경제학 석사 학위논문

Research on the Bank Lending Behavior and Different Measures of Bank Asset Quality

2017 년 2 월

서울대학교 대학원

경제학부

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이 논문을 경제학 석사학위논문으로 제출함

2016 년 10 월

서울대학교 대학원

경제학부

이정현

이정현의 석사학위논문을 인준함

2016 년 12 월

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Abstract

Research on the Bank Lending Behavior and Different Measures of Bank Asset Quality

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This study's goal was to testify if the bank asset liquidity measures, namely the Net Substandard Loan Ratio, the Liquidity Ratio, and the Highly Liquid Asset Ratio, have bi-directional correlation with their lending behavior, specifically the loan growth rate. A number of different models were used to test the explanatory power of both direction, with the independent variables having one period lag from the dependent variable. The results showed that it is possible the bank loan decisions are insulated from the increase or decrease of the asset liquidity measures in the previous period. Rather, the loan growth rate of the current period can be better explained by the macroeconomic variables. Meanwhile, the Net Substandard Loan Ratio can be explained by the previous period's loan growth status. Then, there exists a reasonable incentive for banks with low Net Substandard Loan Ratio to increase loan to recover the asset liquidity measure. Liquidity Ratio, however, did not have significant explanatory power not only on the next period's bank loan decision but also on the market-wide liquidity level.

Keywords: bank asset liquidity, lending behavior, Net Substandard Loan Ratio, Liquidity Ratio, Highly Liquid Asset Ratio

Student Number: 2015-20186

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1. Introduction

Recent issues in Korean economy can be narrowed down to financial regulation. Household debt has caused major pressure, and concerning the ever-increasing household debt situation many economic policy propositions have been made. Traditionally, among various agents in Korean financial market, commercial banks are the major party in charge of loans. Though the ratio of loan from commercial banks has been declining, commercial bank loan takes up to 569 trillion KRW out of the total debt amount 1,158 trillion KRW, which is slightly less than half (KBS News, 2016.05.28) . Even though the ratio is currently the lowest since 2002, the amount of loan itself has gradually increased during last decade. The policy focus this year has been upon regulating the loan itself so as to control household debt, but it has been recently pointed out that the government should deter loan demand from non-bank financial agents. The objective is therefore to contain household loan within the controllable boundary of commercial bank.

What should never be neglected, at times when loan management has become a nationwide problem, is the system of monitoring and regulating the aforementioned commercial banks. As important as the loan amount is by itself, the commercial banks themselves should be in firm grounds, especially in terms of market liquidity risks. This is in line with recent Basel 3 reform of Basel Committee on Banking Supervision (BCBS). The reform was intended to increase bank's ability to cope with market risks (Bank for International Settlements). One of the major implementations is the revised Liquidity Coverage Ratio (LCR) which was formally issued in January of 2013 and introduced on 1st January of 2015. Full implementation of LCR will require a hundred percent, but as it is a reform, the requirement level will be elevated gradually. The minimum requirement level of LCR planned by BIS is as follows.

	2015	**2016**	**2017**	**2018**	**2019**
Minimum LCR requirement	60%	70%	80%	90%	100%

The key of the new measure is that it incorporates bank's 'High Quality Liquid Asset.' In other words, under LCR regulation, banks' asset composition becomes important measure of bank's capacity under stress. The measure for bank asset quality in terms of highly-liquid-asset composition replaces conventional liquidity ratio which simply measured the ratio of liquid asset to liquid debt. Korean commercial banks also have replaced this measure since 2015.

One of the controversies on the measure of bank asset quality was its relationship with bank loans. There were mainly three conflicting ideas regarding whether the bank asset quality is negatively correlated to the amount of bank loans. First of all, the conventional idea by Romer and Romer (1990) argued that the banks' asset structure does not affect their lending behavior. In other words, banks will be able to insure their lending from liquidity loss. From this idea, it can be inferred that the liquidity status of a bank would not affect its loans. It was in line with the famous Modiglinani-Miller separation between a firm's capital structure and its value. Then, researchers such as Diamond and Rajan (2009), Gale and Yorulmazer (2013), and Acharya and Skeie (2011) showed theoretically that there exists an incentive for the banks to hoard liquidity, implying that the banks' asset liquidity is a relevant consideration for banks' loan decisions. Based on this line of ideas, recent studies introduce the positive correlation between banks' funding structure and their lending behavior. From the theory that the banks are willing to hoard liquidity, especially at times of liquidity shock, Jung (2015) argued that the banks' current asset quality affects their lending capacity. Banks better asset structure tend to not decrease, rather increase their loans at times of liquidity crisis. As opposed to the positive correlation theory, there has been an alternative theory mainly by Stein (1998). This theory is also against the conventional Romer and Romer (1990), but it differs from Jung in that it introduces a concept of adverse selection coming from information asymmetry. Due to such condition, the banks with good quality asset refrains from increasing loans under liquidity shocks.

The aforementioned theories have cast light on the issue of the banks' lending behavior and its correlation with the asset quality. Though the asset quality can be measured in different ways, various models in this line of study have focused on the aspect of liquidity. The importance of the correlation between the bank asset quality and the lending lies in three different ways. Firstly, it can analyze the impact of liquidity regulation since the theories help understand what will happen to bank lending when liquidity level mandates good asset quality. Secondly, the lending behavior can be a signal for the banks' asset quality. This insight is based on the premise that the true asset quality is private information for the banks. Then, the correlation between the lending behavior and the asset quality can help infer the private information. Thirdly, most of the researches focused on the correlation of the bank asset quality and lending behavior at times of liquidity crisis. This issue of liquidity shocks has become more and more important recently, and unlike under normal conditions, at times of liquidity crisis banks' asset quality is a decisive factor for the entire economy. And the lending behavior affects myriads of households and firms. Hence, it is of extraordinary importance that the studies focus on the correlation of the two under liquidity shocks.

This study tries to contribute to the line of study on the banks' asset and lending behavior with two original aspects. Firstly, this study adopts the most recent approach regarding the bank asset quality. In other words, the concept of 'highly liquid asset ratio' is introduces as a proxy for the LCR, which is the most recent liquidity measure upon which the BCBS has given approval. This study compares the explaining power of this measure with that of two other conventionally used measures for the bank asset quality. Using quarterly data of seven Korean commercial banks within the time frame of ten years, linear regression is used, as is for other credited research papers issued by the Bank of Korea Secondly, this study tries to investigate the potential causality between the bank asset quality and the lending behavior, by setting one period gap between the bank asset quality measure and the lending behavior. Lending behavior is measured as its growth rate to avoid auto correlation problem. And this study examines both directions of possible impact between the two variables in question. The time gap is what suggests the causality, but it does not guarantee an outright existence of causality even though the explaining power is shown to be strong enough. In line with former researches, this study also incorporates the liquidity crisis measure as one of the variables, to identify whether the impact on either direction is influenced by the liquidity dry up of the market.

Chapter two will start with detailed literature review of the aforementioned researches. Theoretical set up of Stein (1998) and regression model of Jung (2015) is mainly introduced. Then, Chapter three will illustrate this study's regression model and major variables. Then, the results of the regression is presented and interpreted in Chapter four. From basic statistics, the explaining powers of each variable will be discussed. Finally, Chapter five will bring the conclusion, and mention the limitations of this study.

2. Literature Review

The study of banks' asset quality and their lending behavior encompasses various theories and discussions that focus on the banks' lending at times of liquidity crisis. To be specific, when liquidity level of a bank decreases, it was on question whether the bank would move to decrease, hold, or even increase its loan. Before going into contrasting theories, it is worthwhile to introduce a conventional theory on bank lending behavior. Traditionally, bank lending was analyzed with respect to the monetary policy (Van den Heuvel, 2002). By lowering bank reserves, monetary policy was supposed to induce banks to reduce lending. In this point of view, it was a necessary condition for banks to be unable to offset the decline in reservable deposit with non-reservable liabilities. For the monetary policy to work, the banks must prefer reservable deposit to non-reservable, which implies that there must exist a distinction between banks' asset compositions. If not, the banks will proceed to non-reservable substitutes and will not reduce lending despite the decrease in the reserve. Romer and Romer (1990) argued that the effect of monetary policy does not have noticeable impact on bank lending because banks have access to alternative sources of funds. In the paper, Romer and Romer argued that CDs and commercial paper can be substituted with relatively little cost, which "*suggests that the required premium is small-that is, it suggests that banks are able to obtain funds in the general credit market relatively easily when transactions balances fall*" (Romer and Romer, 1990). This can be interpreted, regarding bank asset quality, as bank asset composition does not influence its lending behavior.

