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Interest Rate-oriented Monetary Policy Framework and Financial Procyclicality*

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This paper shows that the current interest rate-oriented monetary policy framework if combined with sophisticated interbank transactions a la Adrian and Shin (2009), can foster or accelerate financial procyclicality since the central bank's high-powered money can be used as a funding source for financial intermediaries. Interbank transactions that involve maturity transformations pave a silky way for the flow of high-powered money to end up as lending for the ultimate borrowers. This paper also provides some empirical evidence using Korean financial data. In particular, we find that the growth of non-core liabilities, as a close proxy for interbank liabilities, has substantial explanatory power for the growths of core assets, monetary base, and broad money. This paper explores the implications of the findings in terms of the central bank's responsibility for asset price misalignments and financial stability.

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I. Introduction

The recent global financial crisis highlighted the financial intermediaries' role in driving boom and bust cycles in credit and asset prices, and called for attention to the credit supply mechanism in the modern banking system. Adrian and Shin (2009) and Shin (2009a) have pointed out that, in a financial system in which financial intermediaries actively manage their balance sheets in response to shifts in measured risks and changes in asset prices, credit supply is dependent upon three key attributes of financial intermediaries' balance sheets: equity, leverage, and funding sources.

In particular, the equity of financial intermediaries increases much faster than their assets during an asset price upturn, partly due to appraisal profits, so that financial intermediaries observe stronger balance sheets and greater room to increase their leverages and balance sheet sizes. During a downturn of asset prices, this mechanism works in reverse. As a result, the leverage becomes highly procyclical. Finally, the funding source determines the total credit supplied by financial intermediaries as a whole to the ultimate borrowers. Shin (2009a) has emphasized the endogeneity of credit supply, and he has noted that lending to the ultimate borrowers must be funded either from the equity of financial intermediaries or by borrowing from creditors outside the intermediary sector.[1] It is noticeable that transactions between financial intermediaries cannot directly increase the size of loans to the ultimate borrowers.

It is questionable, however, that the financial intermediaries' behavior is the only driving force of financial procyclicality that generates financial boom and busts, given that financial intermediaries need a funding source outside its own sector. A loose monetary policy may contribute to the build-up of financial fragility by making the financial intermediaries' funding activity quite easy. Indeed, there is a growing literature on the role of monetary policy on causing the recent global financial crisis. Some authors argue that monetary policy played an important role by pointing out that too low policy rate for a prolonged period contributed significantly to a sharp rise in the financial intermediaries' leverage and risk appetite and in turn increased financial fragility (Adrian and Shin 2008, and Taylor 2008). Meanwhile, other authors reported that monetary policy played at most a modest role while acknowledging that the policy rate was relatively low in the run-up to the global financial crisis (Bean et al. 2010, and Dokko et al. 2009).

This paper combines two suspects above — monetary policy and financial intermediaries' behavior — under the current interest rate-oriented monetary

[1] Shin and Shin (2010) distinguished between core and non-core liabilities of the banking sector. Core liabilities are held by the ultimate domestic creditors, such as the domestic household sector, while non-core liabilities are held by other financial intermediaries or foreign creditors.

policy framework.[2] This paper shows that the central bank's high-powered money (also called the monetary base) can be used as the financial intermediaries' funding source. The interest rate-oriented monetary policy framework drastically changes the way the central bank's high-powered money is injected into the financial system. In particular, under the current monetary policy framework, in which the central bank adjusts the overnight policy rate rather than the money supply, high-powered money is supplied on an on-demand basis into the financial market, which we claim could help foster asset price bubbles by accommodating positive financial shocks.

On the one hand, without the additional supply of central bank money, transactions (lending and borrowing) or securitizations between financial intermediaries rarely, if ever, increase the total credit supply to ultimate borrowers.[3] It is the central bank money fed into the financial system that increases the credit supply to the ultimate borrowers. Being high-powered, the central bank money even generates a multiplier effect.[4] On the other hand, without the interbank transactions that provide a sophisticated tool for financial intermediaries to manage their balance sheets actively, the current monetary policy framework by itself may not foster or accelerate financial procyclicality.

We emphasize that the interplay or combination of sophisticated interbank transactions and the current interest rate-oriented monetary policy framework has made the credit supply more endogenous and in turn increased financial procyclicality.[5] This is especially so in a financial system where the balance sheets of financial intermediaries are continuously marked to market, and as a consequence the relationship between changes in balance sheet size and leverage is strongly positive, as demonstrated by Adrian and Shin (2009). In that sense, this paper complements and extends the studies of Adrian and Shin (2009), Shin (2009a), and Shin and Shin (2010). The sharply distinct point of our paper is that the central bank's high-powered money may account for the larger part of the funding sources that the financial intermediation sector can obtain from outside the sector. And interbank transactions involving maturity transformations pave a silky way for the flow of the central bank's high-powered money into lending to the ultimate

[2] There is a slight abuse of words in using monetary policy framework here as monetary policy framework is a broader concept — inflation targeting is a form of monetary policy framework, for example. Monetary policy operational (or operating) framework would fit better in the sense that a monetary policy framework can be implemented by interest rate-oriented monetary policy operational framework. Nevertheless, we use monetary policy framework throughout the paper. There should be no confusion in the context of this paper.

[3] Interbank transactions involving maturity transformations, however, can have huge implications regarding financial stability, as noted by Shin (2009a) and Shin and Shin (2010).

[4] This seems very similar to the multiple deposit creation process.

[5] In a technical sense, we add a central bank to the model of Adrian and Shin (2009) and Shin and Shin (2010).

borrowers.

Using Korean financial data, we empirically examine the relationship between loans to the ultimate borrowers and interbank transactions.[6] We find that the growth of non-core liabilities, as a close proxy for interbank liabilities, has substantial explanatory power for the growths of core assets, monetary base, and broad money (M2) when the non-core liabilities of the Korean banking sector increased rapidly from the fourth quarter of 2005. In addition, shocks to non-core liabilities growth significantly affect the common factor between monetary base growth and M2 growth, and the considerable proportion of the forecast variance of the common factor is attributable to the movements of non-core liability growth during the boom and bust periods.

The results in this paper are important in the sense that they widen the understanding of the reason that the loose monetary policy and financial intermediaries' credit expansion have become extremely tighter. Our findings also shed light on how monetary and macroprudential policies become inseparable and suggest that central banks need to pay attention and react to the abnormal developments of interbank transactions and financial procyclicality.[7] Some policy implications of our findings are also explored in terms of the central bank's responsibility for asset price misalignments and financial stability.

This paper is organized as follows. Section II briefly touches on the interest rate-oriented monetary policy framework and then analyzes the link between the framework and financial procyclicality. We modify the accounting framework presented in the works of Shin (2009a) and Shin and Shin (2010), in order to consider the central bank's role explicitly and show that the central bank's high-powered money can be used as the funding source for financial intermediaries. Section III describes recent developments in interbank transactions and loans to the ultimate borrowers in Korea. Section IV, using Korean financial data, provides empirical evidence, and Section V concludes with some policy implications.

II. Central Bank's Money as a Funding Source

We start with a brief touch on current mainstream monetary policy (operating) framework: the interest rate-oriented framework. Under the interest rate-oriented monetary policy framework, central banks determine their policy interest rates

[6] The empirical results in this paper extend to other countries adopting interest rate-oriented monetary policy framework. Please refer to Kim et al. (2011).

[7] Shin (2009b) acknowledged the importance of short-term interest rates in determining the size of leverage and fragility of the financial system. Adrian and Shin (2008) found that the level of the federal funds rate target is a key determinant of financial intermediaries' balance sheet growth.

periodically[8] — once a month or eight times a year, for example — and keep the short-term market interest rates closely aligned with them by deploying monetary policy instruments, such as open market operations and standing facilities. Currently, this framework is adopted by major central banks, including the Federal Reserve, the European Central Bank, the Bank of England, the Bank of Japan, and the Bank of Korea.

