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DISCUSSION PAPER

Exchange Rate and Output Dynamics Between Japan and Korea

**Sammo Kang
Soyoung Kim
Yunjong Wang
Deok Ryong Yoon**

HWWA DISCUSSION PAPER

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Exchange Rate and Output Dynamics Between Japan and Korea

ABSTRACT

Japan and Korea are close countries in terms of economic interaction as well as geography. To quantify the impact of changes in the yen-dollar exchange rate on the Korean economy before and after the crisis in 1997, the sample period has been divided into two sub-periods and the causal relationships examined by using vector autoregression analysis. Our estimates show that while the response of Korean industrial production to changes in the yen-dollar exchange rate was not significant during the pre-crisis period, it became significant during the post-crisis period. The forecast error variance decomposition also confirms that the yen-dollar exchange rate shocks have almost negligible explanatory power with regards to Korean industrial production during the pre-crisis period, but they have some significance for the post-crisis period. These empirical results show that the free floating exchange rate regime adopted since the crisis cannot insulate the Korean economy from external nominal shocks such as the yen-dollar exchange rate shocks.

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1. Introduction*

Japan and Korea are close countries in terms of economic interaction as well as geography. However, the countries have never committed to fixing or stabilizing their bilateral exchange rates. Both exchange rates are independently determined in the respective foreign exchange markets. Before the currency crisis in 1997, Korea maintained a managed floating exchange rate regime while Japan freely floated its currency. Under these different exchange rate regimes, no official exchange rate coordination has been attempted. Nonetheless, exchange rates matter. In the context of Japan-Korea economic interdependence, yen-dollar exchange rate fluctuations are an important source of foreign shocks to real economic activities in Korea.

Kwan (2001) and Ueda (1998), among many, assert that one of the key determinants of the boom-bust cycle in East Asia was the sharp appreciation of the yen against the dollar from the mid-1980s to the mid-1990s and its subsequent depreciation. They also find that foreign and domestic real investment and speculative financial capital was overly sensitive to the yen-dollar exchange rate movements. Every time the yen appreciates against the dollar, the economic growth of non-Japanese Asia picks up, as happened between 1986 and 1988 and again between 1991 and 1995. The reverse was also true when economic growth decelerated and the asset-price bubble burst on the back of a weaker yen in 1989-90 and again in 1996-98 (Kwan, 2001). However, this phenomenon has mainly been attributed to the pre-crisis de facto dollar-peg exchange rate regime in East Asia. As the East Asian currency crisis vividly demonstrated, the soft-peg currencies are extremely vulnerable to volatile fluctuations in the yen-dollar exchange rate. The pro-cyclical aspect of capital flows in and out of East Asia is closely related to the instability of the yen-dollar exchange rate.

The Korean government responded to the currency crisis by adopting a free floating exchange rate regime like Japan and by more actively pursuing capital account liberalization. One interpretation of the shift to floating exchange rates is that it reflected the unwillingness of the Korean government to maintain a de facto dollar peg in a situation of high capital mobility.¹ It therefore represents an effort to restore some

* This paper was originally prepared for the workshop on "Synchronized Recession and Policy Coordination in Asia," organized by the Asian Development Bank Institute on 8 April 2002 in Tokyo. We benefited from comments on the earlier draft given by Masaru Yoshitomi, Koichi Hamada, Heather Montgomery and Eisuke Sakakibara. For this revised draft, we thank Eric Girardin, Beate Reszat and two anonymous referees for their detailed comments and suggestions.

1 Most crisis-affected Asian countries except Malaysia shifted their exchange rate regimes from de facto U.S. dollar pegs to floating ones. See Baig (2001) for a detailed description of exchange rate behavior in East Asia after the crisis.

monetary autonomy in a world of high interdependence and increases the impact of domestic monetary policies on real economic activity. Yet floating exchange rates do not insulate national economies from the rest of the world completely.

From a purely theoretical point of view, flexible exchange rates reduce interdependence by maintaining monetary independence.² When the economy is hit by a disturbance, such as a shift in global demand away from the goods it produces (say, semi-conductors, steel and chemicals), the government could respond by means of monetary expansion and currency depreciation. This would stimulate demand for domestic products and return the economy to desired levels of employment and output more rapidly than would be the case under a fixed exchange rate regime (Frankel, Schmukler and Serven, 2002).

The purpose of this paper is to examine the effects of yen-dollar exchange rate shocks to the Korean economy in the pre- and post-crisis periods. This empirical investigation will consider whether the effects of foreign shocks such as the yen-dollar exchange rate shocks on Korean economy are weaker, as the general theory predicts, in the post-crisis period, during which more flexible exchange rate policy is pursued. Using VAR models, we focus on the effects a yen-dollar shock would have on industrial production and the won-dollar exchange rate.

The rest of this paper is organized as follows. The next section will describe stylized facts on the exchange rate movements between yen-dollar and won-dollar rates and discuss the possible channels through which the yen-dollar exchange rate affects the won-dollar exchange rate and the Korean economy. Section 3 empirically analyzes the influence of the yen-dollar rate on the won-dollar rate and industrial production of Korea in the pre- and post-crisis periods. Section 4 examines the robustness of the main results by extending the basic model to various dimensions. The last section will conclude the paper with a discussion of some policy implications.

