

Kim, Meeroo; Oh, Yoon Hae

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Effects of Easing LTV·DTI Regulations on the Debt Structure and Credit Risk of Borrowers[†]

By MEEROO KIM AND YOON HAE OH*

With CB data in South Korea, this study examines whether the credit risk of borrowers changes when the regulation on bank mortgage supply is relaxed. We analyze the effect of deregulation on LTV and DTI limits in the Seoul-metropolitan area in August 2014 with a difference-in-difference approach. We find that the probability of delinquency is lower in the Seoul metropolitan area after the deregulation than in other urban areas. The effect is noticeable among low-income and low-credit borrowers. We also find that borrowers change their debt structure to reduce the interest costs utilizing their improved access to bank mortgages. The findings suggest the necessity to consider the burden of the high interest costs of unsecured loans for debtors with low incomes and low credit ratings in designing housing finance regulations.

Key Word: LTV, DTI, Mortgage Loan, Credit Risk
JEL Code: G28, G51

I. Introduction

This study aims to analyze whether the credit risk of borrowers can decrease when supply regulations on bank mortgages are relaxed. In South Korea, there are housing finance regulations that restrict mortgage loan amounts. The LTV (loan to value ratio, since 2002) and DTI (debt to income ratio, since 2006) was introduced to secure macro-prudential stability and applied to the financial institutions (e.g., banks, savings banks, insurance companies). These regulations have played roles in promoting the macro-stability of the financial industry and stability of the real estate market.

On the other hand, there is a skeptical perspective on such regulations. If the degree of regulation is far higher than an appropriate level, it can constrain the best

* Kim (First author): Associate Fellow, Korea Development Institute (E-mail: mrkim@kdi.re.kr); Oh (Corresponding author): Fellow, Korea Development Institute (E-mail: ohyh@kdi.re.kr)

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source of funding, which is inexpensive and offers long-term maturity. Thus, such regulation can deteriorate the debt structure and increase the debt repayment burden. For example, in the words of the Deputy Prime Minister when relaxing the LTV and DTI ratios of bank mortgage loans in July 2014: “Total household debt will increase due to deregulation of real estate, but the credit risk will decrease as the household loan structure improves.” The rationale for this claim is that bank mortgages are the best loan product from a borrower’s standpoint. Therefore, relaxing housing finance regulations may reduce debtors’ credit risk.

Furthermore, the decreased repayment burden caused by LTV and DTI deregulation can be even more substantial for borrowers with low credit scores. There are two possible explanations for this. First, the interest rates of unsecured loans are much higher for borrowers with lower credit scores. Thus, the burden of interest by borrowers who have used unsecured loans due to LTV and DTI limits on bank mortgages would be much more significant for those with low credit ratings. Second, while variations in interest rates in bank mortgages are not notable, the interest rates of non-bank mortgages (e.g., savings banks, capital companies, and credit card companies) rise when a borrower’s credit score decreases. Accordingly, the interest expense for borrowers with low credit ratings may increase further due to LTV restrictions.

Therefore, we analyze whether the relaxation of the LTV and DTI limit on bank mortgages reduces the credit risk of borrowers and whether the effect is more substantial among low-credit borrowers with extensive CB data. To understand the detailed mechanism, we also analyze the impact of the relaxation of housing finance regulations on the share of high-cost loans (the share of loans other than bank mortgage loans) and the repayment burden (Debt Service Ratio(DSR): repayment of principal and interest of all loans relative to annual income). Finally, we assess changes in the debt structure that could reduce the repayment burden considering the reduced credit risk.

LTV limit was relaxed to 70% in all financial institutions in August 2014. Since the LTV limit in the banking sector was 50-70% in the Seoul metropolitan area and 60-70% in other regions before the deregulation, the degree of the deregulation is differential between Seoul metropolitan area and other regions. We use this differential degree of deregulation as an identification strategy based on the difference-in-difference method to find the effect of the deregulation on borrowers’ debt structure and credit risk. Since the LTV limit of bank mortgage was increased more in the Seoul metropolitan area than in other regions, borrowers in Seoul metro area are classified as a treatment group.¹

According to our analysis, the probability of delinquency among borrowers in the Seoul metropolitan area is lower than in other areas. This effect was pronounced in borrowers with low incomes and low credit scores. Concerning this decline in credit risk, the debt structure of borrowers was changed, reducing their repayment burden via improved access to bank mortgage loans. This result suggests a need to vary LTV

¹On the other hand, the previous LTV limits for mortgages by non-banking institutions, except for insurance companies, were 60-85% in the Seoul metropolitan area and 70-85% in other areas. Thus, this policy can be seen as a reinforced regulation in non-banking financial institutions. However, here we focus on bank mortgage loans, which are the best loan products in terms of the interest rate, and show that the enhanced accessibility to bank mortgage can improve borrowers’ credit risk.

and DTI regulations according to the characteristics of borrowers.

The composition of this chapter is as follows. Section 2 introduces the literature in this area and the housing finance regulatory policy. Section 3 provides the data and research hypotheses. Section 4 presents the estimation results. Finally, Section 5 concludes the paper with a summary and policy implications.

II. Review of LTV·DTI in the Literature

A. LTV and DTI and Major Issues

In August 2014, regulations on mortgage loans were relaxed in Seoul metropolitan area, especially in the banking sector. This was done to revitalize domestic demand and boost the housing market over concerns about the economic slowdown.

In South Korea, from the early 2000s to 2014, the LTV and DTI regulatory policies were alternately reinforced or mitigated considering the housing economy, which differs by region. LTV regulation is introduced in September 2003 in South Korea at a 60% level for speculative areas. Then, according to the condition of housing market, LTV·DTI regulations have been strengthened or mitigated. However, regulations on housing finance were eventually eased as the housing economy in some areas slowed after the 2008 global financial crisis. Since 2012, the housing market has been depressed, and the need for the deregulation of housing finance has been discussed. In May 2012, the three districts of Gangnam-gu were excluded from the list of speculative areas, and the deregulation trend continued. In 2013, LTV and DTI regulations were relaxed for first-time home buyers. In July 2014, 70% as the upper limit of the LTV ratio and 60% as the upper limit for DTI were introduced, corresponding to a significantly relaxed level of borrowing regulation compared to the previous level.

Strengthening housing finance regulations may increase borrowers' risk of default. Table 2 shows the average interest rates and the corresponding differences between mortgage loans and unsecured loans by banking sector or non-banking sector according to the borrower's credit score, suggesting three crucial facts important in this study, as follows:

1. For both unsecured loans and mortgages, borrowers with lower credit scores pay higher interest rates.
2. The interest rates on unsecured loans increase rise very steeply as borrowers' credit ratings worsen, especially in the non-banking sector.
3. In the banking sector, the mortgage interest rate does not vary according to credit score. Still, the interest rate rises significantly when the credit score worsens in the non-banking sector.

Thus, LTV regulations of bank mortgage loans may keep some borrowers from obtaining a sufficient amount of bank mortgages with long-term maturities and low-

TABLE 1—CHANGES IN HOUSING FINANCE REGULATIONS BEFORE AND AFTER AUGUST 2014

		Before August 2014		After August 2014
		Banks & Insurance company	Other Non-banking	All Institutions
LTV	Seoul Metropolitan area	50~70%	60~85% ¹⁾	70%
	Other areas	60~70%	70~85%	
DTI	Seoul	50%	50~55% ²⁾	60%
	Gyeong-gi do Incheon-si	60%	60~65% ²⁾	
	Other areas		none	

Note: 1) Including the adjusted limit of financial co-ops (within 15%p), 2) When the housing price is less than KRW 300 million.

Source: “New Economic Policies” (Ministry of Economy and Finance, 24 July 2014).

TABLE 2—AVERAGE INTEREST RATES FOR MORTGAGES AND UNSECURED LOANS BY INSTITUTION AND CREDIT RATING

(UNIT: %)

Credit rating	Bank loans interest rates			Non-bank loans interest rates		
	Unsecured Loan	Mortgage Loan	Difference	Unsecured Loans	Mortgage Loan	Difference
1 (Best)	4.8	4.1	0.7	7.4	5.0	2.4
2	5.0	4.1	0.9	8.8	5.0	3.8
3	5.7	4.2	1.5	12.4	5.0	7.4
4	6.6	4.3	2.3	14.9	5.4	9.5
5	7.7	4.4	3.3	17.0	5.6	11.4
6	8.4	4.4	4.0	18.5	5.9	12.6
7	8.8	4.5	4.3	20.5	6.4	14.1
8	9.5	4.8	4.7	24.1	7.5	16.5
9	10.4	5.3	5.1	22.5	9.2	13.3
10 (Worst)	10.3	5.3	5.0	22.6	8.3	14.3

Note: As of December 2014, based on KCB credit rating.

Source: Provided by KCB, calculated using total borrower data of KCB.

interest rates. As a result, those borrowers may need to receive an additional mortgage from a non-banking institution or an unsecured loan, both of which are relatively expensive. Therefore, stronger regulations on bank mortgages can negatively impact the debt structures of those with low credit ratings. For this reason, we investigate whether the deregulation of bank mortgage loans reduces the probability of a debtor's delinquency and whether this effect is more noticeable among borrowers with low credit scores.

B. Literature Review

This study is related to previous studies that analyzed LTV and DTI levels and regulatory changes that affected homeownership and mortgage loans and to studies that analyze the effects of LTV and DTI levels on default outcomes. Mian and Sufi (2009) and Park (2017) are most relevant to this study in that they analyze the effects

of changes in housing finance regulations on household credit risk and debt increases. Work by Mian and Sufi (2009) is also similar to our study as they analyze the impact of US housing finance regulations on mortgage delinquency rates. However, Mian and Sufi (2009) focus on the excess supply of credit as one of the factors that caused massive defaults in the US mortgage market in 2007. This is contrary to our finding that deregulation of housing finance regulations can lower the credit risk of borrowers with low credit scores.

