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Exchange Rate Co-movements and Business Cycle Synchronization between Japan and Korea

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Exchange Rate Co-movements and Business Cycle Synchronization between Japan and Korea

Sammo Kang, Yunjong Wang, and Deok Ryong Yoon
August 2002

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Empirical results show that while the response of Korean industrial production to changes in the yen-dollar rate is not significant pre-crisis, it becomes significant during the post-crisis period.

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They prepared the conference version of this paper for the ADB Institute workshop on Synchronized Recession and Policy Coordination in Asia (Tokyo, 8 April 2002).

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PREFACE

The ADB Institute aims to explore the most appropriate development paradigms for Asia composed of well-balanced combinations of the roles of markets, institutions, and governments in the post-crisis period.

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I trust that this series will provoke constructive discussions among policymakers as well as researchers about where Asian economies should go from the last crisis and recovery.

Masaru Yoshitomi
Dean
ADB Institute

ABSTRACT

Japan and the Republic of Korea (Korea) are close countries in terms of economic interaction and geography and important to the economic growth and development of the region. To quantify the impact of changes in the yen/dollar exchange rate and Japanese industrial production on the Korean economy before and after the East Asian financial crisis of 1997, the sample period is divided into two sub-periods and then the causal relationships are examined by using vector auto-regression analysis.

Our estimates show that while the response of Korean industrial production to changes in the yen/dollar exchange rate is not significant during the pre-crisis period, it becomes significant during the post-crisis period. The forecast error variance decomposition also confirms that 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 by Korea since the crisis cannot insulate its economy from external nominal shocks such as yen/dollar exchange rate volatility.

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Exchange Rate Co-movements and Business Cycle Synchronization between Japan and Korea[†]

Sammo Kang, Yunjong Wang, and Deok Ryong Yoon

1. Introduction

Economic integration in East Asia has been advancing rapidly, driven by growing intra-regional trade, increasing investment and financial integration. In the wake of recent discussions on regional and bilateral free-trade agreements as well as on emerging financial cooperation arrangements, this process is likely to deepen over time. Reflecting increasing trade and investment flows, business cycles across countries in the region are becoming more correlated.

Japan and the Republic of Korea (Korea) are close countries in terms of economic interaction and geography. However, they have never committed to fixing or stabilizing their bilateral exchange rate. Exchange rates in both countries are independently determined in their respective foreign exchange markets. Before the East Asian currency crisis in 1997, Korea maintained a managed floating exchange rate regime while Japan freely floated its currency. Under these differing systems, 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 always 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 real investment and speculative financial capital within and into East Asia were overly sensitive to 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 1989–1990 and again in 1996–1998 (Kwan, 2001). However, this phenomenon is mainly attributed to the pre-crisis de facto dollar peg exchange rate regime in East Asia. As the East Asian currency crisis vividly shows, soft peg currencies are highly vulnerable to volatility 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 similar to that of Japan and by more actively pursuing capital account liberalization. One interpretation of the movement to floating exchange rates is that it reflects the unwillingness of the Korean Government to maintain a de

[†] 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 thank Masaru Yoshitomi, Koichi Hamada, Heather Montgomery and Eisuke Sakakibara for their helpful comments.

facto dollar peg in the context of high capital mobility. It therefore represents an effort to restore some monetary autonomy in a world of high interdependence. It also increases the impact of domestic monetary policies, via the exchange rate, on real economic activity. Yet floating exchange rates do not completely insulate national economies from the rest of the world.

From a purely theoretical point of view, flexible exchange rates would reduce interdependence by promoting monetary independence. When the economy is hit by a disturbance, such as a shift in global demand away from the goods it produces (i.e., semi-conductors, steel and chemicals), the government could respond by means of monetary expansion and depreciation of the currency. 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).

Interdependence has nonetheless increased under the flexible exchange rate regime. If prices and wages in the domestic economy were fully flexible, then an increase in the monetary shock would indeed lead immediately to a proportional increase in the price level and exchange rate. In practice, the slow adjustment of domestic prices and wages and the rapid adjustment of the exchange rate to policy changes have meant that monetary and fiscal policy changes in one country affect the real exchange rate rapidly. The changes in the real exchange rate are quickly transmitted to foreign economies, affecting both the profitability of exports and the Consumer Price Index (CPI) as prices of imports change.

The purpose of this paper is to examine the dynamics of the exchange rates and business cycles between Japan and Korea. It divides the sample period into two distinct sub-periods: pre-crisis and post-crisis. Then we analyze the causal relationships between the exchange rates and industrial production of Japan and Korea in both periods. Our empirical results will help demonstrate the need for bilateral exchange rate coordination between Japan and Korea.

The paper is organized as follows. The next section describes the general trend of economic interdependence within East Asia, while Section 3 focuses on the interdependence between Korea and Japan. Section 4 reviews the influence of the Japanese economy on the Korean economy, with a special emphasis on an empirical analysis of exchange rates and business cycles between the two countries. The last section concludes the paper with a discussion of some policy implications.

