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# Risk Taking of "TBTF" Banks in a Concentrated Market: Evidence from Surviving Banks after a Financial Crisis

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Abstract

We examine how banks with a belief in the "Too-Big-To-Fail (TBTF)" doctrine behave when the banking industry becomes concentrated. A simple Cournot-model shows that a stronger TBTF belief increases individual bank's optimal loan supply so high that the industry's aggregate loan supply also increases as the market becomes more concentrated, posing a big systemic risk to the economy. The hypothesis is supported by a cointegration approach based on the aggregate time-series Korean bank data following the financial crisis in 1997. Panel data analyses show that the impact of market concentration on credit expansion increases when a bank becomes larger through mergers, and the impact decreases after the change of ownership to foreigners.

Key words: market consolidation, too big to fail, systemic risk, financial crisis, bank loan
JEL codes: G01, G21, G28

## 1. Introduction

Many financial crises including the recent global financial crisis and the 1997 Asian financial crisis have led to government-assisted mergers and bailouts of large troubled banks and closures of small troubled financial institutions. While financial restructuring and consolidation played an important role in overcoming financial crises, it has made the industry more concentrated with fewer larger banks and has arguably created a stronger belief in the "Too-Big-To-Fail (TBTF)" policy (E. Avgouleas, C. Goodhart and D. Schoenmaker (2010). The TBTF policy implies governments' bailout intervention to prevent a large bank from failing if it is in trouble.

What are the potential costs of the TBTF policy in a concentrated banking industry? As frequently observed, large troubled banks are more likely to be rescued than small ones because their failure may cause systemic risk due to their interconnectedness with other financial institutions and their complicate finance. Despite government's effort to rebuke the TBTF policy, such practices during crises strengthen the TBTF belief for large banks. When they are protected from failing, surviving large banks in a concentrated market may engage in excessive risk-taking activities, contributing to cause recurrence of financial crises as some countries experience. Due to such attributes of large banks, some economists advocate stricter capital requirements for banks to ensure that banks hold capital reserves appropriate to the risk they are exposed to (Admati et al. 2010). On the contrary, large banks might try to reduce taking risks to maintain greater franchise value stemming from higher market power in a more concentrated market. Large banks also have higher profits which provide higher capital buffer protecting them in case of negative shocks. Furthermore, since market participants as a whole might have learned a lesson from the crisis, they can better monitor and discipline excessive systemic risk taking of banks especially with fewer banks in the markets.

In this paper, we examine how banks with the "TBTF" belief behave when the banking industry becomes concentrated. We examine whether these large banks engage in more risk taking, which may lead to a systemic risk event. More specifically, we have two research questions. The first one is whether or not the banks' total loan supply will increase as the market concentration increases when the "TBTF" doctrine prevails in the banking industry.

The second is whether the impact of concentration on loan supply of the bank which believes in the "TBTF" doctrine increases after bank merger.

This paper builds on two strands of literature: the effect of bank competition on risk taking, and TBTF. The literature on bank competition provides contradictory arguments regarding the effects of competition on risk-taking behavior of banks. Many studies showed that erosion of profits following an increase in competition due to deregulation and liberalization can induce banks to take more risks (Keely (1990), Hellman, Murdock, and Stiglitz (2000), Demsetz, Saidenberg and Strahan (1996), Saunders and Wilson (1996), Jiménez, Lopez and Saurina (2007)). Conversely, banks in concentrated markets can be more stable as they have higher profits which provide higher capital buffer protecting them in case of negative shocks (Matutes and Vives, 2000; Boyd et al., 2004). On the other hand, some economists argue that banks in concentrated markets charge higher lending interest rates based on market power, resulting in attracting risky borrowers more than safe ones (Boyd and De Nicolo (2005), Boyd *et al.* (2007)). Furthermore, Schaeck, Čihák, and Wolfe (2009) show that countries with more competitive banking systems are less prone to have a crisis and that time to crisis increases. Meanwhile, existing literature regarding TBTF agrees that the TBTF policy strengthens banks' risk-taking incentives (Boyd and Gertler 1994, Stern and Feldman 2004, Ennis and Malek 2005).

Existing literature did not consider the combined effects of TBTF and concentration in the banking industry, and seldom considers the effects of consolidation on systemic risks. The competition literature mainly focuses its effects on risk taking such as liquidity or credit risk, and literature about TBTF focuses on distorted incentives. However, market consolidation can strengthen the TBTF belief among surviving banks because the financial system depends on a few large banks and thereby any failure of large banks can cause a disruption to the economy. Contrary to existing literature, we provide implications of market concentration for systemic risks by considering the combined effects of TBTF and concentration on the total loan supply of the banking industry.

In order to derive the hypothesis about the relationship between market concentration, loan supply and TBTF, we present a simple theoretical model where banks compete in a Cournot

fashion. Our model shows that when a bank's perceived chance of bailout in case of crisis increases with its loan (or asset) size, the banking industry's total loan supply may increase as the number of banks decreases. This result contrasts to the traditional outcome in industrial organization literature which says that total industry supply would diminish when the number of firms decreases. This theoretical result provides an explanation on why credit expansion follows after market consolidation.

In the empirical analysis, we use aggregate data from the Korean banking industry, whose experience can provide a good opportunity to examine whether more concentration leads to more aggressive strategies of larger banks, which may increase systemic risk in the end. When a financial crisis occurred in Korea in 1997, the Korean government carried out extensive restructuring in a number of sectors including the financial sector. In the process of restructuring the financial sector, the government closed out many small insolvent financial institutions, by assisting mergers between large troubled banks through injection of public funds. The enactment of the Bank Holding Company Act of 2000 has induced size competition among banks which began establishing bank holding companies through either government-assisted mergers between large banks that previously received public bailout funds or voluntary mergers between large banks. As a result, the number of interstate-operating commercial banks declined to a half from 26 to 13. In the bank loan market, the sum of market shares of the four largest banks has increased from 43% in 1997, to 55% in 1999 and to 76% in 2009. Along with the changes in market structure, the ratio of credit supply by banks over GDP has dramatically changed. The ratio had been relatively stable at around 40% before the 1997 crisis, suggesting that there was no serious credit boom in Korea before the crisis. Then, it decreased slightly during the crisis. After the crisis, the ratio jumped from 45% in 1999 to 92% in 2008 in the course of financial sector rebuilding. Outstanding domestic credit soared by 260% while the GDP increased by 75% during the same period.

In this empirical analysis, total loan to GDP ratio is used as a measure of loan supply. Although total loan to GDP ratio can reflect the level and depth of financial market development which can improve economic growth (Goldsmith (1969), King and Levine (1993), Rajan and Zingales (1998), Beck et al. (2000), Levine (2005)) it can also be

interpreted as a measure of systemic risk (Loayza and Rancière, 2004) especially when its level is high or the growth rate of credit is high (Arcand, Berkes and Panizza, 2010, Mishkin 1999). Many studies on financial crisis including Demirgüç-Kunt and Detragiache (1998) and Kaminsky and Reinhart (1999) show that explosion in credit supply is likely connected to a country's financial crisis. Furthermore, a dramatic increase in total loan to GDP ratio in Korea was accompanied by low repayment ability of borrowers and shortened maturity of loans, suggesting that much of credit was given to borrowers with high credit risks. Although loan to GDP ratio is not a perfect indicator for systemic risk, it is better than fragility measures such as non-performing loan ratio when banks increase loans quickly. The reason is that fragility measures understate the likelihood that a systemic risk event occurs. Mengle (1991) notes that the number of actual bank failures exceeds the number of banks with book value insolvencies in the U.S. According to him, only 6 percent of the failed banks in 1985 had reported themselves to be book value insolvent in that year. In addition, Peek and Rosengren (2005) show that weak Japanese banks lent more money to poorly-performing firms than relatively strong banks. Through such ever-greening lending practices, weak banks disguise their trouble and appear sound on paper. In contrast, loan to GDP ratio reflects the increasing likelihood of the systemic risk event occurrence that can build up through time as total credit supply increases, although systemic risk events can be sudden and unexpected.