The distinction between Mian and Sufi (2009) and this study may be due to the discrepancy between the existing level of housing finance regulation in the US mortgage market before 2007 and the Korean housing finance market situation in 2014. In the case of the United States, there were practically no regulations corresponding to Korea's LTV and DTI limits before the global financial crisis. However, with strict LTV and DTI in South Korea, borrowers inevitably need to use unsecured and non-banking sector loans. In the Seoul metropolitan area in 2014, we find that when the LTV of banking mortgage loans was limited to 50-60%, relaxation of housing finance regulations can reduce the debt repayment burden of borrowers and thus reduce the credit risk.

Park (2017) also uses KCB's data for each borrower and policy changes in August 2014. Park (2017) notes the necessity of monitoring the possibility that the credit risk of low-income and low-credit borrowers will increase depending on the housing market conditions in the future. On the other hand, this study shows that deregulations can reduce the debt repayment burden through debt restructuring and consequently reduce credit risk. It is also found that reducing credit risk is more pronounced among low-income and low-credit groups.

Choi, Ji, and Cho (2002) found that introducing housing finance regulations could reduce housing demand for households. Igan and Kang (2011) noted that stricter LTV DTI regulations caused a reduction in housing prices and the transaction volume.

Prior studies of the effects of LTV·DTI ratios on default risk include those by Ji and Choi (2007), Bang, Park, and Park (2010), Hur (2012), and Kim and Lee (2015). They use borrower-level data and show that borrowers' higher LTV·DTI ratios lead to higher default probabilities. The present study is similar to these studies regarding how credit risk and borrowing structure determinants are analyzed. However, it differs from prior studies using the LTV and DTI levels of borrowers in that it utilizes policy changes that have changed LTV regulatory levels exogenously.

In addition, Jeong (2018) and Lee *et al.* (2014) are similar to the present study in that they analyze the delinquency factors of borrowers using large-scale borrower-unit credit information data. However, unlike this study, Jeong (2018) and Lee *et al.* (2014) did not directly analyze the effects of exogenous policy changes.

III. Data and Empirical Strategy

A. Data

We use data from the Korea Credit Bureau (KCB), one of Korea's leading credit rating companies, covering the whole Korean population. A 10% random sample of population data was provided with borrowers who take a mortgage loan between

2008 and 2018. The data covers account-level monthly information, including delinquencies, opening and maturity dates, repayment method, loan amount, monthly loan balance, and the financial institution. It covers all financial institutions including non-banks and all types of loans including unsecured loans. Thus, we can use obtain a detailed picture of all loans held by individual borrowers. The characteristics of the borrowers include the borrower's age, occupation, residential address, DTI, income, credit score, and credit rating. We use delinquency information of 30 business days or more in any loan. We also use regional housing price trend data from the Korea Real Estate Board to control for fluctuations in regional housing prices. Specifically, the year-on-year increase in house prices one month before creating a new account is used as a control variable. This allows us to control the effects of expected price hikes in each region on our empirical results.

This study analyzes the effects of deregulation on bank mortgage loans on borrowers' credit risk and debt structure outcomes. Therefore, it is necessary to construct a sample of borrowers who already had a mortgage loan before the deregulation. We also need to confine the sample to borrowers who used other loans due to housing finance regulations, even if they still sought additional funds in the form of bank mortgage loans. Therefore, we only analyze debtors who concurrently held bank mortgage loans and other types of loans (unsecured loans and other mortgage loans) or who held non-bank mortgage loans as of July 2014. In other words, we exclude borrowers with bank mortgage loans only among the debtors who held mortgage loans just before the deregulation. In Appendix 1, we compare the debt structure of the borrowers to be analyzed and that of total borrowers by comparing the overall loan balance for each financial sector. Also, we examine differences in the maturity structure and repayment method between the borrowers to be analyzed and all borrowers.

Policies regulating the housing market have been announced frequently compared to those in other areas of the economy. Table 3 shows the policies, other than LTV and DTI deregulation, which may confound our difference-in-difference identification strategy within our analysis period.

First, we analyze the sample period between January 2013 and January 2016 to exclude the effects of other policies that may confound our difference-in-difference identification based on housing finance deregulation. By limiting the sample period, we could exclude the impact of the "Guideline for the Advancement of Loan (Home Mortgage Loan) Reviews" implemented in February and May 2016. It was introduced to establish advanced credit practices focusing on the repayment capacity by reflecting the borrower's income and debt accurately and comprehensively during the review process. As the access to an additional loan would be difficult due to this policy, the probability of delinquency can increase among debtors who already held loans. On the other hand, the total delinquency rate can also decrease as banks started to screen debtors in terms of risk more accurately. Therefore, we limited our sample period up to January 2016.

Second, we excluded several debtors from the sample. On March 24, 2015, the Financial Services Commission launched the "Safe Conversion Loan" of 2.5~2.6% per annum through 16 banks. The Safe Conversion Loan is a policy that converts an existing variable rate or interest-only loan into a fixed interest rate loan in which the principal is paid off in installments. This policy was implemented from March 24,

TABLE 3—OTHER POLICIES THAT MAY CONFOUND IDENTIFICATION

Name	Content	Period
Guideline for Advancement of the Loan (Home Mortgage Loan) Review	<ol style="list-style-type: none"> 1. Evaluation of the borrower's repayment ability through objective evidence of income 2. Establishment of non-deferred amortization loan practices 3. Evaluation of repayment capacity considering the possibility of a future interest rate rise (stress rate) when dealing with a variable rate mortgage loan 4. Establishment of a system (DSR) that evaluates the overall repayment burden considering the repayment of principal and interest of other debts 	Feb. 2016 ~ present
Safe Conversion Loan	Converts an existing variable rate or interest-only loan into a fixed interest rate loan in which the principal is paid off in installments	Mar. 24, 2015 ~ Apr. 5, 2015
Collective Loan	<ol style="list-style-type: none"> 1. A loan product that allows multiple people to borrow money together to buy the same apartment 2. Loan up to 70% of the housing value Loan maturity 5 to 30 years 	When necessary

2015 to April 5, 2015. The government attempted to lower the delinquency rate by arranging for the debt to be paid off in installments from the beginning through a safe conversion loan. Therefore, the implementation of the policy may affect the delinquency rates of borrowers. Accordingly, for the validity of the difference-in-difference identification used in this analysis, the policy's beneficiaries are excluded from the sample. When a loan is converted to the Safe Conversion Loan, as it can be considered a new loan, we excluded borrowers with new loans in March and April 2015 from the analysis.

We also exclude borrowers who received collective loans for new condominiums as of July 2014. They generally convert the loans to mortgages after the completion of construction regardless of any deregulation. Collective loans usually involve contracts without much consideration of the repayment ability, which may confound our identification strategy. Therefore, we exclude collective loans in our sample.

Moreover, we add a robustness test with an additionally shortened analysis period, leaving less room for the effects of other policies to intervene. The robustness check results are presented in Appendix 4.

B. Empirical Strategy

The purpose of this study is to examine empirically whether borrowers' credit risk levels change with increased access to bank mortgage loans with relatively low interest rates and with long repayment periods after deregulation. Therefore, in this study, we set the following hypotheses [Hypotheses 1]:

[Hypothesis 1] If housing finance regulations on bank mortgage loans are relaxed, the probability of delinquency decreases for borrowers who already had mortgage loans and could access bank mortgages after the deregulation.

[Hypothesis 1-1] For borrowers with lower credit ratings, the decrease in the probability of delinquency becomes larger.

[Hypothesis 1-2] For the borrowers with lower incomes, the decrease in the probability of delinquency becomes larger.

Deregulation also can increase the overall credit risk in the whole economy, as the total amount of household loans may increase. However, this study only focuses on changes in the credit risk of borrowers who already had mortgage loans and whose access to bank mortgages is constrained despite the demand for additional loans. For these borrowers, improved access to bank mortgage loans may represent an opportunity to change their debt structure at a low cost and to gain a bank mortgage with a long-term maturity.

We also examine whether the extent of the reduction in credit risk is more noticeable for borrowers with worse credit ratings (Hypothesis 1-1). As shown in Table 2, the lower and worse credit score is (i.e., with a higher credit rating) related to the larger the difference in interest rates between bank mortgages and other loans. This can cause the burden of higher interest rates due to housing finance regulations for the low-credit class. Therefore, the decrease in the probability of delinquency when regulations are relaxed may be more pronounced for the low-credit class.

In addition, because incomes and credit ratings are partially related, the decrease in the credit risk is also expected to rise as income decreases. However, for some borrowers with low incomes, their asset possessions can be considerable; therefore, Hypothesis 1-2 is separately established and analyzed.

Suppose the credit risk of a borrower decreases, as in Hypothesis 1. In such a case, this may stem from the borrower converting loans with relatively high interest rates to low-interest bank mortgage loans, also converting short-term unsecured loans to long-term mortgage loans. The change in the debt structure can decrease the interest and monthly repayment burden. Therefore, we also set Hypothesis 2 to analyze whether the relaxation of housing finance regulations affects the debt structure of borrowers.

[Hypothesis 2] With the relaxation of housing finance regulations on bank mortgages, the repayment burden of borrowers with access to bank mortgage loans is reduced.

[Hypothesis 2-1] The ratio of high-interest loans of borrowers will decrease.

[Hypothesis 2-2] The ratio of repayment to the income of borrowers will decrease.

To test the hypotheses, we exploit the housing financial deregulation policy of August 2014 as an identification strategy in the differentiation-in-difference method. Before the policy, the LTV limit in the banking sector was 50-70% in the Seoul metropolitan area and 60-70% in non-metropolitan areas. However, the deregulation relaxed the LTV limit to 70% for all financial institutions in all areas. Therefore, after deregulation, the LTV limit for mortgage loans in the banking sector was further eased in the Seoul metropolitan area compared to non-metropolitan areas. Therefore, we classify residents of the Seoul metropolitan area as the treatment group, while those in non-metropolitan areas are the control group.

In order to achieve unbiased estimates of the deregulation effect through the

difference-in-difference method, the parallel trend assumption must be satisfied. In this analysis, the LTV regulation is considered to be relaxed in all areas, but the magnitude of the deregulation has been greater in the Seoul metropolitan area. Thus, we also assume that the magnitude of the deregulation would have been identical if the degree of deregulation was also identical.

