The Study on Bank Strategy on Corporate and Home Loan Sales
Evidence from Korean Banks' Loan Portfolio

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Abstract

This paper analyzes empirically on the relationship between the change in loan portfolio weight and GDP shock which is recognized as a systematic risk factor. The purpose of this paper is to determine whether Korean banks reduce their loan portfolio risks by flexible adjustment of their loan portfolios designed to escape risk from GDP shock. As the main results. Korean banks show a lending behavior of adjustment to portfolio weight on their loan asset that is sensitive to GDP shock. Moreover, this paper studies whether the effect from GDP shock to the change of loan portfolio weight are differential attributed to difference of bank ownership and location. As the result, we can find out that lending behavior of the Korean banks tends to reduce their portfolio risk in that significant adjustment for loan assets that are sensitive to GDP shock comes out when economy is stagnant. Oppositely, we also confirm that the banks' loan portfolio risk tends to increases in the light of the fact that the loan size with high variability in value to business cycle is getting bigger when the economy expands. Therefore, as the policy implication, we suggest that the financial authorities must note that the risk of the bank loan portfolios may increases during economic expansion rather than economic depression, and that advance supervisory action and related regulations are required.

Keywords: ***Loan portfolio weight, GDP shock, Lending behavior, Bank ownership and location.***

JEL classification: G2; G21

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1. Introduction

Recently, Korea announced that the size of household debt in 2010 was approximately KRW 800 trillion (USD 720 billion). Therefore, the Korean financial market is focused on finding the cause and solution of rapidly increasing home loans. Moreover, the central bank has increased the policy rate, citing the intensification of inflation pressure, and banks are facing the possibility of loan insolvency which further increases fears about this issue. In particular, people are worried about an economy crisis that may be provoked

by the insolvency of credit cards. Their concerns are well founded, since Korea experienced their "credit card crisis" in 2003.

If bank loans become insolvent in a country, the problem can cause a crisis in that country's economy; furthermore, the problem could potentially lead to a global economic crisis. In 2008, the United States suffered from the insolvency of sub-prime mortgage loans due to the country's economic depression, and it results in a global crisis.

The financially distressed U.S. financial institutions attributed from loan insolvency result in liquidity crisis of global financial institutions, and thus make financially distressed banks discontinue the major role of financial intermediation.

Spain, the main country in PIGS: the group of Southern European countries including Portugal, Italy, Greece, and Spain, becomes blocking progress in the 2001 global economy. Its savings banks had been greatly increasing mortgage loans since 2000, but it became insolvent due to economic depression. In fact, the ratio of bad loan from Spain's savings banks, which had been at about 0.9% at the end of 2007, increased to 5.3% by the end of 2009.

Thus, we must pay attention to the fact that the main cause of recent global economic crises is the insolvency of mortgage loans. The value of housing collaterals tends to change depending on how the business cycle is changed. In particular, when real estate demands are reduced, the real estate prices will also drop; this causes insolvency of financial institutions.

However, Korea offers a unique economic situation. In Korea, consumer mortgage loans have largely increased, but we expect that tight monetary policy and reinforcement of mortgage loan regulations by the financial authorities will make the real estate market shrunk. At worst, we expect that it might spread to the Asian financial market if loan insolvency is intensified based on mortgage loans. Therefore, now is the right time to analyze the Korean banks' lending behavior and to find any significant policy implications. To understand of lending behavior, we need to review loan portfolios in banks because loan portfolio is certainly banks' main assets. In finance, the inventors' portfolios are normally composed to reduce risk; however, we know that we will be unable to completely remove systematic risk factors such as economy changes.

The portfolio risk is decided by portfolio weight, variability of individual assets, and the covariance matrix between portfolio assets. However, we assume that the loan portfolio weight is a result of changes in the banks' lending behavior, and that it can be rebalanced in advance according to the business cycle. In this case, the portfolio risk decreases as the weight of the asset with large asset price variability according to the economic

change is reduced. This information can help us understand the risk of the Korean banks' loan portfolio on economy change. Moreover, we can also derive the policy implications of the financial authorities as well.

Korean commercial banks generally classify loan sales as either home loans or corporate loans. Over 60% of home loans and over 80% of corporate loans are owned by mortgage loans and small & medium-sized corporate loans respectively. Banks' portfolio is composed of home loans and corporate loans taking their business areas in consideration.

The Korean banks' loan portfolios are also composed of KRW currency loans and foreign currency loans in terms of standards for classification of each loan's practicing currency. Banks classify capital to make a loan into KRW currency loan and foreign currency loan when the loan is made using the Korean currency and foreign currency respectively. Then the banks manage the portfolio weight of each loan within the entire portfolio.

As a result, the bank loans are listed as fund management in their portfolio; they are listed by business territory and type of currency. However, we can presume that the changes in loan portfolio weight are reflected in the making loan decisions made by banks, and these changes show the lending behavior of Korean banks. In particular, we also expect that the banks' lending behavior will be primarily affected by changes in both the inside and outside business environment. The inside environment refers to financial indices such as profitability, loan soundness, and capital adequacy. Furthermore, the outside environment indicates economic conditions such as business cycles.

The primary purpose of this paper is to understand whether the change of loan portfolio weight according to the risk level that banks face exists, and attempts to find the related policy implications. This paper also analyzes the banks' adjustment behavior on loan portfolio weight to encounter with unexpected systematic risks such as GDP shock. We use variables that are proxies for profitability, loan soundness, and capital adequacy as the control variable.

This paper is organized in the following manner. In chapter 2, we discuss the prior literature that is related to the study topic. Chapter 3 suggests our hypotheses and variables, and chapter 4 explains the data used in our analysis. In chapter 5, we discuss the models for our empirical analysis. Our empirical analysis results are shown in chapter 6, and the following chapter offers our concluding remarks.

2. Related Literature

The precedent studies regarding bank portfolios can be divided into two categories. The first category includes the main functions or roles of bank portfolio, and the second category includes the analyses of decisions and influential factors of bank portfolio composition.

Some of the most important studies include Diamond (1984), Cesari and Daltung (2000), DeYoung and Roland (2001), Stiroh (2004), Stiroh and Rumble (2006), Baele et al. (2007), and Rossi et al.(2009), all of whom have analyzed the functions or roles of bank portfolio. These studies insist that the primary function of bank portfolios is to reduce risk. Diamond (1984) insists that bank portfolio can reduce all kinds of risks that a financial institution faces. Cesari and Daltung (2000) insist that bank portfolio results in reinforcement of monitoring, and DeYoung and Roland (2001), Stiroh (2004), and Stiroh and Rumble (2006) claim that the main purpose of a bank's portfolio composition is ascribed to avoid the high variability of non interest income.

Moreover, Rossi et al. (2009) analyzed on the benefits from the banks portfolio by classifying their portfolio into asset size and to industry type; they use Austrian banks as their subject. Rossi et al. (2009) analyzed on effect from composition of bank portfolio to risk as well as to cost and profit efficiency. As a result of the study, they report that the banks' portfolio composition contributes to reducing risk and costs, and to increasing profit.

Meanwhile, unlike other studies, Baele et al. (2007) insist that well-diversified bank portfolios increase systematic risk. This study performs an analysis that is based on systematic risk and idiosyncratic risk deducted from the banks stock return model; it uses European banks as the target. As a result, Baele et al. (2007) insist that if the portfolio composition is accomplished properly, then systematic risk will occur greatly because the beta value of banks is high.

