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Jeong, Sangjun and Jung, Hueechae

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Sangjun Jeong* Hueechae Jung**

Abstract

Credit procyclicality has recently been the focus of considerable attention, but what fuels the often excessive credit growth is rarely questioned. We investigate the relationship between the composition of banks' liabilities and their credit procyclicality. After examining the macroeconomic context where banks rely increasingly on wholesale funding (WSF), we estimate the effect of WSF on the banks' credit growth using panel data for the commercial banks of Korea between 2000:1 and 2011:2. We find that a higher sensitivity of banks' WSF to the business cycle leads to an excessive response of credit growth to the business cycle, even with a low share of WSF on bank liabilities. This finding suggests that the regulation of banks' WSF mechanism may contribute to financial stability through a bank credit channel of monetary policy. On the other hand, we find that overseas WSF has a more marked effect on credit procyclicality, which may additionally exacerbate the financial fragility of export-led emerging economies.

JEL: E32, E44, G21

Key Words: credit procyclicality; wholesale funding; financial fragility

* Postdoctoral Researcher, Seoul National University, South Korea. Email: vorwarts@snu.ac.kr

** Economist, Bank of Korea. Email: hcjung@bok.or.kr

1. Introduction

The relationship between the credit cycle and the business cycle has often been a major concern for monetary authorities and economists, and it has recently received renewed attention in the wake of the global financial crisis. In particular, with less and weaker financial supervision, the procyclical pattern of credit growth has been considered a warning signal leading up to the crises. For example, Hume and sentence (2010), Borio and Lowe (2004), and Goodhart and Hofmann (2008) find that the credit booms have been noticeably accompanied by business flush times and then followed by financial crises.

With respect to the (over-)sensitivity of credit growth to the business cycle, many posit that a failure to establish appropriate regulations is the main cause of this problem. The reckless liberalization and rapid deregulation of the financial sector allegedly resulted in imprudent lending competition and relaxed lending standards, typified by the sub-prime mortgage boom in the U.S. (Arestis and Karakitsos, 2009). Soaring asset prices have also obscured the potential drawbacks of borrowers for future credit quality and thereby prevented sufficient screenings of riskier borrowers (Jimenez and Saurina, 2006; Dell'Ariccia and Marquez, 2006). As noted by Geanakoplos (2010) and Brunnermeier (2009), when financial agents aim to adjust their balance sheets to hit the target leverage following an asset price growth during a boom, such adjustments lead to a greatly amplified credit cycle while huge debts on balance sheets simultaneously accrue. Then, in the downturn, this leverage procyclicality abruptly becomes as a catalyst for the far-reaching financial crisis. These causal factors of immoderate credit booms are not negligible.

However, considering the bank's intrinsic role in credit creation as distinct from other financial intermediaries, it is also important to understand what *fuels* the bank's often-excessive credit growth. This question has surprisingly been overlooked and even treated as a minor issue with regard to credit expansion. Reasonably, given that commercial banks can turn to non-deposit or wholesale funding (WSF) and retail deposits from consumers, the banks are bound to choose from one source or another as their balance sheet continues to grow, which calls into question the causal links between the composition of liabilities, the credit cycle, and the business cycle.

Therefore, the core question of this paper is as follows: What influences will the composition of bank liabilities have on the bank's excessive credit procyclicality and hence on macroeconomic vulnerability? Given that banks are gradually increasing their reliance on WSF and banks' operations in the WSF market are occurring more frequently, this question is critical to understanding the dynamics of a macroeconomy.

On the other hand, the recent empirical confusion regarding the "bank's leverage effect" suggests another point to consider when investigating the effect of WSF. While investment banks' procyclical leverage

adjustment is revealed explicitly, as in Adrian and Shin (2010), the existing literature fails to verify leverage procyclicality as banks' (mostly commercial banks) general characteristic.[1] Given that the bank's leverage adjustment is implemented mainly through WSF and that the shares of WSF in commercial banks' liabilities worldwide are actually not so high as to be alarming at a glance[2], it is not surprising that the procyclical bank leverage growth has not been as pronounced in all economies.

However, the low share of WSF as such does not guarantee bank and macroeconomic stability. In fact, excessive credit procyclicality has been also found later in the form of foreign currency or in banking crises in the emerging economies where WSF markets are not sufficiently developed. In those economies, WSF accounts for insignificant portion of bank liabilities and consequently banks' leverage growth is seemingly mild. The often-missing link in the existing literature seems to lie with the qualitative rather than the quantitative features of WSF, which is in this paper, the oversensitivity of WSF to economic fluctuations. Therefore, recent perceptions of WSF as a potential cause of macroeconomic instability through, e.g., maturity mismatch due to excessive dependence on short-term instruments, are not incorrect, and the monetary authorities who try to regulate the banks' WSF are not worrying unduly. We present evidence by focusing not only on the share of WSF per se but on the 'relative' dynamics between the sensitivity of WSF and bank credit to the business cycle.

With examining the macroeconomic and historic contexts behind the banks' increased reliance on WSF in terms of the banks' relevant strategy, we seek to answer our questions by investigating the case of banks in South Korea (hereafter Korea). Using the panel data for those 14 banks during the 2000:1-2011:2 period, we empirically trace the causal relationship between credit procyclicality and the banks' several WSF indicators. The sensitivitity of WSF to the business cycle will be shown to have contributed to the excessive responsiveness of credit growth to the business cycle, which suggests that a tendency to over-lend can exist even when banks have relatively low shares of WSF.

Furthermore, given that credit growth allegedly moving in accordance with economic growth and the prices of credit market instruments in the WSF market are also affected by the business cycles, an investigation of

[1] Baglioni *et al.* (2010) depict the leverage of European commercial banks as growing in a less visible way. Dealing with the U.S. commercial banks and Japanese banks, the Joint FSF-CGFS Working Group (2009) also reports that aggregate balance sheet leverage did not increase or even fell over the preceeding period of the financial panic in 2008. Panetta *et al.* (2009) show that the leverage of banks worldwide did not display an explicitly procyclical pattern and that bank leverages in a few countries were broadly stable and sometimes even declined modestly during upturns in the economy.

[2] Demirgüç-Kunta and Huizingab (2010)'s recent investigation of an extensive sample of 1,334 banks in 101 countries shows that 61.3% of the sample banks have non-deposit funding shares of less than 5%, aside from an existence of the fat tail of distribution.

the causal relationship between credit procyclicality and funding sources raises serious endogeneity concerns and potential biases from structural breaks of periods. To address those complicated econometric issues, we adopt the three-stage least squares (3SLS) method and rolling panel regressions.

For export-led emerging economies, domestic banks' WSF from overseas markets tends to be higher to meet the exporters' huge demand of forward foreign exchange, for example. WSF from foreign creditors may function as a critical channel that affects more volatile credit fluctuations through which external shocks are transmitted, and thereby, the domestic economy becomes more vulnerable. Herein, we examine whether this additional effect exists. This topic will cast light on the issues of financial fragility in similar open emerging economies. By making these relationships clear, we open the debate regarding the new regulatory measures for bank regulation and thereby for financial stability.

The remainder of the paper is organized as follows. In addition to a review of the relevant literature, Section 2 discusses the macroeconomic context of the rise of WSF and its effects on the economy. Section 3 explains the bank panel data used in our study and provides the graphic patterns of the aggregated bank data. In Section 4, we present our empirical methodology and discuss the estimation results. Section 5 estimates the effect of overseas WSF and examines its structural grounds. Section 6 concludes the paper and suggests policy implications.

2. Wholesale Funding and Financial Fragility

In this section, we present a few elements that have contributed to banks' higher reliance on WSF and critically review the pros and cons of such bank liability management.

One of the main reasons WSF increased on the bank liabilities was the low interest rate environment since the early 2000s. Contrary to the remarkably high interest rates in the late 1970s and early 1980s, the interest rates showed an overall moderate tendency during the 1990s, apart from frequent fluctuations. With a few financial busts worldwide in the late 1990s and early 2000s, the interest rates in many developed economies began to decline noticeably and were held at record lows throughout much of the first decade of the 2000s. Within the overall low interest rate environment, competition for deposits among banks became more intense, and thus, attracting deposits became more difficult.

The declining household savings rate is another contributing factor to the decline of deposit shares in bank liabilities, though this trend is not so definitive as to be generalized across economies. However, in the case

of Korea, the household savings rate fell from over 20.0% in the 1990s to 2.8% in 2010, which is even lower than the 5.7% rate in the U.S. and the 6.1% average rate of the 20 OECD countries for whom data are available (OECD, 2011). Though Korea's total savings rate is still higher due to high corporate and government savings, a drop in Korea's household savings rate in the 2000s has been substantial enough to impose heavy burdens on traditional bank funding.

Moreover, with the penetrations of new financial agents, such as money market mutual funds and mutual funds, into deposit commodity markets, banks were forced to lose their deposit market shares and decreased the share of core deposits in their liabilities (Erturk and Ozgur, 2009). In effect, with the introduction and development of new financial instruments, such as negotiable CDs, and the expansion of overnight loan markets where banks can acquire funds quickly, liability management through WSF has greatly increased in importance as a source of bank funds. To illustrate the U.S. case, negotiable CDs and bank borrowings accounted for 47% of bank liabilities in 2008, a dramatic increase from the 2% share in 1960. Similarly, the share of checkable deposits decreased from 61% in 1960 to 6% in 2008 (Mishkin, 2009). Because the traditional distinctions between the bank-based and market-based systems are becoming blurred, we expect that banks will rely more on WSF and that the market-to-market changes will affect banks to a higher degree; as a result, WSF would play a more pivotal role in banks' strategies for profitability and stability.

