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The Propagation of the US Financial Crisis to a Small Open Economy: Evidence from Korea*

Andrew Taylor** · Junhee Lee***

The recent 2008/2009 global financial crisis originating from the US seems to have generated recessions worldwide. This paper examines the international propagation of the US financial crisis to a small open economy, Korea, based on a block-recursive vector autoregression model. The results indicate that the US financial shock (crisis) has a contractionary effect on the Korean economy and has considerable influence on the Korean economy in terms of both variance and historical decomposition over the recent financial crisis period. This implies that the model of a realistic international business cycle needs to incorporate the financial transmission mechanism as well as the real one.

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** School of International Economics and Business, Yeungnam University, 280 University Road, Gyeungsan, Gyeongbuk 712-749, Republic of Korea, E-mail: amtaylor@unomaha.edu
*** Author for Correspondence, School of International Economics and Business, Yeungnam University, 280 University Road, Gyeungsan, Gyeongbuk 712-749, Republic of Korea, Tel: +82-53-810-2769, Fax: +82-53-810-4653, E-mail: lee1838@ynu.ac.kr

1. INTRODUCTION

The recent 2008/2009 global financial crisis originating from the US mortgage market seems to accompany recessions worldwide (the so-called 'Great Recession'). This paper quantitatively measures the international transmission of the US financial crisis to Korea, a small open economy, based on a block-recursive structural vector autoregression (VAR) model.

The paper constructs the VAR model with Korean and US blocks by assuming that the Korean block has no effect on the US block because Korea is a small open economy. In addition, the paper identifies US financial shocks and finds them to contract the Korean economy and have considerable influence on fluctuations in the Korean economy in terms of variance and historical decomposition.

Previously Canova (2005) and Ma•kowiak (2007) examine the transmission of US monetary policy shocks to small open economies by using block-recursive VAR models and find their considerable effects on small open economies. This paper examines the propagation of US financial (credit), different from monetary policy, shocks to a small open economy (Korea). Recently numerous studies are focused on the effects of financial shocks on the economy aftermath the global financial crisis. For instance, Gilchrist and Zakrajšek (2012) analyse the effects of US financial shocks on the US economy by using a VAR model. Jermann and Quadrini (2012) find financial shocks contribute significantly during the recent global financial crisis in the context of dynamic stochastic general equilibrium (DSGE) model. The main focus of this paper is to analyze the international propagation of US financial shocks to a small open economy different from previous studies focusing on the effects of US financial shocks on US economy.

Our analysis thus contains several interesting and new respects. First, we focus on financial shocks in the international transmission of business cycles previously omitted in empirical international business cycle studies such as Canova (2005), Ma•kowiak (2007), and Zaidi and Fisher (2010) and examine

credit or financial route of international transmission. The financial shocks originate from credit market frictions as in Bernanke *et al.* (1999) and they are different sources of economic fluctuations from monetary shocks, which are policy shocks. The effects and propagations of financial shocks are important topics aftermath the US financial crisis.

Second, we focus on the international transmission of US financial shocks to another country and thus extend the scope of analysis in the propagation of financial shocks from a closed economy as in Gilchrist and Zakrajšek (2012) and Jermann and Quadrini (2012) to international economies. Third, we empirically measure the international transmission of financial shocks and our results can be used as a basis for constructing theoretical DSGE models with international financial transmission such as Lee and Rhee (2013).

2. BLOCK-RECURSIVE VAR ANALYSIS

A block-recursive (exogenous) structural VAR model is constructed based on Zha (1999) and Ma•kowiak (2007). $z_1(t)$ denotes a vector of m_1 Korean variables, and $z_2(t)$ represents m_2 US variables at time t. The VAR model with the Korean (first) block and the US (second) block is given as

$$\sum_{l=0}^{p}\begin{bmatrix} A_{11}(l) & A_{12}(l) \\ A_{21}(l) & A_{22}(l) \end{bmatrix}\begin{bmatrix} z_1(t-l) \\ z_2(t-l) \end{bmatrix}=\begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}, \tag{1}$$

where l is the lag operator, $A_{ij}(l)$ is an $m_i \times m_j (i, j \in \{1, 2\})$ coefficient matrix, and $\varepsilon_i(t)$ is an $m_i \times 1 (i \in \{1, 2\})$ vector of the structural disturbances. $\varepsilon(t)=[\varepsilon_1(t);\ \varepsilon_2(t)]$ is a normal distribution with

$$E[\varepsilon(t)\varepsilon(t)'\,|\,z(t-l),\ l>0]=I,\ \ E[\varepsilon(t)\,|\,z(t-l),\ l>0]=0, \tag{2}$$

where $z(t)=[z_1(t);\ z_2(t)]$. Block exogeneity implies that $A_{21}(l)$ is zero

for all $l = 0, 1, \ldots, p$ and that Korean variables have no effect on US variables in the VAR model. Korea is assumed to be a small open economy, which implies the block exogeneity.