Second, the study of Haas et al. (2010) analyzes on the decision determinants of the banks' portfolio composition. In this study, bank ownership, bank size, and legal creditor protection are suggested as decision determinants of the bank loan portfolio's composition. The relevant study shows that foreign banks focus on mortgage lending, while state-owned banks focus more on corporate loans in terms of bank ownership. In particular, they insist that multinational banking groups tend to focus on retail sales to the local market which is made loans in the case of the emerging market. They report small banks tend to focus on SME loans, while large banks usually focus on more on mortgage loans than on state-owned enterprise loans when legal creditor protection is well prepared.

We also consider the studies of Berger and Udell (1995, 2002), Petersen and Rajan (2002), Keeton (1996), Berger et al. (2001), Berger et al. (2008), Clarke et al. (2005), and Giannetti and Ongena (2008). Each of these

studies is addressed on relationship between the ownership type and loan portfolio of banks. They insist that domestic banks have soft information about domestic companies as well as hard information such as financial data, while foreign banks do not have it. Therefore, the domestic banks can expand loans to companies with large risks such as small & medium-sized businesses. Berger et al. (2001) insists that foreign banks tend to conduct loan business with companies with small risk, such as large companies or state-owned companies, since these banks do not have soft information about small companies.

Other studies consider macroeconomic variables as influential factors to the portfolio composition of banks. McMillin (1993), Den Haan et al. (2007), and Zulverdi et al. (2007) insist upon relevance to outside influential factors such as macroeconomic variables. On the other hand, the studies of Berger et al. (2008) and Haas et al. (2010) have suggested bank characteristics, such as ownership type and size of bank, are the decision factors in composing loan portfolios.

McMillin (1993) empirically confirms with variance decomposition and a VAR (Vector Autoregressive) model that loan portfolio weight is significantly affected by the macroeconomic variable. This paper interpreted the reason why loan portfolio weight is affected as the value of each asset in loan portfolio is differently influenced by monetary policy and loan demand.

Den Haan et al. (2007) empirically analyze on the change of loan portfolio weight from the change of monetary policy. They confirm that home loans, including mortgage loans, have a tendency to decrease during monetary deflation, and that it is on the contrary to lending behavior on corporate loans with an expansive phase at that time.

Zulverdi et al. (2007) empirically analyze the relationship between bank portfolio and the monetary policy in Indonesia. In this study, the authors confirm that the bank portfolio weight significantly is influenced from the change of the monetary policy phase and regulation as pre-determination of the cap to loan size by the financial authorities. In particular, they confirm that banks intensively invest in risk-free assets such as government bonds rather than that of making loans when capital requirement demand from the financial authorities to banks is relatively strong.

To entirely examine the precedent studies, it is presumed that the bank's loan portfolios are mainly designed to reduce idiosyncratic risk. In addition, it is expected that the portfolio weight tends to be affected by bank characteristics such as ownership structure, the bank size, and macroeconomic variables.

3. Hypotheses and variables

This paper will empirically analyze whether loan portfolio weight in Korean banks is adjusted significantly from GDP shock. In other words, this paper will divide loan portfolio into loan portfolio 1 and loan portfolio 2 respectively according to classification standards of borrower and practicing currency, and we will review whether the change of loan portfolio weight from GDP shock is significantly occurred. Moreover, we will classify the bank ownership type into commercial banks and other banks, and will determine whether the relevant factors exercise differentiated influences on changes of loan portfolio weight when GDP shock occurs.

Our hypotheses are based on the precedent studies, and are presented in the following section.

1) Hypotheses

According to the precedent studies, banks will change their loan portfolio weight in terms of managing risk if their main goals are to reduce risk. This study establishes the following hypotheses between GDP shock, the systematic risk factor, and change of asset weight in the portfolio.

Hypothesis 1: When GDP shock, a unexpected change in business cycle toward over or under average GDP rate, is occurred, the speed of change of a home loan weight within loan portfolio 1 progresses relatively faster than that of change of corporate loan weight.

We assume that home loans mainly composed of mortgage loans will show a relatively sensitive reaction to GDP shock. In particular, we can infer that the reason is ascribed to the fact that changes of real estate prices will be magnified from GDP shock. In Korea, the financial authorities have a regulation policy on mortgage loans, such as DTI (Debt-to-Income) or LTV (Loan to Value). As we expect, the speed of decreasing home loan weight within loan portfolio 1 progresses relatively faster than that of decreasing corporate loan weight when the economy is declining. Therefore, corporate loan weight relative to home loan weight within will result in relatively increasing within the loan portfolio 1. In other words, we assume that the adjustment of home loan weight by banks from unexpected business cycle turn will be accomplished much faster than that of corporate loan weight.

Hypothesis 2: When GDP shock is occurred, the speed of change of KRW currency loan weight within portfolio 2 progresses relatively faster than that of change of foreign currency loan weight.

Foreign currency loans are made based on actual demands. Thus, the demands of foreign currency loans decrease during the time of an economic decline. Decreasing phase of making KRW currency loan is also unavoidable due to the decreasing of demand during an economic decline. However, the speed of decreasing foreign currency loan weight from GDP shock will progress slowly compared to that of decreasing KRW currency loan. As the main reason for above assumption, we can suggest that the size of a foreign currency loan is very small compared to that of KRW currency loan, and that the financial authorities regularly regulate rapid outflow of foreign currency into overseas. Therefore, when an economy is declining, we assume that banks will focus on reducing KRW currency loan weight within portfolio 2 for managing risk. In other words, the reduction of KRW currency loan weight within loan portfolio 2 will be expected to be progress relatively faster than that of foreign currency loan weight. Therefore, an economic decline will bring a relative increase in the weight of foreign currency loans within loan portfolio 2. The following hypotheses are related to the banks' management condition that is used as a control variable.

Hypothesis 3: The increasing speed of each corporate loan and foreign currency loan weight within loan portfolio 1 and loan portfolio 2 progresses relatively faster than that of each home loan and KRW currency loan weight when bank profitability is improved.

As bank profitability is improved, banks will focus on business of corporate loans and foreign currency loans, and they will mainly focus on small & medium-sized businesses that have a large risk premium on borrowers. Banks will especially focus on corporate loans with a large net interest margin (NIM) and a large possibility to create non-interest income through foreign currency deals.

Hypothesis 4: The increasing speed of each corporate loan and foreign currency loan weight within loan portfolio 1 and loan portfolio 2 progresses relatively faster than that of home loan and KRW currency loan weight when the banks' loan soundness is reinforced.

As the banks' loan soundness is reinforced, the faster increase of each corporate loans and foreign currency loan weight within portfolio 1 and portfolio 2 is expected respectively. This is attributed from the assumption that bank can afford to accept risk from corporate loans and foreign currency loans with a large risk premium.

Hypothesis 5: The increasing speed of each corporate loan and foreign currency loan weight progresses relatively faster than that of home loan and KRW currency loan weight when capital adequacy is improved.

If the each weight of the corporate loan and the foreign currency loan in the loan portfolio increases, we expect to see an improvement in the banks' capital adequacy. This can be viewed as the banks' ability to persevere on corporate loans and foreign currency loans with large risk premiums.

Hypothesis 6: Commercial banks located in Seoul, Korea will make a quick adjustment to the speed of change of the weight for home loans and KRW currency loans within each loan portfolio from GDP shock, compared with that of change of the weight for corporate loans and foreign currency loans.

