2015년 외부연구용역 최종보고서

제목	우리나라에서 시중은행의 신용공급은 경기변동을 가속화 시키는가?: 국면전환을 고려한 새로운 실증결과
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제출일자	2015.11

1. Introduction

This work investigates commercial banks aggregate credit supply's effects on business cycle over different regimes of business cycle in Korea. A considerable amount of literature on the relation between commerical banks' credit supply and business cycle is available. However, little of it covers the regime changes' effect on the relation between credit supply and business cycle changes. This work contributes to the investigation of empirical evidence of the credit supply's effect on business cycle by incorporating regimes changes in nonlinear empirical framework.

The Figure 1 depicts the dynamic relation between real GDP and real credit supply in Korea from 1971 Q1 to 2009 Q4 where gray highlighted regions represent recession period.[5] We find that the two variables are dynamically highly correlated but may be in a different pattern over the two distinct regimes of economy. In Table 1, we reconfirm the strong linear binding between real GDP and real credit supply in Korea with highly significant coefficient of credit supply against real GDP with 0.3682. The intuition from these findings suggest a more appropriate empirical model of Vector Error Correction Model (VECM) that incorporate regime changes. Therefore previous empirical models have possible misspecification issue in estimating credit supply's procyclical properties.

The 2008 global financial crisis has emphasized the need for enhanced control of commercial banks' credit supply. Therefore it has refocused the debate on potential negative effects of procyclical credit supply. Attention has been focused on whether the regulatory system on commercial banks credit supply was sufficient enough to absorb the losses incurred by accelerating business cycle changes.

Thus, for example, the Financial Stability Board (FSB) recommended a strengthening of the regulatory credit supply (Financial Stability Forum, 2009) in order to increase the control of business cycle during economic upturns and downturns, and endorsed the work done by the Basel Committee on Banking Supervision (BCBS) to enhance the current credit supply and capital regulatory framework. In addition to the regulatory credit supply on the basis of

[5] In the periods where the coincident composite index exceeds the baseline of 100, the economy is under an expansion phase or boom. In contrast, in the periods where the coincident composite index is below the baseline of 100, the economy is under a contraction phase or recession (highlighted with gray).

individual banks, proposals also include strengthening macro-level financial regulation to alleviate the procyclicality of bank lending and the system-risk of large financial institutions.

As a result, almost all the regulatory proposals are asserted to contribute to resolve the procyclicality problem of bank lending. However an array of prescriptions proposed after the global financial crisis would be misleading when their regulations on credit supply are based on simple linear relation between credit supply and business cycle because these two macro variables are well known as distinct dynamic properties over different phases of economy.

Given that the 2008's global financial crisis has been spurred by the inappropriate financial regulations, it would be highly desirable to re-inspect dynamic relation between credit supply and business cycle to ascertain the necessity for strengthened or reformed financial regulations on credit supply. However, we also need to consider that introducing new regulations or strengthening the regulations in such an excessive way is likely to result in appropriate empirical evidence on the relation between credit supply and business cycle changes.

In addition, excessive implementation of financial regulations on credit supply may inadvertently serve to destabilize business cycle and harm the stability of commercial banking system. In particular, the effectiveness of financial supervisory measures to reduce the procyclicality should be assessed only when both of the overall effects of credit supply and each country uniqueness are appropriately taken into account. As such, it is important to pin down the areas in which the regulations are insufficient or to be reformed over different phases of business cycle and different countries.

This paper's contributions in related literature are as follows. First, we provide empirical evidence of commercial bank credit supply's procyclical property in Korea. Furthermore, GDP's significant effect on credit supply is also found. Second, our empirical evidence show that these effects are significantly different over regimes of economy. Particularly we find that credit supply's procyclical property is intensified in the contraction regime of economy. Lastly, through extended empirical works, we provide evidence that the big bank group's credit supply has large impact on business cycle than that of small bank group.

Another contribution of this work is related to practical regulation purpose on banking industry. Our findings indicates that to lessen the procyclical property of banks' credit supply, big banks (or systematically important financial institution: SIFI) need to be incorporated.

The remainder of this paper is organized as follows. Section 2 describes the appropriateness of the Smooth Transition Autoregressive Vector Error-Correction Model (STAR-VECM) in our study. Section 3 provides construction of data employed and empirical results such as nonlinear Granger causality and cumulative effects between endogenous variables of real GDP and real credit supply. Section 4 extends the question further to discuss different effects of big bank groups and small bank groups on business cycle. Section 5 concludes our investigation.

Figure 1. Graph of **RGDP and Aggregate Credit Supply (1971 Q1 – 2009 Q4)**

notes: Both variables are logarithm value and gray bars represent recession periods. In the periods where the coincident composite index exceeds the baseline of 100, the economy is under an expansion phase or boom. In contrast, in the periods where the coincident composite index is below the baseline of 100, the economy is under a contraction phase or recession (highlighted with gray).

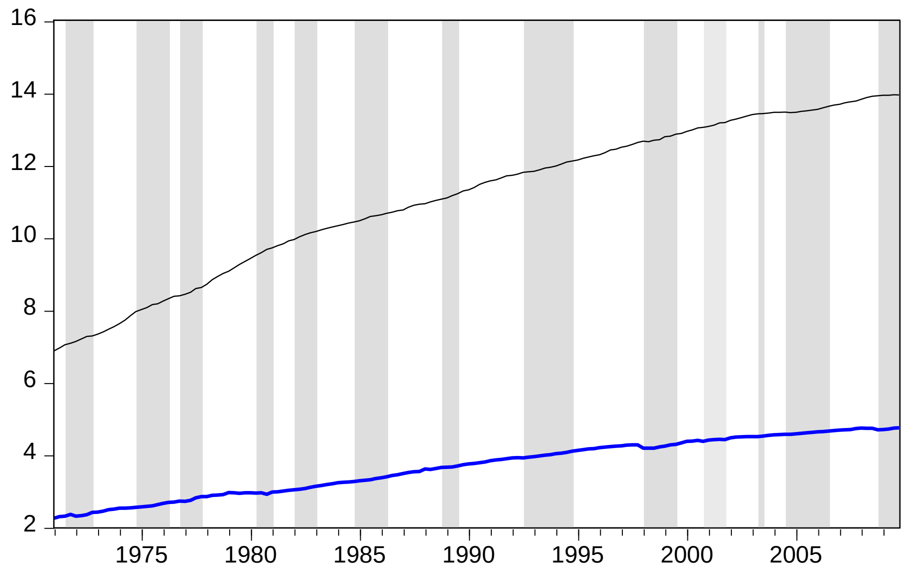


Table 1. Cointegration between **RGDP and Aggregate Credit Supply (1971 Q1 – 2009 Q4)**
notes: Values under regression coefficients in parenthesis are p-values.

$$y_t^1 = \beta_0 + \beta_1 y_t^1 + \varepsilon_t.$$

where y_t^1 is the real GDP and y_t^2 is the real credit supply.

