The Effects of Financial Instability on Real Output Growth

Jin Woong Kim1) · In Chul Kim2) · Young Jin Ro3)

Abstract

We investigate the dynamic relationship between financial uncertainty and real output growth using the time series data for Korea and U.S. To measure the financial uncertainty, we use a financial stress index (FSI) as a proxy variable, following Illing and Liu (2003, 2006). After constructing the FSI, a structural VAR (Vector Autoregressive) model is applied to examine the relationship between financial uncertainty and real economy. Our result confirms that the financial uncertainty significantly decreases the growth in real output in each country. Also, the financial instability affects the real output in different country as the FSI in U.S decreases the real output growth in Korea, which would be due to the deepening of global financial market synchronization.

Keywords : Financial market, Financial Stress Index, Time Series, Structural VAR.

JEL Classification: E40, E44, C32, C82

1. Introduction

According to classical economic theory, the role of financial variable is limited on distributing the remained resources in the economy into a form of investment in a loanable fund market, after consumption is made. This phenomena implies that the nominal variable do not affect the real variables, which is called “classical dichotomy”

However, some of the previous research such as the financial instability hypothesis (Minsky, 1982, 1986, 1992), suggest that the an occurrence of financial uncertainty increases expected return on investment and then it affects the real business cycle through the herd behavior in terms of demand for a given fund. In particular, most of the participants in the financial market show a similar pattern of responding to a global shock, in order to secure the value of their own assets. This relationship provides some useful inferences regarding how financial uncertainty affects the real output.1)
This market uncertainty is also magnified by the surge in volatility resulting from the sudden change in the price of a financial asset. An increase in financial uncertainty in a specific financial market tends to spread to other financial markets areas including interest rates, stocks, and foreign exchange markets. Therefore, as negative expectations prevail in major financial markets, most investors and consumers have made changes to their economic choices. Investors involved in the market would change their investment behavior to a more conservative or cautious one (Demers, 1991). Therefore, under the circumstances, an investor is likely to show a relatively poor response to a positive demand shock, compared to a negative shock. (Bloom, Bond and Reenen, 2007). Also, consumers tend to reduce or delay their expenditures. After all, financial uncertainty is likely to affect industrial production (Erdem, Arslan and Erdem, 2005).

Also, the financial uncertainty would have a larger impact on economy than before by affecting integrated international financial market. The development in information and technology system caused the market information to spread more rapidly not only in the domestic market but also to the international market in other country, which leaded the tighter integration of international financial market. This recent trend of international financial integration induces the instant movement of capital when any financial uncertainty occurs. This implies that the economy could be affected by the financial uncertainty arisen from domestic market as well as financial markets in other countries.

The purpose of this paper is to identify the financial uncertainty and its effect on real output. We also investigate the international spillover effect between Korea and U.S, which make our study distinctive with other previous studies. For the following chapters, financial uncertainty is introduced using a proxy variable which is measured here. Then, the relationship between financial uncertainty and the growth of real output is investigated using a multivariate time series model.

2. Financial Stress Index

Financial instability hypothesis arises from the characteristics for a pro-cyclical response of financial markets to impulse from the real economy (Minsky, 1982, 1986, 1992). That is, the intrinsic fragility which is based on the expectations of lenders and investors not only generates instability indifferent financial variables, but amplifies volatility in the real variables such as investment, consumption, and other related variables. Assuming an open economy, it would provide possible motivation for international business synchronization. Based on this hypothesis, the financial instability in an economy could amplify recessions. The instability in financial variables reflects the financial fragility explained above.
A financial market consists of a number of different types of individual financial markets, i.e. stock, interest rate, exchange rate market, and so on. However, most papers have employed the volatility of a specific financial market as a proxy variable representing uncertainty for the overall financial market. This restrictive choice seems to implicitly assume that the volatility in a specific financial market is closely related with other financial markets, and herein mimics the uncertainty of the overall financial market. However, even if a financial event occurs in a specific financial market, it usually causes an economic agent to change its financial choices, much like a portfolio selection, through a transmission effect of uncertainty among financial variables. However, if financial uncertainty is measured using only a specific financial market, it may cause measurement problem for the overall financial uncertainty in economy. Hence, it is necessary to include all major financial markets rather than just a single market in measuring financial uncertainty.