By employing a cointegration approach using aggregate private bank lending data after the financial crisis in 1997, we test the hypothesis that the banking industry increases the total loan supply, as the market concentration increases while banks strongly believe in the "TBTF" doctrine. Then we find that the hypothesis is supported by the aggregate time-series data from the banking industry of Korea.

In addition, using a panel dataset at the micro level, we examine whether the impact of concentration on bank's loan supply increases after a bank merger when "TBTF" belief prevails. We also analyze whether the impact decreases after the change of ownership to foreigners. Our theoretical model suggests that banks have an incentive to lend more after merger, because they have more benefit from 'TBTF' policy after a merger. Panel data analyses show that interactions of merger and market structure have a positive and significant

relationship with loan growth minus GDP growth. These results are robust even when we control for market structure, financing structure, banks' capital ratio and others. Meanwhile interactions of ownership change to foreigners and market structure in general have a negative and significant relationship with loan growth minus GDP growth.

The rest of the paper is organized as follows. Section 2 briefly describes the Korean banking industry. Section 3 introduces previous studies on the relationship between market concentration and risk taking. Section 4 presents a simple model explaining bank lending decisions when they compete in a Cournot fashion over potential borrowers. Section 5 discusses the data and variables. Empirical results are summarized in Section 6 followed by the conclusion in Section 7.

## 2. Brief Description of the Korean Banking Industry

The banking sector has been the center of the Korean financial industry until recently. With relatively under developed capital markets, the banking sector has played a critical role of channeling resources from households to corporations and the corporate sector has heavily relied on banks for their financing. Corporate capital structure demonstrates the importance of banking sector. Even among listed firms, average debt to equity ratio has been very high, reaching over 300% on average until the 1997 financial crisis.

While banks have been the main supplier of capital to corporations, small and large, listed and unlisted, Korean banks had not experienced failures and closures even when their major borrowers defaulted until the financial crisis of 1997. For example, while many corporate firms failed during the severe recessions in the 1970s and early 1980s, their creditor banks never failed because they were often compensated for their losses from their lending to distressed borrowers by the public sector of Korea (Chung, 1986). Even small financial institutions were rescued when they faced insolvency risks.

Then, the extensive financial restructuring following the financial crisis of 1997 changed the banking industry substantially. During the early restructuring period starting from the second quarter in 1998, the government closed many small financial institutions including large

commercial banks as well. A total of 631 out of 2,101 financial institutions (including commercial banks, savings banks, credit unions, and trust firms) were closed in the process of restructuring. The government has also assisted mergers between troubled banks and enacted the Bank Holding Company Act of 2000.

After exerting effort on restructuring failing financial institutions, the government induced banks to increase their asset size, arguing that larger banks can enjoy economies of scale. Commercial banks in response tried to increase their size either through merging with other banks or through increasing their lending. For example, in 2001, two significant mergers occurred: one merger between two relatively sound large banks created the largest bank: the other merger between one large and one small bank created the second largest bank. The number of commercial banks continues to decline from 26 in 1997 to 17 in 1999, to 15 in 2001, to 14 in 2005, and to 13 in 2007.

With fewer banks remained in the industry, the average asset size of banks increased dramatically from 18.7 trillion won in 1997 to 90.5 trillion won in 2009. In addition, market structure becomes more concentrated.[1] The combined market share by the largest four banks (CR4) in the lending market has increased from 41% in 1995, 43% in 1997, and 55% in 1999, to 76% in 2009. Hershman Herfindahl Index (hereafter HHI) which is the sum of squared market share of all banks in the market changes from 722 in 1995 to 1,640 in 2009. The failure of troubled banks during the crisis and subsequent mergers of banks reduced the competition in the banking industry. With market consolidation, the financial system depends on a few large banks and thereby any failure of large banks can cause a disruption to the economy. In short, severe market consolidation may have strengthened the TBTF belief among surviving commercial banks that become larger compared to the size of the industry because

<Insert Figure 1 around here: HHI and CR4 over time>

[11] This differs from effects of market consolidation on competition in the European countries and Latin American countries studied by Gelos and Roldós (2004)

Along with a substantial increase in the market concentration due to a series of mergers and closure of banks, total bank loans to GDP ratio also increased rapidly. As Figure 2 shows, the trend of total bank loans to GDP ratio had been relatively low and stable, remaining at around 40% before the 1997 crisis. While there were more banks, the ratio was relatively small before the crisis. In other words, there was no clear lending boom in Korea unlike many other countries which had experienced a credit explosion before a financial crisis (Demirgüç-Kunt and Detragiache (1999, 2004)). Then, total bank loans to GDP ratio decreased slightly during the crisis. After the crisis, it skyrocketed during the last 10 years. The ratio had jumped from 45% of GDP in 1999 to 92% of GDP in 2008.[2] Outstanding domestic credit soared by 260% from 250 trillion won in 1999 to 901 trillion won in 2008 while the GDP has increased by 75% from 558 trillion won to 975 trillion won during the same period.

<Insert Figure 2 around here: Domestic banks' total loans to GDP ratio over time >

Some might suspect that changes in bank loans to GDP ratios mainly result from low interest rates or expansionary monetary policy. Figure 3 shows the trends of interest rates and money supply to GDP ratio over time along with the trend of loans to GDP ratios. Panel A exhibits that interest rates have been on a downward trend while loans to GDP ratio has increased. Although the figure suggests that interest rates might have affected credit expansion, some studies argue that interest rates are not the major cause of credit boom. Panel B of Figure 3 shows that high powered money supply over GDP ratios have been stable over years, suggesting that money supply is not a cause of dramatic increases in bank loan to GDP ratios. We suspect that the relationship between monetary policy and bank loan weakens over time as banks can finance their loans through deposits as well as wholesale funding.

<Insert Figure 3 around here: Trends of interest rates and money supply over time >

A sharp increase in the bank loan to GDP ratio means aggressive bank lending, suggesting that some of the borrowers who previously could not borrow from the banking sector are now able to borrow, that those who borrowed before are extended more credits, or both. Until the

[2] While total loans to GDP ratio increased rapidly, the maturity of loans shortened and procyclicality of bank loans substantially increased. Please refer to Jeong (2009).

1997, banks have lent money to large firms. However, as large firms have lowered their debt level after experiencing collapse of debt-ridden firms, banks dramatically increased their lending to small and medium-sized enterprises (SMEs) and households as Figure 4 shows how the composition of borrowers has changed over time. Before the credit explosion, SMEs and households could have limited access to the banking sector, and so some might argue that the increase in total loan to GDP ratio in Korea after the 1997 financial crisis may reflect financial development. They might be true in part. However, lending to SMEs is riskier than loans to large companies because many SMEs are less profitable, more leveraged and thereby more vulnerable to outside shocks than large firms. As a group, SMEs show a low interest coverage ratio. Over 20% of SMEs have experienced that their operating income cannot cover their financial expenses for three consecutive years. Reflecting such low repayment ability of borrowers, banks have shortened maturity of loans to SMEs. In fact, they appear to be more vulnerable to changes in macro-shocks. In 2007 and 2008, the government declared an automatic rollover of debt payment guarantee programs by government agencies when SME bankruptcy has increased as the macro-economic condition deteriorates due to the global financial crisis. In addition, household borrowing has skyrocketed so that the average ratio of household debt to household disposable income increased from 0.94 in 2000 to 1.46 in 2010. Lending to households is correlated with investment in real estate property, which in turn boosted the real estate prices. However, when the current real estate market bubble bursts, such lending can cause another distress to banks.

<Insert Figure 4 around here: Trends of borrower composition over time >

## 3. Previous literature on market competition and TBTF

Previous literature has produced conflicting results on the relationship between increased competition and bank stability (Allen and Gale 2004; Carletti and Hartmann, 2002). According to the ‘competition-fragility’ view in another words ‘concentration-stability’ view, banks take more risk when severe competition occurs (Berger, Klapper and Turk-Ariss, 2008). Many empirical studies on banks’ behavior and performances in the market where deregulation increased competition support the ‘competition-fragility view’. Keely (1990) shows that bank failure increased when state branching restrictions were lifted and monopoly

rents were eroded. According to Hellman, Murdock, and Stiglitz (2000), an increase in market competition with a removal of ceilings on interest rates erodes the franchise value and encourages banks to take more risk.