$y_t^1 = -0.4241 + 0.3682 y_{t-1}^2 + \varepsilon_t$ (0.0000) (0.0000)
Adjusted R^2 = 0.9706

2. Empirical Model: Smooth Transition Autoregressive Vector Error-Correction (STAR-VECM) Model

Given the significant evidence on cointegrations between GDP and credit supply in Korea, a model of particular interest is the one in which the endogenous variables are linked by a linear long-run equilibrium relation, whereas adjustment toward this equilibrium is nonlinear and can be characterized by a slow regime switch triggered by the long run relation between GDP and credit supply or the error correction term.[6] Here, the regimes are determined by the size and sign of the deviation from the equilibrium relation between GDP and credit supply. Therefore, in our empirical analysis, we fully take into account non-linearity, cointegration, and regime changes.

In linear time series framework, this type of behavior is captured by a cointegration and a linear vector error-correction model (VECM) (Engle and Granger, 1987).[7] Escribano and Mira (2002) extend the linear VECM to a general nonlinear VECM by employing the Near Epoch Dependence (NED) concept suggested by Gallant and White (1988) and Wooldridge and White (1988). In particular, they show that the nonlinear VECM can be theoretically formalized

[6] There are two types of nonlinear regime-switching models regarding the speed of transition between regimes: the threshold autoregressive model (TARM) developed by Tsay (1989) and the smooth transition autoregressive model (STARM) developed by Luukkonen, Saikkonen, and Teräsvirta (1988), Teräsvirta and Anderson (1992), and Teräsvirta (1994). While the TARM specifies a sudden transition between regimes with a discrete jump, the STARM allows a smooth transition between regimes.
[7] See also Johansen (1995) and Hatanaka (1996).

by incorporating a smooth transition autoregressive (STAR) model among many possible nonlinear parameterizations.[8]

In preliminary tests, we find strong evidence in favor of smooth transition dynamics over a linear VECM using nonlinearity tests.[9] Therefore, we incorporate nonlinearity into the VECM by following recent developments in nonlinear models. Specifically, we incorporate a smooth transition mechanism into a VECM to allow for a nonlinear or asymmetric adjustment, which is called a smooth transition autoregressive vector error-correction model (hereafter STAR-VECM).[10] This model can be thought of as a special case of vector smooth transition autoregressive model (STARM).

For the two integrated variables in Korea – log of real GDP (y_t^1) and log of real credit supply (y_t^2) – a smooth transition vector error-correction model (STAR-VECM) is given in general form by:[11]

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j\right] \cdot F(\Delta y_{t-d}^c) + \varepsilon_t^1,$$

$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j\right] \cdot F(\Delta y_{t-d}^c) + \varepsilon_t^2.$$

(1)

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$. $F(\Delta y_{t-d}^c)$ is the transition function, and Δy_{t-d}^c is a *common* transition variable.

For the STAR-VECM, two types of the transition function specification, $F(\Delta y_{t-d}^c)$, are available: the logistic smooth transition vector error correction model (LSTAR-VECM) and the exponential smooth transition vector error correction model (ESTAR-VECM). The LSTAR-

[8] For details of the proof, see Escribano and Mira (2002).
[9] We carry out Lagrange Multiplier-Smooth Transition (LM-STR) test for test of linearity. It is available upon on request to author.
[10] See Granger and Swanson (1996) for a more general discussion, and Escribano (1987) and Escribano and Pfann (1998) for an early empirical example of nonlinear error-correcting mechanisms.
[11] All variables are log valued.

VECM is useful in describing a stochastic process that is characterized by an alternative set of dynamics for either the large or small value of the transition function. In the LSTAR-VECM, the transition function is given by the following logistic function:[12]

$$F(\Delta y_{t-d}^{c}) = \frac{1}{[1+exp\{-\gamma(\Delta y_{t-d}^{c}-c)\}]}\ ,\ \gamma > 0 \tag{1.1}$$

In contrast, the ESTAR-VECM is more appropriate in generating alternative dynamics for both large and small values for the transition variable. In the ESTAR-VECM, the transition function is given by:[13]

$$F(\Delta y_{t-d}^{c}) = 1 - exp\{-\gamma(\Delta y_{t-d}^{c} - c)^2\},\ \gamma > 0 \tag{1.2}$$

The adjustment parameter, γ, in both models governs the speed of transition between the two regimes: the greater the value of γ, the faster the transition between the regimes. In the limit, as the value of γ approaches infinity, the model degenerates to the conventional threshold autoregressive model (TARM) of Tsay (1989). Alternatively, if γ approaches zero so that the value of the transition function $F(\Delta y_{t-d}^{c})$ approaches zero, then the model degenerates to a linear AR model, with ρ_i^j parameters unidentifiable. In specifying the STAR-VECM, the error correction term (z_{t-d}) is selected as the common transition variable in

[12] The logistic function, $F(\Delta y_{t-d}^{c})$, takes a value between 0 and 1, depending on the degree and direction by which Δy_{t-d}^{c} deviates from *c*, the switching value of the transition variable. The estimated value for *c* defines a transition between the two regimes: $0 < F(\Delta y_{t-d}^{c}) < 0.5$ (a lower regime) for $\Delta y_{t-d}^{c} < c$ and $0.5 < F(\Delta y_{t-d}^{c}) < 1$ (an upper regime) for $\Delta y_{t-d}^{c} > c$. When $\Delta y_{t-d}^{c} = c$, $F(\Delta y_{t-d}^{c}) = 0.5$ so that that the current dynamics of Δy_t (or growth rate) is half-way between the upper and lower regimes, especially when Δy_{t-d}^{c} takes a large value (i.e., $\Delta y_{t-d}^{c} >> c$), $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)\}$ is close to zero. As a result, the value of $F(\Delta y_{t-d}^{c})$ approaches one, and the dynamics of Δy_t are generated by both ϕ_i^j and ρ_i^j in equation (4). In addition, for a small value of Δy_{t-d}^{c} (i.e., $\Delta y_{t-d}^{c} << c$), $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)\}$ is close to a big number. Then, the value of the transition function $F(\Delta y_{t-d}^{c})$ approaches zero, and the dynamics of Δy_t are generated by only the ϕ_i^j parameter in equation (4).

