International Macroeconomic Fluctuations in Korea

Soyoung Kim *

This paper examines international macroeconomic fluctuations in Korea by focusing on the sources of fluctuations in key international macro variables, such as cross-country output differential, real exchange rate, and trade balance and international transmission of key structural shocks. These structural shocks include country-specific supply, demand, and nominal shocks. A structural VAR model with long-run restrictions (that are consistent with many theoretical models) is constructed to investigate these issues. The main findings are: (1) supply shocks explain most of the fluctuations in cross-country output differential; (2) all three types of shocks play a non-negligible role in explaining fluctuations in real exchange rate and trade balance; and (3) demand and supply shocks generate opposite signs of correlation between trade balance and real exchange rate.

Keywords: Structural VAR, International macroeconomic fluctuations, Output differential, Real exchange rate, Trade balance

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I. Introduction

This paper examines international macroeconomic fluctuations in Korea by focusing on two main issues: the sources of international business cycles and the transmission of structural shocks in open economies. That is, what is the main source of fluctuations in key macro

* Professor, Department of Economics, Seoul National University, San 56-1, Sillim-Dong, Gwanak-Gu, Seoul 151-746, Korea, (Tel) +82-2-880-2689, (Fax) +82-2-886-4231, (E-mail) soyoungkim@snu.ac.kr. This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD) (KRF-2007-327-B00112).

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variables in open economies? What are the effects of the main structural shocks on the key macro variables in open economies?

Three key macro variables in open economies are considered: cross-country output differential, real exchange rate, and trade balance. The presence of cross-country output differential is the main reason for analyzing international business cycles (as opposed to closed economy business cycles). Cross-country output differential or output asymmetry has been one of the key variables in analyzing various macro issues of open economies, such business cycle synchronization, risk sharing, and monetary union. The real exchange rate is the most important price variable that shows the economic linkage between domestic and foreign countries. There is a huge body of literature on the empirical properties of real exchange rate behavior. Trade balance is the most important quantity variable that shows the economic linkage between domestic and foreign countries. It is traditionally at the center of many issues in open-economy macroeconomics.

Three structural shocks, which feature prominently in open-economy macroeconomics, are considered: supply shocks, (real) demand shocks, and nominal (demand) shocks. Supply shocks, such as technology shock, has been considered one of the main sources of business cycles at least from the birth of Real Business Cycle theory (*i.e.*, Kydland and Prescott 1982). In International Real Business Cycle theories (*i.e.*, Backus, Kehoe, and Kydland 1992), supply shocks like technology shocks are also key in explaining international business cycles. However, recent debates on the role of supply shocks in business cycles have arisen. Some recent studies, such as those of Gali (1999), Gali and Rabanal (2004), and Francis and Ramey (2005), have suggested that technology shocks play a minor role in explaining business cycles, but others such as Christiano, Eichenbaum, and Vigfusson (2003, 2004), Chari, Kehoe, and McGrattan (2007), and Fisher (2006) argue that technology shocks, or supply shocks that include types other than technology shock, remain highly important in explaining business cycles. A limited number of studies on the role of technology shocks in explaining international business cycles have been conducted, but studies such as that of Kim and Lee (2008) suggest that (country-specific or country-asymmetric) supply shocks are important in elucidating cross-country output differential in large open economies, such as the U.S., Japan, and the Euro area. This paper examines a small open economy, Korea, and provides further evidence on the above-mentioned issues.

Demand shocks including fiscal and taste shocks, also of great interest

in past studies, are considered as the source of economic fluctuations. These shocks are viewed as the main source of business cycles in the traditional and new Keynesian models. In their open-economy extensions, such as the traditional Mundell-Flemming-Dornbusch model and the New Open Economy Macro model (*i.e.*, Obstfeld and Rogoff 1995), demand shocks continue to be regarded as an important source of international business cycles. In addition, International Real Business Cycle theories, such as those of Stockman and Tesar (1995), introduce taste shocks to better explain some features of international business cycles. Many recent studies, such as those of Kim and Roubini (2008), Ravn, Schmitt-Grohé, and Uribe (2008), and Corsetti and Müller (2006), have investigated the effects of fiscal shocks on trade balance and real exchange rate. Aside from demand shocks being regarded as an important source of output fluctuations in past studies, research including those of Clarida and Gali (1994) and Kim and Lee (2008) suggest that demand shocks are very important sources of real exchange rate fluctuations.