2. Stylized Facts on Yen-Won Exchange Rate Movements

A weaker yen would affect Korea's economic activities through the following four channels.³ The first channel is the response of capital flows to exchange rate movements. For instance, capital flows from Japan to Korea such as foreign direct

2 Recent empirical studies investigate whether the choice of the exchange rate regime affects monetary policy independence in practice. See Borensztein, Zettelmeyer and Philippon (2001), Frankel (1999), Frankel, Schmukler and Serven (2002), Hausmann, Panizza and Stein (1999), and Kim and Lee (2002).

3 See Kwan (2001) for a detailed explanation.

investment (FDI) or portfolio investment decrease when the yen becomes weaker. For example, a weaker yen would mean reduced production costs in Japan relative to Korea. Depreciation of the yen would reduce the incentives for Japanese investors to invest in Korea.

The second channel is related to competitiveness in the international goods market. A weaker yen means a decline in Korea's export competitiveness against Japanese products because a weaker yen would result in lower prices for Japanese products compared to those of its competitors in the international market. Countries like Korea that import labor-intensive products and export capital-intensive ones and have similar trade structures with Japan have a competitive relationship with Japan (Kwan, 2001: 44). If similar trade structures in the two countries promote intra-industry trade bilaterally, competitive pressures in the international goods market would be much smaller. However, the Japanese and Korean producers in the same industry compete each other in the U.S. and Europe for their exports.

The third channel is due to cheaper imports from Japan when the yen is becoming weaker. Korean producers rely mainly on Japan for the import of capital goods, so cheaper imports from Japan are beneficial to Korean producers using Japanese facilities.

The fourth channel is related to the balance sheet effects. When the yen becomes weaker, yen-denominated external debt burden will diminish. The more the yen depreciates, the smaller the yen-denominated debt burden becomes.

The first two channels provide some background on the possibility of co-movements of the exchange rates of the Korean won and the Japanese yen under a flexible exchange rate regime. Through the first channel, capital outflows from Korea may result in the depreciation of the won. On the other hand, major Korean exports, such as motor vehicles, electronic appliances and steel, are sensitive to fluctuations in the yen-dollar exchange rate because those products compete with Japanese products in the third market. When the yen-dollar exchange rate increases, Japanese exporters sell their products at a cheaper price in a third market to raise their market share. In such a case, Korean exporters are likely to lose price competitiveness and exports are likely to decrease, which may lead to won-dollar exchange rate depreciation. This phenomenon becomes conspicuous as competition with Japanese products intensifies.

However, we should also note that the eventual effects of yen-dollar rate changes on Korean economic activities depend on how strongly the won-dollar rate responds to the yen-dollar rate changes. In relation to the second channel, a depreciation of the Korean won may in turn improve Korea's trade balance, which may have positive

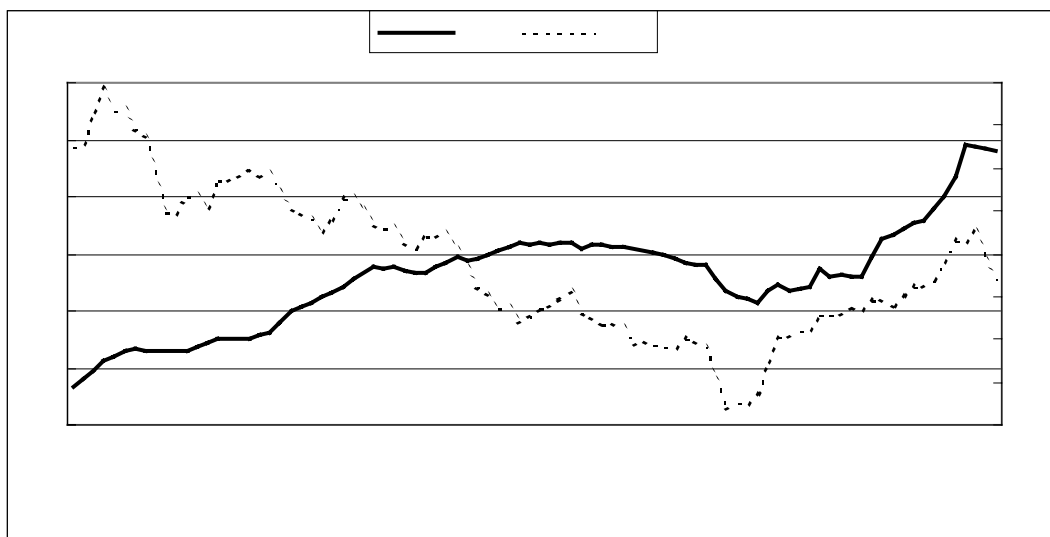
effects on the Korean economic activities. The third channel would not have a strong influence on the Korean economy because Japanese exporters of capital goods to Korea are likely to maintain export prices in dollar terms if the won-dollar exchange rate does not respond. However, if the won-dollar rate does increase significantly in response to a yen-dollar rate increase, Japan's export prices in Korean won would increase for Korean importers, which would have negative effects on the Korean economy. On the other hand, Korea's foreign debt is denominated mainly in dollars, which suggests that the fourth channel is not likely to be very important if the won-dollar rate does not change much. However, if the won-dollar rate also increases, Korea's dollar debt burden will increase, which may have negative effects on the Korean economy.