[13] For a large or small value of Δy_{t-d}^{c}, the value of $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)^2\}$ approaches zero, and the value of the transition function approaches one. The dynamics of Δy_t are generated by both ϕ_i^j and ρ_i^j in equation (4). When the value of Δy_{t-d}^{c} is close to *c*, the value of $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)^2\}$ approaches one and the value of the transition function approaches zero. In these cases, the dynamics of Δy_t are generated only by the ϕ_i^j parameters in equation (4).

$F(\Delta y_{t-d}^{c})$ through Lagrange Multiplier-Smooth Transition (LM-STR) test for linearity.

In accordance with the above discussions on STAR-VECM model specification, common transition variable selection, cointegration test, nonlinearity test, and model selection test, we specify our STAR-VECM as follows:

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^1,$$

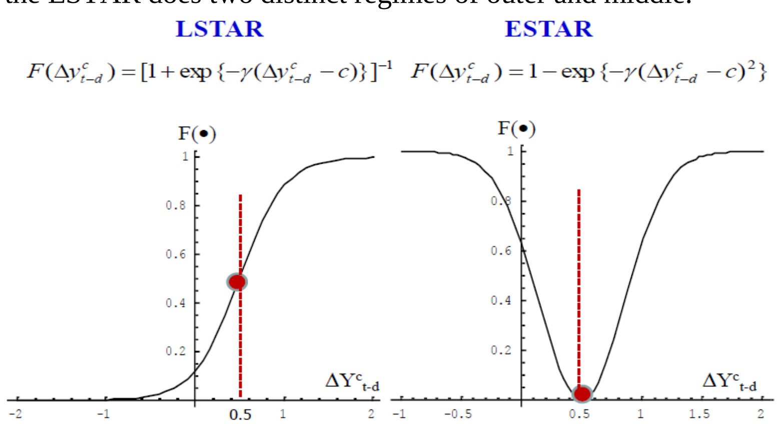
$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^2.$$

(2)

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$. $F(\Delta y_{t-d}^{c})$ is the transition function, and bcs_{t-d} = common transition variable.

The dynamics of LSTAR and ESTAR specifications are compared in the following Figure 2. LSTAR model specifies two distinct regimes of expansion and contraction while ESTAR model does between the outer regime (either expansion or contraction) and the middle regime.

Figure 2. Dynamics of the two Smooth Transition Models.
The following two graphs show different regime shifting property of Logistic STAR (LSTAR) and Exponential STAR (ESTAR) model. The LSTAR model specifies two distinct regimes of expansion and contraction while the ESTAR does two distinct regimes of outer and middle.



3. Data and Empirical Results

3.1 Data

In conducting empirical work, we employ two groups of data. The first group of data is Korean real GDP and real aggregate credit supply compiled from the IMF's International Financial Statistics (IFS) data archive.[14]

The data used is organized as a time series observations from 1971 Q1 to 2009 Q4, comprising a total of 156 quarterly observations for each variable which is seasonally adjusted through X13 option at Eviews.

The second set of data is large and small banks' credit supply from 1999 Q4 to 2009 Q4 with 41 quarterly observations. This data set is retrieved from each bank's balance sheet. The large bank (or SIFI: systematically important financial institution) group includes KB, Shinhan, Woori, Hana, and Korean Foreign Exchange banks while the small bank (or non-SIFI) group includes SC, Citi, Kyungnam, Kwangju, Daegu, Busan, Cheonbuk, and Cheju banks. This group of data is also seasonally adjusted with X13.

For robust nonlinear estimation purpose, we need to employ relatively longer time series sample sets. Thus we've included all observations where the sample periods is available from central banks' data archives. Summary statistics for each variable of each country are presented in Table 2 along with graphs in Figure 3.

3.2 Empirical Results[15]

We present estimation results of simple linear the VECM and STAR-VECM in Table 3 and Table 4 respectively. The simple linear the VECM estimation of Table 3 would be the benchmark result for comparison of Table 4's STAR-VECM results.

[14] Credit supply includes commercial banks, regional banks, foreign banks, and special banks' credit supply altogether.

[15] In interpreting our STAR-VECM empirical results in reflecting Korean financial markets, comments from seminar participants at Bank of Korea are greatly appreciated.

Table 2. Summary statistics for variables
This table reports the summary statistics for eight variables employed.
The large bank (or SIFI: systematically important financial institution) group includes KB, Shinhan, Woori, Hana, and Korean Foreign Exchange banks. The small bank (or non-SIFI) group includes SC, Citi, Kyungnam, Kwangju, Daegu, Busan, Cheonbuk, and Cheju banks.

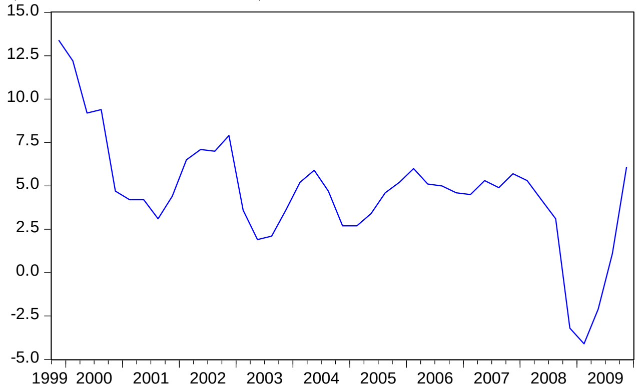
Variable	Mean	Std. Dev.
Log of Real GDP (1971 Q1 to 2009 Q4)	4.5748	0.1244
Log of Aggregate Credit Supply (1971 Q1 to 2009 Q4)	13.4908	0.3069
Log of Big banks' Credit Supply (1999 Q1 to 2009 Q4)	19.8506	0.2806
Log of Small banks' Credit Supply (1971 Q1 to 2009 Q4)	18.3362	0.3103
Growth Rate of Real GDP (1971 Q1 to 2009 Q4)	0.0111	0.0744
Growth Rate of Aggregate Credit Supply (1971 Q1 to 2009 Q4)	0.0264	0.0186
Growth Rate of Big banks' Credit Supply (1999 Q1 to 2009 Q4)	0.0228	0.0227
Growth Rate of Small banks' Credit Supply (1999 Q1 to 2009 Q4)	0.0229	0.0239

First, it needs to be pointed out that the simple linear VECM results in Table 3 does not show significant effect from credit supply to GDP and vice versa. In the second equation of linear VECM reported, the coefficients of real GDP (0.1684 and 0.1042) are not significant at 10% level. Also, in the first equation, the real credit supply's coefficients (0.0713 and -0.0735) are not significant either at 10% level. However, we find the long run linear relation between real GDP and real credit supply with negatively significant error correction term (z_{t-1}) coefficient of -0.0335.

