Country Spread, Foreign Interest Rates, and Macroeconomic Fluctuations in Korea[*]

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This paper examines the dynamic relations between the country spread and macroeconomic fluctuations in Korea using a structural vector autoregressive (SVAR) model as well as a calibrated equilibrium model due to Uribe and Yue (2006). Our empirical analysis shows that the country spread has a small but significant influence on the short-run macroeconomic activities of the Korean economy. We also find that the U.S. and Japanese interest rate shocks have quite different effects on the real activities in Korea. Finally, the calibrated model produces results that are largely consistent with the results from the SVAR model, although there are some gaps to be explained.

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1. INTRODUCTION

In a financially integrated world, a small open economy is well understood to be vulnerable to changes in international financial conditions. In particular, the cost of borrowing in small open emerging economies is reflected in the country interest rate, which may be correlated with business cycles in such economies. What is notable is that movements in country interest rates are not entirely driven by the world interest rate. This implies that there is an important role played by the country spread. The country spread, which defines the relative interest rate faced by a country with access to the global capital markets can have an important bearing on the short run macroeconomic consequences in a small open growing economy. Moreover, the country spread is not only endogenous to the foreign interest rate but to the domestic economic and financial conditions. Hence, country spreads serve as a transmission channel of the world interest rate while capturing the state of domestic economic fundamentals as perceived by the international lenders. Thus, it is important to identify the forces driving country spread and analyze how it interacts with domestic economic activities when assessing the extent of the vulnerabilities of a small open economy to changes in international financial conditions.

A number of studies have documented the role of movements in country spread and the world interest rate in driving business cycles in small open economies (Neumeyer and Perri, 2005; Uribe and Yue, 2006). Among these studies, Uribe and Yue offer a useful analytical framework in which the dynamic relationships between country spread and economic fluctuations can be examined in the context of a small open economy.

This paper employs their proposed analytical framework to study the dynamic relationships between country spread and macroeconomic activities in the context of the Korean economy.[1]   There are a number of recent studies

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[1] They studied a panel of mostly Latin American emerging economies and confirmed a significant link between country spread and economic fluctuations in these countries. Korea was not included in their work, nor considered in previous empirical studies.
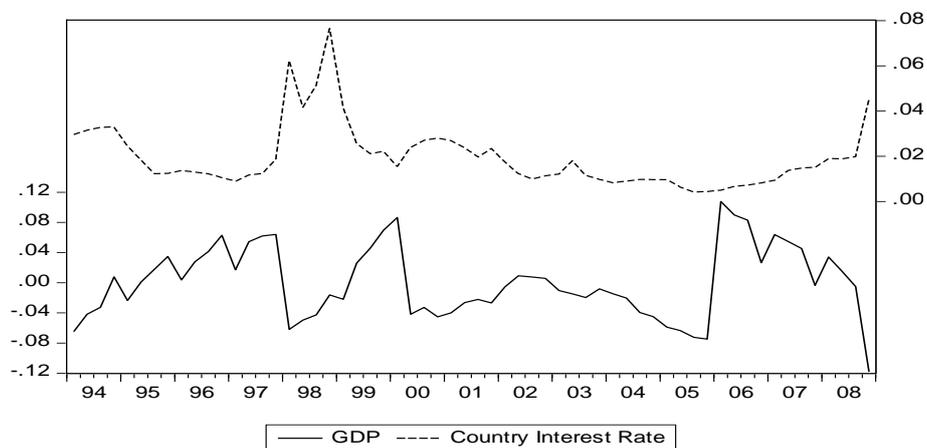
Figure 1   GDP and Country Interest Rates (Korea-U.S.)
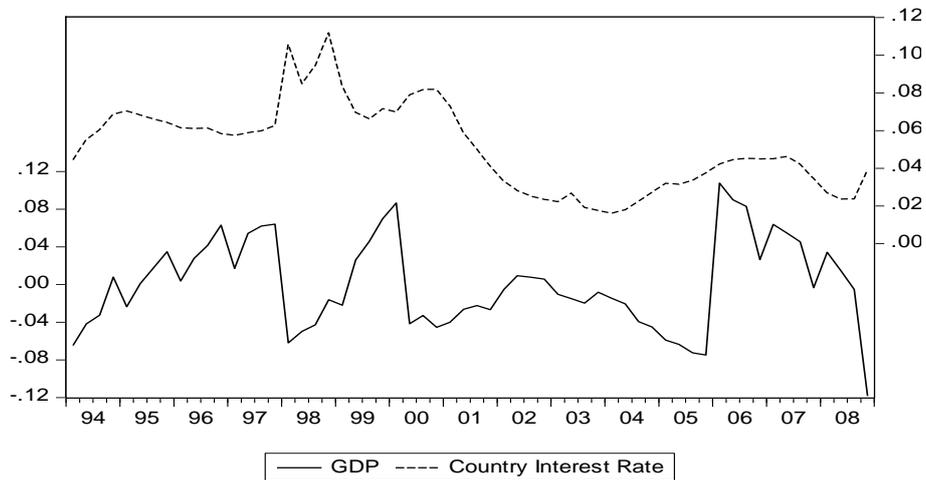
Notes: GDP is seasonally adjusted and detrended using the Hodrick-Prescott filter.   The country interest rate is the sum of country spread and the world interest rate.   Real yields on the U.S. dollar-denominated bond of Korea issued in international financial markets are used as a country spread and the three-month Treasury bill rate of U.S. is used as a world interest rate.   The left-axis values are the numerical values for GDP and the right-axis denotes the values for the country interest rate.

that examined the open economy aspects of the Korean economy or the effects of foreign interest rates on the domestic economic activities (see, for example, Buyangerel and Kim (2013) and Shah and Fisher (2010)).[2] However, a study on the dynamic relations between country spread, and foreign interest rates and their macroeconomic effects on the Korean economy is yet to be done.   This paper aims to fill this void.

Unlike previous studies on Latin America where the main external influence considered was the U.S. interest rate, studying the Korean economy in the presence of foreign interest rate shocks requires an additional consideration due to its close economic ties with Japan as well as the U.S. Figure 1 displays detrended GDP and country interest rate in real terms for

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[2] Buyangerel and Kim (2013) used a structural vector error correction (SVEC) model to study the effects of macroeconomic shocks on exchange rate and trade balances in Korea while Shah and Fisher (2010) used a structural vector autogressive (SVAR) model to analyze the effects of foreign shocks on the Malaysian economy and monetary policy.
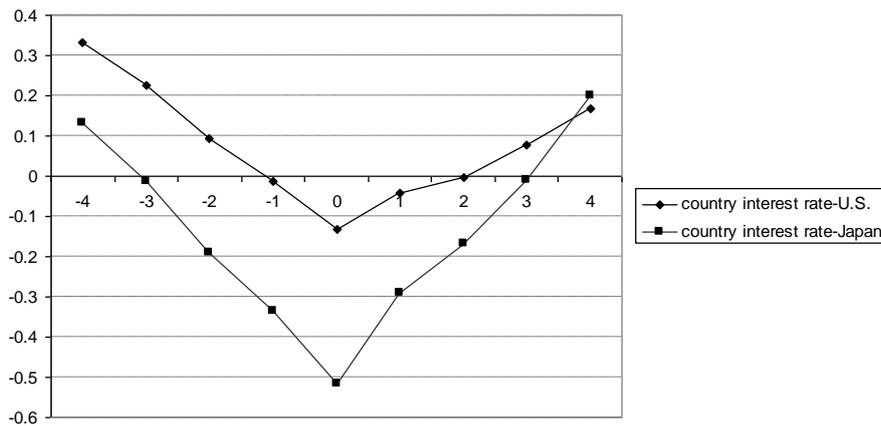
Figure 2   GDP and Country Interest Rates (Korea-Japan)

Notes: GDP is seasonally adjusted and detrended using the Hodrick-Prescott filter.   The
         country interest rate is the sum of country spread and the world interest rate.   Real
         yields on the U.S. dollar-denominated bond of Korea issued in international financial
         markets are used as a country spread and the three-month CD rate of Japan is used as a
         regional interest rate.   The left-axis values are the numerical values for GDP and the
         right-axis denotes the values for the country interest rate.

the period 1994-2008, assuming the U.S. interest rate as the world interest
rate.   Similarly, figure 2 displays the same relationship but using the
country interest rate computed using the Japanese interest rate, rather than the
U.S. interest rate, as the benchmark foreign interest rate.   Both figures
indicate that, during the periods of low country interest rates, Korea was in
economic expansion, while high country interest rates were associated with
the periods of economic contraction.   In particular, during the Asian
financial crisis country interest rates showed rapid escalations whilst output
fell sharply implying a counter-cyclical relationship between country interest
rates and the domestic economic activities.   This observation is indicative of
the stylized fact that there is a negative correlation between the real interest
rate and overall economic activity in emerging countries (Agénor *et al.*, 2000;
Neumeyer and Perri, 2005; Uribe and Yue, 2006).[3]

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[3] For developed countries, the relationship is found to be largely acyclical.

Figure 3   Cross-Correlations between GDP
and Country Interest Rates

Notes: *Y* axis denotes correlation coefficients between GDP and country interest rates.   *X* axis
       denotes the quarters from 0 to both lags and leads directions.

   To illustrate this point further, figure 3 depicts the cross-correlation
coefficients between detrended GDP and country interest rates at different
lags and leads, and the contemporaneous relations between GDP and country
interest rates.   Contemporaneously, the correlation is –0.13 for the country
interest rate computed using the U.S. interest rate, and –0.52 for the country
interest rate computed using the Japanese interest rate, respectively.   The
figure shows the potentially different impacts that the U.S. and Japanese
interest rates have on the Korean economy, which will be made clear later in
the current paper.
   To analyze the effects of a foreign interest rate and the corresponding
country spread, a structural vector autoregressive (SVAR) model is estimated
using quarterly data from 1994Q1 to 2008Q4.[4]   In addition, to assess

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[4] Our sample includes the onset of the US led financial crisis but excludes the subsequent
   period as it could contaminate estimates due to some deliberate government policy
   responses   such as unconventional monetary policy of the US post the global financial
   crisis (GFC).   While our sample period includes the long period of near zero interest rates,
   the whole monetary stance was rather stable and ongoing unlike the GFC.

whether the estimated relationship can be explained theoretically, a dynamic stochastic general equilibrium (DSGE) model for Latin American economies developed by Uribe and Yue is calibrated to the Korean economy. The combined use of an empirical model and a comparable calibrated theoretical model makes it possible to compare theoretical impulse responses with estimated impulse responses, allowing an evaluation of the plausibility of theoretical relationship.