The Korean block variables include the Korean nominal exchange rate (KRW/USD) $(E(t))$, the Korean call rate $(R(t))$, the Korean credit spread (corporate bond rate — government bond yield) $(S(t))$, the Korean CPI index $(P(t))$, Korean GDP $(Y(t))$ and Korean total fixed capital formation $(I(t))$. The US block variables include the US federal fund rate $(R^*(t))$, the US credit spread (Prime loan rate — T-bill rate) $(S^*(t))$, the US CPI index $(P^*(t))$, US GDP $(Y^*(t))$, US business investment $(I^*(t))$. The choice of these US block variables for the VAR model is standard as in Gilchrist and Zakrajšek (2012). The Korean block variables add the nominal exchange rate $(E(t))$ in addition to the US ones.

To identify US financial shocks, we assume $A_{22}(0)$ is upper triangular following Gilchrist and Zakrajšek (2012). Therefore, shocks to the US credit spread, identified as financial shocks, affect US economic activity (output and investment) and inflation with a lag, and the risk free (federal fund) rate can react contemporaneously to financial shocks. In addition, the US financial shocks are assumed to affect Korean economic activity and inflation with a lag such that $A_{12,\,gh}(0) = 0,\ g \in \{4,\ 5,\ 6\},\ h \in \{2\}$, where $A_{12,\,gh}(0)$ represents *g*-th row and *h*-th column element of the $A_{12}(0)$ matrix. The model is weak, not strong, block-recursive according to Zha (1999) because it imposes restrictions on $A_{12}(0)$ in addition to the block exogeneity restriction that all $A_{21}(l)$ are zero matrices.[1)] The VAR model is estimated using maximum likelihood methods. The sample period for the estimation is the first quarter of 2000 to the third quarter of 2012, which corresponds to the period following the 1997-1998 Korean financial crisis.[2)] For the estimation, logged and HP-filtered data are used for all the variables except for the interest rate ($R(t)$ and $R^*(t)$) and the spread ($S(t)$ and

[1)] The likelihood ratio test does not reject these identification assumptions.

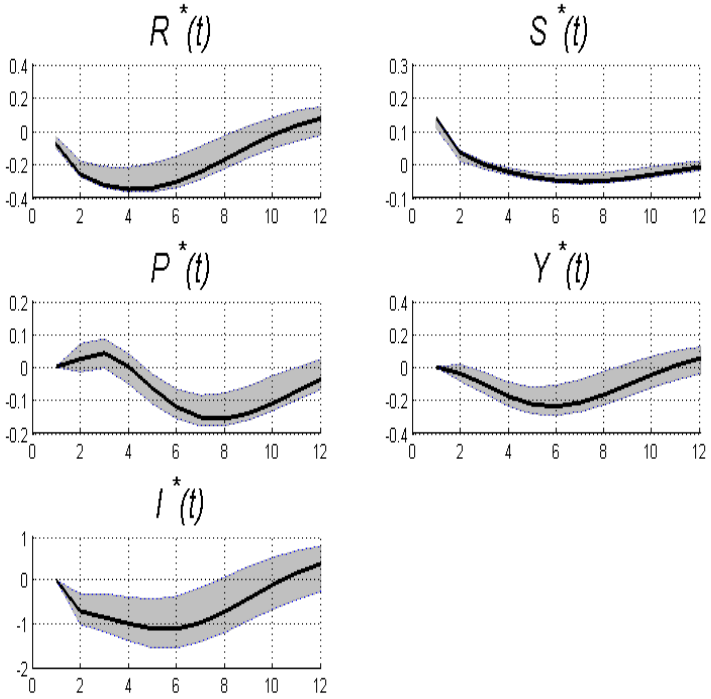
[2)] The Korean economy experiences important structural changes during the 1997-1998 Korean financial crisis, and therefore the VAR model is estimated for the period following the Korean crisis for meaningful results.