2. Interdependence within East Asian Economies

As international openness to trade and capital flows fosters business cycle synchronization across countries, the following three factors can be considered (Loayza, Lopez and Ubide, 2001). First, interaction through trade and capital markets among countries may lead to co-movements of the business cycles by the rapid transmission of country-specific shocks to other countries (Frankel and Schmukler, 1996; Goldfajn and Valdes, 1997; Levy-Yeyati and Ubide, 2000). The co-movement in output can take the form of synchronization with some lags and leads, although the speed and extent of transmission vary. Second, the common shocks, those that affect all countries in a similar fashion, can cause commonality in aggregated output (Dellas, 1986; Fabrizio

and Lopez, 1996). Third, similarities in the economic structure of the countries will raise co-movement of output, if there are shocks specific to one sector of the economy (Bayoumi and Prasad, 1997; Costello, 1993; Marimon and Zilibotti, 1998).

With the ongoing process of globalization, the network of trade and capital flows among countries has become increasingly comprehensive and intricate, contributing to more rapid transmission of shocks from country to country. Thus, the East Asian economic crisis in 1997 had spillover effects on Brazil and Russia, while the global economic recession in 2001 was started by the contraction of the information technology (IT) industry in the United States. The co-movement of business cycles across countries—at least among Organisation for Economic Co-operation and Development (OECD) countries—is becoming a general phenomenon (Loayza, Lopez and Ubide, 2001). However, all countries do not share the same degree and speed of co-movement as these differ according to the intensity of economic integration and the transmission mechanisms.

Loayza, Lopez and Ubide (2001) analyze East Asian countries as a region, showing significant short-run and long-run co-movement of business cycles. This co-movement is based upon highly similar trade structures. According to Kawai and Takagi (2001), East Asia has a high share of intra-regional trade, which accounts for 45% of exports, 49% of imports and 47% of total trade in the period 1990–1998. Table 2-1 shows these relations clearly. Bayoumi and Mauro (1999) find that the degree of intra-regional trade in East Asia as a share of regional gross domestic product (GDP) is similar to that of the euro area.¹ Kawai and Takagi (2001) show that the composition of trade in East Asian countries is highly weighted towards manufacturing goods, which account for between 71% and 96% of total exports, with the average being four fifths of the total exports. The similarities in industrial structure among East Asian countries provide a strong basis for business cycle synchronization.

¹ According to Bayoumi and Mauro (1999), intra-Association of Southeast Asian Nations (ASEAN) exports and imports reached 11.8% and 11.7%, respectively, in 1998, while in the euro area, intra-regional exports account for 12.0% and imports 12.8%. Figures for intra-North American Free Trade Area (NAFTA) trade are lower—5.3% for exports and 5.4% for imports. Mercosur shows intra-regional exports of 2.1% and intra-regional imports of 2.3%.

Table 2-1. Regional Breakdown of East Asian Trade for 1990–1998 (Share of Total)

(Average for 1990-1998 as % share of total)

Trade with	ASEAN	Other EA	EA-14	EA-14 & Japan	Japan	US	EU	ROW
Trading Economies								
Brunei Darussalam	30.2	11.8	42.0	78.4	36.4	7.3	10.4	3.9
Cambodia	58.8	10.6	69.4	78.4	9.0	3.5	11.6	6.5
Indonesia	12.9	16.2	29.1	55.1	26.0	13.0	17.1	14.8
Lao PDR	55.3	7.6	62.9	74.0	11.1	1.2	8.5	16.3
Malaysia	24.0	13.6	37.7	56.6	19.0	17.9	14.6	10.8
Myanmar	34.8	27.8	62.6	71.3	8.7	3.3	8.7	16.6
Philippines	10.8	15.1	25.9	45.4	19.5	26.3	13.9	14.3
Singapore	23.5	15.5	39.1	53.1	14.1	17.9	13.9	15.1
Thailand	15.1	12.1	27.2	50.2	23.0	16.0	16.6	17.3
Viet Nam	24.8	23.0	47.8	64.1	16.3	1.4	11.0	23.5
PRC	6.6	32.4	39.0	57.1	18.1	13.5	13.5	15.9
Hong Kong, China	7.9	43.7	51.6	62.1	10.6	15.0	13.1	9.8
Korea, Rep. of	10.1	11.9	22.0	40.6	18.6	21.7	13.0	24.6
Taipei, China	10.8	15.6	26.5	45.7	19.2	24.2	15.0	15.1
ASEAN	19.9	14.7	34.7	53.8	19.1	16.9	14.8	14.5
EA-14	12.8	23.1	35.9	53.0	17.2	17.7	14.1	15.2
EA-14 & Japan	13.3	22.4	35.6	47.3	11.7	20.5	14.8	17.5

Notes: Other EA includes PRC; Hong Kong, China; Korea; and Taipei, China. EA-14 includes Association of Southeast Asian Nations (ASEAN) and other East Asian countries. ROW = the rest of the world.

Source: Kawai and Takagi (2001).

From a theoretical point of view, however, the effects of trade integration can lead to business cycle synchronization in either direction. For example, as pointed out by Eichengreen (1992) and Krugman (1993), if tighter trade integration boosts higher inter-industry trade resulting in higher specialization in industries, industry-specific shocks can lead to more idiosyncratic business cycle movements. On the other hand, if intra-industry trade accounts for most trade, then business cycles may become more similar across countries when countries trade more. In this regard, whether increased trade leads to more inter-industry trade or intra-industry trade has very different implications for cross-country business cycles. In the context of Japan-Korea trade, the effect of trade integration on business cycle coherence is theoretically ambiguous, and can only be resolved empirically. Thus, further study is necessary to find trends in the trade patterns

of the two countries and their relationship to business cycles. However, this important issue is somewhat beyond the scope of this paper.²

Trade linkages are not the only means of cross-border connectivity. Also at work is the transnational integration brought about by foreign direct investment (FDI). FDI binds the source country and destination country together with a common interest, which causes co-movements of the business cycles. East Asia shows high interconnectivity with respect to FDI. Table 2-2 shows the FDI inflows to East Asia in the period 1990–1998. Intra-regional FDI in East Asia accounts for about 51% of total FDI inflows. As the source of about 11% of total FDI in East Asia, Japan is the greatest investor followed by the United States, which accounts for 10%. About 9% of FDI inflows come from European countries.