The role of nominal shocks, such as monetary shocks, in business cycles is particularly emphasized by the Monetarist. Nominal shock has been regarded as one of the most important sources of international business cycles in various theoretical models, such as the traditional Mundell-Flemming-Dornbusch model and the New Open Economy Macroeconomics model. A huge number of studies have investigated the role of monetary policy shocks in explaining key international variables (*i.e.*, Eichenbaum and Evans 1995; Kim and Roubini 2000; Kim 2001; Faust and Rogers 2003; Scholl and Uhlig 2008).

To investigate these issues, a structural VAR model with long-run restrictions is used in this study. The imposed long-run restrictions are consistent with those in a variety of theoretical models. In this sense, the identified structural shocks in this model may be regarded as plausible ones by a broad audience. In econometric implementation, a nonparametric estimator of the zero-frequency spectral density is used to avoid possible bias in the estimation and identification of the VAR model (Refer to Christiano, Eichenbaum, and Vigfusson, 2007).

Many past studies explored the sources of fluctuations in the key international macro variables and the transmission of structural shocks in open economies. However, these studies often focus on one or two shocks and variables. One of the interesting exceptions is Kim and Lee (2008), who developed a framework for a comprehensive analysis that examines a variety of variables and shocks in a single framework for

large open economies. This paper applies Kim and Lee (2008)'s framework to a small open economy, namely the Korean economy, to analyze international macroeconomic fluctuations. By jointly considering various types of shocks, the relative importance of different shocks in accounting for international macroeconomic fluctuations is examined.

The rest of the paper is organized as follows. Section 2 explains the empirical model. Section 3 discusses the data. Section 4 provides the empirical results, and Section 5 concludes with a summary.

II. Empirical Method

A. Structural VAR model with Long-Run Restrictions

Let us assume that economic relationship is described by the following structural vector moving average form equation:

$$y_t = G(L)e_t \tag{1}$$

where $G(L)$ is a matrix polynomial in lag operator L, y_t is an $m \times 1$ data vector, m represents the number of variables in the model, and e_t denotes a vector of structural disturbances. By assuming that structural disturbances are mutually uncorrelated, var(e_t) can be denoted by Λ, which is a diagonal matrix where diagonal elements are the variances of structural disturbances.

The following reduced-form VAR is estimated.

$$B(L)y_t = u_t, \tag{2}$$

where $B(L)$ is a matrix polynomial in lag operator L, and var(u_t)$=\Sigma$.

Several methods can be used to recover the parameters in the structural-form equation from the estimated parameters in the reduced-form equation. The identification scheme under consideration imposes zero restrictions on long-run structural parameters, that is, $G(1)$. Refer to Blanchard and Quah (1989) for details.

B. Empirical Model

Consider the following structural moving-average representation of a structural VAR model [corresponding to Equation (1)] that includes three

variables.

$$\begin{bmatrix} d\log Y_t - d\log Y_t^* \\ d\log RER_t \\ TB_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) & C_{13}(L) \\ C_{21}(L) & C_{22}(L) & C_{23}(L) \\ C_{31}(L) & C_{32}(L) & C_{33}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{S,t} \\ \varepsilon_{D,t} \\ \varepsilon_{N,t} \end{bmatrix}, \quad (3)$$

$$C_{12}(1) = C_{13}(1) = C_{23}(1) = 0$$

where Y is the real GDP of Korea, Y^* is the real GDP of foreign countries, RER represents the real effective exchange rate of Korea, TB denotes the trade balance of Korea (as a percentage of the trend GDP of Korea), and $e_{S,t}$, $e_{D,t}$, and $e_{N,t}$ are supply, demand, and nominal shocks, respectively.[1]

All structural shocks are country-specific shocks or shocks that reflect the differences between Korean and foreign countries. For example, $e_{S,t}$ is a country-specific supply shock or the shock that reflects the difference between Korean and foreign supply. Identifying country-specific or difference-between-domestic-and-foreign shocks in this framework is reasonable because all the variables in the system reflect differences in domestic and foreign economic conditions.

The identifying restrictions ($C_{12}(1)=C_{13}(1)=C_{23}(1)=0$) imply that (1) only supply shocks can affect output differential in the long run (whereas demand and nominal shocks cannot); and (2) supply and demand shocks can affect real exchange rate in the long run, but nominal shocks cannot.