An important theory counter-arguing the Romer and Romer (1990), was from Stein (1998) who theoretically showed that the bank asset quality is negatively affects its lending behavior. With regard to the impact of monetary policy, Stein set up a model that distinguish the banks by their asset quality to analyze if either of the types were prone to reducing loan when their reserve was exposed to decrease shock. In the theoretical model of one-period, no securities holdings, the modeling equations were as follow:

$$L + R + K \leq M + P + E$$

In the above weak inequality, L stands for incremental loan, R stands for reserves, K stands for current asset of the bank, M stands for insured deposit, P stands for current nondeposit financing, and E stands incremental nondeposit financing. The assumption of this model is K=P, meaning the existing assets are completely supported by existing nondeposit financing. And K is distinguished so that banks with good asset quality have higher level of K than those with bad asset quality. The asset quality is a private information. Then, when faced an exogenous outflow of M, there exists a separating equilibrium for type G and type B. Type B's incremental loan is $L^B = a/2$, a solution that maximizes interest income. Then, combined with the constraint above, incremental nondeposit financing of the type B is:

$$E^B = \max(0, a/2 - M(1 - \varphi))$$

φ stands for the fractional reserve requirement on insured deposit. Type G's incremental lending is less than that of G by Z. In other words, $L^G = L^B - Z$ and hence, the incremental nondeposit financing of type G is:

$$E^G = E^B - Z = \max\big(0, a/2 - M(1 - \varphi)\big) - Z$$

The interest profit is denoted by π and $\pi^G = \pi^B - Z^2/b$ calculated from the simple loan demand function of $L = a - br$. If type B pretends to be type G, its profit falls by Z^2/b but it gains from overpriced equity selling, which is $E^G \times (1 - K^B/K^G)$.

When the gain and cost are equal there is a separating equilibrium. Under the condition that M exceeds certain level, banks of both type will make loan at their first-best level, but as M falls, two types are divergent so that type G banks are reluctant to use uninsured financing, thereby decreasing its loan compared to the first-best level. Moreover, the effect of external shock is stronger when the information asymmetry measured by $(1 - K^B/K^G)$ is larger. Stein's model shows that the lending behavior can differ under certain condition, and there are several implications useful for this study. First, under the condition when there are informational asymmetry, the banks' loan behavior is negatively correlated with their asset quality. This study also tries to investigate the correlation of the asset quality, but it differs from Stein (1998) in that this study uses liquidity measure to avoid the abstractness of the concept asset quality. Secondly, as in the Romer and Romer (1990), Stein (1998) also focused on the monetary policy channel through reserve and lending. This study could also adopt the implication of monetary policy because this study's focus on the liquidity of bank asset is related to exogenous decrease in bank liabilities considering the liquidity measures are intended to insulate the bank from those shocks.

A more recent try to show the correlation between the bank asset quality and the lending behavior was conducted by Jung (2015), using Korean data. Jung (2015) was inspired by former researches by Diamond and Rajan (2009), Gale and Yorulmazer (2013), and Acharya and Skeie

(2011) that showed the banks tend to hoard liquidity against future shocks. Jung (2015) applied this hoarding of liquidity to banks' funding structure, distinguishing core funding from wholesale funding. Since core deposits are more valued source at times of shock, the banks with higher core funding would have relatively larger capacity for lending than those with higher wholesale funding. Berlin and Mester (1999) argued that the access to core deposits insulates banks' cost of funding from exogenous shocks. Likewise, Allen and Paligorova (2011) proved with Canadian data that the more banks rely on wholesale funding, the more likely they are to reduce lending during market stress and crisis.

Jung (2015) examined whether banks with high core funding decrease or even increase their lending to firms during periods of liquidity shocks. The model was dynamic estimation incorporating past loans as well as liquidity shock measure, core funding measure, cross term of both liquidity shock and core funding, bank characteristic variables and also indebted firm characteristic variables. The regression equation is as follows:

$$\ln Loan_{i,k,t} = a_{i,k} + \lambda_t + \delta LiquidityShock_t + \mu CFA_{i,t} + \gamma\left(LiquidityShock_t \times CFA_{i,t}\right) + \theta Z_{i,t} + \beta X_{k,t-1} + \sum_{j=1}^{m} \phi_j \ln Loan_{i,k,t-j} + \epsilon_{i,k,t}$$

Jung (2015) adopted yield spread between one-year bank debentures and one year Treasury bond as liquidity shock measure. CFA in the above equation stands for the ratio of core funding to asset, Z stands for the bank characteristics such as size and BIS, and X stands for the indebted firm characteristics such as ROA, NPL and BASS.

The result of the above estimation using heteroscedasticity-consistent standard errors showed that the coefficient of core funding ratio is positive but statistically insignificant. This is in contrast with former researches with foreign data conducted by Berlin and Mester (1999) and Allen and Paligorova (2011) which emphasized positive correlation. The coefficient of the liquidity shock variable is significantly negative, confirming that under high possibility of liquidity outflow or market-wide shock, banks reduce lending. As one percent point of the yield spread measure increased, 8.62% of bank lending is reduced. The originality of the regression result, however, lies in that it confirmed the significant positive correlation of the cross term, core funding ratio and liquidity shock, with bank lending. This indicates that under liquidity shocks, banks with high core funding ratio actually increase their lending. It was shown that "*banks with core funding ratio above 64.76% appear to increase their lending even when market-wide liquidity worsens*" (Jung, 2013).

Jung's model shows that at least in Korea, core funding ratio is not explicitly correlated to the bank lending, but is rather positively correlated under liquidity shocks. It cast a further question to whether there are other useful measures of bank asset quality that can be interpreted as having positive or negative correlation to the bank lending behavior. This issue is further developed in this study, since the objective of this study is at examining not only the correlation but also intertemporal correlation, with the implication of causality. Also, Jung's result suggest the possibility of positive correlation between the bank asset quality and lending behavior, which can challenge the aforementioned conventional theories of Romer and Romer (1990), and Stein (1998). This study tries to investigate the same issue, but with more concrete measures of liquidity of the bank asset.

This study's research question can be clarified as the following: whether the banks' lending behavior is affected by or correlated with their asset quality measured by liquidity. The importance of this question lies in three aspects of banking system. The first is under the context of monetary policy, as former researchers have focused on. The fluctuation of the liquidity level can be understood in one way as the fluctuation of the banks' reserves, which is a tool for monetary policy. It is important to examine whether the liquidity level can actually influence the lending behavior of the banks. The second is under the context of liquidity crisis. If the lending behavior is not insulated under the liquidity shock, and if it has a negative correlation or is negatively affected by bank asset quality, the liquidity shock can incur secondary shock in the money market. The last is under the context of regulation. As was Stein (1998)'s insight, the asset quality in fact is a private information. If the lending behavior can be a signal for the asset quality of the banks, it can be used for regulatory purpose. This would not mean that there must be a regulatory measure for the loan itself, but it can imply that the loan can be an indication measure for bank asset liquidity. This argument can be questioned with the fact that there are already certain measures to detect the banks at risk, and one of the measures is the BIS ratio. The well-known BIS Capital Adequacy Ratio measures the ratio of capital to risk weighted assets. The BCBS themselves have admitted that the liquidity regulation measures are "in a manner similar to that of the BIS

Capital Adequacy requirements” (BCBS, 2013). However, the liquidity measures such as conventional Liquidity Ratio and newly introduced Liquidity Coverage Ratio are more suitable for the purpose of limiting illiquid assets in the banks. Also, as Cifuentes et al (2005) pointed out, the BIS Capital Adequacy requirements depend much upon the equity value of the banks. Likewise, risk taking with illiquid assets is plausible as long as the equity value sustains the BIS regulation level (Cifuentes, Rodrigo, Hyun Song Shin, 2005). Hence, even though the BIS Capital Adequacy requirements exist, there is a valid motivation to investigate further liquidity regulation measures, especially when the prudential regulations have become an important economic issue.