Table 2-2. FDI Inflows to East Asia, 1990–1998

(US\$ millions; % of total)

Recipients Investors	ASEAN (a)	PRC	Korea	Taipei,China	Total
Japan	57,693 (19.2)	29,715 (5.5)	2,769 (10.5)	4,935 (22.7)	95,112 (10.7)
US	35,082 (11.7)	42,658 (7.9)	9,331 (35.3)	3,885 (17.8)	90,956 (10.3)
Europe (b)	40,375 (13.4)	27,311 (5.1)	8,935 (33.8)	2,484 (11.4)	79,105 (8.9)
ASEAN	27,493 (9.1)	33,421 (6.2)	3,271 (12.4)	1,108 (5.1)	65,293 (7.4)
Other East Asia (c)	46,731 (15.5)	336,132 (62.4)	551 (2.1)	1,571 (7.2)	384,985 (43.4)
Total, including others	301,074 (100.0)	538,477 (100.0)	26,422 (100.0)	21,778 (100.0)	887,751 (100.0)

Notes: (a) 1991–1998 for Brunei Darussalam and Viet Nam; 1992–1998 for the Philippines; and 1994–1998 for Cambodia.

(b) Estimated figures. These figures underestimate the actual volumes because some countries with small volumes are not included.

(c) Hong Kong, China; Korea; and Taipei,China only.

Source: Kawai and Takagi (2001).

In addition, increased financial market integration is leading to greater co-variation in asset prices across countries and, hence, may be responsible for more synchronized domestic demand. One indication that capital is now more mobile and financial markets, thus, are more integrated is the decreasing correlation between

² Frankel and Rose (1998) find a strong positive relationship between the degree of bilateral trade intensity and the cross-country bilateral correlation of business cycle activity by using a panel of 30 years of data from 20 industrialized countries.

savings and investments across countries, i.e., the tendency for the Feldstein-Horioka puzzle to fade. This tendency seems to be particularly marked among European Union (EU) countries where there has been little correlation between savings and investments over the past decade. Increased capital mobility should be associated with more internationally diversified portfolios, which again should increase co-variation of returns. However, a higher asset price correlation could also be the result of increasing synchronization of real economic activities across countries (Dalsgaard, Elmeskov and Park, 2002, p.18).

3. Economic Interdependence between Japan and Korea

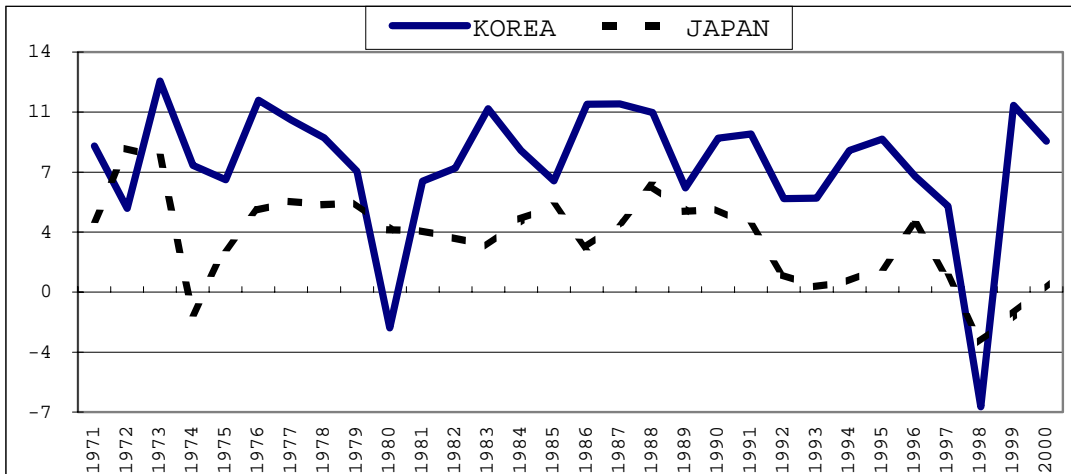
3.1. Co-movement of the Business Cycles

Studies on the correlation of East Asian business cycles point to a stronger relation between the economies of Japan and Korea than other countries. Bayoumi and Eichengreen (1996) find that the correlation of supply shocks in the region is especially high for two groups, with Japan and Korea in one group and Indonesia, Malaysia and Singapore in the other. Loayza, Lopez and Ubide (2001) examine common patterns in the aggregate demand and supply shocks with a different methodology. They find strong co-movements for two groups: Japan, Korea and Singapore make up one group and Indonesia, Malaysia and Thailand the other. These results indicate that there are two different business cycles in the region, even though East Asian countries show relatively strong co-movements as a whole.