The following questions are addressed in this paper. First, what is the extent to which country spread shocks can explain the short-run macroeconomic activity in Korea? Second, how (in)significant are the respective U.S. and Japanese interest rate shocks in explaining short-run economic fluctuations in Korea? Third, what is the economic mechanism by which aggregate economic activity in Korea responds to a country spread shock versus the world or regional interest rate shocks?

The main results of our analysis are as follows. First, we find that innovations in country spread explain up to 7% of output fluctuations in the Korean economy in the case of using the U.S. interest rate and only about 0.2% of output fluctuations in the Korean economy in the case of using the Japanese interest rate. Second, innovations in the U.S. interest rate explain about 3% of output fluctuations in the Korean economy while innovations in the Japanese interest rate explain up to 5% of output fluctuations in Korea. Third, a negative GDP shock leads to an immediate and significant increase in country spread, suggesting an endogenous reaction of the country spread to domestic fundamentals. Fourth, an increase in the U.S. interest rate is followed by an increase in Korean GDP as well as country spread while an increase in the Japanese interest rate is followed by a decrease in the Korean GDP. Compared with the findings from previous studies on Latin American economies, the influence of country spread and the world or regional interest rate on the Korean economy is found to be considerably smaller. This confirms that the Korean economy is much less vulnerable to external financial condition than Latin American economies.

This paper is structured as follows. Section 2 describes the data, outlines

the empirical model, and reports the results.   Section 3 outlines the key features of the model to be calibrated, then compares the results of empirical and theoretical impulse response functions.   Section 4 concludes the paper.

2. EMPIRICAL ANALYSIS

We use quarterly data on real GDP, real investment, the trade balance as a ratio to GDP, country spreads, and interest rates of the U.S. and Japan over the period of 1994Q1 to 2008Q4.   The U.S. three-month Treasury bill rate is used as the world interest rate, and the Japanese three-month CD rate is used as the regional interest rate.   The quarterly series for GDP, investment, imports, exports and three-month Treasury bill rate as the U.S. interest rate are obtained from the IMF's *International Financial Statistics* while the three-month CD rate for Japan was taken from the *DataStream*.   While there are several bond market indicators for the Korean economy, we use the '*credit spread-major USD issues vs. U.S. treasuries*', sourced from the *Asian Bonds Online* of the Asian Development Bank (ADB), to measure the country spread, and also to measure the corresponding country interest rate for Korea.[5]   The data are all in real terms, except for the trade balance, deflated using the GDP deflator and seasonally adjusted.

2.1. The SVAR Model

The empirical model for estimation in this paper takes the form of a SVAR system comprising five variables:

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[5] '*Credit spread–major USD issues vs. U.S. treasuries*' measures the difference between a U.S. dollar-denominated bond's yield and an equivalent U.S. Treasury benchmark bond.   For *Asia Bond Indicators*, the credit spreads of major U.S. dollar-denominated issues by ASEAN+3 issuers are compared with the interpolated yields of the U.S. Treasury of equivalent tenor.   Credit spreads represent the pricing adjustment for the credit risk associated with these securities over risk-free U.S. Treasury securities.   In this study, '*Credit spread-major USD issues vs. U.S. treasuries*' is used as a measure of country spread not only because of its relatively long sample size.

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A \begin{bmatrix} \hat{y}_t \\ \hat{i}_t \\ nxy_t \\ \hat{R}_t^w \\ \hat{R}_t^c \end{bmatrix} = B(L) \begin{bmatrix} \hat{y}_t \\ \hat{i}_t \\ nxy_t \\ \hat{R}_t^w \\ \hat{R}_t^c \end{bmatrix} + \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^i \\ \varepsilon_t^{nxy} \\ \varepsilon_t^{rw} \\ \varepsilon_t^{rc} \end{bmatrix}, \tag{1}
$$

where $B(L)$ is the matrix of lag polynomials, ε_t is a 5×1 matrix of innovations for each variable in time t, y_t denotes real gross domestic output, i_t denotes real gross domestic investment, nxy_t denotes net exports-to-output ratio, R_t^w denotes the gross real interest rate of advanced economies such as the U.S. and Japan as a world or regional interest rate and R_t^c denotes the gross real country interest rate which is computed following the definition of country spread.   Note that output and investment with a hat are cyclical components obtained as log deviations from the Hodrick-Prescott trend.[6]   The hated interest variables indicate that the interest rates are simply the log of gross rates.[7]   As explained before, the definition of the country interest rate comes from the definition of country spread, $S_t \equiv R_t^c - R_t^w$.   That is, the newly defined country interest rate, $R_t^c = R_t^w + S_t$, is used the variable which enters the VAR system.   In terms of identifying the shock to the country spread, we follow Uribe and Yue's strategy that once the world interest rate shock is identified, a shock to the country interest rate is equivalent to the country spread shock, and we denote it by ε_t^{rc}. This is possible because the VAR system identifies the world interest rate

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[6] Uribe and Yue (2006) assumed a linear trend in output and investment for Latin American economies.   However, we assume a stochastic trend, rather than a linear deterministic trend. While the Hodrick and Prescott (1997) filter is known to have some end-point distortion problems, we corrected for that by dropping two years of observations at each end.   As usual, the 'lambda' value is set to 1600 for quarterly series.

[7] Given the relatively short sample period, it is probable that the interest rates and spread are potentially non-stationary due to their persistence.   A plethora of unit-root tests were performed.   While the asymptotic ADF and PP tests were not able to reject the null of unit-root, the more powerful tests such as the KPSS, ERS, and Ng-Perron tests all indicate that the interest rate series are $I(0)$.

shock first and then determines the shock to the country interest rate.[8]   To be precise, the identification of the SVAR model is achieved by imposing restrictions on the *A* and *B* matrices as below.

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix}, \; B = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \\ 0 & 0 & 0 & b_{44} & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} \end{bmatrix}. \quad (2)$$

The world interest rate and country interest rate variables are located on the last two rows of the matrices.   This ensures that domestic real variables respond to the innovations in the world interest rate (ε_t^{rw}) and the country spread (ε_t^{rc}) with a one-period lag.   At the same time, three real domestic shocks (ε_t^{y}, ε_t^{i}, ε_t^{nxy}) are organized so as to affect financial markets contemporaneously because the financial markets react quickly to news about the state of the economic activities in a small open economy. Restriction in the fourth equation of the *A* and *B* matrices implies that the world interest rate is exogenous to macroeconomic variables of a small open economy.   As a result, the fourth equation of R_t^{w} is a simple AR(p) process by restricting $a_{jk} = b_{jk} = 0$ ($j, k = 1, 2, 3, 4, 5$) for all $j=4$ and $k{\neq}4$.

The SVAR model is estimated equation by equation using an instrumental variable method with lagged levels serving as instrumental variables.   For determining lag lengths for the SVAR models, the Akaike information criterion (AIC), the Schwarz information criterion (SIC), and the likelihood ratio (LR) tests suggest either one lag or two lags at most as reported in table 1.   The table shows that the SIC suggests a lag length of one consistently across the models estimated while other lag length tests are somewhat

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[8] Note that in order to prevent confusion in terminology, the term of country spread shock is used in place of country interest rate shock when it refers to the shock to the country interest rate while country interest rate refers to the variable from which the country spread shock is identified.

Table 1   Optimal Lag Length Selection for SVAR

Lag Length	Korea-U.S.			Korea-Japan		
	LR	AIC	SIC	LR	AIC	SIC
SVAR(1)	262.05	–27.31	–26.23*	221.51*	–29.19*	–28.11*
SVAR(2)	49.86*	–27.51*	–25.54	28.89	–28.94	–26.97
SVAR(3)	30.87	–27.39	–24.52	14.76	–28.42	–25.56

Note: * denotes the selected lag length.

inconsistent.   One lag is therefore selected throughout the paper based on the principle of parsimony as well as the precision of estimates.[9]

2.2. Impulse Response and Variance Decomposition

The empirical analysis focuses on the impulse response function and variance decomposition of the SVAR(1) framework.[10]   In particular, we focus on examining the dynamic effects of the world interest rate and country spread shocks on the real domestic macroeconomic variables and how the country spread responds to innovations in the foreign interest rate shocks as well as domestic macroeconomic fundamentals.   Figures 4 and 5 display the impulse response functions to a one standard deviation shock to the country spread   (ε_t^{rc}) for the respective cases of using the U.S. interest rate and Japanese interest rate.

Output and investment show a negative response to an exogenous increase in the country spread in both cases, as expected *a priori*.   The trade balance shows a positive but statistically insignificant, short-run response to the country spread shock.   This is consistent with negative responses of output and investment.   The effects on output and investment are most pronounced

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[9]   We thank an anonymous referee for an insightful suggestion on the appropriate lag length based on the parameter estimates.   One lag was also used in Uribe and Yue (2006) for Latin American countries.

[10]   The estimated parameters of the SVAR(1) are reported in the Appendix 1 (table A1 and A2), for using the country spread with the U.S. interest rate and Japanese interest rate, respectively.

Figure 4   Impulse Responses to Country Spread Shock (Korea-U.S.)
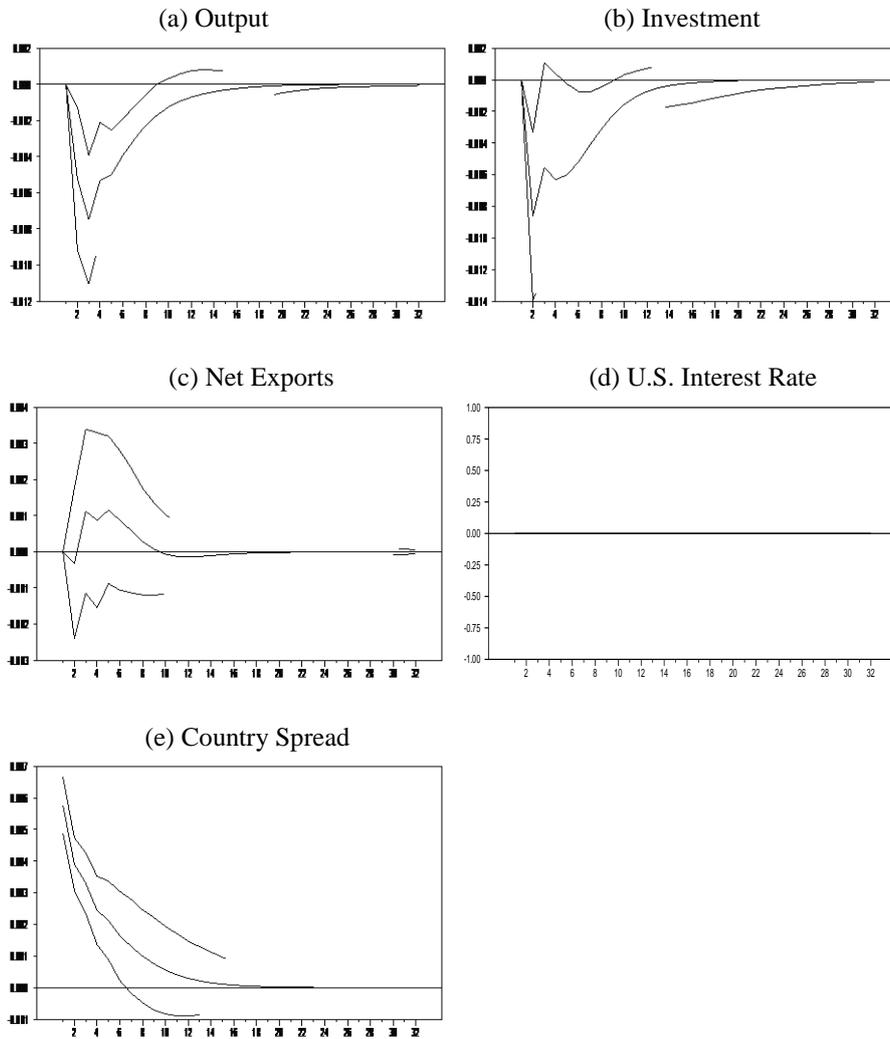
(a) Output