For the regression analysis, we use equation (1) for the main estimation. The dependent variable $y_{i,t}$ represents borrower i 's credit risk or debt structure at period t . As dependent variables, we consider whether one of the borrower's loan accounts was delinquent for more than 30 days within six months after a mortgage account is opened as a measure of credit risk. Note that delinquencies in this study are not limited only to mortgage loans. This measure has a value of 1 when it occurs for more than 30 days in any of the accounts held by the borrower. Regarding the change in the debt structure, we use the high-cost loan ratio (share of loans excluding bank mortgage loans among loans) and the debt service ratio (DSR) referring to the debt repayment burden relative to income. Because the occurrence of a delinquency for more than 30 days can be observed over a considerably long period, we use semiannual observations (January and July). We use monthly observations for the high-cost loan ratio and DSR.

$$(1) \quad y_{i,t} = \beta_0 + \beta_{DD} D_{Sudo} \times D_{1408} + \beta_{Sudo} D_{Sudo} + \beta_{1408} D_{1408} + X_{i,t} \gamma + \varepsilon_{i,t}$$

Here, D_{1408} is a dummy variable indicating the period after August 2014, when the housing finance regulation in the Seoul metropolitan area was relaxed. D_{Sudo} is a dummy variable representing the residents of the Seoul metropolitan area at that time, who belong to the treatment group. $X_{i,t}$ is a matrix that represents a group of control variables that may affect the borrower's credit risk and debt structure. This matrix includes individual debtors' characteristics, such as their ages, average incomes, and credit ratings, including their credit and debit card usage statistics in the previous year. In addition, macroeconomic variables such as the CD91 interest rate (monthly), consumer price index (monthly), real GDP (quarters), and real GRDP (quarter) are also included as control variables. Finally, city-level fixed effects are included in the model.

The coefficient β_{DD} in equation (1) shows the effect of the housing finance deregulation, which is a measure of whether the average value of the dependent variable has changed further in the Seoul metropolitan area compared to those in non-metropolitan areas after the event. Therefore, if there is a decrease in the credit risk and a decrease in the repayment burden of borrowers in the metropolitan area, where the extent of deregulation on housing finance was larger, a negative estimate of β_{DD} is expected, which supports Hypothesis 1.

We also find that the effects of deregulation on a delinquency outcome can differ according to income, credit score, and the existing debt structure. Thus, each sample was classified according to income and credit rating, and for each subsample we also ran estimates using equation (1). The classification criteria for low, middle and high credit ratings, the income quintile, and the existing debt structure are described in detail in Section 4.

C. Descriptive Statistics

This section examines the proportion of debtors who took out bank mortgages after deregulation in the Seoul metropolitan area. It examines whether they tend to reduce their non-bank mortgage loans or unsecured loans. In August 2014, the same deregulation took place in the banking and insurance sectors, but insurance was classified as a non-bank sector in this section. An analysis that categorized the sample into bank/insurance mortgage loans and other secured loans was also conducted. These results are very similar, and the analysis is presented in Appendix 2.

Borrowers who hold only bank mortgage loans and no unsecured loans account for the largest share in the original sample. However, they are excluded from the analysis because there is no room for improvement in the debt structure.

As of July 2014, just before the deregulation, those in category (A), who hold both bank mortgage loans and unsecured loans, accounted for 34.3% of the total. On the other hand, the proportion of borrowers who have both bank and non-bank mortgage loans at the same time was small at about 3.6%. In January 2016, a year and a half after the deregulation, the proportion of borrowers who had only bank mortgage loans without unsecured loans decreased, while the proportion of borrowers who had both bank and non-bank mortgage loans increased. In addition, the average credit rating for each debt structure classification remained similar. In sum, the proportion of borrowers who can access bank mortgage loans in the Seoul metropolitan area after the deregulation has remained relatively constant.

After deregulation, the proportion of debtors who opened bank mortgages was largest at 33.7% in the group with bank mortgage loans and unsecured loans, while this rate was 27% in the group with bank and non-bank mortgage loans at the same time. Moreover, 20-30% of borrowers in each category have increased their total loans since the deregulation. This appears to reflect that it is easy for borrowers who already had a bank mortgage to open a new mortgage loan account within the same sector after deregulation due to the characteristics of the mortgage product. Groups with unsecured loans include a higher proportion of debtors opening bank mortgage

TABLE 4—DEBT STRUCTURE OF MORTGAGE LOAN HOLDERS BEFORE AND AFTER THE DEREGULATION

(BORROWERS IN THE SEOUL METROPOLITAN AREA)

Timing of observation		Jul. 2014		Jul. 2014- Jan. 2016	Jan. 2016	
Debt structure (as of Jul. 2014)		Proportion	Avg. Credit rating	Proportion of borrowers with new bank mortgage	Proportion	Avg. Credit rating
Only bank mortgage loans + no unsecured loans		46.7	3.3		44.0	3.3
Only bank mortgage loans + unsecured loans		A 34.3	3.7	33.7	34.8	3.6
Mortgage loans from both banks and the non-bank sector	Secured loans	B1 1.9	4.6	27.8	3.1	4.5
	No Secured loans	B2 1.7	3.6	26.6	2.7	3.6
Only non-bank mortgage loans	Secured loans	C1 7.2	4.8	12.9	7.2	4.6
	No Secured loans	C2 8.3	3.6	10.8	8.1	3.6

Note: Borrowers with group loan in Jul 2014 and the Secure Convertible loan in Mar. 2015 are excluded.

Source: Authors' calculation using a sample of KCB borrowers.

TABLE 5—CHANGE IN THE SHARE OF NON-BANK MORTGAGE LOANS AMONG WHOM OPENED
A NEW BANK MORTGAGE ACCOUNT AFTER DEREGULATION

(UNIT: KRW 1,000, %, BORROWER IN THE SEOUL METROPOLITAN AREA)

Classification (As of Jul. 2014)			(Based on initial loan amount)		(Based on loan balance)	
			Change	Share of borrowers who reduced non-bank mortgages	Change	Share of borrowers who reduced non-bank mortgages
Mortgage loans from both banks and the non-bank sector	Secured loans	B1	-56,226.9	45.9	-49,961.7	59.7
	No Secured loans	B2	-48,747.8	46.8	-38,933.26	60.4
Only non-bank mortgage loans	Secured loans	C1	-106,497.9	77.7	-100,663.9	83.0
	No Secured loans	C2	-99,336.6	77.0	-86,547.3	82.8

Source: Authors' calculation using a sample of KCB borrowers.

loans after the deregulation compared to other groups, which may be due to the incentive to convert high-interest-rate unsecured loans to bank mortgage loans.

Table 5 describes whether borrowers who opened a new bank mortgage account after deregulation reduced their amounts of non-bank mortgage loans. The average loan contract amount and loan balance decreased in all categories, and the average reduction amount ranged from 38 million won to 100 million won. When calculating the proportion of those who have reduced non-bank mortgage loan, in terms of the loan balance, it represents approximately 60% of those who hold bank and non-bank mortgage loans simultaneously and about 83% of those who have only non-bank mortgage loans. Therefore, among the non-bank mortgage loan holders in the metropolitan area, the proportion of those newly opening bank mortgage loans after deregulation is low, but most of them reduce the amounts of their non-bank mortgage loans, suggesting that additional borrowing in the form of bank loans improves their debt structures.

Table 6 shows the changes in unsecured loans after deregulation by borrowers who newly took out bank mortgages. The average amount of these loans increased after deregulation for the group that held bank mortgage loans and unsecured loans. However, for those who had non-bank mortgage loans, the average loan amount decreased. Calculating the share of those for whom the loan amount was reduced, we find that more than half reduced the unsecured loans in all cases. Therefore, it is

TABLE 6—AVERAGE CHANGE IN UNSECURED LOANS AMONG WHOM OPENED
NEW BANK MORTGAGE ACCOUNTS AFTER DEREGULATION

(UNIT: KRW 1,000, %, BORROWER IN THE SEOUL METROPOLITAN AREA)

Classification (As of July 2014)		Change in Amount of Unsecured Loans	Share of borrowers Who reduced unsecured loans
Only bank mortgage loans + unsecured loans	A	1,122.90	53.82
Mortgage loans from both banks and the non-bank sector + unsecured loans	B1	-18,985.88	61.81
Only non-bank mortgage loans + unsecured loans	C1	-3,463.53	59.57

Note: Borrowers who opened a new bank mortgage account between Jul. 2014 and Jan. 2016.

Source: Authors' calculation using a sample of KCB borrowers.

believed that after the deregulation in the metropolitan area, mortgage loan holders who additionally took out bank mortgages tended to improve their debt structure. Based on these descriptive statistics, we utilized the difference-in-differences method to determine the effects of the LTV deregulation on credit risks and the debt structure of borrowers.

IV. Empirical Results

A. Impact of Deregulation on Credit Risk

This section analyzes the effect of easing housing finance regulation on the delinquency rate exceeding 30 business days. Here, delinquency refers to an overdue record on any loan held by the borrowers, including mortgage loans, unsecured loans, and other secured loans.

Table 7 shows the effect of the housing finance deregulation on the probability of a delinquency. Because we use the difference-in-difference method, a negative estimate of the interaction term between the Seoul metropolitan area and the time dummy(after August 2014) suggests that the borrower's credit risk decreased after the deregulation. The first column stands for estimates using the full sample, and it shows that the delinquency rate decreases by approximately 0.22%p after the deregulation. Considering that the average delinquency rate is close to 1.4%, the deregulation (increase in the LTV limit by 10-20 (%p)) decreases the delinquency rate of borrowers about 15.7%. In other words, the improvement of accessibility to bank mortgages can lower the credit risk of borrowers.

The second and third columns of Table 7 show the estimates for the subsample with a history of being overdue exceeding five days and without overdue between January 2013 and July 2014, just before the deregulation. This comparison examines the heterogeneous effects of deregulation for groups who experienced a liquidity constraint and those who did not. The deregulation reduces the delinquency rate significantly only for those who have experienced liquidity constraints before the deregulation. This suggests that the group suffering from liquidity constraints is more likely to change the debt structure after the deregulation.

