1992

Three Essays on International Linkages of the Korean Economy.

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Order Number 9301074

Three essays on international linkages of the Korean economy

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The Louisiana State University and Agricultural and Mechanical Col., 1992

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Ann Arbor, MI 48106

THREE ESSAYS ON INTERNATIONAL LINKAGES OF THE KOREAN ECONOMY

A Dissertation

submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

in

The Department of Economics

by
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May 1992

ACKNOWLEDGEMENTS

Since I began my dissertation research, I have been greatly indebted to my dissertation chairman, Professor Faik A. Koray. He gave me invaluable assistance and honest criticisms throughout the dissertation research. Above all, I am especially grateful to Dr. Koray for his good personality. He is always kind, accesible, and communicative to me whenever I need his assistance for the dissertation research as well as for personal matters. Once again, I would like to express my sincere appreciation for his time and efforts throughout the dissertation research.

I am also indebted to Dr. W.D. McMillin, Dr. T.R. Beard, Dr. W.P. Culbertson, and Dr. C. Mustafa for their helpful advice and comments on my dissertation.

I owe my greatest debt to my family who encouraged me at every difficult situation. Without the financial and spiritual support of my parents and my wife, completion of this dissertation would not have been possible. Finally, I express my special thanks to my son, Hyung Jin who made the day-to-day work on this dissertation enjoyable.

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ABSTRACT

This dissertation consists of three essays. The first essay investigates whether the long run version of purchasing power parity (PPP) holds between Korea and its two major trading partners - the U.S. and Japan. The PPP relationship is examined using cointegration tests, which are proper to see the departures from the long run equilibrium.

The second essay examines the empirical relationship between real exchange rates and interest rate differentials in the Korean-U.S. as well as the Korean-Japanese economies. This relationship is also examined using cointegration tests.

The third essay examines how foreign economic shocks affect the Korean economy and analyzes the channels through which they are transmitted. Also, the relative importance of domestic and foreign shocks on the dynamics of certain key macro variables is investigated. The techniques of vector autoregression (VAR) are employed to investigate the international transmission of economic disturbances. Each VAR system (that is, Korea-U.S. system and Korea-Japan system) contains variables for Korea and the U.S. or Korea and Japan, and uses monthly data from May 1973 to June 1990. The dynamic effects of foreign shocks on the Korean economy are evaluated by estimating variance decompositions (VDCs) and impulse response functions (IRFs).

The following three results emerge from the empirical findings of this dissertation. First, no evidence of

cointegration is found for any pair of prices and exchange rates between Korean and U.S. as well as Korean and Japanese economies. We might say that monetary models of exchange rate determination understate the role of real disturbances in the world economy. Second, the empirical findings about the relationship between real exchange rates and real interest rate differentials do not support the hypothesis of cointegration between these variables. This suggests that a variable (possibly the expected value of future real exchange rate) is omitted from the real exchange rate-interest rate differential relation. Third, empirical findings regarding the international transmission mechanism indicate that foreign shocks are important for the Korean economy during the sample period, though the channels of transmission differ.

Chapter 1

Introduction

1. Objective of the Dissertation

This dissertation consists of three essays. The first essay investigates whether the long run version of purchasing power parity (PPP) holds between Korea and its two major trading partners - the U.S. and Japan. The theory of PPP states that the change in the exchange rate between two countries is determined by the countries' relative price levels. This implies that the exchange rate and national price levels move together over time. If the PPP holds, there exists a long run equilibrium relationship between the variables examined. The PPP relationship is examined using cointegration tests.

The second essay examines the empirical relationship between real exchange rates and interest rate differentials in Korean-U.S. as well as Korean-Japanese economies. The empirical analysis is focused on investigating whether there exists a long run equilibrium relationship between these variables. Also, it explores the possibility that a single factor can account for the nonstationarity in both series. These relationships are also examined using cointegration tests.

The third essay examines how foreign economic shocks affect the Korean economy and the channels through which they are transmitted. Also, the relative importance of domestic and foreign shocks on the dynamics of certain key macro variables is investigated. As the Korean economy becomes more dependent on the rest of the world through international trade and capital movement, economic disturbances originating in foreign countries directly affect the Korean economy through various channels. Since the U.S. and Japan are the two largest trading partners of Korea, this study chooses the shocks originating in these countries to represent foreign disturbances.

The techniques of vector autoregression (VAR) are used to investigate the international transmission of economic disturbances. The reduced form nature of the VAR analysis makes it possible to investigate the dynamic behavior and interactions of the Korean-U.S. economy as well as the Korean-Japanese economy. For this matter, the VAR representation of a system of macroeconomic variables is estimated and analyzed. Each VAR system contains variables for Korea and the U.S. or Korea and Japan, and uses monthly data from May 1973 to June 1990.

2. Nature of the Korean Economy

What Korea has achieved in economic development in the past three decades is commonly considered as one of the most remarkable cases of economic accomplishment. During the past three decades, Korea has emerged as one of the fastest growing economies of the world and recognized to shift rapidly towards the economically advanced industrialized nation.

In 1962, when Korea launched its first five-year economic development plan, its exports were $55 million and its per capita GNP was only $81. Since 1962, the Korean economy underwent a drastic expansion in both quantity of economic volume and quality of economic structure.

During the last three decades, the real GNP and per capita GNP grew at an annual rate of 8.5% and 6.9%, respectively. The real growth rate of GNP in 1987 was 12.2%, the highest in the world. In 1990, it was 9.0%. The Korean government projects that Korean per capita GNP will reach the level of Great Britain by the year 2006.

Since Korea has a small domestic market, the government adopted an outward-looking policy of export promotion. This policy has been successfully pursued since the early 1960s. In fact, during this period, exports grew at an annual real average rate of 29.1% per year. Korea's exports reached $65 billion in 1990, compared with $55 million in 1962. The bulk of the export increase came from the nation's expanding manufacturing sector. The share of manufactured goods among all Korean exports was

more than 90% in 1990, compared with a mere 20% in 1962. Export volumes of manufactured goods increased more than four times in the 1960s, ten times in the 1970s, and again doubled during the 1980s. Actually, the growth of the manufacturing industries led the Korean economic growth during this period.

Various factors account for Korea's economic success over the last 30 years. The most important factor is the active government role in the preparation and execution of highly effective economic development plans and energetic exploration of export markets abroad. Other factors include the abundance of well-trained and highly educated manpower, proper use of domestic and foreign capital, and favorable international economic circumstances.

As a consequence of the outward-oriented development strategy (that is, the export-oriented industrialization policy), the Korean economy has become more open and interdependent with other countries. Since the early 1960s, Korea has been highly dependent on foreign trade, especially heavily dependent on trade with the U.S. and Japan. These two countries accounted for 49.1% of Korea's exports and 50.8% of Korea's imports in 1990.

As the Korean economy becomes more dependent on the rest of the world, it becomes subject to foreign economic disturbances more than ever. Therefore, this dissertation investigates the degree and channels to which foreign economic disturbances are transmitted to the Korean economy. The U.S. and Japanese economic shocks are chosen to represent foreign disturbances

because the Korean economy is heavily dependent on foreign trade and the U.S. and Japan are the two major trading partners of Korea.

3. Organization of the Dissertation

The dissertation is composed of five chapters. Its organization is as follows. Chapter 2 examines the PPP relationship using cointegration tests. The evidence of the 1920s, 1970s, and the recent period is presented in literature review. Then, unit roots and cointegration tests are done to investigate whether PPP holds between Korea and the U.S. as well as between Korea and Japan.

Chapter 3 analyzes the empirical relationship between the real exchange rates and interest rate differentials in Korean-U.S. and Korean-Japanese economies. Again, unit root and cointegration tests are performed to examine whether there exists any correspondence between the real exchange rates and interest rate differentials.

Chapter 4 investigates international transmission of economic disturbances. The degree and channels to which foreign economic disturbances (that is, the U.S. and Japanese economic disturbances) are transmitted to the Korean economy are examined. The theoretical and empirical literature is reviewed, and then the VAR methodology is discussed.

The recognition of the relative importance of foreign and domestic shocks and the transmission mechanism for the Korean economy is provided by variance decompositions and impulse response functions. Economic implications of empirical findings are also discussed.

Finally, chapter 5 summarizes and concludes this dissertation research.

Chapter 2

Cointegration Test of Purchasing Power Parity

1. Introduction

The theory of purchasing power parity (PPP) indicates that there exists a one-to-one proportionality between prices and the exchange rate, i.e., comovement between price levels and the exchange rate over time. This relationship can be expressed as follows:

$$X_t = a + b(P_{d,t} - P_{f,t}) + u_t \qquad (1)$$

where X_t = the logarithm of exchange rate between the currencies of the two countries, defined as units of domestic currency per unit of foreign currency,

$P_{d,t}$ = the logarithm of domestic price level,

$P_{f,t}$ = the logarithm of foreign price level.

The PPP theory states that b is equal to one if we do not consider transportation costs.

It is widely accepted that PPP does not hold in the short run. The view that there are substantial deviations from PPP in the short run has been supported by a number of studies.[1] As indicated by Frenkel (1981b), short run deviations from PPP occur because commodity prices are less volatile whereas the exchange rate responds quickly to changing situations. However, it remains controversial whether the long run version of PPP holds.

Gailliot (1970), Rush and Husted (1985), Corbae and Ouliaris (1988), and Kim (1990) showed that PPP holds in the long run. On the other hand, Pippenger (1982), Adler and Lehman (1983), Hakkio (1984), and Taylor (1988) found empirical results unfavorable to the PPP hypothesis as a long run equilibrium condition.

To my knowledge, no empirical study has been made regarding the PPP relationship among Korea, the U.S., and Japan. Since it is widely recognized that the Korean economy is closely tied with its two largest trading partners (the U.S. and Japan), it is very useful to examine whether such a relationship holds among these countries.

To investigate whether the long run version of PPP holds between Korea and her major trading partners, the U.S. and Japan, is the main objective of this study.

There is some debate on what price indexes should be used to test the PPP. In choosing the proper price index, two price

measures are commonly used: the wholesale price index (WPI) and the consumer price index (CPI).

Officer (1980) indicates that the use of the WPI biases the analysis in favor of the PPP because it is weighted towards tradeable commodities. In reality, the price index used to test PPP should be broadly based. This suggests that the CPI can be a better choice because it includes both traded and nontraded goods. However, this study uses both price indexes for empirical analysis. By using both indexes, we can check the robustness of the empirical results.

This study follows McNown and Wallace (1989) in testing the PPP relationship. The exchange rate is viewed as something linking the purchasing power of national monies. The domestic price level is expressed in terms of the exchange rate adjusted foreign price level. The PPP hypothesis is stated as follows.

$$P_{d,t} = c + d(P_{f,t} + X_t) + v_t \qquad (2)$$

where $(P_{f,t} + X_t)$ = the logarithm of the exchange rate adjusted foreign price level.

This study estimates the PPP relationship for the U.S. and Japan relative to Korea. Using monthly data obtained from International Financial Statistics tapes the sample period spans

May 1973 - June 1990. To test the long run PPP, the cointegration technique developed by Engle and Granger (1987) is employed.

In the context of this study, if PPP holds there exists a long run equilibrium relationship between $P_{d,t}$ and $(P_{f,t} + X_t)$. In this case, any short run deviations from PPP will be eliminated by equilibrating economic forces. In terms of equation (2), PPP exists if $P_{d,t}$ and $(P_{f,t} + X_t)$ are cointegrated when the cointegrating parameter, d, is equal to one.

2. Literature Review

Though the origins of PPP doctrine can be traced to the 19th century, it is thought that Cassel (1918) is the originator of the PPP theory. Actually, he first used the term "purchasing power parity" in his paper (1918), "Abnormal Deviations in International Exchanges". He placed the PPP within a systematic framework so that it became an operational theory and he tested the PPP empirically. Moreover, Cassel's work of PPP (theoretical analysis and empirical tests of PPP) is not quite different from his contemporaries.[2]

Since Cassel's work many authors examined PPP theory in different ways. In this section, we review the evidence on the PPP.

2.1 Evidence from the 1920s

The twentieth century evidenced two periods of floating exchange rates. One was in the 1920s and the other after 1973. This section reviews the empirical evidence on the PPP doctrine during the 1920s.

Frenkel (1978) examined the absolute and the relative versions of PPP for alternative price indexes using monthly data. According to Frenkel, absolute version of PPP can be written as:

$$\ln S_t = a + b(\ln P_t) - b^*(\ln P_t^*) \qquad (3)$$

where S_t = exchange rates,

P_t = domestic price indexes,

P_t^* = foreign price indexes.

Three exchange rates (Franc/Pound, Dollar/Pound, and Franc/Dollar) are employed in the empirical analysis. The relative version of PPP can be written as:

$$D(\ln S_t) = bD(\ln P_t) - b^*D(\ln P_t^*) \qquad (4)$$

where $D(\ln S_t) = \ln S_t - \ln S_{t-1}$.

He indicated that if PPP holds, $b = b^* = 1$. In other words, if PPP holds, the coefficients of domestic and foreign prices are both unity.[3] His empirical work also deals with the above three exchange rates.

On the whole, the empirical results show that the data are consistent with the absolute version of PPP. This implies that an equiproportionate change in domestic and foreign prices does not affect the exchange rate. The results corresponding to the relative version of PPP are stronger. In all cases, the hypothesis that $b = b^*$ cannot be rejected.

Davutyan and Pippenger (1985) investigated the relative version of PPP during the 1920s for the U.S. versus five other countries - France, Germany, England, Canada, and Japan. Their test equation is as follows:

$$\ln R_t = \alpha_0 + \alpha_1 \ln P_t \qquad (5)$$

where P_t = relative consumer or wholesale price indexes,
R_t = exchange rate.

They indicated that R^2 and the estimate of the regression coefficient α_1 support the PPP hypothesis. That is, R^2 is relatively high and the estimate of α_1 is fairly close to unity for most countries.

Edison (1985) tested the PPP hypothesis by estimating a general distributed lag equation relating the exchange rate to its own past and to current and past relative price levels. He indicated that the earlier studies of PPP employed the inadequate testing procedures, and outlined an alternative method of testing the PPP. Also, he pointed out that tests of the PPP hypothesis focused on two aspects: (1) symmetry between countries (that is, equalization of coefficients across countries), and (2) proportionality between relative prices and the exchange rate (that is, the long run coefficient on prices equals one).

In testing PPP, Edison introduced a general econometric specification, and this took the form of an autoregressive distributed lag model:

$$\ln E_t = \alpha_0 + \alpha_1 \ln P_t + \alpha_2 \ln P_{f,t} + \alpha_3 \ln P_{t-1} + \alpha_4 \ln P_{f,t-1} + \beta_1 \ln E_{t-1} + u_t \quad (6)$$

Edison noted that in most studies, three different forms are used in testing PPP: (a) the absolute form (log levels), (b) the relative form (first differences), and (c) the partial adjustment form (log levels with a lagged dependent variable). Therefore, he put the restrictions conforming to model (a), (b), or (c) on equation (6).

(1) $\alpha_3 = \alpha_4 = \beta_1 = 0$ to obtain (a),
(2) $\alpha_3 = -\alpha_1$, $\alpha_4 = -\alpha_2$, $\beta_1 = 1$ to obtain (b),
(3) $\alpha_3 = \alpha_4 = 0$ to obtain (c).

Edison duplicated Frenkel's study (1978) using this alternative modeling procedure so that the results could be compared. Three exchange rates (Dollar/Pound, Franc/Dollar, and Franc/Pound) were used to reassess the PPP hypothesis.

Empirical results show that the PPP does not hold for two of the three exchange rates studied (that is, Dollar/Pound and Franc/Pound). For the two basic conditions of PPP (that is, symmetry and proportionality), the proportionality restriction is not supported, whereas the symmetry restriction is not rejected for the samples examined.

Overall, the evidence accumulated for the 1920s shows that PPP is useful, relevant, and valid.

2.2 Evidence from the 1970s

This section reviews the empirical evidence from the 1970s.

Krugman (1978) examined the PPP relationship based on monthly data using wholesale prices and exchange rates during the 1970s (Mark/Dollar, Lira/Dollar, Swiss Franc/Dollar, and Pound/Dollar).

First, he did simple tests of PPP. He replicated a test of PPP which was employed by Frenkel (1978), that is, estimation of the following equation:

$$\ln S_t = a + b(\ln P_t - \ln P_t^*) \qquad (7)$$

He examined the PPP relationship by testing the hypothesis $b = 1$. Empirical results show that this simple statistical test leads to reject the PPP. Then he reestimated the above equation using Cochrane-Orcutt due to the substantial serial correlation of the errors, and tested the hypothesis $b = 1$ with an

asymptotic t-statistic. Again, the results showed that exchange rate movements were not closely related to price changes.

However, Krugman indicated that the simple regression test was not appropriate because simple regressions of exchange rates on prices were likely to produce coefficients which differed from one when neither exchange rates nor prices might be taken as exogenous. Therefore, he tested the PPP by methods which allowed for the endogeneity of both prices and exchange rates. He applied an instrumental variable technique to deal with the above problem. Then the above equation was estimated using a constant and a time trend as instruments. These results were found to be more favorable to the PPP than the results of simple regression tests.

Frenkel (1981a) analyzed the relationship between exchange rates and prices during the 1970s based on the experience of the Dollar/Pound, the Dollar/French Franc, and the Dollar/Mark exchange rates. He used the same equations employed to analyze the PPP during the 1920s and used monthly data from June 1973 to July 1979.

He indicated that in the 1970s, world capital markets became much more integrated and the role of real shocks and surprises became much more important than in the 1920s. In addition, he noted that in the 1970s, views about governmental role in conducting macroeconomic policy and the degree of exchange rate management were changed.[4]

Empirical findings showed that for the absolute version of PPP, the coefficients on the price ratios were not statistically significant in most cases. For the relative version of PPP the results showed that those coefficients were also insignificant. These results support that PPP performed poorly during the 1970s. Based on these findings, he suggested that during the 1970s, changes in exchange rates had little relationship with changes in national price levels and deviations from PPP were cumulative.

Hakkio (1984) examined the PPP theory using a time series-cross sectional estimation procedure. That is, by comparing single equation and multiple equation tests of PPP in the 1970s, Hakkio investigated PPP relationship in a multivariate content.

He simplified the PPP relationship as follows:

$$\ln(S_{it}) = \alpha_i + \beta_i \ln(P_t/P_{it}) + u_{it} \qquad (8)$$

where S_{it} = price of currency i in terms of dollars,

P_t = U.S. price index,

P_{it} = price index for country i (U.K., France, Canada, and Japan),

u_{it} = the error term.

Also, he notes that the error term, u_{it}, could be expressed as an AR(1) process because of serial correlation. u_{it} can be written as:

$$u_{it} = \pi_i u_{it-1} + e_{it} \tag{9}$$

where π_i = coefficient of the error term,
e_{it} = white noise disturbance term.

First, he estimated equation (8) using instrumental variables (a constant, time, and time squared) country by country. The single equation evidence on PPP showed that during the 1970s, β is significantly different from unity. The range of β estimates varied from -2.935 to 2.083. In all cases, π was less than one. He pointed out that the failure of PPP in the 1970s was not due to $\beta \neq 1$. The failure is due to PPP holding so poorly. That is, β estimates are very imprecise.

In addition, Hakkio estimated equation (8) for the four exchange rates simultaneously. He formed a simultaneous equation system of four equations and estimated the following equations using three stage least squares.

$$\ln(S_{it}) = \alpha_i(1-\pi_i) + \beta_i \ln(P_t/P_{it}) - \beta_i \pi_i \ln(P_{t-1}/P_{i,t-1}) + \pi_i \ln(S_{i,t-1}) + e_{it} \quad (10)$$

By using this multicurrency model, he improved the estimation of β. He tested the two hypotheses(that is, $\beta_i = \beta_j$, $\beta_i = \beta_j = 1$) using likelihood ratio statistic.

The results showed that the above hypothesis could not be rejected. He indicated that much of the failure of PPP in the 1970s came from ignoring the contemporaneous correlation of deviations from PPP. As he incorporated this aspect to the model specification, Hakkio improved estimates of β.[5] In a multivariate context, his study revealed that PPP hypothesis in the 1970s held quite well. Also, he presented several explanations for the failure of PPP during the 1970s.[6]

Junge (1984) investigated the short run behavior of prices and exchange rates for four countries (France, Germany, the U.K., and the U.S.) in addition to Switzerland in the 1970s. He used monthly data for the periods June 1973 to July 1980. For empirical testing, he expressed the PPP relationship as follows:

$$\ln(S_t) = a_1 + b_1 \ln(P_t/P_t^*) + u_t \quad (11)$$

$$D\ln(S_t) = a_2 + b_2 D\{\ln(P_t/P_t^*)\} + v_t \quad (12)$$

Equations (11) and (12) are both tests of the relative version of PPP, the first in terms of levels and the second in terms of first differences. According to PPP, the elasticities of the exchange rate with respect to the price ratio (that is, b_1 and b_2) are equal to unity. For the first differenced form of PPP, the constant term (a_2) is equal to zero. To see the short run movements in exchange rates and prices, Junge tested the equations over two equal subperiods (June 1973 to December 1976 and January 1977 to July 1980).