The 'competition-fragility' view is consistent with the traditional 'franchise value' argument saying that banks try to maintain their charter or franchise values. Unlike banks with a lower market power and smaller profit margin in a competitive market, banks in more concentrated markets do not pursue more risks as they have a higher franchise value to protect (Hellmann et al.,2000; Matutes and Vives, 2000). Furthermore, large banks can lower risk in portfolio through diversification. Some empirical studies support this view. For example, Konishi and Yasuda (2004) argue that Japanese banks take less risk when market value (or franchise value) is higher. Using bank data from Spain, Salas and Saurina (2003) argue that banks reduce risk when their Tobin's Q increases. Jiménez, Lopez and Saurina (2007) show an increase in the market power of banks does not affect the ratio of non-performing loans which is associated with a higher-risk loan portfolio. In a more recent study, Uhde and Heimeshoff (2008) analyzed how market consolidation affects banks' capital ratio or z-scores using bank data of EU countries. They found that concentration improves each bank's financial stability. In short, proponents for the 'competition-fragility' view argue that banks take more risk when severe competition lowers franchise value as they weigh the benefit and cost of risk taking on franchise value.

Recent studies, however, provide diagonally opposite arguments on the role of competition in stability. Boyd and De Nicolo (2005) argue that an increase in concentration yields two different effects on risk taking. One, with market concentration in deposit markets, banks can lower their deposit interest rates and increase their profit. With higher profit, banks are less likely to take risk. Two, with market concentration in lending markets, banks can charge higher lending interest rates which can attract borrowers with higher risks. Moreover, if banks become TBTF in more concentrated market and are likely to be protected when they fail, they can take excessive risk. Therefore, concentrated banks become exposed to higher risks. Boyd and De Nicolo (2005) show that bank risk falls when the number of banks increases. Boyd *et al.* (2007) shows that market concentration leads to higher risks, suggesting that the effects in lending market concentration are greater than those in deposit

markets. In a related study, Schaeck, Čihák, and Wolfe (2009) show that countries with more competitive banking systems are less prone to have a crisis and that time to crisis increases.

Banks' incentives to take risk depend on TBTF policy as well. Along with deposit insurance, TBTF policy might create wrong incentives for bank stakeholders (O'Hara ad Shaw 1990, Avery, Belton and Goldberg 1988, Morgan and Stiroh 2005). As banks receive implicit or explicit creditor protection in the case of distress, creditors are more willing to provide their capital to banks either through deposit or debt. As their capital is protected, stakeholders' incentive to monitor banks is limited. Banks can take excessive risk without invoking creditors' or shareholders' monitoring. When banks are relatively small in terms of interconnectedness and size, the impact of their risk taking would be limited and might not cause systemic risk. However, TBTF banks in concentrated markets can contribute to systemic risk as they are more heavily engaged in inter-bank transactions (Rochet, Tirole and Rajan 1996). A failure of such banks poses significant potential risks to other financial institutions, to the financial system and to the economy. To avoid such systemic risk, governments provide creditor protection through bailout of these TBTF banks when they are in trouble. Such implicit protection can further distort the incentive of TBTF banks (Boyd and Gertler 1994, Stern and Feldman 2004, Ennis and Malek 2005).

## 4. A simple theoretical model.

In this section, we present a simple theoretical model on how the structure of the banking industry (i.e. the number of banks) affects the total loan supply of the banking industry where the TBTF belief prevails.

The economy consists of banks and potential borrowers. The economy also faces an economic crisis that occurs with the exogenously given probability $\lambda$. Assume that banks are risk neutral and there are no managerial agency problems. Risk-neutral banks maximize their expected profit by competing in loan size over potential borrowers. It is reasonable to assume a Cournot competition in the banking industry.[3] Assume that each borrower is endowed with either a good or bad project, and the project is the only endowment of the borrower. Both

[3] Cournot competition is popular in the banking literature. Refer to Freixas and Rochet (2008)

types of project require one unit of money to implement. When either a good or bad project succeeds, the project generates $Y$, and when it fails, it pays zero. Y is uniformly distributed over the interval $[0.5,1.5]$

The projects have a different probability of success. In the non-crisis situation, a good project has success probability,$P_G$, while a bad project has success probability, $P_B$. In the crisis situation, a good project has success probability, $\alpha P_G$, while a bad project has success probability, $\alpha P_B$. We assume that$P_G > P_B$, $P_B * 1.5 < 1$ and $0 < \alpha < 1$.

Among potential borrowers, let $\delta$ be the proportion of good borrowers. Banks do not have a technology to screen good borrowers from bad borrowers. However, they know that the proportion borrowers with good projects in the economy is $\delta$.

We assume that all borrowers have limited liability. The mass of borrowers is assumed to normalized to 1.With limited liability, the demand side of loans is highly simplified. We have the following demand curve. Furthermore, we know that at each price, the expected repayment probability of loan demand is same, because *Y* is uniformly distributed over the interval.

$$p(x) = 1.5 - x \quad (1)$$

where $p$: loan interest factor, 1 plus the loan interest rate

$x$: market demand for loans

To reflect the observation that governments are more likely to rescue systemically important financial institutions, we assume that the chance of government rescue, f for bank $i$ depends on its loan size. We also assume that the government bailout money is non repayable.

$$f(x_i) = cx_i \quad (2)$$

where $f(x_i)$*:* the probability that Government rescue bank i

$c$: parameter

$x_i$: loan size for bank $i$

For simplicity, banks are assumed to have unlimited access to a deposit market at zero interest rate.

A. Loan supply decisions by a monopoly bank

Under the aforementioned assumption, we first examine the optimal loan decision for a monopoly bank. A monopoly bank solves the following optimization problem.

$$\max_{x_i} E(\pi)$$

$$=\max(\lambda[a \cdot p(x) \cdot x_i - x_i + f(x_i) \cdot (1-a) \cdot x_i] + (1-\lambda)[b \cdot p(x) \cdot x_i - x_i]) \quad (3)$$

$$=\max(h(1.5 - x_i) \cdot x_i - x_i + \lambda \cdot c \cdot (1-a)x_i^2)$$

Where $a = \delta\alpha P_G + (1-\delta)\alpha P_B$ is the probability of getting paid during crisis

$b = \delta P_G + (1-\delta)P_B$ is the probability of getting paid during non-crisis

$h = \lambda a + (1-\lambda)b$

$\lambda$ = probability of crisis

Differentiating equation (3) with $x_i$, we get the following first order condition:

$$1.5h - 1 + [2 \cdot \lambda \cdot c \cdot (1-a) - 2h] \cdot x_i = 0 \quad (4)$$

Since the objective function (4) is concave, the 2nd order sufficient condition is satisfied. The optimal level of lending is

$$x^* = 0.5 \frac{3h-2}{2h-2\lambda c+2\lambda ca} \quad (5)$$

Loan supply decision by monopoly bank depends on probability of getting paid and parameter in government intervention.