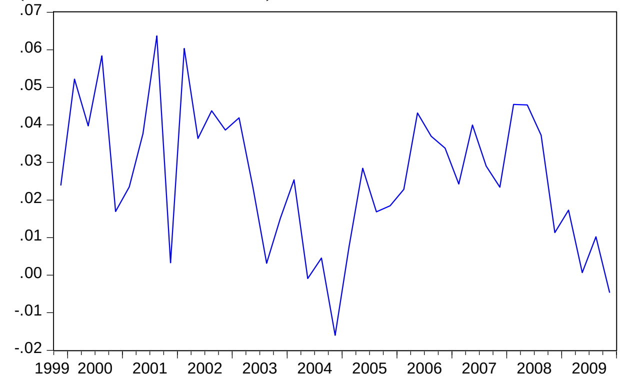
Secondly, in STAR-VECM estimation results of Table 4, the value of the γ -parameter is statistically significant at the 10% level for the real GDP growth (Δy_t^1) and real credit supply growth (Δy_t^2) equations in the sample period of 1971 Q1 to 2009 Q4. This indicates that the transition between regimes is significant for both real GDP and real credit supply.

Figure 3. Graphs of variables.
The large bank (or SIFI: systematically important financial institution) group includes KB, Shinhan, Woori, Hana, and Korean Foreign Exchange banks. The small bank (or non-SIFI) group includes SC, Citi, Kyungnam, Kwangju, Daegu, Busan, Cheonbuk, and Cheju banks.

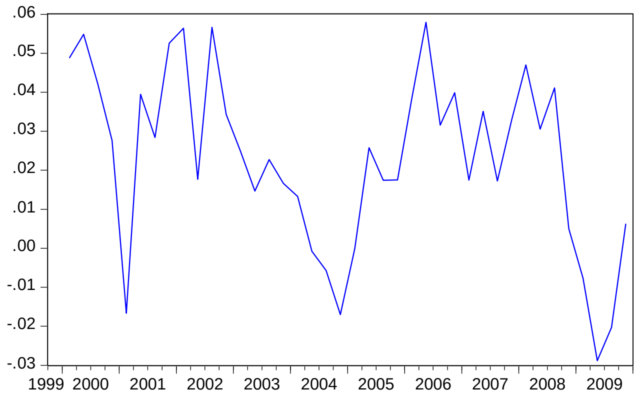
Growth Rate of Real GDP
(1971 Q1 to 2009 Q4)



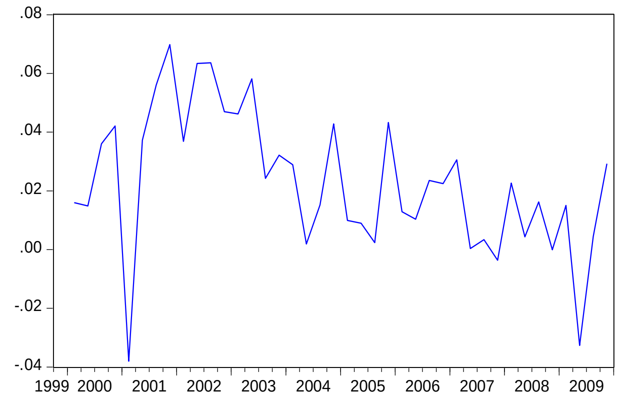
Growth Rate of Aggregate Credit Supply
(1971 Q1 to 2009 Q4)



Growth Rate of Big banks' Credit Supply
(1999 Q1 to 2009 Q4)



Growth Rate of Small banks' Credit Supply
(1999 Q1 to 2009 Q4)



In addition, estimates of the γ -parameter for real GDP growth (Δy_t^1) and real credit supply (Δy_t^2) for the whole sample period are 13.0600 and 7.4233 respectively. These relatively small estimates of γ suggest a slower transition from one regime to another, compared to the TARM or Markov regime-switching models, where γ is infinity and there is a sudden switch between regimes.This provides additional support for our choice of the STAR model against other nonlinear models. The *c*-parameter estimates of 0.0235 and 0.1485 indicate the halfway point between the expansion and contraction phases of real GDP and real credit supply.

In STAR-VECM estimation results, our focus goes on the real credit supply (Δy_t^2)'s dynamic effect on real GDP (Δy_t^1) over different regimes of economy. For this purpose, we carry out both of nonlinear Granger causality test and estimation of cumulative net effect from real credit supply (Δy_t^2) to real GDP (Δy_t^1) over different regime of variables.[16] These results are reported in Table 5.

In the *expansion regime* of real GDP (Δy_t^1) where the transition function $F(z_{t-4}) = 1$ and the cumulative net effect from real credit supply (Δy_t^2) to real GDP (Δy_t^1) is estimated as +0.0045. On the contrary, in the *contraction regime* where the transition function $F(z_{t-4}) = 0$, the cumulative net effect is estimated as +0.0132. Therefore we find a significant evidence of asymmetric effect of real credit supply (Δy_t^2) to real GDP (Δy_t^1) between *expansion* and *contraction* regimes of real GDP. These results indicate that real credit supply (Δy_t^2) accelerates the speed of business cycle downturn in the *contractionary* regime of real GDP (Δy_t^1) rather than in the case of *expansionary* regime.