As opposed to the quantity-oriented monetary policy framework in which the central bank targets monetary aggregates, the interest rate-oriented framework allows much more degree of freedom regarding the movement of monetary aggregates. Monetary aggregates do provide information about economic status, but they are not targeted by the central bank in the interest rate-oriented framework. In contrast, central banks under this framework need to absorb or supply liquidity through open market operations and/or standing facilities in order to keep the short-term market interest rates closely aligned with the policy rate. Consider a case in which interbank overnight interest rate is substantially higher than the policy rate. In this case, the central bank should supply monetary base through open market operations to bring down the market interest rate to the level of policy rate. In particular, the central bank may purchase government bonds for a week by engaging in repurchase agreements (RPs).[9] Note that this job, maintaining the short-term market interest rate aligned with the policy rate, is always pursued by central banks regardless of the level of the policy rate. Suppose that there is a lending boom, perhaps due to low interest rate, which is in turn due to low policy rate. This would increase the amount of deposit and the demand for reserve. In this case, the central bank should supply monetary base through open market operations or standing facilities to prevent the short term market interest rate from misaligned with the policy rate. Therefore, the monetary base is determined endogenously. In other words, the central bank stands ready to clear the excess supply or excess demand of monetary base.[10]

A key insight is that this interest rate-oriented monetary policy framework, combined with sophisticated interbank transactions, could help foster asset price bubbles by accommodating positive financial shocks. Below we analyze the link between the framework and financial procyclicality.

Now, consider an economy composed of a central bank, banks,[11] ultimate

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[8] Of course, the policy rate is determined to achieve the central bank's objectives: price stability, financial stability, economic growth, etc.

[9] In this case, it is called reverse RP from the central bank's point of view.

[10] An immediate result is that changing the reserve requirement ratio has little effect on monetary aggregates in contrast to typical textbook explanations. Changing the reserve requirement ratio generates the deficiency or excess of monetary base. The central bank has to clear the deficiency/excess by supplying/absorbing of monetary base through open market operations in order to keep the short-term market interest rate from deviating from the policy rate. See Hein and Stewart (2002).

[11] In this paper, banks and financial intermediaries are equivalent unless it is clearly stated

borrowers (households and firms), and foreign creditors. Suppose that *n* banks exist in the economy, so that there are $n+3$ entities in the financial system. Banks are indexed from 1 to *n*. The balance sheet identity[12] for bank i is then:

$$R_i + y_i + \sum_{j=1}^{n} x_j \pi_{ji} = x_i + f_i + e_i + L_i. \tag{1}$$

where R_i is bank *i*'s reserves held at the central bank, y_i is bank *i*'s total loans to the ultimate borrowers, x_j is the total liabilities (except to the central bank and to foreign creditors) of bank j, π_{ji} is the share of bank j's total liabilities (except to the central bank) held by bank i, f_i is bank *i*'s liabilities to foreign creditors, e_i is bank *i*'s equity, and L_i is the borrowing from the central bank. The left hand side of the above equation denotes the total assets of bank i, while the right hand side denotes its total liabilities and equity. Let $x=[x_1,x_2,\cdots,x_n]$, $y=[y_1,y_2,\cdots,y_n]$, $R=[R_1,R_2,\cdots,R_n]$, $e=[e_1,e_2,\cdots,e_n]$, $f=[f_1,f_2,\cdots,f_n]$, and $L=[L_1,L_2,\cdots,L_n]$. And let Π denote a $n\times n$ matrix whose (i,j)th entry is π_{ij} with zeros on the diagonal. We can write:

$$R + y + x\Pi = x + f + e + L. \tag{2}$$

Therefore,

$$y = e + x(I-\Pi) + f + L - R. \tag{3}$$

Let λ_i denote the leverage of bank i, the ratio of its assets a_i to its equity, and Λ denote a diagonal matrix with λ_i on the i th diagonal. Then $\lambda_i \equiv a_i / e_i$. Since $x_i / e_i = \lambda_i - 1 - (L_i + f_i)/e_i$,

$$y = e + e(\Lambda - I)(I-\Pi) + f\Pi + L - R - L(I-\Pi). \tag{4}$$

Thus, the profile of total loans to the ultimate borrowers depends upon the profile of equity, profile of leverage, interbank loans, and liabilities to foreign creditors. It is also dependent upon borrowings from the central bank and reserves. We define a column vector $z \equiv (I-\Pi)u$, where $u=[1,\cdots 1]'$. Note that $z_i = 1-\sum_{j=1}^{n}\pi_{ij}$, which means the proportion of bank *i*'s total liabilities (except to the central bank and to foreign creditors) that is held outside the banking sector. Post multiplying u to both sides of Equation (4) yields the total loans to the ultimate borrowers:

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otherwise. They include commercial banks and shadow banks altogether. In addition, non-banks should be interpreted accordingly.

[12] We follow the notations of Shin (2009a) and of Shin and Shin (2010).

$$\sum_{i=1}^{n} y_i = \sum_{i=1}^{n} e_i + \sum_{i=1}^{n} e_i(\lambda_i - 1)z_i + \sum_{i=1}^{n} f_i \sum_{j=1}^{n} \pi_{ij} + \sum_{i=1}^{n} L_i - \sum_{i=1}^{n} R_i - \sum_{i=1}^{n} L_i z_i. \tag{5}$$

Note that $\sum_{i=1}^{n} L_i - \sum_{i=1}^{n} R_i = 0$ under the assumption of zero currency holdings, and that $e_i(\lambda_i - 1) = x_i + f_i + L_i$, so that the following holds:

$$\sum_{i=1}^{n} y_i = \sum_{i=1}^{n} e_i + \sum_{i=1}^{n} x_i z_i + \sum_{i=1}^{n} f_i. \tag{6}$$

It appears that the total loans to the ultimate borrowers as a whole must come from the equity of the banking sector and funding provided by non-banks. We claim, however, that under an interest rate-oriented monetary policy framework this interpretation misses another major funding source. Note that Equation (6) is supported at any level of total reserves, $\sum_{i=1}^{n} R_i$. Recall also that the reserves are related to the total funding provided by non-banks, as follows:

$$\sum_{i=1}^{n} R_i = r\left(\sum_{i=1}^{n} x_i z_i\right) = \sum_{i=1}^{n} L_i, \tag{7}$$

where r denotes the average reserve requirement ratio. Therefore, we can write:

$$\sum_{i=1}^{n} y_i = \sum_{i=1}^{n} e_i + \frac{1}{r}\sum_{i=1}^{n} L_i + \sum_{i=1}^{n} f_i. \tag{8}$$

If banks want to extend loans to the ultimate borrowers, during a boom perhaps, they can finance this from the central bank provided that they are willing to pay the policy rate, under the current interest rate-oriented monetary policy framework. Here the role of shadow banks in extending loans can be crucial in the sense that they are basically engaged in maturity transformation and thus reduce the term risk

[Figure 1] Banks' Balance Sheets

Bank 1		Bank 2	
y_1	D_1	y_2	D_2
m_2	m_1	m_1	m_2
R_1	L_1	R_2	L_2
	e_1		e_2

y_i : Bank i's loans to ultimate borrowers; D_i : Bank i's deposit liabilities; R_i : Bank i's reserves; L_i : Bank i's borrowings from the central bank; m_i : Bank i's interbank liabilities; e_i : Bank i's equity.

so that overnight borrowings from the central bank can be systematically transformed to long-term loans to the ultimate borrowers. We will come back to this later.

The fact that the central bank's high-powered money can be used as the funding source of financial intermediaries can be more easily understood in a flow-based highly simplified illustration as below, with two banks. Figure 1 represents the balance sheets of the banks.