B. Loan supply decisions for duopoly banks and for "n" banks

Suppose that there are two banks in the industry, and they compete in a Cournot fashion over borrowers. Since borrowers can borrow from either bank $i$, $(i = 1, 2)$, bank '$i$' faces the following demand function. "j" means "not $i$"

$$p = 1.5 - x_i - x_j \tag{6}$$

A duopolistic bank $i$ solve the following optimization.

$$\max_{x_i} E(\pi) = \max\left(h\left(1.5 - x_i - x_j\right) \cdot x_i - x_i + \lambda \cdot c \cdot (1 - a)x_i^2\right) \tag{7}$$

Where $h = \lambda a + (1 - \lambda)b$

$a = \delta\alpha P_G + (1 - \delta)\alpha P_B$ is the probability of getting paid during crisis

$b = \delta P_G + (1 - \delta)P_B$ is the probability of getting paid during non-crisis

After differentiating the equation above with $x_i$, we obtain the following first-order conditions.

$$\begin{aligned} &1.5h - 1 + [2 \cdot \lambda \cdot c \cdot (1 - a) - 2h] \cdot x_1 - h \cdot x_2 = 0 \\ &1.5h - 1 + [2 \cdot \lambda \cdot c \cdot (1 - a) - 2h] \cdot x_2 - h \cdot x_1 = 0 \end{aligned} \tag{8}$$

By solving the two equations, we get the following Nash Equilibrium

$$x_1^* = x_2^* = 0.5\frac{3h - 2}{3h - 2\lambda c + 2\lambda ca} \tag{9}$$

Similarly, when there are n identical banks in the market, the expected profit function for bank *i* is as follows.

$$E(\pi) = (h(1.5 - x_1 - x_2 \ldots - x_n) \cdot x_i - x_i + \lambda \cdot c \cdot (1 - a)x_i^2) \tag{10}$$

After differentiating equation (10) with $x_i$, we can obtain the following first-order condition

for all *i* =1…n. By solving the n equations, we obtain the following Nash equilibrium.

$$x_1^* = x_2^* = \cdots = x_{n-1}^* = x_n^* = 0.5\frac{3\mathrm{h}-2}{(\mathrm{n}+1)\mathrm{h}-2\lambda\mathrm{c}+2\lambda\mathrm{ca}} \quad (11)$$

Based on (11), we can examine the relationship between the number of banks and the total loan supply of the banking industry when the Government has a "too big to fail" policy. The results are summarized in the following propositions.

Proposition 1: When $\lambda c(1-a) > 0.5h$, the loan supply of the banking industry increases(decreases) as the number of banks decreases(increases).

Proof: Let *A* mean the total loan supply of the banking industry which consists of n banks. Let *B* mean the total loan supply of the banking industry which consists of $\mathrm{n}-1$ banks. When $\lambda c(1-a) > 0.5h$, the inequality $\mathrm{A}-\mathrm{B} = 0.5\frac{\mathrm{n}(-2+3\mathrm{h})}{(\mathrm{n}+1)\mathrm{h}-2\lambda\mathrm{c}+2\lambda\mathrm{ca}} - 0.5\frac{(\mathrm{n}-1)(-2+3\mathrm{h})}{\mathrm{nh}-2\lambda\mathrm{c}+2\lambda\mathrm{ca}} < 0$ holds.

Proposition 2: When $\lambda c(1-a) < 0.5h$, the loan supply of the banking industry decreases(increases) as the number of banks decreases(increases).

Proposition 3: When $\lambda c(1-a) = 0.5h$, the loan supply of the banking industry does not vary as the number of banks decreases(increases).

## 5. Empirical Analysis

This section consists of two parts. In the first part, we use a cointegration approach at the aggregate level to examine the relationship between the total loan supply and the market concentration over 1999:2-2008:3. The second part provides a panel data analysis at the micro level to examine whether the impact of concentration on a bank's loan supply increases after a bank merger, and the impact decreases after the change of ownership to foreigners.

### 5.1. Data

For cointegration analysis, we use the quarterly aggregate data from the Korean banking industry and relevant quarterly macro data for the time period from the second quarter of 1999 to the third quarter of 2008. We choose this period, because the volatility of foreign exchange market that triggered the 1997 crisis became stable by 1999, and early restructuring in the financial sector was considered to be over in 1999. In addition, the Korean economy seems to have returned to a normal growth path in the second quarter of 1999. And the global financial crisis started to influence the Korean economy starting from the fourth quarter of 2008. Banks' expectation of "TBTF" seems to be augmented after the 1997 crisis due to financial restructuring through closure of many small financial institutions and government-assisted mergers of large troubled banks and enactment of the Bank Holding Company Act of 2000.

The variables employed in this study include total loan supply, market concentration, funding structure of banks, the value of collateral, capital ratio and loan loss provision ratio. These data were obtained from the Financial Supervisory Service (FSS) database and the Bank of Korea database. The total loan supply is measured by total loans to GDP ratio, which may indicate systemic risks. The loan supply refers to loans dominated in Korean Won only of all commercial banks only. By using this definition, we can avoid problems associated with loans denominated in foreign currency which are subject to exchange rate volatility and external shocks. Our data do not include lending by specialized banks which are controlled by governments, because these banks would be largely influenced by industrial and economic policy of governments rather than banks' own decisions.

Market concentration of the banking industry is measured as the sum of the top four largest banks' market shares (CR4) or Hershman Herfindahl Index (hereafter HHI), which is the sum of squared market shares of all the banks in the market.

The funding structure of banks is measured as the sum of bank debenture and CD divided by the deposit. The sum of bank debenture and CD over deposit shows to what extent banks depend on non-traditional ways of funding such as issuing bonds or CDs. Wholesale funding

(i.e. bank debenture and CD) is an important source of bank financing in Korea, in addition to deposits. Banks' dependence on wholesale funding may increase as capital market develops.

The value of collateral is measured by an apartment price index which is normalized using a GDP deflator. We use apartment price index as a proxy for the collateral value, because firms or households usually pledge their real estate property as collateral for their borrowings and an apartment price index is representative of real estate in Korea.

Capital ratio is measured by the ratio of equity to bank assets, which can affect bank lending in two ways. One, banks have to maintain their capital ratio to satisfy at least the minimum level of the prudential regulation requirements. Therefore, capital ratio may be correlated with the lending capacity. Two, bank capital includes their own equity. When a higher portion of assets come from equity, banks are less likely to take risks to protect their investment.

We also include the ratio of loan loss provision to total loans. Loan loss provision ratio is negatively correlated with lending capacity of banks.

For our micro-level panel analysis, we use a panel of quarterly data from the 25 Korean commercial banks and relevant quarterly macro data for the time period of 1999:2-2008:3. These data were also obtained from the FSS database and the Bank of Korea database. The loan supply for an individual bank is measured by loan growth rate minus GDP growth rate. The other variables employed in this study are the same as the aggregate data analysis except that they are measured at each bank level when it is appropriate. For banks merged with other banks, we assume that they were merged from the start of the sample period.

Table 1 shows the summary statistics for variables used in the study.

<Insert Table 1 around here>

5.2. Empirical model and Results

5.2.1

To examine the relationship between market concentration and total loan to GDP ratio, we proceed in the following order: unit root tests, cointegration tests, estimation of conintergrating relationship and estimation of error correction model.

A: Unit roots test and cointegration tests

We conduct the Augmented Dickey-Fuller (ADF) Test for the presence of stochastic trend in variables. Table 2 reports the results of ADF tests. Most variables except one variable have stochastic trend. We do not reject the hypothesis that there are stochastic trends in the levels of the variables such as loan to GDP ratio, and market concentration. And we do reject the hypothesis that their changes contain stochastic trends. These results suggest that the levels of these variables are I(1) and that their changes are I(0). Meanwhile, we do reject the hypothesis that there is stochastic trend in loan loss provision. This suggests that the level of this variable is I(0).

<Insert Table 2 around here: ADF test results>

Since we found that total loan supply, market structure and funding structures contain a single unit root, we test for cointegration among the three variables, using the trace and maximal eigenvalue tests. We use multiple Johansen's methodology in order to allow for the possibility of more than one cointegrating vector. Table 3 reports the result. There is, at most, one cointegrating vector when market concentration is measured by HHI in Panel A and the results do not change when market concentration is measured by CR4 in Panel B.

<Insert Table 3 around here: Johansen trace and maximum eigenvalue test results>

B. Estimating Cointegration Equation

We found that loan to GDP, market competition, and funding structure are cointegrated with one cointegrating vector. As we show in the theoretical analysis in section 3, total loan supply is influenced by market structure. Furthermore, total loan supply can be influenced by how easily banks can access capital markets, which is measured by funding structure. So, we model loans to GDP as a function of concentration and funding structure, and estimate the relationship between loan to GDP and market structure. The regression equation also contains two lags and leads based on the Dynamic OLS approach of Stock and Watson.

$$Loan/GDP_t = \beta_0 + \beta_1 MKT\_Concentration_t + \beta_2 Financing\_Structure_t + \sum_{j=-2}^{2} \gamma_j \Delta MKT\_Concentration_{t-j} + \sum_{j=-2}^{2} \eta_j \Delta Financing\_Structure_{t-j} + \nu_t \quad (12)$$

Table 5 reports the estimation results of cointergrating vector. The estimate of the coefficient of market concentration is positive and significant when we use either of HHI and CR4. This implies that in the long run, market concentration is positively related to the total loan supply. Meanwhile, the estimate of coefficient of funding structure shows mixed results. It is positive and significant when HHI is used, and negative and insignificant when CR4 is used.