Moreover, the delinquency rate tends to increase with older age, worse credit rating, higher CD rates, and lower-income. These results are sensible in expecting the effect of each factor on the probability of delinquency.²

²

TABLE 1-1. DEFAULT RATE BY CREDIT RATING GROUP

Credit Rating Companies	1	2	3	4	5	6	7	8	9	10
NICE	0.05	0.16	0.34	0.51	0.7	1.82	6.29	9.79	11.87	33.03
KCB	0.06	0.11	0.22	0.56	1.31	3.47	7.88	17.79	37.12	75.43

Note: Credit ratings is calculated at the end of 2017 and default information is at the end of 2018 (one year later than 2017).

The main regression analysis in Table 7 included credit rating variables from the first to fourth order terms. According to Table 1-1, the probability of delinquency surges as the credit rating changes by one. As the nonlinear relationship between the credit rating and delinquency rate is remarkable, the high-order terms of the credit rating are included. Otherwise, when we include only the first-order term of the credit rating, the coefficient of annual income was estimated to be a positive value, somewhat insensible (in Table A5).

TABLE 7—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DELINQUENCY RATE

Variable	Dependent Variable: Experience of 30+ days Delinquency in any Loans (Dummy)		
	(1) Whole sample	(2) With delinquency record before the deregulation	(3) Without delinquency record before the deregulation
Seoul Metro. Area x After deregulation (dummy)	-0.0022*** (0.00068)	-0.023*** (0.0046)	0.00017 (0.00035)
Seoul Metro. Area (dummy)	-0.0058 (0.0074)	-0.036 (0.048)	-0.0025 (0.0037)
After deregulation (dummy)	0.0030*** (0.0010)	0.017*** (0.0067)	0.0019*** (0.00057)
Age (unit: 5 years interval)	0.000050*** (0.000015)	0.00055*** (0.00010)	-2.7e-06 (6.9e-06)
ln (income)	-0.0017*** (0.00027)	0.00067 (0.0022)	-0.00026** (0.00012)
Credit rating (Level 1-10)	0.016*** (0.0023)	0.12*** (0.0088)	-0.010*** (0.0014)
1 year credit card usage amount (one million won)	-0.000088*** (6.5e-06)	-0.00023*** (0.000081)	-8.7e-06*** (1.5e-06)
1 year debit card usage amount (one million won)	0.000061** (0.000024)	-0.000017 (0.000097)	6.2e-06* (3.7e-06)
cd 91 interest rates	0.0066*** (0.0012)	0.060*** (0.0079)	-0.00089 (0.00068)
CPI (Inflation Rate)	0.00059 (0.00038)	0.0043 (0.0027)	-0.000010 (0.00016)
GRDP (regional economy)	4.6e-08 (3.0e-08)	3.2e-07 (1.9e-07)	1.2e-08 (1.5e-08)
GDP	8.4e-08*** (2.2e-08)	6.8e-07*** (1.6e-07)	1.6e-08* (8.9e-09)
Housing price growth (YoY, 1 month lag)	0.00022 (0.00015)	0.0011 (0.0010)	0.00023*** (0.000060)
Constant	-0.11*** (0.034)	-1.00*** (0.25)	0.0040 (0.014)
N	719,675	89,354	630,321
R ²	0.193	0.237	0.043

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) The metropolitan and year fixed effect and the second, third, and fourth terms of credit rating are included in the regressions but not reported, 4) This was calculated using information on a semiannual basis (January, July), and 30-day delinquency refers to a case in which more than 30 days of delinquency occur among any loans (including unsecured loans) held by the borrower within the preceding six months, 5) A group with past delinquency is composed of borrowers with a record of more than five days overdue in any loans as of July 2014, 6) The numbers of borrowers of each sample (columns (1),(2),(3)) were 206,361, 33,650 and 172,711 respectively.

As the effect of the deregulation on delinquency rate can be more pronounced for borrowers with more severe liquidity constraints, we need to see whether borrowers with worse credit ratings are more likely to be affected by the deregulation. Thus, we perform the above analysis separately for each credit rating group. Based on the KCB credit rating at the first observation in the sample, borrowers are classified into three groups, a high-credit (1~3 in the KCB ratings), a medium-credit (4~6), and a low-credit (7~10). Note that credit rate 1 is the best rate and 10 is the worst credit

TABLE 8—NUMBER OF BORROWERS BY CREDIT RATING GROUP

	Credit rating group		
	High-credit borrower	Medium-credit borrower	Low-credit borrower
Credit rating	1~3	3~4	7~10
Observations	110,873	71,295	24,193

Source: Authors' calculation using a sample of KCB borrowers.

TABLE 9—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DELINQUENCY RATE: BY CREDIT RATING

Variable	Sample	Dependent Variable: Experience of 30+ days Delinquency in any Loans (Dummy)		
		(1)	(2)	(3)
		High-credit borrower (Levels 1~3)	Medium-credit borrower (Levels 4~6)	Low-credit borrower (Levels 7~10)
Seoul Metro. Area x After deregulation (dummy)		-0.000048 (0.00019)	-0.0017** (0.00083)	-0.011** (0.0055)
Seoul Metro. Area (dummy)		-0.0023 (0.0021)	-0.0036 (0.0081)	0.00078 (0.054)
After deregulation (dummy)		0.000021 (0.00032)	0.0020 (0.0013)	0.019** (0.0086)
N		399,049	241,261	79,365
R ²		0.000	0.004	0.157

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Semiannual basis (January, July) information is utilized, and delinquency refers to an occurrence of more than 30 days overdue in any loans held by borrowers, 5) The numbers of borrowers of each sample (columns (1),(2),(3)) were 110,873, 71,295, and 24,193, respectively.

rating.³

Table 9 shows estimates of the effect of housing finance deregulation by each credit rating group. The deregulation lowers the credit risk of borrowers with poor credit ratings. When LTV of bank mortgage loans was eased by 10-20 (%p), the average delinquency rate for borrowers with the worst credit ratings decreased by about 1.1%p, showing the most significant decline. While, the average delinquency rate declined by 0.17%p for borrowers with mid-level credit ratings. The effect of the credit risk declines greater with lower credit rating when the housing finance regulation is eased. As the credit rating worsens, the reduction in the debt repayment burden becomes more significant. It is because, as suggested in Table 2, the interest rate on unsecured loans increases steeply as the credit rating worsens, especially in the non-banking sector.

Although the correlation between the credit rating and income is high, borrowers with low credit ratings and low-income groups do not necessarily show a perfect match. Therefore, we conduct the same analysis according to the income segment.⁴

³Table 8 shows the number of borrowers of each credit rating group. In the sample, the proportion of low-credit borrowers is relatively small because the sample in this analysis consists only of borrowers with mortgages.

⁴One of the most important factors determining a credit rating is a history of past overdue payments.

TABLE 10—DEFINITION OF INCOME SEGMENT BY NATIONAL TAX SERVICE (ATTRIBUTABLE TO 2014~16)

Income segment	Tax rate segment
1	12 million won or less
2	More than 12 million won and less than 46 million won
3	More than 46 million won and less than 88 million won
4	More than 88 million won and less than 150 million won
5	More than 150 million won

TABLE 11—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DELINQUENCY RATE:
BY INCOME SEGMENT

Variable	Sample	Dependent Variable: Experience of 30+ days Delinquency in any Loans (Dummy)				
		(1)	(2)	(3)	(4)	(5)
		Income segment 1	Income segment 2	Income segment 3	Income segment 4	Income segment 5
Seoul Metro. Area x After deregulation (dummy)		-0.025 (0.016)	-0.0034*** (0.00096)	-0.00093 (0.00085)	-0.00016 (0.0017)	0.0028 (0.0069)
Seoul Metro. Area (dummy)		-0.088 (0.12)	-0.0015 (0.010)	-0.019** (0.0093)	0.011 (0.018)	0.065 (0.089)
After deregulation (dummy)		-0.0017 (0.022)	0.0049*** (0.0014)	0.00075 (0.0013)	-0.00027 (0.0025)	-0.015* (0.0087)
N		405	463,079	208,103	41,670	6,418
R ²		0.166	0.194	0.197	0.128	0.216

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Semiannual basis (January, July) information is utilized, and delinquency refers to an occurrence of more than 30 days overdue in any loans held by borrowers, 5) The sample comprises borrowers holding bank mortgages with other types of loans together and borrowers holding non-bank mortgages as of July 2014, 6) The number of borrowers corresponding to each sample were 128, 138,116, 56,576, 9,986, and 1,555, respectively.

The definition of the income segment is based on the tax rate segment of the National Tax Service as of 2014. As summarized in Table 10, the first segment corresponds to borrowers with the lowest annual income. The higher number of income segment shows higher the annual income.

Table 11 shows the estimates of the regression difference-in-difference method for each income segment. The decline of delinquencies after relaxing the housing finance regulation is greater with the lower income level. In income segment 1, the coefficient estimate is prominent, but the number of observations is insufficient, resulting in a statistically insignificant estimate. In income segment 2, the decline in the delinquency rate due to the relaxation of the housing finance regulation is most noticeable. In particular, the average delinquency rate for borrowers in the second

Delinquency risk is closely linked not only to the income of the borrower but also to assets. For example, for retired borrowers in their 60s or older, the income range is estimated to be low. In contrast, the incidence of delinquency is not high due to a high level of assets and, as a result, the credit rating is often high.

TABLE 12—CHANGES IN DELINQUENCY RATES AFTER THE DEREGULATION:
NEW BANK MORTGAGE ACCOUNT

Variable	Sample	Dependent Variable: Experience of 30+ days Delinquency in any Loans (Dummy)	
		(1) opening new bank mortgages account after the deregulation	(2) Without opening new bank mortgages account after the deregulation
After deregulation (dummy)		-0.0031*** (0.00069)	0.0050*** (0.0016)
N		154,016	359,462
R ²		0.020	0.224

Note: 1) Statistical significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Semiannual basis (January, July) information is utilized, and delinquency refers to an occurrence of more than 30 days overdue in any loans held by borrowers, 5) The sample comprises borrowers holding bank mortgages with other types of loans together and borrowers holding non-bank mortgages as of July 2014.

income segment falls by 0.34%p.