The exchange rate policy in Korea substantially changed from the pre-crisis period to post-crisis period, moving more toward a flexible exchange rate regime. In addition, the capital account is more liberalized.⁴ Therefore, we expect more synchronization of the won-dollar and yen-dollar exchange rates in the post-crisis period, through the two channels discussed above. Further, such differences in the won-dollar exchange rate response to the yen-dollar shocks between the pre-crisis and post-crisis periods can result in huge differences in the ultimate impact of yen-dollar shocks on Korean economic activities.

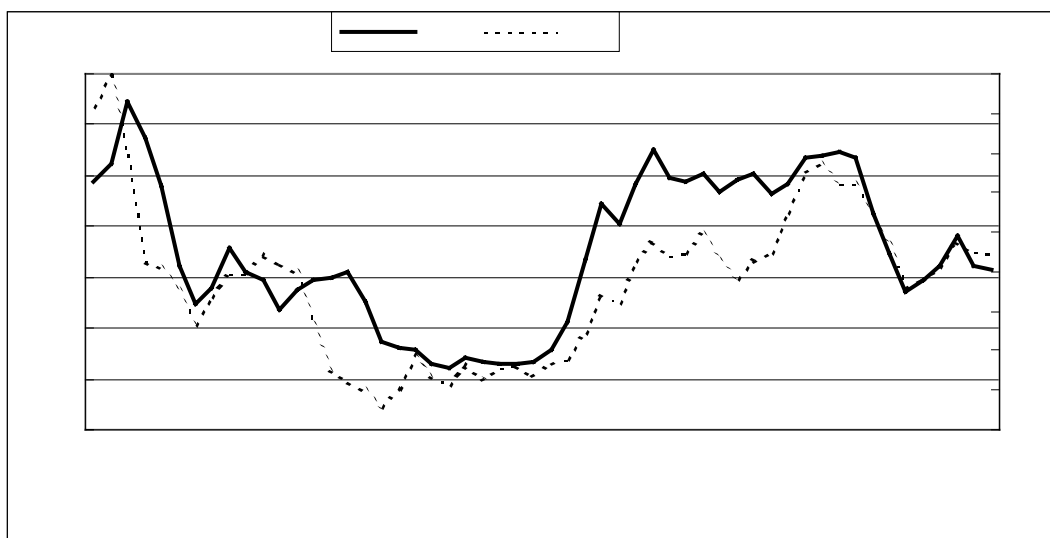
Before formally examining the effects of yen-dollar shocks on the won-dollar exchange rate and Korean economic activities in Sections 3 and 4, let us here examine some simple statistical properties of yen and won exchange rate movements. Figures 1 and 2 show the movement of yen and won exchange rates against the U.S. dollar. The exchange rates of the two currencies moved in opposite directions from the early to mid-1990s. The Japanese yen appreciated continuously in this period while the Korean won experienced depreciation. However, there has been a clear trend of co-movement between these two currencies since the mid-1990s. Especially after Korea's economic crisis, the two currencies fluctuated more tightly together.

4 See Kim, Kim and Wang (2001) and Kang, Kim, Kim and Wang (2002) for detailed explanation of Korea's capital account liberalization.

<Figure 1> Movements of Yen-Dollar and Won-Dollar Exchange Rates (1990-1997)



<Figure 2> Movements of Yen-Dollar and Won-Dollar Exchange Rates (1999-present)



We also report some basic statistical relations between the yen-dollar exchange rate and the won-dollar exchange rate. From January 1990 to June 1997, the coefficient of correlation between the yen-dollar exchange rate and the won-dollar exchange rate recorded -0.51.⁵ In the early 1990s, the yen-dollar exchange rate continued to fall, while the won-dollar exchange rate showed an increasing trend. However, from 1995 to 1997,

⁵ This analysis has focused on statistics for the period after 1990 because Korea's financial market was not liberalized until 1990 and the exchange rate was controlled by the central bank until then.

the won-dollar exchange rate moved in the same direction. Overall, the negative correlation of the early 1990s dominates the positive correlation of the mid-1990s (1995-97). Therefore, the coefficient of correlation between the yen-dollar exchange rate and the won-dollar exchange rate is negative.⁶ From January 1998 to December 2002, the coefficient of correlation was 0.82, indicating that the won-dollar exchange rate moved more or less in the same direction.

<Table 1> Yen-Dollar Exchange Rate and Won-Dollar Exchange Rate

Periods	Correlation Coefficient
1990:01-1997:06	-0.51
1998:07-2002:12	0.82

These simple statistical facts are consistent with the fact that following the crisis, the capital account has become more liberalized and the exchange rate policy is more inclined toward a flexible exchange rate regime. In addition, the yen and won exchange rates are more synchronized, possibly through capital market linkage or trade linkage.

3. Empirical Tests

This section examines the influence of the yen-dollar exchange rate on the Korean economy, in particular, the won-dollar exchange rate and Korean industrial production in more details using VAR models.