We set each of the above hypotheses so that we could understand whether GDP shock's influence on loan portfolios is shown differentially ascribed to difference from bank ownership type and location. We expect that commercial banks located in Seoul will be judged to have superior human resources, big sizes of asset, and well equipped systems compared with those of local banks, foreign banks, and state-owned banks. Therefore, they will preferentially adjust the weight for loan asset which sensitively changes from GDP shock. In other words, their loan behavior will show us tendency in reducing portfolio risk from GDP shock. Moreover, the risk management to GDP shock by commercial banks located in Seoul is more reinforced than that of other type of banks because the monitoring of the financial authorities, stockholders, and borrowers is high. Therefore, commercial banks located in Seoul are likely to quickly adjust to each weight of home loan and KRW currency loan which are sensitive to GDP shock.

2) The variables

(1) GDP Gap as a proxy variable for the unexpected business cycle

In this study, we use domestic GDP growth rate as a proxy variable of economic change by referring to the precedent study (Jokipii & Milne, 2008). However, we use GDP Gap or GDP shock, and it is estimated by subtracting the average economic growth rate from GDP change rate as shown in Table 1. As shown, if the

relevant indicator shows either a positive (+) or negative (-) value, then there will be either a rapid expansion or depression in the economy.

In many precedent studies, the GDP growth rate was considered to be a proxy variable for economic change (Salas and Saurina, 2002; Laeven and Majoni, 2003; Ayuso et al., 2004; Micco and Panizza, 2006; Jokipii and Milne, 2008). Instead, this study considers GDP shock because of assumption that GDP shock shows more significant results in the adjustment of loan portfolio weight in terms of understanding lending behavior of banks from unexpected changes in economy.

(2) Dependent variables as proxy variables for loan portfolio

The loan portfolio is divided into two things according to classification standards of borrower and practicing currency. As the dependent variables, the portfolio 1 meaning the ratio of a corporate loan to a home loan, and the portfolio 2 indicating the ratio of a foreign currency loan to KRW currency loan are adopted. Den Haan et al. (2007) and Haas et al. (2010) are some of the precedent studies that classified loan assets for each borrower as Portfolio 1 in this study. We also include portfolio 2 classified into a KRW currency loan and a foreign currency loan for each loan practicing currency; we analyze portfolio 2 by reflecting the characteristics of the Korean market which has many small & medium-sized companies that take foreign currency loans (primarily Yen currency) due to the low interest rate. This is a differentiated part from that of the precedent studies in terms of the reflecting characteristics of the Korean loan market.

(3) Control variables

This paper suggests that the banks' internal management condition may affect the adjustment of loan portfolio weight. In other words, we consider variables that represent profitability, loan soundness, and capital adequacy among banks' management indices as control variables. By referring to precedent studies, theses variables can affect lending behavior (Jokipii and Milne, 2008; Ayuso et al., 2004; Salas and Saurina, 2002; Laeven and Majoni, 2003; Albertazzi et al., 2009). Thus, we consider two-financial ratio per each management index as follows. As financial ratio representing profitability, loan soundness, and capital adequacy, net non-interest income & net interest income, provisions & NPL ratio (non-performing loan ratio), and capital buffer & BIS ratio (Bank for International Settlement ratio) are adopted in consecutive order.

(4) Dummy variable

In this paper, we also analyze whether the ownership type and bank location differentially effect on the adjustment of loan portfolio weight when GDP shock is occurred. Haas et al. (2010) suggests that ownership and bank size are the main factors in composing bank loan portfolios. In the case of Korean banks, commercial banks located in Seoul must be analyzed separately from other banks because they have a relatively large market share and size. Therefore, Seoul's commercial banks are separated from other banks, and included in the analysis model as dummy variable with 1 and -1 respectively.

4. Data and Sample statistics

1) Data

In Table 1, it shows each definition of variables used in this paper. The change rate of loan portfolio weight is defined as the dependent variable, and GDP shock is defined as the independent variable. Moreover, a dummy variable is used to show ownership type and the bank location. We also suggested defining a control variable to show profitability, loan soundness, and capital adequacy in Korean banks.

Financial data includes a total of 17 banks. The banks in our analysis include 6 commercial and specialized banks located in Seoul, 6 local banks, 2 state-owned banks, and 3 foreign banks. For our analysis period, quarterly data from the 1st quarter of 2003 to the 4th quarter of 2009 is used. The total number of samples is 476. We have obtained the analysis data from the Financial Statistics Information System of Korean Financial Supervisory Service and FnGuide, Data Base providing financial information in Korea. Because some banks among data have merged during the analysis period, we combine the financial data of the bank that was taken over and the bank that took over to make financial data maintained continuity of data before and after the merger.

[Insert Table 1 here]

2) Descriptive statistics

Table 2 shows the descriptive statistics of data that we use in our analysis. Regarding loan portfolios 1 and 2, its average change rates are approximately 2%p and 3%p, respectively. Moreover, the average value of the GDP gap is approximately -0.05%; this value shows that a negatively average GDP shock is occurred during the analysis period. In other words, on average, the economy has a tendency to decline during the analysis period. The ratio of NPL, capital buffer, and BIS that are used as control variables are 1.5%, 49%, and 12%, respectively.

[Insert Table 2 here]

5. Models for empirical analysis

In this study, we use the fixed effect model as the econometric model for our analysis. In addition, we use the Prais-Winsten model and the GMM (Generalized Method of Moment). The fixed effect model and the Prais-Winsten model are used for the static analysis, and the GMM model is used for the dynamic analysis. Multiple panel analysis models are also used because we wanted to get significant implications by cross comparing results from the different analysis models in terms of securing the robustness of our study results.

In the following sections, we further explain on the panel analysis models that we selected for our study.

1) Fixed effect model

As one of the static panel analysis models, its general formula is as follows (1).

In the following model, α_i is a term that shows the banks' characteristics. It assumes that there is no significant correlation between $\mu_{i,t}$, the error term that cannot be observed in the general formula that shows the fixed effect model, and $\Delta X_{i,t}$ as a independent variable.

$$\Delta Y_{i,t} = \beta_0 + \Delta X_{i,t} + \beta_1 + Z_i\gamma + \alpha_i + u_{i,t}, \qquad e_{i,t} = \alpha_i + \mu_{i,t} \quad . \tag{1}$$

The next formula (2) is an analysis model that we use in this study; it is presented as modified fixed effect model. $\Delta \mathrm{P}ortfolio_{1(or\_2)i,t}$ is a dependent variable that shows the change of loan portfolio weight, and $GDPG_{t-1(or\_t)}$ is the GDP gap that represents previous GDP shock. Several other variables include $Control(NNII_{i,t})$, $Control(NII_{i,t})$, $Control(\mathrm{Pr}ov_{i,t})$, $Control(NPL_{i,t})$, $Control(BUFF_{i,t})$, and $Control(BIS_{i,t})$ which refer to net non-interest income, net interest income, provision, non-performing loan ratio, capital buffer, and BIS ratio as control variables. Another variable, Z_i shows a regression factor that does not change with time, and α_i shows the banks' characteristics that cannot be observed. In addition, $\mu_{i,t}$ shows the error term.