Empirical results showed that all coefficients were far away from PPP relationship and associated with large standard errors with the exception of the French franc for the period June 1973 to December 1976. This indicated that the performance of PPP in its standard versions (equations (11) and (12)) was poor in the short run.

Miller (1984) examined whether the poor performance of PPP could be attributed to uncertainty regarding the inflation rate due to the large variations in the relative prices experienced in the 1970s. His analysis was based on the experience of the quarterly Dollar/Pound, Dollar/Mark, and Dollar/French Franc exchange rates.

His test of the PPP relationship was based on the relative version of the PPP. With the addition of an error term, e_t, Miller expressed the relative version of PPP as follows:

$$DS_t = DP_t - DP_t^* + e_t \tag{13}$$

or

$$e_t = DS_t - DP_t + DP_t^* \tag{14}$$

where D = the log change of that variable prefixed

According to Miller, if PPP was to hold, the error term should be equal to zero. Therefore, for this sample period, he calculated the residual, e_t, and its sampling variance, $Var(e_t)$ and tested the hypothesis that e_t was equal to zero.

Empirical results showed that PPP performed very poorly for all three exchange rates. He indicated that this poor performance was supported by the fact that over this period the cumulative deviation from PPP was significantly different from zero for all three exchange rates. In the case of the Dollar/Pound rate, the cumulative deviation from PPP was 41.7%. For the Dollar/Mark and Dollar/French Franc, the deviations were 22.6% and 16.4% respectively. This indicated that the coefficient on the inflation differential in equation (13) was significantly different from unity. Therefore, the evidence was unsupportive of the notion that the poor performance of PPP could be attributed to uncertainty regarding the inflation rate.

Overall, the evidence from the 1970s shows that the exchange rate deviates from PPP and that these deviations are

substantial and persistent. It is usually recognized that the major reason for the failure of PPP hypothesis in the 1970s is the greater importance of real shocks to the economy in that period and the resulting changes in the relative price structure.

2.3 Recent Evidence on the Purchasing Power Parity

This section reviews the empirical evidence on the PPP theory employing some recent time series techniques.

Corbae and Ouliaris (1988) tested whether PPP holds as a long run equilibrium relation using the theory of cointegrated processes. The data employed is monthly averages of daily Canadian dollar, Japanese yen, French franc, German mark, Italian lira, and UK pound - US dollar exchange rates as well as monthly consumer price indexes for each country for the period July 1973 to September 1986.

They noted that if PPP holds, intercountry commodity arbitrage ensures that deviations from a linear combination of exchange rates and domestic and foreign price levels should be stationary. Since a cointegrated system requires a linear combination of the time series to be stationary, they pointed out that the PPP is testable using the cointegration theory.

To detect a unit root in exchange rate and price level, they employed two procedures: (1) the augmented Dickey-Fuller test, and (2) the Phillips-Perron Z_t statistic.[7] The null hypothesis in both tests was that b was equal to unity. The following equation was estimated.

$$\ln Y_t = a + b\ln Y_{t-1} + u_t \qquad (15)$$

where Y_t = exchange rates or consumer price indexes.

Empirical results showed that the null hypothesis of a unit root in the real exchange rate for all five countries considered could not be rejected. This indicated that the deviations from PPP had no tendency to converge to a long run equilibrium path. Thus, the long run version of PPP was rejected.

Enders (1988) investigated the importance and persistence of the observed deviations from PPP under alternative exchange rate regimes. Using monthly data, real exchange rates for three major US trading partners - Germany, Canada, and Japan - were constructed for the periods January 1960 - April 1971 (representing a period of fixed exchange rates) and January 1973 - November 1986 (representing a period of flexible exchange rates).

He considered the following econometric model of PPP:

$$Ex_tP_t^* - \alpha P_t = d_t \qquad (16)$$

where Ex_t = U.S. dollar price of foreign exchange in period t relative to a base year,

P_t = U.S. price index,

P_t^* = foreign price index,

d_t = a stochastic disturbance representing a deviation from PPP,

α = constant.

Enders noted that if α was equal to one and the d_t series was stationary, then PPP was to hold. He employed the cointegration technique to estimate the PPP relationship under fixed and flexible exchange rates.

Unit root tests indicated that PPP performed poorly on both exchange rate regimes. Tests for cointegration showed mixed evidence of PPP. Point estimates of real exchange rates were far from unity. However, cointegration of the U.S. and Japanese price levels during the Bretton Woods period was strongly supported and cointegration of the U.S. and Canadian price levels after 1973 was weakly supported. Based on these findings,

Enders suggests that PPP performed equally well, or equally poorly, in both exchange rate regimes.

Taylor (1988) investigated whether the long run PPP among five major exchange rates (German mark, UK pound, French franc, Canadian dollar, and Japanese yen) held by using econometric techniques based on cointegration tests. The empirical analysis was done using monthly data on nominal exchange rates and relative manufacturing prices for June 1973 through December 1985. He expressed the PPP relationship as follows:

$$C_t \equiv E_t - P_t \qquad (17)$$

where E_t = logarithm of the nominal exchange rate,
P_t = the ratio of logarithm of the domestic to the foreign price level,
C_t = logarithm of the real exchange rate (i.e., short run deviations from PPP).

He noted that if E_t was equal to P_t and C_t represents a zero-mean stationary process, long run PPP holds.

The empirical results showed that the PPP was inappropriate as a long run equilibrium condition. The analysis did not lead to the rejection of the hypothesis of noncointegration of the

exchange rates and relative prices for any of the five nations studied. This indicated that exchange rates and relative prices would tend to drift apart without bound instead of reaching a stable, long run proportionality.

McNown and Wallace (1989) examined the time series properties of the PPP relation for four high inflation countries (Argentina, Brazil, Chile, and Israel). They employed the cointegration technique to test the PPP relationship among these countries, and indicated that the cointegration technique was proper to examine the departures from long run equilibrium. Using monthly data, they tested cointegration for both consumer and wholesale price indices. The estimation period was from August 1972 to June 1986. They expressed PPP relationship as follows:

$$\ln P_{d,t} = a + b(\ln X_t + \ln P_{f,t}) + v_t, \qquad (18)$$

Where X_t = exchange rate measure as the number of units of domestic currency required to purchase a unit of foreign currency.

They pointed out that if the residuals of equation (18) (v_t) were stationary, cointegration existed. Thus, they tested the

hypothesis of a unit root in the residual series with both Dickey-Fuller and augmented Dickey-Fuller statistics. For augmented regressions, differences at lags one through twelve were included. Then the test of cointegration was applied to equation (18).

The empirical evidence showed that the residuals from the WPI cointegrating regressions in Chile, Argentina, and Israel were stationary and those from the CPI regressions were not stationary. Therefore, the evidence supported the cointegration of WPI pairs, but do not support any CPI pair. This result differs substantially from other studies, which typically found little support for PPP.

Layton and Stark (1990) investigated whether there was any long run equilibrium in existence over time between the U.S. inflation rate and the effective exchange-rate-adjusted inflation rate of its major trading partners (Canada, Germany, France, Italy, Japan, and the United Kingdom). This PPP relationship was examined by cointegration technique using monthly data spanning the period January 1963 to December 1987. They suggested that in testing for equilibrium, cointegration technique was proper because the time series were usually nonstationary. They expressed the empirical version of PPP as follows:

$$P_f = \pi(P_i/E_i)w_i = P_{us} \tag{19}$$

where P_f = effective exchange-rate-adjusted foreign price index,

P_i = price index of trading partner i,

E_i = exchange rate i defined as units of currency i per U.S. dollar,

w_i = weight given to country i, $\Sigma w_i = 1$,

P_{us} = U.S. price index.

If P_f and P_{us} were nonstationary, the cointegration regression

$$\ln P_{us} = a + b(\ln P_f) + u_t \tag{20}$$

could be estimated by ordinary least squares. In testing PPP, they chose CPI as the proper price measure because it covered both traded and nontraded goods sectors.

First, they did stationarity tests of the series and found that P_f and P_{us} were nonstationary. Then they estimated the cointegrating regression of equation (20). The empirical results showed that there was little support for the cointegration of the U.S. inflation rate and an effective exchange-rate-adjusted inflation series computed from the six major trading partners.

Kim (1990) applied cointegration analysis to examine the long run bilateral exchange rate - price relationship between the U.S. and each of the following five countries: Canada, France, Italy, Japan, and the United Kingdom. In addition, using annual data he tested whether the choice of the price index matters by considering two of the most popular price indexes in PPP analysis - the wholesale price index (1900-1987 period) and the consumer price index (1914-1987 period). Kim expressed the PPP relationship as follows:

$$\ln S_t = \theta_0 + \theta_1 \ln P_t + u_t \tag{21}$$

where S_t = nominal exchange rate,

P_t = the ratio of the U.S. WPI to a foreign WPI or the corresponding ratio for the CPI.

He employed the Phillips-Perron Z_t statistic to test for the existence of unit roots in the stochastic process of exchange rates and price ratios, and then estimated the cointegrating regression of equation (21).

Empirical findings showed that the nominal exchange rate was cointegrated with both the WPI-ratio and the CPI-ratio, except for the Canadian dollar. The Canadian dollar was not

cointegrated with both price indices. For the Japanese yen and the UK pound, cointegration was found for the WPI-ratio but not for the CPI-ratio. Therefore, the long run PPP was generally supported in his study.

The previous tests of PPP (mostly the tests for the 1920s and 1970s) neglected stationarity in the levels of exchange rates, consumer price index, and wholesale price index. This invalidated the use of conventional methods of hypothesis testing. In contrast, most recent studies tested whether PPP holds using the cointegration technique. Thus, this study also uses the cointegration technique in examining the PPP relationship.

3. Testing for Unit Roots and Cointegration

3.1 Unit Root Tests

The statistical tests of the unit root hypothesis are very important because these tests can help economists to evaluate the nature of nonstationarity in economic time series. Particularly, these tests are useful in determining whether the trend is stochastic through the presence of a unit root.

To test for unit root, three tests are applied in this study: the Dickey-Fuller(DF) test, the augmented Dickey-Fuller(ADF) test, and the Phillips-Perron test.

Test 1. Dickey-Fuller Test

Tests for unit roots are conducted on the individual time series variables $P_{d,t}$ and $(P_{f,t} + X_t)$ using the following equations. Prior to testing for cointegration, it should be checked that $P_{d,t}$ and $(P_{f,t} + X_t)$ are individually not stationary, because cointegration is a test for equilibrium between nonstationary time series.

$$DP_{d,t} = \alpha + \beta P_{d,t-1} + e_t \qquad (22)$$

$$D(P_{f,t} + X_t) = \Gamma + \theta(P_{f,t-1} + X_{t-1}) + \mu_t \qquad (23)$$

Where $P_{d,t}$ = the logarithm of domestic price level,

$(P_{f,t} + X_t)$ = the logarithm of the exchange rate adjusted foreign price level,

$DP_{d,t} = P_{d,t} - P_{d,t-1}$,

$D(P_{f,t} + X_t) = (P_{f,t} + X_t) - (P_{f,t-1} + X_{t-1})$.

The null hypothesis of a unit root (that is, $\beta = \theta = 0$) is tested using the tabulated test statistics in Fuller (1976). Rejection of a unit root implies that the individual series is stationary. Critical values for this test are reported in Fuller (1976).

Test 2. Augmented Dickey-Fuller Test

The augmented DF test gives more dynamics into the Dickey-Fuller regression. These tests are conducted on $P_{d,t}$ and $(P_{f,t} + X_t)$ using equations (22) and (23) with lagged augmentation terms.[8] Though the Dickey-Fuller procedure was originally developed for autoregressive representation of known order, as noted by Said and Dickey (1984), it is still valid asymptotically for unknown orders. The following equations are estimated.

$$DP_{d,t} = A + BP_{d,t-1} + \Sigma_{i=1}^{p} C_i DP_{d,t-i} + E_t \qquad (24)$$

$$D(P_{f,t} + X_t) = F + G(P_{f,t-1} + X_{t-1}) + \Sigma_{i=1}^{p} H_i D(P_{f,t-i} + X_{t-i}) + I_t \qquad (25)$$

The Dickey-Fuller (DF) test is conducted with no lagged differences in equations (22) and (23), and the augmented Dickey-Fuller (ADF) test is done with lagged differences as shown by equations (24) and (25). The null hypothesis of a unit root (that is, B = G = 0) is tested using the test statistics in Fuller (1976). Critical values for these tests are reported in Fuller (1976).

Test 3. Phillips- Perron Test

Phillips (1987) and Phillips and Perron (1988) developed new tests to detect the presence of unit roots in time series. Their approach is nonparametric with respect to nuisance parameters.

This test has the advantage of being based on a nonparametric correction to account for serial correlation and heterogeneously distributed innovations in the data. In this respect, the Phillips-Perron test gives an alternative to the Dickey-Fuller and augmented Dickey-Fuller tests.

The Phillips-Perron test is applicable to a wide range of time series models which include a unit root. It also considers the case where drift and drift and time trend are included in the specification so that it can be used to make distinctions

between unit root nonstationarity and stationarity about a deterministic trend.

To allow this case in regression tests for unit roots is very important because in many cases with economic time series, the main alternative to the presence of a unit root is a deterministic linear time trend.

Essentially two regression specifications are considered. These specifications are estimated by OLS.

$$Y_t = \mu^* + \alpha^* Y_{t-1} + u_t^* \tag{26}$$

$$Y_t = \hat{\mu} + \hat{\beta}(t-T/2) + \hat{\alpha} Y_{t-1} + \hat{u}_t \tag{27}$$

Where $Y_t = P_{d,t}$ or $(P_{f,t} + X_t)$,

T = sample size,

t = regression t statistic,

(μ^*, α^*) and $(\hat{\mu}, \hat{\beta}, \hat{\alpha})$ = the conventional least-squares regression coefficients.

As defined by Phillips and Perron (1988), the regression t statistic is denoted as follows:

$$t_{\alpha^*} = (\alpha^* - \alpha)\{\Sigma(Y_{t-1} - \overline{Y}_{-1})^2\}^{1/2}/s^*,$$

$$t_{\mu^*} = (\mu^* - \mu)\{\Sigma(Y_{t-1} - Y_{-1})^2/\Sigma Y^2{}_{t-1}\}^{1/2}/s^*,$$

$$t_{\hat{\mu}} = (\hat{\mu} - \mu)/(\hat{s}^2 c_1)^{1/2},$$

$$t_{\hat{\beta}} = (\hat{\beta} - \beta)/(\hat{s}^2 c_2)^{1/2},$$

$$t_{\hat{\alpha}} = (\hat{\alpha} - \alpha)/(\hat{s}^2 c_3)^{1/2},$$

Where s^* = standard error of equation (26)

$\hat{s}$ = standard error of equation (27)

c_i = the ith diagonal element of the matrix $(X'X)^{-1}$

X = (Tx3) matrix of explanatory variables in equation (27)

$\overline{Y}_{-1} = T^{-1}\Sigma Y_{t-1}$

T-tests under the null hypothesis of a unit root (i.e., the null hypothesis that $\alpha = 1$ in the above equations) are performed. The test statistics in Fuller (1976) are used to check the significance level. Also, tests of joint hypothesis are performed using the transformation of F-tests from the above equations. Three F-tests are specified and allow for the possible presence of drift and trend in the regression. These F-tests are equivalent to the Φ_1, Φ_2, and Φ_3 tests indicated in Dickey and Fuller (1981).

Phillips and Perron (1988) defined Z statistics as transformations of conventional test statistics from equations (26) and (27). The Z statistics correct the conventional regression statistics (regression t and F statistics) so that they allow for the effects of serially correlated and heterogeneously distributed innovations. Therefore, the standard errors of equations (26) and (27) (s^* and $\hat{s}$) in the conventional t ratios are replaced by the general standard error estimates σ^*_{Tl} and $\hat{\sigma}_{Tl}$.

These general standard error estimates are used to weight the original statistics to account for the correlation in the residuals. According to Phillips and Perron (1988) these weight variance estimates are defined as follows:

$$\sigma^{*2}_{Tl} = T^{-1}\Sigma_{t=1}^{T} u^{*2}_t + 2T^{-1}\Sigma_{s=1}^{l} W_{sl}\Sigma_{t=s+1}^{T} u^*_t u^*_{t-s}$$

$$\hat{\sigma}^2_{Tl} = T^{-1}\Sigma_{t=1}^{T} \hat{u}^2_t + 2T^{-1}\Sigma_{s=1}^{l} W_{sl}\Sigma_{t=s+1}^{T} \hat{u}_t \hat{u}_{t-s}$$

where $W_{sl} = 1 - s/(l+1)$,

l = lag parameter.

Each Z statistic contains a correction term whose magnitude depends on the difference between the general standard error estimates and the standard errors of regression equations (26) and (27) (i.e., $\sigma^{*2}_{Tl} - s^{*2}$ and $\hat{\sigma}^2_{Tl} - \hat{s}^2$). These differences

capture the effects of serial correlation and the transformations from the conventional test statistics to the Z statistics aim to remove these effects asymptotically.[9]

$Z(\Phi_1)$ is based on an F-test under the null hypothesis H_o: $(\mu,\alpha) = (0,1)$ in regression equation (26). $Z(\Phi_2)$ is based on an F-test under the null hypothesis H_o: $(\mu, \beta, \alpha) = (0, 0, 1)$ in regression equation (27). And $Z(\Phi_3)$ is based on an F-test under the null hypothesis H_o: $(\mu, \beta, \alpha) = (\mu, 0, 1)$ (i.e., the null hypothesis of the series having a unit root with drift against the alternative hypothesis of the series being stationary around a nonzero trend) in regression equation (27). The test statistics in Dickey and Fuller (1981) are used to test these null hypotheses.[10]

Equation (26) including a constant term can be used for the presence of the nonzero mean in the data series. However, if the series have significant drift, the distributions of the tests for a unit root are influenced. In that case, equation (27) has to be used.

The testing procedure follows Perron (1988). At first, the test statistics $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_3)$ are estimated from equation (27). $Z(\alpha)$ and $Z(t_\alpha)$ are based on an F-test under the null hypothesis H_o: $\alpha = 1$. If these tests reject the null hypothesis that the series have a unit root, we do not have to test more. However, if these tests do not reject the null hypothesis, then we have to estimate the test statistic $Z(\Phi_2)$. If the above tests indicate that the null hypothesis of a unit root cannot be rejected, the tests $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_1)$ are

taken from equation (26). If the results from $Z(\alpha)$, $Z(t_\alpha)$, $Z(\Phi_3)$, and $Z(\Phi_2)$ suggest the null hypothesis cannot be rejected, this implies that the drift term is zero and the tests applied have low power compared with tests based on regression equation (26).

Also, this study presents the results of unit root test for lags 1, 3, 6, and 12 in order to check the sensitivity of the results to various values of lag.

For all the time series this study takes the natural logarithms and performs the unit root tests on the levels and first differences of the series.

3.2 Cointegration Tests

The concept of cointegration was first introduced by Granger (1983) and later treated more comprehensively by Engle and Granger (1987). They established the statistical notion of cointegration of time series, which corresponds to the theoretical concept of a long run equilibrium relationship between economic time series.

If a nonstationary time series, X_t, has a stationary representation after differencing d times, X_t is said to be integrated of order d, denoted $X_t \sim I(d)$. For a pair of time series to be cointegrated, they should be integrated of the same

order. If both X_t and Y_t are I(d) then the linear combination

$$Z_t = X_t - \alpha Y_t$$

will generally be I(d).

However, if some linear combination of the two time series appears to be I(0), then cointegration exists. For example, if two nonstationary time series (X_t and Y_t) turn out to be stationary in some linear combination, then X_t and Y_t are said to be cointegrated.

Particularly, the theory of cointegration is very useful to examine the long run relationship existing between two (or more) nonstationary economic time series. Cointegration provides statistical background to long run equilibrium. The economic time series (X_t and Y_t) are said to be in equilibrium if some linear combination of these two variables represents a stationary process.

The purpose of this study is to perform the PPP test using the cointegration technique. The analysis involves an empirical examination of whether there exists any long run equilibrium relationship over time between the Korean price level and the exchange-rate-adjusted price level of its major trading partners (the U.S. and Japan).

These time series are usually nonstationary stochastic processes. Therefore, cointegration tests are particularly appropriate in testing for equilibrium relations.

If equation (2) shows a cointegrating relation, PPP holds as a long run equilibrium relation. Namely, proof of cointegration indicates a long run equilibrium relation. Equation (2) is estimated using ordinary least squares (OLS). Engle and Granger (1987) noted that OLS provides consistent estimators of this relation for a sufficiently large sample.