Data and Sample Period

To examine the main issues, we consider four basic variables – the yen-dollar exchange rate, the won-dollar exchange rate, the industrial production of Korea and the industrial production of Japan. The first three variables are major variables to examine

6 It is also interesting to analyze the impact of changes in the yen-dollar exchange rate and Japanese industrial production on the Korean economy from 1995 to 1997 and compare the results with those from other periods. However the amount of data is insufficient to perform the empirical tests in that period.

in our empirical analysis.⁷ The last variable, the industrial production of Japan, is included to control the effects of Japanese real sector shocks on the Korean economy.

The basic data set – the industrial production of Japan, the industrial production of Korea, the yen-dollar exchange rate, and the won-dollar exchange rate – is collected from International Financial Statistics. The sample period is from January 1990 to December 2002. We do not consider the sample period before 1990 since capital account restriction and the exchange rate system were substantially different before 1990 and after 1990 (Kim, Kim and Wang, 2001). Considering that the sample period is relatively short, we use monthly data to increase the degree of freedom as much as possible.

On the other hand, we divide the sample period into two parts since the relationship between the Japanese and Korean economies is likely to change over time. In particular, in East Asian countries like Korea, the economic environment and exchange rate policies have changed significantly since the currency crisis in 1997 (Kim, Kim and Wang, 2001) and we would like to identify the difference between the periods before and after the crisis. Therefore, we divide our sample period into two periods – the period before (1990:1 – 1997:6) and the period after the 1997 East Asian currency crisis (1998:7-2002:12) – and compare the results.

Specification Tests

To determine the specification of each variable to be used in our VAR model, augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests are performed for log of each variable. The results in Table 2 suggest that the tests fail to reject the null hypothesis of unit root at 1-percent significance level for all series. When each time series is differenced, however, the null hypothesis is rejected and the variables are found to be stationary.

7 We used industrial production, which is available in monthly frequency, in order to increase the degree of freedom given our short samples.

<Table 2> Stationary Tests

	ADF unit root test	Phillips-Perron unit root test
Log value of Japanese Industrial Production	-2.77	-1.98
First Difference of Log of Japanese Industrial Production	-3.59**	-15.92**
Log of Yen-Dollar Exchange Rate	-2.41	-2.22
First Difference of Log of Yen-Dollar Exchange Rate	-6.74**	-8.67**
Log of Won-Dollar Exchange Rate	-1.21	-1.36
First Difference of Log of Won-Dollar Exchange Rate	-5.32**	-6.97**
Log of Korean Industrial Production	-0.56	-0.43
First Difference of Log of Korean Industrial Production	-6.44**	-13.19**

Notes: 1) The significance levels of the ADF and Phillips-Perron unit root tests are 1 percent:-3.47, 5 percent:-2.88.

2) In the ADF and Phillips-Perron unit root tests, four lags are used.

3) * and ** denote statistical significance at the 5 percent and 1 percent levels, respectively.

In order to find out whether co-integrating relations exist, we run a Johansen test and the results are shown in Table 3. We do not find any co-integrating relations from the test applied to industrial production of Japan, yen-dollar exchange rate, won-dollar exchange rate and industrial production of Korea.

<Table 3> Johansen Test

Likelihood Ratio	5-Percent Critical Value	1-Percent Critical Value	Hypothesized Number of Co-integrating Equations
38.59	47.21	54.46	None
15.13	29.68	35.65	At most 1
4.77	15.41	20.04	At most 2
0.03	3.76	6.65	At most 3

Notes: 1) * and ** denote statistical significance at the 5 percent and 1 percent levels, respectively.

Based on the specification tests, we use the difference of log of each variable in the basic VAR model. We use the recursive Vector Autoregression (VAR) model including the four variables in the following order: the first difference of log of Japanese industrial production, the first difference of log of the yen-dollar exchange rate, the first

difference of log of the won-dollar exchange rate and the first difference of log of Korean industrial production. We put the contemporaneously exogenous variable first, because Japanese industrial production and the yen-dollar rate are assumed to contemporaneously exogenous to Korean variables such as the won-dollar rate and Korean industrial production. This is a reasonable assumption in the sense that the effects of small open Korean economy on the Japanese economy are likely to be minimal within a month. On the other hand, we put the Japanese industrial production before the yen-dollar rate, following the idea that the real variables are determined in a sluggish real sector but the exchange rate is determined in a financial market (Kim and Roubini, 2001).⁸ We experiment with alternative ordering in Section 4. One lag is chosen based on Schwarz criteria.

Impulse Responses

We examine the impulse responses from the VAR model to examine the following. First, how do the won-dollar rate and industrial production in Korea react to innovations in the yen-dollar rate? Second, how persistent and strong are these effects? Third, is there any difference between the periods before and after the Asian currency crisis?

We analyze the response of the first difference in the log of the won-dollar rate within one standard deviation innovation of the first difference in the log of the yen-dollar rate before the 1997 Asian currency crisis in Figure 3A, using two standard error bands (95 percent probability bands). We obtain the following results. The first difference in the log of the won-dollar rate shows a significant rise after one month, but an insignificant rise after three months and almost no effect after six months.⁹ The point estimate shows that the impact effect is over 0.2 percent, which decreases to 0.01 percent in six months. On the other hand, Figure 4A shows the response of the won-dollar rate after the currency crisis. The won-dollar rate increases 1 percent on impact, 0.4 percent in the next month, then 0.2 percent, and finally converges to 0 percent in six months. From two months after the shock, the responses are not significantly different from zero based on 95 percent standard error band.