$$\begin{aligned}\Delta \mathrm{P}ortfolio_{1(or\_2)i,t} &= \beta_0 + \beta_1 GDPG_{t-1(or\_t)} + \beta_2 GDPG_{t-1(or\_t)} \times Dummy_{i,t} + \beta_3 Control(NNII_{i,t}) + \beta_4 Control(NII_{i,t}) \\ &+ \beta_5 Control(\mathrm{Pr}ov)_{i,t} + \beta_6 Control(NPL)_{i,t} + \beta_7 Control(BUFF)_{i,t} + \beta_8 Control(BIS)_{i,t} + Z_i\gamma + \alpha_i + \mu_{i,t}\end{aligned} \quad (2)$$

2**) Prais-Winsten model**

Next, we use another static panel analysis model called as the Prais-Winsten model. This model is generally used to remove autocorrelation that can exist in an error term. To remove autocorrelation, the model multiplies previous term by ρ which is an autoregressive coefficient, and then subtracts it from the current term.[1] $\Delta Y^*_{i,t}$ and $\Delta X^*_{i,t,k}$ means dependent variable and an explanatory variable removing the autocorrelation respectively.

$$\Delta Y^*_{i,t} = \sum_{k=1}^{P}(\beta_k)\Delta X^*_{i,t,k} + \sum_{j=1}^{Q} \beta_j ControlZ^*_{i,t,j} + u^*_{i,t} \quad (3)$$

$$i = 1,...,N; t = 1,...,T \quad .$$

3**) GMM model**

If we wish to consider the effect of the time series of dependent variables, then a dynamic panel data analysis model is more suitable. Therefore, we have implemented a 2-step dynamic panel data analysis method.[2] The GMM model is effective for solving endogeneity problems that can occur from α_i which represents the banks' characteristics in the fixed effect model. The GMM model uses instrument variables to overcome bias such as

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[1] $\Delta Y_{i,t} - \Delta Y_{i,t-1} = \sum_{k=1}^{P}(\beta_k)\Delta X_{i,t,k} + \sum_{j=1}^{Q} \beta_j ControlZ_{i,t,j} + u_{i,t} - \rho[\sum_{k=1}^{P}(\beta_k)\Delta X_{i,t-1,k}] + \rho[\sum_{j=1}^{Q} \beta_j ControlZ_{i,t-1,j}] + \rho u_{i,t-1}$.

[2] The dynamic panel analysis model suggested by Arellano and Bond (1991).

an endogeneity problem. It estimates parameters based on $E[\varepsilon_{i,t,}Z_{i,t}]=0$ which means condition of moment with instrument variables as in the formula (4). We also use the GDP growth rate and the 1st-order time lag of GDP growth rate as instrument variables. We perform a verification test of over-identifying restrictions to check whether we properly selected the instrument variables. As the verification test result, Sargan verification results are suggested. In other words, the null hypothesis of the relevant verification is 'there is no correlation between instrument variables and error term.' It means that the selection of instrument variable is appropriate if the hypothesis cannot be rejected. η_i in (4) refers to time-effects.

$$\Delta Y_{i,t}=\sum_{k=1}^{P}(\beta_k)\Delta X_{i,t,k}+\sum_{j=1}^{Q}\beta_j Control Z_{i,t,j}+\alpha_i+\eta_i+\varepsilon_{i,t} \quad . \tag{4}$$

6. Empirical analysis results

Table 3 shows results of modified fixed effect model's analysis on the change of loan portfolio weight in portfolio 1 from GDP shock. The analysis results are classified into several categories including whether the case considers the time lag of GDP shock as in models (3) and (4). If the time lag is not considered, then the test results are as shown in models (1) and (2). In the case that includes dummy variable to classify bank ownership type and location, the test results are shown in models (2) and (4), if not, then the results are shown in models (1) and (3).

In models (1) and (2), GDP shock does not have a statistically significant effect on the change of loan portfolio weight in portfolio 1. However, with models (3) and (4) that have considered time lag, we have found that GDP shock has a significant effect on the change of loan portfolio weight in portfolio 1. In addition, GDP shock has a significantly negative (-) effect on loan portfolio 1 at the level of 5%. This effect occurs regardless of whether the dummy variable is included in the relevant model. Each estimated parameter is -0.004, and it is understood that the home loan asset's weight is relatively increasing (decreasing) in the loan portfolio 1 when positive (negative) GDP shock occurs. It implies that the decreasing (increasing) speed of adjustment of the home loan's weight progresses more quickly than that of the corporate loan when the economy is unexpectedly shrinking. Oppositely, it indicates that the weight of corporate loan will comparatively increase (decrease) when negative GDP shock occurs. As expected, the results show that the changing speed of the home loan asset's

weight is achieved more sensitively than that of corporate loans in Korea where mortgage loans are already prevalent. In other words, Korean banks are adjusting the weight of sensitive assets in the portfolio 1 from GDP shock that occurred in the previous term.

However, Table 3 shows whether difference in ownership type and the bank location affects the asset's weight change in the loan portfolio 1. According to result, it is not differential when GDP shock occurs. It does not show there is no statistical significance on the parameter estimated from interaction term between GDP shock and the dummy variable.

Next, we want to review on profitability, loan soundness, and capital adequacy in banks that are used as control variables; we want to determine whether they significantly affect the change of asset weight in the loan portfolio 1. The results show that profitability and loan soundness have no statistical significance. Since the change of loan portfolio weight is not significant regardless of the level of net non-interest income, net interest income, provision, and the non-performing loan ratio that are used as proxy variables, we can mention that the results partially reject hypothesis 3, 4, and 5. However, the capital buffer and the BIS ratio which is considered to be the control variable of capital adequacy have a significant effect on the dependent variable. Namely, capital buffer and BIS ratio have a negative effect at each the 5% and 1% level respectively regardless of the analysis model. In other words, as the capital adequacy is high, it implies that the home loan asset's weight in the loan portfolio 1 tends to increases. This result contrasts to hypothesis 6. In this paper, we expect that the weight of corporate assets in loan portfolio 1 will increase if capital adequacy improves since the bank's capability to bear risk on companies with a high risk premium will increase. However, we can find out the fact that Korean banks tend to increase the weight of home loan assets that focus on mortgage loans that have the low risk-weight in order to maintain it when capital adequacy is high.

[Insert Table 3 here]

Table 4 shows the results of modified Prais-Winsten model which means a static analysis model. The table shows that the estimated parameter is significant only in models (3) and (4) which consider a time lag for the analysis relationship on between GDP shock and change of loan portfolio weight. In other words, the estimated parameter is -0.004, and it is significant at 1% and 5% respectively. The result of this analysis is the same as that of modified fixed effect model. As we suggest the negative estimated parameter that is statistically significant, the adjustment speed of the home loan asset's weight in loan portfolio 1 from previous GDP shock is relatively

faster than that of corporate loan. The Prais-Winsten model's analysis results also conform to modified fixed-effect model results.

Moreover, there is no statistical significance on the estimated parameter of the interaction term between GDP shock and the dummy variable. We found that ownership type and the bank location do not have a differential effect on the relationship between GDP shock and loan portfolio 1.

Meanwhile, models (1) and (2) show statistical significance for the capital buffer that only shows capital adequacy that is considered to be a control variable in terms of the relationship between the management condition and the bank's loan portfolio. The BIS ratio is not statistically significant. In other words, modified fixed effect model shows a significantly negative relationship between the capital adequacy and GDP shock regardless of ownership type and the bank's location. Thus, modified Prais-Winsten model's analysis shows somewhat different results to us.

[Insert Table 4 here]

Table 5 shows the analysis on result of GMM, dynamic analysis model. Our analysis confirms that there is significant negative (-) relationship between the previous GDP shock and the change of loan portfolio weight. This relationship is the same as shown in the static analysis model. It implies that the changing of the home loan asset's weight from GDP shock adjusts relatively faster than the speed of the corporate loan.