It is of greater significance to note that this new trend of liability management is essential for attracting funds in periods when profit opportunities are derived from rapid asset price fluctuations or maturity mismatches between assets and liabilities.

This aspect of WSF does not always deserve criticism. A few of the studies on banking award higher marks to a wholesale financier than to a deposit account holder from a microeconomic perspective. Huang and Ratnovski(2010) suggest that the 'bright' side of WSF is that it enables banks to fully utilize investment opportunities regardless of the deposit supply. That is, the traditional source of deposits held in banks is bound to lag behind the expansion of lending during periods of rapid asset growth. Moreover, while wholesale financiers allow banks to adjust quickly to the changes in assets or market conditions, depositors are relatively insensitive to the bank's misallocations of resources and are sluggish in punishing the bank by withdrawing their deposits. As a result, they cannot offer banks efficient incentives or strong market discipline. Furthermore, considering the criticism that banks' safety nets encourage moral hazard (e.g., Demirgüç-Kunt and Detragiache (2002), Calomiris (1999)), WSF instruments, which are generally not covered by explicit deposit insurance, *may* be more efficient at monitoring banks and preventing them from taking excessive risks. Overall, following the orthodox mainstream economic doctrine that stresses the beneficial effects of financial market liberalization and touts the development of new financial instruments,

those banks with a higher share of WSF may acquire more advanced engineering techniques, such as more efficient options for hedging risks and diversifying portfolios for revenue, which consequently contribute to higher profitability, through competitive market-based liabilities management.

However, Huang and Ratnovski(2010), whose original purpose was to microeconomically model the 'dark' side of bank's WSF in contrast with our political-economic and empirical approach, explain that the bank's reliance on WSF may compromise credit quality due to aggressive lending and lead to inefficient liquidations, where wholesale financiers often exit ahead of and shift significant losses onto depositors, as was observed in recent bank failures. Hahm, Shin and Shin (2011) also formulate a model in which a large stock of a bank's non-core liabilities, a concept similar to WSF in this paper except for the empirical specifics, erodes risk premium and heightens vulnerability to a crisis. Demirgüç-Kunta and Huizingab (2010) empirically demonstrate that a further increase in the non-deposit funding share at higher levels enhances bank fragility, as measured by its Z-score.

Furthermore, Demirgüç-Kunta and Huizingab (2010) insist that non-deposit WSF lowers the rate of return on assets, while the expected beneficial effects of risk diversification are limited only to the low levels of non-deposit funding. In actuality, the relationship between bank profitability and non-deposit funding is not conclusively established due to unavoidable endogeneity problems. Though this topic should be addressed in other papers, we can easily expect mixed results. That is, while the higher prime cost of non-deposit funding is surely detrimental to bank profits, this type of funding combined with non-interest income-bearing projects, such as securitization trading, enhances bank returns during asset price booms. Which of the two will have a stronger effect depends on each economy's structure and the time span[3], and the complicated endogeneity issues warn against a hasty conclusion regarding causality. However, even though the profit-enhancing effect of WSF is found to be robustly significant in some samples, such as U.S. banks during the recent pre-crisis period, we cannot deny that those high profits were built up at the expense of the macroeconomic stability of the banks.[4]

Our paper takes a critical stance toward banks' WSF and argues that WSF, as an increasing funding source of banks, is not always welcome in view of the financial fragility and systemic risk associated with it, apart from the controversial profitability effect. Above all, as banks turn to increased WSF, the integration of the

[3] See, e.g., Tregenna (2009) for an explanation of the effect of the U.S. banking sector concentration on high profitability from 1994 to 2005.

[4] To put it another way, U.S. banks' higher profits before the current crisis increased on a feeble and irregular basis within a 'new financial architecture,' in Jim Crotty's words. For an account of the contradictions in the development of the financial sector in recent years, see Crotty (2007, 2009).

financial system through the provision of liquidity within and among banks and other non-depository institutions is accelerated. This interconnectedness among financial institutions has been cautioned against in a vast literature because such a relationship expands the channels of contagion; that is, problems affecting one bank spread to other banks and sometimes across international borders, and their propagating chain effects are amplified to the extent that rapid deleveraging may freeze the real economy.[5]

In the next sections, we explore the channel through which the liability structure of banks affects their credit operation and how credit cycle expansions lead to macroeconomic vulnerability. However, the strict empirical evidence on this channel is scarce, with the exception of Damar *et al.* (2010) and Jeong (2009), who use panel data from Canadian and Korean banks, respectively. Damar *et al.* (2010) argue that a bank's leverage becomes more procyclical during times of increased liquidity in WSF. Jeong (2009) regresses corporate loan growth on GDP growth and its interaction term with the WSF ratio, thereby demonstrating that a bank's reliance on WSF is partly responsible for the increase in the procyclicality of bank lending. Their findings are broadly in line with ours. However, instead of simply estimating the effect on the leverage or on the corporate loan growth rate, as explained in Section 1, we pay attention to the sensitivity measure of WSF as well. Likewise, whether bank credit growth responds *excessively* to the business cycle matters in this paper because the procyclical lending trend itself is, to a certain extent, natural in the business cycle. Additionally, we first identify determinants of banks' funding structure, accounting for endogeneity biases between the variables, which has not been sufficiently addressed in previous literature.

3. Data and Empirical Trends

3.1. Data

For the empirical analysis, we use balance sheet data from Korean commercial banks, which is available at Financial Analysis Information Retrieval System, and macro variables from the Economic Statistics System, both of which are under the supervision of the Bank of Korea. The data covers the period from the 1st quarter of 2000 to the 2nd quarter of 2011, for a total of 46 quarters.

The panel selection criteria we adopted, that is, which bank should or should not be included in the sample,

[5] 'Interbank contagion' literature suggests that interbank linkages through credit market instruments contribute to higher systemic risk and a more fragile economy; most of these studies employ theoretical modeling because interbank data are usually either unavailable or intractable. See Iori *et al* .(2006) and Battison *et al.* (2009).

are as follows. First, the banks should be Korean. This means that the headquarters of the bank should be located within the national boundaries of Korea; therefore, branches or affiliates of foreign banks are eliminated. Second, given the major differences in the accounting standards and purposes of establishment between commercial and special-purpose banks, the Korea Development Bank, the Export-Import Bank of Korea, and the Nong-hyup (agricultural cooperative) are excluded from our samples.

One critical issue of the panel data analysis is the 'survivorship bias'. In effect, in the aftermath of the massive foreign currency crisis in 1997 and the delay in restructuring the Korean banking sector, merger and acquisition deals with banks continued even into the early 2000s.[6] Hence, because the survivorship problem may cause a serious bias in our study, we address this issue first. The majority of bank M&A deals in the early 2000s were equal mergers between different banks that had few overlapping business and specialization domains. Therefore, banks' balance sheet data, which include outstanding figures on the last day of the quarter, had no critical breakpoints in the time series before or after the mergers. That is, when banks A and B merged to form the new Bank C, the before-merger bank A and bank B data combined smoothly, leading to a continuous time series of data for Bank C. In addition, by logarithmic transformation of the data, which is common in this kind of analysis, the survivorship problem becomes trivial, even though there were actual breakpoints within the raw before-merger bank data. Hence, we added the separate values of before-merger banks so that there are no missing values in our sample. In sum, the data used in this study are the balanced panel data of 14 Korean domestic banks that maintained ongoing business as of the 2nd quarter of 2011.

On the other hand, though the role of WSF is critical for this study, the exact definition or coverage of WSF depends on the relevant literature. For the purpose of this study, we calculate 'WSF' as the sum of inter-bank borrowing, financial bond issues, repurchase agreements and certificates of deposits, thus covering most kinds of non-deposit bank funding. In additon, 'WSF' includes funding from overseas, such as inter-bank foreign currency borrowing or foreign currency denominated bond issue, which will be further discussed in Section 4.4.

3.2. Empirical Trends

We present representative empirical trends in the aggregate sample data. Figure 1 indicates that the average growth rate of total bank assets has generally exceeded the GDP growth rate. This indicates there has been

[6] During the sample period, the following bank mergers occurred: Shinhan Bank+Choheung Bank+Chungbuk Bank.+Kangwon Bank (finalized in 2006-2), Woori Bank+Peace Bank of Korea (finalized in 2002-1), Hana Bank+Seoul Bank (finalized in 2002-4) and Kookmin Bank+Korea Housing Bank (finalized in 2001-4)

an over-expansion of banks' leverage in the recent decade, which is consistent with the common perception. Additionally, the right panel of Figure 1 shows that before the initiation of the financial crisis in 2008, banks' asset growth had been accompanied by an increasing reliance on WSF and that the share of overseas WSF was increasing as well. In the same vein, the abrupt shrinkage of asset expansion for banks was coincidental with a decreased reliance on both domestic and foreign WSF.