The won-dollar rate responses to a yen-dollar shock are substantially different in the two periods. The responses for the post-crisis period are far larger than for the pre-crisis

8 Note that the responses of the won-dollar rate and Korean industrial production are theoretically the same regardless of the ordering between the won-dollar rate and Korean industrial production. See Christiano, Eichenbaum, and Evans (1999).

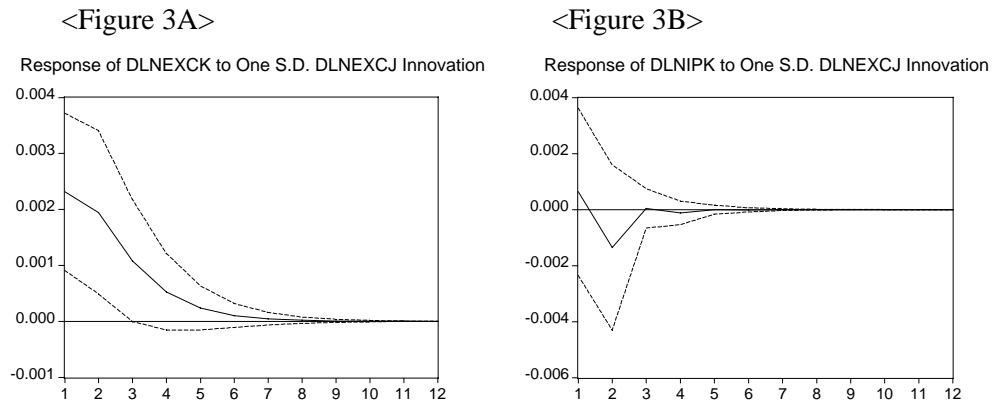
9 The 95-percent significance level is represented by the dotted line in the figure.

period; the point estimates of the impact effects are 1 percent for the post-crisis period but only 0.2 percent for the pre-crisis period. On the other hand, the persistence of the responses is lower for the post-crisis period than for the pre-crisis period. For the pre-crisis period, the response is statistically significant up to three months while the impact is statistically significant for the post-crisis period. Further, the shape of the responses shows lower persistence for the post-crisis period than for the pre-crisis period. To summarize, after the currency crisis, the won-dollar rate response become stronger and the speed of the response also accelerated.¹⁰

Next, we examine the responses of Korean industrial production. Figure 3B shows the response of the first difference in the log of the Korean industrial production to one standard deviation innovation of the first difference in the log of the yen-dollar rate before the 1997 Asian currency crisis, with two standard error bands. The results show that on impact, Korea's industrial production increased by 0.05 percent but decreased by 0.15 percent in the next month. However, the responses are not significant at the 95-percent level. On the other hand, Figure 4B shows the response of the first difference of log of Korean industrial production to one standard deviation innovation of the first difference in the log of yen-dollar rate after the 1997 Asian currency crisis. The point estimates show that Korean industrial production decreased by 0.2 percent on impact and further decreases by 0.4 percent in the next month. Although the responses are not significant at the 95-percent level, the response in the second month after the shock is significant at about the 90-percent level. The results indicate that during the pre-crisis period Korean industrial production responses are smaller with lower significance level but during the post-crisis period, they are larger with higher significance level.

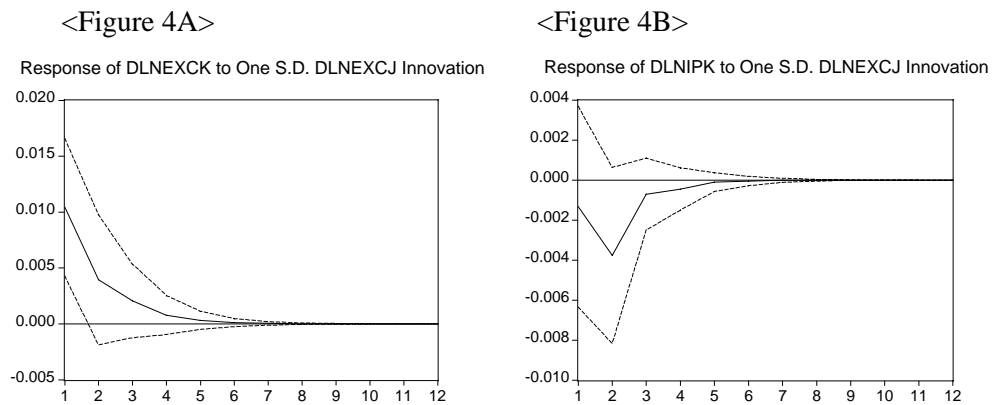
10 The different natures of shocks in the two periods may have caused the different responses. In this regard, we compare the responses of yen-dollar exchange rate to the yen-dollar shocks in the two periods. They are slightly different, but the difference is too small to explain the huge differences in the responses of won-dollar rate.