Suppose that each bank holds the minimum reserves required, and D_i and e_i are constant. Then from the accounting identities the following equations hold:

$$\Delta y_1 + \Delta m_2 = \Delta m_1, \quad \Delta y_2 + \Delta m_1 = \Delta m_2. \tag{9}$$

Adding the two equations in Equation (9), we have:

$$\Delta y_1 + \Delta y_2 = 0. \tag{10}$$

Then suppose, on the other hand, that Bank 1 has excess reserves, and $\Delta R_1 < 0$. Disregarding multiple deposit creation,[13] we then have:

$$\Delta y_1 + \Delta y_2 + \Delta R_1 = 0. \tag{11}$$

Similarly, if Bank 2 taps the central bank, we can write:

$$\Delta y_1 + \Delta m_2 = \Delta m_1, \quad \Delta y_2 + \Delta m_1 = \Delta m_2 + \Delta L_2. \tag{12}$$

Hence, the following equation holds.[14]

$$\Delta y_1 + \Delta y_2 = \Delta L_2. \tag{13}$$

The direct implication of Equations (9)-(13) is that interbank liabilities, while they should expand the balance sheets of the banks, do not affect the size of bank loans to the ultimate borrowers. That increases when excess capacity is exploited (that is, $\Delta R_1 < 0$), or when banks borrow more from the central bank ($\Delta L_2 > 0$).

If Bank 2 is able to fund ΔD_2 from the non-bank sector or abroad, then the fresh funds injected to the banking system can boost bank lending:

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[13] Otherwise, we have $\Delta y_1 + \Delta y_2 + \Delta R_1 / r = 0$.

[14] Here, the multiple deposit creation process is again disregarded. After this consideration, we have $\Delta y_1 + \Delta y_2 = \Delta L_2 / r$.

$$\Delta y_1 + \Delta y_2 = \Delta D_2. \tag{14}$$

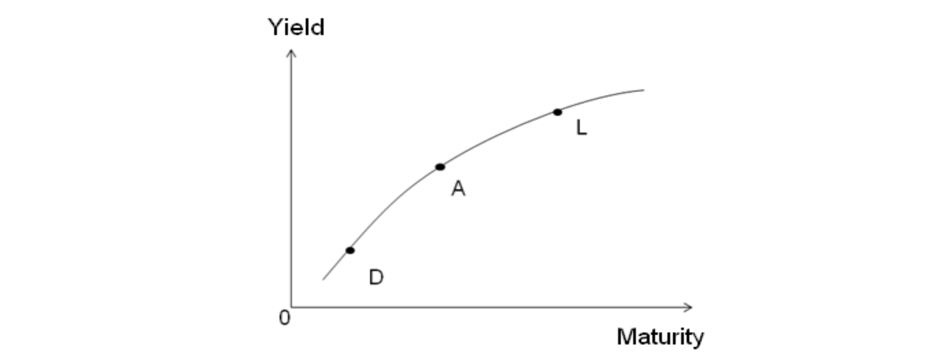
Furthermore, for some reason the equity value e_i of each bank rises, and if other things are constant we then have

$$\Delta y_2 + \Delta y_1 = \Delta e_1 + \Delta e_2. \tag{15}$$

This may be interpreted as pro-cyclicality of the banking system. Asset price inflation can boost bank lending.

The message of this simple accounting exercise is as follows. Unless there is huge excess capacity (in the form of excess reserves or idle money in the non-bank sector) or additional borrowing from the central bank, the banking system cannot by itself generate a lending boom. If it does then there must be some shocks originating from outside the banking system, such as international capital inflows and asset price inflation, which induce banks to exploit the excess capacity in the banking sector or to borrow more from the central bank. Interbank liabilities, while they may affect the distribution of bank lending among banks, should not change the total size of bank lending.

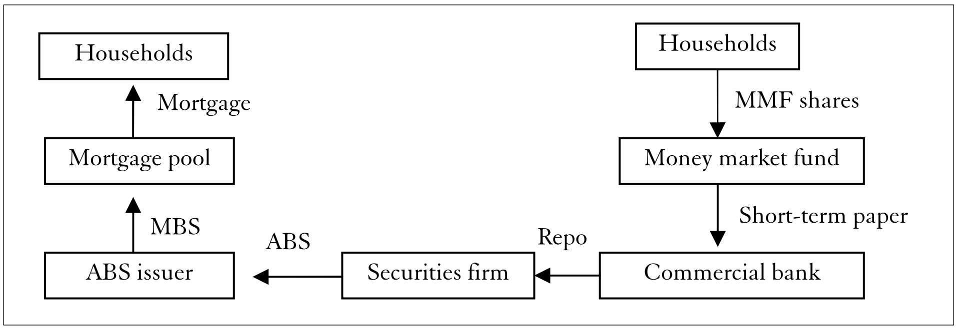
[Figure 2] Interbank Transactions Involving Maturity Transformation



Think about the following upward sloping yield curve, as shown in Figure 2. Bank 1 takes a deposit at *D* and makes a loan at *L*. It then takes profits by the vertical difference between points *L* and *D* multiplied by the volume of the loan (or deposit), at the risk of maturity mismatch by the horizontal difference between points *L* and *D* multiplied by the volume of the loan. And in fact, this is the way banks earn profits. Now, instead of making a loan, Bank 1 may lend to Bank 2 at *A* and Bank 2 in turn supply the loan (at *L*). Here, an interbank liability has been created and a maturity transformation exploited. Through the maturity transformation, Bank 1 shares profits with Bank 2 with the benefit of less risk of maturity mismatch. Through the creation of interbank liabilities, however, systemic risk has emerged. If for some reason Bank 1 refuses to rollover the debt of Bank 2, and if Bank 2 is unable to repay, then Bank 2 becomes insolvent, which may have a chain effect on Bank 1. In fact, when maturity transformation is exploited by many banks, the entire banking system may be exposed to potential systemic risk.

Financial innovation, capital inflows, and lending competition among banks lead to active transformations of maturity through interbank liabilities. The shadow financial system consists of non-depository financial intermediaries such as investment banks, mortgage companies, hedge funds, SIVs, etc. They do not accept deposits like depository banks and are therefore not subject to the same regulations. While they have many different forms in terms of their legal structures and complexities, one activity they pursue in common is this: exploiting maturity transformation.

[Figure 3] Chain of Financial Intermediation

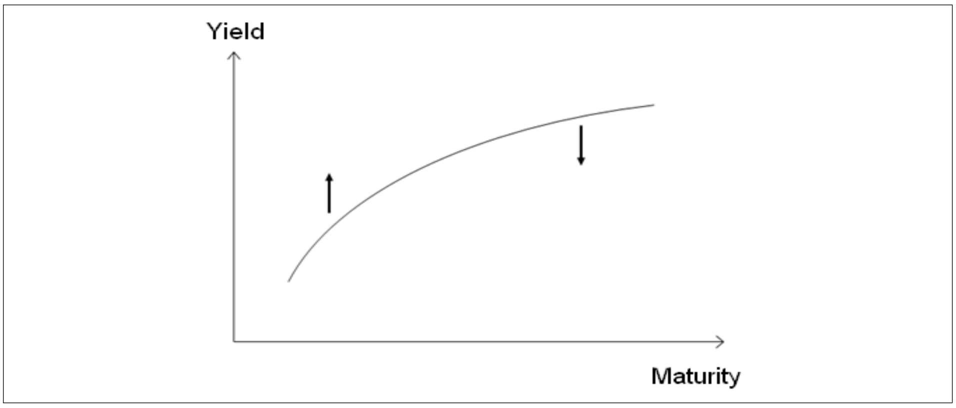


Source: Shin and Shin (2010).

