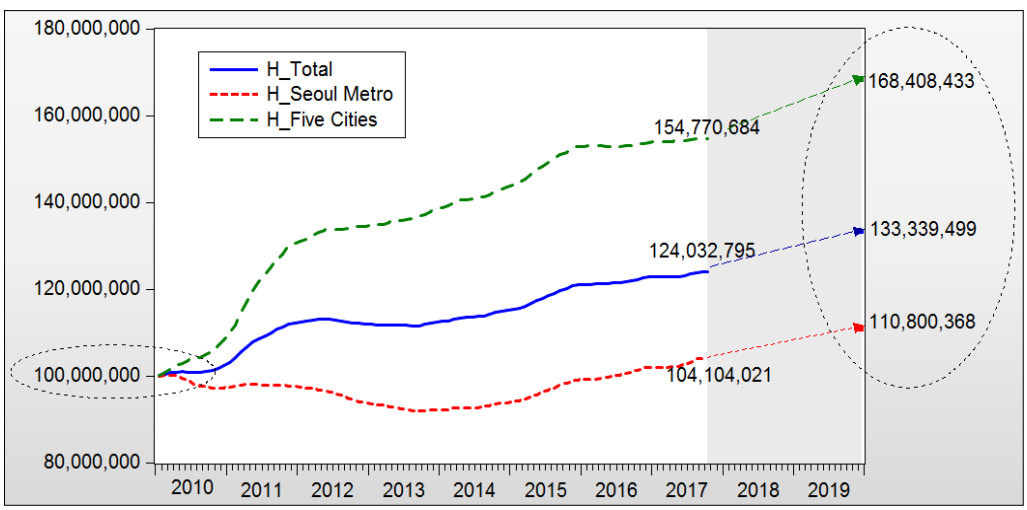

Figure 4. Regional Housing Prices (01.2010 to 12.2019)

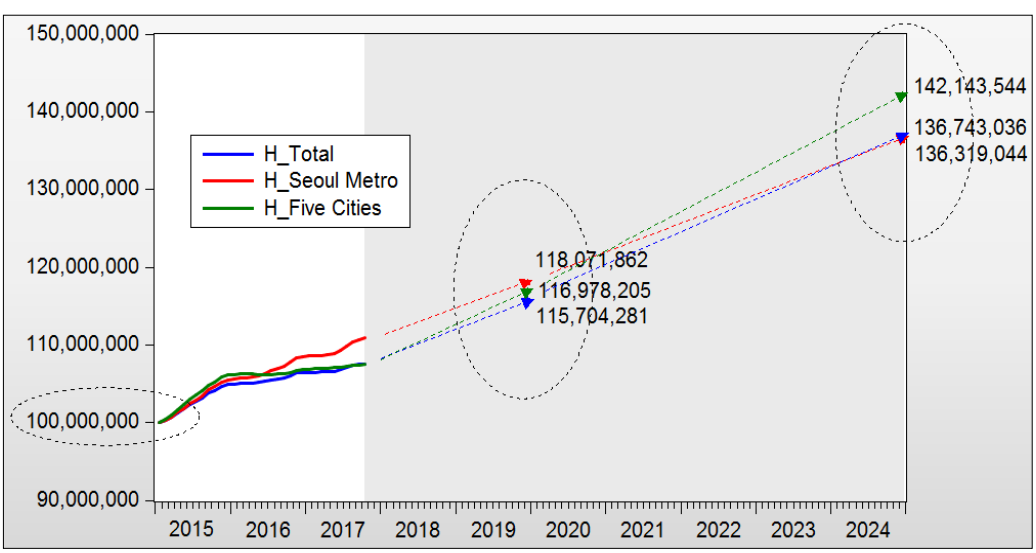

Figure 5. Regional Housing Prices (01.2015 to 12.2024)

housing prices from 11.2017 to 12.2024 in Figure 5 were median values on the probability distributions of future housing prices which were generated by Monte Carlo simulation.

If we compared Figure 3, Figure 4, and Figure 5 each other, we could confirm that the housing prices at the time the loan is terminated would show totally different values according to the circumstance of regional housing market.

When we compared the housing prices at the moment the loan is terminated between Seoul metropolitan area and 5 big cities, the largest price gap appeared with the borrowers who have applied in 01.2010 and the smallest price gap appeared with the borrowers who have applied in 01.2015. From this fact, we could expect that the borrower's net yield would vary according to the time of loans start as well as home regions.