We show that the housing finance deregulation in the banking sector reduces the credit risk of the borrowers, and this can be achieved by adjusting the debt structure to reduce the burden of debt repayment.

Table 12 shows the estimates of the change in the delinquency rate after the deregulation. The sample is divided into two groups that newly opened bank mortgage account after the deregulation and that did not. The delinquency rate decreased significantly for the borrowers who newly opened a mortgage loan in the banking sector. Considering that the average delinquency rate in the Seoul metropolitan area was 1.85%, this decrease in delinquencies is more than 15%. On the other hand, in the group that did not open a new bank mortgage account, the delinquency rate increased by about 0.5%p, which is a 26% change. This result suggests that borrowers may change their debt structure to reduce their debt repayment burden by using a bank mortgage loan after the housing finance deregulation. The delinquency rate may decrease consequently. In the next section, the change in the debt structure, leading to a reduction in the delinquency rate, will be examined in more detail.

Table 13 shows the estimates of the deregulation effect for each group divided by the debt structure of borrowers as of July 2014. After the deregulation, delinquency rate decreased the most with the borrowers who owned additional loans with mortgage loans. In particular, the delinquency rate decreases by 0.6%p when the housing finance regulation is eased in the group that holds non-bank mortgages and additional unsecured loans.

TABLE 13—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DELINQUENCY RATE:
DEBT STRUCTURE

		Dependent Variable: Experience of 30+ days Delinquency in any Loans (Dummy)				
		Bank mortgages + unsecured loans	Bank or non-bank mortgages		Non-bank mortgages	
Variable	Sample		+ Unsecured	Only secured	+ Unsecured	Only secured
Seoul Metro. Area x After deregulation (dummy)		-0.0023*** (0.00075)	-0.0059 (0.0061)	0.014** (0.0063)	-0.0059** (0.0027)	-0.0021 (0.0020)
Seoul Metro. Area (dummy)		-0.0011 (0.0082)	-0.12* (0.068)	0.12 (0.074)	-0.020 (0.029)	-0.024 (0.023)
After deregulation (dummy)		0.0046*** (0.0011)	0.016 (0.0100)	-0.0097 (0.0097)	0.011*** (0.0038)	-0.0015 (0.0029)
N		390,617	12,706	7,712	102,220	89,580
R ²		0.151	0.136	0.141	0.199	0.180

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Semiannual basis (January, July) information is utilized, and delinquency refers to an occurrence of more than 30 days overdue in any loans held by borrowers, 5) The sample comprises borrowers holding bank mortgages with other types of loans together and borrowers holding non-bank mortgages as of July 2014.

B. Impact of Deregulation on Debt Structure I: Proportion of High-cost Loans

Thus far, we have empirically shown that the relaxation of housing finance regulations lowers the credit risk of borrowers who have been constrained to borrow more in the banking sector's mortgage loan market. In this section, we show that the housing finance deregulation reduces the credit risk of borrowers because individual borrowers change their debt structure to lower the repayment burden after the deregulation. Therefore, subsequently, we examine whether the deregulation of housing finance improves the debt structure to reduce the repayment burden of borrowers.

To this end, this chapter introduces a measure called the “proportion of high-cost loans.” It refers to the ratio of the total amount of borrowings excluding bank mortgage compared to total borrowings. This means the proportion of other loans excluding relatively low-interest bank mortgages. When the value of the proportion of high-cost loans is close to zero, the borrower's debt structure is better.

Table 14 shows descriptive statistics of the proportion of high-cost loans by credit rating quantile. When credit rating is worse, the high-cost loan ratio becomes higher. Therefore, worse credit ratings can be linked to a lower proportion of bank mortgages with low-interest rates and long-term repayment.⁵

Table 15 shows the regression difference-in-difference estimates of changes in the proportion of high-cost loans after the deregulation by each credit-rating group. The result shows that the ratio of high-cost loans significantly decreases with the

⁵In addition, as shown in Table 2, the difference between the interest rate of the first financial sector mortgage loan and the interest rates of other loans shows a pattern that increases as the credit rating increases.

TABLE 14—PROPORTION OF HIGH-COST LOANS: BY CREDIT RATING GROUP

Credit rating group	Ratio of high-cost loans			
	Mean	Min	Max	S.D.
High (1~3)	0.31	0	1	0.27
Medium (4~6)	0.37	0	1	0.26
Low (7~10)	0.44	0	1	0.26

Source: Authors' calculation using the KCB mortgage borrower sample DB.

TABLE 15—EFFECTS OF HOUSING FINANCE DEREGULATION ON DEBT STRUCTURES: CREDIT RATING

Variable	Sample	Dependent variable: High-cost loan (loans other than bank mortgages) ratio		
		(1)	(2)	(3)
		High-credit borrower (Levels 1~3)	Medium-credit borrower (Levels 4~6)	Low-credit borrower (Levels 7~10)
Seoul Metro. Area x After deregulation (dummy)		-0.018*** (0.0010)	-0.0090*** (0.0012)	-0.0085*** (0.0021)
Seoul Metro. Area (dummy)		-0.11*** (0.012)	-0.049*** (0.014)	-0.056** (0.023)
After deregulation (dummy)		0.037*** (0.0014)	0.013*** (0.0017)	0.0089*** (0.0029)
N		2,021,907	1,266,915	416,490
R ²		0.046	0.038	0.044

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Monthly information is used, and the share of high-cost loans refers to the share of loans other than bank mortgage loans.

deregulation in all credit rating groups. The decrease in the proportion of high-cost loans is relatively high among high-credit borrowers, who can relatively easily access bank mortgages. As shown in Figure 1, this is related to the fact that most of the new bank mortgage accounts have been opened by the groups with high and middle credit scores since the deregulation

For low-credit-rated borrowers, the decrease in the proportion of high-cost loans after the deregulation is relatively small but still significant. As shown in Table 2, the interest rate gap between bank mortgage loans and other loans is significantly high for the low-credit group, so even the small decrease in the proportion of high-cost loans can effectively reduce the repayment burden for them. This could also lead to a decrease in the delinquency rates for mid/low-credit borrowers. Therefore, although the decrease in the proportion of high-cost loans is the most pronounced for high-credit borrowers, the reduction in the repayment burden may be even more pronounced for medium- and low-credit borrowers. The following section will discuss the change in the debt-service ratio (DSR) due to the relaxation of the housing finance regulation.

Table 16 shows the estimates of the effect of housing finance deregulation on the proportion of high-cost loans by income segments. The reduction in the ratio of

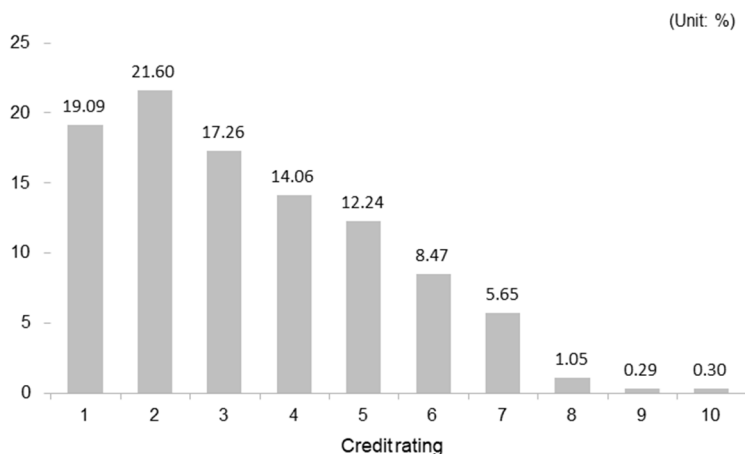


FIGURE 1. OPENING NEW MORTGAGE LOANS IN BANKING SECTOR
AFTER THE HOUSING FINANCE DEREGULATION: BY CREDIT RATINGS

Source: Authors' calculation using the KCB mortgage borrower sample DB.

TABLE 16—EFFECTS OF HOUSING FINANCE DEREGULATION ON DEBT STRUCTURE:
BY INCOME SEGMENT

Variable \ Sample	Dependent variable: High-cost loan (loans other than bank mortgages) ratio				
	(1)	(2)	(3)	(4)	(5)
	Income segment 1	Income segment 2	Income segment 3	Income segment 4	Income segment 5
Seoul Metro. Area x After deregulation (dummy)	-0.068** (0.030)	-0.014*** (0.00089)	-0.015*** (0.0014)	-0.0076** (0.0034)	-0.0066 (0.0096)
Seoul Metro. Area (dummy)	-0.63* (0.37)	-0.10*** (0.010)	-0.034** (0.016)	-0.074* (0.041)	0.16 (0.12)
After deregulation (dummy)	0.046 (0.044)	0.026*** (0.0012)	0.026*** (0.0019)	0.018*** (0.0045)	0.028** (0.013)
N	2,123	2,383,851	1,079,240	216,417	32,934
R ²	0.148	0.050	0.058	0.059	0.060

Note: 1) Statistical significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Monthly information is used, and the share of high-cost loans refers to the share of loans other than bank mortgage loans.