3. Research Model

3.1. Regression model and hypotheses

The study tries to test the following models concerning the bank asset quality and lending behavior. The bank asset quality in question is mainly focused on liquidity, and the following models are distinctive from each other with regards to different liquidity measures. The regression models of this study set a one period time gap between the dependent and independent variables to identify time-based dynamics. The models are constructed to check the impact in both directions, in between the bank asset quality and the lending behavior. Also, as shown in former researches, this study also incorporates market-wide liquidity level in order to check the following hypotheses at times of liquidity crisis.

Hypothesis 1: Bank asset quality at t-1 negatively or positively affects bank loan at t

$$\mathrm{GR}_{i,t} = a_i + \beta_1 \mathrm{NSL}_{i,t-1} + \beta_2 LR_{i,t-1} + \beta_3 HLAR_{i,t-1} + \beta_4 BIS_{i,t-1} + \beta_5 SIZE_{i,t-1} + \gamma X_{t-1} + \epsilon_{i,t}$$

$\mathrm{NSL}_{i,t}$ is Net Substandard Loan ratio, which measures the rate of substandard loan, a critical indicator showing loan quality of a bank.

$\mathrm{GR}_{i,t-1}$ is the Growth Rate of Loan as a whole. BIS and SIZE are the bank specific characteristics. X_{t-1} is the matrix of inflation index, real interest rate, and market-wide liquidity measure, and specifically the third is measured by the yield spread between one year debentures and Treasury Bond as a liquidity level proxy. $\mathrm{HLAR}_{i,t}$ is the ratio of highly liquid asset, including cash, treasury bond, and debentures, to gross asset. It is a useful measure in line with the Liquidity Coverage Ratio, but it has limitation that the net outflow of cash is not captured as in LCR. However, compared to conventional LR, HLAR captures the quality of bank asset regarding liquidity capacity.

Intuitionally, bank asset quality can affect the bank's lending behavior, but the influence can be in quite different directions. According to the literatures of core funding and bank lending, banks tend to become reluctant to further increase lending when its asset composition is centered on wholesale funding rather than core funding. In this context, one possible hypothesis is that the bank asset quality can positively affect bank loan, as banks with better quality will show higher growth rate in loans. However, according to the literatures of information asymmetry and adverse selection, banks with good quality asset is reluctant to expose themselves to raise external financing, hence has less capacity under liquidity shock to increase lending. Broadly speaking, the fluctuation in the asset quality can induce negative impact of bank asset quality on their loan increase, but it should be noted that this is mainly under the circumstances of liquidity shocks.

Three different measures for the asset liquidity could vary in explaining power, and possible explanations are as follows. Firstly, the Net Substandard Loan ratio signifies the loan quality, among other assets. If loan quality worsens, it can be plainly expected for banks to cut down on loans. However, there might be certain cases when even if the loan quality worsens, banks do not cut down on loans due to reasons other than asset prudence. One of the possibilities recently discussed is the competition between commercial banks. Secondly, the conventional Liquidity Ratio signifies the ratio of liabilities and assets with possibility of realization within three-month period. If the liability part increases, the Liquidity Ratio worsens, and if the loan increases despite the deterioration of the Liquidity Ratio, it implies the banks tend to take risks. If the loan decreases, it implies the opposite, in which case the regulation is operative. Lastly, the Highly Liquid Asset Ratio signifies the composition of highly liquid assets, in terms of how much of the assets are considered liquid with the standards of Liquidity

Coverage Ratio of BCBS. The interpretation of the explanatory power of the Highly Liquid Asset Ratio is in most similar to the interpretation drawn by the Liquidity Ratio, but it is worthwhile by itself to examine the validity of this measure.

Hypothesis 2: Bank loan expansion at t-1 affects bank asset quality at t.

$$\mathrm{NSL}_{i,t} = a_i + \beta_1 \mathrm{GR}_{i,t-1} + \beta_2 HCR_{i,t-1} + \beta_3 BIS_{i,t-1} + \beta_4 SIZE_{i,t-1} + \gamma X_{t-1} + \epsilon_{i,t}$$

Hypothesis 2 is tested with **two other measures of bank asset quality**: Liquidity Ratio and High Liquid Asset Ratio.

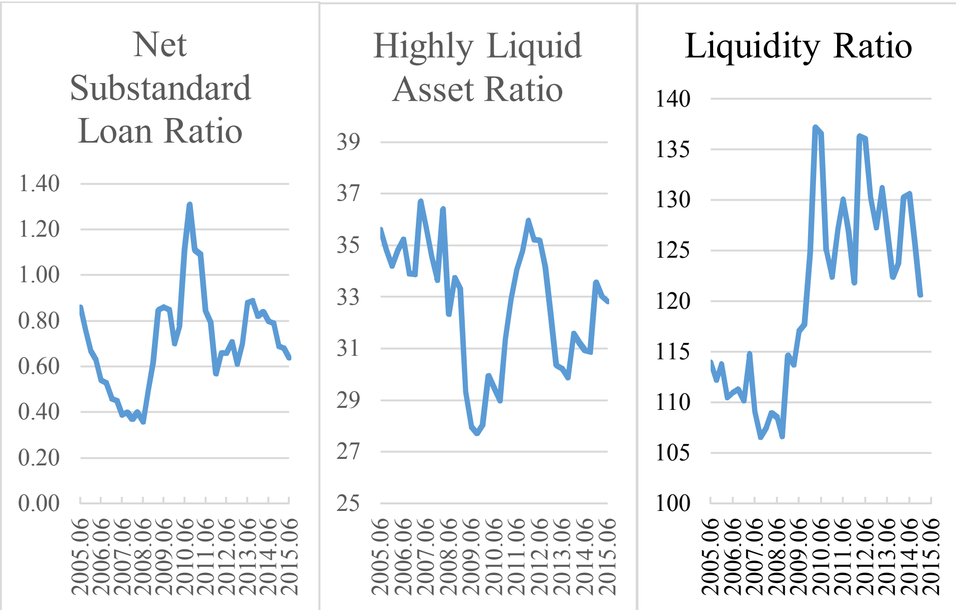
$$\mathrm{LR}_{i,t} = a_i + \beta_1 \mathrm{GR}_{i,t-1} + \beta_2 HCR_{i,t-1} + \beta_3 BIS_{i,t-1} + \beta_4 SIZE_{i,t-1} + \gamma X_{t-1} + \epsilon_{i,t}$$

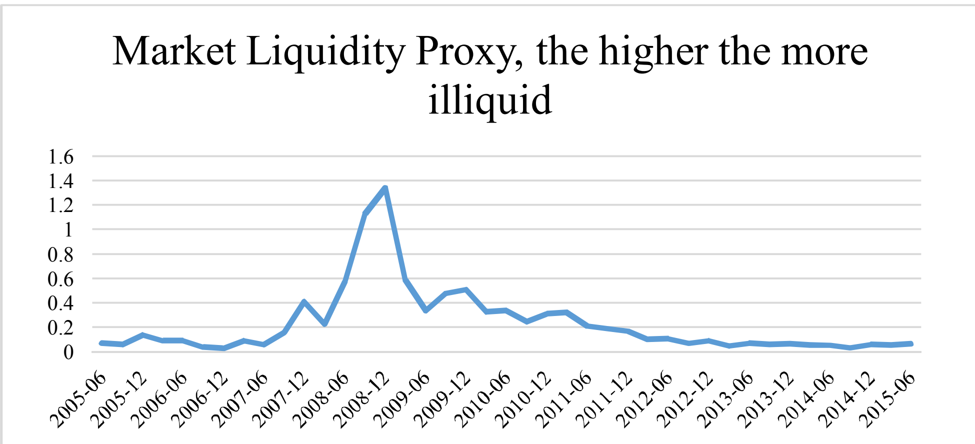
$$\mathrm{HLAR}_{i,t} = a_i + \beta_1 \mathrm{GR}_{i,t-1} + \beta_2 HCR_{i,t-1} + \beta_3 BIS_{i,t-1} + \beta_4 SIZE_{i,t-1} + \gamma X_{t-1} + \epsilon_{i,t}$$

The other variables are explained above, except for $HCR_{i,t-1}$ which is the ratio of household loan to corporate loan. Not only examining the growth rate of loan, this study also incorporated the characteristic of the loan by its composition.

The direction of the regression model in the hypothesis 2 is the opposite of that in the hypothesis 1, and tries to examine the explanatory power of the loan increase on the asset quality. If the loan increased in the previous period, the asset quality measured by the Net Substandard Loan may deteriorate or improve depending on the quality of incremental loan. The asset quality measured by the Liquidity Ratio could have a remote explanatory power, since the loan is one of the illiquid assets. However, there is always the possibility that the asset quality is insulated from the fluctuation of the lending behavior.