C. Analyzing Borrower's Net Yield

1. Borrower's Net Yield When the Loan Period is 10-Years

As we discussed in Table 2, we set up the time of loan start was ①01.2005, ②01.2010, or ③01.2015 respectively when we assumed the loan period is 10-years. It is expected that the borrower's net yield would appear differently due to different trend of regional housing prices. To consider the different effects of residential area on the borrower's net yield, we classified home region into 3 groups (Total, Seoul Metropolitan area, and 5 big cities). First, Table 6 shows the results of analyzed borrowers' net yields in the whole country area(Total).

As we can see in Table 6, the borrowers who applied 10-year Bogeumjari loan in 01.2005 or 01.2010 showed negative(-) net yield, -1.43% and -1.82% respectively. We could say that this results appeared because the amount of lender's yield(y^{**}) from borrower's repayment was larger than borrower's yield(y^{*}) on the portion of housing equity at loan maturity. This phenomenon was mainly resulting from relatively high level of repayments the borrowers have paid continuously during 10 years due to higher fixed loan rates(5.75% and 6.10%).

On the contrary, the borrowers who applied 10-year Bogeumjari loan in 01.2015 showed positive(+) net yield, 0.39%. This results appeared because the estimated amount of y^{**} was smaller than that of y^{*} and this phenomenon was mainly resulting from relatively low level of repayments the borrowers have paid due to lower fixed loan rates(3.20%).

Second, Table 7 shows the results of analyzed borrowers' net yields on the portion of housing equities which were funded by 10-year Bogeumjari loan in the Seoul metropolitan area and five big cities.

According to the results in Table 7, the borrower's net yields in Seoul metropolitan area were similar to

Table 6. Borrowers' Net Yields (Target Region: Total) (unit: 1,000 won)

	Time of Loan Start		
	①01.2005	②01.2010	③01.2015
Initial loan balance: $L_0(=H_0\times LTV_0=E_0)$	70,000	70,000	70,000
Housing equity purchased by loan evaluated at t=n: E_n	103,411	93,363	95,745
Cummulative repayments plus loan balance at t=n: $FVCP_n+L_n$	119,264	111,872	92,110
Borrower's yield on the housing equity: y^{*}	3.91%	2.88%	3.14%
Lender's yield from borrower's repayment: y^{**}	5.34%	4.70%	2.75%
Borrowers' net yield on the housing equity: y	-1.43%	-1.82%	0.39%

(Note) 1. All the initial housing prices were assumed 100 million won irrespective of loan start and all the LTV_0 were assumed 70% (hereafter, all the assumptions are the same)
2. We used actual data of housing prices and discount rates if the time of loan start was 01.2005. But, if the time of loan start was 01.2010 or 01.2015 then we used forecasted values when we use the values after 11.2017
3. We used median values on the probability distribution of future forecasted values which were generated by 30,000 trial Monte Carlo simulation
4. The LTV level has no effect on the borrower's yield (y_n) but, it has a proportional effect on the future housing equity ($H_n\times LTV_0$), cummulative future value of repayment ($FVCP_n$), or outstanding loan balance (L_n)
5. All the results were estimated at loan maturity(t=n=120)
6. Outstanding loan balances at t=n are all zero(L_n=0)

the results in whole country in Table 6. The borrowers who applied to 10-year loans in 01.2005 or 01.2010 showed negative(-) net yield, -2.29% and -3.67% respectively and the borrowers who applied to the loans in 01.2015 showed positive(+) net yield, 0.36%. In this case, the amount of net loss that the borrowers in Seoul metropolitan area could suffer was relatively larger than the borrowers in whole country. This phenomenon has appeared because the cummulative amount of repayments was exactly the same regardless of residential area but, at loan maturity, the housing price in whole country was relatively higher than Seoul metropolitan area. On the other hand, the borrowers who applied to 10-year loans in 01.2015 showed similar net yields because the evaluated housing prices at loan maturity were similar to each other.

On the contrary, the borrower's net yields in five big cities were different from those in whole country or Seoul metropolitan area. In this case, the borrowers who applied to 10-year loans in 01.2010 or 01.2015 showed positive(+) net yield at loan maturity, 0.52% and 0.77% respectively. This phenomenon was resulting from the fact that the housing price in five big cities was relatively higher than that in Seoul metropolitan or whole country at loan maturity.

2. Borrower's Net Yield When the Loan Period is 30-Years

As we discussed earlier, when we assumed the loan period is 30-years, we set up the time of loan start was ④01.2005 or ⑤01.2015 respectively. To confirm the borrower's net yields which could be changed by the passage of time, we separately evaluated the borrower's net yields at t=120, 240, or 360. In this case, to consider the different effects of home regions on the borrower's net yield, we also classified home regions into 3 groups.