Source: Authors' calculation using the KCB mortgage borrower sample DB.

high-cost loans is the most prominent in the lowest income group (income segment 1) when the housing finance regulation is relaxed. Considering that the average proportion of high-cost loans for income segment 1 is about 39%, the proportion of high-cost loans decreases is about 17.4%. This suggests that low-income borrowers improve their debt structures to reduce their repayment burden when the housing finance regulation is eased. High-cost loans are also reduced in other income groups. Considering that the proportion of high-cost loans of borrowers other than those who belong to income segment 1 is 34-41%, the ratio of high-cost loans decreases

TABLE 17—EFFECTS OF HOUSING FINANCE DEREGULATION ON DEBT STRUCTURES:
BY PREVIOUS DEBT STRUCTURE

Variable \ Sample	Dependent variable: High-cost loan (loans other than bank mortgages) ratio				
	Bank mortgage loans	Mortgage Loans from both Bank and Non-bank		Non-bank mortgages	
	+ unsecured loans	Unsecured loans	Only secured	Unsecured loans	Only secured
Seoul Metro. Area x After deregulation (dummy)	-0.0053*** (0.00089)	-0.038*** (0.0042)	-0.045*** (0.0059)	-0.018*** (0.00097)	-0.020*** (0.00089)
Seoul Metro. Area (dummy)	-0.029*** (0.0100)	0.10** (0.051)	-0.030 (0.071)	0.022* (0.013)	-0.010 (0.013)
After deregulation (dummy)	0.0091*** (0.0012)	0.068*** (0.0059)	0.062*** (0.0082)	0.034*** (0.0014)	0.031*** (0.0013)
N	2,089,752	67,908	40,985	547,383	476,231
R ²	0.053	0.028	0.026	0.032	0.017

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Monthly information is used, and the share of high-cost loans refers to the share of loans other than bank mortgage loans.

just about 2.5-5% for those borrowers after the deregulation. This is related to previous results showing that the decline in the delinquency rate after deregulations is prominent in the low-income group.

Table 17 shows the estimates of the effect of the housing finance deregulation on the proportion of high-cost loans for each group by debt structure before the deregulation. The ratio of high-cost loans decreased significantly in all groups after the deregulation. The decline in the proportion of high-cost loans is significant in all groups. Especially for groups with mortgage loans in both banking and non-banking sectors, the decreases in the proportion of high-cost loans were approximately 3.8%p (with unsecured loans) and 4.5%p (without unsecured loans), respectively.

Except for high-credit groups, as the interest payment burden is lower in bank mortgage loans than other loans, the lower proportion of loans other than bank mortgages can lead to a lower interest burden. We will directly examine whether the deregulation causes a lower DSR for some borrowers in the next section.

C. Impact of Deregulation on Debt Structure II: Debt Service Ratio (DSR)

This section examines whether the debt restructuring reduced principal and interest repayment burden by measuring the debt service ratio (DSR). The DSR is the ratio of a borrower's monthly payment of principal and interest for financial institutions to his monthly income. We showed that the proportion of high-cost loans decreased when housing finance regulations were eased, indicating that the debt structure of borrowers has changed in a way that improves their situations. Table 18 shows the basic statistics of DSR, indicating that the average DSR increases as the credit rating quantile increases; that is, the credit rating worsens. This appears to be a natural phenomenon as income decreases as the credit rating worsens while the

TABLE 18—BASIC STATISTICS OF DSR BY CREDIT RATING QUANTILE

Credit rating quantile	DSR		
	Mean	S.D.	N
1	0.22	0.32	112,629
2	0.37	0.44	72,225
3	0.53	0.64	22,112

Source: Authors' calculation using the KCB mortgage borrower sample DB.

TABLE 19—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DEBT REPAYMENT BURDEN:
BY CREDIT RATING

Variable	Sample	Dependent variable: DSR (ratio of principal and interest repayment to income)		
		(1) High-credit borrower (Levels 1~3)	(2) Medium-credit borrower (Levels 4~6)	(3) Low-credit borrower (Levels 7~10)
Seoul Metro. Area x After deregulation (dummy)		-0.021*** (0.0011)	-0.029*** (0.0018)	-0.026*** (0.0047)
Seoul Metro. Area (dummy)		0.065*** (0.0023)	0.064*** (0.0036)	0.11*** (0.0091)
After deregulation of housing finance (dummy)		0.022*** (0.0015)	0.036*** (0.0024)	0.0083 (0.0063)
N		2,737,845	1,721,619	498,407
R ²		0.076	0.121	0.105

Note: 1) Statistical significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Calculated using monthly information, the DSR is a variable provided by KCB and represents the ratio of principal and interest repayment to borrower's income. As DSR information constructed by KCB includes the entire principal amount instead of the principal repayment at the time of delinquency, the observed value at the time of delinquency is removed.

charged loan interest rates increase.

Table 19 shows the regression difference-in-difference estimates of the change in the DSR due to the relaxation of the housing finance regulation for each credit rating quantile. The DSR decreased with the housing finance deregulation for all credit ratings. In particular, the decrease in the DSR is fairly significant in the groups with mid- and low-credit ratings. The DSR can decrease even if the total amount of loans does not decrease if borrowers reduce their proportion of high-cost loans by increasing the amount of bank mortgages. Since the interest rate gap between bank mortgages and other loans is larger with the lower credit ratings, the decrease in DSR can be more significant for the low-credit rating group when the share of high-cost loans decrease after the regulation.

Table 20 shows the estimates of difference-in-difference regression examining the changes in the DSR due to the housing finance deregulation for each income segment. What is notable is that the decrease in the DSR is most prominent in the low-income group, which is similar to the pattern of changes in the average delinquency rate.

Table 21 shows the estimates of the changes in the DSR due to deregulation

TABLE 20—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DEBT REPAYMENT BURDEN:
BY INCOME SEGMENT

Variable \ Sample	Dependent variable: DSR (ratio of principal and interest repayment to income)				
	(1)	(2)	(3)	(4)	(5)
	Income segment 1	Income segment 2	Income segment 3	Income segment 4	Income segment 5
Seoul Metro. Area x After deregulation (dummy)	-0.43*** (0.14)	-0.026*** (0.0015)	-0.018*** (0.0020)	-0.0084* (0.0051)	-0.037** (0.019)
Seoul Metro. Area (dummy)	0.99 (1.70)	0.088*** (0.018)	0.13*** (0.023)	-0.076 (0.055)	0.27 (0.30)
After deregulation of housing finance (dummy)	0.32 (0.20)	0.030*** (0.0022)	0.016*** (0.0027)	0.015** (0.0065)	0.024 (0.026)
N	2,099	2,390,752	1,086,768	218,715	33,287
R ²	0.282	0.191	0.144	0.122	0.154

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Calculated using monthly information, the DSR is a variable provided by KCB and represents the ratio of principal and interest repayment to borrower's income. As DSR information constructed by KCB includes the entire principal amount instead of the principal repayment at the time of delinquency, the observed value at the time of delinquency is removed.

TABLE 21—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DEBT REPAYMENT BURDEN:
BY DEBT STRUCTURE

Variable \ Sample	Dependent variable: DSR (ratio of principal and interest repayment to income)				
	Bank mortgage loans + unsecured loans	Mortgage Loans from both Bank and Non-bank		Non-bank mortgages	
		Unsecured loans	Only secured	Unsecured loans	Only secured
Seoul Metro. Area x After deregulation (dummy)	-0.019*** (0.0023)	-0.14*** (0.024)	-0.018 (0.018)	-0.032*** (0.0083)	-0.040*** (0.0057)
Seoul Metro. Area (dummy)	0.12*** (0.028)	-0.13 (0.28)	0.47** (0.22)	-0.084 (0.10)	-0.10 (0.075)
After deregulation (dummy)	0.030*** (0.0033)	0.19*** (0.033)	-0.030 (0.026)	0.078*** (0.011)	0.0071 (0.0077)
N	2,092,993	67,955	41,242	548,330	481,813
R ²	0.112	0.153	0.070	0.104	0.074

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities, 4) Calculated using monthly information, the DSR is a variable provided by KCB and represents the ratio of principal and interest repayment to borrower's income. As DSR information constructed by KCB includes the entire principal amount instead of the principal repayment at the time of delinquency, the observed value at the time of delinquency is removed.

according to the debt structure before the deregulation. The DSR declines when the housing finance regulation is eased in most of the groups. In particular, borrowers who get additional loans with both bank and non-bank mortgages show the most significant declines in the DSR.

V. Conclusion

This study confirmed that when the supply regulation on LTV and DTI of bank mortgages is eased, the credit risk of borrowers can be reduced. As borrowers can improve their debt structure through the additional borrowing of bank mortgage loans, low-interest and long-term maturity.

In August 2014, financial regulations on bank mortgages were eased in South Korea, especially in Seoul metropolitan area. With the difference-in-difference method, we find that the probability of a borrower being overdue for 30 days or more decreased after the deregulation among debtors who had both bank mortgage loans and other types of high-cost loans.

The reduction in the default risk due to the LTV and DTI deregulation was prominent for borrowers with low credit scores or low incomes. This is because the interest rates gap between bank mortgages and other loans is higher for borrowers with low credit scores and low incomes than those with high credit scores and high incomes. In addition, only the group that took out new bank mortgage loans was less likely to be delinquent than before. This indicates that the reduction in the credit risk was due to the improvement of the debt structure when they took out more bank mortgages.

We also find that the proportion of high-cost loans and the burden of the repayment of principal and interest significantly decreased in Seoul metropolitan area after the deregulation. When the samples were classified by income, credit, and the existing debt structure, the debt structure was improved in all samples.

Considering our results, the relaxation of bank housing finance regulations can improve the debt structure and lessens the credit risk for some borrowers. Especially, borrowers with low credit scores and low incomes may have limited access to bank mortgages as the value of their collateral would not be sizable; therefore, the effect of improving the debt structure was not highest for them. However, for borrowers with low incomes and low credit scores, delinquency rate can be significantly reduced with only a partial improvement in the debt structure. It is because the interest rate gap between bank mortgages and other loans is significantly higher for borrowers with low credit ratings.

Because the deregulation in August of 2014 applied only to bank mortgage loans, this study examined only the effects of the deregulation of bank mortgage loans. Considering that the interest rates of mortgages are lower than those of unsecured loans, our finding cannot be applied to predict the effects of easing housing finance regulations in the entire financial sector. Also, it is not plausible to predict the impact of regulatory reinforcements based on our results, as the reinforced regulations target only new borrowers, while the deregulation affects both new and existing borrowers. However, our finding that a mortgage loan can improve the debt structure and reduce default risk is still valid when regulations are strengthened.