These identifying assumptions are consistent with various theoretical models, such as the traditional Mundell-Flemming-Dornbusch, flexible price equilibrium, and the New Open Economy Macro models. Most theoretical models predict that nominal shocks, such as monetary shocks, do not have the long run effects on real variables (such as output and real exchange rate), and that demand shocks do not have long-run effects on real quantity variables (such as output). Refer to Kim and Lee (2008) for New Open Economy Macro models that explicitly include these three shocks and variables, and are consistent with these long-run restrictions.[2]

[1] Quadratic trend in GDP is assumed. Results are similar when a linear trend is used.

[2] Kim and Lee (2008) include an additional variable, labor productivity, to separate supply shocks into technology and labor supply shocks. This paper does not separate them because of data limitations.

III. Data

The model is estimated using quarterly data for two sub-periods: before (January 1987-April 1996) and after the Asian financial crisis (January 1999-April 2008). Substantial changes in monetary, exchange rate, and financial policies occurred in Korea after the crisis. Korea adopted inflation targeting with monetary instruments as short-term interest rates, moved toward a more flexible exchange rate regime, and fully liberalized capital accounts.[3]

Over the sample period, four countries or regions take up more than a half of Korean international trade. They are: the Euro region, the U.S., Japan, and China. For the sample period before the Asian financial crisis, these four countries/regions account for 53% of Korean exports and 63% of Korean imports. For the sample period after the Asian financial crisis, the four countries/regions account for 53% of Korean exports and imports. To construct each variable, these four major Korean trade partners are treated as foreign countries. Foreign output is constructed as the trade-weighted average of these main trade partners. The trade weight is obtained by considering the sum of bilateral import and export data of Korea. The effective real exchange rate is constructed using the trade-weighted average of real exchange rate against these four countries. Trade balance is constructed as the trade balance against the four countries.

For output measure, real GDP is used. To construct the real exchange rate, nominal exchange rate and GDP deflator are used; GDP deflator, instead of CPI, is used because GDP deflator is available for longer time spans than CPI for China. To construct trade balance against the four countries, the bilateral trade data of Korea are used. The real GDP, GDP deflator, and nominal exchange rate for all countries, except for the real GDP and GDP deflator of China, are obtained from *International Financial Statistics*. The real GDP and GDP deflator of China are obtained from the Oxford Global Databank. Bilateral trade data are obtained from Direction of Trade. Bilateral trade data are in terms of U.S. dollars, and converted to Korean won by multiplying the won-dollar exchange rate. Appendix 1 shows the graphs for each variable in the

[3] Refer to Pyo (2004) for the discussion on the post-crisis reform programs and the post-crisis macroeconomic adjustment in Korea. Also, refer to Kim and Park (2006) and Nam (2005) for changes in monetary policy frameworks after the Asian financial crisis in Korea.

model.

Augmented Dicky-Fuller and Phillip-Perron Unit root tests are performed for each variable. For real effective exchange rate and output differential, the null hypothesis of unit root is not rejected in most cases to be consistent with the empirical model. For trade balance, the null hypothesis of unit root is not rejected, but the level of trade balance (as a percentage of the trend GDP) is used as many theories predict that the trade balance is stationary.[4] The Johansen cointegration test suggests that the null hypothesis of cointegration between output differential and real effective exchange rate is rejected in all cases. A constant term and two lags are included in the empirical model.[5] Refer to Appendix 2 for more detailed results on various specification tests. A non-parametric estimator of the zero-frequency spectral density is used to avoid possible bias in the estimation and identification of the VAR model with long-run restrictions (Refer to Christiano, Eichenbaum, and Vigfusson, 2007).

IV. Empirical Results

A. Impulse Responses

Figures 1 and 2 show the impulse responses with 90% probability bands over four years for the periods before and after the Asian financial crisis, respectively. Each column shows the impulse responses to each shock. The structural shocks are denoted at the top of each column, and the responding variables are denoted at the far left of each row.

In response to supply shocks, output differential permanently increases in both periods. The size of the supply shock tends to be slightly larger in the period after the Asian financial crisis; in response to supply shock, the long-run output increase is 0.7-0.8% in the period after the Asian financial crisis but 0.4-0.5% in the period before the Asian financial crisis.

[4] For example, the inter-temporal approach suggests that the trade balance is stationary. Refer to Asdrubali and Kim (2009).

[5] Based on the Akaike and Schwartz criteria, one lag is chosen for both periods. However, in the main result section (Section 4), two lags are allowed because the purpose of this paper is to investigate structural relationship (instead of forecasting) and one lag may not capture enough interactions among variables. The main conclusion is still robust in the model that uses only one lag.