Meanwhile, the real GDP (Δy_t^1)'s cumulative net effect on real credit supply (Δy_t^2) is estimated by -3.5142 in the *expansion regime* of real credit supply (Δy_t^2). In the *contraction regime* of real credit supply (Δy_t^2), it is estimated by +0.3526. We find significant differences in effect of real GDP (Δy_t^1) on real credit supply (Δy_t^2). In particular, the real GDP (Δy_t^1)'s effect is counter cyclical in the *expansion regime* of real credit supply (Δy_t^2). We would expect

[16] The '(cumulative) net effect' is estimated by the sum of the lagged coefficients of the Granger-causing variable. Before adding up the coefficients, we test whether the sum of the lagged coefficients is significant by Wald test. For example, in equation (2), $\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j\right] \cdot F(bcs_{t-d}) + \varepsilon_t^1$, if real credit supply (Δy_t^2) Granger causes real GDP (Δy_t^1), we test the null hypothesis of $H_0\colon \sum_{i=1}^{p}\phi_i^j = 0 \; and \; \rho_i^j = 0$. When the null hypothesis is rejected, we add up the coefficients as an estimate of the (cumulative) net effect from real credit supply (Δy_t^2) to real GDP (Δy_t^1).

that the countercyclical impact of real GDP (Δy_t^1) on real credit supply (Δy_t^2) in the *expansion regime* is mainly due to Korean firms' quickly declining demand for bank loans.[17] Also due to strictly regulated mortgage loans to households are another reason of this negative effect.

Table 3. Estimation of VECM: **RGDP and Aggregate Credit Supply (1971 Q1 – 2009 Q4)**
notes: Values under regression coefficients in parenthesis are p-values.

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \varepsilon_t^1,$$

$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \varepsilon_t^2.$$

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$.

Real GDP (Δy_t^1)

$$\Delta y_t^1 = [\underset{(0.0000)}{0.0136} - \underset{(0.0536)}{0.0335} z_{t-1} + \underset{(0.7482)}{0.0286}\Delta y_{t-1}^1 + \underset{(0.1114)}{0.1162}\Delta y_{t-2}^1 + \underset{(0.2876)}{0.0713}\Delta y_{t-1}^2 - \underset{(0.2303)}{0.0735}\Delta y_{t-2}^2] + \varepsilon_t^1$$

Adjusted $R^2 = 0.0159$

Real Credit Supply (Δy_t^2)

$$\Delta y_t^2 = [\underset{(0.0101)}{0.0120} + \underset{(0.2531)}{0.0197} z_{t-1} + \underset{(0.1512)}{0.1684}\Delta y_{t-1}^1 + \underset{(0.3082)}{0.1042}\Delta y_{t-2}^1 + \underset{(0.0003)}{0.2884}\Delta y_{t-1}^2 + \underset{(0.2531)}{0.0197}\Delta y_{t-2}^2 + \varepsilon_t^2$$

Adjusted $R^2 = 0.2985$

[17] Recently Korean large companies became more inclined to use retained earnings for financing investment.

Table 4. Estimation of STAR-VECM: **RGDP and Aggregate Credit Supply (1971 Q1 – 2009 Q4)**

notes: Values under regression coefficients in parenthesis are p-values.

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^1,$$

$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^2.$$

$F(z_{t-d}) = \frac{1}{[1+exp\{-\gamma(z_{t-d}-c)\}]}$, $\gamma > 0$: LSTAR

$F(z_{t-d}) = 1 - exp\{-\gamma(z_{t-d} - c)^2\}$, $\gamma > 0$: ESTAR

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$. $F(z_{t-d})$ is the transition function, and z_{t-d} = common transition variable.

Real GDP (Δy_t^1: LSTAR)

$\Delta y_t^1 = [0.0107 - 0.0385 z_{t-1} + 0.2021 \Delta y_{t-1}^1 + 0.0569 \Delta y_{t-2}^1 + 0.1057 \Delta y_{t-1}^2 - 0.0924 \Delta y_{t-2}^2]$

(0.0005) (0.0802) (0.0580) (0.4824) (0.0798) (0.0909)

$+ [0.0077 + 0.0320 z_{t-1} - 0.3907 \Delta y_{t-1}^1 + 0.2226 \Delta y_{t-2}^1$

(0.5536) (0.3864) (0.0387) (0.1011)

$-0.1495 \Delta y_{t-1}^2 + 0.1408 \Delta y_{t-2}^2] \cdot [\frac{1}{[1 + exp\{13.0600 \cdot (z_{t-4} - 0.0235)\}]}] + \varepsilon_t^1$

(0.1051) (0.0802) (0.0828) (0.0000)

Adjusted R^2 = 0.3912

Real Credit Supply (Δy_t^2:LSTAR)

$\Delta y_t^2 = [0.0109 + 0.0139 z_{t-1} + 0.2436 \Delta y_{t-1}^1 + 0.1091 \Delta y_{t-2}^1 + 0.2958 \Delta y_{t-1}^2 + 0.3211 \Delta y_{t-2}^2$

(0.0240) (0.4595) (0.0323) (0.3265) (0.0066) (0.0002)

$+ [-0.2679 + 1.9952 z_{t-1} - 2.5885 \Delta y_{t-1}^1 - 1.2784 \Delta y_{t-2}^1$

(0.0015) (0.0099) (0.0158) (0.0727)

$+2.9905 \Delta y_{t-1}^2 - 1.4123 \Delta y_{t-2}^2] \cdot [\frac{1}{[1 + exp\{7.4233 \cdot (z_{t-4} - 0.1485)\}]}] + \varepsilon_t^2$

(0.0585) (0.2828) (0.0204) (0.0000)

Adjusted R^2 = 0.3738

Table 5. Summary of Net Effect between and Aggregate Credit Supply, SIFI's Credit Supply, and Non-SIFI's Credit Supply[18]

notes: Values under regression coefficients in parenthesis are p-values. * and ** implies significant at 10% and 5% levels, respectively.

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^1,$$

$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^2.$$

$$F(z_{t-d}) = \frac{1}{[1+exp\{-\gamma(z_{t-d}-c)\}]}\ ,\ \gamma > 0\text{: LSTAR}$$

$$F(z_{t-d}) = 1 - exp\{-\gamma(z_{t-d} - c)^2\},\ \gamma > 0\text{: ESTAR}$$

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$. $F(z_{t-d})$ is the transition function, and z_{t-d} = common transition variable.