(b) Investment

(c) Net Exports

(d) U.S. Interest Rate

(e) Country Spread

Notes: Solid lines depict point estimates of impulse responses to a one standard deviation
       country spread shock.   Broken lines depict upper and lower one standard error bands
       computed using bootstrapping of 1,000 replications.

Figure 5   Impulse Responses to Country Spread Shock (Korea-Japan)
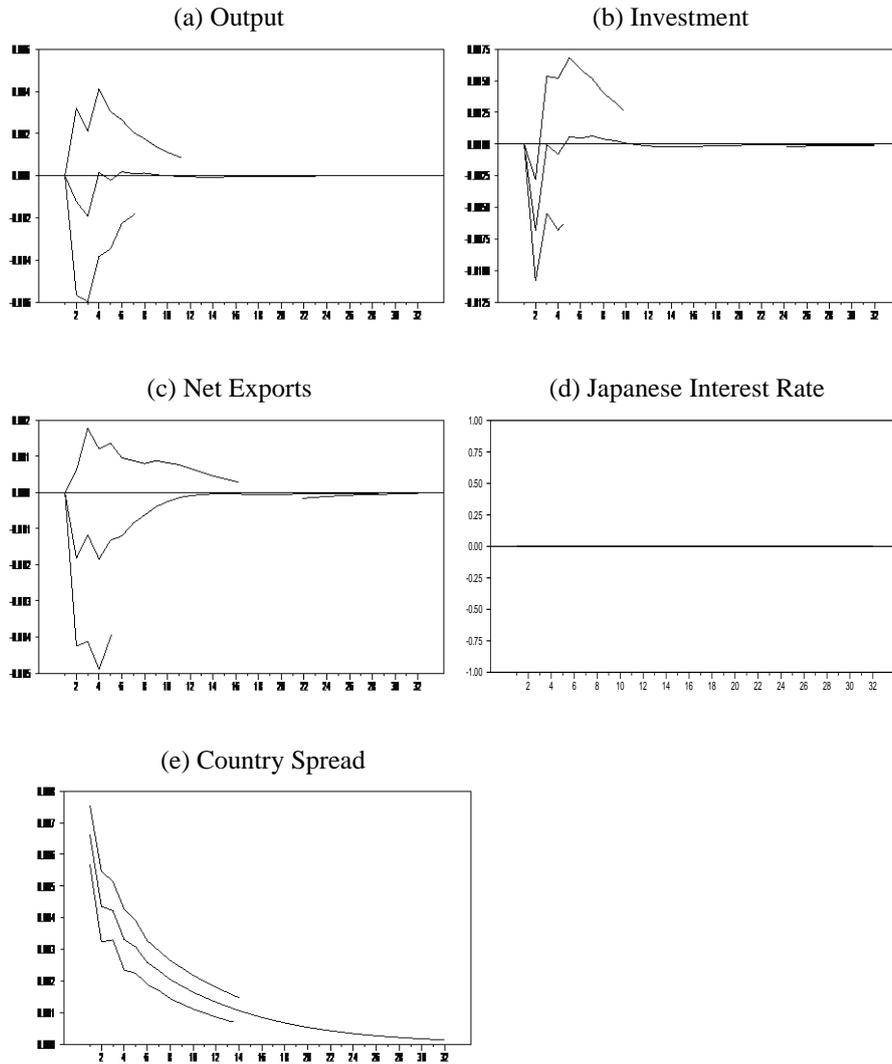
(a) Output

(b) Investment

(c) Net Exports

(d) Japanese Interest Rate

(e) Country Spread

Notes: Solid lines depict point estimates of impulse responses to a one standard deviation country spread shock. Broken lines depict upper and lower one standard error bands computed using bootstrapping of 1,000 replications.

between two and four quarters after impact, and persist up to about three years before they return to their steady state level.   As expected from the identifying assumption, the U.S. interest rate does not respond to the country spread shock.

In the case of using the Japanese interest rate as the foreign interest rate, output and investment both show a negative but statistically insignificant response which is less persistent than the U.S. interest rate case.   Another difference is that the trade balance shows a negative response to the country spread shock in this case.   That is, an increase in the country spread over the Japanese interest rate not only lowers output and investment but also the trade balance.   This implies that a higher borrowing cost over the Japanese interest rate may reduce the competitiveness and turn the trade balance into a deficit, while the offsetting effects associated with decreases in output and investment are modest.

Figures 6 and 7 display the impulse responses to positive U.S. interest rate (ε_t^{rus}) and Japanese interest rate (ε_t^{rj}) shocks, respectively.   In figure 6, while output, investment and the trade balance do not respond on impact of the shock, they show gradually a positive response to the shock in subsequent periods.   Since an increase in the U.S. interest rate is most likely to be associated with a strong domestic demand in the U.S. economy, causing a relative depreciation of the Korean won, the positive response of output and investment is theoretically plausible.[11]

This interpretation is consistent with Kim and Roubini (2000), who also present similar responses of output to a positive U.S. interest rate shock. The responses of Korean macroeconomic variables to the U.S. interest rate shock are rather in line with the responses of developed economies (Kim and Roubini, 2000; Favero, 2001; Miniane and Rogers, 2003; Maćkowiak, 2007). Thus, the impulse responses of the Korean economy to the U.S. interest rate

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[11] The results of output and investment are inconsistent with the results of Uribe and Yue (2006), which show decreasing responses of output and investment to a U.S. interest rate shock.   This should not be too surprising given that the countries they studied are all Latin American countries with a significant dependence on the U.S. capital while deriving relatively smaller benefits from exports to the U.S.

Figure 6   Impulse Responses to U.S. Interest Rate Shock
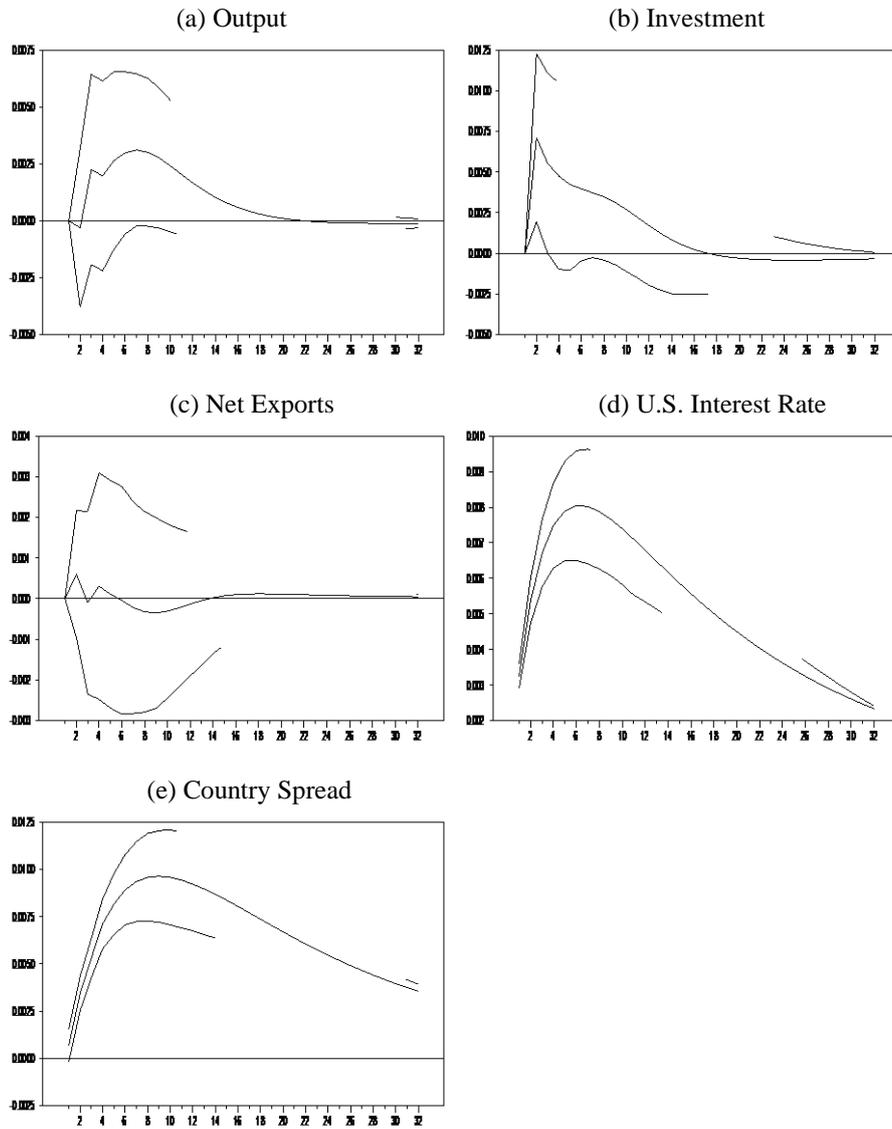
(a) Output

(b) Investment

(c) Net Exports

(d) U.S. Interest Rate

(e) Country Spread

Notes: Solid lines depict point estimates of impulse responses to a one standard deviation U.S. interest rate shock. Broken lines depict upper and lower one standard error bands computed using bootstrapping of 1,000 replications.