$S^*(t)$), for which HP-filtered data are used.[3] The lag length of the VAR model is set to one based on Schwartz and Hannan-Quinn information criteria.

Figure 1 plots impulse response functions (IRFs) to a US financial (spread) shock with 68% confidence intervals. The first panel (1A) shows IRFs of the US variables to the shock. The shock increases the US credit spread $(S^*(t))$ and reduces the US output $(Y^*(t))$, investment $(I^*(t))$ and interest

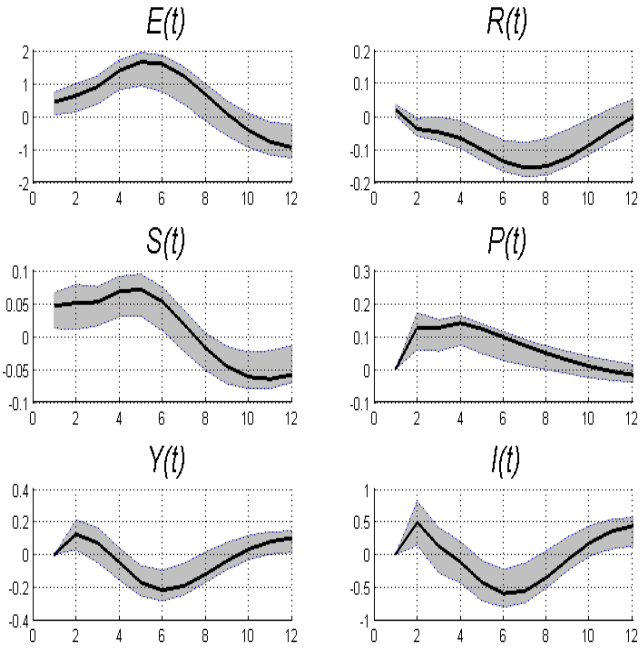
Figure 1 Impulse Responses to a US Financial Shock

1A Responses of US Variables to a US Financial Shock



[3] Deterministic (instead of stochastic) trends are assumed in variables as in usual international DSGE models such as Justiniano and Preston (2010). HP-filter is used for the removal of the trends.

1B Responses of Korean Variables to a US Financial Shock



Notes: All variables except the interest rate and the spread are shown as percentage deviations from their long-run trends. Responses of these two variables are presented as the percentage of the annualized values to the long-run value. Confidence intervals for IRFs are calculated using simple bootstrap with 1,000 iterations.

rate $(R^*(t))$. The US price level $(P^*(t))$ does not respond much initially and declines afterward. These IRFs are consistent with the findings of Gilchrist and Zakrajšek (2012). These results may be interpreted based on a DSGE model with a financial accelerator, as in Bernanke *et al.* (1999). A financial disruption can widen the credit spread. Firms and consumers have more difficulty borrowing externally when the credit spread widens and the level of investment or output declines. The price level and the interest rate decrease when the economy contracts.

The second panel (1B) shows the IRFs of the Korean variables to the US financial shock. The IRFs of the Korean output, investment, interest rate,

and credit spread are similar to those of their US counterparts. More specifically, the Korean output $(Y(t))$, investment $(I(t))$, and interest rate $(R(t))$ decrease in response to the shock, whereas the Korean credit spread $(S(t))$ widens. Therefore, the Korean economy as well as US economy contracts because of the US financial shock, and the IRFs demonstrate the international transmission of the US financial shock. The nominal exchange rate $(E(t))$ rises (or the Korean won depreciates) in response to the shock. The Korean won may depreciate because international investors want to hold the US dollar as the safer currency during the financial turmoil, reflecting the so-called 'flight to quality' as in Bernanke *et al.* (1996). Korean price level $(P(t))$ rises in response to the US financial shock, which is somewhat inconsistent with the fall in the US price level. This suggests that the financial shock is more likely to work through the cost channel as in Ravenna and Walsh (2006) than the demand channel in the Korea economy.

Table 1 reports the forecast error variance decomposition of the Korean variables due to US shocks. The US financial shock explains 11.1-23.6%, 4.4-24.9%, 7.0-15.0%, 18.0-25.1%, 1.6-9.9%, and 1.8-9.5% of the fluctuations in the Korean nominal exchange rate, interest rate, credit spread, price level, GDP, and investment, respectively. US shocks all together explain more than 50% of the fluctuations in all the Korean variables. This suggests that the US financial shock plays significantly important role and US (external) shocks all together play dominant role in the Korean business cycles over the sample period.