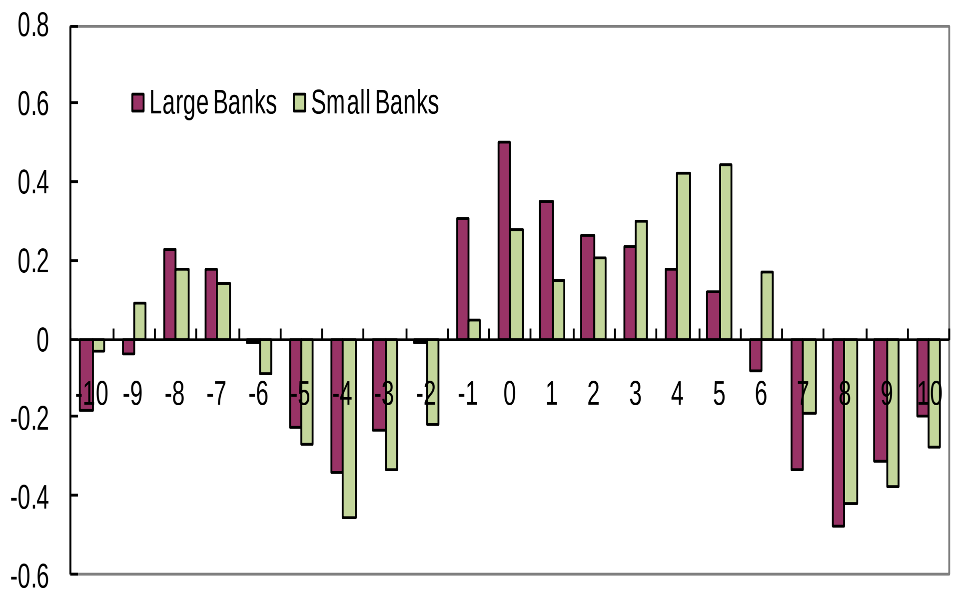
Real credit supply's (Δy^2) net effect on real GDP (Δy^1)	
Nonlinear STAR-VECM	(Expansion regime) 0.0045* (Contraction regime) 0.0132**
Real GDP's (Δy^1) net effect on real credit supply (Δy^2)	
Nonlinear STAR-VECM	(Expansion regime) -3.5142* (Contraction regime) 0.3526*

[18] Before calculating the net effect of real stock return on other variables, we test whether the sum of estimates is zero [i.e., $H_0 : \sum_{i=1}^{3}\{\hat{a}_i + \hat{b}_i\} = 0$].

4. Is there a SIFI (systematically important financial institution) effect in Korea?

In the previous section, we have found evidence to support the hypothesis of varying credit supply (Δy_t^2)'s effect on business cycle (Δy_t^1) over regimes of each variable. As pointed out recent Basel III, we extend our interest to the sources of this asymmetric effect between big banks and small banks. Figure 4 shows a simple cross correlation with time lags between GDP growth rates (Δy_t^1) and banks' credit supply growth rates (Δy_t^2) between big banks and small banks in the 2000s. Even though we observe the procyclicality of bank lending in Korea, different correlations are seen between large banks and small banks. According to Figure 3, the correlations with GDP are both positive at lags of 0 to 5 between large banks and small banks. However, from lag 0 to 5, large banks' correlations with GDP decrease while the small banks correlations with GDP increase. Thus Figure 4 shows different effects of credit supply to business cycle between the two groups of banks.

Figure 4. Cross Correlation between GDP and Bank Loans in Korea (from 1999 Q4 to 2009 Q4)
The large bank (or SIFI: systematically important financial institution) group includes KB, Shinhan, Woori, Hana, and Korean Foreign Exchange banks. The small bank (or non-SIFI) group includes SC, Citi,



By employing the STAR-VECM model, we investigate big (or SIFI) and small (or non SIFI) banks' different effect on business cycle in this section. However the credit supply of individual banks are only available from 2000 to 2009 in quarterly frequency.

The estimation results of STAR-VECM between large banks (SIFIs) and small banks (non-SIFIs) are reported in Table 6 and Table 7 respectively. In both groups of banks, we have significant STAR-VECM estimation results with regime transition estimates of the γ -parameters between 4.6981 and 45.1039. All estimates are significant at 10% level.

The cumulative net effect between GDP growth rates (Δy_t^1) and banks' credit supply growth rates (Δy_t^2) is summarized in Table 8. To reiterate our categorization between SIFIs and non-SIFIS, KB, Shinhan, Woori, Hana, and Korea Foreign Exchange banks are SIFIS while Citi, Kyungnam, Kwangju, Daeju, Busan, Cheonbuk, and Cheju banks are non-SIFIs.

Our main finding is that SIFIs credit supply (Δy_t^2) has more significant effect on business cycle changes. In the *expansion regime* of real GDP (Δy_t^1) where the transition function $F(z_{t-4})$ = 1 and the cumulative net effect from SIFI's real credit supply (Δy_t^2) to real GDP (Δy_t^1) is estimated as +0.0064. On the contrary, in the *contraction regime* where the transition function $F(z_{t-4})$ = 0, the cumulative net effect is estimated as +0.1729. However we do not find either significant or large enough effect of non-SIFI real credit supply (Δy_t^2) on real GDP (Δy_t^1). Over all, our results support large banks (SIFIs) is the major driving power in the relation between credit supply (Δy_t^2) to GDP (Δy_t^1).

Then what is the implication of these results in Korean banking industry? A reasonable interpretation is Basel III's requirements on financial buffer and regulations on banking industry would not be effective without controlling large banks (SIFI)'s credit supply.

Table 6. Estimation of STAR-VECM: **RGDP and Credit Supply of SIFI (1999 Q4 – 2009 Q4)**
notes: Values under regression coefficients in parenthesis are p-values.

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^1,$$

$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^2.$$

$F(z_{t-d}) = \frac{1}{[1+exp\{-\gamma(z_{t-d}-c)\}]}$, $\gamma > 0$: LSTAR

$F(z_{t-d}) = 1 - exp\{-\gamma(z_{t-d} - c)^2\}$, $\gamma > 0$: ESTAR

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$. $F(z_{t-d})$ is the transition function, and z_{t-d} = common transition variable.