Figure 7   Impulse Responses to Japanese Interest Rate Shock
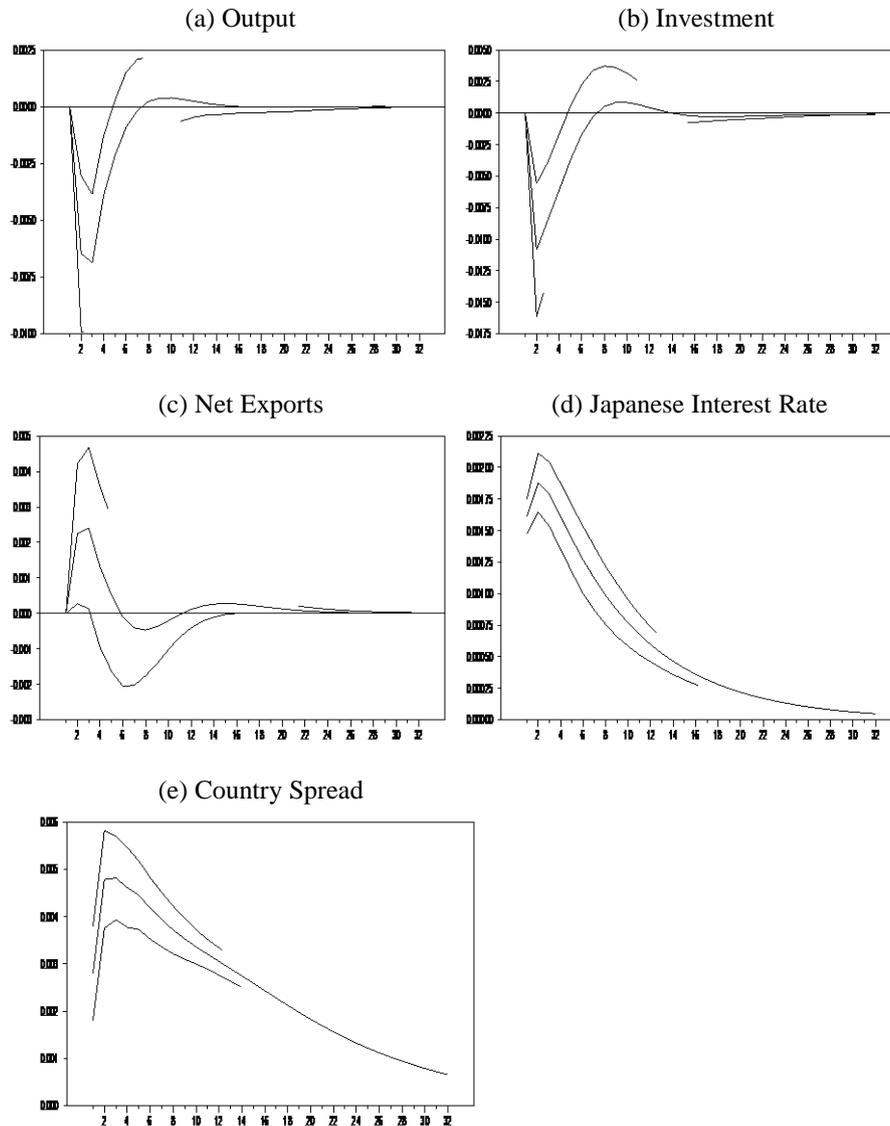
(a) Output

(b) Investment

(c) Net Exports

(d) Japanese Interest Rate

(e) Country Spread

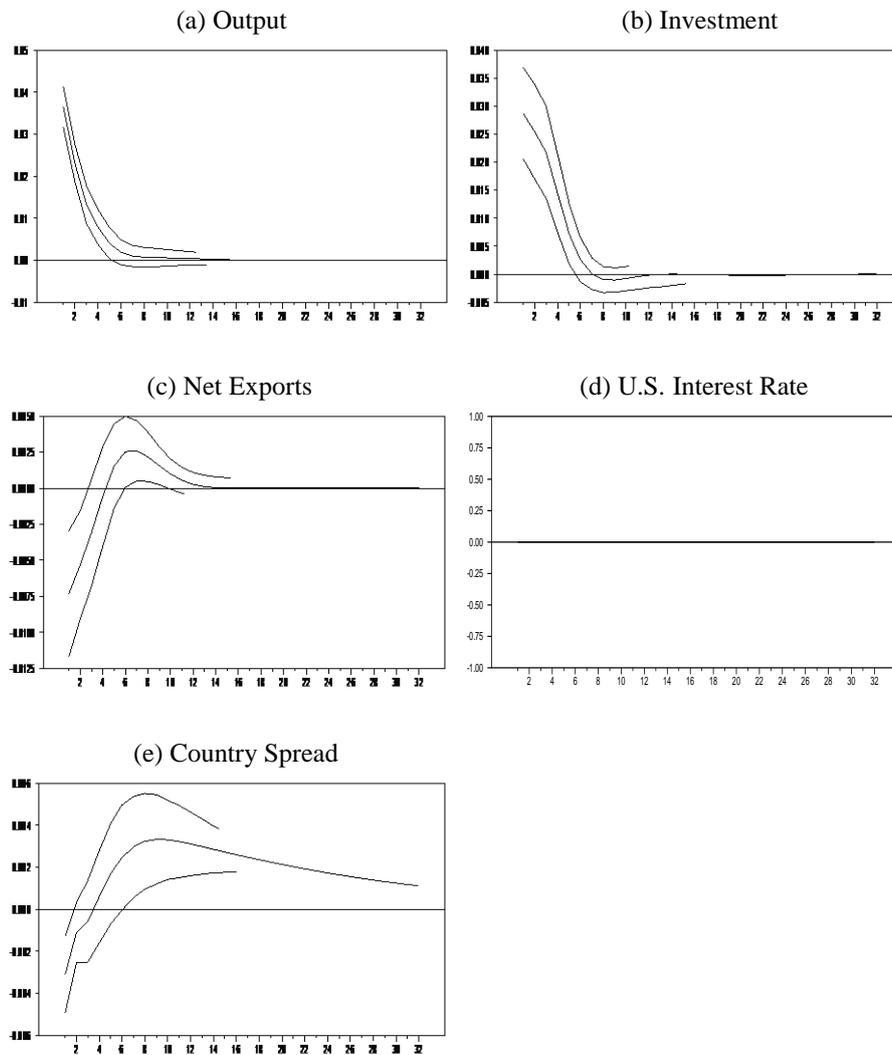Notes: Solid lines depict point estimates of impulse responses to a one standard deviation Japanese interest rate shock.   Broken lines depict upper and lower one standard error bands computed using bootstrapping of 1,000 replications.

shock are different from the typical responses of emerging markets to the world interest rate shock (Ahn and Kim, 2003; Uribe and Yue, 2006).

The trade balance shows a small improvement followed by a slight decrease but is all statistically insignificant. It is most likely that income and exchange rate effects on the trade balance offset each other on the trade balance. The country spread responds one for one to the U.S. interest rate shock, but is more persistent than the own response of the U.S. interest rate.

Figure 7 displays the impulse responses of the Korean macroeconomic variables to a Japanese interest rate shock. Output and investment show a sharp negative response after one quarter, peaking after two quarters, while the trade balance shows a positive response to the shock. The response of country spread to the positive shock in the Japanese interest rate is strong and quite persistent. The extent of the response is much more than one for one, showing the sensitivity of the country spread to the Japanese interest rate shock. An unexpected hike in the Japanese interest rate leads to a more than a proportionate increase in the country spread, which can explain sharp contraction in domestic output and investment. The positive response of the trade balance is consistent with the contraction in aggregate demand. The responses to the shock in Japanese interest rate are qualitatively different from those to the shock in the U.S. interest rate. That is, the effect of the U.S. interest rate change is largely reflective of the state of the US economy, and hence has direct effects on investment, output and the trade balance, which more than offset the negative effects of the higher borrowing costs due to a rise in the country spread. In contrast, a change in the Japanese interest rate does not have a direct demand effect on the Korean economy but rather leads to a higher cost of borrowing as reflected in the pronounced change in the country spread. Hence, our results provide the different channels of the U.S. versus Japanese interest rate shocks as well as the respective country spread shocks on the Korean economy.

The responses to a positive output shock (ε_t^y) are displayed in figures 8 and 9. In both cases, one standard deviation increase in output leads to short run increases in output and investment and also to an immediate deterioration

Figure 8   Impulse Responses to Output Shock (Korea-U.S.)

(a) Output

(b) Investment

(c) Net Exports

(d) U.S. Interest Rate

(e) Country Spread

Notes: Solid lines depict point estimates of impulse responses to a one standard deviation output shock.   Broken lines depict upper and lower one standard error bands computed using bootstrapping of 1,000 replications.

Figure 9　Impulse Responses to Output Shock (Korea-Japan)
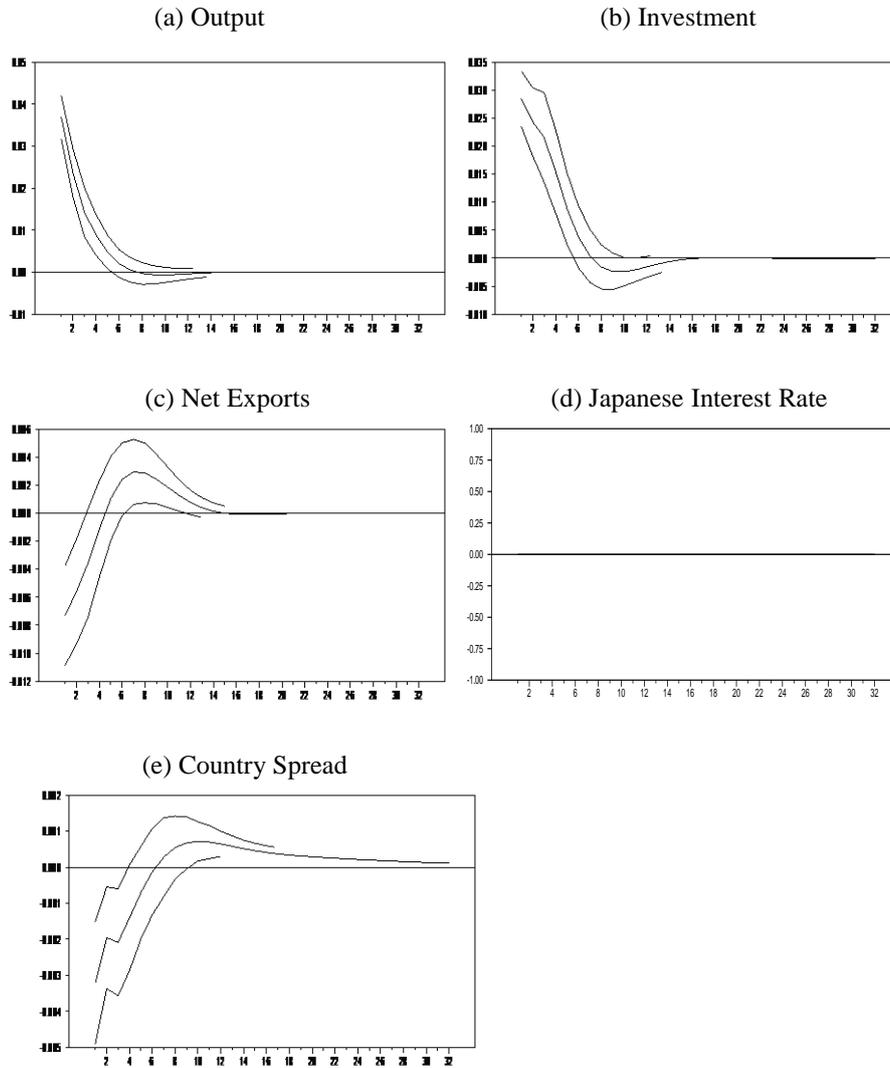
(a) Output