For cointegration, three tests are applied in this study: the Cointegrating-Regression Durbin Watson test (CRDW), the Dickey-Fuller test (DF), and the augmented Dickey-Fuller test (ADF).

Test 1. Cointegrating Regression Durbin Watson Test(CRDW)

The Durbin Watson statistic is employed to see if the residuals are stationary. The null hypothesis is that the CRDW statistic is equal to zero (i.e., noncointegration between the time series). If the residuals are nonstationary, the CRDW statistic will approach zero and thus the tests indicate cointegration of the time series if the CRDW statistic is large.

The CRDW statistic is obtained by estimating equation (2). Although the CRDW statistic is calculated in the same manner as a standard DW statistic, this test has critical values which

differ significantly from conventional values due to the null hypothesis of a unit root in the variables concerned. The critical values based on Engle and Yoo (1987) are 0.29, 0.20, and 0.16 for the 1%, 5%, and 10% significance levels, respectively for sample size 200.

Test 2. Dickey-Fuller Test

The residual series of equation (2) is used to examine whether it is stationary. If it appears to be stationary, cointegration of the time series is suggested. The following regression equation is estimated.

$$D\hat{v}_t = g\hat{v}_{t-1} + e_t \tag{28}$$

where $\hat{v}_t$ = the error term of equation (2),

$D\hat{v}_t = \hat{v}_t - \hat{v}_{t-1}$.

The coefficient of $\hat{v}_{t-1}$ is tested to check whether it is statistically significantly less than zero. If g turns out to be statistically significantly less than zero, the two series are cointegrated.

Test 3. <u>Augmented Dickey-Fuller Test</u>

Equation (28) with lagged difference term

$$D\hat{v}_t = g\hat{v}_{t-1} + \Sigma_{i=1}^{p} h_i D\hat{v}_{t-i} + e_t \qquad (29)$$

is estimated. The coefficient of $\hat{v}_{t-1}$ is tested to examine whether it is significantly less than zero. If it is significantly less than zero, the two variables are cointegrated.

The above tests are used to check the residuals from equation (2) for a unit root. If these tests reject a unit root, it indicates that the residuals of equation (2) are stationary. Then equation (2) shows a cointegrating relation of the time series involved.

Finally, for the robustness of the results, this cointegrating equation is reestimated by interchanging two variables in equation (2).

4. Empirical Results

Unit roots and cointegration were tested using monthly data spanning the period 1973:5 to 1990:6. The estimation period is from 1974:10 to 1990:6. In all cases, the tests are performed on the logarithms of the original series. In the augmented regressions differences at lags one to fourteen were included. In addition, tests were applied to the renormalized forms of equation (2) with dependent and independent variables interchanged.

Tables 1, 2, and 3 present the results for unit roots. Table 1 displays the calculated t-statistics for Dickey-Fuller and augmented Dickey-Fuller unit root tests of each series. Tables 2 and 3 shows the computed t-statistics for Phillips-Perron unit root test on the log levels and first differences of each series.

The tests reported in Table 1 for unit roots show each series to be nonstationary over the sample period. The hypothesis of unit roots cannot be rejected at the 5% level and at the 1% level in all cases.

The test strategy of Phillips-Perron unit root tests adopted in this study is to start with equation (27). If the null hypothesis of a unit root can be rejected, we do not have to proceed further. If we cannot reject the null hypothesis, we take $Z(\Phi_2)$ test to check whether the null hypothesis of zero

drifts can be rejected. If the null hypothesis of zero drift cannot be rejected, $Z(\Phi_1)$ test is taken from equation (26).

Table (2) shows that for the U.S. and Japanese wholesale prices the null hypothesis of a unit root cannot be rejected for the tests $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_3)$. For these series, the empirical results are insignificant at the 5% level for any value of lag. However, the Korean wholesale prices have significant $Z(\Phi_3)$ statistics even at lag 12 at the 5% significance level.

For the consumer prices, table (2) shows that the null hypothesis of a unit root cannot be rejected. Actually, none of the test results are significant at the 5% level for any value of lag with the exception of Korean consumer price index which has significant $Z(\Phi_3)$ statistics at lags 1, 3, and 6 at the 5% level.

From table (3) we can find that all test statistics are significant at the 5% level for any value of lag. Namely, Korean, Japanese, and the U.S. wholesale and consumer price indexes reach the 5% significance level at any value of lag.

Overall, the results of unit root tests demonstrate that all series are I(1).[11] This implies that first differencing is required to produce stationary time series in doing regression analysis.

The strong support that each series is nonstationary provides the need for the examination of equilibrium relations with the cointegration tests.

Table 4 presents no evidence in support of the hypothesis of cointegration. It shows that both wholesale price index and the exchange-rate-adjusted wholesale price index are not cointegrated in both systems. For the consumer prices, the same is true.

Table 5 shows the test result of cointegrating regressions. The CRDW statistic indicates that the null hypothesis of noncointegration between the series cannot be rejected in all cases. The residuals from the cointegrating regressions appear to be nonstationary in all cases presented in Table 5.

Both nonaugmented and augmented Dickey-Fuller tests do not support cointegration. The nonaugmented and augmented Dickey-Fuller tests are insignificant at the 5% and 1% level for the Korean-US and the Korean-Japanese wholesale prices over the sample period. The consumer prices tell the same story.

When dependent and independent variables are interchanged, cointegration is also rejected at the 5% and 1% level for both consumer and wholesale prices, even though for the rejection of cointegration the renormalized regressions are somewhat weaker in wholesale prices and somewhat stronger in consumer prices.

The nonexistence of evidence of an equilibrium relation is also supported by the point estimates of the coefficients of cointegration in cointegrating regressions. In all cases except the renormalized equation of Korean wholesale prices and the U.S. exchange-rate-adjusted wholesale prices, the coefficients of cointegration are statistically different from one. The

discrepancies from a value of one are considered to be inconsistent with PPP.

5. Conclusions

This study tested the PPP to examine whether price levels and the exchange-rate-adjusted price levels between Korea and the U.S. as well as Korea and Japan form a cointegrated system.

Cointegration tests are performed to check whether there exists any long run equilibrium relation between Korean prices and the exchange-rate-adjusted price levels of its major trading partners (the U.S. and Japan). For empirical study, two price measures were used - the wholesale price index and the consumer price index. The main results of this study are not affected by the price index chosen.

Empirical evidence is not favorable to the PPP. No evidence of cointegration is found for any pair of prices for the Korea-U.S. system as well as the Korea-Japan system

Since cointegration is interpreted as evidence of a long run equilibrium relation, then the findings of this study suggest that prices and exchange rates may diverge even in the long run. From this empirical evidence we can say that simple monetary models of the exchange rate, and even Dornbusch's

(1976) overshooting model, understate the role of real disturbances in the world economy.[12]

It is not quite clear what factor or factors (possibly changes in relative prices, technology, and tastes, etc.) are driving this result. One possible reason is that real disturbances in the world economy dominated exchange rate movements during the sample period.[13]

Endnotes

1. Among economists, it is widely believed that PPP does not provide an explanation of short run movements of the exchange rate. See, for example, Frenkel (1981), Junge (1984), and Dornbusch (1985).

2. Cassel (1922) pointed out that factors of deviations from PPP are changes in relative prices due to structural change, expectations, changes in taste and in technology, and speculation.

3. The validity of this restriction ($b = b^* = 1$) is tested using an F-test. In testing PPP, three alternative price indexes are used (wholesale price index, material price index, and food price index).

4. According to his empirical results, during this periods, the average absolute monthly percentage change of the exchange rates studied were about double that of the corresponding wholesale and consumer price indexes. Frenkel suggests that government should adopt more stable and predictable patterns of polices to reduce excessive variations in exchange rates.

5. Actually, β is closer to 1.0 and becomes more precise.

6. He suggested several reasons why the PPP did not hold very well in the 1970s. The first reason was that deviations from PPP existed due to real shocks to the system in a world of imperfect substitution between domestic and foreign goods. The second reason was the inefficiency of most tests of PPP. The third reason was a question of the proper testing procedure. Many studies find that the exchange rate empirically follows a random walk. As noted by Hakkio (1984), in that case the standard test of PPP is invalid, because that test for a random walk is not very powerful.

7. They indicate that the augmented Dickey-Fuller test accounts for heterogeneously distributed errors by including lagged innovation sequences in the fitted regression, whereas the Phillips and Perron procedure accounts for nonindependent and identically distributed processes using a nonparametric adjustment to the standard Dickey-Fuller procedure.

8. Said and Dickey (1984) indicate that the ADF test is proper for economic time series including unknown orders of autoregressive and moving average components.

9. For the definition of Z statistic, see Phillips and Perron (1988).

10. Z statistics are asymptotically equivalent to the corresponding Dickey-Fuller test statistics. Therefore, critical values from Dickey-Fuller (1981) can be used to test the null hypotheses.

11. The possibility that the series could be I(2) was also investigated by employing Dickey-Fuller test. The empirical findings rejected the hypothesis that the series were I(2).

12. Dornbusch (1976) formalized a monetary model of the exchange rate in which consumer prices adjust very slowly relative to the speed of adjustment in the foreign exchange market. Within this framework, he pointed out that an unanticipated change in the money supply leads to exchange rate overshooting because consumer prices cannot move immediately to reflect the money supply change.

13. Mussa (1982) notes that the real exchange rate has to adjust to the real shock to the economy, and this will require movements in the exchange rate and domestic and foreign price levels, then there will be deviations from PPP.

Chapter 3

Empirical Analysis of Real Exchange Rate - Interest Rate Differentials

1. Introduction

This study investigates the empirical relationship between real exchange rates and interest rate differentials in the Korea-U.S. as well as in the Korea-Japan over the periods 1973:5 - 1990:6. The exchange rates empolyed here are won per dollar and won per yen.

Our motivation is two-fold. First, it is well known that the current system of capital markets is highly integrated among countries. Given the highly integrated system of capital markets, long run real interest rate differentials appear to be stationary. If we find that long run real interest rate differentials are nonstationary, this indicates that Korean-U.S. and Korean-Japanese capital markets are not highly integrated. Second, most theories of exchange rate determination, such as monetary models of exchange rate determination, rational expectations models, or portfolio balance models forecast the exchange rate poorly. This makes it worthwhile to trace the instability or misspecification of the empirical exchange rate

equations to their building blocks. One of these building blocks is the uncovered interest rate parity condition which implies that assets denominated in different currencies are viewed by international investors as perfect substitutes in portfolios. The uncovered interest rate parity condition states that the real exchange rate is equal to the real interest rate differentials. It has been argued that despite the failure of most exchange rate models, there is a strong relationship between real exchange rates and real interest rate differentials. Shafer and Loopesko (1983) discuss the theoretical models in which there is a relationship between real exchange rates and real interest rate differentials.[1] Therefore, it is important to know whether there is a strong correspondence between these two variables. If there exists a long run equilibrium relationship between real exchange rates and real interest rate differentials, we can say that these models can be useful in forecasting the Korean exchange rate.

The existence of a long run relationship between real exchange rates and real interest rate differentials is investigated using the cointegration technique. This econometric technique is proper to examine the relationship between two nonstationary time series since it provides statistical background to long run equilibrium. It is also useful to detect the possibility that the nonstationarity in both series can be explained by a single factor. Therefore, cointegration technique forms the basis of the test.

In this study, the real exchange rate (Q) can be defined as follows:

$$\ln Q_t \equiv \ln S_t + \ln P^*_t - \ln P_t \qquad (30)$$

where ln = natural logarithm,

S = nominal exchange rate (in this study, domestic currency (Korean won) per foreign currency unit (U.S. dollar or Japanese yen)),

P = domestic currency price of the domestically produced good,

P^* = foreign currency price of the foreign good.

Also, the real interest rate (R) can be expressed as follows:

$$R_t \equiv r_t - (\ln E_t P_{t+1} - \ln P_t) \qquad (31)$$

where R_t = real interest rate at time t,

r_t = nominal interest rate at time t,

E_t = the time-t expectations operator,

$(\ln E_t P_{t+1} - \ln P_t)$ = the expected change rate of the price level.

For empirical study, the ex post realized price level is used as a proxy for its expected value.

Tests for cointegration of real exchange rates and real interest rate differentials are based on the following regression:

$$\ln Q_t = \alpha + \beta(R_t - R^*_t) + e_t \qquad (32)$$

where R^*_t = real interest rate of the foreign country (in this study, the U.S. and Japan).

Section 2 presents the testing procedure for unit roots and cointegration. The empirical results are given in section 3, and section 4 concludes this study.

2. Testing for Unit Root and Cointegration

The statistical tests of the unit root hypothesis have been applied by a number of economists to evaluate whether economic time series are stationary. As noted by Nelson and Plosser (1982), many macroeconomic time series have first-order unit roots. This implies that first differencing of variables is needed to achieve stationarity.

This section describes several tests regarding unit root and cointegration employed in this study.

2.1 Unit Root Tests

For unit roots, three tests are performed in this study. These tests are the nonaugmented Dickey-Fuller (DF) test, the augmented Dickey-Fuller (ADF) test, and the Phillips-Perron test. For unit root tests, the conventional t-tables are not proper. We can use the results of Dickey and Fuller (1979) and the tabulated distribution in Fuller (1976). The critical values for this ratio for the 1% and 5% significance level are -3.46 and -2.88, respectively.

Test 1. Dickey-Fuller Test

Tests for unit roots are conducted on the real exchange rates and real interest rate differentials using the following equations.

$$D(\ln Q_t) = a + b(\ln Q_{t-1}) + e_t \qquad (33)$$

$$D(R_t - R^*_t) = c + d(R_{t-1} - R^*_{t-1}) + \mu_t \qquad (34)$$

where $D(\ln Q_t) = \ln Q_t - \ln Q_{t-1}$,

$D(R_t - R^*_t) = (R_t - R^*_t) - (R_{t-1} - R^*_{t-1})$.

Since cointegration is a test for equilibrium relation between nonstationary time series, it should be checked whether the logarithms of real exchange rates and the levels of real interest rate differentials are not stationary.

The Dickey-Fuller test checks whether the null hypothesis that $\ln Q_t$ and $(R_t - R^*_t)$ are stationary is accepted. If we cannot reject a unit root, then the individual time series, $\ln Q_t$ and $(R_t - R^*_t)$, are nonstationary. The null hypothesis cannot be

rejected if we find negative and statistically significant coefficients on $\ln Q_{t-1}$ and $(R_{t-1} - R^*_{t-1})$.

Test 2. Augmented Dickey-Fuller Test

This test is performed on $\ln Q_t$ and $(R_t - R^*_t)$ using equations (33) and (34) with lagged augmentation terms. That is, the following equations are used to perform the augmented DF test.

$$D(\ln Q_t) = A + B(\ln Q_{t-1}) + \Sigma_{i=1}^{p} C_i D(\ln Q_{t-1}) + E_t \qquad (35)$$

$$D(R_t - R^*_t) = F + G(R_{t-1} - R^*_{t-1}) + \Sigma_{i=1}^{p} H_i D(R_{t-i} - R^*_{t-i}) + I_t \qquad (36)$$

For empirical testing, p is set at fourteen. Critical values for this test are based on Fuller (1976).

Test 3. Phillips-Perron Test

The Phillips-Perron test can be an alternative to the Dickey-fuller and augmented Dickey-Fuller tests, because it accounts for serial correlation and heterogeneously distributed innovations in the time series.

This study considers two regression equations estimated by ordinary least squares.

$$Y_t = \mu^* + \alpha^* Y_{t-1} + u_t^* \tag{37}$$

$$Y_t = \hat{\mu} + \hat{\beta}(t - T/2) + \hat{\alpha} Y_{t-1} + \hat{u}_t \tag{38}$$

where Y_t = logarithm of real exchange rates($\ln Q_t$) or level of real interest rate differentials ($R_t - R^*_t$),

T = sample size,

t = regression t statistic,

(μ^*, α^*) and ($\hat{\mu}$, $\hat{\beta}$, $\hat{\alpha}$) = the least-squares regression coefficients.

For the regression t statistic, Phillips and Perron (1988) denote it as follows:

$$t_{\alpha^*} = (\alpha^* - \alpha)\{\Sigma(Y_{t-1} - \overline{Y}_{-1})^2\}^{1/2}/s^*$$

$$t_{\mu^*} = (\mu^* - \mu)\{\Sigma(Y_{t-1} - Y_{-1})^2/\Sigma Y^2_{t-1}\}^{1/2}/s^*$$

$$t_{\hat{\mu}} = (\hat{\mu} - \mu)/(\hat{s}^2 c_1)^{1/2}$$

$$t_{\hat{\beta}} = (\hat{\beta} - \beta)/(\hat{s}^2 c_2)^{1/2}$$

$$t_{\hat{\alpha}} = (\hat{\alpha} - \alpha)/(\hat{s}^2 c_3)^{1/2}$$

where s^* = standard error of equation (37)

$\hat{s}$ = standard error of equation (38)

c_i = the ith diagonal element of the matrix $(X'X)^{-1}$

X = (Tx3) matrix of explanatory variables in equation (38)

$\overline{Y}_{-1} = T^{-1}\Sigma Y_{t-1}$

T-tests under the null hypothesis of a unit root (that is, the null hypothesis that $\alpha = 1$ in the equations (37) and (38)) are conducted. For the significance level, the test statistics in Fuller (1976) are employed. Also, three F-tests which are equivalent to the Φ_1, Φ_2, and Φ_3 tests indicated in Dickey and

Fuller (1981) are performed and allow for the possible presence of drift and trend in the regression.

Phillips and Perron (1988) transformed the conventional test statistics using Z statistics which account for the effects of serially correlated and heterogeneously distributed innovations. They defined Z statistics as follows:

$$Z(\alpha^*) = T(\alpha^* - 1) - \pi^*/\overline{m}_{yy}$$

$$Z(t_{\alpha^*}) = (s^*/\sigma^*_{t1})t_{\alpha^*} - \pi^{*\prime}\sigma^*_{t1}/\overline{m}^{1/2}_{yy}$$

$$Z(t_{\mu^*}) = (s^*/\sigma^*_{t1})t_{\mu^*} + \pi^{*\prime}\sigma^*_{t1}m_y/\overline{m}^{1/2}_{yy}m^{1/2}_{yy}$$

$$Z(\hat{\alpha}) = T(\hat{\alpha} - 1) - \hat{\pi}/M$$

$$Z(t_{\hat{\alpha}}) = (\hat{s}/\hat{\sigma}_{t1})t_{\hat{\alpha}} - \hat{\pi}'\hat{\sigma}_{t1}/M^{1/2}$$

$$Z(t_{\hat{\mu}}) = (\hat{s}/\hat{\sigma}_{t1})t_{\hat{\mu}} - \hat{\pi}'\hat{\sigma}_{t1}m_y/M^{1/2}(M + m^2_y)^{1/2}$$

$$Z(t_{\hat{\beta}}) = (\hat{s}/\hat{\sigma}_{t1})t_{\hat{\beta}} - \hat{\pi}'\hat{\sigma}_{t1}(\tfrac{1}{2}m_y - m_{ty})/(M/12)^{1/2}\overline{m}^{1/2}_{yy}$$

where $m_{yy} = T^{-2}\Sigma Y^2_t$, $\quad \overline{m}_{yy} = T^{-2}\Sigma(Y_t - \overline{Y})^2$

$m_y = T^{-3/2}\Sigma Y_t$, $\quad m_{ty} = T^{-5/2}\Sigma tY_t$

$$M = (1 - T^{-2})m_{yy} - 12m^2_{ty} + 12(1 + T^{-1})m_{ty}m_y - (4 + 6T^{-1} + 2T^{-2})m^2_y$$

$$\pi^* = \tfrac{1}{2}(\sigma^{*2}_{tl} - s^{*2}), \qquad \pi^{*\prime} = \pi^*/\sigma^{*2}_{tl}$$
$$\hat{\pi} = \tfrac{1}{2}(\hat{\sigma}^2_{tl} - \hat{s}^2), \qquad \hat{\pi}' = \hat{\pi}/\hat{\sigma}^2_{tl}$$

As noted by Phillips and Perron (1988), these Z statistics correct the conventional regression statistics in order to allow for the effects of serially correlated and heterogeneously distributed innovations. They indicate that the general standard error estimates σ^*_{tl} and $\hat{\sigma}_{tl}$ which allow for serial correlation and variance replace the standard errors of regression s^* and $\hat{s}$.[3] The effects of serial correlation are computed by the difference between the variance estimates $(\sigma^{*2}_{tl} - s^{*2})$ or $(\hat{\sigma}^2_{tl} - \hat{s}^2)$.[4] The above transformations of the conventional test statistics are designed to remove the effects of serial correlation asymptotically.