In this study, we use the financial stress index (FSI) as a proxy for financial uncertainty. The FSI was initiated by Illing and Liu (2003, 2006) and was used in Das et al. (2005), Li & St-Amant (2007), Misina and Tkacz (2008), Cardarelli, Elekdag and Lall (2009), Balakrishnan, Danninger, Elekdag, and Tytell (2009). The FSI is defined as the force exerted on economic agents by uncertainty and changing expectations of loss. Financial stress in an economy is usually expressed by a number of financial variables. Also, financial stress is the outcome of fragility of the financial structure and some exogenous shock. The more fragile a financial market is, the more rapidly a shock is transmitted into other economic sectors via the weaker financial structure. An extreme FSI value implies a crisis.

In measuring FSI, Illing and Liu (2003, 2006) estimated financial stress in each financial market using three methods: standard, refined, and the GARCH variable method. Then each stress is aggregated into a single FSI using one of the three different methods for a weighted average. Then, they evaluated the historical trends of FSI using type-I and type-II errors based on their survey data. Cardarelli, Elekdag, and Lall (2009) constructed 17 countries’ financial stress index. Using the database of 17 developed countries, they, constructed financial stresses in each of the three markets using a standard variable method, and aggregated them using a variance–equal method. In this paper, we adopt the methodological choice of Cardarelli, Elekdag and Lall (2009), and construct financial stress index for Korea and U.S.

### 2.1 Banking sector

Financial stress in the banking sector is comprised of three parts: a beta
coefficient of bank shares, an inverted term spread, and a TED spread. The theoretical background of the beta coefficient goes back to the capital asset pricing model (CAPM). Based on the theory, a beta coefficient ($\beta$) represents the systematic risk, which is non-diversifiable risk. Generally, when a beta coefficient is greater than 1, the volatility of returns for bank shares over the past year is greater than the volatility of those for the overall stock index. Hence, this implies that the banking sector is riskier than the overall financial market. The measurement of a beta coefficient is in equation 1.

$$\beta = \frac{Cov(r, m)}{Var(m)} \quad (2.1)$$

where $r$ and $m$ are the returns on bank shares and the overall stock index, respectively. The returns are calculated on the basis of comparison the same period of the previous year.

Secondly, an inverted term spread, is calculated by subtracting the long-term government bond yield from the short-term rate. A bank usually makes its revenue from investing in long-term assets using relatively short-term deposits. When the inverted term spread increases, the profitability of bank assets is reduced. Lastly, the TED spread is measured by subtracting the short-term government yield from the interbank short-term rate (i.e. LIBOR). The TED spread tends to reflect the general credit risk in the overall economy. Directly, an increase in the TED spread implies that the interbank loan risk has increased.13)

2.2 Securities sector

The stress index in the security sector comprises three indicators - one for the debt market and two for the equity market. First, corporate spread is used as a stress from the debt market, which is obtained by subtracting the long-term government rate from the corporate bond yield. An increase in the corporate spread means that the corporate bond rate is relatively higher to the government bond rate, which implies that the demand of raising funds by issuing corporate bonds is not preferred by firms. Hence, this indicates that financing using bond issues is less desirable.

Secondly, stress in the equity market is estimated using the EGARCH (Exponential Generalized Autoregressive Conditional Heteroskedasticity) volatility.14) The greater the volatility in the stock market, the greater uncertainty there is in the market. Initially, Engle (1982) suggests the ARCH model which systematizes a time-varying variance model using an autoregressive model. Bollerslev (1986) then
generalized this and suggested a GARCH model. The EGARCH model, which was provided by Nelson (1991), guarantees model stability without restrictions on coefficients in a conditional variance equation, and considers the asymmetry of the conditional variance. The EGARCH model is comprised of a mean equation, equation 1, and a conditional variance equation, equation 2.

\[ y_t = \sum_{i=1}^{l} (y_{t-i} \gamma_i) + \epsilon_t \]  