Figure 3-1 shows the business cycles of Japan and Korea represented by the growth rate of GDP. The general trend of the cycles appears symmetric, especially in the 1990s, even though they do not move so closely together. However, Korea shows greater volatility in business cycles than Japan. According to our calculation, the standard deviation of Korea's GDP from 1971 to 2000 is 3.86 and that of Japan is 2.62. In the 1990s, the standard deviation of Korea increased to 4.75 while that of Japan's GDP fell to 2.28.³ The economic growth rate of Korea has been greater than that of Japan on average. For both countries, negative economic growth is exceptional. Korea experienced negative economic growth in 1980 due to a political crisis and in 1997 due to an economic crisis. Japan's economy grew negatively in 1974 because of the oil shock. It has been going through another period of negative economic growth since 1998 as a consequence of a long recession.

³ Nam and Pyo (1999) find that the standard deviation of Korea's GDP is much greater than that of Japan and the United States. They explain that the higher volatility results from turbulence in investment and trade.

Figure 3-1. Business Cycles of Japan and Korea



Following the negative economic growth in 1998, Korea has recovered rapidly and returned to its growth path while the prospects for Japan's economy remain bleak. Although the Korean economy is highly dependent upon Japan, Japan's influence on it is limited, because the influence of the United States is stronger. Japan is the second largest trading partner for Korea after the United States, and has greater importance as a source of imports rather than as a destination for Korean exports. In 2001, Japan was the destination for 11% of Korea's total exports. The United States maintains the largest share, with about 20% of the total, while the People's Republic of China (PRC) became the second largest destination for Korean exports in 2001, accounting for 12.1%. As an import market for Korea, Japan continues to enjoy the greatest share, accounting for 18.9% of Korea's total imports, while the United States and PRC account for 16% and 9.4%, respectively.

Korea's exports to Japan have continuously decreased during the 1990s. However, Korea was able to avoid the negative impact of the Japanese recession by expanding its exports to the United States, with the latter enjoying an economic boom in the 1990s. Through this process, Korea could mitigate the negative impact of the recession in Japan. Nonetheless, the interdependence of these two economies shows that Korea and Japan may be good candidates for establishing a common currency area, according to the theory of optimum currency area (Loayza, Lopez and Ubide, 2001, p.395).

3.2. Co-movement of Exchange Rates

The co-movement between the Korean won and Japanese yen vis-à-vis the US dollar provides these two economies with another basis for monetary cooperation.⁴ Figure 3-2 and Figure 3-3 show the movement of exchange rates of the won and yen

⁴ A stable exchange rate between currencies was one of the criteria for convergence in establishing European monetary integration.

against the US dollar since 1990. The rates of the two currencies moved in opposite directions from the early 1990s to mid-1990s. The yen appreciated continuously in this period, while the won experienced depreciation. However, there has been a clear trend of co-movement between the two currencies since the mid-1990s. Especially after Korea's economic crisis, the two currencies have fluctuated more tightly together.

Figure 3-2. Movements of Yen/Dollar and Won/Dollar Exchange Rates (1990–1997)

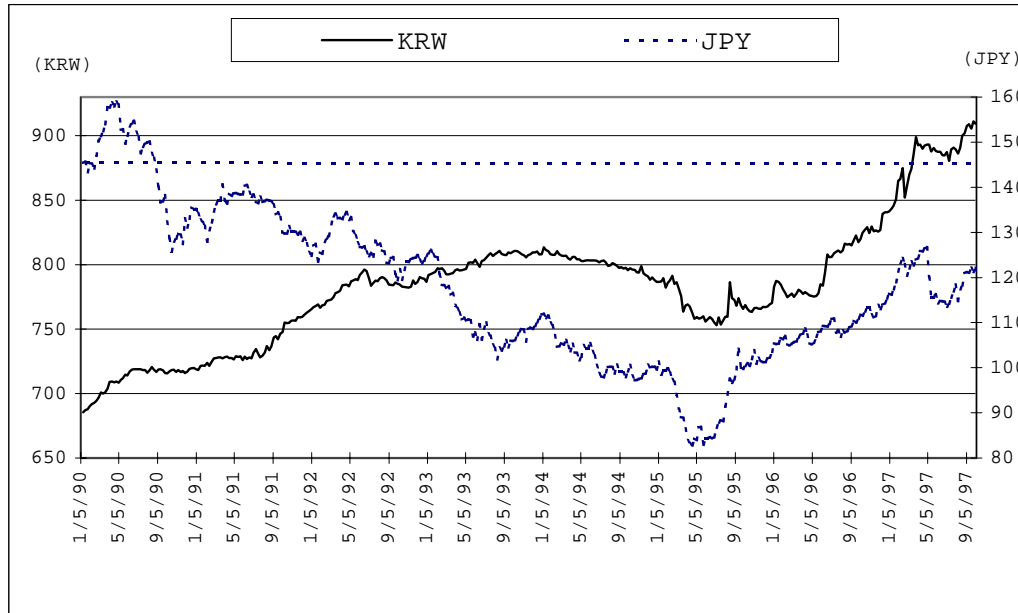
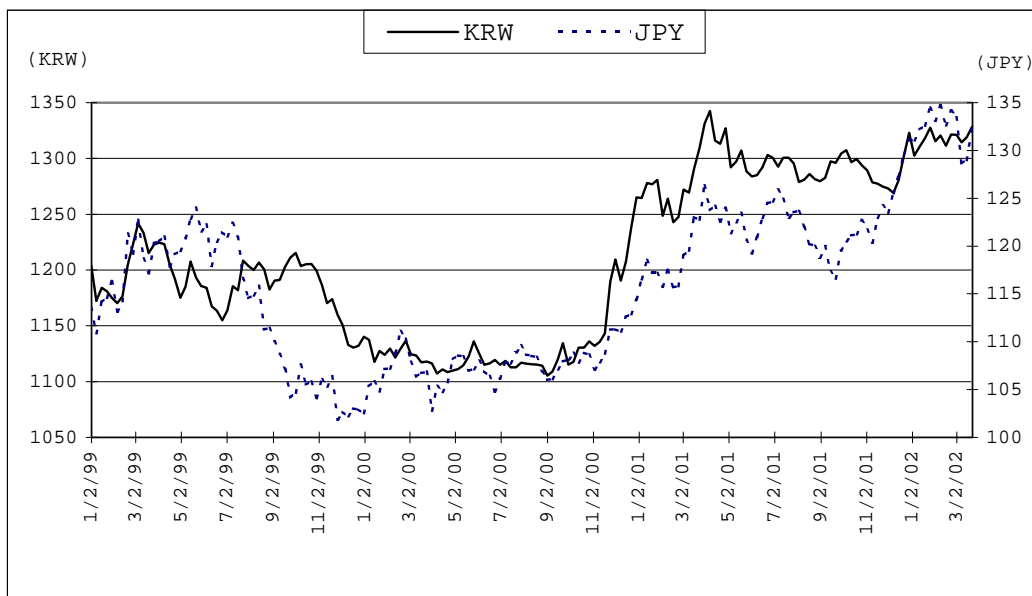