(b) Investment

(c) Net Exports

(d) Japanese Interest Rate

(e) Country Spread

Notes: Solid lines depict point estimates of impulse responses to a one standard deviation output shock.　Broken lines depict upper and lower one standard error bands computed using bootstrapping of 1,000 replications.

in the trade balance before they all revert to the steady-state level.   The counter-cyclical feature of the trade balance to an output shock is in line with the result of Neumeyer and Perri.   The positive output shock decreases the country spread immediately and then raises it after about four quarters before they revert to the steady state level.   Such a response of country spread implies that favourable output shocks lower the international cost of borrowing in the short run but can increases the spread in the medium run due to possible inflationary expectations.

Variance decomposition can provide a way to measure the relative significance of each stochastic error to variables in the VAR framework. Table 2 presents the results of variance decomposition for the variables contained in the SVAR(1) model at different horizons to compose the fraction of the variance on the basis of the explanatory power of country spread and world or regional interest rate to the Korean economy.   The results in table 2 are categorized by two cases considering Korea-U.S. and Korea-Japan.   Our discussion in this section is focused on the features of the results not already uncovered in the preceding analysis.

Innovations in the U.S. interest rate (ε_t^{rus}) account for less than 3% of movements in output over the horizon of 32 quarters. In contrast, innovations in the country spread (ε_t^{rc}) explain about 7% of movements in output over four years.   This implies that it is country spread, rather than the U.S. interest rate, which influences the short-run macroeconomic performance in Korea.   The table also indicates that the country spread is largely explained by own shocks and other variables such as domestic macroeconomic performance in the short run, but, in the medium to longer run, the U.S. interest rate become, rather unsurprisingly, the dominant driver, as a key driving force of international capital markets.

The Japanese interest rate shock (ε_t^{rj}) explains about 5% of movements in Korean output over after about 2 to 3 years but no further explanation beyond 3 years.   On the other hand, country spread shock (ε_t^{rc}) explains only about 0.2% of movements in output even in the medium run.   When Japanese interest rate and country spread are combined, they explain about 5% of

Table 2   Variance Decomposition

Case	Variable	Shock	Horizons								
			1	4	8	12	16	20	24	28	32
Korea - U.S.	*Y*	RC	0	4.86	6.80	6.94	6.95	6.95	6.95	6.95	6.95
		RUS	0	0.40	1.79	2.58	2.73	2.74	2.74	2.74	2.74
		SUM	0	5.26	8.59	9.52	9.68	9.69	9.69	9.69	9.69
	I	RC	0	3.69	5.34	5.48	5.49	5.49	5.49	5.49	5.49
		RUS	0	2.64	3.72	4.23	4.28	4.29	4.30	4.31	4.33
		SUM	0	6.33	9.06	9.71	9.77	9.78	9.79	9.80	9.82
	NX/Y	RC	0	0.23	0.46	0.46	0.47	0.47	0.47	0.47	0.47
		RUS	0	0.05	0.06	0.09	0.09	0.10	0.10	0.10	0.10
		SUM	0	0.28	0.52	0.55	0.56	0.57	0.57	0.57	0.57
	R^c	RC	54.5	30.6	12.6	7.6	5.77	4.92	4.47	4.22	4.08
		RUS	0.79	42.7	69.8	77.4	80.5	81.9	82.7	83.2	83.5
		SUM	55.3	73.3	82.4	85.0	86.3	86.8	87.2	87.4	87.6
Korea - Japan	*Y*	RC	0	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23
		RJ	0	4.44	4.59	4.61	4.61	4.61	4.61	4.61	4.61
		SUM	0	4.66	4.82	4.84	4.84	4.84	4.84	4.84	4.84
	I	RC	0	1.22	1.16	1.16	1.16	1.16	1.16	1.16	1.16
		RJ	0	5.87	5.88	5.90	5.90	5.90	5.90	5.90	5.90
		SUM	0	7.09	7.04	7.06	7.06	7.06	7.06	7.06	7.06
	NX/Y	RC	0	0.88	1.24	1.25	1.25	1.25	1.25	1.25	1.25
		RJ	0	1.36	1.32	1.32	1.34	1.36	1.36	1.36	1.36
		SUM	0	2.24	2.56	2.57	2.59	2.61	2.61	2.61	2.61
	R^c	RC	56.3	41.2	35.1	32.4	30.7	29.8	29.3	29.0	28.9
		RJ	10.1	33.9	42.5	47.1	50.0	51.6	52.5	52.9	53.1
		SUM	66.4	75.1	77.6	79.5	80.7	81.4	81.8	81.9	82.0

Notes: RC denotes the fraction of the variable's movement in country spread shock.   RUS denotes the fraction of variable's movement in the U.S. interest rate shock.   RJ denotes the fraction of variable's movement in Japanese interest rate shock.   SUM denotes the Sum of fraction of variable's movement in world or regional interest rate shock and country spread shock.   Each number is a percentage of variance decomposition.

movements in output over the time horizon.   The table also shows that the country spread over the Japanese interest rate is largely explained by the Japanese interest rate shock as the time horizon expands.   However, a still sizable fraction (about 29%) of the country spread remains unexplained by

the Japanese interest rate in the medium to longer run, which is likely to be explained by the financial conditions in the rest of the world.

3. THEORETICAL EXPLANATION

In the previous section, although the SVAR(1) model includes several restrictions to explain the empirical relationships among the variables, it remains important that empirical results are given theoretical plausibility to gain insights.   This section examines the extent to which the empirical results from a SVAR analysis can be understood in a theoretical model.   We take a neoclassical small open economy dynamic equilibrium model developed by Uribe and Yue (2006), which is parameterized and calibrated to the Korean data.   For brevity, we only provide the key features of the model, followed by an explanation of the model calibration.[12]   In particular, we compare the estimated impulse responses from the SVAR(1) model with the theoretical impulse responses from the calibrated model, allowing us to assess the extent to which the theoretical model can provide a reasonable account of the Korean data.

3.1. Model Description

The model features a representative household maximizing the expected lifetime utility by choosing consumption and hours worked.   The utility function features external habit formation, à la Abel (1990) and Campbell and Cochrane (1999).   The household also holds a one period bond, which can be traded internationally, and also owns domestic financial institutions which borrow funds at the world interest rate R_t and incur operation costs as a convex debt-adjustment cost function $\Psi(d_t)$, a function of debt level (d_t), and then lend the borrowed funds to domestic firms at a higher domestic rate R_t^d.   Domestic financial institutions should decide the optimal volume

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[12] For details of the model, see Uribe and Yue (2006).

of lending or debt d_t.[13]   Firms rent capital and hire labour services from perfectly competitive markets to produce final goods.   An important feature is that firms' production process is subject to a working capital in advance constraint that firms are required to hold non-interest-bearing assets, which corresponds to a fraction of the wage bill for each period.[14]   This implies that the firm is under the constraint of reserving some portion (η) of the total wages in period $t(w_t h_t)$.   That is, the amount of working capital (κ_t) is given by $\kappa_t \geq \eta w_t h_t; \eta \geq 0$.

In addition, the mode features the time to build and capital adjustment costs in investment and capital accumulation in order to better capture some empirical features of the business cycles for a small open economy as is standard in the literature.   The household's and firm's optimization problems are then solved to yield first order conditions.[15]

3.2. Model Calibration

In equilibrium, households consume identical quantities and individual consumption is set equal to average level across all households, $\tilde{c}_t$;

$$c_t = \tilde{c}_t; \ \ t \geq -1. \tag{3}$$

The following standard utility function, production function, capital adjustment cost function and debt adjustment cost function are adopted.

$$U(c - \mu\tilde{c}, \ h) = \frac{[c - \mu\tilde{c} - \omega^{-1}h^\omega]^{1-\gamma} - 1}{1-\gamma}, \tag{4}$$

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[13] The relation is captured by the equation $R_t^d = \dfrac{R_t}{1 - \Psi'(d_t)}$.

[14] This constraint introduces a direct supply side effect of changes in the cost of borrowing in international financial markets and allows the model to predict a more realistic response of domestic output to external financial shocks.

[15] The formulation of the Lagrangean problem and first order conditions are available upon request.

$$F(k,\ h) = k^{\alpha} h^{1-\alpha}, \tag{5}$$

$$\Phi(x) = x - \frac{\varphi}{2}(x - \delta)^2;\ \varphi > 0, \tag{6}$$

$$\Psi(d) = \frac{\phi}{2}(d - \bar{d})^2. \tag{7}$$

In calibrating the model, the time unit is set to one quarter. Since the calibrated parameters are endogenously determined to produce the benchmark data, estimated coefficients such as AR parameters (see Appendix 1 - tables A1 and A2) are used for some parameters of the calibrated model as equilibrium values. By contrast, the numerical values of some model parameters are set on the basis of estimates drawn from the literature. In the current paper, these parameter values are drawn from Mendoza's (1991) paper, which are standard in the international business cycle literature. We set $\gamma = 2$, $\omega = 1.455$ and $\alpha = 0.32$, where γ is the inverse of intertemporal elasticity of substitution, $1/(\omega - 1)$ is labour supply elasticity, and α denotes capital elasticity of output. The depreciation rate is set at 10% per year. The steady-state level of the country rate is set based on the average U.S. interest rate of about 4%, the Japanese interest rate of about 0.5%, and an average country premium of 2%, which result from the time series data used in the empirical test. There still remain four parameters to be assigned values: $\varphi,\ \phi,\ \eta$ and μ. Since little consensus or data exists to obtain estimates of these parameters, we follow the procedures used by Boldrin *et al*. (2001) and Uribe and Yue (2006). They choose the values of the parameters that have the minimized distance between the empirically estimated impulse response functions and the theoretical impulse response functions stemming from the calibrated model. Table 3 summarizes the parameter values and descriptions.