<Insert Table 4 around here: long run effects using dynamic OLS >

C. Short-run dynamics

Now, we can specify the changes in loans to GDP ratio in the following single equation error correction form, because loans to GDP ratio is cointegrated with market concentration and funding structure, and because it is reasonable to assume that market concentration is an exogenous variable. ECT is the deviation of loans to GDP ratio from its long-run equilibrium condition with concentration and funding structure. We conduct OLS Regression.

$$\Delta\left(\frac{\text{Loan}}{\text{GDP}}\right)_t = \beta_0 + \beta_1 \Delta \text{MKT\_Concentration}_t + \beta_2 \Delta \text{Financing\_structure}_{t-1} + \beta_3 \Delta \text{Capital\_Structure}_{t-1}$$

$$+\beta_4 \text{Loan\_provision}_{t-1} + \beta_5 \Delta\text{Call\_rate}_{t-1} + \beta_6 \Delta\text{Collateral\_value}_{t-1} + \text{EC}_{t-1} + v_t \quad (13)$$

The estimation results are reported in Table 5. The estimate of the coefficient of ECT is negative and significant; it suggests that loans to GDP ratio adjusts to deviation to long run equilibrium. The estimate of the coefficient of market concentration is positive and significant; it suggests that market concentration increases loans to GDP ratio in short term.

<Insert Table 5 around here: short run dynamics using error correction model >

5.2.2 Micro-level panel analysis

Using information at the bank level, we examine whether the impact of concentration on a bank's loan supply increases after a bank merger when the "TBTF" doctrine prevails in the banking industry. We also analyze whether the impact decreases after the change of ownership to foreigners.

A. Estimation equation and results

We model loan supply of bank as a function of market concentration and funding structure and control variables in a form of fixed-effects model. Loan supply in the analysis is measured as loan growth minus GDP growth. The demand for bank loan is closely related to the size of the economy. So bank loans are likely to increase as the economy grows. To control for economic growth, we use the net bank loan growth rate in excess of GDP growth rate. If the net bank loan growth rate in excess of GDP growth rate is positive, then the loan to GDP ratio also increases.

In the estimation equation, we include the interaction term between market concentration and bank merger dummy variable to see whether or not the impact of concentration on bank loan expansion increases after bank mergers when the "TBTF" belief prevails in the banking industry. We also include the interaction term between market concentration and foreign bank dummy variable to see whether or not the impact of concentration on credit expansion of

banks decreases after the change of ownership to foreigners. The merger dummy takes one after a merger occurs and takes zero otherwise. Foreign bank dummy is one when a majority of bank ownership is in the hand of foreign investors and equal to zero before the transfer.

$$\begin{aligned} Y_{it} = {} & \beta_0 + \beta_1 \text{MKT\_Concentration}_t + \beta_2 \text{Fundin\_Structure}_{it-1} + \beta_3 \text{merger\_dummy}_{it} \\ & + \beta_4 \text{MKT\_Concentration}_t * \text{merger\_dummy}_{it} + \beta_5 \text{foreign\_dummy}_{it} \\ & + \beta_6 \text{MKT\_Concentration}_t * \text{foreign\_dummy}_{it} + \text{other controls} + \mu_i + \epsilon_{it} \end{aligned} \quad (14)$$

$$\text{Where } Y_{it} = \text{loan growth}_{it} - \text{GDP growth}_t$$

Table 6 reports the results[4] when the dependent variable is the difference between bank total[5] loan growth rate and GDP growth rate. The estimate of coefficient of interaction term between market concentration and merger dummy is positive and significant. This suggests that the extent to which banks increase their lending in response to an increased concentration is strengthened after a merger. This result is consistent with the argument that the extent to which banks increase their lending in response to an increased concentration is strengthened after a merger, when the "TBTF" doctrine prevails. Interaction term between market concentration and a foreign bank dummy is negatively related to bank lending. This suggests that the extent to which banks increase their lending in response to an increased concentration is weakened after the change of ownership to foreigners.

<Insert Table 6 around here>

In order to check the robustness of the estimation results, we also use each bank's net growth rate of corporate loans after subtracting the GDP growth rate as a dependent variable. After the 1997 crisis, highly debt-ridden large corporations in Korea have accelerated their deleveraging process, reducing their reliance on bank debt and increasing direct equity

[4] These results are very similar to those results using bank loan to GDP as the dependent variable (which are available upon request from the authors).

[5] Total loans consist of corporate and household loans.

financing from the markets and cash-holdings. So, most of corporate loans after year 2000 are allocated to SMEs.

Table 7 reports the results when growth rate of corporate loans minus GDP growth rate is used as a dependent variable. The results are similar to the analysis when we use growth rate of total loans minus GDP growth rate as a dependent variable. Interaction term between market concentration and merger dummy is positively related to bank lending. This suggests that the extent that banks increase their lending in response to an increased concentration is strengthened after a merger.

<Insert Table 7 around here>

## 6. Summary and Conclusion

This paper theoretically and empirically dealt with how banks which believe the "TBTF" doctrine respond when the banking industry becomes concentrated. This was motivated by the emergence of highly concentrated banking industry after a financial crisis in Korea. We developed a very simple model that shows aggregate loan supply increases when large banks have a belief of TBTF doctrine in consolidated markets. We also empirically presented the evidence that surviving large banks contribute to such a credit boom as they are entrenched with TBTF doctrine in consolidated markets. Using quarterly data on bank loan supply for all operating commercial banks, we have found that the loan to GDP ratio grows fast as the market becomes more concentrated. In addition, after merger, we found that banks show more aggressive attitude toward lending.

The results suggest that surviving large banks engage in more risk taking even after experiencing a series of bank failures and financial reform emphasizing their prudent lending behavior. It might not be too much absurd to guess that large banks have lent more aggressively, believing that their chance of bailout is likely to increase as each large bank becomes essential to the economy because only fewer banks are present in the economy.

While it might be too early to talk about the consequences of structural changes following the recent global financial crisis, experiences from a country which already had such changes some years ago could be insightful. We believe that the case of Korea may provide an insight regarding the potential risks that a highly concentrated banking industry can cause when TBTF doctrine prevails.

Our study identifies a new adverse effect of market consolidation: large banks with TBTF belief in concentrated markets tend to expand their lending portfolio, causing an increase in systemic risk. The problem is different from conventional problem of consolidation that it hurts small borrowers as large banks restructure their portfolio by expanding their lending capacity to larger borrowers at the cost of smaller borrowers. To reduce potential problems with credit explosion, it is important to lower bank expectation of government bailouts when they are in trouble or to enhance market competition. Since a new entry into concentrated banking industry is difficult, it becomes more important to strengthen financial supervision on banks' risk taking behavior.

In our analysis, we examined the organizational-failure risk without considering how managerial incentives affect the risk taking behavior. While some might argue that bank managers would be prudent as they are afraid of losing their jobs in case of distress, it is also possible that short-sighted top managers have an incentive to increase their bank size through more lending as they are paid more when their bank becomes bigger. As there are conflicting effects, future studies on risk taking should empirically examine this issue as well.