The turbulence observed regarding three different indicators of bank asset liquidity is plotted as follows. According to the gross data of major domestic commercial banks, Net Substandard Loan ratio has soared after the 2008 financial crisis, and has been going through up and down ever since. Highly Liquid Asset Ratio has also undergone drastic decrease after the 2008 financial crisis, has recovered relatively soon afterwards, but has fallen again around 2012 and 2013. Quite in contrast to the two fore-mentioned indicators, Liquidity Ratio has improved despite frequent turbulence. It does not seem to be much affected by financial crisis. It has been pointed out that the Liquidity Ratio does not represent asset liquidity of banks, and has been recently replaced by newly adopted indicators.





3.2. Explanation on the chosen explanatory variables

Aside from the major variables, namely the Bank Loan Growth Rate, the Net Substandard Loan Ratio, the Liquidity Ratio, and the Highly Liquid Asset Ratio, this study incorporates six different variables for explanatory purpose. Each variable is defined and justified in the following paragraphs.

(1) HCR stands for the household-corporate loan ratio, and is calculated with a simple ratio of $\mathrm{HCR}_{i,t} = \frac{Bank\ i's\ Loan\ amount\ to\ Household\ at\ t}{Bank\ i's\ Loan\ amount\ to\ Corporate\ at\ t}$. HCR represents the bank's loan composition, especially the qualitative characteristic of the loan. It captures the bank characteristics in terms of its lending behavior between different economic agents. Jung (2015) has focused on the bank lending behavior regarding firms, and this study tries to take a step further, and incorporate the composition of the loan as one of the explanatory variables.

(2) SIZE stands for the amount of asset in Korean Won, natural log transformed. It is calculated as $\mathrm{SIZE}_{i,t} = \ln(Bank\ i'sasset\ at\ t\ in\ KRW)$. SIZE represents the bank's capacity, measured by gross asset. The distinction between relatively large banks and small banks can be made using this

characteristic variable. Gambacorta et al. (2004) and other studies have been influential in choosing this variable.

(3) BIS stands for the BIS capital adequacy ratio. It is a given data from the Financial Supervisory System Korea. It is calculated as $\mathrm{BIS}_{i,t} = \frac{bank\ i'samount\ of\ equity\ at\ t}{bank\ i's\ risk{-}weighted\ gross\ asset\ at\ t}$ and BIS is a very typical measure representing bank operation status at any given time period. Recent studies on the bank lending behavior such as that of Kapan (2015) have chosen BIS ratio to be an important characteristic to capture the strength of the bank at times of market shock.

The three variables mentioned above captures each bank's characteristics, in terms of loan composition, gross capacity, and the robustness, whereas the three variables following captures macroeconomic characteristics of a given period.

(4) P stands for the inflation proxy. It is calculated using the Consumer Price Index of each quarter, $\mathrm{P}_t = \frac{CPI_{\ t}}{CPI_{\ t-1}} - 1$. P represents the degree of inflation of a given period relative to the previous. It controls the effect of loan growth coming from general economic growth and decline. Jung (2015) and other papers also incorporate inflation proxy for the

macroeconomic control variable, and the calculation method is identical to this paper.

(5) R stands for the real interest rate proxy. It is calculated using the three-months CD rate and P, $\mathrm{R}_t = (3\ months\ CD\ interest\ rate\ at\ t) - \mathrm{P}_t$. R represents the expense of the lending in the money market. Goldberg (2000) has pointed out that it is important to capture the bank's reaction to the macroeconomic variables, especially the real interest rate.

(6) Q stands for the market liquidity level. The indicator is the yield spread between one-year bank debentures and one-year Treasury bonds over the sample period, and it is calculated as $\mathrm{Q}_t = (1\ year\ Treasury\ bond\ yield) - (1\ year\ bank\ debentures\ yield)$. Q is an alternative of the spread between three month LIBOR and government debenture. As noted in Jung (2015), interbank capital market is not well developed in Korea, and hence, the alternative measures of financial debenture and government bond of one-year can represent market liquidity level. When the proxy has higher value, it represents more illiquid market status.

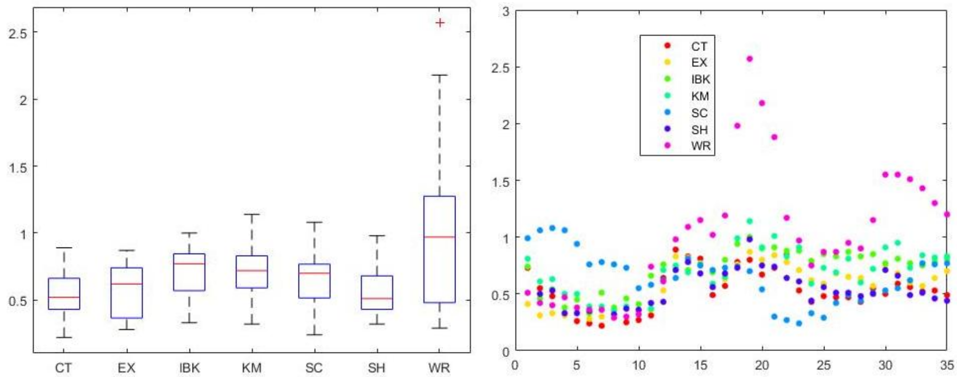
4. Data

4.1. Basic statistics and correlation

The time span of the quarterly data dates back to the 2nd quarter of 2006 to 4th quarter of 2014, within which 35 quarter periods exist. Seven major commercial bank data was extracted from the Financial Supervisory Service Korea. The time span was chosen in order to minimize data loss due to the merger of banks and the change of accounting requirements.

Variable	Notation	Sample #	Mean	Std.	Max	Min
Net Substandard Loan	NSL	245	0.674408	0.316268	2.57	0.22
Liquidity Ratio	LR	245	119.6987	13.392	163.46	97.36
Highly Liquid Asset Ratio	HLAR	245	30.97943	15.65664	68.159	5.8265
Gross Loan Growth Rate	GR	245	1.319485	3.018045	15.02603	-6.23082
Household-Corporate Loan Ratio	HCR	245	1.209753	0.747233	3.265644	0.208461
Natural Log of Total Asset	SIZE	245	16.3607	0.860451	17.4404	14.33247
BIS	BIS	245	13.77049	1.986326	18.25	9.4
Quarterly CPI Growth Rate	P	35	0.64	0.5704	2.1	-0.4
Real Interest Rate	R	35	2.939143	1.1122	5.74	1.24
Market Liquidity	Q	35	0.2578	0.2952	1.3400	0.0300

Figure 1 Loan Growth Rate of the banks

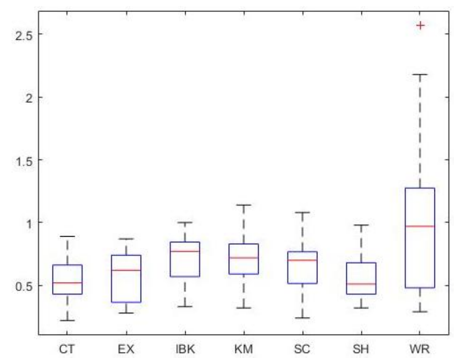


	NSL	LR	HLAR	GR.	HCR	SIZE	BIS	P	R	Q
LR	0.2641 (0.0000)	1.0000 (1.0000)								
HLAR	0.0573 (0.3716)	-0.2441 (0.0001)	1.0000 (1.0000)							
GR	-0.2126 (0.0008)	-0.2717 (0.0006)	0.2053 (0.0003)	1.0000 (1.0000)						
HCR	-0.1463 (0.2519)	-0.0745 (0.1789)	-0.3926 (0.0000)	-0.2497 (0.0012)	1.0000 (1.0000)					
SIZE	0.1795 (0.0048)	0.4365 (0.0000)	0.0500 (0.4356)	0.1115 (0.0816)	-0.5548 (0.0000)	1.0000 (1.0000)				
BIS	0.1339 (0.0362)	0.6423 (0.0000)	-0.3242 (0.0000)	-0.4648 (0.0000)	0.1736 (0.0065)	0.2457 (0.0001)	1.0000 (1.0000)			
P	-0.0661 (0.3027)	-0.1234 (0.0537)	0.0456 (0.4777)	0.1615 (0.0114)	-0.0176 (0.7838)	-0.0782 (0.2225)	-0.2563 (0.0000)	1.0000 (1.0000)		
R	-0.4433 (0.0000)	-0.4447 (0.0000)	0.0554 (0.3883)	0.3622 (0.0000)	0.0410 (0.5232)	-0.1318 (0.0392)	-0.5101 (0.0000)	-0.2116 (0.0009)	1.0000 (1.0000)	
Q	-0.0365 (0.5694)	-0.2141 (0.0007)	0.0723 (0.2596)	0.1368 (0.0323)	-0.0648 (0.3126)	-0.1013 (0.1138)	-0.3259 (0.0000)	0.1409 (0.0275)	0.3020 (0.0000)	1.0000 (1.0000)

The among the above correlation coefficients, BIS Capital Adequacy ratio and the Liquidity Ratio show remarkably high correlation with high credibility. Hence, when fitting with the regression model, both results with and without either of the two variables has to be checked.