Stabilizing the housing market would be a fundamental policy goal when the housing market is overheated, and strengthening LTV and DTI regulations is an effective and necessary policy tool to achieve this goal. However, there may be debtors with high credit risk among those living in overheated districts. Limiting their access to low-interest rates and long-term mortgages may increase their credit

risk. Therefore, it is necessary to conduct additional studies to analyze borrowers' credit risk changes during regulatory reinforcement, which is left as a follow-up study.

The LTV·DTI policy introduced in Korea in 2002 has played a valuable role in securing macro-prudential and real estate market price stability. However, the regulation has been understood as only stabilizing the housing market and increasing household debt. Thus, we suggest that it is necessary to pay attention to another impact of the policy by showing that the housing finance regulation policy can also affect credit risk and the debt structure depending on how it is introduced. The results of this study suggest a need to vary the level of housing finance regulation given the high levels of credit risk in some low-credit and low-income classes and general debtors when designing policies that will ease or strengthen housing finance regulations.

APPENDIX

1. Characteristic of Sample Borrowers

Table A1, A2 compares the descriptive statistics of total borrowers in the KCB dataset and borrowers in our sample. Table A1 shows the average amount of loans other than bank mortgage, and borrowers in our sample hold a higher amount of loans in unsecured loans and non-bank mortgages than the total population. This is because we exclude borrowers without any mortgages or borrowers with only bank mortgages in our sample. Table A2. shows that borrowers in our sample have slightly higher incomes and lower credit scores than total borrowers in South Korea demonstrated in the KCB dataset.

Figure A1 summarizes the loan maturity of the sample borrowers and total borrowers for each banking and non-banking sector. The figure shows that 30-year-maturity loan contracts were the most frequently assigned in the banking and non-banking sectors. Also, the maturity of the mortgage loans in the banking sector is longer than that in the non-banking sector. These features are similar in total borrowers and our sample.

Figure A2 shows the distribution of repayment methods for the bank mortgages and the non-bank mortgages. The amortization method is most common in bank mortgages, while the share of the lump-sum payment is still high in non-bank mortgages. The percentage of the lump-sum repayment is slightly higher in our

TABLE A1—COMPARISON OF TOTAL BORROWERS IN KCB DATASET AND BORROWERS IN OUR SAMPLE:
LOAN AMOUNT

(UNIT: KRW 1,000)

Object		Total Borrowers in KCB dataset		Borrowers in our sample (Bank mortgage + other loans or Non-bank mortgages)	
Variable		Average	S.D.	Average	S.D.
Unsecured loans	Bank	7,271.41	24,312.22	10,484.79	27,192.38
	Non-bank sector	3,897.71	21,467.19	5,711.23	27,561.94
Non-bank mortgages		10,732.83	111,072.8	15,202.63	150,065.6

Source: Provided by KCB, calculated using total borrower data of KCB.

TABLE A2—COMPARISON OF TOTAL BORROWERS IN KCB DATASET AND BORROWERS IN OUR SAMPLE:
OTHER CHARACTERISTICS

Object		Total Borrowers in KCB dataset		Borrowers in our sample (Bank mortgage + other loans or Non-bank mortgages)	
Variable		Average	S.D.	Average	S.D.
Age		51.29	8.81	51.28	8.43
DTI		0.26	0.39	0.35	0.73
Income (KRW 1,000)		41223.96	50434.07	43770.83	57233.5
Credit Score		825.55	135.23	800.6	147.2
Credit Rating		3.28	2.03	3.66	2.17
Delinquency rate		0.01	0.11	0.01	0.11

Source: Provided by KCB, calculated using total borrower data of KCB.

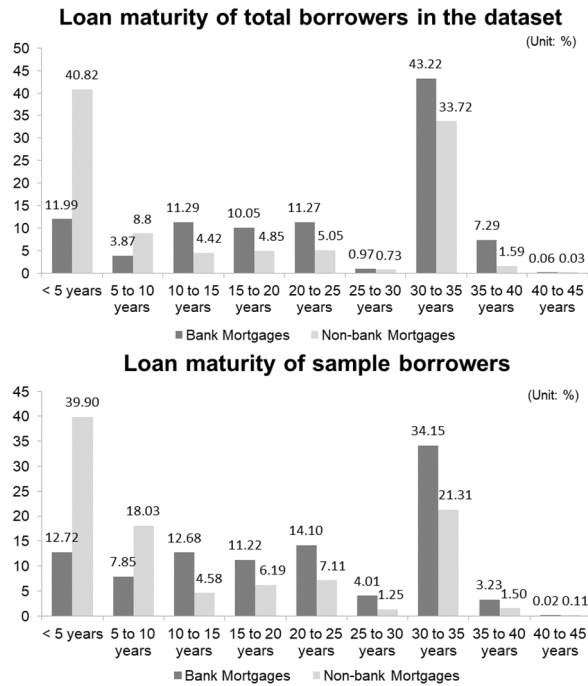


FIGURE A1. COMPARISON OF TOTAL BORROWERS IN KCB DATASET AND SAMPLE BORROWERS:
BY MORTGAGE MATURITY

Source: Provided by KCB, calculated using total borrower data of KCB.

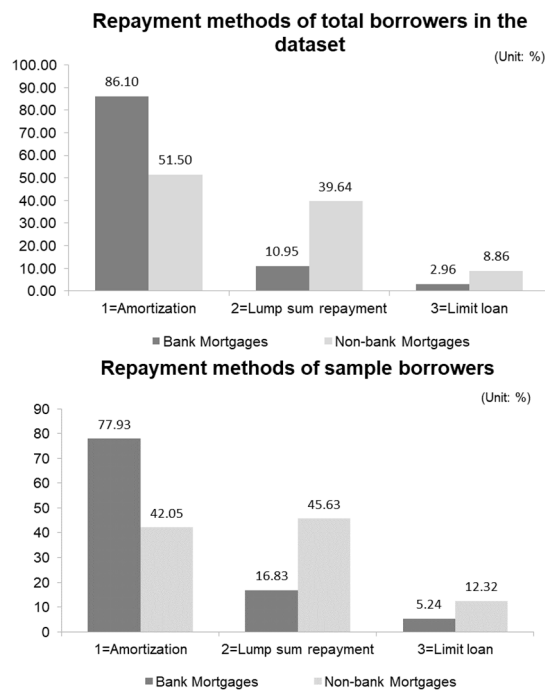


FIGURE A2. COMPARISON OF TOTAL BORROWERS IN KCB DATASET AND SAMPLE BORROWERS:
REPAYMENT METHODS

Source: Provided by KCB, calculated using total borrower data of KCB.

sample than in total borrowers. This can be because we excluded borrowers who converted to the Secure Convertible loans in March and April 2015.

2. Changes in debt structure before and after the deregulation

TABLE A3—DEBT STRUCTURE DISTRIBUTION OF MORTGAGE LOAN HOLDERS
BEFORE AND AFTER THE DEREGULATION (BANK + INSURANCE MORTGAGE LOANS)

(BORROWER IN METROPOLITAN AREA)					
Time of observation		Jul. 2014		Jul. 2014 - Jan. 2016	
Debt structure (as of Jul. 2014)		Proportion	Avg. Credit rating	Proportion of borrowers who opened a bank mortgage account	
Only bank and insurance comp. mortgage loans + without unsecured loans		31.0	26.5	36.2	
Only bank and insurance comp. mortgage loans + with unsecured loans		A 26.2	26.7	27.7	
Mortgage loans from both banks/Ins. and the non-bank sector	Secured loans	B1 25.3	27.8	30.8	
	Unsecured loans	B2 23.8	27.6	9.8	
Only non-bank mortgages	Secured loans	C1 18.5	25.4	7.0	
	Unsecured loans	C2 8.3	3.6	10.8	

Note: Borrowers with Group loan in July 2014 and the Secure conversion loan in March 2015 are excluded.

Source: Authors' calculation using the KCB mortgage borrower sample DB.

TABLE A4—AVERAGE CHANGE IN NON-BANK MORTGAGES OF BORROWERS WHO OPENED
A NEW BANK MORTGAGE ACCOUNT AFTER DEREGULATION (BANK + INSURANCE MORTGAGE LOANS)

(UNIT: KRW 1,000, %, BORROWER IN THE SEOUL METROPOLITAN AREA)						
Classification (As of July 2014)			(Based on initial loan amount)		(Based on loan balance)	
			Change	Share of borrowers who reduced non-bank mortgages	Change	Share of borrowers who reduced non-bank mortgages
Mortgage loans from both bank/Ins.Comp. and the non-bank sector	Secured loans	B1	-27,648.2	40.6	-25,184.3	51.4
	Unsecured loans	B2	-33,080.7	42.4	-25,709.0	52.4
Only non-bank mortgage loans	Secured loans	C1	-90,950.2	51.4	-89,618.4	79.1
	Unsecured loans	C2	-68,419.0	52.4	-59,863.2	74.2

Source: Authors' calculation using the KCB mortgage borrowers.

3. Robustness test 1

Table A5 shows the estimates after adding control variables for credit rating from square to fourth-order term. We also add a square term of age and include the GDP growth rate instead of GDP and GRDP. The difference-in-difference estimates (first row in the table) are robust to the results in Table 7. When the variable for credit rating is controlled only linearly, a positive relationship is found between income and delinquency, which indicates that borrowers with high incomes are more likely to be delinquent. This is in contrast to common knowledge, showing possible evidence of omitted-variable bias. Therefore, we add the second to fourth terms of the credit rating and find a negative relationship between income and delinquency, which is reasonable.