$Z(\alpha)$ and $Z(t_\alpha)$ are based on an F-test under the null hypothesis H_o: $\alpha = 1$. $Z(\Phi_1)$ is based on an F-test under the null hypothesis H_o: $(\mu, \alpha) = (0, 1)$ in equation (37). $Z(\Phi_2)$ is based on an F-test under the null hypothesis H_o: $(\mu, \beta, \alpha) = (0, 0, 1)$ in equation (38). And $Z(\Phi_3)$ is based on an F-test under the null hypothesis H_o: $(\mu, \beta, \alpha) = (\mu, 0, 1)$ in equation (38). In this case, the null hypothesis indicates that the time series studied has a unit root with drift, and the alternative hypothesis means that the time series is stationary around a nonzero trend.

The testing procedure adopted here follows that of Perron (1988). First, the test statistics $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_3)$ are estimated from equation (38). If the results appear to reject

the null hypothesis that the time series has a unit root, we do not have to go further. However, if the results show that we cannot reject the null hypothesis, then we have to estimate the test statistic $Z(\Phi_2)$. Again, if the results indicate that we cannot reject the null hypothesis of a unit root, the tests $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_1)$ are taken from equation (37).

This study presents the results of unit root tests for lags 1, 3, 6, and 12 in order to check the robustness of the test results to various values of lag parameter.

2.2 Cointegration Tests

The statistical concept of cointegration of the time series was established by Engle and Granger (1987). In reality, the cointegration technique is particularly appropriate to examine long run equilibrium relationship existing between two (or more) nonstationary time series. For example, if some linear combination of the economic time series (in this study, real exchange rates and real interest rate differentials) represents a stationary process, these two series form a cointegrated system. In this case, these two series are said to be in equilibrium.

To test whether real exchange rates and real interest rate differentials are cointegrated, a regression analysis of real exchange rates on real interest rate differentials is performed,

and for the examination of nonstationary behavior, the residuals are used. Also, as a check on the robustness of the empirical results, the two variables in equation (32) are interchanged and cointegrating equations are reestimated with the residuals.

For cointegration, this study employs three tests: the Cointegrating Regression Durbin Watson test (CRDW), the Dickey-Fuller test (DF), and augmented Dickey-Fuller test (ADF).

Test 1. Cointegrating Regression Durbin Watson (CRDW)

After running the cointegrating regression equation (32), the Durbin Watson statistic is tested to see whether the residuals are stationary. If the residuals are nonstationary, the Durbin Watson statistic will approach zero and then cointegration between two time series ($\ln Q_t$ and $(R_t - R^*_t)$) is rejected. If the Durbin Watson statistic is significantly greater than zero, then cointegration between the above time series is accepted.

Test 2. Dickey-Fuller Test

The Dickey-Fuller statistic also tests the residuals from the cointegrating regression equation (32). That is, the following regression is estimated.

$$D\hat{e}_t = \theta\hat{e}_{t-1} + u_t \tag{39}$$

where $D\hat{e}_t = \hat{e}_t - \hat{e}_{t-1}$

Using its t-ratio, the coefficient of $\hat{e}_{t-1}$ is tested to see whether it is statistically significantly less than zero. If the coefficient of e_{t-1} turns out to be statistically significantly less than zero, then such a finding supports cointegration between real exchange rates and real interest rate differentials.

Test 3. Augmented Dickey-Fuller Test

Equation (39) with lagged difference term

$$D\hat{e}_t = \theta\hat{e}_{t-1} + \Sigma_{i=1}^{P} h_i D\hat{e}_{t-i} + u_t \tag{40}$$

is estimated. The coefficient of $\hat{e}_{t-1}$ is tested to see whether it is significantly less than zero. If it is significantly less than zero, such a finding supports the cointegration between real exchange rates and real interest rate differentials.

3. Empirical Results

Unit roots and cointegration tests are performed using monthly data from May 1973 through June 1990. The estimation period is from October 1974 through June 1990. For real exchange rates, the logaritms of the original data are used to perform these tests. However, for real interest rate differentials, the levels of the above series are used to do these tests. In the augmented regressions differences at lags one to fourteen were included.

Tables 6, 7, and 8 show the results for unit roots. Table 6 displays the calculated t-statistics for the Dickey-Fuller and augmented Dickey-Fuller unit root tests of the real exchange rates and the real and nominal interest rate differentials.

Table 7 presents the computed t-statistics for the Phillips-Perron unit root test of the above series. Table 8 shows the result of the Phillips-Perron unit root test on the

first differences of each series. As noted before, the testing strategy adopted is to start with the regression equation (38). If the null hypothesis of a unit root can be rejected, we do not need to go further. However, if we cannot reject a unit root, then we should estimate the test statistic $Z(\Phi_2)$. This tests the null hypothesis H_0: $\mu = 0$, $\beta = 0$, $\alpha = 1$ in equation (38). If the results from this test show that the null hypothesis of zero drift cannot be rejected, then the tests $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_1)$ should be applied using equation (37).

Table 6 shows that real exchange rates and real and nominal interest rate differentials are nonstationary over the sample period. Therefore, we cannot reject the hypothesis that there exists a unit root in the series. Actually, the results indicate that the hypothesis of unit root cannot be rejected at the conventional 5% and even at the 1% level in all cases. The failure to reject the unit root for the Korean-U.S. and Korean-Japanese interest rate differentials might be attributed to Korean capital controls in effect over much of the sample period. In addition, Meese and Rogoff (1988) indicate that the nonstationarity of long run interest rate differentials might be a consequence of the lack of homogeneity of the corresponding long run bond yields, the lack of liquid forward markets for long maturities, or the low power of the unit root tests to detect stationarity.

Table 7 reports that the unit root hypothesis cannot be rejected for the real exchange rates (won/dollar and won/yen). The results of the real interest rate differentials (Korean real

interest rate (RKR) - U.S. real interest rate (RUR) and Korean real interest rate (RKR) - Japanese real interest rate (RJR)) tell the same story. In fact, for the tests $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_3)$, none of the results are significant even at the 1% level for any value of lag parameter. Also, the estimation of the test statistic $Z(\Phi_2)$ shows the same results. Table 7 also shows the test results based on equation (44). Again, the test results of $Z(\alpha)$, $Z(t_\alpha)$, and $Z(\Phi_1)$ show that we are unable to reject the null hypothesis of a unit root.

From table (8) we can see that all test statistics are significant at the 5% and 1% level for any value of lag parameter.

Overall, the results of unit root tests are clear and demonstrate that real exchange rates and real interest rate differentials are I(1). Tests of higher orders support that these series are I(1).[3] This implies that special attention should be given in doing regression analysis with such data series. That is, to make these data series stationary, first differencing is needed.

Since this study aims to investigate a long run equilibrium relationship between real exchange rates and real interest rate differentials among Korea, the U.S., and Japan, and to check whether the findings of this study are conflicting with the building blocks of monetary and portfolio balance models of exchange rate determination, cointegration tests are needed to examine the above-mentioned relationship.

Table 9 presents the result of cointegration tests between real exchange rates and real interest rate differentials. It shows that these two variables are not cointegrated. Both the nonaugmented and augmented Dickey-Fuller tests do not support the cointegration of real exchange rates and real interest rate differentials.

Table 10 shows the test result of cointegrating regressions. The cointegrating Durbin-Watson (CRDW) statistic shows that the null hypothesis of noncointegration between the real exchange rates and real interest rate differentials cannot be rejected. This indicates that the residuals from the cointegrating regression are nonstationary. Also, both the Dickey-Fuller and augmented Dickey-Fuller tests do not support the hypothesis of cointegration for the above time series. The results of these two tests show that test statistic is insignificant at the 5% and 1% level for both systems (Korea-U.S. and Korea-Japan systems) over the sample period.

When dependent and independent variables are interchanged, the empirical results tell the same story. That is, cointegration of real exchange rates and real interest rate differentials is again rejected at the 5% and 1% level for both systems, even though for the rejection of cointegration, the renormalized regressions are somewhat stronger in the Korea-Japan system.

In addition, the evidence of the point estimates of the coefficients of cointegration in cointegrating regressions shows that an equilibrium relation between real exchange rates and

real interest rate differentials does not exist. In all cases, the coefficients of cointegration are never close to one and they are statistically insignificant. The large discrepancies from a value of one support the nonexistence of an equilibrium relation between the variables examined.

The empirical results of noncointegration in both series suggest that the shocks inducing nonstationarity in real exchange rates cannot be the same as those impinging on real interest rate differentials. Therefore, we can say that a single factor cannot explain the nonstationarity in real exchange rates and real interest rate differentials.

4. Conclusions

This study aims to investigate the relationship between real exchange rates and real interest rate differentials among Korea, the U.S., and Japan using monthly data spanning the periods 1973:5 - 1990:6.

The empirical analysis is focused on examining the existence of a long run equilibrium relationship between the above two series. Also, it explores the possibility that a single factor can account for the nonstationarity in both time series. The above relationships are investigated using the cointegration technique.

The following three salient features are made from this study. First, the time series studied do not show a strong correspondence between both series. That is, the results show that monetary disturbances do not explain much of the exchange rate behavior. Thus, it is expected that real factors affected the exchange rates over the sample period. Second, cointegration of both series is rejected at the conventional 5% significance level for both the Korea-U.S. and Korea-Japan systems. This supports the nonexistence of long run equilibrium relations between both series. Finally, the results show that a single factor cannot explain the nonstationarity in both series. Empirical findings of noncointegration in both series indicate that the shocks inducing nonstationarity in both series cannot be the same.

Endnotes

1. s^* and s measure scale effects in the conventional t ratios.

2. Phillips and Perron (1988) point out that σ^*_{tl} and $\hat{\sigma}_{tl}$ are used to weight the original statistics to account for the correlation in the residuals. They define these weight variance estimates as follows:

$$\sigma^{*2}_{tl} = T^{-1}\Sigma_{t=1}^{T} u^{*2}_t + 2T^{-1}\Sigma_{s=1}^{l} W_{sl}\Sigma_{t=s+1}^{T} u^*_t u^*_{t-s}$$

$$\hat{\sigma}^2_t \hat{\sigma}^2_{tl} = T^{-1}\Sigma_{t=1}^{T}\hat{u}^2_t + 2T^{-1}\Sigma_{s=1}^{l} W_{sl}\Sigma_{t=s+1}^{T}\hat{u}_t\hat{u}_{t-s}$$

where $W_{sl} = 1 - s/(l + 1)$,
l = lag parameter.

3. The possibility that the series could be I(2) was also investigated by employing Dickey-Fuller test. The empirical findings rejected the hypothesis that the series were I(2).

Chapter 4

International Transmission of Economic Disturbances

1. Introduction

In 1962, when Korea launched its first five-year economic development plan, its per capita GNP was only $81.
After the implementation of a series of five-year economic development plans since 1962, the Korean economy has dramatically turned around. The economic achievements of Korea over the last three decades are often called miraculous and have been a text-book example of economic development. During the last three decades, the real GNP and per capita GNP grew at an annual rate of 8.5% and 6.9%, respectively.

Since Korea has a small domestic market, the government adopted an outward-looking policy of export promotion. This policy has been successfully pursued since the early 1960s. In fact, during this period, exports grew at an annual real average rate of 29.1% per year. Export success has transformed one of the poorest nations into the 12th largest trading nation in the world over the course of three decades. As a consequence of the outward-oriented development strategy, the Korean economy has become more open and interdependent with other countries.

Since the early 1960s, Korea has been highly dependent on foreign trade, with nearly 30% of its GNP accounted for by exports. Also, capital movements have been gradually liberalized since the 1960s. According to the government plans, capital movements will be almost perfectly liberalized in 1992.

As the Korean economy becomes more dependent on the rest of the world through international trade and capital movements, it becomes subject to foreign disturbances more than ever. Namely, economic disturbances originating in other countries have an influence on the Korean economy through various channels.

It is widely believed that the U.S. and Japanese economies have a direct effect on the Korean economy. These two countries are the major trading partners of Korea. To the policymakers, it is very important to know how economic disturbances generated by these two countries are transmitted to the Korean economy. Actually, these two countries account for a considerable amount of Korea's exports and imports.[1]

The major objective of this study is to examine how foreign economic shocks affect the Korean economy and the channels through which they are transmitted. The relative importance of domestic and foreign shocks on the dynamics of certain key macro variables is also investigated. In addition, this study explores the possibility that the Japanese influence on the Korean economy can be traced to the U.S. impact on the Japanese economy. Since more than 50% of Korea's trade is with the U.S. and Japan, this study chooses the shocks originating in the U.S. and Japan to represent foreign disturbances.

A vector autoregression (VAR) model is employed to investigate the international transmission of economic disturbances. The dynamic behavior and interactions of the Korean-U.S. and Korean-Japanese economies are investigated by using variance decompositions (VDCs) and impulse response functions (IRFs).

The reduced form nature of the VAR analysis makes possible this kind of study. Namely, the VAR representation of a system of macroeconomic variables is estimated and analyzed for this matter.

Two VAR models are employed to analyze the transmission of disturbances. Each VAR system contains variables for Korea and the U.S. or Korea and Japan, and uses monthly data from May, 1973 to June, 1990. This data set provides a sufficient number of observations to estimate the systems separately. We might expect external shocks to influence the Korean economy, since the Korean economy is heavily dependent on international trade and the U.S. and Japan are the two largest trading partners of Korea.

2. Literature Review

2.1. Theoretical Literature

The early theoretical contributions of the transmissions of economic disturbances between nations were made by Harberger (1950), Laursen and Metzler (1950), Mundell (1968), and Fleming (1962). In the context of the efficiency of alternative exchange rate systems, Friedman (1953), Haberler and Willet (1968), McTeer (1968), Tower (1972), Modigliani and Askari (1973), and Turnovsky and Kaspura (1974) have also adressed this issue. These studies pointed out that stabilization policies can change the level of economic activity at home and abroad.

However, the rational expectations approach has changed the interpretation of policy effectiveness dramatically. Lucas (1973), Barro (1976), and Sargent and Wallace (1976) studied the closed economy rational expectations models. Cox (1980), Saidi (1980), Turnovsky (1981), Flood and Marion (1982), Kimbrough and Koray (1984), Svensson and Wijnbergen (1989), and Argy (1990) extended the closed economy models to the open economy context and investigated the effects of domestic and foreign economic disturbances on the level of economic activity. They reached the conclusion that anticipated monetary policy changes do not affect the level of economic activity, but only unanticipated

monetary policy changes have an effect on the level of economic activity.[2]

2.2. Empirical Literature

The empirical studies analyzing the effects of international disturbances were performed by Choudhri (1983), Swoboda (1983), Burbidge and Harrison (1985), Winer (1986), Genberg and Salemi (1987), Genberg, Salemi, and Swoboda (1987), Kuszczak and Murray (1987), Darby and Lothian (1989), Burdekin (1989), Moreno (1990), and Lastrapes and Koray (1990).

Using different techniques, the above studies indicate that domestic economies are dependent upon foreign variables, even though the channels of such influence differ across the countries. This section briefly reviews the empirical results of the above studies.

Choudhri (1983) investigated the effects of US monetary disturbances on the Canadian inflation rate. He focused on estimating the effect of US money growth on Canadian inflation and analyzed whether the choice of a different exchange rate regime mattered in the transmission of disturbances. A vector autoregression model with white noise disturbances was estimated using quarterly data for 1962:2 to 1980:4. The methodology used in his paper is an unconstrained VAR technology comprising only

four variables (Canadian money growth, Canadian inflation, US money growth, and US inflation). The results show that the U.S. money supply innovations had an important effect on Canadian inflation during both exchange-rate regimes and the effect lasts for long periods.

Swoboda (1983) analyzed the degree of interdependence of key macroeconomic variables across six major industrial economies (the U.S., Canada, Japan, France, West Germany, and the U.K.) over the periods 1960-71 and 1974-82. The main statistical tool employed is the principal components method. The results suggest that short-run changes in inflation, interest rates, and changes in real output growth have become significantly more interdependent in the latter period.

Burbidge and Harrison (1985) investigated the impact of fluctuations in the US variables on the Canadian economy. They estimated a nine-variable macroeconomic model including the U.S. and Canadian variables and using monthly data covering the period January 1971 to December 1983. The transmission of shocks between these two countries was examined through innovation accounting. The result shows that the U.S. variables have a significant influence on the Canadian economy (especially, a strong and positive response of the Canadian interest rate to a shock in the U.S. interest rate).

Winer (1986) investigated the role of exchange rate flexibility in the transmission of inflation from the U.S. to Canada, using measures of linear feedback between variables. The main results are that exchange rate flexibility after 1972 was sufficient to insulate the inflation rate in Canada against nominal shocks originating in the U.S.

Genberg and Salemi (1987) examined how external factors have influenced the evolution of the Swiss economy, using monthly data. They studied the degree of dependence of the Swiss economy on foreign shocks and the transmission mechanisms within the framework of a VAR model. The results show that the Swiss economy, especially Swiss prices and interest rates, reacts to the U.S. shocks.

Genberg, Salemi, and Swoboda (1987) examined whether flexible exchange rates insulate the Swiss economy from economic shocks originating in foreign countries. By employing the vector autoregression methodology, they estimated four Swiss and three world aggregate time series. The main results are that foreign disturbances explain most of the variation of the Swiss variables in both exchange rate regimes.

Kuszczak and Murray (1987) examined the international transmission of business cycles among Canada and the U.S. and the rest of the world using the VAR methodology. They focused on analyzing the interactions of Canadian and U.S. economies, using

quarterly data. The result of their study is that the economies of Canada, the U.S., and the rest of the world are significantly affected by external factors.

Darby and Lothian (1989) investigated how the behavior of monetary policy was different in the long run across 20 OECD countries between fixed and floating exchange rate regimes. Also, they examined how the movement of economic variables was interrelated in the short run across sample countries under both exchange rate regimes. To evaluate the extent of the differences in monetary policy behavior between both exchange rate regimes, they derived a series of test equations and examined the correspondence between movements in economic variables in the various countries. The empirical results show that there exists a greater long run monetary policy independence under flexible exchange rates. This indicates that economic variables are more variable under flexible exchange rates. However, the results of short term behavior in economic variables are mixed.

Burdekin (1989) investigated the relationship between monetary policy, government budget deficits, and inflation for four European countries(the United Kingdom, West Germany, France, and Italy), considering the impact of U.S. macroeconomic policy. The empirical model consists of a three-equation system (monetary base, deficit, and inflation equations) including the U.S. variables as explanatory variables as a proxy for foreign variables. This paper used Akaike's FPE criterion to choose the

variables to be included in each equation and to select the lag length of the variables. After applying the FPE criterion, the three equations are jointly estimated by generalized least squares (GLS), using the maximum likelihood method. The likelihood ratio tests were done to assess the significance of the US variables for each European country in the study. The empirical results show that the US monetary and fiscal policy variables have a statistically significant impact on the four European countries, although the magnitude of the influence differs across the countries.

Moreno (1990) examined how external shocks (world rate of interest and the terms of trade) and the response to them have influenced economic performance in four Asian economies (Korea, Thailand, Malaysia, and Singapore). The main result is that the ability of the four Asian economies to prevent real exchange rate overvaluation in the face of adverse external shocks has contributed to their successful economic performance.

Lastrapes and Koray (1990) investigated the international transmission of aggregate shocks between the U.S. and three major European countries (the United Kingdom, France, and Germany) under fixed and flexible exchange rate regimes in the context of vector autoregression models. They found that the channels through which shocks are transmitted differ across three countries, though the three European economies react to the U.S. shocks.

This study investigates issues of economic interdependence between Korea and the U.S. as well as Korea and Japan using the VAR methodology. As suggested by Lastrapes and Koray (1990), it is not appropriate a priori to generalize previous results to other countries, given differences in economic structure. Therefore, this extension can provide useful insights into international interdependence. The methodology employed in this paper allows us not only to use a measure of the relative importance of external shocks for a domestic economy, but also to analyze the dynamic interactions of foreign and domestic variables. Thus, we can discuss international transmission mechanisms of economic disturbances. The following section describes the methodology that will be used in the present study.

3. Empirical Methodology

3.1 VAR Methodology

A vector autoregression can be viewed as a system of reduced form equations in which each variable is regressed on a vector of past values of all variables in the system. Each

variable in the system acts as an endogenous variable, and is decomposed into a component that is predictable from the past values of all variables, and an unpredictable innovation.

Since the VAR is interpreted as a reduced form of the structure, VAR coefficients are not structural parameters and are considered as nonlinear functions of the structural parameters. Therefore, the identification of the structural parameters and the test of the structural relationships cannot be done by estimating the unrestricted VAR system. As Lucas (1976) indicates, a change in policy rule such as monetary policy can change the VAR coefficients. Even though this study does not test a structural model, it is necessary to interpret VAR coefficients carefully.[3]

In the context of this study, the advantages of the VAR technique are summarized as follows. The VAR methodology employed in this paper does not impose exogeneity on any variable in the system. The VAR methodology is a particularly useful means for characterizing the dynamic relationships among economic variables without imposing certain types of theoretical restrictions. It can isolate the dynamic effects on, and the relative importance to, the variables in the system of a shock to any one variable. This allows the model to capture a wide range of transmission channels. This study does not aim to estimate a structural model. The objective is to characterize the dynamic relationships between Korea and the U.S. as well as Korea and Japan and specify the international transmission mechanisms among economies under investigation. Therefore, VAR

techniques that analyze the mechanisms through which foreign shocks are transmitted to the Korean economy are well-suited for this purpose. In studying international transmission of disturbances it is important to know something about the direction of causality. The VAR method makes this possible by employing Granger-causality tests and variance decompositions.