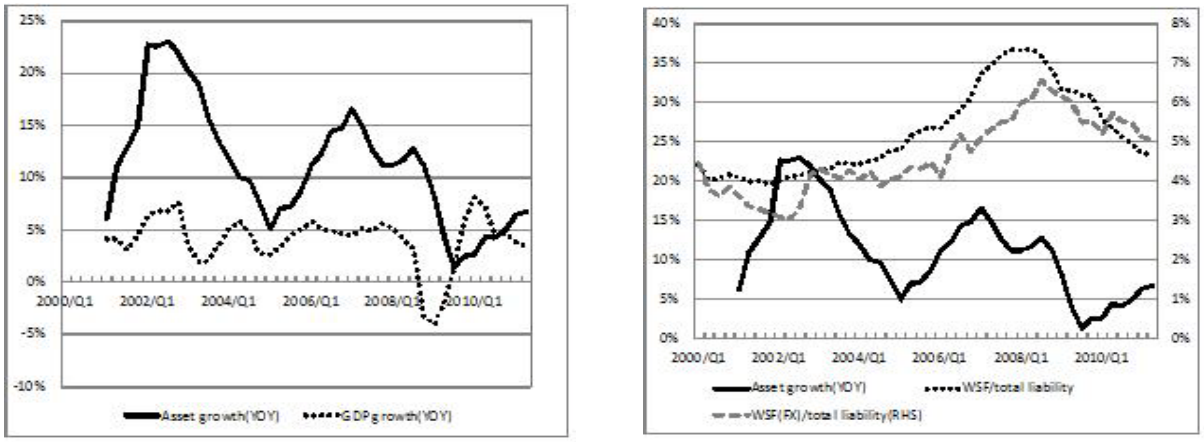


Fig. 1. Bank asset growth, GDP growth and bank liability structure

Notably, as Figure 2 indicates, when banks' asset expansions were deactivated by contagions from the financial crisis in 2008, banks' funding preferences changed, placing increased emphasis on funding via deposit rather than on WSF, which resulted in lower shares of WSF. The standard deviation of WSF among banks also decreased, which reflects that a decreased reliance on WSF was a common phenomenon among banks.

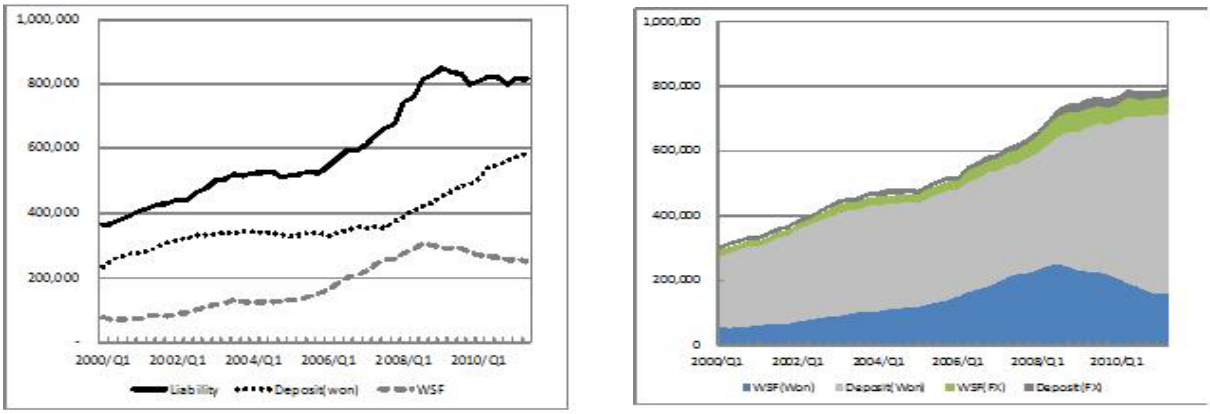
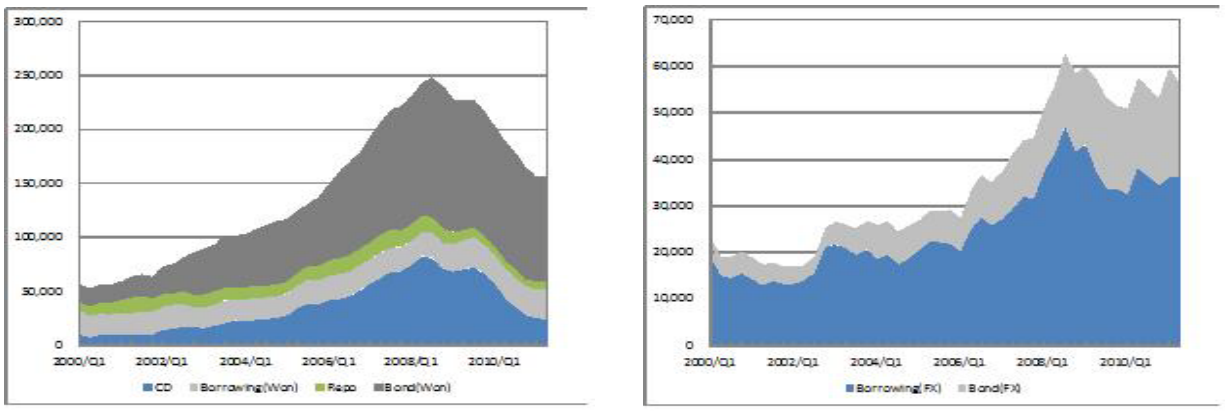


Fig. 2. Bank liability structure, on average (in 100 mil. won)

Considering the various trends with regard to the currency of WSF, after the financial crisis in 2008, Korean banks dramatically reduced Won (Korean currency)-denominated WSF, mainly CDs and financial bonds. However, WSF from foreign creditors underwent few or minimal adjustments. The trend in the composition of WSF is clearly depicted in Figure 3. Neither the amount of inter-bank foreign currency borrowings nor the foreign-currency denominated financial bond showed a definite downward trend, though there was some loss in volume.



(Korean Won) (Foreign Currency in Won)

Fig. 3. Composition of wholesale funding (in 100 mil. won)

4. Empirical Analysis

4.1 Econometric Methods

The statistical stability of the time span should be certain enough to conduct an econometric analysis. Particularly in Korea, we cannot deny the possibility of structural changes in the economy during the 11 years of the sample period. Thus, to control the time effect due to possible structural changes and to determine the dynamics of the relationship among the variables in more detail, we applied the '*rolling regression*' method, which is in contrast to the common techniques in many empirical studies, e.g., inclusion of a time dummy variable[7]. At each rolling regression, the time window was set as 12 quarters, or 3 years.

Figure 4 depicts the main framework of our empirical analysis. The seemingly complex structure of the

[7] This common method may not work in the case of long panels such as ours because including a time dummy responding to each time spot can lead to a singularity problem in an estimation process.

estimation process has the advantage of identifying various factors that could not be dealt with in a one-shot estimation of a single equation. By splitting up of the estimation process, we expect to identify the determinants of bank funding decisions, to determine the extent to which and the way in which the banks' liability structure influences loan operations, and finally, to grasp the potential driver of macroeconomic fluctuations.

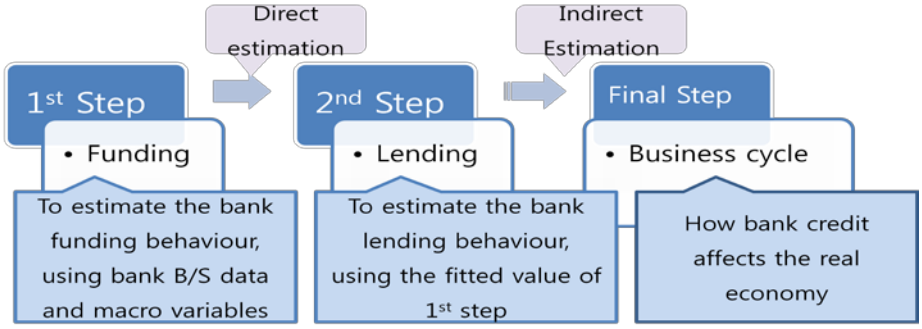


Fig. 4. The outline of the estimation framework

With respect to other aspects, the separation of the liability structure estimation from the loan behavior estimation challenges the widely recognized perception that in a bank, the decision on how to raise funds and the decision related to loan supply are not related. Once a bank decides to whom and to what extent it lends funds, where the funds come from is irrelevant. In short, there is no customized funding for a specific loan, which is reminiscent of the myth of the Modigilani-Miller theorem in a perfect capital market.[8] If this myth were true, funding structures would have no effect on the lending decision. Contrary to this prevalent perception, we test the validity of the myth by separately estimating the factors that affect the funding and lending behaviors of banks. Hence, separate estimations of the individual steps reveal the inner mechanism of the lending channel through which bank lending influences macroeconomic fluctuations[9].

In the first step of estimation, we analyze the banks' liability structure determination process using specific factors of the bank and macroeconomic variables, particularly focusing on WSF. We construct an estimation model consisting of a system of three equations. The regressands of each equation are as follows: the share of

[8] For an account of the failure of the Modigliani-Miller theorem for banks, see Van den Heuvel (2002).

[9] This phased estimation process is also consistent with the well-known economic theory. The effect on the banking sector incurred by banks' funding/lending behaviors and capital enhancements spreads by way of many steps, that is, the indirect impacts on asset allocation and the production of goods; fiscal policy has direct impacts.