Figure 3-3. Movements of Yen/Dollar and Won/Dollar Exchange Rates (1999–present)



The Korean Government has a keen interest in the yen/dollar exchange rate movement. A weaker yen would affect Korea's economy through the following four channels:⁵ a decreasing capital inflow from Japan, a decline in export competitiveness against Japanese products, cheaper imports from Japan, and a cost reduction of yen-denominated foreign debt. The first two channels have negative impacts on the Korean economy, while the latter two can exert a positive influence. The most important among these four channels is the change in competitiveness. As already stated, the FDI from Japan accounts for just about 10% of the total FDI inflow for Korea. FDI from the United States and Europe is much more significant in Korea (see Table 2-2). Korea's foreign debt is denominated mainly in dollars and its exports have reacted sensitively to changes in the yen/dollar rate because the products of Japan and Korea compete tightly in the world market. Kwan (2001) finds that higher-income countries in Asia, such as the newly industrialized economies (NIEs), have a similar trade structure to Japan. This is the main reason that movements of the won have shadowed those of the yen. The exchange rates of these two currencies will move together as long as there is strong competition between Korea and Japan in the world market.

4. Empirical Tests

This section reviews the influence of the Japanese economy on the Korean economy, with a special emphasis on an empirical analysis of business cycles and exchange rates between the two countries. First, we will review the relationship between the Korean and Japanese business cycles. Japan is the largest exporter to Korea and second largest importer of Korean goods. When the Japanese economy booms, Korean exports to Japan increase, whereas Korean exports drop when the Japanese economy experiences a recession. Since Korea's export ratio to GDP is high, an increase in exports is essential to sustained economic growth.⁶ Therefore, it is reasonable to expect that, to some extent, Korea's business cycles will be positively correlated to Japan's.

Second, we will examine the relationship between the Korean and Japanese exchange rates. The 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 the third market to raise their market share. When this happens, Korean products lose price competitiveness, which leads to a decrease in Korean exports. As a result, the won tends to depreciate against the dollar. This phenomenon becomes conspicuous as competition with Japanese products intensifies. However, in East Asia the economic environment has changed significantly since the currency crisis in 1997. Therefore, we will divide our sample period into two periods—before the 1997 crisis and after—and employ empirical analyses to compare them.

⁵ See Kwan (2001) for a detailed explanation.

⁶ Korea's export ratio to GDP was 36% in 2001.

4.1. Some Basic Statistical Relations

Using IFS monthly data, we charted industrial production in Japan, industrial production in Korea, the yen/dollar exchange rate and won/dollar exchange rate.⁷ The period analyzed in this study is January 1990 to December 2001. We use monthly data to extend the time series as much as possible.⁸ First, when we examine Japanese and Korean industrial production (Table 4-1), we find the following results. From January 1990 to June 1997, the coefficient of correlation is -0.01, indicating no relationship. From January 1998 to December 2001, the coefficient of correlation is 0.46, implying that there is a positive correlation in industrial production between the two countries. The results of the Granger-Causality test show that before the 1997 currency crisis, Japan's industrial production has no Granger-Causal effect on Korea's; however, after this period, its Granger-Causality is significant at the 95% confidence level.⁹

Second, some basic statistical relations between the yen/dollar exchange rate and the won/dollar exchange rate are calculated (Table 4-2). From the period January 1990 to June 1997, the coefficient of correlation between the yen/dollar exchange rate and the won/dollar exchange rate recorded -0.53. In the early 1990s, the yen/dollar exchange rate continued to fall, while the won/dollar exchange rate was increasing. However, from 1995 to 1997, the won/dollar exchange rate moved in the same direction as the yen/dollar rate. Overall, the negative correlation of the early 1990s dominates the positive correlation of the mid-1990s (1995–1997). Therefore, the coefficient of correlation between the yen/dollar exchange rate and the won/dollar exchange rate is negative.¹⁰ From January 1998 to December 2001, the coefficient of correlation was 0.72, indicating that the won/dollar exchange rate moved more or less in the same direction. The results of a Granger-Causality test show that the yen/dollar exchange rate did not Granger-Cause the won/dollar exchange rate at the 95% significance level before the crisis but the Granger-Causality became significant after the crisis.¹¹

4.2. Stationary Test and VAR Impulse Response Analysis

Since ordinary least square (OLS) regression cannot be used when data are non-stationary, Augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests are used to verify whether the variables concerned are stationary or not (Table 4-3).¹² As a result,

⁷ Exchange rates are nominal variables, and industrial production in Japan and Korea are real variables.