Finally, the VAR procedure provides useful statistics that are necessary to this study. We can measure the relative importance of foreign and domestic shocks for the Korean economy by the forecast error variance decomposition proposed by Sims (1980a). Furthermore, the recognition of the transmission mechanisms revealed by the data is provided by the impulse response functions.

The impulse response functions (IRFs) show the relationship between the response of a dependent variable to innovations in another variable and the horizon over which the effect occurs. In this study, the IRFs indicate how the U.S. and Japanese innovations are dynamically transmitted to the Korean economy. The variance decompositions (VDCs) measure the contribution of each shock in the system to the forecast error variance of the dependent variables. For example, if the Korean economy is independent of the U.S. and Japanese shocks, the contribution of these external disturbances in explaining the forecast error variance of Korean variables would be small in magnitude. In the context of this study, the VDCs are useful for measuring the relative importance of the U.S. and Japanese shocks on the Korean economy.

Two VAR systems (Korea-US and Korea-Japan) are estimated with monthly data, each containing nine variables.
In each system, the VAR model can be written as

$$y_t = A(L)y_t + u_t \tag{41}$$

$$E(u_t) = 0,$$

$$E(u_t u_t') = \Sigma,$$

$$E(u_t u_s') = 0 \quad t \neq s.$$

where y_t = a 9 X 1 vector of endogenous variables,
$A(L)$ = lag polynomial($A_1L+A_2L^2+----+A_pL^P$),
L = lag operator defined by $Ly_t = y_{t-1}$,
u_t = a 9 X 1 vector of white noise disturbance terms assumed to be independent and normally distributed with zero mean.

To estimate equation (41) is very easy. Ordinary least squares estimating equation by equation gives consistent estimates. However, it is difficult to interpret the empirical

results. Therefore, the vector moving average (VMA) representation of y_t is needed for the interpretation of VARs as proposed by Sims.

We can form the VMA representation by inverting the system. If y_t is a stationary series, a VMA representation of equation (41) can be derived. The VMA representation of equation (41) can be written as

$$y_t = [I - A(L)]^{-1}u_t = B(L)u_t \tag{42}$$

The VMA representation is the final form for y_t and gives the dynamic response of each y_t to each component of the disturbance terms. Generally, the innovations are contemporaneously correlated so that estimates of dynamic responses are affected by a decomposition of the covariance matrix of disturbance terms. This implies that there exists an interaction among the system variables within the period and the responses to a given shock are not unique (i.e., common effects of a given shocks).

This study orthogonalizes these innovations using the Choleski decomposition of the residual covariance matrix, because innovations are uncorrelated under orthogonalization. To make the variance of the orthogonalized innovations ($v_t = u_tH^{-1}$) an identity matrix (e.g., $Ev_tv_t' = I$), we need to choose any non-singular matrix H having the property that

$H^{-1}\Sigma H'^{-1} = I$. In Choleski decompositions, H is the lower triangular matrix. This yields a recursive structure (block recursive system among the errors) that is efficiently estimated by ordinary least squares.

3.2 Data and Estimation

Since this study aims to investigate the degree to which external shocks are transmitted to the Korean economy, data that properly represents the state of the Korean economy are needed and useful proxies for relevant foreign disturbances are required.

It is believed that the state of Korean economy is well represented by the following four variables - the money supply, interest rate, price level, and output - the same as Sims' (1980b) study and the other VAR studies mentioned. This study chooses the same variables for the U.S. and Japan to represent external shocks. The Korean economy's close ties with the U.S. and Japan justify the choice of these countries as representing foreign factors. The Korean economy's relationship with these countries yields insights into international transmission mechanisms.

Data are obtained from the June 1990 International Financial Statistics tape for the following variables for each country: the narrow money supply M1 (M), the long-term

government bond yield (R), the consumer price index (P) and the industrial production index (Y).[4] Money and interest rate represent credit market channels and show policy reactions of monetary authorities. The consumer price index accounts for supply shocks and price level channels. Since GNP is not available on a monthly basis, the industrial production index is used to represent real economic activity. Also, the nominal bilateral exchange rate (monthly average) is included in the VAR and measured as the foreign currency price of the Korean won (expressed as WD in the Korea-U.S. system and WY in the Korea-Japan system). In order to check the robustness of empirical results, the empirical analysis is also conducted using real exchange rates.

The IFS tape contains the seasonally adjusted industrial production index and money supply. Since seasonally adjusted data for the consumer price index is not available in the IFS tape, the X-11 procedure of SAS is used to adjust the consumer price index seasonally. This makes all variables included in the VAR consistent.

The results reported in this study are based upon the estimation of the two VAR systems. The Korea-U.S. system contains four Korean variables and the same variables for the U.S. The Korea-Japan system comprises four Korean variables and their Japanese counterparts. The nominal exchange rate is also included in each system.

The data range is May 1973 to June 1990. This is due to data availability which also corresponds to the flexible rate

period ranging from March 1973 to the end of the sample period. Our sample therefore contains 206 monthly observations.

The VAR analysis is based on the assumption of variance-covariance stationarity of all the stochastic processes in the VAR system. However, economic time series are not usually stationary. Therefore, some method of detrending is needed before each system is estimated. Before estimating the VAR system, this study transforms all variables into natural logs except the interest rates. It is common in the literature to achieve stationarity by representing all variables in log differences.[5] However, it is not appropriate that all variables are to be first differenced in order to make the data stationary, if the variables are cointegrated.

To check data stationarity and choose log level or log difference of variables, this study performs unit root and cointegration tests. If we can reject the null hypothesis of unit root, we can use log levels of the variables. If we cannot reject the null hypothesis of unit root (i.e., if we find unit root), then we can use log differences of those variables. However, as indicated by Engle and Granger (1987), a VAR system with only differenced data will be misspecified if the variables are cointegrated. If the series are not cointegrated, then using log differences is justified.

For unit roots, augmented Dickey-Fuller tests are performed. To find the test-statistic for each variable, a linear regression analysis is conducted. The log level of each variable except the interest rate is regressed on a constant,

the trend, the log level of that variable lagged once, and the first difference of log level of that variable with lags one to fourteen. The lag length fourteen is chosen following Schwert (1987). For monthly data, he indicates that the lag length, l_{12}, can be obtained as follows:

$$l_{12} = \mathrm{Int}\{12(T/100)^{1/4}\}$$

where T = sample size.

Table 11 presents the statistics of unit root tests. The test statistics show that only U.S. and Japanese output are stationary, whereas the other variables appear to be non-stationary. Thus, we can use log levels of these variables (U.S. and Japanese output) for empirical study.

Then, augmented Dickey-Fuller tests for cointegration are performed for variables except stationary series. The test procedure is as follows. The log level of each variable except the interest rate is regressed on a constant and the log level of the other eight variables. The residuals of each variable obtained from the above regression are then used in the cointegration test. The level of the residual is regressed on the level of the residual with one lag, and the values of the first difference of the residual with fourteen lags. Then we can check whether the residual series have a unit root. If this null

hypothesis cannot be rejected, the variables are not cointegrated. Table 12 shows the results of the cointegration test. The test statistics indicate that these series are not cointegrated. For these series, we can use log difference.

To specify lag length of the explanatory variables in the VAR system, a maximum lag length of 12 months is used. To determine the optimal lag length of each variable, likelihood-ratio tests are performed. The estimation procedure is as follows. At first, one lag versus two lags are tested. If the system cannot be rejected in this case, two lags are tested against three lags, and so on. By this procedure, we can find optimal lag length for each system. Table 13 presents the statistics of likelihood-ratio test. This table shows only the test result without trend. Test statistic both with and without trend shows that the optimal lag length for the Korea-U.S. system is six. For the Korea-Japan system, the optimal lag length with trend is twelve and the optimal lag length without trend is eight. However, for both systems, t-statistic shows that trend is insignificant. Therefore, for the rest of empirical study, six is used as the optimal lag of the Korea-U.S. system and eight is used as the optimal lag of the Korea-Japan system.

The sensitivity of variance decompositions and impulse responses can be affected by the orderings of the variables. In order to identify variable combinations with high correlation, this study examines the contemporaneous correlations of the residuals in each system. If the residuals of variables are not

significantly correlated, the order of variables makes little difference. To check whether variable orderings affect the empirical results significantly, the variance decompositions and impulse responses are recomputed by changing the order of the variables.

In this study, it is important to determine whether there are any causal relationships between the Korean and foreign variables. For this purpose Granger-causality tests are employed. For Granger causality, this paper performs F-tests. Granger's procedure is to regress each variable in the VAR system on lags of that variable and of the other variables. If past values of variable X are useful in predicting variable Y then variable X is said to "Granger-cause" variable Y. Through Granger-causality tests, we can check whether past values of a given variable are significant in a particular equation. Therefore, Granger-causality tests are used to determine whether the lagged values of one variable have predictive power in a particular equation.

4. Empirical Results

Table 14 contains the partial correlation coefficients of the residuals from each equation of the Korea-U.S. and Korea-Japan systems. To check whether VDCs and IRFs are sensitive to the variable orderings, these correlation coefficients are considered.

This table indicates that cross-correlation of the residuals does not cause any serious problem in interpreting the VAR results of both systems. In only one case (Japanese money supply versus Japanese output), the correlation coefficient exceeds 0.30 and is significant at the 5% level. The largest correlation coefficients for the Korean versus the U.S. residuals happen to be for Korean price and output against the U.S. price. The correlation coefficients for the Korean versus Japanese residuals are much weaker compared to those of the Korean versus the U.S. residuals.

Table 15 shows the critical levels of F-statistics in both systems. The empirical results of F-test indicate that the U.S. price causes Korean price at the 1% significance level and the U.S. output causes Korean price at the 5% significance level. For the Korea-Japan system, the results show that Japanese variables do not cause Korean variables, at the 5% significance level.

Tables 16 and 17 report the results of the variance decompositions at various horizons. The variable ordering for

the Korea-U.S. system is: Korean money (KMS), interest rate (KR), price (KPS), output (KY), nominal exchange rate (WD), the U.S. money (UMS), interest rate (UR), price (UPS), and output (UY). This is because Korean variables are considered to be more important than the U.S. and Japanese variables in explaining the forecast error variance of Korean variables. Several orderings are considered and estimated. The other estimated variable orderings for the Korea-U.S. system are (1) KMS, KPS, KR, KY, WD, UMS, UPS, UR, UY; (2) KMS, KY, KPS, KR, WD, UMS, UY, UPS, UR; (3) UMS, UR, UPS, UY, WD, KMS, KR, KPS, KY; (4) UMS, UPS, UR, UY, WD, KMS, KPS, KR, KY; (5) UMS, UY, UPS, UR, WD, KMS, KY, KPS, KR; (6) UY, UPS, UR, UMS, WD, KY, KPS, KR, KMS. For the Korea-Japan system, the above orderings in addition to the basic ordering are also estimated.

If the residuals have high contemporaneous correlations, the variable orderings can change the results significantly. This is because the Choleski decomposition converting the VAR models into their moving average representations (orthogonalization of the variance-covariance matrix) attributes all the contemporaneous correlation between two series to the variable higher in the order. Empirical results show that if Korean variables are placed after the U.S. or Japanese variables, then the impact of Korean innovations on the U.S. and Japanese variables is much smaller.

Table 16 also presents two summary measures representing the relative importance of domestic and foreign shocks on the

Korean economy. VF is the proportion of forecast error variance of Korean variable explained by all foreign shocks. This can be obtained by summing the last four columns at each horizon for each system. VFR is the proportion explained by foreign shocks relative to the proportion explained by all variables in each system except the dependent variable.

In all cases, the contribution of own shocks in explaining forecast error variance of the Korean variables at a horizon of four years exceeds VF in both systems. This implies that the most important factor in explaining one variable's forecast error variance is its own shocks. In most cases, VF and VFR increase as the forecast horizon grows in both systems.

Table 16 shows that shocks to some U.S. and Japanese variables have significant effects on some Korean variables. For the Korea-U.S. system, innovations to U.S. prices contribute a large proportion of the variance of Korean prices, explaining up to 21% after two years. This contribution is the largest except its own innovations. After nine months, the VDC coefficients for U.S. prices are significant at two standard deviations. Also, U.S. prices explain a substantial portion of the forecast error variance of the nominal exchange rate.

For the Korea-Japan system, Japanese variables such as money supply, prices, and output explain a substantial portion of the forecast error variance of the Korean money supply. Japanese variables explain 24% of the variance of Korean money supply and 21% of the variance of Korean output after two years. This figure is larger than those of the other domestic variables

except its own innovations. Shocks to Japanese money supply have a significant effect on Korean output after six months. As with the Korea-U.S. system, Japanese external effects on the Korean variables reach their peak after three or four years.

It is interesting to mention the relative impact of the U.S. and Japanese variables on the Korean money supply and prices. Quantitatively, the U.S. innovations are much more important for the Korean prices than Japanese innovations, and then Japanese innovations are more important for the Korean money supply than the U.S. innovations. That is, whereas the U.S. effect on the Korean money supply and Japanese impact on the Korean prices are small, Japanese impact on the Korean money supply and the U.S. effect on the Korean prices are substantial.

The empirical results show that the Korean monetary policy is to a large extent independent from the U.S. shocks, whereas there is a certain degree of Korean monetary dependence on Japanese shocks. For external shocks on the exchange rate, innovations to the U.S. and Japanese variables have a substantial effect on the exchange rate. Among foreign variables, the U.S. prices have the largest influence on the exchange rate, and its effect on the exchange rate is statistically significant.

Figures 1-20 report the impulse response functions, which display the responses of all variables in the system to a one standard deviation shock to each variable. After computing the IRFs a Monte Carlo integration technique similar to that described in Doan and Litterman (1988) is employed to generate

estimates of the standard errors of the IRFs. Thus, for each impulse response a lower and upper band is calculated. If the two standard deviation band around the mean included zero, the corresponding point estimate of the IRF is judged to be insignificant. Three features of these responses draw particular attention. First, the positive innovations to the Japanese money supply lead to a statistically significant decrease in the Korean output. Second, there is an unambiguously positive response of the Korean prices to the U.S. price innovations. Third, While the Korean interest rates respond positively to positive innovations in the U.S. interest rates, innovations to the Japanese interest rates have no significant effect on the Korean interest rates. In a similar fashion, while the Korean money supply does not respond significantly to the U.S. money supply innovations, it responds significantly to the Japanese money supply innovations.

The following impulse responses are also worth noting. The Korean money supply and Korean prices do not respond significantly to the U.S. money supply innovations. The Korean output first increases and then decreases in response to the U.S. and Japanese interest rate innovations. Likewise, Korean prices first increase, then decrease in response to the U.S. and Japanese output innovations. While positive innovations to the Japanese money supply lead to a decrease in Korean output, positive innovations to the U.S. money supply first lead to an increase, then a decrease in Korean output.

To analyze the impact of Japanese variables on the Korean economy through the U.S. influence on the Japanese economy, this study also investigates two ten variable VAR systems (nine variables plus ups or ur). Since the U.S. economy is larger than Japan, it is possible that the Japanese economy may respond to the U.S. shocks and what may appear as the effects of the Japanese economy on the Korean economy may actually be the effects of the U.S. economy.

Table 17 presents the VDCs for the two ten variable Korea-Japan systems respectively. The VDCs show that in most cases, the inclusion of U.S. prices or interest rates decreases the impact of other domestic and foreign variables on the Korean economy and increases the influence of its own innovations after one year of horizon. This suggests that to a certain degree, the Japanese influence on the Korean economy is affected by the U.S. impact on the Japanese economy.

Although in these ten variable Korea-Japan systems the impact of the U.S. variables on the Korean economy is negligible in most cases, table 17 shows that U.S. prices have the biggest influence on the Korean prices except its own variable. This is supported by the nine variable Korea-U.S. system. Also, Japanese prices have a greater impact on Korean prices when the U.S. interest rate is included in the system. This can be explained by the fact that the U.S. interest rate has an impact on U.S. prices and then U.S. prices directly affect Japanese prices through international trade. Therefore, the influence of

Japanese prices on Korean prices is strengthened through the impact of U.S. prices on Japanese prices.

Table 18 shows the results of the variance decompositions with the real exchange rate for each system. The empirical results are not much different from those with the nominal exchange rate.

5. Economic Implications

Since the moving average representation can be understood as a final form solution to a structural model, we cannot identify the structural coefficient. Therefore, economic interpretation of VAR results must be done with caution.

Since the main objective of this study is to analyze the transmission of economic disturbances, we can present some economic implications of empirical results within these limits.

a. The transmission of the U.S. disturbances to the Korean credit market reflects some degree of Korean monetary policy independence. The U.S. disturbances do not have a significant effect on the Korean money supply and interest rates even at longer horizons.[6] This indicates that Korean monetary authorities can pursue their objectives without heavily depending on the U.S. monetary policies.

However, the transmission of Japanese disturbances to the Korean credit market represents some extent of monetary dependence. Japanese innovations are an important factor affecting the Korean credit market after one year of horizon. Since Korea and Japan have similar economic structures (e.g., scarcity of natural resources, export-oriented trade policy, concentration on high-tech industry, etc.), it is likely to interpret economic events (especially, in the credit market) similarly between Korean and Japanese monetary authorities. Many policy objectives can be shared between Korean and Japanese policymakers. Therefore, we can think that the Korean credit market is more closely related to the Japanese market than the U.S. market.

b. The IRFs reveal that the Korean output responds negatively to the Japanese money supply innovations. This result confirms the Mundell effect, i.e., the inverse transmission of monetary disturbances.[7] The Mundell effect, however, is not as strong in considering the effects of the U.S. money supply on the Korean output. In response to a positive shock to the U.S. money supply, the Korean output first increases and then decreases.

c. The evidence is very clear on how the U.S. price shocks are transmitted to Korea. The Korean prices increase in response to a positive shock to the U.S. prices. The shock to the U.S. prices has a long lasting impact on the Korean prices. Shocks to the Japanese prices, on the other hand, do not have a long

lasting impact on the Korean prices. Korean prices first increase and then decrease in response to the Japanese price innovations. This may be due to the different level of technologies adopted by the firms using the U.S. and Japanese inputs and substitution of foreign inputs with domestic inputs.

d. The exchange rate responds to both the Korean and foreign shocks. However, the response of the exchange rate is stronger and more significant with respect to innovations to foreign variables. There are some differences and similarities in how the exchange rate responds to the U.S. and Japanese variables. For example, a positive shock to the U.S. or Japanese output appreciates the Korean won against the U.S. dollar and the Japanese yen. This may be due to an increase in the U.S. and Japanese imports. The differences occur especially in the dynamic pattern of how the exchange rate responds to foreign shocks of the same nature.

6. Conclusions

This study investigates the extent of international transmission of economic disturbances using VAR techniques. The empirical work is focused on Korea, taking it as a small open

economy with two influential trading partners, the U.S. and Japan.

The following three points emerge from this study. First, this study investigated whether foreign shocks (the U.S. and Japanese shocks) were important for the Korean economy during the sample period and the channels of transmission differed across countries. The results of this study provide the evidence that foreign shocks are important for the Korean economy during the sample period, though the channels of transmission differ. Second, we can draw some economic implications based on empirical results, even though there exist some limitations in interpreting VAR results economically. The transmission of the U.S. disturbances to the Korean credit market reflects some degree of Korean monetary policy independence, whereas the transmission of Japanese disturbances to the Korean credit market represents some extent of monetary dependence. Also, this study provides partial evidence for the Mundell effect. The empirical results show that Korean output negatively responds to the Japanese money supply. Finally, this study supports the notion of economic dependence of a small open economy such as Korea to a large economy such as the U.S. or Japan. However, it is very important to mention that we cannot generalize these VAR results of international economic linkages to other countries.

Endnotes

1. The U.S. was the largest export (34.8%) and the second largest import partner (23.3%) of Korea during the last 9 years (1981-1989). Japan was the largest import (28.1%) and the second largest export partner (17.7%) of Korea during the same period.

2. For an anticipated expansion in the money supply abroad, Argy (1990) indicates that the price level abroad will rise in proportion, leaving output and the interest rate unchanged. At home the domestic currency appreciates to offset the inflation abroad. Therefore, domestic prices are unchanged; at the same time neither the interest rate nor output will change. For an unanticipated expansion in the money supply abroad, he suggests that output and prices both rise abroad. At home outcomes are more complicated. That is, monetary expansion abroad has ambiguous effects on both domestic output and prices. In addition, Svenson and Wijnbergen (1989) point out that the response to domestic output of a foreign monetary expansion depends on what regimes the world markets for domestic and foreign goods are in.