The debt adjustment cost parameter (φ) in the case of using Japanese interest rate (Case II) is smaller than that of using the US interest rate (Case I).

Table 3   Parameter Values

Symbol	Value		Description
	Case I	Case II	
β	0.985	0.993	Subjective discount factor
γ	2	2	Inverse of intertemporal elasticity of substitution
μ	0.06	0.15	Habit formation parameter
ω	1.455	1.455	$1/\omega - 1$=Labor supply elasticity
α	0.32	0.32	Capital elasticity of output
ϕ	45.52	20.48	Capital adjustment cost parameter
φ	0.41	0.14	Debt adjustment cost parameter
δ	0.025	0.025	Depreciation rate (quarterly)
η	0.83	0.67	Fraction of wage bill subject to working-capital constraint
R	2%	2%	Steady-state real country interest rate (quarterly)

Notes: Case I; the case of using the U.S. interest rate as a world interest rate, Case II; the case of using the Japanese interest rate as a regional interest rate.

This implies that the increasing rate of the debt adjustment cost on the basis of the U.S. interest rate is higher than that of the Japanese interest rate, when domestic residents borrow foreign assets from the international financial market.   The capital adjustment costs may seem very significant in both cases.   In particular, the capital adjustment cost parameter (ϕ) of Case I is larger than that of Case II.   For the fraction of the wage bill that is subject to the working capital constraint (η), firms maintain a level of working capital equivalent to about two and half months of wage payments for Case I and about two months of wage payments for Case II.   Lastly, although the intensity of external habit formation (μ) in Case II is larger than that in Case I, both estimated degrees of habit formation are modest compared with the typically used values to explain asset price regularities in closed economies such as Mehra and Prescott (1985) and Constantinides (1990).

3.3. Theoretical vs. Empirical Impulse Responses

The theoretical impulse response functions of four variables — output, investment, the trade balance and the country interest rate — to two driving forces — the U.S. or Japanese interest rate shock and the country spread shock — are displayed in figures 10 and 11, respectively. In almost all of the graphs displayed, the theoretical impulse responses are plotted against the empirical impulse responses and their two standard error bands.   In almost all cases, the theoretical impulse responses are largely consistent with the patterns of the empirical impulse responses with the exception of the impulse response of the trade balance to country spread shock (ε_t^{rc}) over the Japanese interest rate, as shown in figure 11 (f).   However, given the empirical impulse response function is statistically insignificant from zero, the theoretical impulse response function cannot be discarded.   Since a tightening of borrowing costs as reflected in the increase in the country spread is associated with a negative response of output, the positive response of the trade balance is expected a priori.   When the US interest rate is used to measure the world interest rate and country spread, this anomaly is not found.

Figures 10 and 11 also show that the theoretical impulse responses are mostly within the estimated two standard error bands of the empirical impulse responses.   That is, the model replicates the estimated impulse responses of the domestic variables such as output, investment and the trade balance reasonably well.   It should be noted that output and investment contract in response to an increase in the Japanese interest rate whereas they show positive responses to an increase in the U.S. interest rate.   This implies that an increase in the U.S. interest rate signals a strong U.S. demand for foreign goods improving output, investment and the trade balance in Korea. The opposite responses observed in the case of the increase in the Japanese interest rate can also be given plausible interpretations.   When the Japanese interest rate increases, it directly increases the cost of borrowing for local firms, lowering output and investment while improving the trade balance.   Empirically, an increase in the interest rate in Japan may also lead

Figure 10   Theoretical and Estimated Impulse Response Functions
                    (Korea-U.S.)
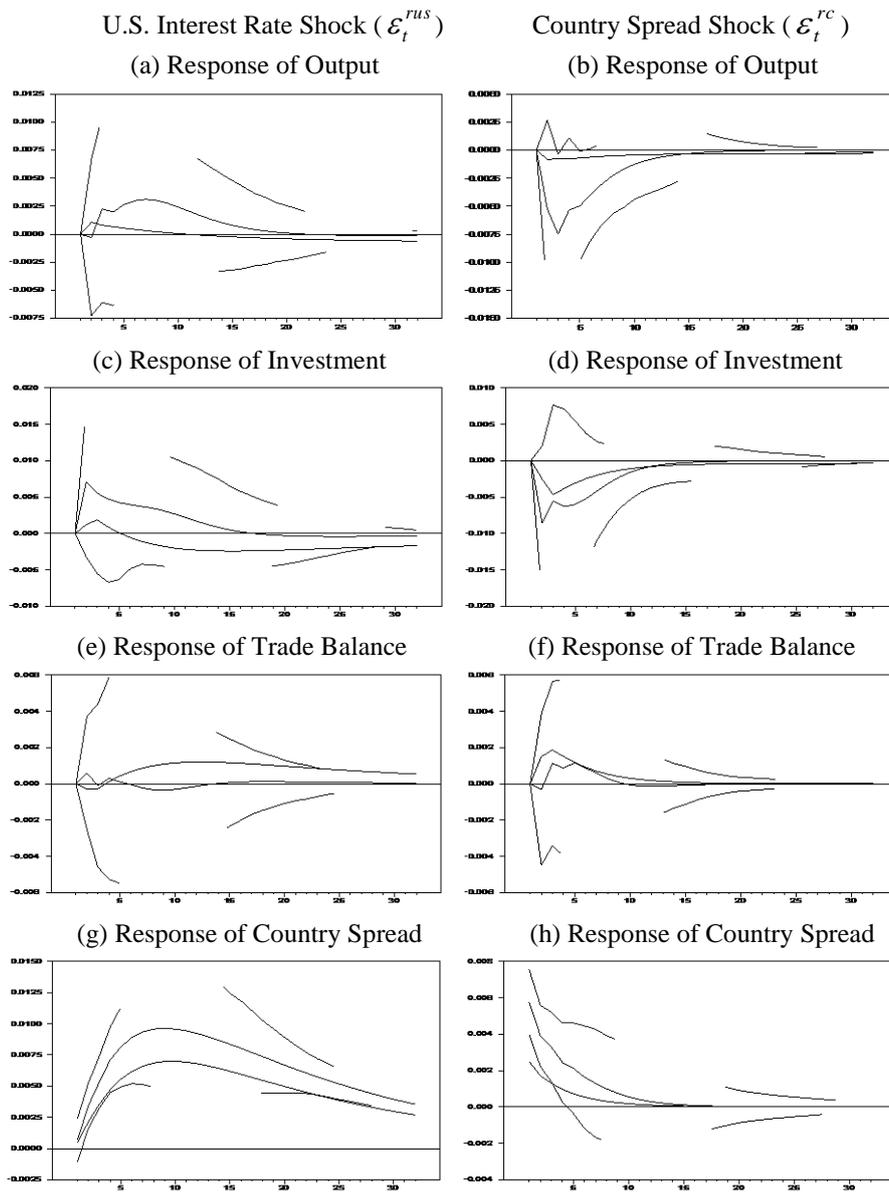
U.S. Interest Rate Shock (ε_t^{rus})   Country Spread Shock (ε_t^{rc})

(a) Response of Output   (b) Response of Output

(c) Response of Investment   (d) Response of Investment

(e) Response of Trade Balance   (f) Response of Trade Balance

(g) Response of Country Spread   (h) Response of Country Spread

Notes: ― ― ― Theoretical impulse responses. ――― Estimated impulse responses.
       ‐ ‐ ‐ ‐ ‐ Upper and lower two standard error bands around estimates.

Figure 11   Theoretical and Estimated Impulse Response Functions
(Korea-Japan)
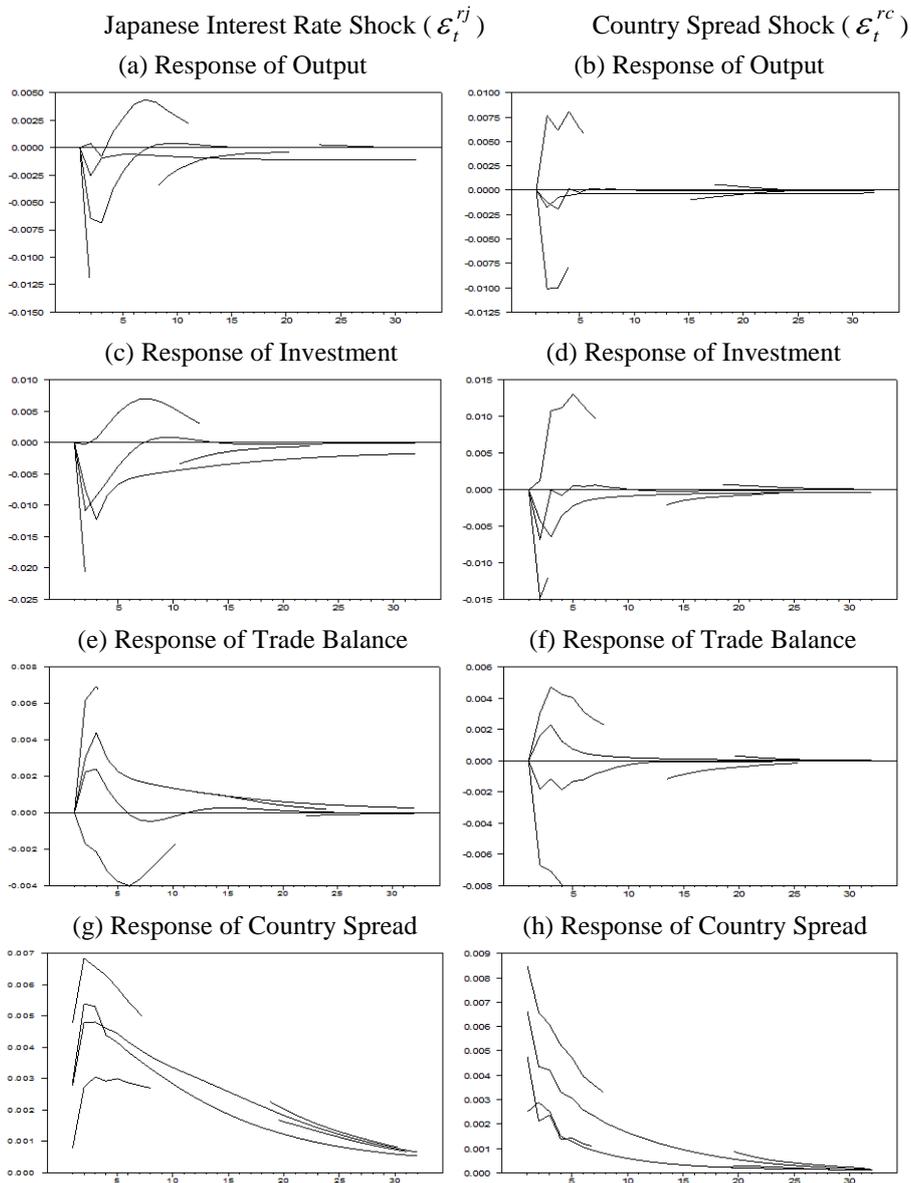
Japanese Interest Rate Shock (ε_t^{rj})   Country Spread Shock (ε_t^{rc})