However, we have found that the estimated parameter of the interaction term between GDP shock and the dummy variable does not show statistical significance regardless of the model type. This result is the same as that of the static analysis model.

Meanwhile, we will also examine the relationship between the control variable and the dependent variable. Unlike the static model, the net non-interest income that represents profitability shows a significantly positive relationship with 1% level. It is interpreted that if the performance of non-interest income in the profit part of the bank is improved, banks tend to increase the corporate loan asset's weight in the loan portfolio 1. Thus, we can infer that banks focus on corporate loan sales because they expect to make non-interest income increased as foreign exchange transaction derived from corporate loan sale is increased. This result partially supports hypothesis 3.

Moreover, the home loan asset's weight in loan portfolio 1 increases in the analysis model that considers the time lag of GDP shock when the NPL ratio is high. In other words, we can understand that home loan sale with

the low risk-weight is activated when the loan soundness is deteriorated. Thus, we can partially support hypothesis 4. However, just as in the static model, the proxy variables that are related to capital adequacy do not show statistical significance.

The test result of Sargan $\chi 2$ in order to prove adequacy of the instrument variables shows that it is appropriate to select instrument variables since the null hypothesis (there is no correlation between the instrument variables and error term) could not be rejected.

[Insert Table 5 here]

Next, we will examine Table 6 which uses modified fixed effect model to analyze the relationship between loan portfolio 2 indicating ratio of foreign currency loans relative to KRW currency loans and GDP shock. However, we found that GDP shock only has a significant effect on the change of loan portfolio weight when we do not consider the difference of time lag, ownership type, and location. It implies that a significant increase occurs in the KRW currency loan from the currently positive (negative) GDP. However, in model (2) which includes a dummy variable that reflects the difference of ownership type and bank location, we have found that the reaction of the dependent variable from current GDP shock is not significant. It can be inferred that Korean banks more quickly adjust to KRW currency loan asset weight than that of foreign currency loan asset weight from current GDP shock. Thus, we can mention that this supports hypothesis 2. However, we know that portfolio 2 shows a significant reaction from current GDP shock; on the other hand, portfolio 1 shows a significant reaction from previous GDP shock. In Table 6, we have found no statistical significance on the interaction term between GDP shock and the dummy variable with the dependent variable.

Meanwhile, we will examine the relationship between a control variable that shows management condition and the change of asset in the loan portfolio 2. We have confirmed that only the BIS ratio that represents capital adequacy has a significantly negative (-) relationship with dependent variable. The estimated parameter value is significant at a 10% level regardless of the analysis model. These results mean the fact that the KRW currency loan weight is high when capital adequacy is high. As improving the bank's capital adequacy, we can expect that the sale on a foreign currency loan with the relatively high risk-weight tends to decreased. These results are contrary to hypothesis 5. Therefore, we will dismiss hypothesis 5 in the light of results for loan portfolio 1 and 2.

[Insert Table 6 here]

Next, we will examine the results of Table 7 analyzed using modified Prais-Winsten model. During our analysis, we have found a statistical significance on the relationship between GDP shock and the dependent variable in models (1) and (2). These show that there is the speed in adjusting weight of the KRW currency loan asset which is sensitive to the change of business cycle from the current GDP shock is more quickly progressed than that of the foreign currency loan asset. The GDP shock's influence due to difference of ownership and the bank's location was not differential.

Several variables show statistical significance in the relationship between control variables such as profitability, loan soundness, and capital adequacy and the dependent variables. These variables are net interest income, NPL ratio, and BIS ratio. In other words, we have found that the banks exhibit lending behavior that the weight of the KRW currency loans is high as the bank's net interest income and BIS ratio are high. We have also found that as the NPL ratio is low the weight of the foreign currency loan tends to increase.

[Insert Table 7 here]

Table 8 shows the results analyzed with GMM. As in the static analysis results, the reaction of the dependent variable from current GDP shock shows a negative (-) estimated parameter that is statistically significant in models (1) and (2). Thus, if the current term exhibits positive (negative) GDP shock, we can expect that then lending behavior indicating that KRW currency loan increases (decreases) exists. In the model that did not consider time lag, the interaction term between GDP shock and the dummy variable shows statistical significance at the 5% level. The relevant result suggests that commercial banks in Seoul do not have lending behavior of increasing (decreasing) KRW currency loans when a currently positive (negative) GDP shock occurs. This result is different from hypothesis 6, and we can understand that this result does not support hypothesis 6 which states that commercial banks in Seoul that have superior human resources, asset size, and systems will quickly adjust weight of their loan asset that is sensitive to GDP shock. In fact, only the result of the GMM analysis shows that a difference of ownership type and the bank's location has a differential effect on change in the asset's weight in loan portfolio 2 from GDP shock. We understand that the differential influence

attributed to the difference of ownership type and bank location is not significant because of inconsistency of each model's analysis.

Meanwhile, while reviewing the relationship between the control variable and dependent variable, we see that only model (3) shows statistically significant non-interest income, and we find significant NPL ratio in model (1), (2), (3). BIS ratio is also significant regardless of the model we use. In particular, we note that the BIS ratio shows statistically negative (-) significance regardless of whether we include the type of the panel analysis model, time lag, and dummy variable. Therefore, we have found a significant relationship between the BIS ratio that shows capital adequacy and the bank's loan portfolio 2. It implies that the weight of the KRW currency loan increases as the BIS ratio is high. When there is an increase in demand to maintain a BIS ratio over a certain level, banks will adjust the weight in the portfolio 2 by making the weight of the KRW currency loans with the low risk-weight increased relatively.

[Insert Table 8 here]

7. Concluding remarks

This paper empirically analyzes the relationship between the change of loan portfolio weight and GDP shock recognized as a systematic risk factor. Our main purpose is to discover whether Korean banks reduce their loan portfolio risk by flexibly adjusting weight of loan portfolios in order to escape risk to the outside variable called as GDP shock. As a result, Korean banks show a specific lending behavior that they adjust the loan portfolio weight by making the loan asset that is sensitive to GDP shock changed mainly. Thus, Korean banks show lending behavior that they decrease their portfolio risk by reducing the weight of home loans and KRW currency loan assets which are sensitive to the change of business cycle during economic depression. On the other hand, the banks shows lending behavior that they maximize their related business income by increasing the weight of loan asset that is sensitive to the change of economy when the economy is booming. Thus, our results show that the portfolio risk increases when the economy is booming. The results support the precedent study (Baele et al., 2007) which shows that systematic risk increases for the well-diversified portfolio. Thus, the systematic risk of the Korean banks' portfolio increases only during economic boom as the result of precedent study is.

In addition, we have selected profitability, loan soundness, and capital adequacy variables as control variables.

Our paper has confirmed the main results which are summarized in the following paragraphs.

Firstly, in case of loan portfolio 1, ratio of corporate loan assets relative to home loan assets, it shows significantly negative (-) adjustment of loan portfolio to previous GDP shock. In other words, Korea's home loan assets which main focus on mortgage loans have a characteristic of more sensitively adjusted in size from GDP shock than corporate loan assets. When the economy unexpectedly enters the expanding condition, the home loan size will rapidly increase, and home loan portfolio weight will relatively expand. Therefore, these results can be interpreted to mean that it increases the loan portfolio risk by increasing size of the loan asset with large variability. The relevant result supports the results of the precedent study (Baele et al., 2007).