First, Table 8 shows the results of analyzed borrowers' net yields which were funded by 30-year loans when the loan started in 01.2005.

When we assumed the beginning of loan period was 01.2005, the borrower's net yields which were evaluated at t=120, 240, or 360 showed -1.87%, -1.49%, or -0.99% respectively in whole country. As we can see in Table 8, the borrower's net yields were increased by the passage of time. In previous analysis, we could confirm that the borrower's net yield at t=120 was -1.43% when the borrower applied to10-year nest loans in 01.2005. Therefore, if we compare the values at t=120, we could confirm that the net yield of 10-year Bogeumjari loan was relatively

Table 7. Borrowers' Net Yields (Seoul Metropolitan and Five Big Cities) (unit: 1,000 won)

	Seoul Metropolitan			Five Big Cities		
Loan Start	①01.2005	②01.2010	③01.2015	①01.2005	②01.2010	③01.2015
$L_0 = E_0$	70,000	70,000	70,000	70,000	70,000	70,000
E_n	94,923	77,612	95,530	110,718	117,881	99,469
$FVCP_n + L_n$	119,264	111,872	92,110	119,264	111,872	92,110
y^*	3.05%	1.03%	3.11%	4.59%	5.22%	3.52%
y^{**}	5.34%	4.70%	2.75%	5.34%	4.70%	2.75%
y	-2.29%	-3.67%	0.36%	-0.75%	0.52%	0.77%

Table 8. Borrowers' Net Yields (Time of Loan Start : 01.2005) (unit: 1,000 won)

	Total			Seoul Metropolitan			Five Big Cities		
	t=120	t=240	t=360	t=120	t=240	t=360	t=120	t=240	t=360
E_n	103,411	141,664	197,844	94,923	129,633	173,019	110,718	157,823	233,068
$FVCP_n$	64,792	153,128	266,274	64,792	153,128	266,274	64,792	153,128	266,274
L_n	59,741	37,685	0	59,741	37,685	0	59,741	37,685	0
y^*	3.91%	3.53%	3.47%	3.05%	3.09%	3.02%	4.59%	4.07%	4.02%
y^{**}	5.77%	5.02%	4.46%	5.77%	5.02%	4.46%	5.77%	5.02%	4.46%
y	-1.87%	-1.49%	-0.99%	-2.72%	-1.94%	-1.44%	-1.18%	-0.95%	-0.45%

(Note) Assumption: H_0 = 100 million won, LTV_0 = 70%

larger than 30-year loan. However, when we evaluated the values at loan maturity, the net yield of 10-year loan was relatively smaller than 30-year loan. This results tell us the fact that the borrowers who applied 30-year Bogeumjari loans could reduce the amount of loss if they keep the loan contracts continuously until the loan expire.

The results in Seoul metropolitan area were similar to those in whole country. As we can see in Table 8, the borrower's net yields which were evaluated at t=120, 240, or 360 showed -2.72%, -1.94%, or -1.44% respectively. In Seoul metropolitan area, the amount of net losses was estimated relatively larger than that in whole country.

The results in five big cities were also similar to those in whole country or Seoul metropolitan area. The borrower's net yields which were evaluated at t=120, 240, or 360 showed -1.18%, -0.95%, or -0.45% respectively. Hence, the amount of net losses in five big cities was relatively smaller than that in whole country or Seoul metropolitan area.

Second, Table 9 shows the results of analyzed borrowers' net yields which were funded by 30-year Bogeumjari loans when the time of loan start was 01.2015.

When we assumed the time of loan start was 01.2015, the borrower's net yields which were evaluated at t=120, 240, or 360 showed -0.22%, 0.23%, or 0.40% respectively in whole country. As we can see in Table 9, the borrower's net yields in this case were also increased by the passage of time. Different from previous cases, when we evaluated the values at maturity, the borrower's net yield showed positive(+) value.

As we can see in Table 9, the borrower's net yields which were evaluated at t=120, 240, or 360 in Seoul metropolitan area showed -0.24%, -0.01%, or 0.09% respectively. In Seoul metropolitan area, the amount of net profits at maturity was estimated relatively smaller than that in whole country.

The borrower's net yields which were evaluated at t=120, 240, or 360 in five big cities showed 0.17%, 0.70%, or 0.90% respectively. In this case, all the borrower's net yields showed positive(+) values regardless of evaluated time.