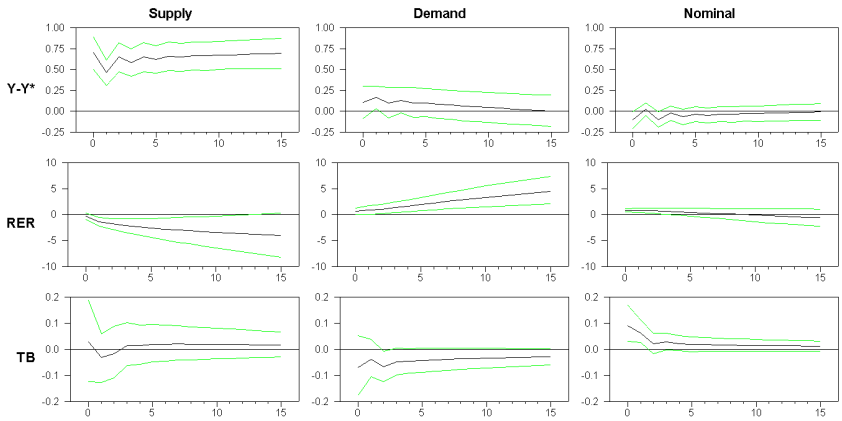

FIGURE 1
IMPULSE RESPONSES (1999:1-2008:4)

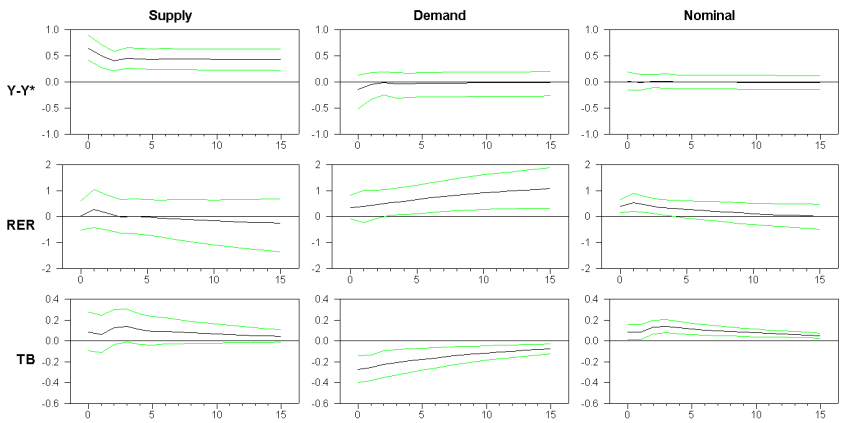

FIGURE 2
IMPULSE RESPONSES (1987:1-1996:4)

In response to supply shocks, the real exchange rate appreciates over time after the Asian financial crisis. The long-run appreciation of the real exchange rate is consistent with the Balassa-Samuelson theory; a permanent productivity appreciates the real exchange rate in the long run. However, the real exchange rate responses before the Asian financial crisis do not differ much from zero, considering the wide probability

band. This difference might be due to the variances in exchange rate and financial policies; as exchange rate becomes more flexible and capital account is liberalized, the real exchange rate might respond more to supply shocks. The trade balance responses are unclear as well, considering the wide probability band.

Demand and nominal shocks tend to generate opposite signs of correlation between real exchange rate and trade balance. Nominal shocks depreciate the real exchange rate and improve the trade balance; nominal shocks generate a positive correlation between the real exchange rate and the trade balance. On the other hand, demand shocks depreciate (or increase) the real exchange rate and worsen the trade balance. That is, demand shocks generate a negative correlation between the real exchange rate and the trade balance. This negative correlation is particularly interesting because the positive correlation between these two variables, which is implied by the expenditure switching effect, is regarded as a natural one by most practitioners.

Theoretically, country-specific demand shocks, such as government spending shocks and taste shocks toward domestic goods (vs. foreign goods), generate a negative correlation between real exchange rate and trade balance. Government spending shocks tend to fall mostly on domestic goods, not much on foreign goods, indicating the increase in the relative demand for domestic goods (vs. foreign goods). Similarly, taste shocks toward domestic goods (against foreign goods) increase the relative demand for domestic goods (vs. foreign goods). As the relative demand for domestic goods (vs. foreign goods) increases, the trade balance improves but the relative price of local versus foreign goods increases (which is a real exchange rate appreciation by definition). Conversely, nominal shocks, such as monetary shocks, tend to generate a positive correlation between real exchange rate and trade balance. A monetary expansion depreciates the real exchange rate and improves the trade balance by expenditure switching effect. Therefore, the responses of the trade balance and real exchange rate to demand and nominal shocks tend to be consistent with theory.