(2.2)

\[ \sigma_t^2 = \exp \left[ \delta_0 + \delta_1 \left( \frac{\epsilon_{t-1}}{\sigma_{t-1}} \right) + \delta_2 \epsilon_{t-1} + \delta_3 \log \sigma_{t-1}^2 \right] \]  

(2.3)

where a disturbance (\( \epsilon_t \equiv \sigma_t \xi_t | \xi_t \) is normally distributed as \( N(0, \sigma_t^2) \)) and \( y_t \) is the return rate of shares, i.e. log-difference, and \( \sigma_t^2 \) is the conditional variance, at time \( t \). \( \gamma_i, \delta_0, \delta_1, \delta_2, \delta_3 \) indicate the coefficients to be estimated.15)

Lastly, a decline in the stock market as an additional factor of financial stress is considered. That is, a decrease in stock prices leads to the burden of financing for a firm as well as income loss for investors.

\[ \text{Stock Decline} = \frac{S_{t-1} - S_t}{S_t}, \text{ where, } S_t \text{ is the share price at time } t \]

### 2.3 Foreign Exchange

The stress of the foreign exchange sector is estimated by the volatility in the EGARCH (1, 1) using the real effective exchange rate (REER). An increase in the volatility of the foreign exchange rate increases the uncertainty and then lowers the efficiency of the market.

### 2.4 Constructing a single FSI and its critical value

Here, each financial stresses in the three sectors; banking, securities, and foreign exchange, are combined to construct a single FSI for the economy. Each stress measured is normalized so that it ranges from 0 to 100, respectively. Then, using an equal-variance weighted average method, their impacts are combined.

Figure 1 show the trend of financial stress index and corresponding critical values in Korea and the US, respectively. The critical values are calculated one standard deviation above the trend using the Hodrick-Prescott filter.16) When the
FSI reaches a critical value, this implies that one or more of the banking, securities, and/or foreign exchange market variables have shifted abruptly.17) Because the FSI is normalized using past information within an economy, it is possible to compare between FSIs of two other periods in a given economy, but not between the FSIs two different economies.

Note: The solid line and dotted line are the FSI and critical value.

Figure 1: Financial Stress Index (FSI) in Korea and US
3. Model

In order to investigate the relationship between financial instability and real output growth, we used a structural VAR (Vector Autoregressive) model which is a standard multivariate time series model. Consider the following structural form of $n$ variable VAR with lag $p$.

$$A y_t = \sum_{i=1}^{p} \gamma_i y_{t-i} + B \epsilon_t$$

(3.1)

$y_t$ is a vector of $n$ endogenous variables, $\epsilon_t$ is a white noise vector of the disturbance terms for the each endogenous variable. A matrix contains the structural parameters of the contemporaneous endogenous variables. The B matrix contains the contemporaneous response by the variables to disturbances or innovations. Because of the parameter identification problem, we first estimate it as a reduced VAR. The representation of a reduced VAR is as follows:

$$y_t = \sum_{i=1}^{p} \Gamma_i y_{t-i} + u_t$$

(3.2)

Then, in order to estimate the structural VAR, an identification procedure is applied from the relationship between equation (3.1) and (3.2). Equation (3.1) shows the model for applying the AB-model by Amisano and Giannini (1997). From both equations, we can determine the relationship, $u_t = A^{-1} B \epsilon_t$. After the reduced form error term ($u_t$) is estimated from the data, the structural form errors can be obtained using one-to-one mapping from the covariance matrix of reduced form errors to the $A$ and $B$ matrices. Bernanke (1986) defined structural shocks $\epsilon_t$ as “primitive exogenous forces”, not directly observed by econometricians, which acts as a buffet for the system and causes fluctuations. Because these shocks are primitive, i.e., they do not have common causes, it is natural to treat them as uncorrelated. Therefore, when we assume an uncorrelated diagonal matrix, $E[\epsilon_t \epsilon_t] = \Sigma$, the reduced form errors have the following covariance $\Omega = \text{Cov}(u_t) = A^{-1} B \Sigma B (A^{-1})'$.