The long chain of financial intermediation, as seen in Figure 3, has been exemplified by the infamous subprime mortgage lending mechanism. At each stage of intermediation, maturity was transformed and cheap sources of funding such as interbank liabilities and short term debts facilitated the intermediation chain. As a result of intense maturity transformation, the balance sheet of the banking sector grew rapidly. Other things being constant, active maturity transformation putting upward pressure on short term interest rates and downward pressure on long term rates should lead to a flattening of the yield curve.[15]

[15] Flattening or even inversion of the yield curve usually draws some degree of attention from policymakers. For example, Alan Greenspan mentioned in February 2005 that "The favorable inflation performance across a broad range of countries resulting from enlarged global goods, services and financial capacity has doubtless contributed to expectations of lower inflation in the years ahead and lower inflation risk premiums. But none of this is new and hence it is difficult to attribute the long-term interest rate declines of the last nine months to glacially increasing globalization. For the moment, the broadly unanticipated behavior of world bond markets remains a conundrum."

[Figure 4] Twist of Yield Curve



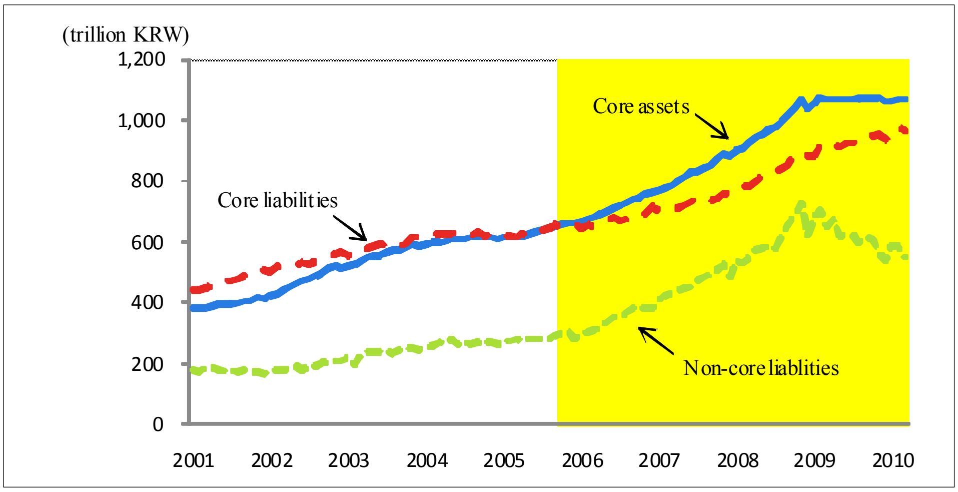
We demonstrate that the contemporary interest rate-oriented monetary policy framework is designed in a way that accommodates possible credit shocks caused by maturity transformation. The logic is simple. Suppose a central bank follows a (Taylor type) rule-based inflation targeting monetary policy. A massive maturity transformation will rapidly increase credit and raise short term market interest rates. Short term market rates will diverge from the policy rate set by the central bank. Other things being constant (or as long as this financial activity does not change the inflation path), the central bank will then act to reduce the gap between market interest rates and the policy rate through open market operations. As a result, the central bank's high-powered money will be additionally supplied. A massive increase in interbank liabilities should therefore lead to increases in the monetary aggregates as well as in the loans supplied to the ultimate borrowers, which in turn contributes to the increase in financial procyclicality.

III. Credit Supply in the Korean Banking Sector

In this section, we explore the relationship between the credit supply to the ultimate borrowers and non-core liabilities as a close proxy for interbank liabilities,[16] by using Korean banking data. We henceforth define non-core KRW liabilities as the sum of CDs (interbank), commercial bank debentures, borrowings from financial institutions, repos, call money, and bills and credit card receivables sold in KRW. Non-core FX liabilities are meanwhile defined as total liabilities in foreign currency minus total deposits in foreign currency. Core assets and core liabilities are defined as the loans and the deposits of the banks, respectively.

[16] For example, non-core liabilities include commercial bank debentures owned by the private sector (households and firms).

[Figure 5] Core Assets, Core Liabilities, and Non-Core Liabilities



[Figure 6] Relationships between Core Assets and Non-Core Liabilities

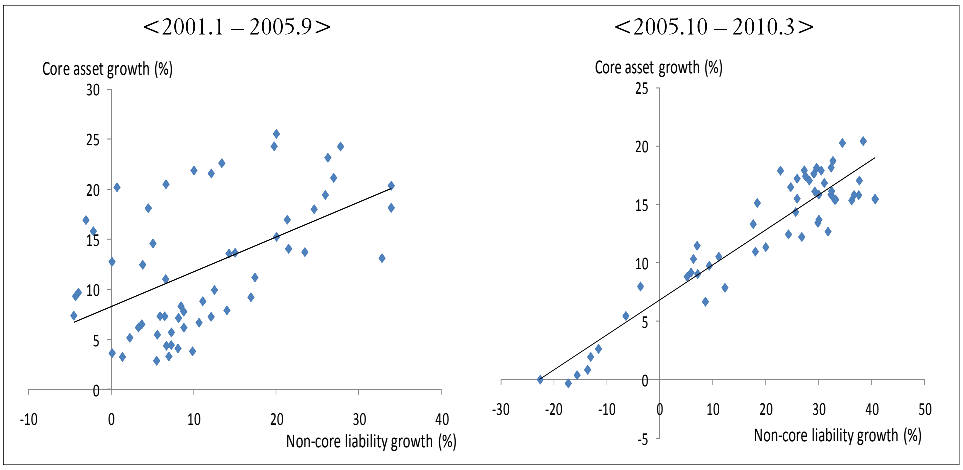


Figure 5 plots the core assets (loans), core liabilities (deposits), and non-core liabilities of the Korean banking sector. From the fourth quarter of 2005 until the emergence of the global financial crisis in 2008, non-core liabilities increased rapidly. This was mainly related to the faster growth of private credit (loans to ultimate borrowers such as households and corporations), which was due to increases in both lending competition among domestic banks and in capital inflows through the foreign currency liabilities of foreign bank branches in Korea. Accordingly, core asset growth and non-core liability growth exhibit positive correlations, as shown in Figure 6. Interestingly, the relationship between core asset growth and non-core liability growth got stronger from October 2005 to March 2010. A sharp increase in loans to ultimate borrowers seemed to be induced by a surge in non-core liability since the fourth quarter of 2005.[17] In this sense, non-core liability growth may play an important role in the core asset growth dynamics. This is one of our main hypotheses to be tested empirically.

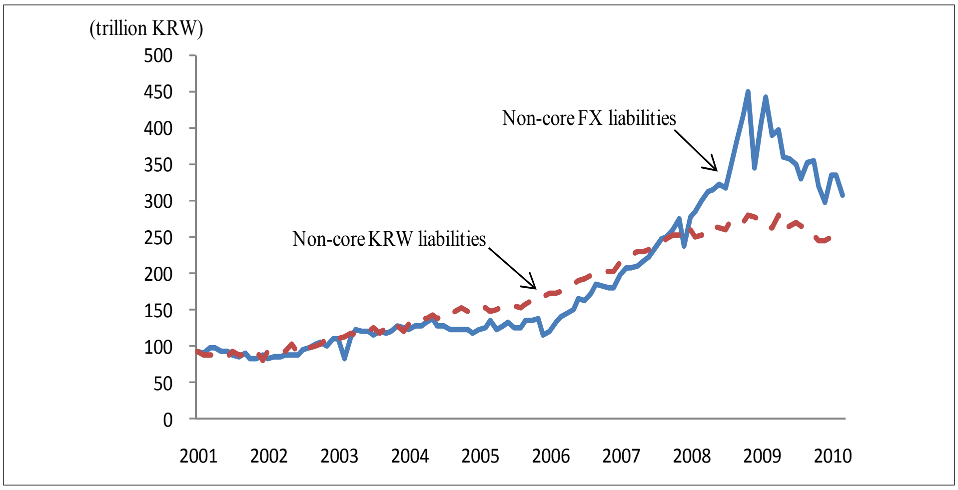
Now let us talk about two major sources that remarkably increased non-core liabilities. First, lending competition among banks caused a substantial increase in the size of interbank liabilities. The oligopolistic market structure often leads Korean banks to compete for lending, and the loan-to-deposit ratio increased rapidly in consequence. The shortage of retail deposits also forces banks to rely on the credit market. Hence, core assets remained above the level of core liabilities, meaning that the loan-to-deposit ratio exceeded 1, as shown in Table 1.