Similar to the real exchange rate responses to supply shocks, the real exchange rate responds to demand shocks more strongly after than before the Asian financial crisis. Output differential does not respond much to demand and nominal shocks. Before the Asian financial crisis, the probability bands of output differential responses are wide and include zero responses. After the Asian financial crisis, output differential increases under demand shocks and decreases under nominal shocks,

TABLE 1

FORECAST ERROR VARIANCE DECOMPOSITION (1999:1-2008:4)

(1) Output differential

	Steps	Supply	Demand	Nominal
Level	4	82.7 (67.3,97.1)	13.7 (1.2,27.0)	3.5 (0.6,6.2)
	16	87.4 (77.4,97.7)	10.1 (1.1,19.2)	2.5 (0.3,4.5)
Diff.	4	77.4 (61.1,91.9)	13.0 (2.3,23.1)	9.6 (2.8,15.7)
	16	76.7 (60.3,91.2)	13.3 (2.7,23.7)	10.0 (3.0,16.3)

(2) Real exchange rate

	Steps	Supply	Demand	Nominal
Level	4	50.3 (19.5,79.4)	32.0 (5.5,63.3)	17.7 (2.8,33.6)
	16	47.6 (13.0,81.3)	43.2 (11.8,77.4)	9.2 (0.9,16.0)
Diff.	4	49.5 (29.3,69.9)	28.7 (8.9,49.3)	21.9 (7.7,37.8)
	16	46.1 (25.9,68.1)	34.9 (14.8,57.0)	19.0 (7.3,31.1)

(3) Trade balance

	Steps	Supply	Demand	Nominal
Level	4	32.6 (8.7,60.2)	36.7 (9.7,66.2)	30.7 (8.9,54.3)
	16	35.2 (9.1,64.4)	40.7 (12.1,70.6)	24.1 (5.8,44.4)

but the size of the responses are relatively small, especially compared with the responses to supply shocks.

B. Forecast Error Variance Decomposition

To compare the relative importance of structural shocks in accounting for international macroeconomic fluctuations, Tables 1 and 2 list the forecast error variance decomposition of output differential, real exchange rate, and current account at 4-quarter and 16-quarter horizons, for the periods after and before the Asian financial crisis, respectively. For output differential and real exchange rate, the results for the level and difference are reported because the results on these are sometimes different. The numbers in parentheses are one standard-error bands.

Fluctuations in output differential are mostly explained by supply shocks. They explain 75-90% of fluctuations in output differential. Demand shocks accounts for around 10%, whereas nominal shocks accounts for mostly less than 10%. In applications to the U.S., Japan, and the Euro area using a similar framework, Kim and Lee (2008) also find the key role of supply shocks in explaining output differential. This

TABLE 2

FORECAST ERROR VARIANCE DECOMPOSITION (1987:1-1996:4)

(1) Output differential

	Steps	Supply	Demand	Nominal
Level	4	82.4 (65.9,96.9)	11.1 (1.4,22.3)	6.5 (0.3,12.2)
	16	87.8 (76.3,98.0)	7.8 (0.8,15.3)	4.4 (0.3,8.4)
Diff.	4	86.6 (77.4,95.5)	9.4 (2.5,16,3)	4.0 (0.4,7.5)
	16	86.5 (77.4,95.3)	9.5 (2.5,16.4)	4.0 (0.4,7.5)

(2) Real exchange rate

	Steps	Supply	Demand	Nominal
Level	4	23.0 (7.1,40.8)	39.4 (11.8,67.3)	37.6 (14.4,64.2)
	16	31.2 (7.5,57.2)	54.3 (28.5,80.3)	14.5 (2.9,25.4)
Diff.	4	31.9 (12.1,53.4)	28.9 (6.2,54.2)	39.2 (18.5,62.9)
	16	33.6 (14.1,54.2)	29.9 (9.6,52.1)	36.5 (17.3,57.6)

(3) Trade balance

	Steps	Supply	Demand	Nominal
Level	4	46.5 (10.1,80.3)	38.5 (6.6,75.0)	15.0 (3.1,26.6)
	16	46.9 (10.3,80.7)	37.1 (5.4,73.0)	16.0 (3.4,28.3)

result is interesting because closed economy literature, such as studies by Gali (1999), Gali and Rabanal (2004), and Francis and Ramey (2005), find that supply shocks, such as technology shocks, play a minimal role in explaining output fluctuations.