Compared to orthogonal innovations ($\epsilon_t$), $u_t$ which is a linear combination of $\epsilon_t$, can be correlated with each other. When we impose some identifiable restrictions on $A$ and $B$, we can identify the structural shocks. More specifically, if we assume that the lower triangular $A$ matrix with the normalized diagonal
elements and diagonal B matrix with unknown diagonal elements,\(^\text{18}\) then the identification is equivalent to the conventional Cholesky decomposition. This Cholesky type (just-identified) restriction has been popular and used by many researchers because of its convenience. However, the empirical results, like an impulse response analysis, tend to depend on the assumption of ordering which imposes contemporaneous causality among variables. Hence, Pesaran and Shin (1998) suggest an ordering–invariant identification method. This is a generalized impulse response analysis method, of which an innovation to the j-th variable are estimated using a variable–specific Cholesky factor computed with the j-th variable at the top of the Cholesky ordering. Despite its ordering–invariant feature, it tends to accept an unrealistic assumption. That is, a specific variable is a causal sink, but it can be used as a causal parent in the estimation. Despite this shortcoming, the generalized impulse response analysis is useful to check the robustness of a specific ordering assumption.\(^\text{19}\) However, the following two reasons enable us to use Cholesky assumption. At first, the causal flow between two economies is usually one way from U.S. to Korea. Secondly, our purpose of the analysis is on investigating the effect of financial instability on the real economy. In the following empirical study, hence, we estimate impulse response functions and forecasting error variance decomposition based on the Cholesky ordering.

4. Data and Empirical Results

In the following empirical study, we applied the SVAR model using quarterly data from Q1, 1995 to Q4, 2009 for US and Korea. The endogenous variables in our model are GDP growth (log differences, \(DY_{t}^{US}\) and \(DY_{t}^{KR}\)) and the FSIs in both economies (\(X_{t}^{US}\) and \(X_{t}^{KR}\)). The sources of financial data to measure the FSI are Bloomberg, the Federal Reserve Bank, and the Bank of Korea. Also, real GDP data is obtained from IFS (International Financial Statistics).

The test results for the unit root based on the ADF (Augmented Dickey–Fuller) and PP (Philips & Perron) show that all endogenous variables are stationary (see Table 1). Also, there is no cointegrating relationship using the Johansen (1988, 1991) method between both GDP levels, which are non stationay.\(^\text{20}\) The Optimal lag of VAR is chosen as 1 by Schwarz Information Criteria.
The empirical results (Figure 2 and Table 2) regarding the impulse response function and forecast variance decomposition provide the following evidence with respect to domestic and international spillover matters. The assumption of contemporaneous causality follows Cholesky ordering, which is recursively listed by $X_{t}^{US}$, $DY_{t}^{US}$, $X_{t}^{KR}$ and $DY_{t}^{KR}$.21 The unconditional correlation coefficient matrix using those endogenous variables implies a negative relationship between FSI and GDP growth rate, but a positive relationship between FSIs and the growth rate of GDP.

\[
\text{Corr} = \begin{bmatrix}
X_{t}^{US} & DY_{t}^{US} & X_{t}^{KR} & DY_{t}^{KR} \\
1.00 & 1.00 & 1.00 & 1.00 \\
-0.27 & -0.14 & 1.00 & 0.43 \\
0.43 & -0.14 & 1.00 & 0.43 \\
-0.51 & -0.72 & 0.43 & 1.00 \\
\end{bmatrix}
\]

Our main findings can be summarized as follows. First, a surge of financial stress in an economy induces a fall in each subsequent economy. Based on the impulse response function, a financial stress in the US decreases its real output growth for one quarter ahead, significantly. Similarly, a shock of financial stress in Korea affects real output growth, contemporaneously.

Second, a shock of financial stress in the US significantly increases the financial stress in Korea. Also it causes an immediate decline in real output growth. This means that US financial instability changes the expectations and portfolio of economic agents and then leads to a drop in real output, which implies a reduction or postponement of investment and consumption. Then, international financial integration spreads out this effect to other countries.

Third, the effect of financial stress on real output growth may not be trivial even if the duration of the effect is temporary. This is because the change in real output after the financial stress shock does not reach to zero growth for a long time.