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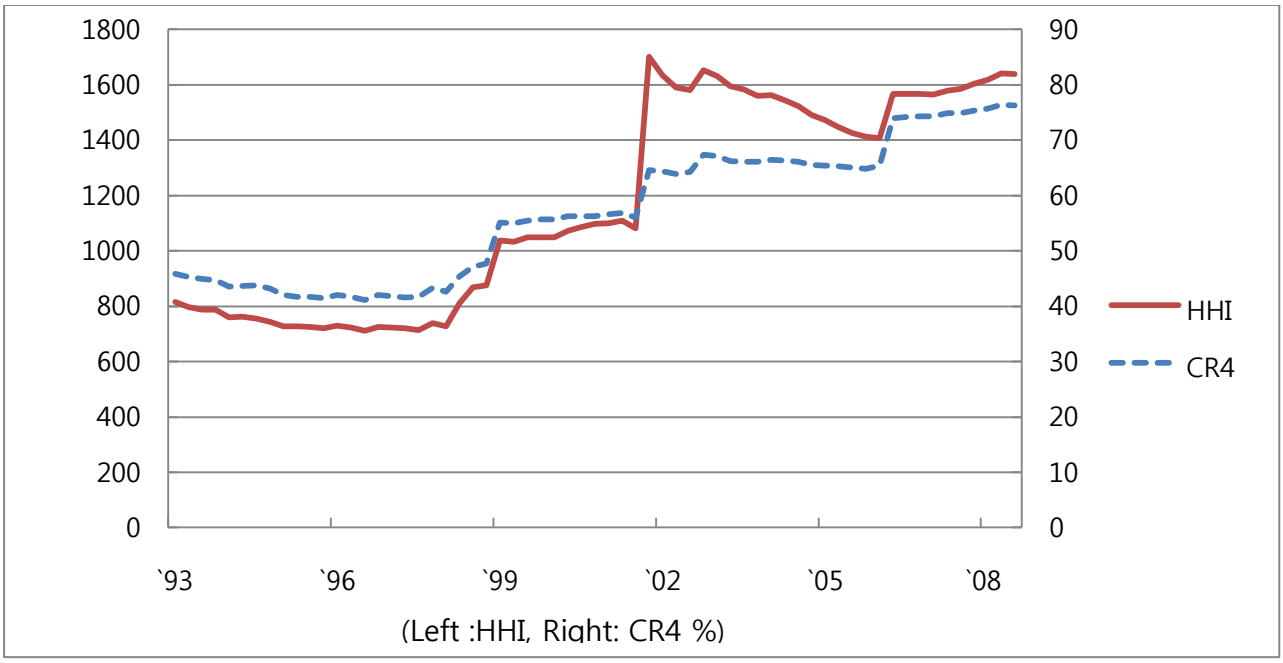
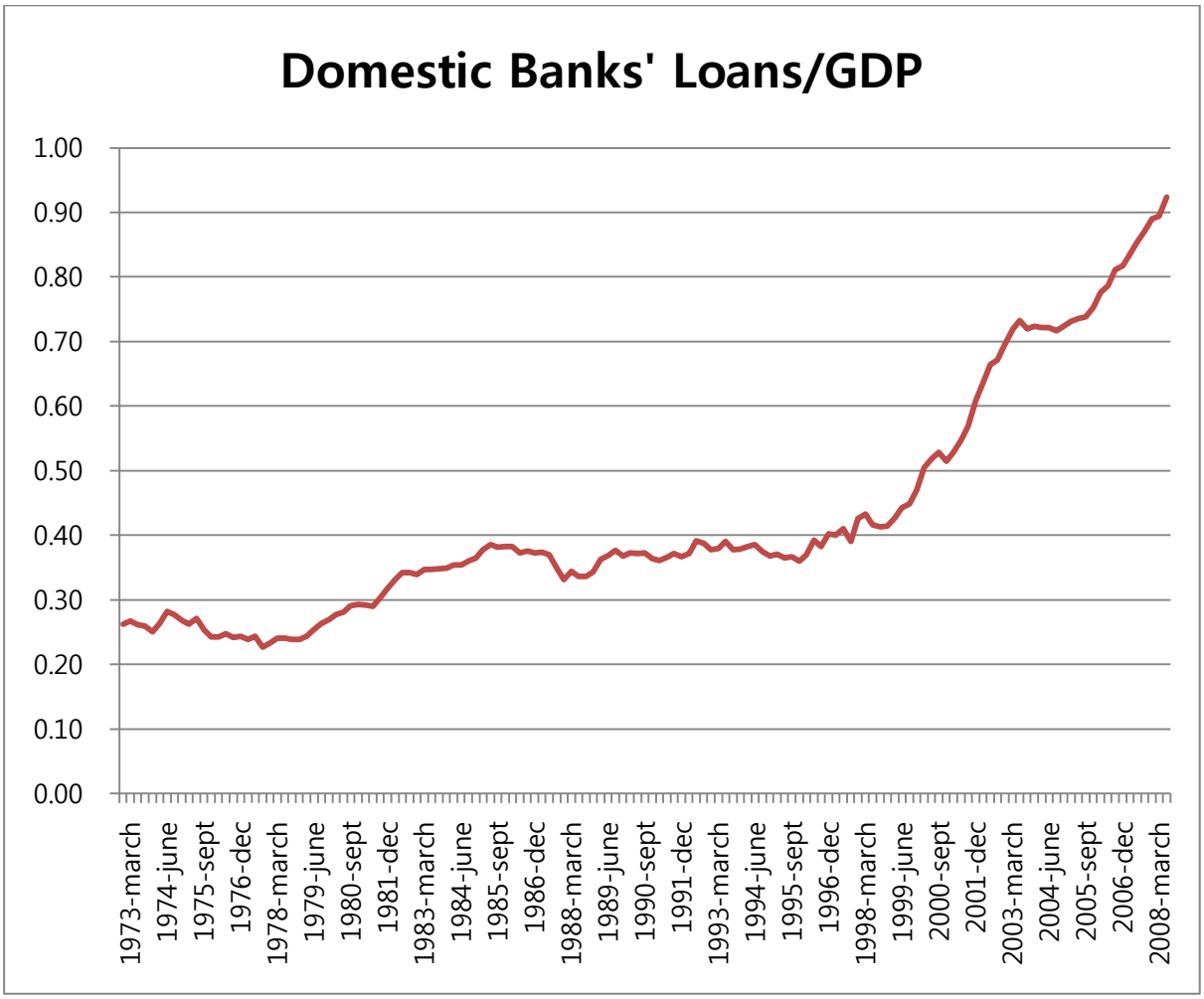
<Figure 1: HHI and CR4 over time>

Market concentration is measured by Herfindhal Hirshman Index (HHI) and largest four firm concentration ratio (CR4). HHI is the sum of squared market share of each bank in the lending market. CR4 is the combined market share of the largest four banks in the lending market.



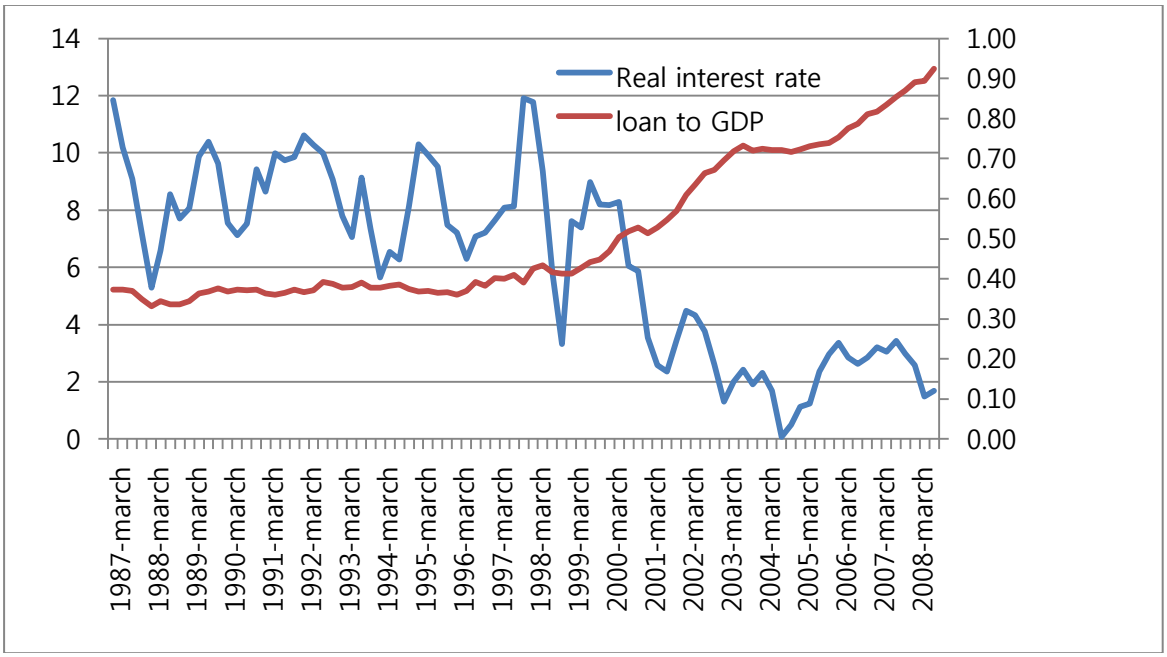
<Figure 2: Trends of total loans of domestic banks / GDP >

Domestic banks' outstanding aggregate loans denominated in Korean currency divided by GDP.