Real exchange rate fluctuations are explained by various shocks. After the Asian financial crisis, supply shocks explain about half of real exchange rate fluctuations (46-51%) and demand shocks explain about 28-44% of real exchange rate fluctuations. The role of nominal shocks is relatively small, ranging from 9-22%. Before the Asian financial crisis, the role of each shock is more evenly distributed. Supply, demand, and nominal shocks explain 23-34%, 28-55%, and 14-40%, respectively. This finding is in contrast to those of Clarida and Gali (1994) and Kim and Lee (2008), who find that demand shocks play a dominant role in explaining real exchange rate fluctuations.

The role of each shock in explaining trade balance fluctuations is evenly distributed after the Asian financial crisis. Supply, demand, and nominal shocks explain 32-36%, 36-41%, and 24-31%, respectively. Before the Asian financial crisis, the role of supply shock is larger and the role of nominal shock is smaller. Supply, demand, and nominal

shocks explain 46-47%, 37-39%, and 15-16%, respectively. These results suggest that modeling trade balance using a variety of structural shocks (as opposed to a single structural shock) is a more appropriate approach.

Overall, supply shocks play a huge role in explaining international macroeconomic fluctuations. They explain most of the fluctuations in output differential. They also explain a considerable portion of fluctuations in real exchange rate and trade balance; in particular, supply shocks explain about half of the real exchange rate fluctuations prevalent after the Asian financial crisis, and about half of the trade balance fluctuations that occurred before the Asian financial crisis. On the other hand, the role of nominal shocks is limited in some cases; nominal shocks play a minor role in explaining output differential and real exchange rate fluctuations after the Asian financial crisis, and trade balance fluctuations before the Asian financial crisis. Demand shocks explain a non-negligible portion of fluctuations in real exchange rate and trade balance, but a small portion of fluctuations in output differential.

C. Historical Decomposition

Although the forecast error variance decomposition reports the contribution of each structural shock averaged over the sample period, it does not directly show the role of each shock in different historical episodes. In this section, we examine the historical role of each structural shock using historical decomposition, shown in Figures 3 and 4. The first column ("deterministic") shows the actual series (dashed line) and the contribution of the deterministic part (solid line).[6] In other columns (denoted by each shock), the dashed line shows the difference between the actual series and the contribution of the deterministic part, and the solid line shows the contribution of each structural shock in explaining that difference. Although the estimation uses log-differenced values for labor productivity, output, and the real exchange rate in the model, we construct the decomposition based on log-level values by cumulating the decomposed contributions.

Supply shocks explain most of the historical variations in output differential, especially before the Asian financial crisis. In the middle of

[6] The actual series is the sum of two parts: (1) the contribution of the deterministic part (the model without structural shocks), and (2) the contribution of realized structural shocks. By decomposing the second part into the contribution of each structural shock, we infer the role of each shock.

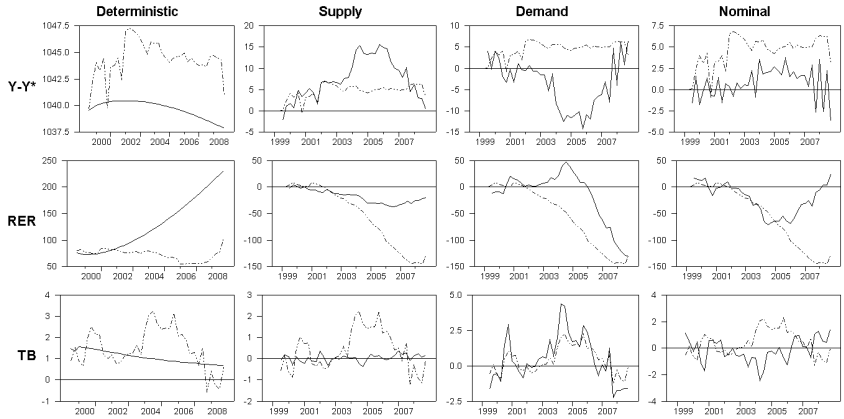

FIGURE 3
HISTORICAL DECOMPOSITION (1999:1-2008:4)