4.2. Discussion on the individual effect

In order to specify the model, it is important to note that this study uses the data of different banks, and hence there can be individual effect resulting from the category itself. Even though this study incorporates bank characteristics such as BIS ratio and size, there can still remain the random effect arising from category groups. Hence, this study tries different models to fit the data. In addition to conventional pooled regression model, this study introduces a fixed and random effect model, which is generally understood as one of the maximum likelihood approach. Then, the study comes back to the pool regression but this time introduces an interaction term. The categorical random effect is shown in the figures below.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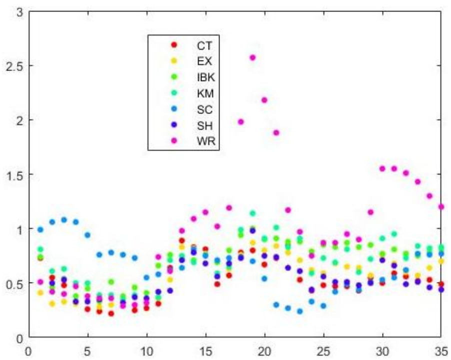
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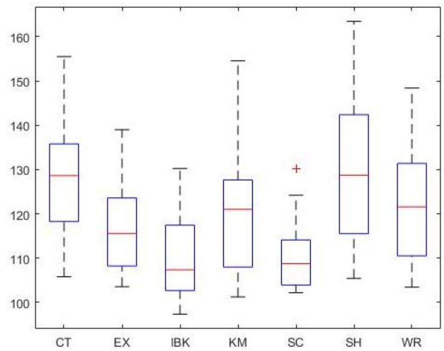
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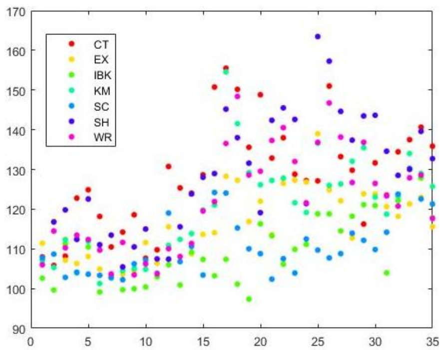
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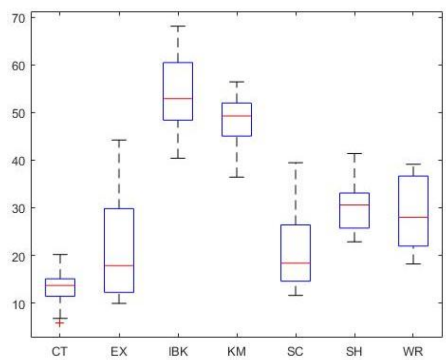
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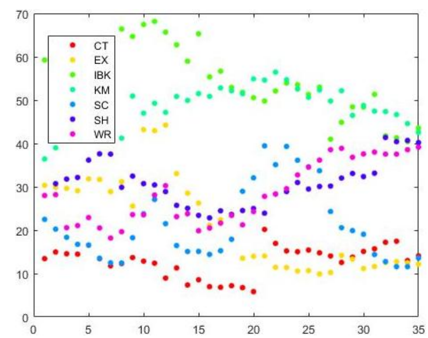
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5. Regression Results

5.1. Hypothesis 1

The following hypothesis is tested with three different regression methods in order to investigate the explanatory power of the bank asset liquidity measures on the bank loan growth rate in the next period.

$$\mathrm{GR}_{i,t} = a_i + \beta_1 \mathrm{NSL}_{i,t-1} + \beta_2 LR_{i,t-1} + \beta_3 HLAR_{i,t-1} + \beta_4 BIS_{i,t-1} + \beta_5 SIZE_{i,t-1} + \gamma X_{t-1} + \epsilon_{i,t}$$

(A) Pooled ordinary linear regression model:

GR	Estimate	Standard Error	t Statistics	p Value
(Intercept)	-9.2076	3.7941	-2.4268	0.015984
NSL	-0.50545	0.64413	-0.7847	0.43342
LR	-0.00032	0.018461	-0.01754	0.98603
HLAR	0.01577	0.011861	1.3295	0.18496
SIZE	0.71867	0.22643	3.1739	0.001705
BIS	-0.31206	0.13462	-2.3181	0.021302
P	1.5706	0.38266	4.1045	5.59E-05
R	0.78378	0.24371	3.216	0.001483
Q	-1.6488	0.62933	-2.6199	0.00937
Number of observations: 244, Error degrees of freedom: 235, Root Mean Squared Error: 2.64 R-squared: 0.261, Adjusted R-Squared 0.236, F-statistic vs. constant model: 10.4, p-value = 1.9e-12				

(B) Fixed effect regression model:

GR	Estimate	Standard Error	t Statistics	p Value
NSL	-0.882793	0.746767	-1.1822	0.238
LR	0.00892	0.019014	0.4691	0.639
HLAR	-0.039206	0.025569	-1.5334	0.127
SIZE	-0.442254	0.500883	-0.8829	0.378
BIS	-0.089336	0.157108	-0.5686	0.570
P	1.786357	0.411912	4.3367	0.0000 (***)
R	0.917982	0.271647	3.3793	0.001 (***)
Q	-1.363375	0.630809	-2.1613	0.032 (**)
N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.23037, Adj R-squared = 0.18352 Wald F(8, 230) = 8.605493 p-value = 0.0000 RSS = 1538.972225 ESS = 1110.079497 TSS = 1110.079497				
"Individual effect"	6.936731	8.919313	0.7777	0.438

(C) Random effect regression model:

GR	Estimate	Standard Error	z Statistics	p Value	0.95 Lower	0.95 Upper
(Intercept)	-9.209831	3.788429	-2.431	0.015 (**)	-1.74983	0.76907
NSL	-0.49038	0.642588	-0.7631	0.445	-0.03655	0.035706
LR	-0.00042	0.018432	-0.0228	0.982	-0.00716	0.039225
HLAR	0.016031	0.011834	1.3546	0.176	0.268834	1.153477
SIZE	0.711155	0.225678	3.1512	0.002 (***)	-0.56736	-0.04281
BIS	-0.30509	0.133816	-2.2799	0.023 (**)	0.821557	2.319331
P	1.570444	0.382092	4.1101	0.000 (***)	0.311111	1.264595
R	0.787853	0.24324	3.239	0.001 (***)	-2.85965	-0.40007
Q	-1.62986	0.627456	-2.5976	0.009 (***)	-16.635	-1.78465

N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.26058, Adj R-squared = 0.23551
Wald Chi2(8) = 83.167809 p-value = 0.0000
RSS = 1643.365280 ESS = 1005.686442 TSS = 1005.686442

(D) Hausman test result:

The hausman test result did not show the significance with H = 10.778932 ~ Chi2(8) and p-value = 0.2145. Hence, for the Hypothesis 1, random effect model can be interpreted as valid, instead of the fixed effect model.

5.2. Hypothesis 2

A set of hypotheses in the Hypothesis 2 are tested each with a multiple of different regression methods in order to investigate the explanatory power of the bank loan growth rate on each of three bank asset liquidity measures in the next period.