[Table 1] Loan-to-Deposit Ratio of the Korean Banking Sector

(End of period)

Year	2001	2003	2005	2007	2008	2009	2010.3
Ratio	0.82	0.95	1.00	1.17	1.18	1.13	1.11

[Figure 7] Non-Core KRW and FX Liabilities

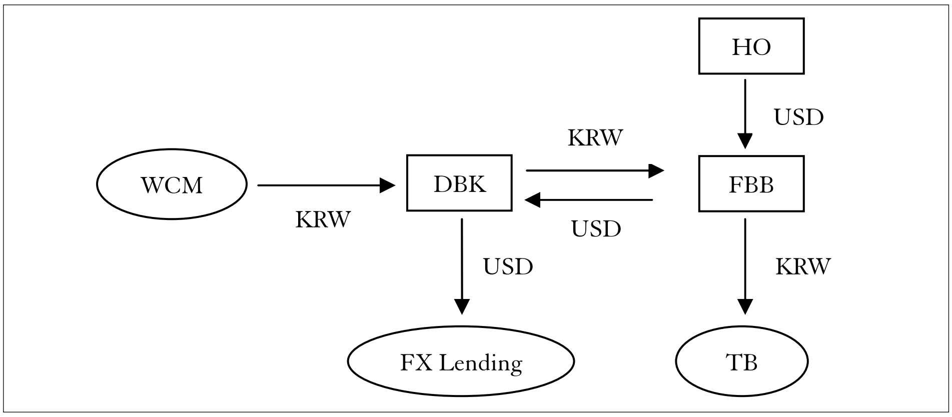


Next, the FX borrowings of foreign bank branches in Korea also contributed to the sharp increase in non-core liabilities from the first quarter of 2006. While

[17] A referee suggested a possible route through which an increase in non-core liabilities stimulated the growth of core assets of the banking sector during the covered period. In particular, he/she explained that an increase in non-core liabilities due to a surge in foreign capital inflows in the form of short-term foreign currency liabilities of Korean banks was one of the driving forces that caused a steep increase in core assets. Massive capital inflows suppressed long-term interest rates and helped strengthening a housing boom. Indeed, real estate project finance and/or mortgage loans rose sharply during the covered period.

Korean banks raised the necessary funds by issuing CDs and commercial bank debentures, foreign bank branches were funded mainly by their headquarters. As clearly seen in Figure 7, non-core FX liabilities were increasing substantially relative to non-core KRW liabilities, implying that a large amount of the non-core liability growth was ascribable to non-core FX liabilities, particularly of foreign bank branches in Korea.

[Figure 8] Foreign Exchange Swap



Source: Kim (2010).

These two major sources (lending competition and FX borrowings), we emphasize, are closely related to each other. Most foreign bank branches are known to borrow foreign currency from their head offices (HO) in attempts to seek capital gains without risk. In Korea, for example, foreign exchange swaps (FES) are a prevalent form of foreign liquidity funding by the banking sector (Figure 8). Through an FES, a domestic bank (DBK) raises US dollar funds from a foreign bank branch (FBB) and makes foreign currency loans. In return, the domestic bank borrowing Korean won from the wholesale credit market (WCM) through CDs and commercial bank debentures furnishes the foreign bank branch with KRW funds. The foreign bank branch then invests this money in TBs and obtains capital gains. Also, maturity is transformed in this way: through borrowing at short term interest rates and investing in assets with longer term rates. It is not a coincidence that non-core foreign currency and Korean won liabilities move in the same direction. Capital inflows often lead to real exchange rate appreciation, inflationary pressures on asset markets and the economy as a whole, deterioration in the current account, and a boom in bank lending.[18] In Korea, overseas borrowings of banks, i.e., non-core FX liabilities, contribute to enhancing the procyclicality of capital inflows.[19]

[18] See Calvo et al. (1994).
[19] See Song and Kim (2009).

The relationship between the capital inflows denominated in foreign currencies and loans to the ultimate borrowers denominated in the domestic currency will be investigated through empirical analysis in the next section.

Table 2 shows the flow of foreign liquidity funds. In 2007, a total of 102 billion dollars flowed in, and the banking sector borrowed 56.3 billion dollars. Foreign investors purchased 33.8 billion dollars worth of TBs and monetary and foreign exchange stabilization bonds issued by the monetary authority. Of the 102 billion dollar inflow, only 15.1 billion dollars were absorbed as foreign reserves by the monetary authority and 16.2 billion dollars held as external assets by the government and the banking sector. The rest was recycled.

In 2007, foreign investors and the foreign bank branches in Korea purchased 44.7 billion dollars of domestic assets, and the equivalent worth of KRW liquidity therefore had to increase.[20] Regardless of the volume recycled, a significant part of the capital inflows was intermediated, and liquidity swelled as capital flowed in massively. Indeed, the sharp rise in non-core foreign currency liabilities was matched by an increase in non-core KRW liabilities, i.e., interbank liabilities. But again, as pointed out previously, without huge excess lending capacity the banking sector cannot generate substantial liquidity through interbank liabilities alone.

[Table 2] Uses and Sources of FX Liquidity (2007)

Uses (billion USD)		Sources	
External Assets		**External Liabilities**	
General government	3.0	General government	21.5
Banks	13.2	Banks	56.3
(Domestic banks)	(10.3)	(Domestic banks)	(26.8)
(FBB)	(2.9)	(FBB)	(29.5)
Other	-0.0	Other	33.0
MA	15.1	MA	12.3
Overseas equity investment	52.6	Foreign equity investment	-28.9
Overseas FDI	15.6	Foreign FDI	1.8
Financial derivatives	-5.4	Others	0.2
Other investments	2.4	CA	5.9
Other capital accounts	7.8		
Errors and omissions	-2.1		
Total	102.0	**Total**	102.0

Note: MA (Monetary Authority), FBB (Foreign bank branches).
Source: Kim (2010).

[20] Foreign bank branches purchased 10.9 billion dollars of TBs and MSBs in 2007.

IV. Empirical Evidence

1. Non-core Liabilities and Core Assets

In this section, we investigate the relationship between non-core liabilities and core assets in the Korean banking sector. Toward this end, we run the following regression:

$$CA_t = \alpha + \beta_1 CA_{t-1} + \beta_2 NCL_t + \beta_3 Z_t + \varepsilon_t , \tag{16}$$

where CA_t is the core asset growth rate, NCL_t is the non-core liability growth rate, and Z_t denotes the control variables.

First, core asset growth is regressed on non-core liability growth and other explanatory variables by OLS for the full-sample period, 2001:1-2010:3. The overnight call rate (first differenced) and the term spread between 3-year government bond yields and the overnight call rate are considered as other control variables. All growth rates are calculated as the differences in logarithms of the variables at times t and $t-12$, that is, the year-on-year growth rate.

We furthermore divide our sample period into two sub-samples, 2001:1-2005:9 and 2005:10-2010:3, in an attempt to address how the results differ depending upon the sub-sample period. During the second sub-sample period, there was a substantial increase in capital inflows first, followed by sharp capital outflows immediately after onset of the global financial crisis in 2008.

We present the estimation results in Table 3. With an adjusted R^2 of 97%, the coefficients of non-core liabilities are statistically significant in the second sub-sample. In contrast, the coefficients of non-core liability growth are not significant in the first sub-sample. Thus, non-core liability growth is positively related to core asset growth in the second sub-sample period, when non-core liabilities increased remarkably and decreased after the global financial crisis. Our finding suggests that an increase in private credit would be induced by rising non-core liabilities.