Secondly, in case of loan portfolio 2, ratio of foreign currency loan assets relative to KRW currency loan assets, it shows negatively (-) affected by current GDP shock. These results can be interpreted to mean that KRW currency loans having a relatively large size are sensitively adjusted to GDP shock. The relevant result can be understood as Korean banks' lending behavior that flexibly adjusts portfolio risk.

Thirdly, GDP shock did not show a differential influence on change of loan portfolio weight attributed to the difference of ownership and the bank location. Even though commercial banks located in Seoul have show that adjusting the KRW currency loan asset to GDP shock is less sensitive compared to other banks as shown in the dynamic analysis model, the consistency of results from each model is lacking; therefore, it cannot be affirmed.

Fourthly, we have found that adjustment of weight in the loan portfolio 1 is not significantly fulfilled according to the bank management condition levels. However, asset weight of loan portfolio 2 is influenced significantly according to BIS ratio level as the capital adequacy indicator.

In conclusion, we understand that the Korean banks' loan portfolio reduce their risk level by showing significant adjustments to loan assets that are sensitive to GDP shock during economic depression. However, the banks' portfolio risks increase when the economy expands because the size of the loan asset with large variability increases.

Moreover, requests to maintain a BIS ratio over a certain level is shown as a possibility of increase in KRW currency loans. However, these requests did not lead to increases in home loans. Therefore, the financial authorities must note that the risk level of the banks' portfolio increases when the economy expands rather than during economic depression. Thus, advance supervisory action and related regulations are required.

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Appendices: Tables

Table 1. Definition of the variables

	Variables	Definitions
Dependent Variables	ΔPortfolio 1	$(\text{Corporate loan / Home loan})_t$ - $(\text{Corporate loan / Home loan})_{t-1}$
	ΔPortfolio 2	$(\text{Foreign currency loan / KRW currency loan})_t$ - $(\text{Foreign currency loan / KRW currency loan})_{t-1}$
Independent Variables	GDP as a level (lnGDP)	Real Gross Domestic Product quarterly basis standardized using natural logarithmic scale
	ΔGDP_t	lnGDP(t)-lnGDP(t-1)
	$GDPG_t$	ΔGDP(t)– Average of ΔGDP Average of ΔGDP is estimated by using Hodrick-Prescott filter
	$\text{Dummy}_{t,i}$	Bank Ownership Dummy. Managerial ownership of banks is equal to 1 or -1 if the banks are commercial bank in Seoul or not. It is a proxy for banks' ownership and location's constraints.
Control Variables	$\text{Ln(Net Int. Income)}_{t,i}$	Standardization using natural logarithm on the difference between the interest income generated by each bank and the amount of interest paid out to their lenders.
	$\text{Ln(Net Non Int. Income)}_{t,i}$	Standardization using natural logarithm on the difference between non- interest income generated by each bank and the amount of non-interest paid out to their lenders.
	$\text{Ln(Prov.)}_{t,i}$	Standardization using natural logarithm on provisions for bad debts on quarterly basis standardized using natural logarithmic scale
	$\text{NPL}_{t,i}$	Non Performing Loans / Total loans × 100 in each bank
	$\text{Buff}_{t,i}$	(Capital-Required capital)/Required capital × 100
	$\text{BIS}_{t,i}$	Capital to risk-weighted asset × 100

Table 2. Descriptive statistic

Variables	Mean	Std. Dev	Degree of skewness	Kurtosis	The maximum value	The minimum value
ΔPortfolio 1 $_{t,i}$	0.0207	0.1345	0.6077	3.9280	0.5465	-0.2972
ΔPortfolio 2 $_{t,i}$	0.0344	0.2462	6.5512	66.1814	2.7407	-0.6402
$GDPG_t$ (%p)	-0.0497	1.4032	-2.0452	10.4742	2.6152	-5.7397
Ln(Net Int. Income) $_{t,i}$	12.2820	1.5357	-4.2275	51.8663	14.7203	-6.8501
Ln(Net Non Int. Income) $_{t,i}$	-11.0633	4.3643	4.5625	24.0188	13.7249	-14.7072
Ln(Prov.) $_{t,i}$	13.0344	1.3543	-0.4327	2.1818	15.3345	10.0145
NPL $_{t,i}$ (%)	1.5013	0.7964	1.4707	5.3735	4.8400	0.3600
Buff $_{t,i}$ (%)	49.0036	24.1341	1.0040	4.9983	138.2693	-21.1341
BIS $_{t,i}$ (%)	12.0954	1.8054	1.3852	5.0612	19.0600	8.5500

Table 3. The Result of modified fixed effect model (Portfolio 1)

This table reports modified fixed effect model's estimation to change of portfolio 1 which consists of the ratio of corporate loans to home loans from GDP shock. The panel data analysis method uses major variables such as GDP Gap_{t-1}, GDP Gap_t, interaction terms like $GDPG_{t-1} \times Dummy_{t,i}$ (Bank ownership type & location), and control variables.

	No time lag of business cycle		Time lag of business cycle	
	No Dummy of Ownership & Location	Dummy of Ownership & Location	No Dummy of Ownership & Location	Dummy of Ownership & Location
	(1)	(2)	(3)	(4)
Constant	**-0.0825**	**-0.0726**	**-0.0514**	**-0.0500**
	(-1.31)	**(-1.16)**	**(-0.82)**	**(-0.80)**
$GDPG_{t-1}$			**-0.0042 ****	**-0.0041 ****
			(-2.57)	**(-2.13)**
$GDPG_t$	**0.0002**	**-0.0004**		
	(0.14)	**(-0.19)**		
$GDPG_t \times Dummy_{t,i}$		**-0.0011**		
		(-0.58)		
$GDPG_{t-1} \times Dummy_{t,i}$				**0.0001**
				(0.08)
Control_Net Non Int. $Income_{t,i}$	**-0.0000**	**-0.0000**	**-0.0001**	**-0.0001**
	(-0.07)	**(-0.05)**	**(-0.13)**	**(-0.13)**
Control_Net Int. $Income_{t,i}$	**0.0045**	**0.0047**	**0.0047**	**0.0047**
	(1.06)	**(1.06)**	**(1.13)**	**(1.13)**
$Control\_Prov_{t,i}$	**0.0207**	**0.0201**	**0.0184**	**0.0183**
	(0.60)	**(0.58)**	**(0.54)**	**(0.53)**
$Control\_NPL_{t,i}$	**-0.0012**	**-0.0008**	**-0.0038**	**-0.0037**
	(-0.10)	**(-0.07)**	**(-0.33)**	**(-0.33)**
$Control\_Buff_{t,i}$	**-0.0007 ****	**-0.0007 ****	**-0.0007 ****	**-0.0007 ****
	(-2.05)	**(-2.04)**	**(-2.00)**	**(-1.99)**
$Control\_BIS_{t,i}$	**-0.0122 *****	**-0.0123 *****	**-0.0122 *****	**-0.0122 *****
	(-2.97)	**(-3.00)**	**(-3.00)**	**(-3.00)**
R^2	**0.0519**	**0.0526**	**0.0660**	**0.0660**
D.W.	**0.3050**	**0.3050**	**0.3047**	**0.3048**
VIF	**1.0547**	**1.0555**	**1.0707**	**1.0707**
Obs.	**476**	**476**	**476**	**476**

Notice:

① *** and ** denote significant 1% and 5%, respectively.