WSF in the liability, the year-over-year (hereafter y-o-y) growth rate of WSF and the normalized deviation of WSF from its trend; all of these are expected to be the proper indicators of the liability structure of banks.[10] The system of equations resembles a vector autoregression (VAR) model that includes the lagged variables of each equation's regressands. Actual estimations of systems are performed via 3SLS with individual fixed effects.

In the second estimation step, we analyze the effect of banks' WSF indicators on the procyclicality of bank credit. Regressors in the equation are fitted values of the first estimation step. If the bank credit response to the real economy fluctuation is excessive, it will be a major factor in amplifying the business cycle fluctuation in the next period because it will distort the liquidity allocation process.

In the final estimation step, unfortunately, we cannot estimate the macroeconomic implications of bank lending behavior in our econometric framework. According to our framework, we should estimate the real economic fluctuation or fragility using the fitted values of the second estimation step. However, while we use the panel data on individual banks until the second step, estimating the macroeconomic relationship requires placing the macro level variable, that is, the GDP deviation or GDP fluctuation, on the left-hand side of equation. This means that the regressands of the equation are the same across the panel, while individual bank-specific variables are used as regressors on the right-hand side. This type of estimation would be illogical.

Aggregating bank-specific data would also cause a massive loss in degrees of freedom. With few degrees of freedom, the estimation result would not be robust, and the problem due to singularity would persist. Therefore, we would briefly provide the macroeconomic implications of bank credit. Despite the shortcomings of our estimation framework, we hold to it because it has the ability to reveal the individual inner mechanisms of how bank credit works, given there are a vast number of studies on bank credit channels at the aggregate level.

4.2. First Step

As previously mentioned, in the first estimation step, we analyzed the bank's funding behavior, focusing on WSF. The regressands of the equations are the indicators reflecting the individual bank's preference

[10] The variables for growth rate and the level of WSF are included simultaneously in our system of equations. It may look inappropriate to include both in one system. However, the WSF level is determined by the bank's total liability level, while the WSF growth rate is simply the y-o-y growth rate of the bank's WSF. Each variable tells a different story in the same system. We can identify the linkage and dynamics between the WSF level or growth rate; these dynamics include deacreases or increases compared to the previous level.

regarding WSF, and the regressors in the equations are the probable factors influencing WSF, such as the amount of capital, asset operation behavior, dynamics of non-performing loans, asset price dynamics, interest rate fluctuations, funding gap (the difference between operating assets and liabilities) and the dependence of other banks on WSF.

For the interest rate variables representing the relative cost of the bank's funding, we used the over-night call market interest rate variables (non-collateral)[11], the average interest rate of loans and deposits, and the spread between the return on a 3-year treasury note and a AA-grade corporate bond. For the other variables, such as the amount of bank assets, loans, and non-performing loans and asset (housing) prices, we used the y-o-y growth rate of each variable. Finally, for the other variables, including the other banks' dependence on WSF, the relative loan amount to total asset volume, and the funding gap, we used the percentage value of each variable. Another important variable worthy of consideration is the bank's excess capital. It is rational to expect that a bank confronted with loan demands prefers to use its excess capital holdings above the regulatory level rather than using cost-incurring outside funding, thus suggesting an adverse relationship between the bank's excess capital and its reliance on WSF. Therefore, we used the banks' excess capital holdings above the capital standard of CAMELS (Capital, Asset, Management, Earning, Liquidity and Sensitivity to market risk) criteria, as recommended by the Korea Financial Supervisory Service (FSS)[12].

We used the banks' WSF indicators, as defined in Section 3, as the regressands, and we did not distinguish between domestic and overseas WSF. The three regressands in the system equations are the WSF ratio to each bank's total liability, the y-o-y growth rate of the WSF outstanding value and the normalized deviation of WSF from its trend, defined as in (1). The last indicator of deviation is defined for each sub-sample of the rolling regression.

$$W_{it} \equiv \frac{\Delta WSF_{it,t-4} - \overline{\Delta WSF_{it,t-4}}}{\delta(\Delta WSF_{it,t-4})} \qquad (1)$$

[11] Because there are no changes in policy rate between the period of the monetary policy decision meeting and there may be no change even after several meetings, instead of this sticky policy rate, we use the over-night call rate in estimation.

[12] While BIS's regulatory capital level has stayed at 8%, FSS adjusted its bank management testament's first-grade criteria on capital in response to financial crisis contagion: in the first half of 2009, FSS hiked its criteria, 10% of total capital to 12% and 7% of tier 1 capital to 9%. This change was implemented with the 'Bank Capital Enhancement Fund' being activated. In Korea, this measure is important because banks would make efforts to comply with FSS' criteria thoroughly to manage their market reputations.

We estimated the system equations using the 3SLS technique considering individual fixed effects. We exploited the advantage of seemingly unrelated regression (SURE) by controlling correlations among equations and among panel entities in a system of equations where each equation had regressors similar to those of any VAR model. In addition, we used instrumental variables to obtain the fitted value of regressors and then used those fitted values for the estimation process. In sum, the 3SLS method enables us to avoid any possible problems that would occur in correlations between regressors and cause errors in the individual equations.[13]

Because any macroeconomic variable cannot be perfectly exogenous, establishing the pools of instrumental variables is of great concern. Therefore, we used the seemingly predetermined or exogenous variables, such as the lagged regressors or the banks' balance sheet variables, including the net profit indicators, which are thought to have little feedback on regressands and other macroeconomic indicators. Furthermore, by expressing the regressors of each system equation by the linear combination of exogenous variables, we eliminated the idiosyncratic fluctuations contained in the regressors of system equations. This reflects our effort 1) to explain the dynamics of the bank lending channel with only a limited class of regularly reported bank-specific and macroeconomic variables and 2) to observe the inner mechanism of the bank's behavior, which relates to funding and lending in a more explicit manner.

The estimation results are presented in Appendix. The prior purpose of the first estimation step was to obtain the fitted values to be used in the second step. The fitted values are the linear combination of the bank's specific balance sheet variables and the macro variables without idiosyncratic and irregular variations. That is, significant tests for the individual coefficients of equations are of little importance. In addition, while structural fluctuations seem to exist during the whole sample period, the coefficient of determination of each rolling regression showed little fluctuation. This result meets our prior expectation regarding the structural dynamics of economy; thus, applying rolling regression proves to be the correct strategy because the individual regressor's contribution varies from one sub-sample to another. The results also show that there are inter-correlations among regressands in the system of equations, which are similar to a three-variable VAR model, thus supporting the validity of our estimation framework.

[13] Though the lagged variables of regressands are on the right-hand side of the equations, we did not use a common panel GMM method because of the rolling regression framework we adopted. Adjusting the instrumental variables to fit the model appropriately at each rolling of estimation is not only arbitrary but runs the risk of undermining the consistency of our estimation process. Moreover, the given model specification criteria applied to test the suitability of the GMM estimation cannot be fully satisfied to every equation and every rolling in practice; therefore, the GMM method fares no better than ours.

4.3. Second Step

The second step is to estimate the procyclicality of bank credit and to identify the determinants of this process. We used the fitted values of the first step's regressands as regressors in the behavioral equation. In this step, the estimation procedure is simpler than the first, as the econometric model is reduced to a single equation. As in the first step, the individual bank's fixed effect was considered, and the GMM technique was not employed because of the previously stated reason.

The most important part of the second step is determining the regressand. As we estimate the impact of WSF on bank credit fluctuation, we define a bank credit sensitivity measure that is an indicator variable to estimate bank credit fluctuation. As noted in Section 1, it is natural to assume that the bank credit cycle is, to some degree, synchronized with the business cycle. This synchronization would not be a critical problem, however, if and only if there were moderate loan adjustments at the macro level during an economic downturn, which would be a natural adjustment converging to a new equilibrium. In the case where the bank credit cycle is a critical problem, the over-responses of bank credit compared to the business cycle should be evaluated; during downturns, the excessive response of credit, including the cutting-off of lending, would result in further liquidity shortages, thus aggravating the pressing economic recession. Hence, we defined *the measure of sensitivity of credit growth to the business cycle, θit*. This is a variation of the concept of elasticity.

$$Z_{it} \equiv \frac{\Delta loan_{it,t-4} - \overline{\Delta loan_{it,t-4}}}{\delta(\Delta loan_{it,t-4})}, \quad X_t \equiv \frac{\Delta GDP_{t,t-4} - \overline{\Delta GDP_{t,t-4}}}{\delta(\Delta GDP_{t,t-4})}, \quad \theta_{it} \equiv \frac{Z_{it}}{X_t} \qquad (2)$$

As with the previous measures for credit procyclicality, we applied the same concept to the regressors. While we used the fitted value earned from the first step for the two variables of the WSF ratio and the growth rate of WSF, we built another variable for the WSF deviation in the same manner as the numerator of the bank credit sensitivity measure. By dividing the fitted value of the WSF deviation by the GDP deviation, we built *the measure of the WSF sensitivity, εit*.[14]

[14] It may seem coherent to estimate the WSF sensitivity directly in the first step and use its fitted value in the second step. However, including the WSF sensitivity measure directly in the system equations makes the model's explanatory power less reliable because of the inherent volatility of the measure. In addition, including this measure does not meet our purpose of separating steps to find the driving factors of oversensitivity of credit in the second step.