In particular, there are significant, negative coefficients on the term spread between 3-year government bond yields and the overnight call rate in the second sub-sample, implying that the core asset growth rate increases higher as the slope of the yield curve flattens. It is well known that the term spread of the yield curve is usually regarded as a leading indicator of the business cycle, but the term spread is unlikely to reflect real activity of the Korean economy during the second sub-sample period, due to the active maturity transformations by the banking sector and some other reasons.

[Table 3] Regression of Core Asset Growth on Non-core Liability Growth

Full-sample Period (2001.1 – 2010.3)

Dependent variable : **Core asset growth**	Model 1	Model 2	Model 3
Core asset growth (-1)	0.514*** [0.139]	0.963*** [0.047]	0.512*** [0.142]
Non-core liability growth	0.071*** [0.024]	0.028 [0.020]	0.073*** [0.024]
Term spread		0.003 [0.004]	0.003 [0.003]
Call rate			0.001 [0.006]
Constant	0.040*** [0.015]	-0.004 [0.005]	0.037** [0.017]
Adjusted R-squared	0.973	0.959	0.973

Sub-sample period 1 (2001.1 – 2005.9)

Dependent variable : **Core asset growth**	Model 1	Model 2	Model 3
Core asset growth (-1)	0.763** [0.352]	0.981*** [0.033]	0.944*** [0.038]
Non-core liability growth	0.023 [0.014]	-0.003 [0.024]	0.016 [0.016]
Term spread		0.013*** [0.003]	0.011*** [0.004]
Call rate			0.007 [0.009]
Constant	0.023 [0.032]	-0.011*** [0.004]	-0.006 [0.005]
Adjusted R-squared	0.982	0.979	0.983

Sub-sample period 2 (2005.10 – 2010.3)

Dependent variable : **Core asset growth**	Model 1	Model 2	Model 3
Core asset growth (-1)	0.636*** [0.083]	0.764*** [0.075]	0.758*** [0.081]
Non-core liability growth	0.128*** [0.026]	0.069* [0.035]	0.069* [0.035]
Term spread		-0.006* [0.003]	-0.006* [0.003]
Call rate			-0.002 [0.004]
Constant	0.020*** [0.006]	0.022*** [0.005]	0.023*** [0.006]
Adjusted R-squared	0.972	0.972	0.971

Note: The values in brackets are Newey-West standard errors.
*, **, and *** indicate statistical significances at the 10%, 5%, and 1% levels, respectively.

2. Non-core Liabilities and Monetary Aggregates

Of central interest is the relationship between non-core liabilities and the monetary aggregates. In order to examine this relationship, the following regression model is estimated:

$$M_t = \alpha + \beta_1 M_{t-1} + \beta_2 NCL_t + \beta_3 Z_t + \varepsilon_t, \tag{17}$$

where M_t is the monetary aggregate growth rate, NCL_t is the non-core liability growth rate, and Z_t denotes other control variables. Both the monetary base and M2 growth rates are employed as dependent variables. We regard the short-term interest rate (overnight call rate) and the industrial production growth rate as other control variables,[21] in that the real money balance is a function of nominal interest rates and real output.

In the first sub-sample period, the coefficients of non-core liability growth are insignificant, with a low R^2 of about 10%, suggesting that non-core liability growth does not play a key role in accounting for monetary base growth. In the second sub-sample period, in contrast, the coefficients of non-core liability growth have statistical significance at the 5% level, with a relatively high R^2 of about 36%. In conjunction with the estimation results shown in Table 4, it is argued that monetary base growth is attributable to the growth in non-core liabilities. This means that, under an interest rate-oriented monetary policy framework, the central bank increases the money supply to reduce short-term market interest rates when private credit via non-core liabilities increases rapidly.

In parallel fashion, the dynamics of M2 growth are also associated with and explained by non-core liability growth since October, 2005, as presented in Table 5. When M2 Growth is regressed, the size of the coefficient of non-core liabilities is smaller, not surprisingly, because M2 as broad money is increased through the creation of credit. The significantly positive coefficient of non-core liability growth is robust across different model specifications. As non-core liability growth has differing effects on core asset growth across the two sub-sample periods, so does it impact monetary aggregate growth differently. In summary, an increase in non-core liabilities has explanatory power for the increases in both private credit and the monetary aggregates.

[21] Including the spread between call rate and the policy rate as a control variable had little effect on the estimation result.

[Table 4] Regression of Monetary Base Growth on Non-core Liability Growth

Full-sample Period (2001.1 – 2010.3)

Dependent variable : **Monetary base growth**	Model 1	Model 2	Model 3
Monetary base growth (-1)	0.482*** [0.089]	0.467*** [0.084]	0.443*** [0.066]
Non-core liability growth	0.090** [0.045]	0.080* [0.045]	0.086* [0.049]
Call rate		-0.073* [0.043]	-0.089* [0.051]
Industrial production growth			0.375 [0.429]
Constant	0.040*** [0.012]	0.041*** [0.012]	0.040*** [0.012]
Adjusted R-squared	0.256	0.270	0.274

Sub-sample period 1 (2001.1 – 2005.9)

Dependent variable : **Monetary base growth**	Model 1	Model 2	Model 3
Monetary base growth (-1)	0.678*** [0.124]	0.663*** [0.095]	0.663*** [0.098]
Non-core liability growth	-0.011 [0.055]	-0.014 [0.057]	-0.013 [0.057]
Call rate		-0.051 [0.094]	-0.052 [0.092]
Industrial production growth			-0.361 [0.418]
Constant	0.030** [0.013]	0.030** [0.014]	0.031** [0.014]
Adjusted R-squared	0.115	0.107	0.099

Sub-sample period 2 (2005.10 – 2010.3)

Dependent variable : **Monetary base growth**	Model 1	Model 2	Model 3
Monetary base growth (-1)	0.563*** [0.105]	0.547*** [0.095]	0.492*** [0.084]
Non-core liability growth	0.108** [0.043]	0.092** [0.044]	0.109** [0.054]
Call rate		-0.070 [0.048]	-0.098* [0.056]
Industrial production growth			0.572 [0.511]
Constant	0.030** [0.013]	0.034*** [0.013]	0.033** [0.013]
Adjusted R-squared	0.352	0.363	0.378

Note: The values in brackets are Newey-West standard errors.
*, **, and *** indicate statistical significances at the 10%, 5%, and 1% levels, respectively.

[Table 5] Regression of M2 Growth on Non-core Liability Growth

Full-sample Period (2001.1 – 2010.3)

Dependent variable : **M2 growth**	Model 1	Model 2	Model 3
M2 growth (-1)	0.922*** [0.035]	0.924*** [0.035]	0.927*** [0.036]
Non-core liability growth	0.005 [0.008]	0.005 [0.008]	0.006 [0.008]
Call rate		0.004 [0.003]	0.003 [0.003]
Industrial production growth			0.036 [0.039]
Constant	0.007** [0.003]	0.006** [0.003]	0.006* [0.003]
Adjusted R-squared	0.873	0.872	0.872

Sub-sample period 1 (2001.1 – 2005.9)

Dependent variable : **M2 growth**	Model 1	Model 2	Model 3
M2 growth (-1)	0.921*** [0.054]	0.922*** [0.055]	0.920*** [0.056]
Non-core liability growth	-0.020 [0.019]	-0.020 [0.020]	-0.019 [0.020]
Call rate		-0.001 [0.014]	-0.001 [0.014]
Industrial production growth			-0.048 [0.072]
Constant	0.008* [0.005]	0.008* [0.005]	0.009* [0.005]
Adjusted R-squared	0.852	0.849	0.847

Sub-sample period 2 (2005.10 – 2010.3)

Dependent variable : **M2 growth**	Model 1	Model 2	Model 3
M2 growth (-1)	0.835*** [0.045]	0.844*** [0.046]	0.858*** [0.047]
Non-core liability growth	0.016** [0.006]	0.016** [0.006]	0.017** [0.007]
Call rate		0.003 [0.003]	0.001 [0.004]
Industrial production growth			0.065 [0.046]
Constant	0.015*** [0.005]	0.014*** [0.005]	0.012** [0.005]
Adjusted R-squared	0.812	0.809	0.812

Note: The values in brackets are Newey-West standard errors.
*, **, and *** indicate statistical significances at the 10%, 5%, and 1% levels, respectively.