(a) Response of Output   (b) Response of Output

(c) Response of Investment   (d) Response of Investment

(e) Response of Trade Balance   (f) Response of Trade Balance

(g) Response of Country Spread   (h) Response of Country Spread

Notes: – – – – Theoretical impulse responses. ——— Estimated impulse responses.
 - - - - - Upper and lower two standard error bands around estimated impulse
 responses.

to an appreciation of the Korean won relative to the U.S. dollar worsening international competitiveness of domestically produced goods, while an increase in the U.S. interest rate is associated with a depreciation of the Korean won.[16]

It is of particular interest to note that while the domestic macroeconomic variables show similar response to country spread shocks both in theory and in data, the macroeconomic responses to the foreign interest rate shocks are shown to be quite different, which is not well replicated by the calibrated theoretical model.   This is because the theoretical model only assumes one world interest rate (e.g., the U.S. interest rate) while ignoring the interaction between another major foreign interest rate and its relative impact on the domestic economy via exchange rate movements.   Hence, this leaves a room for developing a small open economy model with both regional and world dimensions to be able to fully account for the Korean economy as a small open economy.

Since the results may be sensitive to the parameter values assumed, we also performed a sensitivity analysis by re-estimating alternative parameterizations of the theoretical model: a model without habit formation $(\mu = 0)$, a model with adjustment costs 10 times smaller than in the baseline specification ($\varphi = 4.55$ for Case I, $\varphi = 2.04$ for Case II), and a model without working capital constraint $(\eta = 0)$.   Where there were discernible changes due to the change of a certain parameter value, the results were reported in the impulse response functions.   Table 4 reports the parameter values used for each parameterization of sensitivity analysis.

Out of all three parameterizations reported, the most discernible changes occur with the model with no working capital constraint.   Figures 12 and 13 display the impulse responses to the U.S. interest rate and country spread

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[16] A referee suggested that we strengthen our interpretation by including a bilateral exchange rate in each SVAR model to examine whether the interest rate shocks in Japan and in the U.S. have asymmetric effects as reflected in the trade balance.   Our estimation of the SVAR model with the exchange rate as an additional variable confirms the asymmetric effects on the trade balance and output with respect to the different origin of the interest rate shock.   The results are available upon request.
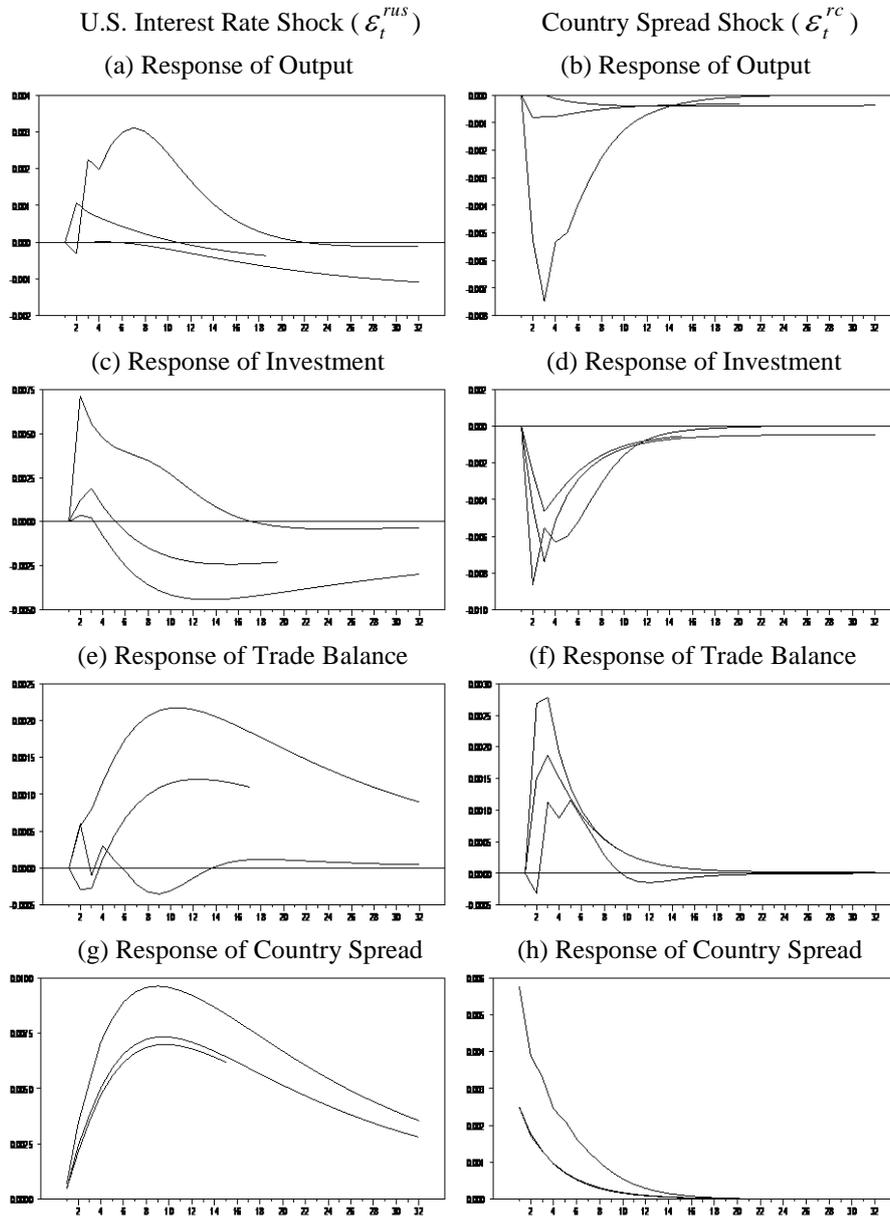
Table 4   Sensitivity Analysis

Model Specification	φ	ϕ	η	μ
Case I				
Base Line	0.41	45.52	0.83	0.06
No Habits	0.41	45.52	0.83	0
Low Adjustment Costs	0.41	4.55	0.83	0.06
No Working Capital	0.41	45.52	0	0.06
Case II				
Base Line	0.14	20.48	0.67	0.15
No Habits	0.14	20.48	0.67	0
Low Adjustment Costs	0.14	2.04	0.67	0.15
No Working Capital	0.14	20.48	0	0.15

Notes: Case I; the case of using the U.S. interest rate as a world interest rate, Case II; the case of using the Japanese interest rate as a regional interest rate. ϕ is debt adjustment cost parameter. φ is capital adjustment cost parameter. η is fraction of wage bill subject to working capital in advance constraint. μ is habit formation parameter.

shocks, and to the Japanese interest rate and country spread shocks, respectively when the model featuring no working capital constraint is simulated.   When there are no working capital constraints in the model, the model fails to reproduce the observed contraction in output in response to unexpected increases in country spreads or the world interest rate unlike the baseline model featuring the working capital constraint.   As shown by Neumeyer and Perri (2005) and Uribe and Yue (2006), the working capital constraint is important in models of open economies as it amplifies the effects of shocks to the interest rate or cost of borrowings.

Figure 12   Sensitivity Analysis: No Working Capital (Korea-U.S.)

U.S. Interest Rate Shock (ε_t^{rus})   Country Spread Shock (ε_t^{rc})

(a) Response of Output   (b) Response of Output

(c) Response of Investment   (d) Response of Investment

(e) Response of Trade Balance   (f) Response of Trade Balance

(g) Response of Country Spread   (h) Response of Country Spread

Notes: — — — —   Theoretical impulse responses of a model with no working capital.
              ————   Estimated impulse responses.
              - - - - - -   Theoretical impulse responses of baseline model.

Figure 13   Sensitivity Analysis: No Working Capital (Korea-Japan)
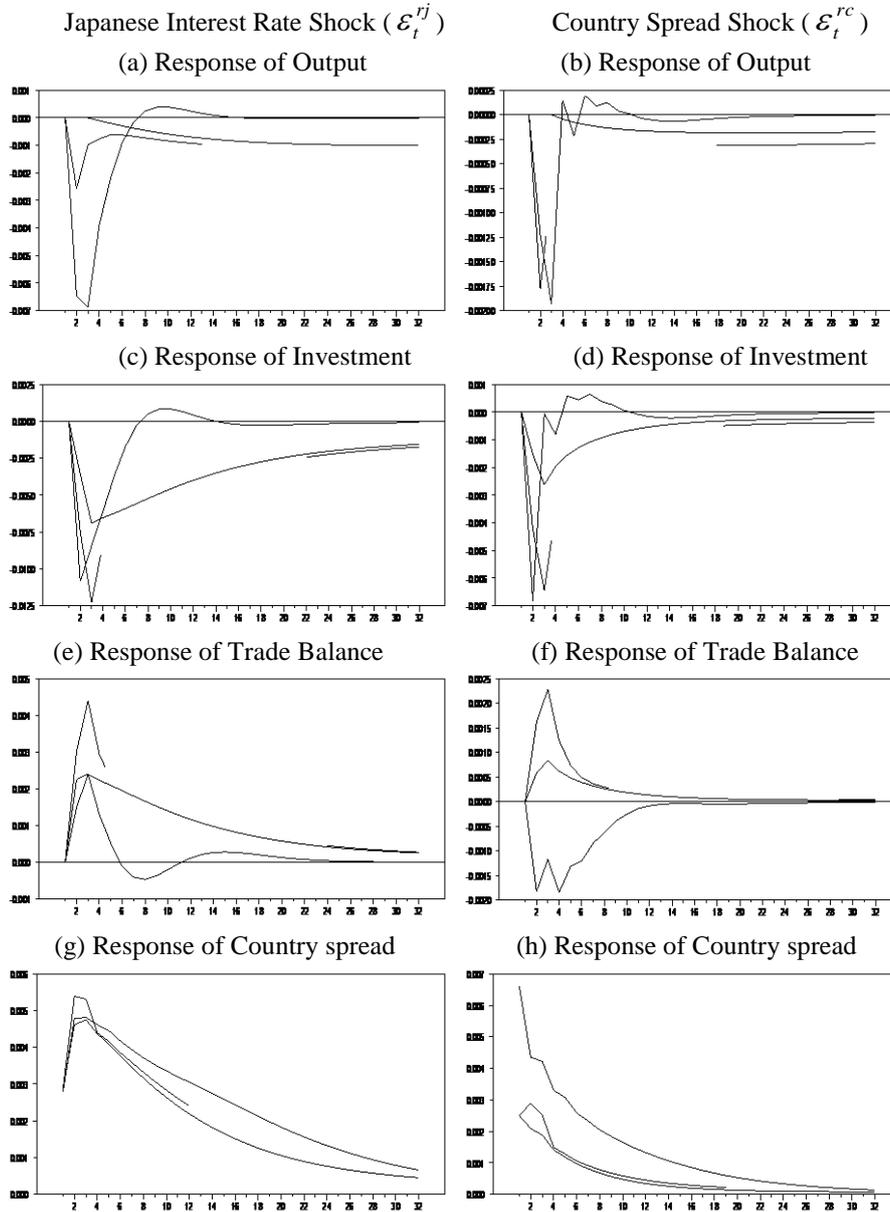
Japanese Interest Rate Shock (ε_t^{rj})   Country Spread Shock (ε_t^{rc})

(a) Response of Output   (b) Response of Output

(c) Response of Investment   (d) Response of Investment

(e) Response of Trade Balance   (f) Response of Trade Balance

(g) Response of Country spread   (h) Response of Country spread

Notes: – – – –   Theoretical impulse responses of a model with no working capital.
        ————   Estimated impulse responses.
        - - - - - -   Theoretical impulse responses of baseline model.