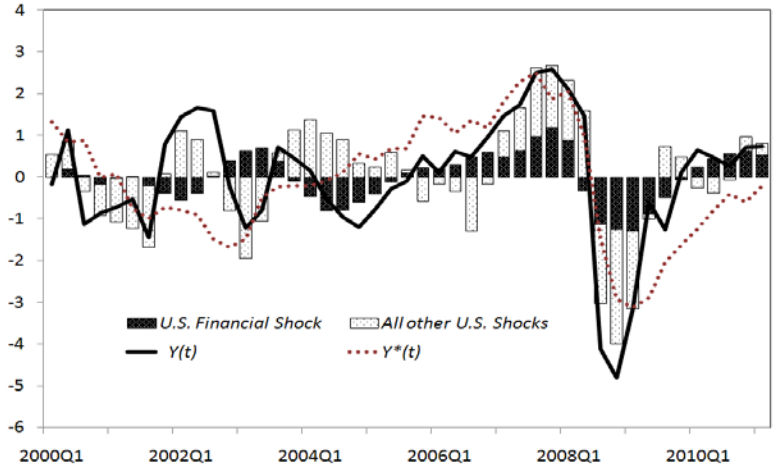
Figure 2 shows the historical variance decomposition of Korean GDP $(Y(t))$ according to US shocks over the sample period. The US financial shock, together other shocks originating from the US, makes a substantial contribution to the decrease in Korean GDP around the 2008/2009 global financial crisis.

Table 1 Variance Decomposition

	$E(t)$			$R(t)$		
Quarter	4th	8th	16th	4th	8th	16th
US Financial Shock	11.1 (4.5 19.2)	19.8 (8.6 27.7)	23.6 (10.9 30.9)	4.4 (1.2 9.9)	21.8 (9.0 29.9)	24.9 (10.5 31.5)
All US Shocks	75.4 (74.5 85.3)	85.9 (83.6 91.9)	87.9 (85.5 93.5)	59.5 (58.2 79.1)	76.2 (74.8 89.2)	80.7 (79.0 92.1)
	$S(t)$			$P(t)$		
Quarter	4th	8th	16th	4th	8th	16th
US Financial Shock	7.0 (3.2 13.0)	9.3 (5.0 15.9)	15.0 (7.7 21.4)	18.0 (7.3 24.8)	24.8 (9.6 30.5)	25.1 (10.4 30.7)
All US Shocks	72.0 (71.3 83.7)	77.6 (76.8 87.3)	80.5 (79.4 89.2)	55.6 (54.1 72.4)	61.2 (58.8 77.1)	62.2 (61.2 79.4)
	$Y(t)$			$I(t)$		
Quarter	4th	8th	16th	4th	8th	16th
US Financial Shock	1.6 (1.1 7.1)	8.1 (4.0 16.0)	9.9 (5.2 18.1)	1.8 (1.1 7.8)	6.3 (3.3 14.1)	9.5 (5.1 17.8)
All US Shocks	60.4 (57.9 76.3)	68.8 (66.1 82.6)	70.4 (68.1 84.1)	55.8 (54.8 72.9)	65.6 (64.6 79.9)	68.5 (67.4 82.5)

Note: Numbers in parentheses represent confidence intervals calculated using simple bootstrap with 1,000 iterations.

Figure 2 Historical Decomposition of Korean GDP According to US Shocks



3. CONCLUSIONS

The recent 2008/2009 global financial crisis originating from the US seems to have induced recessions worldwide. This paper measures the effects of the US financial crisis on Korea, a small open economy, by using a block-recursive VAR model. The results can be summarized as follows: First, the US financial shock has contractionary effects on the Korean economy. Second, this shock has considerable influence on the Korean economy in terms of variance and historical decomposition during the recent global financial crisis. The results show that a realistic DSGE model of international business cycles needs to incorporate a financial accelerator mechanism in addition to real propagation mechanisms.

We conclude the paper by noting several limitations of the analysis. The VAR analysis is limited to a small open economy, Korea, and the robustness of the results needed to be checked with other small open economies. Further we assume US economy represents all the foreign economies and the assumption can be relaxed so that the foreign variables can include variables from other big economies such as E.U. and Japan.

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