D. Relationship between Borrower's Net Profit and LTV Ratio

The level of LTV does not affect the level of borrower's net yield (y_n) we have discussed so far. But, it makes a proportional impact on the amount of future housing equity (E_n), cumulative future value of repayment ($FVCP_n$), or outstanding loan balance (L_n).

Table 10 shows the values of borrower's net profit (Y_n) evaluated at maturities in the 10-year and 30-year Bogeumjari loans according to the level of LTV ratios, time of loan start, and home regions. We evaluated the borrower's net profit by subtracting cumulative future value of repayment ($FVCP_n$) from the amount of future housing equity (E_n).

$$Y_n = E_n - FVCP_n \qquad (10)$$

Where, Y_n: borrower's net profit at t=n.

It was estimated that all the borrowers who applied to loans in 01.2005 would get net loss regardless of loan periods as we can see in Table 10. The amount of net loss ($Y_n < 0$) in Seoul metropolitan area was relatively

Table 9. Borrowers' Net Yields (Time of Loan Start : 01.2015) (unit: 1,000 won)

	Total			Seoul Metropolitan			Five Big Cities		
	t=120	t=240	t=360	t=120	t=240	t=360	t=120	t=240	t=360
E_n	95,715	133,759	187,055	95,525	127,673	170,452	99,521	146,960	216,909
$FVCP_n$	42,167	96,206	165,883	42,167	96,206	165,883	42,167	96,206	165,883
L_n	55,645	31,664	0	55,645	31,664	0	55,645	31,664	0
y^*	3.13%	3.24%	3.28%	3.11%	3.01%	2.97%	3.52%	3.71%	3.78%
y^{**}	3.35%	3.02%	2.88%	3.35%	3.02%	2.88%	3.35%	3.02%	2.88%
y	-0.22%	0.23%	0.40%	-0.24%	-0.01%	0.09%	0.17%	0.70%	0.90%

(Note) Assumption: H_0 = 100 million won, LTV_0 = 70%

Table 10. Borrower's Net Profit at Maturity (unit: 1,000 won)

Loan Start	LTV_0	10-Year Bogeumjari loans			30-Year Bogeumjari loans		
		Total	Seoul Metropolitan	5 Big Cities	Total	Seoul Metropolitan	5 Big Cities
01.2005	70%	-15,852	-24,340	-8,546	-68,429	-93,255	-33,206
	50%	-11.323	-17,386	-6,104	-48,877	-66,611	-23,718
	30%	-6,794	-10,431	-3,663	-29,327	-39,966	-14,231
01.2010	70%	-18,530	-34.325	6,027			
	50%	-13,236	-24,518	4,305			
	30%	-7,941	-14,711	2,583			
01.2015	70%	3,632	3,345	7,402	21,173	4,569	51,027
	50%	2,594	2,389	5,287	15,123	3,263	36,448
	30%	1,557	1,434	3,172	9,074	1,958	21,869

(Note) 1. H_0 = 100 million won
2. Borrower's net profit at maturity(Y_n) : $Y_n = E_n - FVCP_n$
3. For the values of market interest rates and housing prices after 11.2017, we used the median values on the probability distribution of forecasted values at each time period created by 30,000 trials of Monte Carlo simulation

larger than the other regions. In the view point of LTV ratios, we could confirm that the amount of net loss would become relatively higher when the borrowers selected higher LTV ratio.

Unlike Seoul metropolitan area or whole country, it appeared that the borrowers would get net profit ($Y_n > 0$) at loan maturity in the five big cities when they applied to 10-year Bogeumjari loans in 01.2010. So, in this case, we could confirm that the amount of net profit would become relatively higher in the five big cities when the borrowers selected higher LTV ratio.

When the borrowers have applied to Bogeumjari loans in 01.2015, it was estimated that all the borrowers would get net profit regardless of loan periods as we can see in Table 10. In this case, we could confirm that the amount of net profit would become relatively higher in the five big cities compared to the other home regions and the amount of net profit would be increased when the borrowers selected higher LTV ratio.

E. The Loan Rates which Make Borrower's Net Yield Become Zero

We defined fair rate (y_n^F) as the level of loan rate which makes borrower's net yield become zero at loan maturity in our analysis ($y_n^F = y_n^* - y_n^{**} = 0$). Table 11 shows the level of fair rates which would vary with borrower's home regions, loan periods, or the time of loan start.

As we can see in Table 11, when the borrowers applied to Bogeumjari loans in 01.2005, the level of fair rates appeared to be lower than the level of actual fixed loan rates regardless of home regions or loan periods. This phenomenon was resulting from the fact that the growing speed of housing prices was relatively lower than that of cumulative future values of repayment. Consequently, all the borrowers are expected to suffer a net loss at maturity due to high fixed loan rates (5.75% in 10-year loan or 5.95% in 30-year loan).