4. CONCLUSION

This paper examined the dynamic relations between the cost of foreign borrowings as reflected in country spread, foreign (the U.S. and Japanese) interest rate shocks and their respective effects on real activities in Korea. Using a simple SVAR model, we investigated how domestic variables respond to the external shocks to the foreign interest rates and to country spread. In particular, we not only relied on the world interest rate as proxied by the U.S. interest rate but also the key regional interest rate benchmarked by the Japanese interest rate, allowing us to analyze the different channels and impacts of the U.S. versus Japanese interest rate shocks on the Korea economy.

The main findings are summarised as follows. First, Korea's macroeconomic activity reacts strongly to the identified shocks to the country spread as well as to the U.S. interest rate. A positive shock to the country spread, reflecting an increase in country risk perceived by foreign investors, has significant negative effects on domestic activities in Korea. However, domestic activities show positive responses to an exogenous increase in the U.S. interest rate. This indicates that the U.S. interest rate shocks and country spread shocks were clearly identified as they have quite different channels of transmission to the Korean economy. To the extent the U.S. interest rate shocks reflect the state of the U.S. economy and affect the Won-dollar exchange rate directly, the foreign demand effects is found to be the channel of transmission. Second, the Korean economy appears to be less responsive to the country spread shocks identified when the U.S. interest rate was replaced with the Japanese interest rate. This implies that country risk implicit in the country spread is less responsive to the Japanese interest rate than the U.S. interest rate. In contrast, a positive shock to the Japanese interest rate has a sharp negative impact on the Korean economy.

Our interpretation is that (i) it increases the cost of borrowing directly for Korean firms and (ii) the Korean won tends to appreciate against the U.S. dollar, worsening the trade balance. That is, the macroeconomic effects of

the U.S. and Japanese interest rate shocks are not symmetric, which provides an insight into the different nature of the U.S. and Japanese economies in terms of their respective influence on the short-run macroeconomic performance of Korea.   Given the long period of stagnant Japanese economy with very low interest rates in our sample, the Korean economy was probably little affected by the Japanese demand but it has an important implication for the cost of future borrowings from Japan once the interest rates in Japan significantly escalate.

Finally, we also showed that a small open economy model parameterised and calibrated to the Korean data produces the theoretical impulse responses broadly consistent with the empirical responses obtained from the SVAR models.   However, it leaves room to develop an extended DSGE model that fully accounts for the macroeconomic effects of both the U.S. interest rate and a regional interest rate on the Korean economy.

APPENDIX

Table A1   Parameter Estimates of the SVAR(1) (Korea-U.S.)

Independent Variable	Dependent Variable				
	$\hat{y}_t$	$\hat{i}_t$	nxy_t	$\hat{R}_t^{us}$	$\hat{R}_t^c$
$\hat{y}_t$	-	0.7543 (6.26)*	−0.0442 (−0.53)	-	−0.0477 (−1.53)
$\hat{y}_{t-1}$	0.5031 (2.68)*	−0.0232 (0.13)	0.1203 (1.29)	-	0.0134 (0.38)
$\hat{i}_t$	-	-	−0.2392 (−3.31)*	-	−0.0089 (−0.30)
$\hat{i}_{t-1}$	0.0475 (0.28)	0.0941 (0.64)	0.0923 (1.18)	-	0.0075 (0.26)
nxy_t	-	-	-	-	0.2050 (4.00)*
nxy_{t-1}	0.0916 (0.40)	−0.5652 (−2.81)*	0.7107 (6.27)*	-	−0.182 (−2.12)*
$\hat{R}_t^{us}$	-	-	-	-	0.4325 (2.16)
$\hat{R}_{t-1}^{us}$	0.7939 (1.10)	0.8463 (1.32)*	0.3294 (0.96)	0.9873 (68.04)*	0.0520 (0.20)
$\hat{R}_t^c$	-	-	-	-	-
$\hat{R}_{t-1}^c$	−0.5511 (−1.03)	−0.6191 (−1.29)	−0.2455 (−0.96)	-	0.6397 (6.54)*
R^2	0.36	0.7453	0.7422	0.9343	0.9383
S.E.	0.0393	0.0348	0.0183	0.0046	0.0067

Notes: *t*-statistics are presented in parentheses. * denotes the significance under the 5% critical value of *t* statistics.

Table A2   Parameter Estimates of the SVAR(1) (Korea-Japan)

Independent Variable	Dependent Variable				
	$\hat{y}_t$	$\hat{i}_t$	nxy_t	$\hat{R}_t^{jp}$	$\hat{R}_t^c$
$\hat{y}_t$	-	0.7771 (6.44)*	−0.0420 (−0.50)	-	−0.0589 (−1.64)*
$\hat{y}_{t-1}$	0.5076 (2.65)*	0.0114 (0.06)	0.1102 (1.18)	-	0.0151 (0.37)
$\hat{i}_t$	-	-	−0.2304 (−3.22)*	-	0.0043 (0.13)
$\hat{i}_{t-1}$	0.0949 (0.58)	0.1393 (0.96)	0.1111 (1.45)	-	0.0264 (0.79)
nxy_t	-	-	-	-	0.2144 (3.67)*
nxy_{t-1}	0.0363 (0.16)	−0.6103 (−3.04)*	0.7076 (6.24)*	-	−0.1558 (−2.46)*
$\hat{R}_t^{jp}$	-	-	-	-	1.5180 (2.42)*
$\hat{R}_{t-1}^{jp}$	−0.0758 (−0.07)	0.2565 (0.30)	0.3702 (0.82)	0.9138 (31.58)*	−1.0766 (−1.77)*
$\hat{R}_t^c$	-	-	-	-	-
$\hat{R}_{t-1}^c$	−0.0228 (−0.08)	−0.1607 (−0.53)	−0.1194 (−0.75)	-	0.8784 (13.01)*
R^2	0.3466	0.7283	0.7421	0.8929	0.7752
S.E.	0.0398	0.0352	0.0183	0.0017	0.0077

Notes: *t*-statistics are presented in parentheses. * denotes the significance under the 5% critical value of *t* statistics.

REFERENCES

Abel, A. B., "Asset Prices under Habit Formation and Catching up with the Joneses," *American Economic Review Papers and Proceedings*, 80(1), 1990, pp. 38-42.

Agénor, P.-R., C. J. McDermott, and E. Prasad, "Macroeconomic Fluctuations in Developing Countries: Some Stylized Facts," *The World Bank Economic Review*, 14(2), 2000, pp. 251-285.

Ahn, H. D. and S. H. Kim, "Dynamics of Open Economy Business Cycle Models: The Case of Korea," Korea Institute for International Economic Policy (KIEP) Working Paper, 03-04, 2003.

Boldrin, M., L. J. Christiano, and J. Fisher, "Asset Pricing Lessons for Modeling Business Cycles," *American Economic Review*, 91(1), 2001, pp. 149-166.

Buyangerel, B. and W. J. Kim, "The Effects of Macroeconomic Shocks on Exchange Rate and Trade Balances in Korea," *Korea and the World Economy*, 14(1), 2013, pp. 91-119.

Campbell, J. and J. Cochrane, "By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior," *Journal of Political Economy*, 107(2), 1999, pp. 205-251.

Constantinides, G. M., "Habit Persistence: A Resolution of the Equity Premium Puzzle," *Journal of Political Economy*, 98, 1990, pp. 519-543.

Favero, C. A., *Applied Macroeconomics*, Oxford University Press, 2001, pp. 183-238.

Hodrick, R. J. and E. C. Prescott, "Post-war US Business Cycles: An Empirical Investigation," *Journal of Money, Credit and Banking*, 29, 1997, pp. 1-16.

Kim, S. Y. and N. Roubini, "Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach," *Journal of Monetary Economics*, 45, 2000, pp. 561-586.

Maćkowiak, B., "External Shocks, U.S. Monetary Policy and

Macroeconomic Fluctuations in Emerging Markets," *Journal of Monetary Economics*, 54, 2007, pp. 2512-2520.

Mehra, R. and E. C. Prescott, "The Equity Premium: A Puzzle," *Journal of Monetary Economics*, 15, March 1985, pp. 145-161.

Mendoza, E. G., "Real Business Cycles in a Small Open Economy," *American Economic Review*, 81, 1991, pp. 798-818.

Miniane, J. and J. H. Rogers, "Capital Controls and the International Transmission of U.S. Money Shocks," Board of Governors of the Federal Reserve System International Finance Discussion Paper, No. 778, 2003.

Neumeyer, P. A. and F. Perri, "Business Cycles in Emerging Markets: The Role of Interest Rates," *Journal of Monetary Economics*, 52, 2005, pp. 345-380.

Shah Zaidi, M. A. and L. A. Fisher, "Monetary Policy and Foreign Shocks: A SVAR Analysis for Malaysia," *Korea and the World Economy*, 11(3), 2010, pp. 527-550.

Uribe, M., "The Price Consumption Puzzle of Currency Pegs," *Journal of Monetary Economics*, 49, 2002, pp. 533-569.

Uribe, M. and V. Z. Yue, "Country Spreads and Emerging Countries: Who Drives Whom?," *Journal of International Economics*, 69, 2006, pp. 6-36.