⁸ The reason for using industrial production data as an output variable representing business cycles is that in the case of GDP, monthly data do not exist.

⁹ Causality in the sense defined by Granger (1969) and Sims (1980) is inferred when lagged values of a variable, say X_t , have explanatory power in a regression of a variable Y_t on lagged values of Y_t and X_t .

¹⁰ 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 with other periods. However, the data are insufficient to perform empirical tests for that period.

¹¹ When the Granger-Causality test is performed, the time lag is laid by two, four, and six months. However, the results do not show a significant difference.

¹² If a typical OLS regression analysis is carried out when time series data are non-stationary, the R square and t value will turn out high even when there is no correlation between the two variables and, thus, lead to a false conclusion that the relation is significant.

Table 4-1. Japanese and Korean Industrial Production

Periods	Correlation coefficient	Does Japanese industrial production “cause” Korean industrial production?
1990:01–1997:06	-0.01	No
1998:01–2001:12	0.46	Yes**

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 4-2. Yen/Dollar Exchange Rate and Won/Dollar Exchange Rate

Periods	Correlation coefficient	Does the yen/dollar exchange rate “cause” the won/dollar exchange rate?
1990:01–1997:06	-0.53	No
1998:01–2001:12	0.72	Yes**

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 4-3. Stationary Tests

	ADF unit root test	Phillips-Perron unit root test
Log value of Japanese industrial production	-2.05	-2.29
First difference of log of Japanese industrial production	-3.71**	-17.00**
Log of yen/dollar exchange rate	-2.26	-2.09
First difference of log of yen/dollar exchange rate	-6.18**	-8.16**
Log of won/dollar exchange rate	-0.94	-1.07
First difference of log of won/dollar exchange rate	-5.07**	-6.52**
Log of Korean industrial production	-0.40	-0.70
First difference of log of Korean industrial production	-6.44**	-15.83**

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

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

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

the tests fail to reject the null hypothesis in all time series under the 1% significance level. When these time series are differentiated, however, the null hypothesis is rejected and the variables are found to be stationary.

On the other hand, Table 4-4 shows the results of the Johansen test (1988). We cannot find any co-integrating relations from the co-integration test applied to industrial production in Japan, yen/dollar exchange rate, won/dollar exchange rate and industrial production in Korea. We use an unrestricted vector auto-regression (VAR) analysis to answer the following questions. First, how does industrial production in Korea or the won/dollar exchange rate react to innovations in Japan's industrial production or the yen/dollar exchange rate? Second, how persistent and strong are these effects? Third, is it possible to identify any changes between before and after the Asian currency crisis?

Table 4-4. Johansen Test

Likelihood ratio	5 Percent critical value	1 Percent critical value	Hypothesized number of cointegrating equations
46.13	47.21	54.46	None
20.82	29.68	35.65	At most 1
4.56	15.41	20.04	At most 2
0.04	3.76	6.65	At most 3

Note: * and ** denote statistical significance at the 5% and 1% levels, respectively.

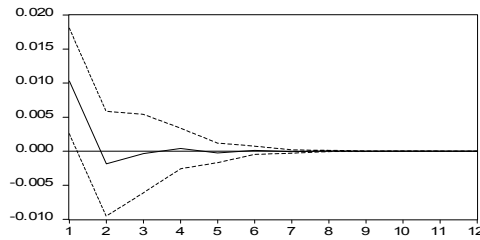
The following variables are ordered in our VARs: the first difference of log of Japanese industrial production, the first difference of log of the yen/dollar exchange rate, the first difference of log of the won/dollar exchange rate and the first difference of log of Korean industrial production. As is customary, in estimating the VARs, the different series were ordered in a way that takes into account their degree of exogeneity.¹³ When alternative orderings were tried, however, most of the results reported here were not altered. The lag length of the VARs is one month as chosen according to Schwarz criteria.

Figure 4-1-a shows the response of the first difference of log of Korean industrial production to one standard deviation innovation of the first difference of log of Japanese industrial production before the 1997 Asian currency crisis. The test results show that one month later, Korea's industrial production increases by 1%, but decreases by 0.2% after two months. However, after two months, the impulse response is not statistically significant. We analyze the response of the first difference of log of the won/dollar exchange rate to one standard deviation innovation of the first difference of log of the yen/dollar exchange rate before the 1997 Asian currency crisis in Figure 4-1-b. We obtain the following results: the first difference of log of the won/dollar exchange rate shows a significant rise after one month, but an insignificant rise after three months and almost no effect after six months. As shown in Figure 4-1-b, they range from 0.2% after one month to 0.01% after six months. Figure 4-1-c shows the response of the first difference of log of Korean industrial production to one standard deviation innovation

¹³ It is assumed that Japanese industrial production and the yen/dollar exchange rate are exogenous variables to Korea. Therefore, these variables are put ahead of the won/dollar exchange rate and industrial production in Korea.