3. For questioning the reliability and usefulness of VAR techniques, see Gordon and King (1982), Cooley and LeRoy (1985).

4. All series are defined on a monthly basis.

5. For the use of log level and log differences in estimating VAR, see Burbidge and Harrison (1985), Genberg, Salemi, and Swoboda (1987), Genberg and Salemi (1987), and Kuszczak and Murray (1987).

6. The U.S. disturbances contribute only 8.6% of the forecast error variance of Korean money even at 4 years of horizon.

7. The Mundell-Fleming model indicates that a foreign monetary contraction causes a depreciation of the domestic currency. Thus, its effect at home is expansionary.

Chapter 5

Summary and Conclusions

There are three objectives of this dissertation. The first objective is to investigate whether the long run version of purchasing power parity (PPP) holds between Korea and its two major trading partners - the U.S. and Japan. The second objective is to examine the empirical relationship between real exchange rates and real interest rate differentials in Korean-U.S. and Korean-Japanese economies. The empirical analysis is focused on investigating whether the building blocks of monetary and portfolio balance models of exchange rate determination hold in this case. Also, it explores the possibility that a single factor can explain the nonstationarity in both series. The third objective is to examine how foreign economic shocks (the U.S. and Japanese shocks) affect the Korean economy and the channels through which they are transmitted. The relative importance of domestic and foreign shocks on the dynamics of certain key macro variables is also investigated. In addition, this study explores the possibility that the Japanese influence on the Korean economy can be affected by the U.S. impact on the Japanese economy.

Chapter 2 discusses the first objective of this dissertation. The PPP relationship is tested by examining whether price levels and the exchange-rate-adjusted price levels between Korea and the U.S. as well as Korea and Japan form a cointegrated system. Unit root and cointegration tests are performed to check the existence of any long run equilibrium relation between Korean prices and the exchange-rate-adjusted price levels of its two major trading partners. For unit root, the Dickey-Fuller, the augmented Dickey-Fuller, and the Phillips-Perron tests are conducted. For cointegration, the Cointegrating Regression Durbin Watson (CRDW), the Dickey-Fuller, and the augmented Dickey-Fuller tests are performed.

Empirical evidence is not favorable to the PPP hypothesis. No evidence of cointegration is found for any pair of prices for the Korea-U.S. system as well as the Korea-Japan system. For the empirical study, two price measures were employed - the wholesale price index and the consumer price index. However, the main results of this study are not affected by the price index chosen. Since cointegration is understood as evidence of a long run equilibrium relation, the findings of this study indicate that prices and exchange rates are not in equilibrium and may diverge even in the long run.

Chapter 3 deals with the second objective of this dissertation. The empirical relationship between real exchange rates and real interest rate differentials in Korean-U.S. and Korean-Japanese economies is investigated using cointegration tests. In the context of this study, cointegration technique is

appropriate to examine the relationship between two (or more) nonstationary time series. Also, this method is useful to detect the possibility that the nonstationarity in both series can be explained by a single factor.

The empirical evidence is summarized as follows. First, the empirical findings conflict with the building blocks of monetary and portfolio balance models of exchange rate determination. We cannot find any strong correspondence between both series. That is, the results indicate that monetary disturbances do not explain much of the exchange rate behavior over the sample period. Second, cointegration of real exchange rates and real interest rate differentials is rejected at the conventional 5% significance level in Korean-U.S. and Korean-Japanese economies. This implies that the empirical results support the nonexistence of a long run equilibrium relation between both series. Finally, the results show that the nonstationarity cannot be explained by a single factor. This is supported by the findings of noncointegration that the shocks impinging nonstationarity in both series cannot be the same.

The empirical findings in chapters 2 and 3 indicate that further research is needed to explain the factors responsible for deviations from PPP and exchange rate behavior between Korea and its two major trading partners (the U.S. and Japan). Since monetary disturbances did not explain much deviation from PPP and exchange rate behavior, the real shocks hypothesis can be applied in this study. Therefore, future research along the

lines of real business cycle models is worthwhile. This task is well beyond the scope of this study and left for future study.

Chapter 4 discusses the third objective of this dissertation. The notion that the U.S. and Japanese economies have a significant effect on the Korean economy is widely believed among economists, because the Korean economy is heavily dependent on foreign trade during the last three decades and these two countries are the major trading partners of Korea. As the Korean economy becomes more dependent on the rest of the world through international trade and capital movements, economic disturbances originating in foreign countries directly affect the Korean economy through various channels. This study chooses the shocks originating in the U.S. and Japan to represent foreign disturbances.

The techniques of vector autoregression (VAR) are used to investigate the international transmission of economic disturbances. The reduced form nature of the VAR analysis makes it possible to investigate the dynamic behavior and interactions between Korean and U.S. as well as Korean and Japanese economies. For this matter, the VAR representation of a system of macroeconomic variables is estimated and analyzed. Each VAR system contains variables for Korea and the U.S. or Korea and Japan. The state of the Korean economy is well represented by the money supply, interest rate, price level, and output. The variables chosen in this study are the same as Sims' (1980b) study and the other VAR studies mentioned. The same variables for the U.S. and Japan are chosen to represent external shocks.

The dynamic effects of foreign shocks to the Korean economy are evaluated by estimating impulse response functions (IRFs) and variance decompositions (VDCs) based on the moving average representation of the VARs.

In this study, the IRFs show how the U.S. and Japanese innovations are dynamically transmitted to the Korean economy. The VDCs are useful for measuring the relative importance of the U.S. and Japanese shocks on the Korean economy. The sensitivity of the variance decompositions and impulse responses can be affected by the orderings of the variables. To check whether variable orderings affect the empirical results significantly, the VDCs and IRFs are recomputed by changing the order of the variables. However, this study shows that the main empirical results are not affected by variable orderings.

Empirical evidence is summarized as follows. Foreign shocks originating in the U.S. and Japan are important for the Korean economy during the sample period, though the channels of transmission differ. For the Korea-U.S. system, innovations to U.S. prices explain a large proportion of the variance of Korean prices. For the Korea-Japan system, Japanese variables explain a substantial portion of the variance of Korean money supply and output. Japanese impact on the Korean money supply and the U.S. effect on Korean prices are substantial, whereas the U.S. effect on the Korean money supply and Japanese impact on Korean prices are small.

There is the possibility that Japanese influence on the Korean economy can be affected by the U.S. impact on the

Japanese economy. The results also indicate that to a certain degree, the Japanese influence on the Korean economy is affected by the U.S. influence on the Japanese economy. Actually, the inclusion of the U.S. price or interest rate in the Korea-Japan system decreases the impact of other domestic and foreign variables on the Korean economy and that increases the influence of its own innovations.

Finally, this study supports the notion of economic dependence of a small open economy such as Korea to a large economy such as the U.S. or Japan. The empirical findings show that the transmission of Japanese economic disturbances to the Korean credit market represents some extent of monetary dependence. In reality, Japanese economic innovations are an important factor affecting the Korean credit market after one year. The investigation of the transmission mechanism of foreign shocks on the Korean economy using an alternative VAR methodology (structural VAR) is worthwhile. In a structural VAR, the disturbances are defined by the identification we make. As noted by Bernanke (1986), this alternative methodology is more appropriate to use when we attempt to discriminate among structural hypotheses. This is well beyond the scope of this study and left for future research.

Table 1. Unit Root Tests

	WPI		XWPI	
	DF	ADF	DF	ADF
KOREA-U.S.	-0.987	-1.568	-0.182	-1.248
KOREA-JAPAN	-0.987	-1.568	-0.540	-1.915
	CPI		**XCPI**	
	DF	ADF	DF	ADF
KOREA-U.S.	-1.654	-1.757	-0.102	-1.420
KOREA-JAPAN	-1.654	-1.757	-1.029	-1.411

Note: Numbers are reported are the values of the calculated t-statistics. Critical values based on Fuller(1976) are -3.99, -3.43, and -3.13 for 1%, 5%, and 10% significance levels respectively. For each system test statistics are reported for the WPI and CPI, and the exchange-rate-adjusted WPI (XWPI) and CPI (XCPI). In all cases, empirical analysis is performed on the logarithms of the series.

Table 2. Phillips-Perron Test

A. Wholesale Price Index

Tests based on Regression Equation 27

	LKW				LUPW			
	l=1	l=3	l=6	l=12	l=1	l=3	l=6	l=12
$Z(\alpha)$	-2.30	-2.49	-2.57	-2.84	-0.21	-0.38	-0.64	-1.08
$Z(t_\alpha)$	-1.88	-1.82	-1.80	-1.77	-0.15	-0.25	-0.38	-0.56
$Z(\Phi_3)$	14.42	11.72	10.92	8.93	5.95	5.09	4.22	3.31
$Z(\Phi_2)$	10.65	8.64	8.04	6.56	4.75	4.06	3.36	2.62

	LJPW			
$Z(\alpha)$	-2.26	-2.70	-3.16	-3.54
$Z(t_\alpha)$	-0.75	-0.85	-0.96	-1.04
$Z(\Phi_3)$	2.42	2.32	2.24	2.21
$Z(\Phi_2)$	2.00	1.90	1.82	1.77

Tests based on Regression Equation 26

	LKW				LUPW			
	l=1	l=3	l=6	l=12	l=1	l=3	l=6	l=12
$Z(\alpha)$	-2.95	-2.98	-3.00	-3.05	-1.99	-2.02	-2.07	-2.16
$Z(t_\alpha)$	-5.65	-5.08	-4.89	-4.39	-3.50	-3.24	-2.96	-2.64
$Z(\Phi_1)$	16.67	13.50	12.47	10.07	6.89	5.88	4.90	3.86

	LJPW			
$Z(\alpha)$	-2.10	-2.13	-2.17	-2.21
$Z(t_\alpha)$	-2.46	-2.39	-2.32	-2.27

Table 2. Continued

$Z(\Phi_1)$	3.81	3.55	3.33	3.16

Significance levels

Regression Equation 27

	10%	5%	1%
$Z(\alpha)$	-18.0	-21.3	-28.4
$Z(t_\alpha)$	-3.13	-3.43	-3.99
$Z(\Phi_3)$	5.39	6.34	8.43
$Z(\Phi_2)$	4.07	4.75	6.22

Regression Equation 26

	10%	5%	1%
$Z(\alpha)$	-11.2	-14.0	-20.3
$Z(t\alpha)$	-2.57	-2.88	-3.46
$Z(\Phi_1)$	3.81	4.63	6.52

B. Consumer Price Index

Tests based on Regression Equation 27

LKPS

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-1.45	-1.63	-1.78	-2.11
$Z(t_\alpha)$	-1.69	-1.57	-1.52	-1.48
$Z(\Phi_3)$	11.01	7.91	6.35	4.63
$Z(\Phi_2)$	14.51	10.27	8.13	5.73

LUPP

	l=1	l=3	l=6	l=12
$Z(\alpha)$	0.16	-0.14	-0.43	-0.94
$Z(t_\alpha)$	0.11	-0.08	-0.23	-0.44
$Z(\Phi_3)$	2.70	2.14	1.81	1.48
$Z(\Phi_2)$	3.24	2.56	2.15	1.71

LJPP

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-2.89	-3.64	-4.53	-5.18
$Z(t_\alpha)$	-0.84	-1.00	-1.17	-1.28
$Z(\Phi_3)$	1.28	1.32	1.40	1.49
$Z(\Phi_2)$	1.48	1.44	1.43	1.44

Table 2. Continued

Tests based on Regression Equation 26

	LKPS				LUPP			
	l=1	l=3	l=6	l=12	l=1	l=3	l=6	l=12
$Z(\alpha)$	-1.78	-1.79	-1.81	-1.84	-1.45	-1.48	-1.52	-1.59
$Z(t_\alpha)$	-6.63	-5.57	-4.96	-4.15	-2.90	-2.62	-2.42	-2.18
$Z(\Phi_1)$	22.61	16.00	12.64	8.85	4.94	4.00	3.39	2.73

	LJPP			
$Z(\alpha)$	-1.62	-1.66	-1.70	-1.73
$Z(t_\alpha)$	-2.09	-2.01	-1.94	-1.90
$Z(\Phi_1)$	2.95	2.71	2.49	2.36

Note: Critical values are based on Fuller(1976).

Table 3. Phillips-Perron Test

Tests based on Regression Equation 26

A. Wholesale Price Index

DLKW

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-102.61	-107.05	-115.64	-147.43
$Z(t_\alpha)$	-8.39	-8.50	-8.72	-9.53
$Z(\Phi_1)$	36.24	37.15	38.96	46.08

DLUPW

$Z(\alpha)$	-131.69	-131.41	-150.05	-192.77
$Z(t_\alpha)$	-9.89	-9.88	-10.25	-11.14
$Z(\Phi_1)$	49.89	49.84	53.41	62.62

DLJPW

$Z(\alpha)$	-144.55	-135.84	-140.92	-150.03
$Z(t_\alpha)$	-10.47	-10.32	-10.40	-10.56
$Z(\Phi_1)$	55.73	54.29	55.12	56.71

B. Consumer Price Index

DLKPS

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-69.07	-71.15	-78.64	-108.77
$Z(t_\alpha)$	-6.58	-6.65	-6.91	-7.90
$Z(\Phi_1)$	22.75	23.19	24.84	31.84

Table 3. Continued

		DLUPP		
$Z(\alpha)$	-120.50	-121.26	-133.07	-165.87
$Z(t_\alpha)$	-9.27	-9.29	-9.56	-10.30
$Z(\Phi_1)$	44.02	44.17	46.53	53.66
		DLJPP		
$Z(\alpha)$	-143.58	-135.59	-142.63	-151.88
$Z(t_\alpha)$	-10.42	-10.28	-10.40	-10.57
$Z(\Phi_1)$	55.21	53.88	55.05	56.71

Note: Critical values are based on Fuller (1976).

Table 4. Cointegration Tests

	WPI on XWPI		CPI on XCPI	
	DF	ADF	DF	ADF
KOREA-U.S.	-1.2870	-1.5697	-0.7336	-1.5221
KOREA-JAPAN	-1.3831	-1.8530	-1.1736	-1.8957

Note: Numbers reported are the calculated t-statistic for tests for a unit root in the residual processes from cointegrating regressions of equation (2). Nonaugmented Dickey-Fuller(DF) and augmented Dickey-Fuller(ADF) tests are reported. Critical values based on Engle and Yoo(1987) are -3.78, -3.25, and -2.98 for the 1%, 5%, and 10% significance levels respectively.

Table 5. Cointegrating Regressions

A. Wholesale Prices: Korean prices(KW) vs. exchange-rate-adjusted U.S. prices(UPW)

	Renormalized
KW = 2.70 + 0.97UPW	UPW = -2.57 + 1.00KW
(0.049) (0.012)	(0.083) (0.013)
R^2 = 0.97 obs = 205	R^2 = 0.97 obs = 205
CRDW = 0.040	CRDW = 0.040
DF = -1.2870	DF = -1.2357
ADF = -1.5697	ADF = -1.5012

B. Wholesale Prices: Korean prices(KW) vs. exchange-rate-adjusted Japanese prices(JPW)

	Renormalized
KW = 5.68 + 0.89JPW	JPW = -5.86 + 1.04KW
(0.019) (0.018)	(0.137) (0.021)
R^2 = 0.92 obs = 205	R^2 = 0.92 obs = 205
CRDW = 0.036	CRDW = 0.038
DF = -1.3831	DF = -1.3327
ADF = -1.8530	ADF = -1.7219

C. Consumer Prices: Korean prices(KPS) vs. exchange-rate-adjusted U.S. prices(UPP)

	Renormalized
KPS = 0.28 + 0.93UPP	UPP = -0.31 + 1.03KPS
(0.012) (0.013)	(0.010) (0.015)

Table 5. Continued

R^2 = 0.96 obs = 205	R^2 = 0.96 obs = 205
CRDW = 0.022	CRDW = 0.023
DF = -0.7336	DF = -0.8152
ADF = -1.5221	ADF = -1.5666

D. Consumer Prices: Korean prices(KPS) vs. exchange-rate-adjusted Japanese prices(JPP)

	Renormalized
KPS = 2.53 + 0.79JPP	JPP = -3.24 + 1.18KPS
(0.055) (0.015)	(0.015) (0.022)
R^2 = 0.94 obs = 205	R^2 = 0.94 obs = 205
CRDW = 0.035	CRDW = 0.037
DF = -1.1736	DF = -1.2784
ADF = -1.8957	ADF = -1.9384

Note: In the cointegrating regressions standard errors are given in parentheses. The residuals from each reported regression are tested for unit roots with the DF and ADF test with lags 1, 3, 6, and 12. Critical values based on Engle and Yoo(1987) are -3.78, -3.25, and -2.98 for the 1%, 5%, and 10% significance levels, respectively, for sample size 200. This table also presents CRDW statistic. Critical values based on Engle and Yoo(1987) are 0.29, 0.20, and 0.16 for the 1%, 5%, and 10% significance levels, respectively, for sample size 200.

Table 6

A. Tests for Unit Roots in the Logarithm of the Real Exchange Rates

	DF t-ratio	ADF t-ratio
Won/Dollar(REU)	-0.6354	-1.4228
Won/Yen(REJ)	-1.1897	-2.0561

B. Tests for Unit Roots in the Real Interest Rate Differentials

	DF t-ratio	ADF t-ratio
RKR-RUR(RKU)	-2.3812	-1.8762
RKR-RJR(RKJ)	-2.2791	-2.1766

C. Tests for Unit Roots in the Nominal Interest Rate Differentials

	DF t-ratio	ADF t-ratio
KR-UR(KU)	-2.3785	-1.8781
KR-JR(KJ)	-2.2776	-2.1780

Table 6. Continued

Note: RKR, RUR, and RJR indicate Korean real interest rate, the U.S. real interest rate, and Japanese real interest rate, respectively. KR, UR, and JR represent Korean nominal interest rate, the U.S. nominal interest rate, and Japanese nominal interest rate, respectively. Numbers reported are the values of the calculated t-statistics. Critical values based on Fuller(1976) are -3.99, -3.43, and -3.13 for the 1%, 5%, and 10% significance levels, respectively.

Table 7

Phillips-Perron Unit Root Tests

A. Tests based on Regression Equation (45)

	REU				REJ			
	l=1	l=3	l=6	l=12	l=1	l=3	l=6	l=12
$Z(\alpha)$	-3.23	-3.79	-4.12	-4.74	-6.16	-7.04	-8.18	-9.53
$Z(t_\alpha)$	-1.33	-1.43	-1.49	-1.59	-1.72	-1.84	-1.99	-2.15
$Z(\Phi_3)$	0.82	0.97	1.06	1.22	1.47	1.69	1.98	2.32
$Z(\Phi_2)$	0.59	0.68	0.74	0.84	0.98	1.13	1.32	1.55

	RKU				RKJ			
$Z(\alpha)$	-12.21	-11.37	-11.13	-12.20	-10.16	-9.61	-9.77	-10.93
$Z(t_\alpha)$	-2.65	-2.57	-2.55	-2.65	-2.42	-2.36	-2.38	-2.49
$Z(\Phi_3)$	3.48	3.27	3.21	3.48	2.93	2.79	2.83	3.12
$Z(\Phi_2)$	2 33	2 19	2.15	2 32	1 95	1 87	1 89	2 08

B. Tests based on Regression Equation (44)

	REU				REJ			
	l=1	l=3	l=6	l=12	l=1	l=3	l=6	l=12
$Z(\alpha)$	-2.99	-3.53	-3.84	-4.41	-3.58	-4.04	-4.64	-5.34
$Z(t_\alpha)$	-1.26	-1.37	-1.42	-1.52	-1.35	-1.43	-1.54	-1.64
$Z(\Phi_1)$	1.60	1.60	1.62	1.68	1.69	1.71	1.77	1.87

Table 7. Continued

	RKU				RKJ			
$Z(\alpha)$	-5.04	-4.47	-4.12	-4.19	-6.91	-6.41	-6.41	-7.05
$Z(t_\alpha)$	-1.58	-1.49	-1.43	-1.44	-1.89	-1.83	-1.83	-1.91
$Z(\Phi_1)$	2.38	2.38	2.40	2.40	2.97	2.94	2.94	2.98

Note: REU(Won/Dollar) and REJ(Won/Yen) are real exchange rates. RKU(RKR-RUR) and RKJ(RKR-RJR) are real interest rate differentials. For real exchange rates, empirical analysis is performed on the logaritms of the series. For real interest rate differentials, empirical analysis is performed on the levels of the series. Critical values are based on Fuller(76). For significance levels, see table (2).