② D.W. means Durbin Watson test statistic making a decision whether correlation exists, and it shows 0<D.W. <4 that indicates there is no correlation.

③ VIF means Variance Inflation Factor to check of multicollinearity, and it shows 1.00<VIF<1.08 below 10.

Table 4. The result of modified Prais-Winsten model (Portfolio 1)

This table reports modified Prais-Winsten model's estimation to change of portfolio 1 which consists of the ratio of corporate loans to home loans from GDP shock. The panel data analysis method uses major variables such as GDP Gap_{t-1}, GDP Gap_t, interaction terms like $GDPG_{t-1} \times Dummy_{t,i}$ (Bank ownership type & location), and control variables.

	No time lag of business cycle		Time lag of business cycle	
	No Dummy of Ownership & Location	Dummy of Ownership & Location	No Dummy of Ownership & Location	Dummy of Ownership & Location
	(1)	(2)	(3)	(4)
Constant	**0.0107**	**0.1187**	**0.0222**	**0.0206**
	(0.09)	**(0.10)**	**(0.19)**	**(0.18)**
$GDPG_{t-1}$			**-0.0043 *****	**-0.0044 ****
			(-2.59)	**(-2.51)**
$GDPG_t$	**0.0012**	**0.0008**		
	(0.77)	**(0.45)**		
$GDPG_t \times Dummy_{t,i}$		**-0.0009**		
		(-0.53)		
$GDPG_{t-1} \times Dummy_{t,i}$				**-0.0002**
				(-0.10)
Control_Net Non Int. $Income_{t,i}$	**0.0000**	**0.0000**	**-0.0000**	**-0.0000**
	(0.01)	**(0.03)**	**(-0.05)**	**(-0.05)**
Control_Net Int. $Income_{t,i}$	**0.0062**	**0.0061**	**0.0062**	**0.0062**
	(1.26)	**(1.26)**	**(1.30)**	**(1.30)**
$Control\_Prov_{t,i}$	**0.0013**	**0.0013**	**0.0007**	**0.0008**
	(0.13)	**(0.12)**	**(0.07)**	**(0.09)**
$Control\_NPL_{t,i}$	**-0.0105**	**-0.0104**	**-0.0130**	**-0.0131**
	(-1.30)	**(-1.30)**	**(-1.61)**	**(-1.62)**
$Control\_Buff_{t,i}$	**-0.0005 ***	**-0.0005 ***	**-0.0005**	**-0.0005**
	(-1.67)	**(-1.65)**	**(-1.64)**	**(-1.64)**
$Control\_BIS_{t,i}$	**-0.0049**	**-0.0050**	**-0.0051**	**-0.0052**
	(-1.17)	**(-1.21)**	**(-1.25)**	**(-1.25)**
R^2	**0.0236**	**0.0241**	**0.0379**	**0.0379**
VIF	**1.0242**	**1.0247**	**1.0394**	**1.0394**
Obs.	**476**	**476**	**476**	**476**

Notice:

① *** and * denote significant 1% and 10%, respectively.

② VIF means Variance Inflation Factor to check of multicollinearity, and it shows 1.00<VIF<1.04 below 10.

Table 5. The result of GMM model (Portfolio 1)

This table reports GMM's estimation to change of portfolio 1 which consists of the ratio of corporate loans to home loans from GDP shock. The panel data analysis method uses major variables such as GDP Gap_{t-1}, GDP Gap_t, interaction terms like $GDPG_{t-1} \times Dummy_{t,i}$ (Bank ownership type & location), and control variables.

	No time lag of business cycle		Time lag of business cycle	
	No Dummy of Ownership & Location	Dummy of Ownership & Location	No Dummy of Ownership & Location	Dummy of Ownership & Location
	(1)	(2)	(3)	(4)
Constant	**-0.0011**	**-0.0006**	**-0.0008**	**0.0014**
	(-0.79)	**(-0.48)**	**(-0.68)**	**(0.98)**
$GDPG_{t-1}$			**-0.0025 ****	**-0.0031 *****
			(-2.53)	**(-3.56)**
$GDPG_t$	**-0.0013 ***	**-0.0012**		
	(-1.82)	**(-1.13)**		
$GDPG_t \times Dummy_{t,i}$		**0.0005**		
		(0.46)		
$GDPG_{t-1} \times Dummy_{t,i}$				**0.0008**
				(0.86)
Control_Net Non Int. $Income_{t,i}$	**0.0015 *****	**0.0014 *****	**0.0015 *****	**0.0011 *****
	(4.80)	**(4.47)**	**(4.84)**	**(3.01)**
Control_Net Int. $Income_{t,i}$	**0.0038**	**0.0021**	**0.0162**	**0.0160**
	(0.45)	**(0.26)**	**(1.47)**	**(1.61)**
$Control\_Prov_{t,i}$	**-0.0111**	**-0.0158**	**0.0087**	**0.0220**
	(-0.36)	**(-0.50)**	**(0.30)**	**(0.79)**
$Control\_NPL_{t,i}$	**-0.0077**	**-0.0068**	**-0.0172 ****	**-0.0156 ****
	(-1.19)	**(-0.95)**	**(-2.34)**	**(-2.24)**
$Control\_Buff_{t,i}$	**-0.0003**	**-0.0003**	**-0.0003**	**-0.0001**
	(-1.35)	**(-1.28)**	**(-1.46)**	**(-0.47)**
$Control\_BIS_{t,i}$	**-0.0011**	**-0.0020**	**-0.0019**	**-0.0098 ****
	(-0.28)	**(-0.55)**	**(-0.55)**	**(-2.31)**
Sargan χ^2	**13.18**	**13.60**	**11.65**	**8.13**
Obs.	**476**	**476**	**476**	**476**

Notice:

① ***, **, and * denote significant 1%, 5%, and 10%, respectively.

② Sargan test statistic does not reject the H_0: There exists no autocorrelation between instrument variables and the residual term.

Table 6. The result of modified fixed effect model (Portfolio 2)

This table reports the fixed effect model's estimation to change of portfolio 2 which consists of the ratio of foreign currency loans to KRW currency loans from GDP shock. The panel data analysis method uses major variables such as GDP Gap_{t-1}, GDP Gap_t, interaction terms like $GDPG_{t-1} \times Dummy_{t,i}$ (Bank ownership type & location), and control variables.