Real GDP (Δy_t^1: LSTAR)

$$\Delta y_t^1 = [0.0123 - 0.1792 z_{t-1} + 0.0648 \Delta y_{t-1}^1 - 0.0701 \Delta y_{t-2}^1 + 0.4350 \Delta y_{t-1}^2 - 0.2621 \Delta y_{t-2}^2]$$
(0.0191) (0.1860) (0.8239) (0.0828) (0.0681) (0.1054)

$$+ [-0.0248 - 0.8679 z_{t-1} + 1.8664 \Delta y_{t-1}^1 + 4.0966 \Delta y_{t-2}^1$$
(0.0001) (0.0628) (0.0165) (0.0000)

$$-0.8984 \Delta y_{t-1}^2 + 0.7919 \Delta y_{t-2}^2] \cdot [\frac{1}{[1 + exp\{4.6981 \cdot (z_{t-3} - 0.0203)\}]}] + \varepsilon_t^1$$
(0.0025) (0.0001) (0.7920) (0.0000)

Adjusted R^2 = 0.3510

SIFI Real Credit Supply (Δy_t^2:LSTAR)

$$\Delta y_t^2 = [0.1782 + 3.8841 z_{t-1} - 3.7772 \Delta y_{t-1}^1 - 0.9114 \Delta y_{t-2}^1 + 1.6003 \Delta y_{t-1}^2 - 0.9220 \Delta y_{t-2}^2$$
(0.0670) (0.0306) (0.1772) (0.0134) (0.0000) (0.0279)

$$+ [-0.1780 - 3.6333 z_{t-1} + 4.1897 \Delta y_{t-1}^1 + 1.0545 \Delta y_{t-2}^1$$
(0.0742) (0.0491) (0.1697) (0.0154)

$$-1.1699 \Delta y_{t-1}^2 + 1.1741 \Delta y_{t-2}^2] \cdot [\frac{1}{[1 + exp\{45.1039 \cdot (z_{t-3} - 0.0274)\}]}] + \varepsilon_t^2$$
(0.0003) (0.0064) (0.0719) (0.0600)

Adjusted R^2 = 0.4760

Table 7. Estimation of STAR-VECM: **RGDP and Credit Supply of Non-SIFI (1999 Q4 – 2009 Q4)**
notes: Values under regression coefficients in parenthesis are p-values.

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^1,$$

$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^2.$$

$F(z_{t-d}) = \frac{1}{[1+exp\{-\gamma(z_{t-d}-c)\}]}$, $\gamma > 0$: LSTAR

$F(z_{t-d}) = 1 - exp\{-\gamma(z_{t-d} - c)^2\}$, $\gamma > 0$: ESTAR

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$. $F(z_{t-d})$ is the transition function, and z_{t-d} = common transition variable.

Real GDP (Δy_t^1: LSTAR)

$$\Delta y_t^1 = [\underset{(0.6503)}{0.0180} + \underset{(0.6829)}{0.0386} z_{t-1} + \underset{(0.0411)}{0.2304} \Delta y_{t-1}^1 - \underset{(0.4127)}{0.1203} \Delta y_{t-2}^1 + \underset{(0.7850)}{0.0178} \Delta y_{t-1}^2 - \underset{(0.6751)}{0.0224} \Delta y_{t-2}^2]$$

$$+ [\underset{(0.0000)}{1.1523} - \underset{(0.0000)}{1.8133} z_{t-1} + \underset{(0.0507)}{0.6823} \Delta y_{t-1}^1 + \underset{(0.0000)}{1.2887} \Delta y_{t-2}^1$$

$$-\underset{(0.0000)}{1.0434} \Delta y_{t-1}^2 + \underset{(0.0040)}{0.3476} \Delta y_{t-2}^2] \cdot [\frac{1}{[1 + exp\{\underset{(0.0982)}{3.7920} \cdot (z_{t-3} - \underset{(0.1133)}{0.0195})\}]}] + \varepsilon_t^1$$

Adjusted R^2 = 0.7975

Non-SIFI Real Credit Supply (LSTAR)

$$\Delta y_t^2 = [\underset{(0.6107)}{0.0959} + \underset{(0.0166)}{1.9283} z_{t-1} + \underset{(0.0318)}{1.8249} \Delta y_{t-1}^1 - \underset{(0.0051)}{1.5597} \Delta y_{t-2}^1 + \underset{(0.1922)}{0.4595} \Delta y_{t-1}^2 + \underset{(0.0362)}{0.5065} \Delta y_{t-2}^2$$

$$+ [\underset{(0.3144)}{0.2085} - \underset{(0.0129)}{1.1512} z_{t-1} - \underset{(0.0291)}{1.9937} \Delta y_{t-1}^1 + \underset{(0.0032)}{1.8284} \Delta y_{t-2}^1$$

$$+\underset{(0.4439)}{0.2794} \Delta y_{t-1}^2 - \underset{(0.0203)}{0.4468} \Delta y_{t-2}^2] \cdot [\frac{1}{[1 + exp\{\underset{(0.0442)}{14.1006} \cdot (z_{t-3} - \underset{(0.0000)}{0.0185})\}]}] + \varepsilon_t^2$$

Adjusted R^2 = 0.9705

Table 8. Summary of Net Effect between and Aggregate Credit Supply, SIFI's Credit Supply, and Non-SIFI's Credit Supply[19]

notes: Values under regression coefficients in parenthesis are p-values. * and ** implies significant at 10% and 5% levels, respectively.

$$\Delta y_t^1 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^1,$$

$$\Delta y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{2}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(z_{t-d}) + \varepsilon_t^2.$$

$F(z_{t-d}) = \frac{1}{[1+exp\{-\gamma(z_{t-d}-c)\}]}$, $\gamma > 0$: LSTAR

$F(z_{t-d}) = 1 - exp\{-\gamma(z_{t-d} - c)^2\}$, $\gamma > 0$: ESTAR

where Δy_t^1 is the log difference (or growth rate) of real GDP, Δy_t^2 is the log difference (or growth rate) of real credit supply. z_t denotes an error-correction term. That is, z_t is the deviation from the equilibrium relation given by $\beta' y_t = 0$. $F(z_{t-d})$ is the transition function, and z_{t-d} = common transition variable.

Real credit supply's (Δy^2) net effect on real GDP (Δy^1)		
	SIFI (1999 Q4 – 2009 Q4)	**Non-SIFI (1999 Q4 – 2009 Q4)**
Nonlinear STAR-VECM	(Expansion regime) 0.0664** (Contraction regime) 0.1729**	(Expansion regime) -0.7004 (Contraction regime) -0.0046*
Real GDP's (Δy^1) net effect on real credit supply (Δy^2)		
	SIFI (1999 Q4 – 2009 Q4)	**Non-SIFI (1999 Q4 – 2009 Q4)**
Nonlinear STAR-VECM	(Expansion regime) 0.5555* (Contraction regime) -4.6885*	(Expansion regime) 0.0998* (Contraction regime) 0.2651

[19] Before calculating the net effect of real stock return on other variables, we test whether the sum of estimates is zero [i.e., $H_0 : \sum_{i=1}^{3}\{\hat{a}_i + \hat{b}_i\} = 0$].