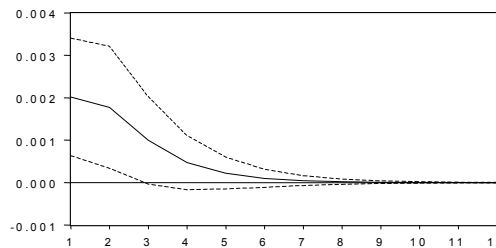
Figure 4-1. VAR Impulse Response Analysis: Before the Asian Currency Crisis

Figure 4-1-a Response of DLNIP_KR to One S.D. DLNIP_JP Innovation



Notes: 1) DLNIP_JP: First difference of log industrial production in Japan.
2) DLNIP_KR: First difference of log industrial production in Korea.

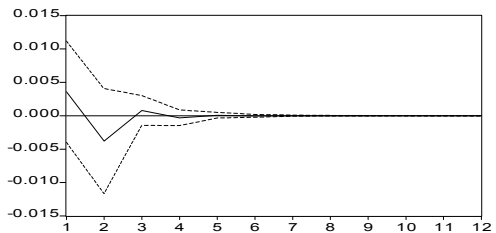
Figure 4-1-b Response of DLNKRW to One S.D. DLNJPY Innovation



Notes: 1) DLNKRW: First difference of log won/dollar exchange rate.
2) DLNJPY: First difference of log yen/dollar exchange rate.

of the first difference of log of the yen/dollar exchange rate before the 1997 Asian currency crisis. The test results show that one month later, Korea's industrial production increases by 0.4%, but decreases by 0.4% after two months. However, their statistical properties are insignificant.

Figure 4-1-c Response of DLNIP_KR to One S.D. DLNJPY Innovation

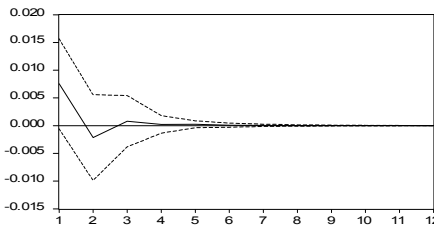


Notes: 1) DLNIP_KR: First difference of log industrial production in Korea.
2) DLNJPY: First difference of log yen/dollar exchange rate.

Figure 4-2-a indicates the effects of the changes in Japan's industrial production on Korea's industrial production after the crisis. In response to one standard deviation innovation of Japan's industrial production, Korea's industrial production increases by 0.8% in one month but decreases to 0.2% after two months and increases again to 0.1% after three months. However, it is not statistically significant. Compared to the pre-crisis period, the overall impulse response is also similar even during the post-crisis period but the statistical significance dwindles. Since the Japanese economy has been in a recession for more than 10 years, its influence seems to be steadily decreasing.

Figure 4-2. VAR Impulse Response Analysis: After the Asian Currency Crisis

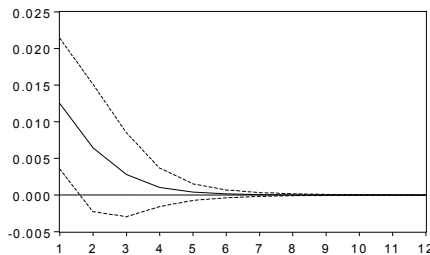
Figure 4-2-a Response of DLNIP_KR to One S.D. DLNIP_JP Innovation



Notes: 1) DLNIP_JP: First difference of log industrial production in Japan.
 2) DLNIP_KR: First difference of log industrial production in Korea.

Figure 4-2-b shows the response of the won/dollar exchange rate after the currency crisis. The won/dollar exchange rate increases 1.3% one month later, 0.6% two months later, 0.3% three months later and converges to 0% after seven months. From the two-month point, it does not have statistical significance. Comparing the impulse responses before and after the currency crisis, it increases from 0.2% to 1.3% in one month. These results show similar outcomes based on the correlation or Granger-Causality test analysis. Before the 1997 currency crisis, the response is statistically significant up to three months. However, it is not statistically significant two months after the currency crisis. In other words, after the currency crisis, the won/dollar exchange rate shows a strong correlation with the yen/dollar exchange rate and the speed of the response is also accelerated.

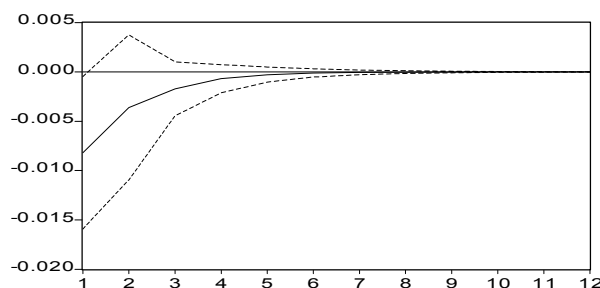
Figure 4-2-b Response of DLNKRW to One S.D. DLNJPY Innovation



Notes: 1) DLNKRW: First difference of log won/dollar exchange rate.
 2) DLNJPY: First difference of log yen/dollar exchange rate.

Figure 4-2-c shows the response of the first difference of log of Korean industrial production to one standard deviation innovation of the first difference of the log of the yen/dollar exchange rate after the 1997 Asian currency crisis. The test results show that one month later, Korea's industrial production significantly decreases by 0.8%, but insignificantly decreases by 0.4% after two months.