$$W_{it} \equiv \frac{\Delta WSF_{it,t-4} - \overline{\Delta WSF_{it,t-4}}}{\delta(\Delta WSF_{it,t-4})}, \quad X_t \equiv \frac{\Delta GDP_{t,t-4} - \overline{\Delta GDP_{t,t-4}}}{\delta(\Delta GDP_{t,t-4})}, \quad \epsilon_{it} \equiv \frac{\widetilde{W}_{it}}{X_t} \tag{3}$$

We then estimate the following single behavioral equation (4).

$$\theta_{it} = c + \alpha\theta_{it-1} + \beta_1 \widetilde{WSF}_{it} + \beta_2 \Delta \widetilde{WSF}_{it,t-4} + \beta_3 \epsilon_{it} + \beta_4 X_t + \sum_{k=1}^{K} \beta_k Z_{it}^k + \eta_i + \zeta_{it} \tag{4}$$

The coefficients β1 to β3 are the regression coefficients of the main variables. Xt is the GDP deviation from its time trend, as defined above, and Z_{it}^k are the other factors, which include loan to asset ratio, excess capital holding, and overnight interest rate. Considering possible correlations between a bank's own non-observable characteristics and other regressors, we estimated equation (4) with individual fixed effects. Likewise, in the first step, for the 46 quarters of our sample, we conducted the rolling regression 11 times. The results are presented in Table 1.

As Table 1 clearly shows, the sensitivity of WSF has a significantly positive impact on the sensitivity of bank credit to the business cycle. This result generally holds regardless of the period covered in each of the sub-samples. In other words, if a bank is over (under)-funded in the WSF market in response to the real economy growth (decline), then bank credit would be overly sensitive as well, and it would be a common aspect of bank lending, regardless of the corresponding time period. This finding is not surprising as over-borrowing would mean over-lending and would, in turn, result in the bank over-borrowing from its counter party. This finding suggests that unregulated WSF may contribute to the excessive expansion in the credit cycle.

On the other hand, two other major variables, the WSF ratio and the WSF growth rate, seem to have little impact on the sensitivity of bank credit. There is no doubt that these variables may have explanatory power with respect to the dynamics of the loan volume. In explaining what caused the over-sensitivity of bank credit, however, these variables were found to have no impact. In our framework, procyclicality of bank credit is defined in relative terms as the fluctuation between the credit volume and the GDP. There is a chance that the volume and the growth rate variables of WSF contribute to the dynamics of bank credit rather than to the relative dynamics. However, to observe the relative dynamics of bank credit, it is better to focus on the relative dynamics of the funding structure of the banks. The result of doing so suggests that the over-lending tendency may occur even when banks have relatively low shares of WSF, and in this respect, recognizing WSF sensitivity as the main driver of excessive procyclicality of bank credit is of more importance as an appropriate tool for identifying increasing financial fragility.

rolling / variables	1	2	3	4	5	6	7	8	9	10	11
Intercept	16.98	38.53	1.39	-2.77	-24.76	0.06	16.10	-6.53	-3.53	-9.36	-6.07
	8.86	16.70	6.85	4.92	17.33	6.71	61.01	4.69	5.46	8.52	5.77
	1.92	**2.31**	**0.20**	**-0.56**	**-1.43**	**0.01**	**0.26**	**-1.39**	**-0.65**	**-1.10**	**-1.05**
Loan sensitivity(-1)	-0.04	-0.23	-0.14	0.04	-0.57	0.03	-0.08	0.17	0.01	0.02	-0.05
	0.08	0.07	0.09	0.09	0.12	0.07	0.07	0.06	0.06	0.06	0.04
	-0.56	**-3.10**	**-1.63**	**0.45**	**-4.91**	**0.40**	**-1.09**	**2.67**	**0.22**	**0.29**	**-1.27**
Fitted WSF growth rate	0.04	0.01	-0.01	0.00	-0.02	-0.02	0.11	0.00	-0.01	0.08	0.03
	0.02	0.04	0.02	0.02	0.04	0.02	0.16	0.01	0.01	0.04	0.03
	1.45	**0.26**	**-0.92**	**-0.21**	**-0.58**	**-1.60**	**0.69**	**-0.38**	**-0.68**	**2.01**	**0.98**
Fitted WSF ratio	-0.11	0.32	-0.04	-0.01	-0.11	0.08	-0.09	-0.13	-0.06	-0.26	-0.05
	0.10	0.18	0.08	0.05	0.20	0.07	0.70	0.05	0.09	0.13	0.09
	-1.06	**1.79**	**-0.48**	**-0.13**	**-0.56**	**1.14**	**-0.13**	**-2.66**	**-0.67**	**-2.01**	**-0.61**
Fitted WSF sensitivity	0.61	0.64	0.14	0.02	0.67	0.64	0.39	0.56	1.20	0.87	0.35
	0.13	0.11	0.10	0.14	0.10	0.08	0.05	0.11	0.11	0.07	0.09
	4.54	**5.62**	**1.29**	**0.12**	**6.60**	**8.30**	**7.88**	**5.31**	**11.34**	**12.81**	**4.05**
Loan to asset	-0.17	-0.24	0.07	0.06	0.24	0.00	-0.64	0.13	0.11	0.28	0.10
	0.07	0.14	0.07	0.06	0.25	0.11	0.91	0.05	0.08	0.12	0.07
	-2.41	**-1.73**	**0.91**	**1.02**	**0.96**	**0.03**	**-0.70**	**2.39**	**1.40**	**2.24**	**1.37**
Excess capital	0.03	0.61	0.08	-0.21	-1.33	0.54	1.00	-0.94	-0.43	0.12	0.23
	0.34	0.63	0.28	0.14	0.64	0.34	2.78	0.18	0.20	0.32	0.22
	0.10	**0.97**	**0.28**	**-1.53**	**-2.07**	**1.56**	**0.36**	**-5.15**	**-2.13**	**0.37**	**1.05**
Call rate	-0.99	-7.50	-1.39	-0.22	3.52	-0.77	6.03	1.00	-0.39	-0.39	0.28
	1.40	2.30	0.79	0.62	2.13	0.65	6.63	0.74	0.36	0.48	0.39
	-0.70	**-3.26**	**-1.77**	**-0.36**	**1.65**	**-1.18**	**0.91**	**1.36**	**-1.09**	**-0.81**	**0.73**
GDP deviation	-0.20	1.49	-0.69	0.28	0.39	-0.31	2.43	-1.10	0.48	-0.43	-0.42
	0.27	0.44	0.20	0.16	0.76	0.31	3.30	0.94	0.40	0.46	0.29
	-0.76	**3.37**	**-3.51**	**1.77**	**0.52**	**-1.03**	**0.74**	**-1.17**	**1.18**	**-0.94**	**-1.46**

Table 1. Loan sensitivity results

Notes: The first row of each variable is for its coefficient, the second row is for its standard error, and the third row is for t-statistics. The shaded areas indicate the case of t-statistics exceeding 2 in the absolute value. Same marking rule applies hereafter.

Finally, the results from the most recent sub-sample beginning in the 3rd quarter of 2008 are noteworthy. Although the direct effect of the intervention of the monetary authority was found to be insignificant, the result suggests the existence of an indirect channel of the monetary policy. A monetary authority could have

prevented the further economic downturn caused by the reduction in bank lending by reducing the overnight interest rate.[15] At least to some degree, the monetary authority can affect how banks fund, and thus, through this channel, it can indirectly influence banks' strategies with respect to asset operations, which can overheat the business cycle.

To add briefly to the third step, as noted in Section 4.1, it would be unreasonable to estimate and compare the macro level variables, which are identical at every panel entity, with the variables representing the individual specific characteristics of panel entities. Rather, we describe briefly the macroeconomic implication of over-sensitivity of bank credit incurred by over-sensitivity to WSF.

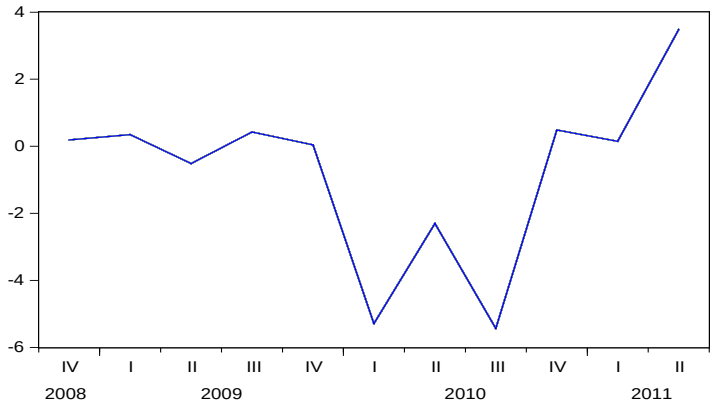


Fig. 5. GDP deviation to aggregate loan deviation

Figure 5 shows the normalized trend deviation of the GDP to the average loan deviation. Notably, the ratio between the two variables has, at times, exceeded the absolute value of 1, which means that the real economy has reacted sensitively to bank credit fluctuations. From this reaction, we can infer the macroeconomic implications of the bank lending channel, although it works indirectly in our study.