TABLE A5—EFFECT OF DEREGULATION ON THE PROBABILITY OF 30+ DELINQUENCY - ROBUSTNESS TEST

Variable	Sample	Dependent variable: 30+ days delinquency (in any loan) dummy				
		(1)	(2)	(3)	(4)	(5)
Seoul Metro. area x After deregulation (dummy)		-0.0026*** (0.00073)	-0.0022*** (0.00070)	-0.0022*** (0.00068)	-0.0022*** (0.00068)	-0.0029*** (0.00068)
Seoul Metro. area (dummy)		0.0031 (0.0079)	-0.0068 (0.0075)	-0.0058 (0.0074)	-0.0058 (0.0074)	0.0092*** (0.00075)
After deregulation (dummy)		0.0024** (0.0011)	0.0030*** (0.0010)	0.0030*** (0.0010)	0.0030*** (0.0010)	0.00125 (0.00092)
Age (by 5 years interval)		0.00027 (0.00023)	-0.00021 (0.00022)	0.000022 (0.00022)	0.000046 (0.00022)	0.000125*** (0.000017)
Age2 (by 5 years interval)		-1.4e-06 (2.2e-06)	2.5e-06 (2.1e-06)	3.0e-07 (2.1e-06)	3.7e-08 (2.1e-06)	
ln (income)		0.0052*** (0.00034)	-0.0013*** (0.00029)	-0.0017*** (0.00028)	-0.0017*** (0.00028)	0.0052*** (0.00033)
Credit rating (Level 1~10)		0.016*** (0.00016)	-0.043*** (0.00049)	0.038*** (0.00094)	0.016*** (0.0023)	0.016*** (0.00016)
Credit rating ²			0.0066*** (0.000069)	-0.013*** (0.00027)	-0.0042*** (0.0010)	
Credit rating ³				0.0013*** (0.000022)	-0.000017 (0.00017)	
Credit rating ⁴					0.000067*** (8.9e-06)	
1 year credit card usage amount (one million won)		-0.00016*** (0.000011)	-0.00012*** (8.1e-06)	-0.000086*** (6.4e-06)	-0.000088*** (6.5e-06)	-0.00016*** (0.000011)
1 year debit card usage amount (one million won)		0.00015*** (0.000039)	0.000080** (0.000032)	0.000059** (0.000024)	0.000061** (0.000024)	0.00015*** (0.000039)
cd91 interest rate		0.0061*** (0.0013)	0.0072*** (0.0012)	0.0065*** (0.0012)	0.0066*** (0.0012)	0.0053*** (0.0010)
CPI (Inflation rate)		0.00018 (0.00040)	0.00052 (0.00038)	0.00058 (0.00038)	0.00059 (0.00038)	0.00086** (0.00037)
GRDP (Regional economy)		2.3e-08 (3.2e-08)	5.0e-08* (3.0e-08)	4.6e-08 (3.0e-08)	4.6e-08 (3.0e-08)	
GDP		5.5e-08** (2.3e-08)	8.9e-08*** (2.2e-08)	8.4e-08*** (2.2e-08)	8.4e-08*** (2.2e-08)	
GDP growth rate						0.0011*** (0.00040)
Housing price growth (YoY, 1 month lag)		-0.000010 (0.00016)	0.00018 (0.00016)	0.00022 (0.00015)	0.00022 (0.00015)	0.00011 (0.00015)
Constant		-0.16*** (0.037)	-0.038 (0.035)	-0.12*** (0.034)	-0.11*** (0.034)	-0.20*** (0.037)
N		719,675	719,675	719,675	719,675	719,675
R ²		0.077	0.167	0.193	0.193	0.077

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) The fixed effect of metropolitan cities is included in the regression equation, but omitted, 4) This was calculated using information on a semiannual basis (January, July), and 30-day delinquency refers to a case in which more than 30 days of delinquency occur among loans (including unsecured loans) held by the borrower within the preceding six months, 5) As of July 2014, if there is more than 5 days of overdue experience (in any type of loan), it is classified as a borrower with past overdue experience, 6) The total number of borrowers for each sample was 206,361.

Source: Author's calculations using the KCB mortgage borrower sample DB.

TABLE A6—EFFECT OF DEREGULATION ON DELINQUENCY RATE: TRIPLE-DIFFERENCE BY CREDIT RATING

Independent Variables	Dependent variable: 30+ days delinquency
Seoul Metro. Area x After deregulation(dummy) x Credit rating	-0.0086*** (0.00079)
Seoul Metro. Area x After deregulation (dummy)	0.011*** (0.0012)
Seoul Metro. Area (dummy)	0.0030 (0.0079)
After deregulation of housing finance (dummy)	0.0026** (0.0011)
Constant	-0.15*** (0.036)
N	719,675
R ²	0.078

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth rate, constant terms, fixed effects of metropolitan cities.

Source: Author's calculations using the KCB mortgage borrower sample DB.

TABLE A7—EFFECT OF DEREGULATION: TRIPLE-DIFFERENCE BY INCOME LEVEL

Dependent Variable	30+ days delinquency	High-cost loan ratio	DSR
Seoul Metro. Area x After deregulation (dummy) x Income level	0.00068** (0.00033)	0.022*** (0.00041)	0.11*** (0.00093)
Seoul Metro. Area x After deregulation (dummy)	-0.0039*** (0.0012)	-0.067*** (0.0012)	-0.28*** (0.0027)
Seoul Metro. Area (dummy)	-0.0058 (0.0074)	-0.079*** (0.0084)	0.085*** (0.014)
After deregulation (dummy)	0.0030*** (0.0010)	0.026*** (0.0010)	0.030*** (0.0017)
Constant	-0.11*** (0.034)	-0.80*** (0.045)	3.03*** (0.076)
N	719,675	3,714,565	3,731,621
R ²	0.193	0.050	0.140

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth, constant terms, fixed effects of metropolitan cities.

Source: Author's calculations using the KCB mortgage borrower sample DB.

Table A6 shows the estimates with the triple-difference term (interaction between the double-difference term and the credit rating dummy). The negative estimates of the triple-difference term indicate that the average delinquency rate of borrowers with poor credit ratings falls more with deregulation. This is consistent with the results shown in Table 9.

The first column in Table A7 shows the estimates by the triple-difference term (interaction between the double-difference term and the income level). The signs of estimates are all reasonable and consistent with our results in Table 10, Table 16, and Table 20.

4. Robustness test 2: Shorter Period

In the primary analysis, the sample period is from January 2013 to January 2016, but we include a shorter sample period from January 2013 to August 2015 in this section. This is to prevent the effect of policies affecting the credit risk or debt structure other than housing finance deregulation.

Table A8 is comparable to Table 7, which shows the effects of the deregulation (increase in the LTV limit by 10-20(%p)) on the probability of delinquency. In the

TABLE A8—EFFECTS OF HOUSING FINANCE DEREGULATION ON DELINQUENCY RATE

Independent Variables	Dependent Variables	Dependent variable: 30+ days delinquency (in any loan)		
		(1) Whole sample	(2) Delinquent experiences exist before deregulation	(3) No delinquent experience before deregulation
	Seoul Metro. Area x After deregulation (dummy)	-0.0020*** (0.00076)	-0.024*** (0.0052)	0.00052 (0.00037)
	Seoul Metro. Area (dummy)	-0.0083 (0.011)	-0.15** (0.076)	0.0077** (0.0036)
	After deregulation of housing finance (dummy)	0.0020* (0.0012)	-0.0026 (0.0083)	0.0033*** (0.00059)
	Constant	-0.11*** (0.036)	-1.11*** (0.27)	-0.0075 (0.014)
	N	616,355	74,002	542,353
	R ²	0.206	0.248	0.036

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth rate, constant terms, fixed effects of metropolitan cities.

Source: Author's calculations using the KCB mortgage borrower sample DB.

TABLE A9—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DEBT STRUCTURE: BY CREDIT GROUP

Independent Variables	Dependent Variables	Dependent variable: High-cost loan ratio		
		(1) High-credit borrower (Levels 1~3)	(2) Medium-credit borrower (Levels 4~6)	(3) Low-credit borrower (Levels 7~10)
	Seoul Metro. Area x After deregulation (dummy)	-0.015*** (0.0011)	-0.0054*** (0.0013)	-0.0057** (0.0023)
	Seoul Metro. Area (dummy)	-0.14*** (0.013)	-0.073*** (0.016)	-0.060** (0.027)
	After deregulation (dummy)	0.028*** (0.0015)	0.0076*** (0.0018)	0.0062** (0.0031)
	Constant	-1.84*** (0.067)	-1.08*** (0.082)	-0.44*** (0.14)
	N	1,752,412	1,087,594	362,631
	R ²	0.047	0.038	0.044

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth rate, constant terms, fixed effects of metropolitan cities.

Source: Author's calculations using the KCB mortgage borrower sample DB.

TABLE A10—EFFECTS OF HOUSING FINANCE DEREGULATION ON THE DEBT REPAYMENT BURDEN:
CREDIT RATING GROUP

Independent Variables	Dependent Variables	Dependent variable: DSR (ratio of principal and interest repayment to income)		
		(1) High-credit borrower (Levels 1~3)	(2) Medium-credit borrower (Levels 4~6)	(3) Low-credit borrower (Levels 7~10)
Seoul Metro. Area x After deregulation (dummy)		-0.019*** (0.0015)	-0.023*** (0.0024)	-0.012* (0.0061)
Seoul Metro. Area (dummy)		0.055*** (0.017)	0.083*** (0.028)	0.20*** (0.078)
After deregulation (dummy)		0.023*** (0.0020)	0.031*** (0.0033)	-0.0013 (0.0087)
Constant		1.29*** (0.089)	2.88*** (0.15)	3.87*** (0.39)
N		1,822,706	1,080,156	314,349
R ²		0.073	0.117	0.109

Note: 1) Statistical significance level: ***p<0.01, **p<0.05, *p<0.1, 2) All standard errors were calculated as Huber-White robust standard errors, 3) Additional explanatory variables: age, income, credit rating, credit card usage for the previous year, debit card usage for the previous year, CD interest rates, CPI, GRDP, GDP, housing price growth rate, constant terms, fixed effects of metropolitan cities.

Source: Author's calculations using the KCB mortgage borrower sample DB.

entire sample, delinquency rate decreases by about 0.20%p, which is a 14.2% change. This is robust to the main analysis in Table 7, showing a 15.7% change. Table A9 is comparable to Table 15, and Table A10 is comparable to Table 19. Estimates in the robustness checks in this section are all consistent to those of the main regression.

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