Table 8

Phillips-Perron Unit Root Tests

Test based on Regression Equation (44)

DREU

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-151.79	-155.24	-155.63	-164.99
$Z(t_\alpha)$	-11.04	-11.10	-11.11	-11.25
$Z(\Phi_1)$	62.06	62.58	62.63	64.16

DREJ

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-146.45	-138.19	-143.72	-152.11
$Z(t_\alpha)$	-10.59	-10.46	-10.55	-10.69
$Z(\Phi_1)$	57.07	55.74	56.62	58.01

DRKU

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-228.50	-218.24	-207.38	-200.25
$Z(t_\alpha)$	-16.25	-16.40	-16.64	-16.86
$Z(\Phi_1)$	133.09	135.57	139.64	143.46

DRKJ

	l=1	l=3	l=6	l=12
$Z(\alpha)$	-236.39	-230.23	-225.32	-223.73
$Z(t_\alpha)$	-16.94	-17.04	-17.15	-17.19
$Z(\Phi_1)$	144.45	146.33	148.18	148.85

Significance Levels

	10%	5%	1%
$Z(\alpha)$	-11.2	-14.0	-20.3
$Z(t_\alpha)$	-2.57	-2.88	-3.46
$Z(\Phi_1)$	3.81	4.63	6.52

Table 9

Cointegration Tests

REU on RKU		REJ on RKJ	
DF	ADF	DF	ADF
-1.5552	-1.6642	-1.6693	-2.0258

Note: Numbers reported are the calculated t-statistics for tests for a unit root in the residual processes from cointegrating regressions of equation (32). DF and ADF tests are reported. Critical values based on Engle and Yoo(87) are -3.78, -3.25, -2.98 for the 1%, 5%, and 10% significance levels, respectively.

Table 10

Cointegrating Regressions

A. Korea-US system

	Renormalized
REU = 6.69 - 0.01RKU	RKU = 199.49 - 28.99REU
(0.012) (0.001)	(17.67) (2.68)
CRDW = 0.065	CRDW = 0.100
DF = -1.5552	DF = -2.1948
ADF = -1.6642	ADF = -1.5525

B. Korea-Japan system

	Renormalized
REJ = 1.49 - 0.02RKJ	RKJ = 22.89 - 9.06REJ
(0.034) (0.003)	(1.95) (1.49)
CRDW = 0.044	CRDW = 0.096
DF = -1.6693	DF = -2.1347
ADF = -2.0258	ADF = -2.0309

Note: In the cointegrating regressions standard errors are given in parentheses.

Table 11

Unit Root Tests

A. Korea-US System

KY	KMS	KPS	KR	WD	UY	UMS	UPS	UR
-2.47	-1.92	-1.56	-2.02	-1.52	-3.53	-2.44	-1.41	-1.89

B. Korea-Japan System

KY	KMS	KPS	KR	WY	JY	JMS	JPS	JR
-2.47	-1.92	-1.56	-2.02	-2.86	-4.79	-2.42	-2.24	-3.41

Notes: All regressions contain a constant and a trend. Critical values based on Fuller (1976) are -3.99, -3.43, and -3.13 for the 1%, 5%, and 10% significance level, respectively.

Table 12

Cointegration Test

A. Korea-US System

KY	KMS	KPS	KR	WD	UMS	UPS	UR
-3.62	-3.56	-2.57	-3.67	-2.03	-3.02	-3.08	-4.49

B. Korea-Japan System

KY	KMS	KPS	KR	WY	JMS	JPS	JR
-4.41	-3.96	-3.40	-2.82	-3.36	-4.42	-0.94	-3.04

Notes: Since UY and JY are stationary, based on unit root test, all regressions are performed without these variables. The 5% critical value for this case is larger than 4.50 and, the 10% is larger than 4.2, in absolute terms.

Table 13

Likelihood Ratio Test

A. Korea-US System

	Value of the likelihood ratio		Chi-square	Significance level
Lag 1 vs 2	-66.75	-67.56	139.75	*
Lag 2 vs 3	-67.56	-68.09	87.55	0.290
Lag 2 vs 4	-67.56	-68.75	183.74	0.114
Lag 2 vs 5	-67.56	-69.52	286.34	0.025
Lag 5 vs 6	-69.52	-70.38	118.13	*
Lag 6 vs 7	-70.38	-70.94	71.02	0.778
Lag 6 vs 8	-70.38	-71.82	170.42	0.320
Lag 6 vs 9	-70.38	-72.70	254.35	0.303
Lag 6 vs 10	-70.38	-73.31	295.33	0.870
Lag 6 vs 11	-70.38	-74.12	343.35	0.985
Lag 6 vs 12	-70.38	-75.02	384.77	0.999

B. Korea-Japan System

	Value of the likelihood ratio		Chi-square	Significance level
Lag 1 vs 2	-61.50	-62.40	154.31	*
Lag 2 vs 3	-62.40	-63.09	114.04	*
Lag 3 vs 4	-63.09	-63.67	89.54	0.242
Lag 3 vs 5	-63.09	-64.43	196.13	0.029
Lag 5 vs 6	-64.43	-65.10	91.85	0.192
Lag 5 vs 7	-64.43	-65.83	178.78	0.176
Lag 5 vs 8	-64.43	-66.82	283.51	0.033
Lag 8 ws 9	-66.82	-67.74	101.33	0.063
Lag 8 vs 10	-66.82	-68.66	186.39	0.088
Lag 8 vs 11	-66.82	-69.74	268.92	0.120
Lag 8 vs 12	-66.82	-71.09	354.50	0.115

Notes: * indicates a value of less than 0.01.

Table 14

Partial Correlations of Estimated Residuals

A. Korea-US system

	KMS	KR	KPS	KY	WD	UMS	UR	UPS	UY
KMS	1.000								
KR	0.188*	1.000							
KPS	0.100	0.022	1.000						
KY	0.109	-0.036	0.131#	1.000					
WD	0.047	-0.056	0.069	0.003	1.000				
UMS	0.044	0.100	-0.021	-0.030	0.020	1.000			
UR	-0.197*	0.026	0.068	0.036	0.161*	0.006	1.000		
UPS	-0.013	-0.077	0.277*	-0.268*	0.014	0.066	0.076	1.000	
UY	0.002	0.040	0.006	0.073	-0.165*	0.111	-0.009	-0.033	1.000

B. Korea-Japan system

	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY
KMS	1.000								
KR	0.182	1.000							
KPS	-0.021	0.062	1.000						
KY	0.095	0.073	-0.106	1.000					
WY	0.139#	-0.009	-0.003	-0.067	1.000				
JMS	-0.010	-0.113	0.162*	0.031	-0.186*	1.000			
JR	0.091	-0.035	0.174*	-0.057	0.044	-0.050	1.000		
JPS	0.050	0.147*	-0.109	-0.062	0.010	0.062	0.007	1.000	
JY	-0.073	-0.062	-0.000	0.197*	-0.140#	-0.371*	0.008	0.027	1.000

Notes: * denotes significance at 5%; # denotes significance at 10%, based upon the t-statistic.

Table 15

Critical Levels of F-statistics

A. Korea-US System

DV	KMS	KR	KPS	KY	WD	UMS	UR	UPS	UY
KMS	0.01	0.47	0.47	0.15	0.58	0.93	0.95	0.63	0.08
KR	0.10	0.14	0.24	.*	0.32	0.47	0.17	0.44	0.79
KPS	0.58	0.58	0.11	0.23	0.04	0.78	0.90	*	0.01
KY	0.04	0.83	0.46	*	0.97	0.55	0.29	0.06	0.19
WD	0.70	0.97	0.02	0.09	0.08	0.58	0.25	0.08	0.19
UMS	0.99	0.66	0.49	0.09	0.02	0.28	*	0.58	0.75
UR	0.06	0.33	0.68	0.92	0.03	*	*	0.10	0.02
UPS	0.22	0.74	0.21	0.79	0.11	0.14	0.29	*	0.84
UY	0.32	0.99	0.60	0.50	0.03	0.77	0.18	0.06	*

B. Korea-Japan System

DV	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY
KMS	0.01	0.08	0.25	0.03	0.37	0.05	0.41	0.23	0.09
KR	0.58	0.40	0.43	0.08	0.73	0.77	0.95	0.86	0.55
KPS	0.59	0.16	*	0.64	0.29	0.61	0.41	0.31	0.60
KY	0.12	0.98	0.58	*	0.04	0.42	0.38	0.06	0.55
WY	0.09	0.18	0.24	0.75	*	0.31	0.22	0.35	0.83
JMS	0.22	0.28	0.49	*	0.27	*	0.04	0.33	0.06
JR	0.94	0.49	0.02	0.42	0.03	0.40	0.05	0.24	0.72
JPS	0.77	0.77	0.07	0.76	0.22	0.47	0.71	*	0.07
JY	0.81	0.95	0.39	0.04	0.62	0.02	0.88	*	*

Notes: D.V. is the dependent variable. The critical level is the significance level at which the null hypothesis that all lagged coefficients of indicated right-hand-side variables are zero is rejected.
* indicates a value of less than 0.01.

Table 16

Variance Decompositions

A. Korea-US system

Innovation to

Dependent Variable: KMS

h	KMS	KR	KPS	KY	WD	UMS	UR	UPS	UY	VF	VFR
3	92.7	1.2	1.1	2.9	0.9	0.6	0.3	0.0	0.4	1.3	17.6
	(3.7)	(1.7)	(1.3)	(2.1)	(1.4)	(1.3)	(0.9)	(0.8)	(1.1)		
6	85.7	1.6	1.4	4.4	1.6	1.3	0.3	1.7	2.1	5.4	37.5
	(4.6)	(1.9)	(1.6)	(2.7)	(1.8)	(1.7)	(1.2)	(1.9)	(1.8)		
9	80.8	2.2	1.7	6.9	1.7	1.5	0.6	2.5	2.1	6.7	34.9
	(4.9)	(2.0)	(1.8)	(3.3)	(1.8)	(2.0)	(1.4)	(2.0)	(1.7)		
12	79.6	2.5	1.8	6.9	1.7	1.6	0.8	2.6	2.5	7.5	36.8
	(5.2)	(2.1)	(1.8)	(3.2)	(1.9)	(2.0)	(1.5)	(2.0)	(1.8)		
24	78.5	2.5	1.8	7.0	1.9	1.7	1.3	2.7	2.6	8.3	38.6
	(5.7)	(2.1)	(1.8)	(3.1)	(1.9)	(2.0)	(1.8)	(1.9)	(1.8)		
36	78.4	2.5	1.8	7.0	1.9	1.7	1.3	2.7	2.7	8.4	38.9
	(5.8)	(2.1)	(1.8)	(3.1)	(1.9)	(2.0)	(1.9)	(2.0)	(1.8)		
48	78.2	2.5	1.9	7.0	1.9	1.7	1.3	2.8	2.8	8.6	39.3
	(5.9)	(2.1)	(1.8)	(3.1)	(1.9)	(2.0)	(2.1)	(2.0)	(1.9)		

Dependent Variable: KR

h	KMS	KR	KPS	KY	WD	UMS	UR	UPS	UY	VF	VFR
3	7.0	85.4	2.8	2.4	1.4	0.4	0.5	0.0	0.0	0.9	6.2
	(3.4)	(4.9)	(2.2)	(2.2)	(1.9)	(1.0)	(1.1)	(0.9)	(1.0)		
6	7.2	74.6	2.6	4.5	1.7	1.5	2.9	2.0	3.1	9.5	37.3
	(3.2)	(5.0)	(1.9)	(2.7)	(1.9)	(1.8)	(1.9)	(1.7)	(2.0)		
9	6.5	68.1	3.0	9.6	2.4	2.7	3.0	2.0	2.9	10.6	33.0
	(2.9)	(5.4)	(2.0)	(3.6)	(2.0)	(2.3)	(1.9)	(1.7)	(1.9)		
12	6.8	66.8	3.2	9.9	2.6	2.9	3.0	2.0	2.9	10.8	32.4
	(2.8)	(5.4)	(2.0)	(3.5)	(2.1)	(2.4)	(1.9)	(1.7)	(1.8)		
24	6.8	65.9	3.2	10.1	2.6	2.9	3.2	2.2	3.0	11.3	33.2

Table 16. Continued

	(2.8)	(5.6)	(2.0)	(3.5)	(2.0)	(2.4)	(2.0)	(1.8)	(1.9)		
36	6.8	65.9	3.2	10.1	2.6	2.9	3.2	2.2	3.1	11.4	33.4
	(2.8)	(5.7)	(2.0)	(3.5)	(2.0)	(2.4)	(2.1)	(1.8)	(1.9)		
48	6.8	65.9	3.2	10.1	2.6	2.9	3.2	2.2	3.1	11.4	33.4
	(2.8)	(5.8)	(2.0)	(3.6)	(2.0)	(2.4)	(2.2)	(1.8)	(1.9)		

Dependent Variable: KPS

3	1.7	0.0	85.6	1.5	4.9	0.5	1.1	1.4	3.5	6.5	44.5
	(2.2)	(1.1)	(4.7)	(1.7)	(2.9)	(1.1)	(1.4)	(1.6)	(2.6)		
6	4.8	1.3	71.2	1.6	5.8	0.8	5.0	2.7	6.7	15.2	53.0
	(3.5)	(1.9)	(5.4)	(1.8)	(2.8)	(1.7)	(2.9)	(2.4)	(3.1)		
9	4.0	1.5	60.8	3.6	5.6	0.8	4.4	13.2	6.2	24.6	62.6
	(3.0)	(1.8)	(5.5)	(2.1)	(2.5)	(1.7)	(2.6)	(4.3)	(2.9)		
12	3.9	1.9	58.1	3.6	5.7	1.1	4.8	15.0	5.8	26.7	63.9
	(3.0)	(1.8)	(5.7)	(2.1)	(2.5)	(2.0)	(2.7)	(4.5)	(2.8)		
24	4.1	1.8	54.0	3.3	6.3	1.7	4.5	19.1	5.1	30.4	66.2
	(3.4)	(2.1)	(6.4)	(2.1)	(2.9)	(3.0)	(3.0)	(5.7)	(3.1)		
36	4.1	1.8	53.0	3.2	6.2	1.8	4.4	20.7	4.9	31.8	67.5
	(3.7)	(2.3)	(7.1)	(2.3)	(3.1)	(3.6)	(3.2)	(6.5)	(3.7)		
48	4.1	1.8	52.5	3.2	6.1	1.9	4.4	21.2	4.8	32.3	68.0
	(4.0)	(2.5)	(7.6)	(2.5)	(3.2)	(4.0)	(3.4)	(7.0)	(4.3)		

Dependent Variable: KY

3	5.1	0.4	0.5	89.7	0.3	1.0	0.5	1.6	1.0	4.1	39.4
	(3.3)	(1.3)	(1.4)	(4.5)	(1.0)	(1.4)	(1.1)	(1.5)	(1.5)		
6	6.4	0.5	0.7	82.8	0.7	2.2	3.1	1.6	1.9	8.8	51.5
	(3.3)	(1.6)	(1.6)	(5.1)	(1.5)	(2.4)	(2.2)	(1.8)	(2.2)		
9	6.5	1.0	1.2	79.8	0.8	2.3	3.7	2.2	2.6	10.8	53.2
	(3.4)	(1.9)	(1.7)	(5.5)	(1.6)	(2.3)	(2.4)	(1.9)	(2.2)		
12	6.4	1.3	1.4	77.6	1.1	2.4	4.3	2.4	3.2	12.3	54.7
	(3.3)	(1.9)	(1.7)	(5.5)	(1.6)	(2.2)	(2.5)	(1.9)	(2.1)		
24	6.7	1.3	1.6	76.2	1.2	2.8	4.3	2.4	3.4	12.9	54.4
	(3.2)	(1.9)	(1.7)	(5.9)	(1.6)	(2.3)	(2.5)	(2.0)	(2.2)		
36	6.7	1.3	1.6	76.1	1.2	2.8	4.3	2.4	3.6	13.1	54.8
	(3.3)	(1.9)	(1.7)	(6.0)	(1.7)	(2.3)	(2.5)	(2.1)	(2.2)		
48	6.7	1.3	1.6	75.9	1.2	2.8	4.3	2.5	3.7	13.3	55.2
	(3.3)	(1.9)	(1.7)	(6.2)	(1.7)	(2.3)	(2.6)	(2.3)	(2.3)		

Dependent Variable: WD

3	0.4	0.5	4.3	2.7	87.0	1.3	1.4	0.4	2.1	5.2	39.7
	(1.6)	(1.5)	(2.6)	(2.5)	(4.6)	(1.8)	(1.9)	(1.1)	(2.1)		
6	0.8	0.8	4.3	9.4	74.9	1.5	2.0	3.8	2.6	9.9	39.3

Table 16. Continued

	(1.9)	(1.6)	(2.3)	(3.7)	(5.1)	(1.8)	(1.8)	(2.4)	(2.2)		
9	2.2	1.1	4.7	8.9	68.3	1.5	2.5	8.3	2.5	14.8	46.7
	(2.5)	(1.8)	(2.2)	(3.3)	(5.1)	(1.8)	(1.9)	(3.1)	(2.1)		
12	2.3	1.2	5.1	8.8	66.3	1.7	2.6	9.3	2.8	16.4	48.5
	(2.6)	(1.7)	(2.2)	(3.2)	(5.2)	(1.8)	(1.9)	(3.2)	(2.0)		
24	2.4	1.3	5.5	8.8	64.4	1.9	2.7	10.0	3.0	17.6	49.4
	(2.6)	(1.7)	(2.2)	(3.1)	(5.7)	(2.0)	(2.0)	(3.4)	(2.3)		
36	2.4	1.3	5.7	8.8	63.8	1.9	2.7	10.4	3.0	18.0	49.7
	(2.6)	(1.8)	(2.3)	(3.1)	(6.1)	(2.1)	(2.1)	(3.9)	(2.4)		
48	2.4	1.3	5.8	8.8	63.6	1.9	2.7	10.6	3.0	18.2	49.9
	(2.7)	(1.8)	(2.5)	(3.2)	(6.5)	(2.3)	(2.2)	(4.3)	(2.5)		

Innovation to

h	KMS	KR	KPS	KY	WD	UMS	UR	UPS	UY	WF	WFR
						Dependent Variable: UMS					
3	0.3	1.1	1.1	1.4	0.6	85.6	8.3	0.5	1.0	3.9	27.3
	(1.2)	(1.7)	(1.6)	(2.0)	(1.4)	(4.9)	(3.6)	(1.2)	(1.4)		
6	0.7	2.5	2.3	4.6	5.7	65.1	15.2	1.3	2.7	10.1	28.9
	(1.6)	(2.0)	(1.8)	(2.7)	(2.6)	(5.3)	(4.4)	(1.5)	(2.1)		
9	1.3	2.3	2.5	5.3	10.5	58.3	15.2	1.8	2.9	11.4	27.3
	(2.0)	(2.0)	(1.7)	(2.6)	(3.4)	(5.1)	(4.3)	(1.7)	(2.1)		
12	1.6	2.6	2.6	6.6	10.2	56.6	15.1	1.9	2.8	13.4	30.9
	(2.1)	(2.1)	(1.7)	(2.6)	(3.3)	(5.1)	(4.1)	(1.7)	(2.1)		
24	2.6	2.6	3.0	6.6	10.2	55.1	15.0	2.0	3.0	14.8	32.9
	(2.5)	(2.0)	(1.8)	(2.6)	(3.2)	(5.3)	(4.0)	(1.9)	(2.3)		
36	2.6	2.6	3.0	6.6	10.2	55.0	15.0	2.0	3.0	14.8	32.9
	(2.7)	(2.0)	(1.8)	(2.7)	(3.2)	(5.5)	(4.0)	(2.0)	(2.4)		
48	2.6	2.6	3.0	6.6	10.2	55.0	15.0	2.0	3.1	14.8	32.8
	(2.8)	(2.0)	(1.9)	(2.7)	(3.2)	(5.6)	(4.0)	(2.3)	(2.5)		
						Dependent Variable: UR					
3	4.7	2.8	3.1	0.3	5.7	4.4	70.8	1.7	6.7	10.9	46.0
	(2.9)	(2.5)	(2.2)	(1.2)	(2.9)	(2.6)	(6.0)	(1.8)	(3.4)		
6	4.6	3.1	3.0	1.2	9.5	6.0	62.9	3.1	6.6	11.9	32.1
	(2.7)	(2.6)	(2.2)	(1.8)	(3.4)	(2.6)	(5.6)	(2.3)	(3.0)		
9	6.0	3.4	3.1	1.8	8.8	7.7	58.2	4.8	6.3	14.3	34.1
	(3.0)	(2.5)	(2.1)	(2.0)	(3.2)	(2.8)	(5.5)	(2.6)	(2.8)		
12	6.5	3.8	3.4	2.2	8.6	7.8	56.5	4.8	6.5	15.9	36.5
	(3.0)	(2.6)	(2.0)	(2.1)	(3.1)	(2.8)	(5.5)	(2.5)	(2.8)		