(A) Pooled ordinary linear regression model:

NSL	Estimate	Standard Error	t Statistics	p Value
(Intercept)	0.80989	0.42215	1.9185	0.056257
GR	-0.01551	0.00678	-2.288	0.02302
HCR	0.008481	0.029354	0.28892	0.77289
SIZE	0.079526	0.02597	3.0622	0.002452
BIS	-0.05927	0.01255	-4.7225	4.00E-06
P	-0.1879	0.036991	-5.0795	7.69E-07

R	-0.18581	0.021409	-8.6793	6.62E-16
Q	0.25575	0.062227	4.1099	5.46E-05
Number of observations: 244, Error degrees of freedom: 236, Root Mean Squared Error: 0.262 R-squared: 0.335, Adjusted R-Squared 0.316, F-statistic vs. constant model: 17, p-value = 3.67e-18				

LR	Estimate	Standard Error	t Statistics	p Value
(Intercept)	8.319	15.328	0.54274	0.58782
GR	-0.28836	0.24618	-1.1714	0.24264
HCR	0.38632	1.0658	0.36247	0.71733
SIZE	5.095	0.94294	5.4033	1.60E-07
BIS	2.6758	0.45569	5.8719	1.45E-08
P	-2.3953	1.3431	-1.7835	0.075798
R	-2.8166	0.77732	-3.6235	0.00035587
Q	5.2103	2.2594	2.3061	0.021972
Number of observations: 244, Error degrees of freedom: 236, Root Mean Squared Error: 9.51 R-squared: 0.512, Adjusted R-Squared 0.497, F-statistic vs. constant model: 35.4, p-value = 1.58e-33				

HLAR	Estimate	Standard Error	t Statistics	p Value
(Intercept)	109.31	22.419	4.8755	1.99E-06
GR	0.2128	0.36008	0.59099	0.55509
HCR	-7.9083	1.5589	-5.073	7.93E-07
SIZE	-1.8351	1.3792	-1.3306	0.18462
BIS	-2.372	0.66652	-3.5588	0.00045

P	-1.492	1.9645	-0.7595	0.44831
R	-1.6044	1.137	-1.4111	0.15952
Q	-2.8743	3.3047	-0.86976	0.38532
Number of observations: 244, Error degrees of freedom: 236, Root Mean Squared Error: 13.9 R-squared: 0.234, Adjusted R-Squared 0.214, F-statistic vs. constant model: 10.4, p-value = 2.14e-11				

(B) Fixed effect regression model:

NSL	Estimate	Standard Error	t Statistics	p Value
GR	-0.015504	0.005851	-2.6499	0.009 (***)
HCR	-0.018719	0.082815	-0.226	0.821
SIZE	0.061211	0.040214	1.5221	0.129
BIS	-0.031591	0.013311	-2.3732	0.018 (**)
P	-0.153204	0.034302	-4.4663	0.000 (***)
R	-0.158403	0.021123	-7.4992	0.000 (***)
Q	0.269235	0.056304	4.7818	0.000 (***)
N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.37404, Adj R-squared = 0.33881 Wald F(7, 231) = 19.719145 p-value = 0.0000 RSS = 11.437003 ESS = 124.401697 TSS = 124.401697				
"Individual effect"	0.653907	0.726157	0.9005	0.369

LR	Estimate	Standard Error	t Statistics	p Value
GR	-0.156649	0.227246	-0.6893	0.491
HCR	-13.051739	3.216603	-4.0576	0.000 (***)
SIZE	4.438353	1.561946	2.8416	0.005 (***)
BIS	1.072039	0.517026	2.0735	0.039 (**)

P	-4.595425	1.332311	-3.4492	0.001 (***)
R	-4.018894	0.820414	-4.8986	0.000 (***)
Q	0.849636	2.186874	0.3885	0.698
N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.44985, Adj R-squared = 0.41889 Wald F(7, 231) = 26.983492 p-value = 0.0000 RSS = 17253.825551 ESS = 3536809.593149 TSS = 3536809.593149				
"Individual effect"	63.361732	28.204421	2.2465	0.026 (**)

HLAR	Estimate	Standard Error	t Statistics	p Value
GR	0.117777	0.182439	0.6456	0.519
HCR	1.291515	2.582375	0.5001	0.617
SIZE	-5.233299	1.253973	-4.1734	0.000 (***)
BIS	1.107993	0.415083	2.6693	0.008 (***)
P	2.678356	1.069616	2.504	0.013 (**)
R	1.237782	0.65865	1.8793	0.061 (*)
Q	1.454068	1.755681	0.8282	0.408
N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.13611, Adj R-squared = 0.08749 Wald F(7, 231) = 5.199296 p-value = 0.0000 RSS = 11120.627973 ESS = 283823.885806 TSS = 283823.885806				
"Individual effect"	93.701984	22.64327	4.1382	0.000 (***)

(C) Random effect regression model:

NSL	Estimate	Standard Error	z Statistics	p Value	0.95 Lower	0.95 Upper
(Intercept)	0.825097	0.421057	1.9596	0.05 (*)	-0.00016	1.650354
GR	-0.015281	0.006764	-2.2594	0.024 (**)	-0.028538	-0.002025
HCR	0.007536	0.029286	0.2573	0.797	-0.049864	0.064936
SIZE	0.077984	0.025839	3.0181	0.003 (***)	0.027341	0.128627
BIS	-0.058521	0.012486	-4.6867	0.000 (***)	-0.082993	-0.034048
P	-0.188613	0.036933	-5.1069	0.000 (***)	-0.261	-0.116226

R	-0.185916	0.021383	-8.6944	0.000 (***)	-0.227827	-0.144005
Q	0.258131	0.062054	4.1598	0.000 (***)	0.136508	0.379754
N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.33502, Adj R-squared = 0.31538 Wald Chi2(7) = 119.400173 p-value = 0.0000 RSS = 16.229730 ESS = 119.608970 TSS = 119.608970						

LR	Estimate	Standard Error	z Statistics	p Value	0.95 Lower	0.95 Upper
(Intercept)	8.208514	15.273947	0.5374	0.591	-21.7279	38.1449
GR	-0.29005	0.245349	-1.1822	0.237	-0.77092	0.190827
HCR	0.393184	1.062363	0.3701	0.711	-1.68901	2.475378
SIZE	5.106152	0.937303	5.4477	0.000 (***)	3.269073	6.943232
BIS	2.670323	0.452947	5.8954	0.000 (***)	1.782564	3.558083
P	-2.39011	1.33974	-1.784	0.074 (*)	-5.01596	0.23573
R	-2.8159	0.775691	-3.6302	0.000 (***)	-4.33623	-1.29557
Q	5.193023	2.251012	2.307	0.021 (**)	0.78112	9.604926
N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.51197, Adj R-squared = 0.49755 Wald Chi2(7) = 248.621461 p-value = 0.0000 RSS = 21356.567988 ESS = 3532706.850712 TSS = 3532706.850712						

HLAR	Estimate	Standard Error	z Statistics	p Value	0.95 Lower	0.95 Upper
(Intercept)	109.5572	22.34192	4.9037	0.000 (***)	65.76786	153.3466

GR	0.216633	0.358883	0.6036	0.546	-0.48677	0.920031
HCR	-7.92389	1.553969	-5.0991	0.000 (***)	-10.9696	-4.87816
SIZE	-1.86053	1.371036	-1.357	0.175	-4.54771	0.826652
BIS	-2.35963	0.662547	-3.5615	0.000 (***)	-3.6582	-1.06107
P	-1.50385	1.959701	-0.7674	0.443	-5.34479	2.337092
R	-1.6061	1.13464	-1.4155	0.157	-3.82995	0.617753
Q	-2.83496	3.292661	-0.861	0.389	-9.28846	3.618534
N = 245 n = 7 T = 35 (Balanced panel), R-squared = 0.23602, Adj R-squared = 0.21345 Wald Chi2(7) = 73.216904 p-value = 0.0000 RSS = 45695.111263 ESS = 249249.402516 TSS = 249249.402516						

(D) Hausman test result:

According to the p-value table of the three different regression results, the NSL has to be estimated with random effect model, whereas the other two, the LR and the HLAR have to be estimated with fixed effect model. For the estimation of NSL, H =12.875324 ~ Chi2(7), with p-value =0.92618For the estimation of LR, H = 65.890476 ~ Chi2(7), with the p-value = 0.0000. For the estimation of HLAR, H = 835.126013 ~ Chi2(7), with p-value = 0.0000.