When the borrowers applied to 10-year loans in 01.2010 in whole country or Seoul metropolitan area, the levels of fair rates appeared to be lower than actual fixed loan rates as similar to the case that the borrowers applied to loans in 01.2005. Especially, the level of fair value showed -1.45% in the Seoul metropolitan area when the borrowers applied to 10-year loans in 01.2010. This was mainly due to negative(-) growth rates of housing prices shown in the Seoul metropolitan area during the loan period. So, in this case, we could see that the borrowers who applied to 10-year Bogeumjari loans in 01.2010 in the Seoul metropolitan area must have been suffered net loss although the level of fixed loan rate was zero. On the contrary, the level of fair rates appeared to be higher than actual fixed loan rates in the five big cities. This phenomenon was resulting from the fact that the growing speed of housing prices in the five big cities was relatively higher than that of cumulative future values of repayment although the fixed loan rate was very high.

Table 11. The Level of Loan Rates which Makes Borrower's Net Yield Become Zero (unit: %)

Region	Loan Period	Loan Start	Loan Rate		
			Actual Rate (A)	Fair Rate (B)	Difference: (A-B)
Total	10-year	01.2005	5.75	2.70	3.05
		01.2010	6.10	2.25	3.85
		01.2015	3.20	4.02	-0.82
	30-year	01.2005	5.95	3.39	2.56
		01.2015	3.45	4.45	-1.00
Seoul Metropolitan	10-year	01.2005	5.75	0.95	4.80
		01.2010	6.10	-1.45	7.55
		01.2015	3.20	3.97	-0.77
	30-year	01.2005	5.95	2.35	3.60
		01.2015	3.45	3.62	-0.17
Five Big Cities	10-year	01.2005	5.75	4.14	1.61
		01.2010	6.10	7.27	-1.17
		01.2015	3.20	4.85	-1.65
	30-year	01.2005	5.95	4.75	1.20
		01.2015	3.45	5.75	-2.30

(Note) Fair rate: the level of loan Rates which makes borrower's net yield become zero

Finally, we could confirm that the levels of fair rates appeared to be higher than actual fixed loan rates when the borrowers applied to Bogeumjari loans in 01.2015. This phenomenon was resulting from the fact that the growing speed of housing prices was relatively higher than that of cumulative future values of repayment. In this case, the level of monthly payments was low due to low fixed loan rates (3.20% in 10-year loan or 3.45% in 30-year loan).

Ⅴ. Conclusions

In this analysis, we evaluated the borrower's net yield focusing on the long-term amortizing fixed rate loans. The value of borrower's net yield could show positive(+) or negative(-) value according to the time of loan start or the level of fixed loan rate because borrower's net yield would be affected by the future fluctuations of housing values and market interest rates. The borrower's yield also would vary with home regions due to different housing appreciation rates.

According to the historical experience, we could see that the borrowers who applied to Bogeumjari loans in 01.2005 suffered net loss due to higher burden of repayment. The borrowers who applied to loans in 01.2010 showed different results by home locations. In this case, the borrowers who applied to loans in whole country or Seoul metropolitan area experienced net loss because the growing speed of housing prices was relatively lower than that of cumulative future values of repayment. But, in the five big cities, the borrowers experienced net profit because the growing speed of mortgaged housing prices was relatively higher than that of cumulative future values of repayment. On the other hand, the borrowers who applied to loans in 01.2015 were expected to have net profit from using Bogeumjari loans due to lower burden of repayment. So, in this case, the borrowers who have selected a higher LTV ratio were expected to have a higher net profit[5].

It is expected that the results of this analysis could give a useful information to the borrowers who plan to

[5] On the contrary, from the view point of lenders, the risk of reverse margins is likely to increase due to the application of low fixed loan rates. Therefore, maintaining a low LTV ratio might be a possible way to reduce the size of risk for the lenders.

use long-term amortizing fixed rate loans when they decide the loan amount, the loan maturity and the timing of applying for a loan considering the environment of mortgage market. And, the results of this analysis could also be used to create policies related to LTV regulation. In the aspect of financial consumer protection, the government is necessary to consider decrease of LTV when the actual loan rate is expected larger than the level of fair rate(y_n^F). On the contrary, the government is necessary to consider increase of LTV when the level of fair rate(y_n^F) is expected larger than actual loan rate.

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