The single equation models estimated above implicitly assume the exogeneity of non-core liability growth. In practice, however, we can instead consider the interactions between monetary aggregate growth and non-core liability growth; accordingly, our VAR model could be specified as usual. However, since monetary base growth and M2 growth are highly correlated with each other, it would be better to extract the money growth factor, that is, the common factor in the variations of monetary base growth and M2 growth.[22]

We set up a traditional VAR model as follows:

$$\begin{bmatrix} NCL_t \\ F_t \end{bmatrix} = \Phi(L) \begin{bmatrix} NCL_{t-1} \\ F_{t-1} \end{bmatrix} + \nu_t, \quad (18)$$

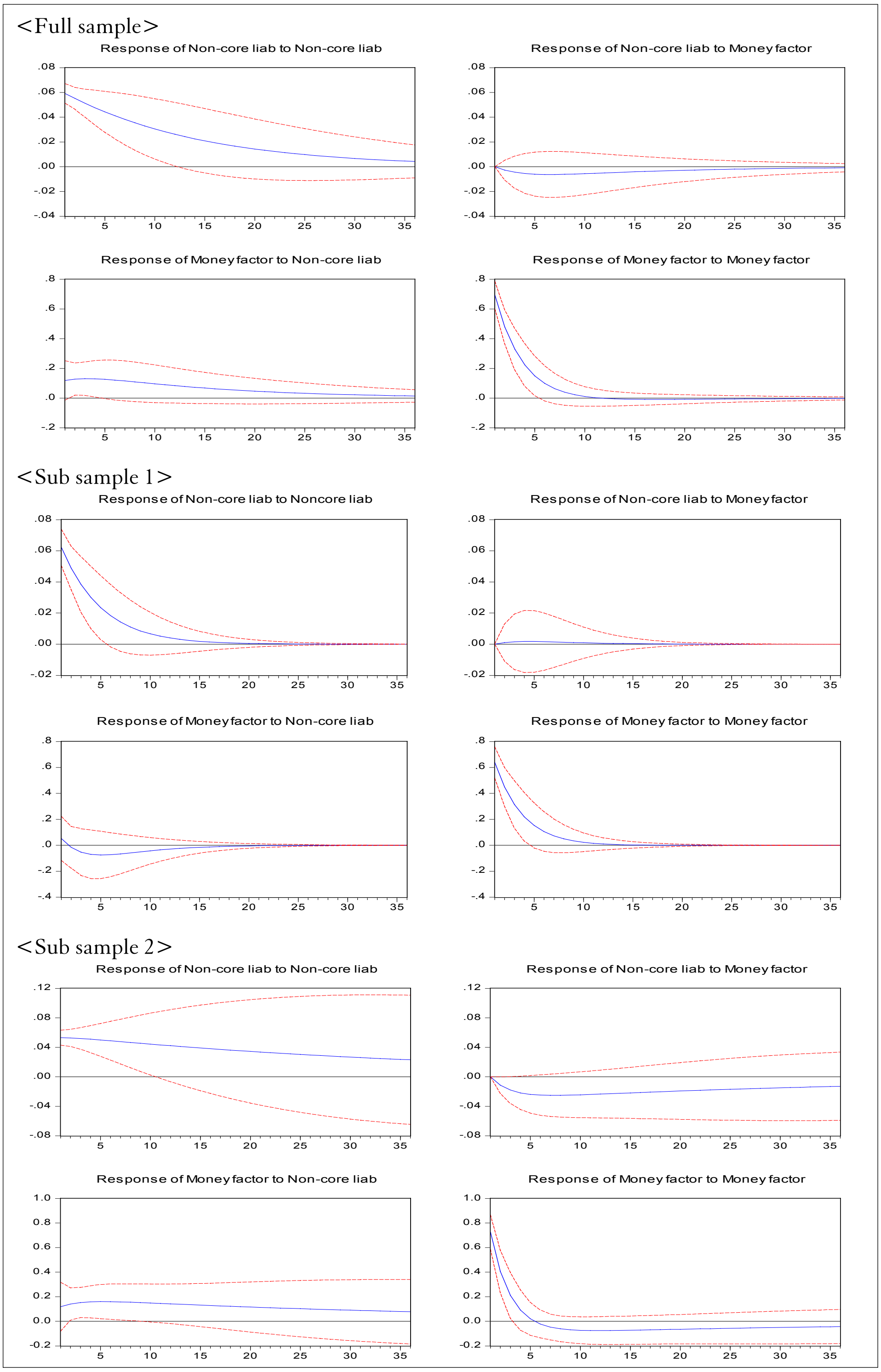
where NCL_t is the non-core liability growth rate, F_t is the money growth factor, $\Phi(L)$ is a lag polynomial , and the error term ν_t is mean zero with covariance matrix R.

To start with, we extract the first principal component of monetary base growth and M2 growth. More precisely, the money growth factor series is normalized with zero mean and unit variance. Evidently, over 90% in the variance in monetary aggregate growth is accounted for by the first principal component, and the money growth factor is highly correlated with monetary base growth (0.81) and M2 growth (0.77).

Now we stack non-core liability growth and the money growth factor into a vector, and estimate the dynamics of the vector as a VAR. The order of the VAR is determined by AIC criteria; as a result, one lagged variable is added into the VAR system. We order the variables with non-core liability growth placed first, and then the money growth factor. We display the parameter estimates of the VAR model in Table 6. The off-diagonal coefficients seem insignificant in the full-sample and first sub-sample periods, while appearing significant at the 5% level in the second sub-sample period. This implies that the money growth factor is influenced by the lagged variables of non-core liability growth as well as the money growth factor. Meanwhile, the loading on the money growth factor is negative and significant when non-core liability growth is regressed for the second sub-sample period, indicating that non-core liability growth at t is inversely affected by the money growth factor at $t-1$.

[22] This approach has the benefit of controlling the idiosyncratic shocks to each monetary aggregate. For example, in December 2006, the Bank of Korea raised the average reserve requirement ratio from 3.0% to 3.8%, which significantly increased the monetary base while M2 barely changed. Conversely, M2 sometimes increases without a change in the monetary base in the case that non-banks (e.g., insurance companies) purchase CDs from banks.

[Figure 9] Impulse Responses of VAR Model



Now, in Figure 9, we consider the results of the impulse responses to Cholesky one standard deviation shocks along with two standard deviation bands. In the second sub-sample period, a one standard deviation shock to non-core liability growth raises the money growth factor significantly; it peaks after about 3 months and then dies out slowly.[23] This suggests that a non-core liability growth shock has an impact on the dynamics of the money growth factor.