<Figure 3> VAR Impulse Response Analysis: (1990:01 - 1997:06)



Notes: 1) DLNEXCK: First Difference of Log Won-Dollar Exchange Rate
 2) DLNEXCJ: First Difference of Log Yen-Dollar Exchange Rate
 3) DLNIPK: First Difference of Log Industrial Production in Korea

<Figure 4> VAR Impulse Response Analysis: (1998:07 - 2002:12)



Notes: 1) DLNEXCK: First Difference of Log Won-Dollar Exchange Rate
 2) DLNEXCJ: First Difference of Log Yen-Dollar Exchange Rate
 3) DLNIPK: First Difference of Log Industrial Production in Korea

Variance Decomposition

Let us examine how much forecast error variance of each variable is explained by various shocks. Tables 4 and 5 report the variance decomposition of each variable. The yen-dollar exchange rate shocks explain 11.61 percent of the won-dollar rate variation on impact for the pre-crisis period but 19.58 percent for the post crisis period. The results for the longer horizons show a smaller difference between the two periods,

but still the role of yen-dollar shocks is larger in the post-crisis period than in the pre-crisis period. The yen-dollar shocks also explain Korean industrial production in the post-crisis more than in the pre-crisis period; the peak contribution is 1.03 percent for the pre-crisis period but 4.43 percent for the post crisis period. Overall, the contribution of the yen-dollar rate shocks to the won-dollar rate and Korean industrial production movements is larger in the post-crisis period than in the pre-crisis period, consistent with the results from the impulse responses analysis.

<Table 4> Variance Decomposition

- Won-Dollar Exchange Rate - (1990:01~1997:06)

Period	Standard Error	First Difference of Log of Industrial Production in Japan	First Difference of Log of Yen-Dollar Exchange Rate	First Difference of Log of Won-Dollar Exchange Rate	First Difference of Log of Industrial Production in Korea
1	0.01	0.10	11.61	88.29	0
3	0.01	0.11	18.46	81.41	0.02
6	0.01	0.11	18.94	80.92	0.03

- Industrial Production in Korea - (1990:01~1997:06)

Period	Stander Error	First Difference of Log of Industrial Production in Japan	First Difference of Log of Yen-Dollar Exchange Rate	First Difference of Log of Won-Dollar Exchange Rate	First Difference of Log of Industrial Production in Korea
1	0.01	0.03	0.21	2.85	96.91
3	0.01	0.64	1.03	3.35	94.99
6	0.01	0.69	1.03	3.35	94.93

<Table 5> Variance Decomposition

- Won-Dollar Exchange Rate - (1998:07~2002:12)					
Period	Standard Error	First Difference of Log of Industrial Production in Japan	First Difference of Log of Yen-Dollar Exchange Rate	First Difference of Log of Won-Dollar Exchange Rate	First Difference of Log of Industrial Production in Korea
1	0.02	0.10	19.58	80.32	0
3	0.02	0.16	20.68	75.60	3.55
6	0.02	0.17	20.76	75.44	3.64

- Industrial Production in Korea - (1998:07~2002:12)					
Period	Standard Error	First Difference of Log of Industrial Production in Japan	First Difference of Log of Yen-Dollar Exchange Rate	First Difference of Log of Won-Dollar Exchange Rate	First Difference of Log of Industrial Production in Korea
1	0.02	3.11	0.51	3.33	93.04
3	0.02	5.04	4.39	3.94	86.64
6	0.02	5.06	4.43	3.96	86.54

4. Robustness

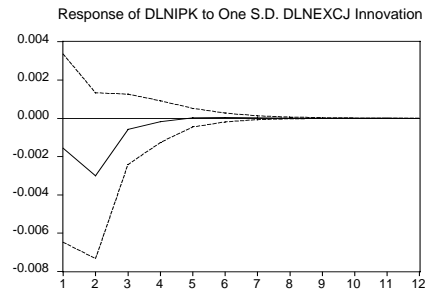
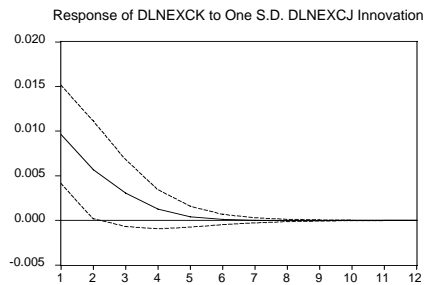
Alternative Orderings and Sample Periods

In this section, we examine the robustness of the empirical results for alternative orderings of variables and sample periods. First, we consider alternative post-crisis periods. In the basic experiment, the post-crisis period is deemed to start from July 1998, but the exact starting point and duration of the crisis may be controversial. We consider various starting points of the periods used in the experiments and the main results remain robust. Figure 5A shows the impulse responses results for the post-crisis period starting from September 1998 and November 1998, respectively. In addition, Table 6 shows the variance decomposition results for the post-crisis period starting from September 1998 and for the post-crisis period starting from November 1998. Although the exact quantitative results differ slightly, the main qualitative results are similar. In response to yen-dollar rate increases, won-dollar rate rises and Korean industrial production falls. These responses were larger in the post-crisis period than in the pre-crisis period. The contribution of yen-dollar shocks to won-dollar and Korean