	No time lag of business cycle		Time lag of business cycle	
	No Dummy of Ownership & Location	Dummy of Ownership & Location	No Dummy of Ownership & Location	Dummy of Ownership & Location
	(1)	(2)	(3)	(4)
Constant	**0.7280**	**0.7232**	**0.4177**	**0.4174**
	(1.01)	**(1.00)**	**(0.59)**	**(0.59)**
$GDPG_{t-1}$			**-0.0096**	**-0.0096**
			(-1.17)	**(-0.99)**
$GDPG_t$	**-0.0168****	**-0.0139**		
	(-1.97)	**(-1.41)**		
$GDPG_t \times Dummy_{t,i}$		**0.0052**		
		(0.54)		
$GDPG_{t-1} \times Dummy_{t,i}$				**0.0001**
				(0.01)
Control_Net Non Int. $Income_{t,i}$	**-0.0012**	**-0.0012**	**-0.0014**	**-0.0014**
	(-0.42)	**(-0.45)**	**(-0.50)**	**(-0.50)**
Control_Net Int. $Income_{t,i}$	**0.0495**	**0.0492**	**0.0875**	**0.0875**
	(0.82)	**(0.81)**	**(1.43)**	**(1.42)**
$Control\_Prov_{t,i}$	**-0.0761**	**-0.0755**	**-0.0866**	**-0.0866**
	(-1.25)	**(-1.24)**	**(-1.39)**	**(-1.38)**
$Control\_NPL_{t,i}$	**-0.0324**	**-0.0327**	**-0.0309**	**-0.0309**
	(-1.52)	**(-1.53)**	**(-1.43)**	**(-1.43)**
$Control\_Buff_{t,i}$	**-0.0001**	**-0.0001**	**-0.0002**	**-0.0002**
	(-0.10)	**(-0.11)**	**(-0.24)**	**(-0.24)**
$Control\_BIS_{t,i}$	**-0.0227***	**-0.0226 ***	**-0.0243***	**-0.0243***
	(-1.92)	**(-1.91)**	**(-2.03)**	**(-2.03)**
R^2	**0.0432**	**0.0438**	**0.0373**	**0.0373**
D.W.	**1.7485**	**1.7491**	**1.7225**	**1.7225**
VIF	**1.0452**	**1.0458**	**1.0387**	**1.0387**
Obs.	**476**	**476**	**476**	**476**

Notice:

① ** and * denote significant 5% and 10%, respectively.

② D.W. means Durbin Watson test statistic making a decision whether correlation exists, and it shows 0<D.W. <4 that indicates there is no correlation.

③ VIF means Variance Inflation Factor to check of multicollinearity, and it shows 1.00<VIF<1.05 below 10.

Table 7. The result of modified Prais-Winsten model (Portfolio 2)

This table reports the Prais-Winsten model's estimation to change of portfolio 2 which consists of the ratio of foreign currency loans to KRW currency loans from GDP shock. The panel data analysis method uses major variables such as GDP Gap_{t-1}, GDP Gap_t, interaction terms like $GDPG_{t-1} \times Dummy_{t,i}$ (Bank ownership type & location), and control variables.

	No time lag of business cycle		Time lag of business cycle	
	No Dummy of Ownership & Location	Dummy of Ownership & Location	No Dummy of Ownership & Location	Dummy of Ownership & Location
	(1)	(2)	(3)	(4)
Constant	**0.6532 *** **	**0.6542 *** **	**0.6983 *** **	**0.6987 *** **
	(3.36)	**(3.35)**	**(3.38)**	**(3.38)**
$GDPG_{t-1}$			**-0.0056**	**-0.0063**
			(-0.70)	**(-0.99)**
$GDPG_t$	**-0.0177 ** **	**-0.0151 ** **		
	(-2.25)	**(-2.46)**		
$GDPG_t \times Dummy_{t,i}$		**0.0048**		**-0.0013**
		(0.80)		**(-0.21)**
$GDPG_{t-1} \times Dummy_{t,i}$				
$Control\_Net\ Non\ Int.\ Income_{t,i}$	**-0.0002**	**-0.0002**	**-0.0003**	**-0.0003**
	(-0.18)	**(-0.23)**	**(-0.33)**	**(-0.34)**
$Control\_Net\ Int.\ Income_{t,i}$	**-0.0117 ***	**-0.0117 ***	**-0.0118 ***	**-0.0118 ***
	(-2.01)	**(-1.99)**	**(-2.01)**	**(-2.01)**
$Control\_Prov_{t,i}$	**-0.0128**	**-0.0127**	**-0.0128**	**-0.0128**
	(-0.91)	**(-0.90)**	**(-0.86)**	**(-0.86)**
$Control\_NPL_{t,i}$	**-0.0430 ** **	**-0.0436 ** **	**-0.0447 ** **	**-0.0448 ** **
	(-2.26)	**(-2.25)**	**(-2.06)**	**(-2.06)**
$Control\_Buff_{t,i}$	**0.0002**	**0.0001**	**0.0001**	**0.0001**
	(0.20)	**(0.18)**	**(0.14)**	**(0.14)**
$Control\_BIS_{t,i}$	**-0.0212 *** **	**-0.0212 *** **	**-0.0245 *** **	**-0.0245 *** **
	(-3.02)	**(-3.01)**	**(-3.21)**	**(-3.21)**
R^2	**0.0516**	**0.0521**	**0.0421**	**0.0421**
VIF	**1.0544**	**1.0550**	**1.0440**	**1.0440**
Obs.	**476**	**476**	**476**	**476**

Notice:

① ***, **, and * denote significant 1%, 5%, and 10%, respectively.

② VIF means Variance Inflation Factor to check of multicollinearity, and it shows 1.00<VIF<1.06 below 10.

Table 8. The result of GMM model (Portfolio 2)

This table reports GMM's estimation to change portfolio 2 which consists of the ratio of foreign currency loans to KRW currency loans from GDP shock. The panel data analysis method uses major variables such as GDP Gap_{t-1}, GDP Gap_t, interaction terms like $GDPG_{t-1} \times Dummy_{t,i}$ (Bank ownership type & location), and control variables.

	No time lag of business cycle		Time lag of business cycle	
	No Dummy of Ownership & Location	Dummy of Ownership & Location	No Dummy of Ownership & Location	Dummy of Ownership & Location
	(1)	(2)	(3)	(4)
Constant	**0.0020**	**0.0023**	**0.0045**	**0.0330 ***
	(1.01)	**(1.18)**	**(0.91)**	**(1.86)**
$GDPG_{t-1}$			**-0.0101 ****	**-0.0090 *****
			(-2.55)	**(-2.57)**
$GDPG_t$	**-0.0119 *****	**-0.0076 ***		
	(-2.93)	**(-1.67)**		
$GDPG_t \times Dummy_{t,i}$		**0.0071 ****		
		(2.30)		
$GDPG_{t-1} \times Dummy_{t,i}$				**-0.0025**
				(-1.04)
Control_Net Non Int. $Income_{t,i}$	**-0.0007**	**-0.0006**	**-0.0020 ****	**-0.0017**
	(-0.73)	**(-0.60)**	**(-2.21)**	**(-1.13)**
Control_Net Int. $Income_{t,i}$	**0.0396**	**0.0150**	**0.0443**	**0.0408**
	(0.87)	**(0.32)**	**(0.74)**	**(0.74)**
$Control\_Prov_{t,i}$	**-0.0446**	**-0.0058**	**-0.0022**	**-0.7664**
	(-0.61)	**(-0.08)**	**(-0.02)**	**(-1.41)**
$Control\_NPL_{t,i}$	**-0.0343 ****	**-0.0404 *****	**-0.0411 ****	**0.1368**
	(-2.46)	**(-2.93)**	**(-2.22)**	**(1.04)**
$Control\_Buff_{t,i}$	**-0.0007**	**-0.0011**	**-0.0007**	**-0.0028 ****
	(-0.99)	**(-1.53)**	**(-1.26)**	**(-2.41)**
$Control\_BIS_{t,i}$	**-0.0242 *****	**-0.0229 *****	**-0.0189 *****	**-0.0168 ***
	(-3.07)	**(-3.00)**	**(-3.44)**	**(-1.79)**
Sargan χ^2	**11.37**	**7.02**	**10.64**	**6.89**
Obs.	**476**	**476**	**476**	**476**

Notice:

① ***, **, and * denote significant 1%, 5%, and 10%, respectively.

② Sargan test statistic does not reject the H_0: There exists no autocorrelation between instrument variables and residual term.