5. Role of overseas WSF

We estimated and discussed the inner mechanism of how banks' WSF could affect their credit supply and

[15] The overnight interest rate was estimated to have a significant positive effect on WSF deviation at the first-step regression. Hence, reducing the policy rate would reduce the WSF deviation and thus make WSF sensitivity less volatile.

found that WSF could affect the sensitivity of bank lending, and this, in turn, could result in further business cycle fluctuations. It is probable that whether the funds are from domestic or foreign creditors makes a difference with respect to their impact and channel on credit procyclicality. In actuality, because countries such as Korea have suffered from the volatile flows of foreign capital, which has led to over-fluctuations of exchange rates and accumulations of currency mismatch risk, this analysis could provide further macroeconomic implications.

The majority of foreign currency inflows and outflows are from institutional trade because domestic commercial banks are one of the major borrowers in this market. In Korea, on average, overseas WSF, defined as the sum of inter-bank foreign currency borrowings and foreign currency denominated financial bonds, has remained constant at its maximum, that is, slightly below 40% of the domestic currency denominated WSF, as shown in Figure 6. While its absolute and relative volumes are still smaller than the domestic, it is noteworthy (see Figure 3) that the relative volume of overseas WSF has increased, even after the financial crisis, although this increase partially reflects a dramatic decrease in domestic currency denominated WSF.

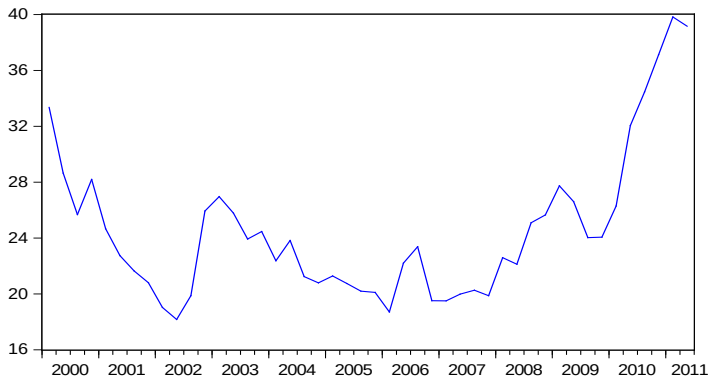


Fig.6. WSF volume comparison: Foreign vs. Domestic (on average among banks)

We separated the total WSF into one denominated by domestic currency and one denominated by foreign currency to analyze the dynamics and effects of the latter on bank credit fluctuation. The estimation framework is identical to that in the previous section, and therefore, we report the results of the second-step estimation only.

The results displayed in table 2 and 3 indicate that the impact of overseas WSF on bank lending is more marked compared to the previous results for total WSF and with only domestic currency denominated WSF. It meets our prior expectation that overseas WSF contributes more to fluctuations in bank credits than does domestic WSF.

rolling / Variables	1	2	3	4	5	6	7	8	9	10	11
Intercept	3.79	36.85	1.66	-5.45	-14.86	-2.36	26.67	1.45	-4.05	-13.05	-4.11
	9.51	15.20	6.11	4.54	17.14	7.24	72.35	5.25	6.40	8.40	5.41
	0.40	**2.42**	**0.27**	**-1.20**	**-0.87**	**-0.33**	**0.37**	**0.28**	**-0.63**	**-1.55**	**-0.76**
Loan sensitivity(-1)	0.01	-0.22	-0.12	0.03	-0.55	0.13	-0.12	0.22	0.01	0.04	-0.01
	0.08	0.07	0.08	0.08	0.11	0.08	0.08	0.06	0.07	0.06	0.04
	0.13	**-2.93**	**-1.49**	**0.39**	**-4.83**	**1.68**	**-1.46**	**3.40**	**0.10**	**0.69**	**-0.21**
Fitted WSF growth rate	0.01	0.01	0.00	0.00	-0.01	0.02	-0.05	0.00	-0.05	-0.04	-0.02
	0.01	0.01	0.01	0.01	0.03	0.02	0.09	0.01	0.02	0.02	0.01
	1.07	**1.21**	**0.39**	**-0.53**	**-0.41**	**1.24**	**-0.57**	**-0.10**	**-2.98**	**-1.68**	**-1.28**
Fitted WSF ratio	0.01	-1.17	-0.53	-0.27	0.96	-0.42	0.90	-0.03	0.31	0.28	-0.29
	0.39	0.63	0.28	0.22	0.95	0.40	4.06	0.20	0.35	0.54	0.29
	0.03	**-1.86**	**-1.85**	**-1.23**	**1.01**	**-1.05**	**0.22**	**-0.15**	**0.89**	**0.51**	**-0.99**
Fitted WSF sensitivity	0.48	0.85	0.47	0.57	0.73	1.22	0.41	0.30	0.60	0.86	0.30
	0.10	0.15	0.09	0.19	0.10	0.19	0.17	0.12	0.07	0.07	0.14
	4.98	**5.87**	**5.05**	**3.06**	**7.15**	**6.28**	**2.40**	**2.48**	**8.18**	**12.41**	**2.18**
Loan to asset	-0.06	-0.08	0.06	0.07	0.15	0.04	-0.49	0.06	0.00	0.18	0.08
	0.08	0.15	0.07	0.06	0.25	0.12	1.07	0.06	0.09	0.13	0.08
	-0.78	**-0.55**	**0.86**	**1.18**	**0.58**	**0.36**	**-0.46**	**1.07**	**0.04**	**1.37**	**1.03**
Excess capital	0.01	-0.03	-0.10	-0.30	-1.55	0.23	0.73	-0.64	-0.10	-0.29	0.03
	0.34	0.62	0.31	0.14	0.66	0.37	3.41	0.19	0.22	0.34	0.22
	0.04	**-0.05**	**-0.33**	**-2.14**	**-2.34**	**0.61**	**0.21**	**-3.40**	**-0.45**	**-0.87**	**0.13**
Call rate	0.07	-6.66	-0.91	0.66	0.72	0.12	0.38	-0.91	0.92	0.31	0.14
	1.44	2.21	0.80	0.65	2.06	0.65	7.26	0.91	0.37	0.38	0.44
	0.05	**-3.02**	**-1.14**	**1.02**	**0.35**	**0.19**	**0.05**	**-1.00**	**2.48**	**0.82**	**0.32**
GDP deviation	-0.12	1.18	-0.53	0.27	0.54	-0.29	0.44	0.97	-0.64	-0.04	-0.37
	0.27	0.44	0.18	0.14	0.72	0.34	3.88	1.19	0.44	0.38	0.24
	-0.46	**2.68**	**-3.00**	**1.93**	**0.75**	**-0.87**	**0.11**	**0.82**	**-1.47**	**-0.10**	**-1.53**

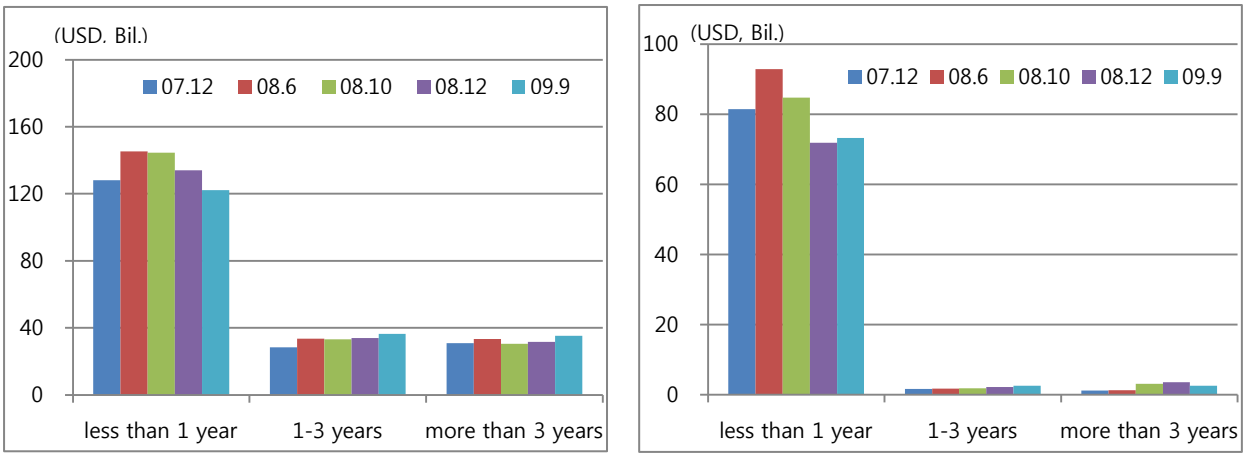
Table 2. Result on the loan sensitivity (foreign currency)