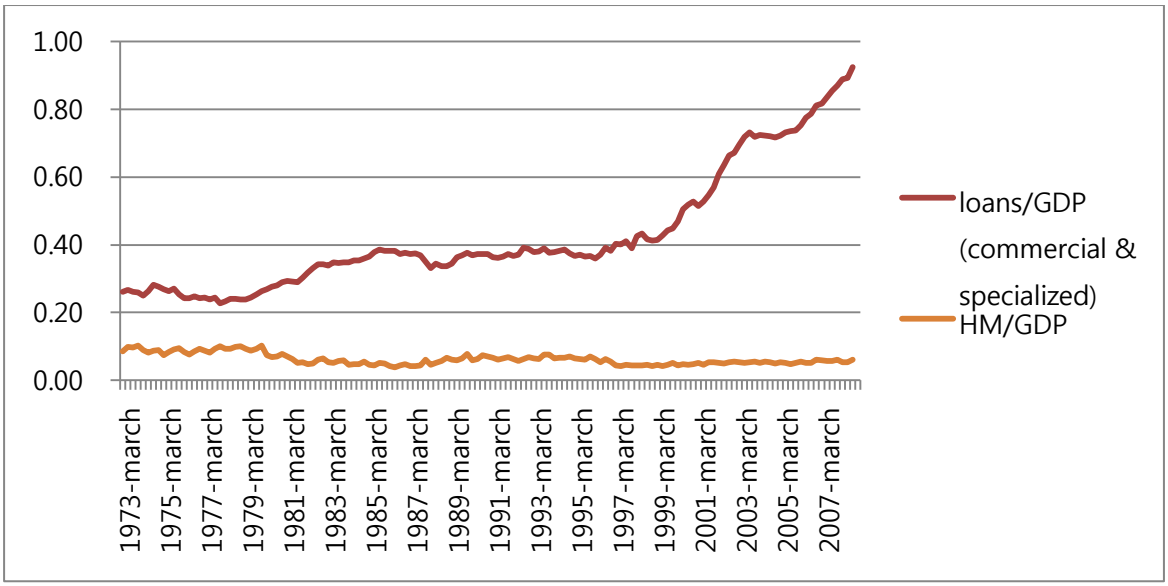


<Figure 3: Trends of Interest Rates and Money supply to GDP>

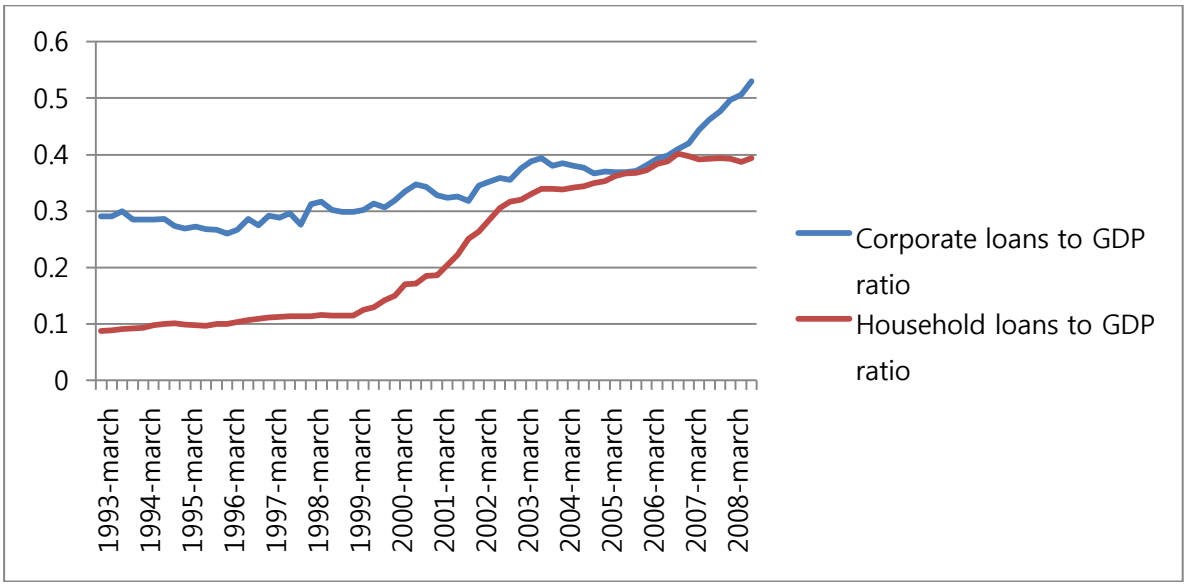
Panel A: Trends of Interest Rates and Bank loan to GDP ratio




Panel B: Trends of High Powered Money Supply to GDP ratio and Bank loan to GDP ratio



<Figure 4: Trends of corporate loan to GDP ratio and household loans to GDP ratio>



<Table 1: Summary statistics for the available data (1999:2-2008:3)>

| Variable | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|
| *Individual bank* | | | | |
| growth rate of total loans-GDP growth rate | 0.06 | 0.08 | -0.22 | 0.24 |
| growth rate of corporate loans-GDP growth rate | 0.03 | 0.09 | -0.39 | 0.23 |
| Funding structure (Bank debenture+ CD)/Deposit | 0.21 | 0.17 | 0.01 | 0.95 |
| capital to assets ratio | 0.05 | 0.01 | -0.01 | 0.10 |
| loan loss provision ratio | 0.03 | 0.03 | 0.01 | 0.32 |
| *Aggregate information* | | | | |
| Total loans/quarterly GDP | 1.89 | 0.35 | 1.20 | 2.50 |
| HHI(logarithm) | 7.25 | 0.17 | 6.93 | 7.43 |
| four-bank concentration ratio | 0.65 | 0.07 | 0.55 | 0.76 |
| Funding structure (Bank debenture+ CD)/Deposit | 0.23 | 0.12 | 0.08 | 0.47 |
| call rate(%) | 4.34 | 0.60 | 3.25 | 5.33 |
| growth rate of apartment price index | 0.06 | 0.06 | -0.03 | 0.22 |
| capital to assets ratio | 0.06 | 0.007 | 0.01 | 0.08 |
| loan loss provision ratio | 0.03 | 0.02 | 0.01 | 0.08 |

<Table 2: ADF unit root test results>

| | | |
|---|---|---|
| Level | Loan Ratio:(loan amount/GDP) | -1.98 |
| | Market concentration 1: (log(HHI)) | -2.03 |
| | Market concentration 2: (CR4) | -2.61 |
| | Financing Structure<br>(Bank debenture+ CD)/Deposit | 2.51 |
| | Capital Ratio: capital/asset | 2.79 |
| | Loan loss provision ratio<br>(loan loss provision/loan amount) | -3.85*** |
| | Call rate | -1.08 |
| First differencing time series | ΔLoan Ratio: Δ Loan amount/GDP | -3.52* |
| | ΔMarket concentration 1: Δ log(HHI) | -7.26*** |
| | ΔMarket concentration 2: ΔCR4 | -7.36*** |
| | ΔFinancing Structure 1:<br>Δ (Bank debenture+ CD)/Deposit | -6.34*** |
| | ΔCapital Ratio: Δcapital/asset | -6.19*** |
| | ΔLoan loss provision ratio:<br>Δ (loan loss provision/loan amount) | NA |
| | ΔCall rate | -5.75*** |

Note: *, **, and *** represent a significance level at 10%, 5% and 1%, respectively. Seasonal adjustment is made for GDP variables.