[Table 6] Parameter Estimates of VAR Model

< Full-Sample Period : 2001.1 – 2010.3 >

Money growth factor$_t$ = -0.094 +0.690***Money growth factor$_{t-1}$ +0.769Non-core liability growth$_{t-1}$
[0.103] [0.068] [0.508]
(Adjusted R-squared=0.538)

Non-core liability growth$_t$ = 0.008 -0.004Money growth factor$_{t-1}$ +0.940*** Non-core liability growth$_{t-1}$
[0.009] [0.006] [0.043]
(Adjusted R-squared=0.829)

< Sub-Sample Period 1 : 2001.1 – 2005.9 >

Money growth factor$_t$ = -0.008 +0.702***Money growth factor$_{t-1}$ -0.854Non-core liability growth$_{t-1}$
[0.132] [0.097] [0.864]
(Adjusted R-squared=0.483)

Non-core liability growth$_t$ = 0.025* +0.002Money growth factor$_{t-1}$ +0.785*** Non-core liability growth$_{t-1}$
[0.013] [0.009] [0.084]
(Adjusted R-squared=0.605)

< Sub-Sample Period 2 : 2005.10 – 2010.3 >

Money growth factor$_t$ = -0.113 +0.576***Money growth factor$_{t-1}$ +1.506**Non-core liability growth$_{t-1}$
[0.164] [0.109] [0.705]
(Adjusted R-squared=0.481)

Non-core liability growth$_t$ = -0.002 -0.159**Money growth factor$_{t-1}$ +1.026*** Non-core liability growth$_{t-1}$
[0.011] [0.008] [0.049]
(Adjusted R-squared=0.902)

Note: The values in brackets are standard errors.
*, **, and *** indicate statistical significances at the 10%, 5%, and 1% levels, respectively.

We conduct variance decompositions to see how much of the forecast variance can be ascribable to shocks in variables at certain forecasting horizons. Table 7 displays the variance decompositions for the full-sample and the two sub-sample periods. For the first sub-sample period, a large portion of the forecast variance of non-core liability growth is explained by itself (99%), without regard to forecast horizon. Similarly, the money growth factor is mostly accounted for by itself (96%).

For the second sub-sample period, on the other hand, the proportion of

[23] For a robustness check, we additionally incorporated a term spread into the yield curve and an industrial production growth rate into the VAR system. We obtained similar results.

unconditional variance of non-core liability growth explained by the money growth factor is 17% at a 12-month horizon and rises slightly to 20% at a 36-month horizon. Notably, 26% of the forecast variance of the money growth factor is accounted for by non-core liability growth at a 12-month horizon. As the forecast horizon lengthens, this percentage rises, for example to 39% at a 36-month horizon. These results indicate, for the second sub-sample period, that a considerable portion of the variance decomposition for the money growth factor is attributable to non-core liability growth. This is consistent with the results of impulse response analysis.

[Table 7] Variance Decompositions (%)

Horizon (month)	Non-core liabilities		Money factor	
	Non-core Liabilities	Money factor	Non-core liabilities	Money factor
Full-Sample Period (2001.1 – 2010.3)				
1	100.00	0.00	2.83	97.17
6	99.12	0.88	9.49	90.51
12	98.47	1.53	14.53	85.47
24	98.14	1.86	17.37	82.63
36	98.09	1.91	17.81	82.19
Sub-Sample Period 1 (2001.1 – 2005.9)				
1	100.00	0.00	0.68	99.32
6	99.88	0.12	2.65	97.35
12	99.82	0.18	4.30	95.70
24	99.81	0.19	4.48	95.52
36	99.81	0.19	4.48	95.52
Sub-Sample Period 2 (2005.10 – 2010.3)				
1	100.00	0.00	2.56	97.44
6	88.20	11.80	15.10	84.90
12	83.02	16.98	25.70	74.30
24	80.45	19.55	34.92	65.08
36	79.73	20.27	38.66	61.34

V. Conclusion with Policy Implications

We have illustrated that the interplay or combination of sophisticated interbank transactions and the current interest rate-oriented monetary policy framework can foster or accelerate financial procyclicality.[24] Financial intermediaries can tap the

[24] We would like to make it clear that our paper does not propose returning to a previous monetary policy framework in which the central bank controls the money supply and targets the monetary aggregates. That system has already been proven obsolete. See Bindseil (2004) Ch. 6 and Mishkin

central bank because the central bank's high-powered money is injected on an on-demand basis into the financial system to keep the short-term market interest rates closely aligned with the policy rate. Interbank transactions involving maturity transformations pave a silky way for this overnight funding to be extended into long-term loans to the ultimate borrowers. This process can cause excessive leverage by financial intermediaries, and can further increase financial procyclicality.

We have also provided empirical evidences using Korean financial data that, during the period when non-core liabilities increased remarkably and then decreased after the global financial crisis, non-core liability growth was positively related to growths of core assets, monetary base, and broad money. From impulse response analysis, a shock to non-core liability growth is shown to have significantly heightened the common factor between money base growth and broad money growth from October 2005 through March 2010. Moreover, the considerable portion of the variance decomposition for the common factor is attributable to non-core liability growth. These results suggest that an increase in non-core liabilities growth leads to increases in the growths of total credit supply to the ultimate borrowers and of the monetary aggregates.

To explore the implications of our findings, we begin with an old episode. During the entire 19th century in London, there were debates on whether (a) the Bank of England was able to set the policy rate (Bank rate) at the level it wishes and (b) there existed a well-defined relationship between the policy rate and the market interest rate.[25] The Bank of England was reluctant to answer these questions affirmatively and denied responsibility for all effects of short-term interest rate developments, including the economic imbalances that might be caused by an inadequate level of the policy rate.

About almost two centuries later, and after observing the recent global financial crisis preceded by a housing market bubble, central banks and academic scholars around the world are now asking whether (a) central banks should pay attention and react to the development of asset prices, and (b) central banks should be responsible for financial stability.[26] And the answer to these questions will determine the range of responsibility of the central bank related to the asset price misalignments and financial stability.

This paper does not answer the questions raised above in a direct manner, since its focus is on financial procyclicality that can be generated by the interplay of interest rate-oriented monetary policy framework and sophisticated interbank transactions. To answer the questions above we need to analyze the relationships among financial procyclicality, asset price booms and busts, and financial stability.

(2000).

[25] See Bindseil (2004), pp. 14-15.

[26] See Blanchard et al. (2010) and Caruana (2010), for example.

It is well known that asset price booms are not always accompanied by credit expansion, as can be seen from dot com bubble in the 1990s. Asset price bubbles that threaten financial stability are typically associated with a feedback loop between asset prices and credit conditions: credit expansion raises the asset price, which in turn expands lending further.[27] However, this observation does not necessarily mean that the central bank should react proactively to asset price bubbles. Monetary policy in the form of policy rate adjustments may not be sufficient to ward off asset price bubbles on some occasions.[28] The central bank may additionally need an adequate set of tools, other than the policy rate, if it is to do so.[29]

Our findings imply that the current interest rate-oriented monetary policy framework has made monetary policy and macroprudential policy inseparable.[30] Therefore, the central bank's monetary policy needs to take into account the endogeneity of asset prices and credit cycles. The bottom line is that our findings justify the central bank's wider and greater concern about asset price misalignments and financial stability,[31] and provide a new insight which can be used in search for the right answers to the questions raised above.

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[27] See Demirgüç-Kunt and Servén (2010).

[28] According to Dokko et al. (2009), a policy rate adjustment sufficient to have a sizable impact on house prices would possibly bring large and negative effects on growth and inflation. In contrast, Adrian and Shin (2008) pointed out that small changes in the policy rate could have non-negligible impact on the credit supply by affecting the profitability of financial intermediaries in some cases.

[29] Many central bankers and researchers have pointed out that the policy rate alone is a blunt and poor instrument for dealing with asset price bubbles and financial stability. See Dale (2009) and Blanchard et al. (2010).

[30] This is naturally in line with Adrian and Shin (2008), since this paper extends their model by explicitly incorporating the central bank's monetary policy framework and gets the same (and perhaps stronger) result.

[31] It is worthwhile to note that many economists and scholars, Blanchard et al. (2010) and Squam Lake Working Group on Financial Regulation (2009) to name a few, have recommended recently that the central bank should be given an explicit mandate for financial stability and should be a macroprudential regulator.

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