5. Conclusion

This work investigates commercial banks aggregate credit supply's effects on business cycle over different regimes of business cycle in Korea. A considerable amount of literature on the relation between commerical banks' credit supply and business cycle is available. However, little of it covers the regime changes' effect on the relation between credit supply and business cycle changes. This work contributes to the investigation of empirical evidence of the credit supply's effect on business cycle by incorporating regimes changes in nonlinear empirical framework.

This paper's contributions in related literature are as follows. First, we provide empirical evidence of commercial bank credit supply's procyclical property in Korea. Furthermore, GDP's significant effect on credit supply is also found. Second, our empirical evidence show that these effects are significantly different over regimes of economy. Particularly we find that credit supply's procyclical property is intensified in the contraction regime of economy. Lastly, through extended empirical works, we provide evidence that the big bank group's credit supply has large impact on business cycle than that of small bank group.

Then what is the implication of these results in Korean banking industry? A reasonable interpretation is Basel III's requirements on financial buffer and regulations on banking industry would not be effective without controlling large banks (SIFI)'s credit supply.

References

Basel Committee on Banking Supervision (BCBS), "Enhancement to the Basel II framework, " Bank for International Settlements (BIS), July 2009.

BIS, "The New Basel Capital Accord: Consultative Document," Basel Committee on Banking Supervision, Bank for International Settlements, April 2003.

BIS, "Modifications to the capital treatment for expected and unexpected credit losses in the New Basel Accord," Basel Committee on Banking Supervision, Bank for International Settlements, January 2004.

Boissay, F. and C. Kok Sørensen, "The Stabilizing Effects of Risk-Sensitive Bank Capital," ECB Working Paper Series, European Central Bank, February 2009.

Borio, C., C. Furfine and P. Lowe, "Procyclicality of the Financial System and Financial Stability: Issues and Policy Options," in Marrying the Macro- and Micro-Prudential Dimensions of Financial Stability, BIS Papers, No. 1, pp. 1-57, March 2001.

Brunnermeier, Markus, Andrew Crockett, Charles Goodhart, Martin Hellwig, Avinash D. Persaud, and Hyun Shin, "The Fundamental Principles of Financial Regulation," ICMB-CEPR Geneva Reports on the World Economy 11, January 2009.

Catarinew-Rabell, E., P. Jackson and D. P. Tsomocos, "Procyclicality and the new Basel Accord: banks' choice of loan rating system," Working Paper No. 181, Bank of England, 2003.

Financial Stability Forum (FSF), "Report of the Financial Stability Forum on Addressing Pro-cyclicality in the Financial System, " April 2009.

Goodhart, C., B. Hofmann and M. Segoviano, "Bank Regulation and Macroeconomic Fluctuations," Oxford Review of Economic Policy, Vol. 20, No. 4, pp. 591-615, 2004.

Heid, Frank, "The Cyclical Effects of the Basel II Capital Requirements," Journal of Banking and Finance, Vol. 31, 2007, pp. 3885-3900.

Huizinga, H. and D.Zhu, "Financial Structure and Macroeconomic Volatility: Theory and Evidence," CEPR Working Paper, No.5697, 2006.

Illing, Mark and Graydon Paulin, "The New Basel Capital Accord and the Cyclical Behaviour of Bank Capital," Working Paper 2004-30, Bank of Canada, 2004.

Kashyap A. K. and J. C. Stein, "Cyclical Implications of the Basel II Capital Standards," Economic Perspectives, Federal Reserve Bank of Chicago, pp. 18-31, 2004.

Kim, Hyeon-Wook and Hangyong Lee, "Pro-cyclicality of Buffer Capital and its Implications for Basel II: A Cross Country Analysis," Paper prepared for the 2006 KDI conference on "Adopting the New Basel Accord: Impact and Policy Responses of Asian-Pacific Developing Countries," July 2006.

Kim, Sei-Wan, André V. Mollic, Kiseok Nam, "Nonlinear Dynamic Relations Between Equity Return and Equity Fund Flow: Korean Market Empirical Evidence," Asia-Pacific Journal of Financial Studies Volume 39, Issue 2, pages 139–170, April 2010

Kim, Sei-Wan and Kiseok Nam, "Common nonlinearities in long-horizon stock returns: Evidence from the G-7 stock markets," Global Finance Journal, Volume 19, Issue 1, 2008, Pages 19–31

Lindquist, K., "Banks' Buffer Capital: How Important is Risk," Journal of International Money and Finance, pp. 493-513, 2004.

Pelizzon, Loriana and Stephen Schaefer, "Pillar 1 vs. Pillar 2 under Risk Management," NBER Working Paper Series, No. 11666, National Bureau of Economic Research, September 2005.

Perotti, Enrico and Javier Suarez, "Liquidity Insurance for Systemic Crises," CEPR Policy Insight, 31, February 2009.

Repullo, Rafael, Jesus Saurina, and Carlos Trucharte, "Mitigating the Procyclicality of Basel II," in Mathias Dewatripont, Xavier Freixas and Richard Portes, eds., Macroeconomic Stability and Financial Regulation: Key Issues for the G20, Centre for Economic Policy Research (CEPR), London, U.K., March 2009, pp. 105-112.

Repullo, Rafael and Javier Suarez, "The Procyclical Effects of Basel II," Working Paper presented at the 9th Jacques Polak Annual Research Conference hosted by the International Monetary Fund, Washington, DC, November 2008.

Segoviano, M. A. and P. Lowe, "Internal Ratings, the Business Cycle and Capital Requirements: Some Evidence from an Emerging Market Economy," BIS Working Papers, No. 117, September 2002.

Shin, Hyun Song, "Basel II and Bank Competition in Emerging Market Economies: Background and Recent Developments," mimeo, November 2003.

Zhu, Haibin, "Capital Regulation and Banks' Financial Decisions," BIS Working Papers No. 232, Monetary and Economic Department, Bank for International Settlements, July 2007.

Zicchino, Lea, "A Model of Bank Capital and the Macroeconomy: Basel I versus Basel II," Working Paper No. 270, Bank of England, 2005.