rolling / Variables	1	2	3	4	5	6	7	8	9	10	11
Intercept	21.70	35.14	2.49	-2.96	-22.58	-0.80	14.61	-7.04	-3.76	-10.64	-5.93
	9.00	16.42	6.75	4.78	18.02	6.85	63.28	4.68	5.44	8.65	5.45
	2.41	**2.14**	**0.37**	**-0.62**	**-1.25**	**-0.12**	**0.23**	**-1.50**	**-0.69**	**-1.23**	**-1.09**
Loan sensitivity(-1)	-0.08	-0.26	-0.16	0.04	-0.63	0.03	-0.07	0.18	0.00	0.01	-0.06
	0.08	0.08	0.09	0.09	0.12	0.07	0.07	0.06	0.06	0.06	0.04
	-0.98	**-3.38**	**-1.79**	**0.46**	**-5.25**	**0.46**	**-1.04**	**2.99**	**0.02**	**0.11**	**-1.33**
Fitted WSF growth rate	0.02	-0.01	-0.01	-0.01	-0.04	-0.03	0.20	-0.01	-0.02	0.06	0.02
	0.02	0.03	0.01	0.01	0.04	0.02	0.15	0.01	0.01	0.03	0.02
	0.73	**-0.18**	**-0.61**	**-0.53**	**-0.96**	**-1.66**	**1.31**	**-0.60**	**-1.35**	**2.15**	**1.29**
Fitted WSF ratio	-0.09	0.45	0.01	0.01	-0.14	0.08	0.00	-0.12	-0.13	-0.38	-0.12
	0.11	0.19	0.08	0.05	0.21	0.07	0.66	0.04	0.09	0.13	0.09
	-0.85	**2.42**	**0.08**	**0.16**	**-0.65**	**1.22**	**0.00**	**-2.81**	**-1.43**	**-2.82**	**-1.36**
Fitted WSF sensitivity	0.53	0.46	-0.01	-0.04	0.53	0.76	0.43	0.57	1.26	0.88	0.42
	0.15	0.12	0.09	0.13	0.11	0.10	0.06	0.10	0.11	0.07	0.11
	3.61	**3.95**	**-0.14**	**-0.30**	**4.93**	**7.80**	**7.61**	**5.44**	**10.98**	**12.15**	**3.85**
Loan to asset	-0.23	-0.20	0.04	0.06	0.20	0.01	-0.68	0.13	0.13	0.31	0.11
	0.07	0.14	0.07	0.06	0.26	0.11	0.94	0.05	0.08	0.13	0.07
	-3.31	**-1.44**	**0.57**	**1.06**	**0.78**	**0.08**	**-0.72**	**2.46**	**1.64**	**2.45**	**1.44**
Excess capital	0.06	0.81	0.07	-0.24	-1.55	0.71	1.13	-0.95	-0.58	-0.06	0.27
	0.36	0.66	0.28	0.14	0.67	0.35	2.81	0.18	0.20	0.31	0.21
	0.16	**1.21**	**0.26**	**-1.69**	**-2.29**	**2.02**	**0.40**	**-5.19**	**-2.88**	**-0.20**	**1.31**
Call rate	-1.33	-7.60	-1.55	-0.26	3.77	-0.67	5.76	0.86	-0.13	0.07	0.49
	1.45	2.20	0.75	0.60	2.18	0.63	6.05	0.72	0.35	0.46	0.38
	-0.92	**-3.46**	**-2.06**	**-0.43**	**1.73**	**-1.05**	**0.95**	**1.20**	**-0.38**	**0.14**	**1.30**
GDP deviation	-0.21	1.58	-0.66	0.27	0.36	-0.43	2.80	-0.88	0.45	-0.56	-0.58
	0.28	0.45	0.19	0.15	0.79	0.31	3.35	0.92	0.41	0.45	0.28
	-0.76	**3.48**	**-3.39**	**1.80**	**0.46**	**-1.38**	**0.84**	**-0.96**	**1.09**	**-1.26**	**-2.09**

Table 3. Loan sensitivity results (domestic currency)

We further examine the mechanism behind the aforementioned results. That is, how does the sensitivity of external wholesale liabilities to the business cycle cause bank credit procyclicality even though the volume of overseas WSF is relatively small? We first consider Korea's economic condition. In Korea, the borrowing of foreign currency is much more significant than the issue of foreign currency denominated financial bonds, suggesting that the latter has not been a long-term stable funding source for Korean banks. Figure 7, displaying data from the Bank of Korea (2010), illustrates the essence of the story. Although banks included

in the sample differ somewhat from ours, the maturity structure of the Korean banking sector's WSF from overseas shows a more distinct distribution with concentrated short-term funding.



(Domestic Banks) (Foreign Banks' Branches in Korea)

Fig. 7. Maturity structure of the Korean banking sector's overseas funding

This distribution seems to result, at least in part, from the distorted industrial structure of Korea, the heavy reliance on large export firms, such as Chaebol conglomerates in the shipbuilding, automobile and semiconductor industries.[16] Furthermore, because the Korean domestic currency, the Won, is not widely accepted, firms have no choice but to incur massive exchange rate risk. To hedge the exchange rate risk, however, the major export firms in the world market demand to be in a short position with respect to the FX forwards contract, en masse. This demand has been matched in turn by the domestic banks' short-term foreign currency borrowings[17].

As many studies have noted, under this kind of economic condition, external liabilities further influence the entire economy through the direct channel of exchange rate fluctuation in the FX market, as well as through

[16] Kim and Seo(2009) analyzed the currency mismatch in Korea using the external debt data and the banks' balance sheet statistics. Their findings suggest that financial indicators, such as arbitrage incentives and derivative market activities, are associated with currency mismatches of both Korean domestic banks and foreign bank branches. In the case of domestic banks especially, the real economic variables, such as the value of shipbuilding orders, act as a determinant of currency mismatch.

[17] This mechanism can be summarized as follows: the exchange risk is transferred to the bank from the transaction, and then, the bank borrows the same amount of foreign currency in short-term borrowing contracts and sells it in the spot market to hedge the exchange rate risk. With this scheme, banks can pursue an arbitrage profit without exchange rate risk as long as the roll-over on foreign debt is performed properly, because the same amount of foreign debt that banks should repay will be amortized from the previous FX forwards contract with the exporter.

the indirect channel of bank lending. This process inevitably results in currency and maturity mismatch risks related to overseas WSF. These risks affect the creditworthiness of domestic banks and exchange rate fluctuations, which can, in turn, directly distort an entire economy.[18] Contagions from financial panics reflect the contribution of overseas WSF to such currency and maturity risks. In Korea, during the financial crisis of 2008, foreign creditors began to withdraw the money they had lent to Korean banks, not because of the weakened economy of Korea but because of their own funding problems. This currency and maturity mismatch on overseas WSF triggered a foreign liquidity squeeze on Korean banks, and it came close to erupting into a foreign exchange crisis similar to that of the late 1990s. In this respect, although the share of foreign currency denominated WSF of a bank's total liabilities is insignificant in absolute volume, its impact on the real economy should not be ignored.

In sum, through the direct channels of the exchange rate and the banks' credit risk incurred by currency and maturity mismatch in the FX market, overseas WSF leads to a more volatile loan cycle and then a more fragile macroeconomy. Our estimation result that procyclicality of overseas WSF has a more marked statistical relationship with bank credit procyclicality is therefore not surprising.

6. Conclusion

Credit procyclicality has recently received considerable attention, while the factors that fuel the often-excessive credit growth are rarely part of the discussions. We investigated the relationship between the composition of banks' liabilities and their credit procyclicality. In our empirical study of Korean banks, a higher sensitivity of banks' WSF to the business cycle is found to have contributed to the excessive procyclicality of bank credit, thus exacerbating macroeconomic fragility.

Our discussion has regulatory policy implications. With respect to the countercyclical measures, WSF, through which banks are able to overextend their credit growth, is an important domain that must be monitored and regulated. The regulation of a bank's WSF mechanism would contribute to financial stability through a bank credit channel. In a similar vein, much stronger regulations or harsher levies on banks' WSF

[18] There are many studies on the macroeconomic implications of foreign currency denominated funding, and they mainly focus on the risk of currency and maturity mismatches. However, a thorough investigation of the topic is beyond the scope of this paper. For a detailed review of the direct channel of foreign currency denominated funding, see Bank of Korea (2008).

liabilities, such as the 'Financial Stability Contribution' proposed by the IMF in 2010 and the 'Systemic Risk-adjusted Levy' that was partially launched in Germany, should be given more serious consideration. Additionally, as this study implies, the over-lending by banks can be the result of their over-sensitive borrowing, even when they have relatively low shares of WSF, which highlights the need to monitor the qualitative aspects of the funding structures of banks, such as the maturity and frequency of borrowing as well as the quantity of bank liabilities, per se.

On the other hand, the more pronounced effect of overseas WSF suggests the need for further regulatory policies. These policies are particularly needed in emerging economies with an increasing openness toward cross-border financial markets where the banks' unfettered access to foreign currency denominated liabilities can be a fatal channel through which the credit cycle is unduly amplified and external shocks are easily transmitted. Furthermore, given that the banks' rising reliance on overseas WSF is primarily due to the excess demand for foreign currency that is intrinsic to export-led economies, macroprudential regulation should aim to reform the industry structure, which is over-dependent on exports, and should aim to contain the unbridled movements of cross-border capitals in WSF markets.

It has been proposed that commercial banks' traditional reliance on deposit funding would become more difficult to sustain and banks' WSF would become more important because of the sluggishness in overall income increases, the global decline in income shares of the working class, the innovations in financial instruments, and the continuous penetrations of non-depository financial institutions into the deposit markets. Therefore, clarifying the role and the effects of the banks' WSF on the macroeconomic dynamics would be a meaningful work.