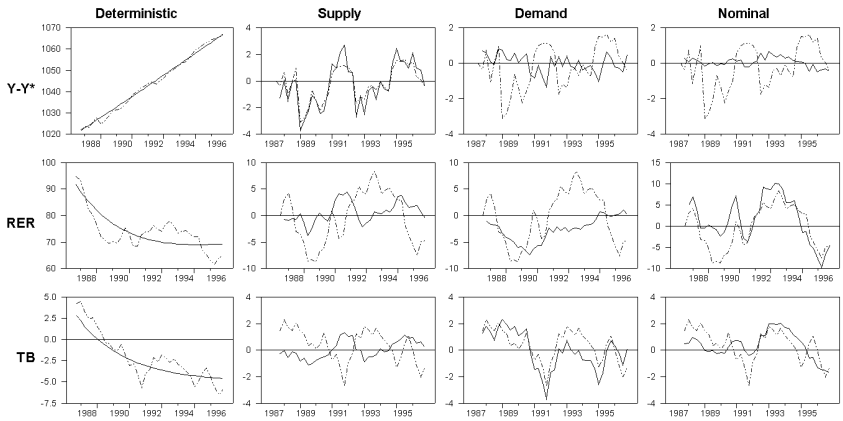

FIGURE 4
HISTORICAL DECOMPOSITION (1987:1-1996:4)

the 2000s, supply and nominal shocks drive output differential up but demand shocks drive it down. On net, output differential is positive as the former is stronger than the latter. The historical decomposition of trade balance and real exchange rate show the different roles of particular shocks in different periods. Real exchange rate fluctuations in the early 1990s are substantially explained by nominal shocks, whereas

real exchange rate appreciation in the late 1980s is considerably explained by demand shocks. The appreciation of the real exchange rate in the early 2000s is explained to a great extent by nominal shocks, whereas the appreciation of the real exchange rate in the mid and late 2000s is mostly driven by demand shocks. The trade balance worsening from the late 1980s to the early 1990s is explained to a great extent by demand shocks, whereas nominal shocks explain the improvement of trade balance in the early 1990s. Demand shocks explain much of trade balance movements after the Asian financial crisis.

V. Conclusion

This paper examines international macroeconomic fluctuations in Korea by paying particular attention to the sources of fluctuations in key macroeconomic variables and international transmission of main structural shocks.

We find that fluctuations in cross-country output differential are mostly explained by supply shocks. This result is worth emphasizing because a heated debate on the role of supply shocks in explaining business cycle fluctuations has arisen. Supply shock is an important factor in explaining fluctuations in real exchange rate and trade balance, but nominal and demand shocks also play a role. This result is interesting because past studies often find that demand shocks play a huge role in explaining real exchange rate fluctuations, and because the source of trade balance fluctuations has not been investigated frequently in previous studies.

Positive supply shocks appreciate the real exchange rate after the Asian financial crisis (consistent with the Balassa-Samuelson theory), but do not have a clear effect on the direction of trade balance changes. The real exchange rate responses to demand shocks are also larger after than before the Asian financial crisis. This may be related to changes in the exchange rate and financial policies of Korea. Nominal and demand shocks generate opposite correlations between real exchange rate and trade balance; nominal shocks generate a positive correlation but demand shocks generate a negative correlation. These opposite correlations are interesting because positive correlation between real exchange rate and trade balance is often emphasized among practitioners, based on the expenditure switching effect.

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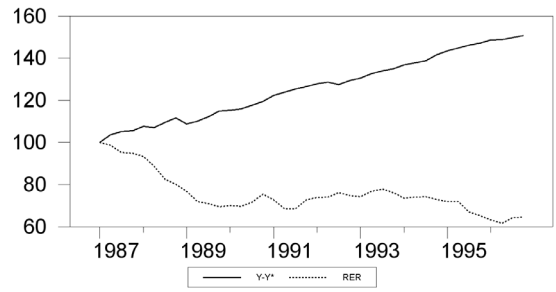
Appendix 1. Data

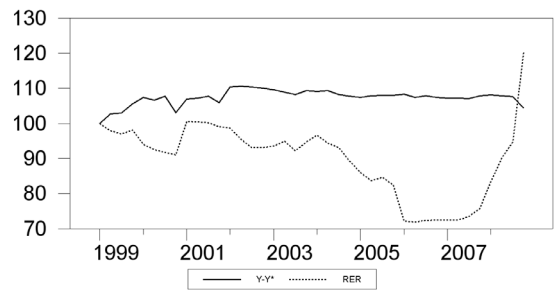
This appendix contains the graphs for each variable included in the empirical model.



Note: The value of each variable in the first quarter of 1987 is normalized to 100.