(E) Pooled ordinary linear regression model with interaction term:

NSL	Estimate	Standard Error	t Statistics	p Value
(Intercept)	-0.55899	0.32425	-1.7239	0.086062
GR	-0.00381	0.00308	-1.2372	0.21729
HCR	-0.01758	0.028491	-0.61686	0.53794

SIZE	0.044534	0.016674	2.6709	0.008106
BIS	0.023134	0.007759	2.9818	0.003174
P	-0.02945	0.019054	-1.5455	0.1236
R	-0.04627	0.012236	-3.7812	0.000199
Q	0.19684	0.028605	6.8814	5.57E-11
BANK_EX: NSL	0.38999	0.05245	7.4355	2.05E-12
BANK_IBK: NSL	0.58256	0.061394	9.4887	3.11E-18
BANK_KM: NSL	0.48848	0.040436	12.08	2.42E-26
BANK_SC: NSL	0.66627	0.076354	8.7261	5.43E-16
BANK_SH: NSL	0.25233	0.057119	4.4177	1.54E-05
BANK_WR:NSL	0.68282	0.026709	25.565	3.68E-69
Number of observations: 244, Error degrees of freedom: 230, Root Mean Squared Error: 0.117 R-squared: 0.871, Adjusted R-Squared 0.864, F-statistic vs. constant model: 120, p-value = 1.72e-94				

LR	Estimate	Standard Error	t Statistics	p Value
(Intercept)	5.9741	21.878	0.27306	0.78505
GR	0.98514	0.53305	1.8481	0.065868
HCR	0.089177	1.4535	0.061353	0.95113
SIZE	5.0855	1.2726	3.9962	8.67E-05
BIS	2.7508	0.44939	6.1211	3.97E-09
P	-1.6007	1.3311	-1.2025	0.2304
R	-1.9164	0.78344	-2.4461	0.015192
Q	3.6942	2.2522	1.6403	0.10232
BANK_EX:GR	-1.1802	0.65119	-1.8124	0.071229
BANK_IBK:GR	-2.0679	0.89931	-2.2994	0.02238

BANK_KM:GR	-3.4652	0.80449	-4.3073	2.45E-05
BANK_SC:GR	-0.4752	0.74899	-0.63445	0.52642
BANK_SH:GR	-1.6517	0.83286	-1.9832	0.048535
BANK_WR:GR	-1.9179	0.69523	-2.7587	0.006271
Number of observations: 244, Error degrees of freedom: 230, Root Mean Squared Error: 9.14 R-squared: 0.56, Adjusted R-Squared 0.536, F-statistic vs. constant model: 22.6, p-value = 3.35e-34				

HLAR	Estimate	Standard Error	t Statistics	p Value
(Intercept)	73.785	22.639	3.2591	0.0012867
GR	0.14461	0.29278	0.49392	0.62183
HCR	-6.3385	1.5729	-4.0298	7.59E-05
SIZE	-0.89266	1.3465	-0.66294	0.50803
BIS	-1.381	0.55724	-2.4783	0.013919
P	0.089396	1.6049	0.055703	0.95563
R	-0.47168	0.94337	-0.5	0.61755
Q	-31.881	5.2829	-6.0347	6.32E-09
BANK_EX:Q	17.028	7.028	2.4229	0.016171
BANK_IBK:Q	61.231	7.6821	7.9706	7.33E-14
BANK_KM:Q	64.842	7.0777	9.1614	2.92E-17
BANK_SC:Q	25.099	7.7297	3.2471	0.0013399
BANK_SH:Q	25.699	7.2667	3.5366	0.00049014
BANK_WR:Q	17.215	7.2036	2.3897	0.017669
Number of observations: 244, Error degrees of freedom: 230, Root Mean Squared Error: 11.1 R-squared: 0.523, Adjusted R-Squared 0.496, F-statistic vs. constant model: 19.4, p-value = 2.83e-30				

5.3. Interpretation

This study's goal was to testify if the bank asset quality measures have bi-directional correlation with their lending behavior. A number of different methods including fixed effect and random effect models were used to test the explanatory power of both direction, with the independent variables having one period lag from the dependent variable. Multi-collinearity was suspected between the Liquidity Ratio and the BIS ratio, and between the bank SIZE and the House-Corporate Loan Ratio. However, the regression result incorporating both the variables and one of the variables did not show meaningful difference, hence as in Seo (2012), the model incorporated both variables at issue.

Hypothesis 1 tries to identify whether the bank asset quality measures in the previous period can have the explanatory power on the lending behavior. Three different regression models were used, the first being the simplest ordinary linear regression model. Model itself has a relatively low level of R-squared value, and hence, the inference with this result has to be limited. None of the three variables representing the bank asset quality were shown to be significant in terms of p-value, and the Liquidity Ratio was the least to fit the model. Highly Liquid Asset Ratio was shown to be the most significant among the three variables of the bank asset quality, but has fairly small coefficient value. However, the inflation measure and market liquidity proxy were both shown to be significantly affecting the lending behaviors. Autocorrelation problem was checked with the Durbin-Watson test, with d=1.655622782274020, and a significant p-value of 3.898891421575733e-04. The second model is the fixed effect regression model, but it was rejected after the Hausman test statistics was not significant enough to approve fixed effect model. Even though this model is proven to be inappropriate, all three macroeconomic variables were shown to be significant. The R-square value is subsequently low, and this model of fixed effect has much to improve. The alternative model is the random effect model. R-square value improved by a small scale, and compared to the fixed effect model which was rejected, all three macroeconomic variables remain significant, with the unchanged coefficient sign. The market-wide liquidity level gained more weight in terms of the coefficient value, and two variables representing the bank characteristics have become significant. However, all three liquidity measures were not proven to be significant. Among the three, the Highly Liquid Asset Ratio is the most likely to be positively explaining the next period's Loan Growth Rate. Still, the p-value is not considered significant. Therefore, this study's result with the Hypothesis 1 casts doubt on the influence of the three liquidity measures on the bank lending behavior. With respect to the macroeconomic variables, inflation proxy of the previous period and the real interest rate is positively correlated with the next period's Loan Growth Rate. And, when the BIS ratio in the previous period is lower, it is likely that the banks have more tendency to further expand on the loan. The result regarding the SIZE is in line with the intuition that when the asset value of the bank increases in the previous period, the banks tend to expand on the loan.

Hypothesis 2 tries to identify whether the lending behavior of the previous period has the explanatory power on different bank asset quality measures. This hypothesis has important implication on the previous studies. If the explanatory power is shown to be insignificant, it is possible to infer that Korean banks have access to external finance or other financial measures even when the asset liquidity deteriorates. To testify the hypothesis, three different measures representing the bank asset quality, namely the Net Substandard Loan Ratio, the Liquidity Ratio and the Highly Liquid Asset Ratio were used and each was tested with three different regression models.

The first model adopted the simple linear regression, and among the three variables, the one to fit the Net Substandard Loan Ratio showed the highest R-squared value of 0.3, but it is still relatively low and the coefficient of the Loan Growth Rate was -0.01551, which can be deemed insignificant. The other variables, the Liquidity Ratio and the Highly Liquid Asset Ratio both showed low R-squared values, and the p-value of the Loan Growth Rate estimate was insignificant as well. However, it is notable that the estimate of the coefficient of the Loan Growth Rate on the Highly Liquid Asset Ratio is positive. However, all three variables with the simple linear regression model were problematic in terms of autocorrelation. Especially, as the table below represents, the Liquidity Ratio shows the most stable value.

dependent variable	Durbin-Watson statistics	p-value
Net Substandard Loan Ratio	0.399128045720631	1.467253669823374e-58
Liquidity Ratio	0.979639651251484	5.299570468327629e-19
Highly Liquid Asset Ratio	0.109609824307477	1.160802205070831e-123

The second and third models are alternative to each other, and it depends on the Hausman test statistics whether to fit the data with the fixed effect or the random effect model.