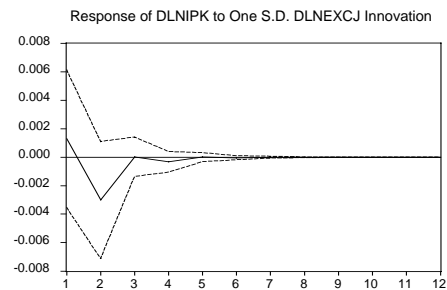
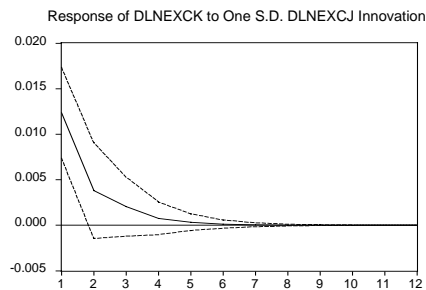
<Figure 5> VAR Impulse Response Analysis:

5A. Alternative Post-Crisis Periods

1. 1998:09 - 2002:12

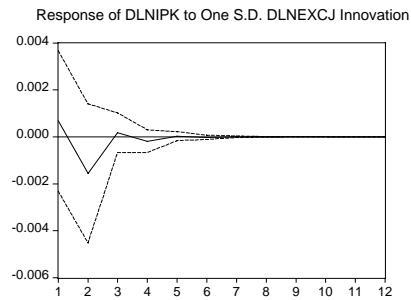
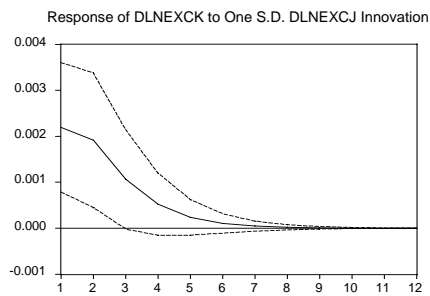


2. 1998:11 - 2002:12

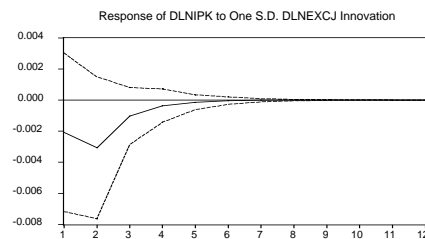
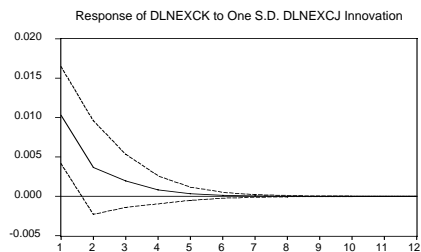


5B. Alternative Ordering

1. 1990:01 – 1997:06



2. 1998:07 - 2002:12



Notes: 1) DLNEXCK: First Difference of Log Won-Dollar Exchange Rate
 2) DLNEXCJ: First Difference of Log Yen-Dollar Exchange Rate
 3) DLNIPK: First Difference of Log Industrial Production in Korea

industrial production movements are larger in the post-crisis period than in the pre-crisis period.

Next, we consider an alternative ordering. From the basic model, we switch the ordering of Japanese industrial production and yen-dollar exchange rate since yen-dollar exchange rate might affect Japanese real economic conditions within a month. Therefore, we consider the ordering of {yen-dollar rate, Japanese industrial production, won-dollar rate, Korean industrial production}. The main results are quite robust with this alternative ordering. The results are reported in Figure 5B and Table 7.

<Table 6> Variance Decomposition: Alternative Post-Crisis Periods

Variables	Post Crisis Periods	Periods	First Difference of Log of Industrial Production in Japan	First Difference of Log of Yen-Dollar Exchange Rate	First Difference of Log of Won-Dollar Exchange Rate	First Difference of Log of Industrial Production in Korea
Won-Dollar Exchange Rate	1998:09~	1	0.00	21.44	78.56	0
		3	0.09	25.04	68.81	6.06
	1998:11~	1	0.05	40.12	59.82	0
		3	0.79	34.55	57.90	6.75
Industrial Production	1998:09~	1	4.96	0.76	0.07	94.21
		3	6.94	3.41	0.69	88.95
	1998:11~	1	4.40	0.56	3.08	91.96
		3	6.72	3.29	3.21	86.78

<Table 7> Variance Decomposition: Alternative Orderings

Variables	Sample Periods	Periods	First Difference of Log of Industrial Production in Japan	First Difference of Log of Yen-Dollar Exchange Rate	First Difference of Log of Won-Dollar Exchange Rate	First Difference of Log of Industrial Production in Korea
Won-Dollar Exchange Rate	1990:01~1997:06	1	10.43	1.28	88.29	0
		3	17.18	1.39	81.41	0.02
	1998:07~2002:12	1	19.09	0.59	80.32	0
		3	19.93	0.99	75.60	3.55
Industrial Production	1990:01~1997:06	1	0.23	0	2.85	96.91
		3	1.33	0.33	3.35	94.99
	1998:07~2002:12~	1	2.37	2.37	3.33	93.04
		3	5.46	5.46	3.94	86.64

Extended models

Next, we extended the basic four-variable model to the five-variable model in order to examine the robustness of the main results and to shed a light on the transmission mechanism that leads to our main findings. We also include the following variables in the model: capital account, trade balance, interest rate and CPI of Korea.¹¹

According to the results of a stability test on each variable, consumer price, interest rate and trade balance are not stable while capital account is. The Johansen test suggests that no co-integrating relations exist for the system that includes consumer price, but one co-integrating relation exists for the systems that include the interest rate or the trade balance.¹² Based on these tests, the consumer price is included in a difference form while the current account is included in a level form. On the other hand, for a system that includes the interest rate or the trade balance, a cointegrating relation is imposed on the model.