<Table 3: Johansen trace and maximum eigenvalue test results>

Panel A; Johansen trace and maximum eigenvalue test using thee time series of loan to GDP ratio, HHI and financing structure

| Trace test | | maximum eigenvalue test | |
|---|---|---|---|
| H0: $r = 0$ | 57.30*(42.91) | H0: $r = 0$ | 34.00*(25.82) |
| H0: $r \leq 1$ | 23.30(25.87) | H0: $r = 1$ | 15.44(19.38) |

Panel B; Johansen trace and maximum eigenvalue test using thee time series of loan to GDP ratio, CR4 and financing structure

| Trace test | | maximum eigenvalue test | |
|---|---|---|---|
| H0: $r = 0$ | 48.80*(42.91) | H0: $r = 0$ | 30.29* (25.82) |
| H0: $r \leq 1$ | 18.51 (25.87) | H0: $r = 1$ | 13.76 (19.38) |

<Table 4: Effects of market structure on bank loan to GDP ratio using dynamic OLS >

| | | |
|---|---|---|
| Constant | -7.39***<br>(-7.29) | -1.89***<br>(-3.25) |
| Market Concentration I (log HHI) | 1.24***<br>(8.83) | |
| Market Concentration II (CR4) | | 6.11***<br>(5.57) |
| Financing structure<br>(Bank debenture +CD )/Deposit | 1.33***<br>(8.34) | -0.68<br>(-1.52) |
| DW | 0.94 | 0.77 |
| Adjusted $R^2$ | 0.97 | 0.94 |

Note: numbers in parenthesis is t-stat using Newey-West HAC standard error

<Table 5: Error correction model>

| Market concentration is measured by | HHI | CR4 |
|---|---|---|
| Constant | 0.02<br>(1.19) | 0.02**<br>(2.33) |
| ΔMarket concentration<br>(Δ log HHI) | 0.12*<br>(1.78) | |
| ΔMarket concentration<br>(Δ CR4) | | 0.49*<br>(1.77) |
| ΔFinancing structure(t-1)<br>Δ(BankDebenture+CD)/(Deposit) | 0.06<br>(0.20) | -0.24<br>(-0.73) |
| Δcapital structure(t-1) | -1.64**<br>(-2.38) | -0.87<br>(-1.33) |
| loan loss provision ratio(t-1) | 0.21<br>(0.92) | -0.0007<br>(-0.002) |
| Δcall rate | 0.01<br>(0.36) | 0.14<br>(0.75) |
| Δcollateral value(t-1) | 0.002<br>(0.54) | 0.003<br>(0.77) |
| Error correction | -0.33***<br>(-2.95) | -0.29***<br>(-3.71) |
| DW | -1.70 | 1.80 |
| Adjusted $R^2$ | 0.15 | 0.23 |

Note: numbers in parentheses are t-values. *, **, and *** represent a significance level at 10%, 5% and 1%, respectively

<Table 6: Panel Analysis of market concentration on bank risk taking>

We examine factors affecting the net bank loan growth in excess of GDP growth using quarterly information. Merger dummy takes 1 for banks after merger or foreign bank dummy takes one for banks whose ownership is in foreign investors. Collateral value is measured using an apartment price index which is normalized using GDP deflator.

| Market concentration is | Log HHI | | CR4 | |
|---|---|---|---|---|
| Constant | -0.96*** | -0.86* | -0.15* | -0.15** |
| | (-4.53) | (-3.18) | (-3.00) | (-2.82) |
| Market concentration | 0.14*** | 0.11** | 0.44*** | 0.26*** |
| | (5.09) | (3.26) | (5.31) | (3.15) |
| Financing structure(t-1) | -0.11*** | -0.13 | -0.15*** | -0.12*** |
| | (-4.63) | (-4.28) | (-4.85) | (-3.52) |
| Merger dummy | -2.96*** | -2.21*** | -0.50*** | -0.38** |
| | (-4.82) | (-3.76) | (-4.65) | (-3.72) |
| Market concentration *Merger dummy | 0.39*** | 0.28*** | 0.55*** | 0.39*** |
| | (4.65) | (3.59) | (3.59) | (2.69) |
| Foreign bank dummy | 1.32*** | 1.93*** | 0.46*** | 0.64*** |
| | (2.50) | (3.84) | (4.40) | (6.66) |
| Market concentration *foreign bank dummy | -0.19*** | -0.27*** | -0.82*** | -1.04*** |
| | (-2.67) | (-3.95) | (-5.30) | (-7.28) |
| Capital Ratio (t-1) | | -0.75** | | -0.66** |
| | | (-2.39) | | (-2.04) |
| Loan loss provision (t-1) | | -0.56** | | -0.70*** |
| | | (-2.55) | | (-3.39) |
| Collateral value | | 0.32*** | | 0.40*** |
| | | (5.59) | | (8.15) |
| Call rate | | 0.03*** | | 0.03*** |
| | | (5.43) | | (5.03) |
| Fixed effects | Yes | Yes | Yes | Yes |
| Within $R^2$ | 0.24 | 0.37 | 0.26 | 0.43 |

Note: numbers in parentheses are t-values. *, **, and *** represent a significance level at 10%, 5% and 1%, respectively

<Table 7: Panel Analysis of market concentration on corporate loans>

Dependent variable is bank's corporate loan growth rate minus GDP growth rate
We examine factors affecting the ratio of bank loan over GDP using quarterly information. The dependent variable is the growth rate bank loan to firms after subtracting the growth rate of GDP. Merger dummy takes 1 for banks after merger or foreign bank dummy takes one for banks whose ownership is in foreign investors. Collateral value is measured using an apartment price index which is normalized using GDP deflator.

| Market concentration is measured through | Log HHI | | CR4 | |
|---|---|---|---|---|
| Constant | -0.93***<br>(-3.59) | -1.96***<br>(-5.71) | -0.31***<br>(-5.27) | -0.45***<br>(-6.30) |
| Market concentration | 0.13***<br>(3.70) | 0.24***<br>(5.31) | 0.59***<br>(6.03) | 0.64***<br>(5.85) |
| Financing structure(t-1) | 0.07**<br>(2.54) | -0.06*<br>(-1.70) | --0.08**<br>(-2.09) | -0.14***<br>(-3.23) |
| Merger dummy | -3.72***<br>(-4.94) | -2.51***<br>(-3.37) | -0.8***<br>(-6.25) | -0.64***<br>(-4.82) |
| Market concentration *merger dummy | 0.50***<br>(4.90) | 0.33***<br>(3.33) | 1.07***<br>(5.84) | 0.84***<br>(4.46) |
| Foreign Bank dummy | -0.43<br>(-0.67) | -0.004<br>(-0.01) | -0.12<br>(-1.01) | 0.004<br>(0.04) |
| Market concentration *foreign bank dummy | 0.04<br>(0.55) | -0.006<br>(-0.07) | 0.08<br>(0.46) | -0.05<br>(-0.29) |
| Capital Ratio (t-1) | | -0.30<br>(-0.75) | | -1.09**<br>(-2.04) |
| Loan loss provision (t-1) | | -0.76**<br>(-2.77) | | -0.70***<br>(-2.64) |
| Collateral value | | -0.02<br>(-0.33) | | 0.10<br>(1.59) |
| Call rate | | 0.06***<br>(7.50) | | 0.04***<br>(5.32) |
| Fixed effects | Yes | Yes | Yes | Yes |
| Within $R^2$ | 0.16 | 0.27 | 0.23 | 0.30 |

Note: numbers in parentheses are t-values. *, **, and *** represent a significance level at 10%, 5% and 1%, respectively