The forecast variance decomposition analysis over the preceding twelve quarters using recursively designed for orthogonality conditions is shown in Table 2. It examines the relative influence of innovations in each endogenous variable.

### Table 1: Unit Root Test

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<tr>
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<th>ADF</th>
<th>PP</th>
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<tr>
<td>FSI(US)</td>
<td>-2.751*</td>
<td>-2.718*</td>
</tr>
<tr>
<td>FSI(Korea)</td>
<td>-3.107**</td>
<td>-3.143**</td>
</tr>
<tr>
<td>GDP(US) growth rate</td>
<td>-7.138***</td>
<td>-7.159***</td>
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<tr>
<td>GDP(Korea) growth rate</td>
<td>-5.861***</td>
<td>-5.783***</td>
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Note) *, ** and *** indicate significance at the 10%, 5% and 1% levels respectively.
out of the total variation of a specific variable. We break up the forecast uncertainty of each variable into information for each of the four series. Each panel shows the uncertainty associated with each forecast horizon, and the decomposition from initial innovation shocks arising in each of the four series.

First, one of the most apparent results in Table 2 is that a national financial stability plays an important role for the growth of real output. That is, the explanatory shares of a financial stress innovation on the variation of real output growth can’t be negligible in both economies. For example, the share of US real growth variation explained by innovations of its own financial stress is less than 1% at the zero-quarter horizon, but reaches about 10% at the 12-quarter horizon. Moreover, the shares of Korean real growth variation explained by innovations of its own financial stress are over 30% at the zero- to 12-quarter horizons.

Another important result in Table 2 is the importance of US financial uncertainty in explaining the variation of real output growth in Korea. The innovation shock of the US financial stress explains 33–34% of real growth in Korea.

Note: The forecast horizon is measured in quarter and is given on the horizon. The vertical line shows magnitude of response. The dotted line indicates confidence band. The variables are (financial stress index in US), (financial stress index in Korea), (growth rate of GDP in US), (growth rate of GDP in Korea).

*Figure 2* Impulse Response Function
<Table 2> Forecast Variance Decomposition

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<th>Period</th>
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Note: The variables are $X_{IS}$ (financial stress index in US), $X_{KR}$ (financial stress index in Korea), $DY_{US}$ (growth rate of GDP in US), $DY_{KR}$ (growth rate of GDP in Korea).
5. Conclusion

This study investigates the dynamic relationship between financial uncertainty and real output growth. In addition, we focus on the international spillover effect of US financial uncertainty on the financial uncertainty and real output growth in Korea. In order to examine overall financial uncertainty in an economy, we constructed the financial stress index as a proxy variable, which reflects the degree of uncertainty in several major financial markets including banking, securities, and foreign exchange markets.

Based on the empirical analysis, we found that a national financial stress significantly decreases growth in real output. A financial shock in the US deteriorates its real output growth for one-quarter. Also, a financial shock in Korea brings about a significant fall of the real output growth for the present quarter. If we do not consider the confidence interval for each economy, the effect of a national financial shock on the corresponding real output growth is not just in the short-term. It means that it would take a long time for a real output to recover after the financial stress shock occurred. Also, the shares of real output growth variation explained by a financial shock are no less than 10%, which is quite consistent over time. Apparently, the spillover effect of a financial shock from U.S. to Korea is found out to be significant for two quarters including the present quarter. It implies that the sudden instability in the US financial market is transmitted into another economy through the mass-media, investor behavior, and other factors.

Lastly, a shock in the US financial market consequently decreases real output growth in Korea via both of the above two effects, financial stress on real output growth and an international synchronization effect of financial stress.