In the models including the current account or the consumer price index, the results on the responses of won-dollar rate and Korean industrial production in two periods do not differ greatly. In the models that include the interest rate or the trade balance, the results are quantitatively different, but the main conclusion still holds; the effects on the won-dollar rate are positive and stronger in the post-crisis period, and the effects on the Korean industrial production are negative and stronger in the post-crisis period. The results for the systems including capital account are reported in Figure 6. The variance decomposition results also show the robustness of the main conclusion.¹³

Finally, from the responses of the additional variable, we can infer transmission mechanism, although very limited. First, we cannot reject the possibility that a capital account worsening following a depreciation of the yen against the dollar is an important reason for the decrease in Korean industrial production in the post crisis period. Even though the estimates are not significant, we find a decrease in the capital account in response to an increase in the yen-dollar rate in the post crisis period (Figure 6B). Second, the decline in the relative competitiveness of Korean exporters against Japanese exporters due to yen-dollar rate increases does not seem to be the main reason for the decrease in the Korean industrial production in the post crisis period. The decline in the

11 Each variable is a variable of the small open economy, Korea, so it is reasonable to include each variable after Japanese variables. Again, note that the results do not depend on the exact ordering of Korean variables as long as we are interested in the shocks to a Japanese variable, that is, the yen-dollar rate.

12 The results are available from the authors upon request.

13 The results not reported are available from the authors upon request.

competitiveness would result in a decrease in the trade balance in response to a yen-dollar rate increase, but Korean trade balance actually increases, which seems to be due to the following won-dollar rate changes. To be consistent, the trade balance improves more in the post crisis period, when a larger increase in the won-dollar rate was observed.

5. Conclusion

According to our VAR analysis, a decline in the Korean industrial production in response to increases in the yen-dollar rate is not much significant during the pre-crisis period while it becomes more significant during the post-crisis period. The forecast error variance decomposition also confirms that the yen-dollar rate shocks account for only 1.03 percent of the industrial production in Korea at the peak during the pre-crisis period, while they account for 4.43 percent at the peak during the post-crisis period. These empirical results are rather surprising in the sense that a free floating exchange rate regime adopted since the crisis cannot insulate the Korean economy from external nominal shocks such as the yen-dollar exchange rate shocks. Since the crisis, the won-dollar exchange rate has moved more tightly with the yen-dollar exchange rate. Thus, the soft-peg exchange rate regime is no longer accountable for severe fluctuations of the industrial production. Then, why has the Korean economy become more vulnerable to the yen-dollar exchange rate shocks? This is a puzzle to be solved.

There are many potential reasons for the increasing influence of the yen-dollar rate on Korean economic activities. First, a more liberalized capital account in the post-crisis period may promote capital outflows from the Korean economy to the Japanese economy when the yen is weaker. Therefore, the negative effects of the yen-dollar rate can have on Korea's economic activities have become significant in the post-crisis period. Second, exchange rate policy changes toward a flexible exchange rate regime and a more liberalized capital account in the post crisis period, combined with the increasing competition between Korean and Japanese exporters in the world market, would result in a high degree of synchronization of the yen and won exchange rates in the post-crisis period. A larger increase in the won-dollar exchange rates during the post-crisis period implies that Korea's dollar debt will increase in terms of won and that the price of import materials, usually set in dollar terms, rises in terms of won. As recently emphasized in the third generation crisis models (for example, Krugman 1999, 2001; Miller and Stiglitz, 1999), the exchange rate depreciation (against the dollar) increases the dollar denominated debt, worsens the balance sheet of firms and has

serious negative effects on the economy. All these may strengthen the negative effect of a yen-dollar rate increase on Korean economic activities in the post crisis period.

If the two countries were symmetric in terms of economic size, monetary independence would work well under floating exchange rates, as pointed out by Frankel, Schmukler and Serven (2002).¹⁴ However, we should note that economic influence is more or less one-sided between Japan and Korea. In this regard, Japan may choose to set macroeconomic policies without considering its influence on neighboring countries, leading to serious repercussions in many East Asian countries. If monetary easing in Japan led to a weakening of the Japanese yen, many small emerging market economies in East Asia would be affected severely. In this regard, bilateral (Japan and Korea) or extended multilateral surveillance and policy consultation among East Asian countries would be the first step to coordinating a macroeconomic policy through peer pressure. Furthermore, East Asian countries may begin to examine the possibilities and desirability of cooperation and coordination in exchange rate policies. Although a full-fledged form of monetary integration is not viable at this stage, regional financial arrangements can be structured and managed in order to support a coordinated exchange rate mechanism.

14 According to Frankel, Schmukler and Serven (2002), two large industrial countries (Germany and Japan) appear to be the only ones that benefited from independent monetary policies in the 1990s. Interestingly, during the 1990s, interest rates in European countries of the DM-EMU zone have become virtually unresponsive to U.S. interest rates – but extremely sensitive to German interest rates. Thus, European countries have shifted from the U.S. monetary area to the DM-EMU monetary area, and the observed decline in the responsiveness of their interest rates to U.S. interest rates does not signify any increase in their monetary independence.

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