Figure 4-2-c Response of DLNIP_KR to One S.D. DLNJPY Innovation



Notes: 1) DLNJPY: First difference of log yen/dollar exchange rate.
2) DLNIP_KR: First difference of log industrial production in Korea.

4.3. Variance Decomposition

Let us examine how much forecast error variance in each variable is explained by its own and other lagged variables. Table 4-5 to Table 4-8 report the variance decomposition of each variable. The shocks to industrial production in Korea explain most of its own variation during the pre-crisis period, while the shocks to industrial production in Japan explain about 6.86% of industrial production variation in Korea at the peak. However, after the currency crisis, the shocks to industrial production in Japan explain about 8.88% of Korean industrial production variation at the peak. Similarly, yen/dollar exchange rate shocks explain about 15.29% of the won/dollar exchange rate variation at the peak. However, after the currency crisis, yen/dollar exchange rate shocks explain about 17.46% of the won/dollar exchange rate variation.

Table 4-5. Variance Decomposition (Industrial Production in Korea)

1990:01–1997:07					
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	0.04	7.43	0.62	0.30	91.6
2	0.04	6.86	1.50	1.22	90.4
3	0.04	6.81	1.54	1.21	90.4

Table 4-6. Variance Decomposition (Won/Dollar Exchange Rate)

1990:01–1997:07

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	2.94	9.11	87.96	0
2	0.01	4.39	13.78	81.51	0.32
3	0.01	4.35	15.29	80.05	0.31

Table 4-7. Variance Decomposition (Industrial Production in Korea)

1998:01–2001:06

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	0.03	8.97	8.67	4.17	78.18
2	0.03	8.88	9.76	8.19	73.17
3	0.03	8.85	10.03	8.37	72.74

Table 4-8. Variance Decomposition (Won/Dollar Exchange Rate)

1998:01–2001:06

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	0.03	1.86	15.19	82.94	0
2	0.03	2.33	16.95	79.87	0.84
3	0.03	2.38	17.46	79.33	0.84

Yen/dollar exchange rate shocks explain about 1.54% of industrial production variation in Korea at the peak during the pre-crisis period. However, after the currency crisis, yen/dollar exchange rate shocks explain about 10.03% of industrial production variation in Korea at the peak. That is to say, after the currency crisis, the influence of the yen/dollar exchange rate on industrial production in Korea increases.

5. Conclusion

Experience demonstrates that the growing interdependence in the world through trade and financial integration has heightened the need to engage in international economic policy coordination. A broad definition of spillover effects implies the transmission of shocks from one country to another through various channels. From a business cycle perspective, the degree of synchronization has implications for the appropriate policy response to cyclical developments, given that the domestic cycle may be either amplified or mitigated by impulses coming from abroad. This issue is of particular interest for a common currency area such as the euro zone, where it would be difficult for the European Central Bank to meet large cyclical divergences among countries with a common monetary response.

According to our VAR analysis, the response of Korean industrial production to the changes in the yen/dollar exchange rate is not significant during the pre-crisis period, but becomes significant during the post-crisis period. The forecast error variance decomposition also confirms that yen/dollar exchange rate shocks account for a variance of only 1.54% of the industrial production in Korea at the peak during the pre-crisis period, compared to 10.03% at the peak during the post-crisis period. These empirical results are 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 yen/dollar exchange rate volatility. 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 in industrial production. Then, why has the Korean economy become more vulnerable to yen/dollar exchange rate shocks? This is a puzzle to be resolved.

The VAR analysis is useful for identifying whether or not exchange rate or business cycle fluctuations are transmitted internationally. However, it is not an appropriate tool for answering questions as to how or why such transmission occurs. Certainly, it is a stimulating subject for further research to explore the transmission mechanism between Japan and Korea. A number of business cycle studies disentangle the source of shocks, different channels through trade and financial linkages, and efforts to coordinate macroeconomic policies in order to identify the factors in determining business cycle coherence. This important issue has not been addressed in this paper.

There are many potential reasons for the increasing influence of the yen/dollar exchange rate on the won/dollar exchange rate. Among them, changes in the bilateral exchange rate between Japan and Korea affect the competitiveness of similar products produced by Japanese and Korean exporters. Given the increasing competition between these two countries' exporters in world markets, fluctuations in the yen/dollar exchange rate have a significant effect on Korean trade. As Korea has adopted a floating exchange

rate regime since the crisis, the Korean won/dollar exchange rate has moved more sensitively to changes in the yen/dollar exchange rate.

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 the economic influence is more or less one-way between Japan and Korea. In this regard, if Japan devises macroeconomic policies without any consideration of their influence on its neighbors, serious repercussions could occur in many East Asian countries. If monetary easing in Japan weakened the yen, many small emerging market economies in East Asia would be affected severely. In this regard, bilateral (between Japan and Korea) or extended multilateral surveillance and policy consultation among East Asian countries would be a first step in coordinating macroeconomic policy through peer pressure. Further, 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 could be structured and managed in order to support a more coordinated exchange rate mechanism.

¹⁴ According to Frankel, Schmukler and Serven (2002), only Germany and Japan among industrial countries appear to have benefited from an independent monetary policy in the 1990s. Interestingly, during that decade, interest rates in European countries of the DM-EMU zone became virtually insensitive to US interest rates—but fully sensitive to German interest rates. Thus, European countries have shifted from the US monetary area to the DM-EMU monetary area, and the observed decline in the responsiveness of their interest rates to US interest rates does not signify any increase in their degree of monetary independence.

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