The empirical results support, in some sense, that output would be affected by a financial uncertainties or financial stress. Co-movement can occur from the interaction of financial uncertainties or financial stresses. Of course, the relationship between financial integration and business cycle synchronization is controversial. However, as Ranciere et al. (2006) suggest, one of the most important premises for maximizing a positive effect from financial integration on a firm is to maintain a lower degree of financial uncertainty or risk.
Reference


Kim, J.W. and Ro, Y. (2009), Analysis of the Relationship Between Financial Instability and the Real Economy and its Implications, e-KIET Industrial Economic Information, 436.(in Korean)


(2011년 6월 접수, 2011년 8월 채택)
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Footnotes

1) The previous studies related with the stagnation of investment due to economic (financial) instability or uncertainty starts from debate between Hartman (1972) or Abel (1983) and Pindyck (1991). After that, most research explained that financial uncertainty tends to decrease expected (future) profits, aggravate the profitability of investment, and debase present investment. Furceri and Mourougane (2009) also state that financial uncertainty can negatively affect investment decisions as a result of a reduced demand and corresponding credit crunch. That is, when the event which amplifies a financial uncertainty is occurred, the basic factors to affect investor appear to be influenced via an increase of risk premium and uncertainty in compensation of investment. In this case, it is possible that the effect of some positive factor for investment might decrease. Also, more directly, the financial uncertainty makes a firm which has a willingness to invest difficult to raise an enough resources for investment. For the related literature survey and research regarding to Korean economy, refer Ro et al. (2009) in detail.


3) In particular, it is effective about durable goods. (Hassler, 1996)

4) In this sense, Yoon(2007), Lee(2002) provide that synchronization between financial markets in Korea and U.S. is significant. Also, Kim, C.(2002), Kim, J. W.(2007) provide that the co-movement of financial markets in two economies – especially from U.S. To Korea – has been deepening and therefore it affects business synchronization.

5) The pro-cyclical risk is assessed or evaluated by lenders and investors. It tends to be underestimated during times of expansion, but overestimated during contractions.


7) i.e. stock market, interest rates, and foreign exchange rate market.

8) i.e. rapid decrease of cash flow, behavior changes of the lender toward more risk averse, and a highly leveraged economy.

9) banking, equity, debt, and exchange rate sectors

10) First, a credit weight method, which considers relative market size (share), secondly, a variance-equal weight, which uses the same weight across specific financial markets, then thirdly, a factor analysis based weight.

11) banking, security (equity and debt), and exchange rate sectors

12) For the application of FSI in Korea, please see Joo and Hahn(2006), Kim and Ro(2009), Kim et al.(2009).

13) In Korea, the second and third parts of banking stress are calculated jointly by subtracting the long–term government bond yield from the short–term certificate rate (3-month CD rate). This considers short–term risk as well as fund raising activity stress in the banking sector, simultaneously. This method is used because of the data restrictions on 3-month short–term government yields and the interbank rate.

14) Cardarelli, Elekdag and Lall (2009) measure volatility using GARCH to calculate the FSI. However, based on our work, the results from both methods, GARCH and EGARCH, are similar.

15) The asymmetry in stock market volatility arises usually when is positive and is negative in the second equation, a conditional variance equation. This implies that a past negative shock has a larger effect on the increase of the present volatility, relative to a past positive shock.
If $\epsilon_{t-1} > 0$ then $\frac{\partial \ln \sigma_t^2}{\partial (\epsilon_t/\sigma_t^2)} = \delta_1 + \delta_2$. Otherwise: $\frac{\partial \ln \sigma_t^2}{\partial (\epsilon_t/\sigma_t^2)} = -\delta_1 + \delta_2$

16) A standard Hodrick-Prescott (HP) filter breaks down a time series into a trend component and a cyclical component (Hodrick and Prescott, 1997), using a coefficient of 100 for annual data, 1,600 on quarterly data, and 14,400 for monthly data.

17) Lall, Cardarelli & Elekdag (2008) identify the period of financial episode when the FSI is greater than the critical value during two and more quarters.

18) Or vice versa.

19) In this analysis, the Granger causality is not applied because the typical Granger Causality tests the significance of past values of the possible ‘cause’ variable to explain the ‘effect’ variable, which implies that a cause precedes its effect but the effect does not precede its cause.

20) The result of co-integration is not reported here. It will be provided upon request.

21) When we apply the general impulse response which does not depend on a specific ordering, there is not a significant difference in the results.

22) Standard error of the forecast error in each horizon

23) See Kalemli-Ozcan, Papaioannou, and Peydro (2009)

24) As other factors, they provide an implementation of effective system for risk compensation, and deregulation of financial constraint.