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Appendix

Table A.1. WSF ratio results

rolling / variables	1	2	3	4	5	6	7	8	9	10	11
Intercept	2.00	9.19	17.55	2.69	-9.10	-2.59	6.33	-2.37	-33.12	0.55	-0.27
	5.05	7.16	11.33	5.30	6.81	9.04	7.59	6.25	9.13	2.78	5.31
	0.40	**1.28**	**1.55**	**0.51**	**-1.34**	**-0.29**	**0.83**	**-0.38**	**-3.63**	**0.20**	**-0.05**
WSF ratio(-1)	0.89	0.94	0.87	0.93	0.91	0.92	0.43	0.69	0.85	0.97	0.47
	0.08	0.08	0.10	0.08	0.07	0.08	0.24	0.15	0.14	0.12	0.45
	11.65	**11.64**	**8.70**	**12.01**	**12.79**	**10.96**	**1.80**	**4.48**	**6.30**	**7.76**	**1.03**
WSF growth rate(-1)	-0.02	0.07	0.03	0.06	0.09	0.08	0.01	0.05	0.08	0.07	0.15
	0.06	0.05	0.05	0.04	0.03	0.05	0.04	0.01	0.02	0.02	0.07
	-0.33	**1.47**	**0.77**	**1.52**	**3.61**	**1.45**	**0.41**	**3.76**	**3.35**	**2.77**	**2.00**
WSF deviation(-1)	0.38	-1.61	-0.73	-1.38	-2.14	-2.27	1.68	-1.18	-2.91	-1.97	-2.31
	1.26	1.03	1.02	1.02	0.77	2.26	1.57	0.47	1.06	0.77	0.92
	0.30	**-1.57**	**-0.71**	**-1.36**	**-2.79**	**-1.01**	**1.07**	**-2.50**	**-2.75**	**-2.56**	**-2.50**
Excess loan to deposit	0.04	0.00	0.04	0.02	0.03	0.02	0.12	0.06	0.04	0.00	0.11
	0.04	0.03	0.03	0.03	0.02	0.02	0.06	0.04	0.03	0.03	0.11
	1.16	**0.14**	**1.10**	**0.67**	**1.32**	**1.26**	**2.18**	**1.73**	**1.57**	**0.04**	**1.05**
Call rate	0.19	-1.49	-2.92	-0.78	0.99	0.12	1.20	0.14	-0.52	1.27	0.05
	0.87	1.69	1.65	1.24	1.00	1.22	1.90	0.29	0.40	0.39	0.88
	0.22	**-0.88**	**-1.77**	**-0.63**	**0.99**	**0.10**	**0.63**	**0.50**	**-1.31**	**3.23**	**0.06**
Growth rate of housing price	0.04	0.04	0.12	0.02	-0.07	0.12	0.23	0.24	0.30	-0.61	-0.38
	0.05	0.08	0.09	0.10	0.17	0.10	0.13	0.09	0.12	0.20	0.39
	0.97	**0.47**	**1.33**	**0.17**	**-0.44**	**1.18**	**1.78**	**2.70**	**2.53**	**-3.02**	**-0.96**
WSF dependency of other banks	-0.16	-0.12	-0.27	-0.03	0.11	0.00	-0.32	0.02	0.84	-0.08	0.06
	0.17	0.22	0.25	0.09	0.17	0.30	0.37	0.17	0.24	0.08	0.18
	-0.97	**-0.55**	**-1.11**	**-0.29**	**0.65**	**-0.02**	**-0.87**	**0.14**	**3.50**	**-0.96**	**0.34**

Table A.2. WSF growth rate results

rolling / variables	1	2	3	4	5	6	7	8	9	10	11
Intercept	-25.36	-17.52	31.70	31.46	-2.37	-10.96	14.42	2.05	-11.18	-17.12	7.43
	29.21	65.79	32.82	28.42	22.91	38.70	12.09	7.84	5.06	4.54	8.54
	-0.87	**-0.27**	**0.97**	**1.11**	**-0.10**	**-0.28**	**1.19**	**0.26**	**-2.21**	**-3.77**	**0.87**
WSF ratio(-1)	0.10	-0.25	-0.15	-0.07	-0.15	0.03	-0.32	-0.30	0.02	0.14	-0.10
	0.26	0.31	0.18	0.14	0.13	0.32	0.14	0.12	0.08	0.08	0.11
	0.40	**-0.82**	**-0.84**	**-0.48**	**-1.12**	**0.08**	**-2.35**	**-2.46**	**0.24**	**1.73**	**-0.91**
WSF growth rate(-1)	0.84	1.22	0.89	1.32	1.55	1.34	0.92	0.84	0.76	0.86	1.22
	0.38	0.43	0.30	0.25	0.17	0.40	0.13	0.07	0.07	0.10	0.14
	2.23	**2.85**	**2.99**	**5.24**	**9.18**	**3.33**	**6.85**	**11.91**	**11.41**	**9.01**	**8.56**
WSF deviation(-1)	-6.06	-12.77	-3.03	-14.71	-19.67	-21.86	-5.36	-2.56	-3.06	-3.54	-9.74
	9.18	9.32	6.81	6.24	4.87	16.55	4.99	2.49	3.46	3.45	3.45
	-0.66	**-1.37**	**-0.44**	**-2.36**	**-4.04**	**-1.32**	**-1.08**	**-1.03**	**-0.88**	**-1.03**	**-2.82**
Excess capital	2.14	4.33	2.27	0.30	-0.43	-1.95	-2.39	-2.88	-0.56	0.53	-1.21
	3.65	4.28	2.23	1.20	1.57	1.97	1.49	1.64	0.67	0.74	1.14
	0.59	**1.01**	**1.02**	**0.25**	**-0.27**	**-0.99**	**-1.61**	**-1.76**	**-0.85**	**0.71**	**-1.06**
Call rate	4.20	3.59	-8.47	-10.06	-1.45	0.09	-1.82	0.96	1.47	1.64	-0.53
	7.32	17.58	9.09	8.06	6.34	6.06	2.39	1.41	1.19	1.50	1.84
	0.57	**0.20**	**-0.93**	**-1.25**	**-0.23**	**0.01**	**-0.76**	**0.68**	**1.24**	**1.09**	**-0.29**
Growth rate of housing price	0.66	0.25	0.65	0.43	1.03	1.14	1.74	2.04	1.66	1.26	0.81
	0.42	0.72	0.55	0.65	0.79	0.88	0.48	0.47	0.40	0.84	0.97
	1.57	**0.35**	**1.19**	**0.66**	**1.31**	**1.29**	**3.58**	**4.30**	**4.19**	**1.50**	**0.84**

Table A.3. WSF deviation results

rolling / variables	1	2	3	4	5	6	7	8	9	10	11
Intercept	−1.62	−1.06	3.07	2.19	0.17	1.34	0.03	−0.28	−0.54	−0.51	−1.60
	1.36	2.68	1.60	1.54	1.24	1.07	1.14	0.32	0.27	0.24	0.55
	−1.19	**−0.39**	**1.92**	**1.43**	**0.13**	**1.25**	**0.02**	**−0.87**	**−1.99**	**−2.09**	**−2.88**
WSF ratio(-1)	0.00	−0.01	−0.01	0.00	0.00	−0.01	−0.01	0.00	0.00	0.00	0.01
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
	−0.15	**−1.15**	**−1.25**	**−0.52**	**0.55**	**−0.74**	**−1.29**	**−0.99**	**−0.87**	**0.63**	**0.71**
WSF growth rate(-1)	0.00	0.01	0.00	0.02	0.03	−0.01	0.00	0.00	0.00	0.00	−0.01
	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
	−0.29	**0.36**	**0.30**	**1.21**	**3.12**	**−0.49**	**−0.47**	**−1.13**	**−0.34**	**−0.32**	**−0.95**
WSF deviation(-1)	0.64	0.51	0.59	0.27	−0.09	0.92	0.80	0.75	0.66	0.86	1.05
	0.34	0.33	0.32	0.33	0.25	0.43	0.19	0.09	0.18	0.29	0.28
	1.92	**1.52**	**1.84**	**0.82**	**−0.35**	**2.15**	**4.30**	**8.34**	**3.68**	**3.01**	**3.70**
Call rate	0.36	0.34	−0.83	−0.66	−0.25	−0.35	−0.05	0.03	0.07	0.16	0.70
	0.35	0.75	0.46	0.44	0.35	0.23	0.22	0.07	0.06	0.09	0.18
	1.03	**0.46**	**−1.82**	**−1.51**	**−0.71**	**−1.54**	**−0.22**	**0.42**	**1.08**	**1.73**	**3.90**
Growth rate of housing prices	0.03	−0.01	0.06	0.03	0.07	0.09	0.08	0.07	0.09	−0.04	−0.12
	0.02	0.04	0.03	0.04	0.04	0.03	0.02	0.02	0.02	0.05	0.08
	1.35	**−0.29**	**1.93**	**0.78**	**1.66**	**2.54**	**3.46**	**3.38**	**4.50**	**−0.70**	**−1.52**
Growth rate of NPL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−0.01	0.00	−0.01	−0.01
	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	−0.21	**−1.23**	**−0.79**	**0.58**	**0.29**	**−0.15**	**0.01**	**−2.17**	**−0.28**	**−2.68**	**−2.50**