FIGURE A.1

LOGS OF OUTPUT DIFFERENTIAL AND REAL EFFECTIVE EXCHANGE RATE BEFORE THE ASIAN FINANCIAL CRISIS



Note: The value of each variable in the first quarter of 1999 is normalized to be 100.

FIGURE A.2

LOGS OF OUTPUT DIFFERENTIAL AND REAL EFFECTIVE EXCHANGE RATE AFTER THE ASIAN FINANCIAL CRISIS

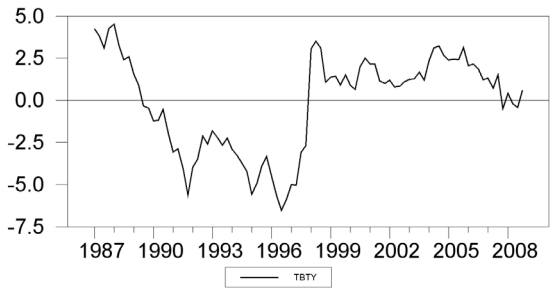


FIGURE A.3
TRADE BALANCE AS PERCENTAGE OF TREND GDP

Appendix 2. Specification Tests

This appendix reports various specification tests for the empirical model.

A2.1 Lag-length Tests

Lags	Before the crisis		After the crisis	
	Akaike	Schwartz	Akaike	Schwartz
0	370.2	374.3	399.3	403.4
1	335.1*	348.4*	366.3*	380.2*
2	350.1	367.2	384.4	402.7
3	372.9	385.9	407.4	422.8
4	409.8	406.9	443.0	444.5
5	467.5	429.4	489.2	459.5
6	544.9	437.7	573.6	483.1
7	687.1	441.6	645.1	436.9
8	1002.0	438.9	856.8	395.7

Note: Each number shows the penalty based on each criterion. "*" indicates the smallest penalty among the model that allows various lags in each case.

A2.2 Unit Root Tests

(1) Period before the Asian financial crisis

Variables	Period	Constant			Constant and Trend		
		t (ADF)	*z* (PP)	Lag	*t* (ADF)	*z* (PP)	Lag
Log (*Y*/*Y**)	Before	-0.59	-0.29	0	-3.10	-16.39	0
Log (RER)	Before	-3.10*	-9.64	3	-3.26	-16.01	3
TB	Before	-2.33	-1.37	0	-1.98	-7.32	0

(2) Period after the Asian financial crisis

Variables	Period	Constant			Constant and Trend		
		t (ADF)	*z* (PP)	Lag	*t* (ADF)	*z* (PP)	Lag
Log (*Y*/*Y**)	After	-3.69**	-12.83	0	-2.94	-11.71	0
Log (RER)	After	-1.14	-7.65	1	1.17	8.28	1
TB	After	-2.31	-10.29	0	-2.39	-10.70	0

Note: "*t* (ADF)" and "*z* (PP)" indicate the statistics for the Augmented Dickey-Fuller and Phillip-Perron tests, respectively. "constant" indicates that a constant is allowed for cointegration relation. "constant and trend" indicate that a constant and a trend are allowed for cointegration relation. "*" and "**" indicate that the null hypothesis of unit root is rejected at 5% and 1%, respectively.

A2.3. Cointegration Tests for Log (Y/Y) and Log (RER)*

(1) Period before the Asian financial crisis: Intercept in cointegration relation

No. of CE	Eigenvalue	Trace statistics	95% Critical value	Max-Eigen statistics	95% Critical value
0	0.210	8.980	15.495	8.957	14.264
1	0.001	0.024	3.842	0.024	3.842

(2) Period before Asian financial crisis: Intercept and trend in cointegration relation

No. of coint.	Eigenvalue	Trace statistics	95% Critical value	Max-Eigen statistics	95% Critical value
0	0.259	19.743	25.872	11.380	19.387
1	0.198	8.364	12.518	8.364	12.518

(3) Period after Asian financial crisis: Intercept in cointegration relation

No. of coint.	Eigenvalue	Trace statistics	95% Critical value	Max-Eigen statistics	95% Critical value
0	0.272	13.100	15.495	12.720	14.264
1	0.009	0.381	3.842	0.381	3.842

(4) Period after Asian financial crisis: Intercept and trend in cointegration relation

No. of coint.	Eigenvalue	Trace statistics	95% Critical value	Max-Eigen statistics	95% Critical value
0	0.302	16.498	25.872	14.383	19.387
1	0.051	2.115	12.518	2.115	12.518

Note: None of the tests reject the null hypothesis of no cointegration at 5% level.

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