(i) The Net Substandard Loan Ratio is the only among the three that is better suited for the random effect model. Individual effect was not identified with enough significance, and even though the Loan Growth Rate as well as BIS and all macroeconomic variables were shown to be significant, it has to incorporate a random term $\delta_{i,t}$. It is ironic that the R-squared value worsens by a small scale when the NSL is fit with the random effect model. However, SIZE is also shown to be significant as well as BIS, macroeconomic variables, and most importantly, the Loan Growth Rate. When the Loan Growth Rate increases, the next period's Net Substandard Loan Ratio decreases, and the asset liquidity measured by the NSL improves. If the gross asset increases, the NSL in the next period increases, which implies that the banks might pursue profit over prudence when the SIZE increases. When BIS level increases, the next period's NSL decreases. It can be interpreted such that the BIS ratio is a valid regulation measure. When the inflation proxy and the real interest rate increases, the NSL decreases, implying the bank asset liquidity increases. Meanwhile, when the market-wide liquidity measure increases, the NSL increases as well, which is not an intuitional result.

(ii) The Liquidity Ratio shows a favorable R-squared value compared to the other regression results. The Hausman test statistics is significant enough to approve that the LR can be fit with the fixed effect regression, even though the random effect shows an even higher R-squared value. Individual effect is shown to be significant and considerably large, compared to the coefficient estimates of other variables. A notable result in this hypothesis is that, the Liquidity Ratio is largely inexplicable by the Loan Growth Rate in the previous period. However, it can be explained by almost all other variables used in the regression. The most powerful among the variables is the Household-to-Corporate Loan Ratio. When the household loan proportion increases in the previous period, the Liquidity Ratio worsens. The increase in the bank gross asset value and the BIS ratio both explain the LR improvement in the next period. It can again, be said that the BIS ratio is a valid regulation measure. Bank asset value also helps improve the next period's LR. However, when the inflation proxy decreases or the real interest rate decreases, bank asset liquidity measured by LR tends to increase in the next period.

(iii) The Highly Liquid Asset Ratio does not yield a fair R-squared value, and it even improves when using the random effect regression.

However, the explanatory variables are shown to be more valid when fit with the fixed effect regression. Also, the individual effect is even higher than that of the Liquidity Ratio. Again, the Loan Growth Rate of the previous period could not explain the Highly Liquid Asset Ratio in the next period. It is notable, however, that the increase in the gross bank asset could imply the next period's bank asset liquidity deterioration. The coefficient value is significant and considerably large in negative value. BIS is once again shown to be positively correlated with the bank asset liquidity measure, and is a valid regulation measure. The increase in the real interest rate could imply the next period's HLAR improve, but the p-value is not small enough compared to other variables.

In addition to the simple pooled regression, the fixed effect regression, and the random effect regression, an interaction term is introduced to the pooled regression, specifically the interaction term between the bank categorical value and one of the explanatory variables. Among the three variables, both the Liquidity Ratio and the Highly Liquid Asset Ratio were shown to be well fitted by the model, with the R-squared value of over 0.5. As opposed to the result of the fixed effect regression model, the coefficient of the Loan Growth Rate is not rejected by insignificant p-value. Also, it is notable that the market liquidity proxy is significantly influential on the Highly Liquid Asset Ratio, with a huge negative coefficient. In this model, the Net Substandard Loan Ratio did not show any meaningful coefficient estimates except for the real interest rate and market liquidity proxy. Rather, bank individual terms showed higher coefficient estimates. However, all three variables with the simple linear regression model were relatively problematic in terms of autocorrelation, and among the three, the Liquidity Ratio shows the most stable Durbin-Watson value, but is around one.

6. Conclusion

With the bi-directional hypotheses, this study could yield three important conclusions. The first is that the bank loan decisions could be insulated from the increase or decrease of the asset liquidity measures in the previous period. Rather, the loan growth rate of the current period can be better explained by the macroeconomic variables or characteristic indicators such as the BIS ratio, the gross asset amount. It is noteworthy that the decrease in the BIS ratio could imply the next period's loan growth. It casts an unfavorable implication that when the bank asset adequacy worsens, it tends to expand on the loan, taking action toward the profitability. Considering the result of the hypothesis 2 that the lower BIS ratio tends to imply asset liquidity deterioration, there is a possibility that the loan growth decision and the liquidity measures are simultaneously decided, in a way negatively correlated. Even so, the explanatory power of the liquidity measures could not be exerted to the next period. Either the bank loan decision is insulated from the asset liquidity or is simultaneously decided with the asset liquidity, the result does not imply any causal relationship between the two.

The study's second and major contribution is that, the Net Substandard Loan Ratio can be explained by the previous period's loan growth status. According to the result of the hypothesis 2, when a bank decides on the expansion of the loan, it is likely that the bank's asset liquidity indicator measured by the Net Substandard Loan Ratio improves. Then, there exists a reasonable incentive for banks with low Net Substandard Loan Ratio to increase loan to recover the asset liquidity measure. Similar cautionary interpretation is also possible with the correlation between the bank SIZE, namely the gross asset amount, and the Net Substandard Loan Ratio. Hypothesis 2 showed that the increase in the SIZE can imply the next period's increase Net Substandard Loan Ratio, in which case the bank asset liquidity deteriorates. Combined with the result that the SIZE is a negative explanatory variable to the next period's Highly Liquid Asset Ratio, it can be argued that the increase in the bank asset capacity has to be carefully monitored by regulatory organizations.

Lastly, this study focuses on the Liquidity Ratio's function as the bank asset liquidity measure. As seen in the former part of this study, the Liquidity Ratio shows considerably high level of bank asset liquidity even at times of market-wide liquidity shock. This study's result confirms that the Liquidity Ratio is remotely reflecting the market-wide liquidity fluctuation, which is obviously an important factor that explains the other two liquidity measures. Considering that the Liquidity Ratio is a simple ratio between three-month-liquid-asset and three-month-liquid-debt, the Liquidity Ratio does not incorporate the composition of the bank asset. Rather, it is notable that when the household proportion of the gross loan increases, the Liquidity Ratio decreases. It is possible that the household loan leads to external financing, which might add up to liquid-debt. However, once again it is important that the correlation results cannot lead to causal inference, and there can only be plausible potential explanations.

Other than the major conclusions, this study could confirm several results that can be intuitionally justified as well. BIS ratio in the previous period is shown to be positively explaining all the liquidity measures in the next period. Real interest rate in the previous period implies a more active loan growth in the next period, since the banks pursue interest profit. Market-wide liquidity proxy has a negative explanatory power to the loan growth rate as well as two of the liquidity measures, but not to the Liquidity Ratio. The decision of the BCBS to reform the Liquidity Ratio can be justified, in this context, since the Liquidity Ratio fails to capture the external shocks that considerably affect the banks' asset liquidity.

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국문 초록

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경제학과

본 연구에서는 시중은행의 자산 유동성 지표와 대출 행태의 관계를 분석하고자 단순선형회귀, 고정효과, 랜덤효과 모형을 사용하여 추정한 결과를 해석하였다. 기존의 Jung (2015), Seo (2012) 등의 연구와 유사한 문제의식에서 출발하였으나 자산 유동성 지표와 대출 행태 사이의 양방향의 설명력을 조사하고자 하였다는 점, 한 기간의 시차를 두어 설명변수를 설정하였다는 점에서 차별성을 가진다. 연구 결과, 전기의 유동성 지표들은 대체적으로 다음 기의 대출 결정을 설명하는 데에 유효한 변수가 되지 못했으며, 이는 대출 결정이 동기의 유동성 지표와 동시에 결정되어 한 기간의 시차를 두고서는 설명력을 잃거나, 대출 결정이 전기의 자산 유동성과는 분리되어 있을 수 있음을 시사한다. 또한, 전기의 대출의 증가를 변수로 하여 다음 기의 순고정이하여신비율의 증가를 설명할 수 있었는데, 여기에서 대출을 단기적으로 늘려 순고정이하여신비율의 분모를 키움으로써 해당 유동성 지표의 개선을 추구할 수 있다는 점을 유추할 수 있다. 또한 은행 총자산 변수가 다음 기의 순고정이하여신비율의 증가와 양의 상관을 갖는 한편 고유동성자산비율과는 음의 상관을 보이는 점은 은행 총자산이 증가할 경우 다음 기 혹은 그 이후의 자산 유동성을 모니터해야 한다는 해석이

가능하다. 한편 기존의 은행 자산 유동성 지표로 사용되어 온 유동성비율은 대출 행태뿐 아니라 개별 은행들에게 큰 영향을 주는 변수인 시장유동성에 대해서도 설명력을 결여함으로써 자산 유동성 지표로서 문제가 제기될 여지가 있음이 확인되었다.

키워드: 은행 자산 유동성, 은행 대출 행태, 순고정이하여신비율, 유동성비율

학번: 2015-20186