Table 16. Continued

24	6.6	3.9	3.5	2.6	8.5	7.8	55.5	5.2	6.5	16.6	37.2
	(3.1)	(2.6)	(2.1)	(2.2)	(3.0)	(2.7)	(5.7)	(2.6)	(2.8)		
36	6.6	3.9	3.5	2.6	8.5	7.8	55.4	5.2	6.5	16.6	37.2
	(3.2)	(2.6)	(2.2)	(2.3)	(3.0)	(2.7)	(5.8)	(2.7)	(2.8)		
48	6.6	3.9	3.6	2.6	8.5	7.8	55.3	5.2	6.5	16.7	37.4
	(3.3)	(2.6)	(2.3)	(2.3)	(3.0)	(2.7)	(6.0)	(2.8)	(2.9)		

Dependent Variable: UPS

3	0.2	0.4	15.1	7.6	0.8	3.0	2.6	69.1	1.4	23.3	74.9
	(1.3)	(1.4)	(5.3)	(3.5)	(1.4)	(2.4)	(2.4)	(6.1)	(1.9)		
6	0.7	1.8	14.6	6.9	2.4	3.2	9.3	56.6	4.4	24.0	55.4
	(2.0)	(2.6)	(5.2)	(3.3)	(2.3)	(2.6)	(4.8)	(6.3)	(3.4)		
9	2.8	1.9	14.0	6.1	5.0	3.8	8.0	54.5	4.1	24.8	54.3
	(2.6)	(2.3)	(5.0)	(2.7)	(3.3)	(3.1)	(3.9)	(6.2)	(3.2)		
12	3.0	1.8	15.9	5.6	4.6	4.5	7.3	53.3	4.0	26.3	56.3
	(2.8)	(2.4)	(5.5)	(2.7)	(3.2)	(3.6)	(3.7)	(6.5)	(3.5)		
24	3.7	1.9	18.1	5.2	4.6	4.5	6.7	51.7	3.7	28.9	59.7
	(3.6)	(2.8)	(6.3)	(3.0)	(3.4)	(4.1)	(3.7)	(7.2)	(4.3)		
36	3.7	1.9	18.7	5.0	4.6	4.5	6.5	51.6	3.5	29.3	60.5
	(3.9)	(3.0)	(6.8)	(3.1)	(3.6)	(4.5)	(3.9)	(7.8)	(4.9)		
48	3.8	1.9	19.0	4.9	4.6	4.5	6.4	51.5	3.5	29.6	60.9
	(4.2)	(3.1)	(7.0)	(3.2)	(3.8)	(4.7)	(4.0)	(8.3)	(5.5)		

Dependent Variable: UY

3	0.9	0.2	0.6	1.1	2.2	1.4	10.7	0.2	82.8	2.8	16.2
	(1.7)	(1.2)	(1.3)	(2.2)	(2.7)	(2.1)	(5.0)	(1.1)	(6.1)		
6	2.1	0.3	0.4	3.7	4.6	1.8	8.5	1.7	76.9	6.5	28.1
	(3.2)	(1.9)	(1.5)	(4.1)	(4.5)	(2.9)	(5.4)	(2.7)	(8.2)		
9	4.1	0.9	0.2	6.2	3.8	2.4	5.7	4.7	71.8	11.4	40.7
	(4.9)	(3.1)	(1.7)	(5.5)	(4.6)	(3.7)	(4.8)	(4.5)	(9.9)		
12	5.9	1.3	0.2	6.7	2.8	2.3	4.1	8.3	68.5	14.1	44.6
	(6.2)	(3.8)	(2.0)	(6.1)	(4.1)	(4.1)	(4.3)	(6.2)	(11.2)		
24	5.5	1.7	2.3	5.6	1.5	1.2	2.0	21.1	59.1	15.1	36.9
	(7.2)	(4.7)	(4.4)	(6.2)	(3.2)	(4.3)	(3.9)	(10.6)	(13.9)		
36	3.9	2.0	5.2	5.1	1.2	0.8	1.3	28.7	51.7	16.2	33.6
	(6.7)	(4.9)	(6.7)	(6.2)	(3.2)	(4.5)	(4.1)	(12.6)	(15.4)		
48	2.9	2.1	7.7	4.8	1.2	0.7	1.1	33.8	45.6	17.5	32.2
	(6.5)	(5.0)	(8.2)	(6.2)	(3.5)	(4.9)	(4.4)	(13.6)	(16.4)		

Table 16. Continued

B. Korea-Japan System

Innovation to

Dependent Variable: KMS

h	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY	VF	VFR
3	83.4	4.1	1.5	3.4	1.6	2.9	0.2	2.4	0.4	5.9	35.8
	(4.6)	(2.7)	(1.7)	(2.5)	(1.7)	(1.9)	(1.0)	(1.5)	(1.0)		
6	69.5	3.5	2.5	6.1	2.4	4.0	2.0	3.6	6.6	16.2	52.8
	(4.8)	(2.2)	(2.1)	(3.2)	(2.0)	(2.0)	(1.8)	(1.7)	(3.1)		
9	60.2	5.1	3.8	7.3	2.7	6.4	3.0	3.7	7.8	20.9	52.5
	(4.4)	(2.3)	(2.4)	(3.1)	(2.1)	(2.6)	(2.0)	(1.8)	(3.1)		
12	57.9	5.3	3.9	8.2	3.2	6.3	3.4	4.0	8.0	21.7	51.3
	(4.5)	(2.4)	(2.4)	(3.2)	(2.1)	(2.5)	(2.1)	(1.9)	(2.9)		
24	54.0	5.2	4.9	8.6	3.6	6.9	4.6	4.1	8.1	23.7	51.5
	(4.8)	(2.4)	(2.5)	(3.3)	(2.0)	(2.4)	(2.6)	(1.9)	(2.8)		
36	53.5	5.3	4.9	8.7	3.6	6.9	4.7	4.1	8.3	24.0	51.6
	(5.2)	(2.4)	(2.7)	(3.5)	(2.1)	(2.5)	(2.9)	(1.9)	(2.9)		
48	53.5	5.3	4.9	8.7	3.6	6.9	4.7	4.1	8.3	24.0	51.6
	(5.5)	(2.5)	(2.8)	(3.7)	(2.2)	(2.7)	(3.1)	(2.0)	(3.0)		

Dependent Variable: KR

h	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY	VF	VFR
3	5.5	83.8	4.5	2.1	1.5	0.5	0.2	0.1	1.8	2.6	16.0
	(3.2)	(4.9)	(2.6)	(2.1)	(1.6)	(1.3)	(0.9)	(0.8)	(1.8)		
6	8.0	76.6	4.3	4.1	1.9	1.3	0.3	0.6	3.0	5.2	22.1
	(3.3)	(5.1)	(2.3)	(2.7)	(1.9)	(1.7)	(1.3)	(1.4)	(2.2)		
9	7.5	68.3	5.4	9.8	1.9	1.4	1.0	0.9	3.8	7.1	22.4
	(3.0)	(5.0)	(2.5)	(3.8)	(1.9)	(1.7)	(1.6)	(1.5)	(2.4)		
12	7.4	66.3	5.8	10.0	1.9	1.7	1.8	1.3	3.7	8.5	25.3
	(2.8)	(4.9)	(2.5)	(3.6)	(1.9)	(1.8)	(1.8)	(1.6)	(2.3)		
24	7.3	63.6	6.8	10.0	2.4	1.9	2.2	1.9	3.9	9.9	27.2
	(2.7)	(5.1)	(2.6)	(3.4)	(2.0)	(1.8)	(2.2)	(1.8)	(2.2)		
36	7.3	63.4	6.8	10.1	2.4	1.9	2.2	1.9	3.9	9.9	27.1
	(2.8)	(5.4)	(2.6)	(3.6)	(2.1)	(1.9)	(2.4)	(2.1)	(2.3)		
48	7.3	63.3	6.8	10.1	2.4	2.0	2.2	1.9	3.9	10.0	27.3
	(2.9)	(5.8)	(2.7)	(3.7)	(2.1)	(2.1)	(2.6)	(2.2)	(2.4)		

Table 16. Continued

Dependent Variable: KPS

3	0.2	1.5	91.1	0.5	0.0	0.5	1.3	3.1	1.8	6.7	75.3
	(1.1)	(2.1)	(3.9)	(1.2)	(0.8)	(1.0)	(1.5)	(1.8)	(1.7)		
6	3.5	5.8	78.9	2.1	0.2	1.4	2.0	3.2	2.9	9.5	45.0
	(3.2)	(3.7)	(5.3)	(2.0)	(1.3)	(1.5)	(2.0)	(1.7)	(2.2)		
9	3.2	7.3	72.5	5.7	1.5	1.6	1.9	3.2	3.2	9.9	35.9
	(3.0)	(3.5)	(5.5)	(3.3)	(1.7)	(1.5)	(2.0)	(1.7)	(2.0)		
12	3.2	7.7	72.2	5.9	1.6	1.5	1.9	2.9	3.0	9.3	33.6
	(3.4)	(3.7)	(5.9)	(3.6)	(2.1)	(1.5)	(1.9)	(1.6)	(1.9)		
24	3.3	7.8	70.0	6.4	3.0	1.6	2.1	2.9	3.1	9.7	32.1
	(4.1)	(3.7)	(6.9)	(4.1)	(3.9)	(1.6)	(2.0)	(1.7)	(2.4)		
36	3.4	7.7	69.6	6.4	3.2	1.6	2.1	2.8	3.2	9.7	31.9
	(4.5)	(3.6)	(7.6)	(4.2)	(4.3)	(1.7)	(2.0)	(1.8)	(2.6)		
48	3.4	7.7	69.4	6.5	3.2	1.7	2.1	2.9	3.3	10.0	32.5
	(4.6)	(3.7)	(7.9)	(4.3)	(4.5)	(1.8)	(2.1)	(1.9)	(2.7)		

Dependent Variable: KY

3	2.9	0.5	1.6	84.9	5.8	0.4	1.1	0.3	2.7	4.5	29.4
	(2.3)	(1.5)	(1.8)	(4.5)	(2.8)	(1.1)	(1.2)	(1.0)	(2.2)		
6	4.1	1.4	2.4	67.7	7.6	7.2	3.2	3.8	2.5	16.7	51.9
	(2.6)	(1.9)	(1.9)	(5.3)	(3.5)	(3.1)	(2.2)	(2.2)	(1.9)		
9	4.6	2.4	3.4	64.5	7.6	7.0	3.1	4.7	2.7	17.5	49.3
	(2.7)	(2.3)	(2.3)	(5.2)	(3.3)	(2.9)	(2.1)	(2.6)	(2.1)		
12	4.8	3.2	3.9	60.2	9.1	7.1	3.7	4.8	3.3	18.9	47.4
	(2.6)	(2.5)	(2.4)	(5.2)	(3.3)	(2.8)	(2.3)	(2.6)	(2.1)		
24	4.9	3.3	4.1	58.1	9.1	6.9	4.1	5.2	4.4	20.6	49.0
	(2.5)	(2.5)	(2.4)	(5.4)	(3.2)	(2.5)	(2.4)	(2.7)	(2.5)		
36	4.9	3.4	4.1	57.7	9.1	6.9	4.2	5.2	4.5	20.8	49.2
	(2.6)	(2.6)	(2.6)	(5.6)	(3.2)	(2.7)	(2.7)	(2.8)	(2.7)		
48	4.9	3.4	4.1	57.6	9.1	6.9	4.2	5.2	4.6	20.9	49.3
	(2.7)	(2.6)	(2.7)	(5.9)	(3.3)	(2.8)	(2.9)	(3.0)	(2.9)		

Dependent Variable: WY

3	2.4	4.1	0.9	1.4	85.0	3.6	1.2	1.2	0.3	6.3	41.7
	(2.0)	(2.9)	(1.4)	(1.8)	(4.8)	(2.6)	(1.4)	(1.3)	(0.9)		
6	4.9	7.1	1.8	4.5	73.4	3.3	2.3	2.1	0.8	8.5	31.7
	(2.6)	(3.4)	(1.9)	(2.9)	(5.5)	(2.3)	(1.9)	(1.8)	(1.6)		
9	5.4	6.9	4.9	5.3	67.3	3.5	3.6	2.4	0.8	10.3	31.4
	(2.9)	(3.1)	(2.7)	(2.9)	(5.1)	(2.2)	(2.1)	(1.9)	(1.5)		
12	6.2	7.0	4.8	5.4	65.0	4.2	3.7	2.6	1.1	11.6	33.1
	(3.0)	(3.0)	(2.7)	(2.9)	(5.2)	(2.3)	(2.1)	(1.9)	(1.5)		
24	6.4	7.1	5.2	5.7	63.4	4.3	3.8	2.8	1.3	12.2	33.3
	(3.1)	(2.9)	(2.7)	(2.8)	(5.3)	(2.2)	(2.2)	(1.9)	(1.7)		

Table 16. Continued

36	6.5	7.1	5.3	5.8	63.1	4.3	3.8	2.8	1.4	12.3	33.2
	(3.1)	(2.8)	(2.8)	(2.8)	(5.4)	(2.3)	(2.3)	(2.0)	(1.8)		
48	6.5	7.1	5.3	5.8	63.1	4.3	3.8	2.8	1.4	12.3	33.2
	(3.2)	(2.9)	(2.9)	(2.8)	(5.6)	(2.3)	(2.5)	(2.0)	(1.8)		

Innovation to

h	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY	WF	WFR
					Dependent Variable: JMS						
3	2.3	4.2	2.3	1.7	4.4	75.4	4.9	0.4	4.5	10.5	42.5
	(2.1)	(3.0)	(2.0)	(2.0)	(2.8)	(5.5)	(2.8)	(0.9)	(2.8)		
6	3.1	3.8	3.6	4.5	4.2	61.5	8.0	2.5	8.8	15.0	39.0
	(2.3)	(2.6)	(2.4)	(2.8)	(2.8)	(5.3)	(3.3)	(1.9)	(3.6)		
9	4.8	3.7	5.4	5.3	4.4	50.6	10.2	5.6	10.1	19.2	38.8
	(2.7)	(2.6)	(2.7)	(2.8)	(2.7)	(5.0)	(3.7)	(2.8)	(3.8)		
12	4.6	3.3	5.2	7.1	4.9	47.4	11.1	5.5	11.0	20.2	38.3
	(2.5)	(2.5)	(2.7)	(3.1)	(2.9)	(5.0)	(3.9)	(2.8)	(4.1)		
24	4.5	3.2	6.1	10.2	4.9	39.7	11.6	5.3	14.6	24.0	39.7
	(2.7)	(2.8)	(2.7)	(3.5)	(3.1)	(5.3)	(4.0)	(3.0)	(4.9)		
36	4.5	3.3	6.1	10.2	5.0	39.2	11.7	5.3	14.9	24.1	39.5
	(2.8)	(3.0)	(2.8)	(3.6)	(3.3)	(5.5)	(4.0)	(3.1)	(5.3)		
48	4.5	3.3	6.1	10.2	5.0	39.1	11.7	5.3	14.9	24.1	39.5
	(2.9)	(3.1)	(2.9)	(3.8)	(3.4)	(5.8)	(4.1)	(3.1)	(5.6)		
					Dependent Variable: JR						
3	1.3	1.1	8.9	3.7	0.7	0.8	81.7	1.7	0.0	15.0	82.4
	(1.7)	(1.7)	(3.3)	(2.3)	(1.4)	(1.4)	(4.6)	(1.6)	(0.7)		
6	1.8	4.1	8.8	4.5	2.3	1.2	74.1	2.5	0.8	19.2	73.8
	(1.9)	(2.7)	(3.2)	(2.3)	(1.9)	(1.6)	(4.8)	(1.8)	(1.3)		
9	2.7	4.4	11.8	3.9	5.5	2.1	65.7	2.6	1.4	22.8	66.3
	(2.1)	(2.6)	(3.2)	(2.0)	(2.6)	(1.8)	(4.6)	(1.7)	(1.5)		
12	3.4	3.9	14.2	3.6	7.5	3.2	58.8	2.8	2.6	25.1	60.9
	(2.0)	(2.4)	(3.3)	(1.9)	(2.8)	(2.0)	(4.5)	(1.6)	(1.7)		
24	4.2	4.9	14.8	3.8	8.6	3.2	54.7	3.0	2.9	27.7	61.0
	(2.2)	(2.6)	(3.2)	(1.9)	(3.0)	(2.1)	(4.7)	(1.7)	(1.8)		
36	4.2	5.0	14.7	3.9	8.6	3.2	54.4	3.0	3.0	27.8	61.0
	(2.2)	(2.6)	(3.3)	(2.1)	(3.2)	(2.2)	(5.0)	(1.8)	(2.0)		
48	4.2	5.0	14.7	3.9	8.6	3.2	54.4	3.0	3.0	27.8	61.0
	(2.3)	(2.7)	(3.4)	(2.2)	(3.3)	(2.4)	(5.3)	(1.9)	(2.1)		

Table 16. Continued

Dependent Variable: JPS

3	1.2	1.7	2.7	0.4	2.7	0.6	1.3	84.2	5.4	6.0	37.5
	(1.6)	(1.9)	(2.3)	(1.3)	(2.1)	(1.5)	(1.8)	(4.8)	(2.6)		
6	2.9	2.3	7.9	1.3	3.0	2.0	2.6	72.8	5.5	14.4	52.4
	(2.1)	(2.1)	(3.3)	(1.9)	(2.1)	(2.2)	(2.0)	(5.0)	(2.5)		
9	2.9	2.5	10.2	1.2	5.9	2.3	2.5	67.4	5.1	16.8	51.5
	(2.1)	(2.2)	(3.4)	(1.8)	(2.7)	(2.2)	(2.0)	(4.7)	(2.3)		
12	3.4	2.8	10.5	1.5	6.6	2.5	2.5	64.7	5.5	18.2	51.6
	(2.1)	(2.2)	(3.3)	(1.9)	(2.8)	(2.2)	(1.9)	(4.8)	(2.3)		
24	4.6	3.2	12.1	1.9	7.3	2.6	2.8	60.2	5.5	21.8	54.5
	(2.7)	(2.2)	(3.9)	(2.1)	(3.0)	(2.1)	(1.9)	(5.2)	(2.3)		
36	4.6	3.2	12.3	2.2	7.2	2.6	2.8	59.4	5.7	22.3	54.9
	(2.8)	(2.2)	(4.2)	(2.2)	(3.1)	(2.2)	(2.0)	(5.6)	(2.5)		
48	4.5	3.2	12.4	2.2	7.3	2.6	2.8	59.2	5.8	22.3	54.7
	(2.9)	(2.3)	(4.4)	(2.4)	(3.3)	(2.3)	(2.2)	(5.9)	(2.6)		

Dependent Variable: JY

3	0.6	0.3	1.6	6.8	1.4	5.6	0.7	3.0	80.2	9.3	46.5
	(1.5)	(1.4)	(1.9)	(3.9)	(2.0)	(2.3)	(1.4)	(2.1)	(5.3)		
6	0.3	0.4	2.2	15.5	2.4	4.2	0.4	5.3	69.4	18.4	59.9
	(1.6)	(2.2)	(3.1)	(6.8)	(3.0)	(3.0)	(1.6)	(3.7)	(8.0)		
9	1.0	0.3	1.4	18.9	2.9	4.5	0.5	9.9	60.7	21.6	54.8
	(2.8)	(2.5)	(2.8)	(8.6)	(3.9)	(3.7)	(2.0)	(5.4)	(9.7)		
12	2.7	0.2	1.0	19.5	2.6	5.0	0.4	12.6	56.1	23.4	53.2
	(4.6)	(2.8)	(2.9)	(9.5)	(4.1)	(4.3)	(2.0)	(6.6)	(10.7)		
24	5.9	0.1	1.0	17.0	2.3	7.5	0.3	22.8	43.2	24.0	42.2
	(8.6)	(3.4)	(4.8)	(10.0)	(4.5)	(5.5)	(2.0)	(10.0)	(11.4)		
36	4.7	0.2	3.6	14.6	3.6	8.5	0.2	26.1	38.5	23.1	37.6
	(8.7)	(3.5)	(7.8)	(9.6)	(6.4)	(5.8)	(2.0)	(11.1)	(11.4)		
48	3.7	0.3	6.1	14.1	4.1	8.8	0.2	26.9	35.9	24.2	37.7
	(8.7)	(3.6)	(9.9)	(9.7)	(7.0)	(5.9)	(2.1)	(11.6)	(11.6)		

Notes: h is the forecast horizon. The numbers in parentheses are standard deviations. WF is the proportion of forecast error variance of foreign variable explained by all Korean shocks. This can be obtained by summing the first four columns at each horizon.
WFR is the proportion explained by Korean shocks relative to the proportion explained by all variables in each system except the dependent variable.

Table 17

Variance Decompositions for Korean Variables

A. Korea-Japan System(10 variables; ups)

Innovation to

h	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY	UPS	VF	VFR
					Dependent Variable: KMS							
3	90.3	1.7	1.7	2.1	0.4	2.3	0.1	0.7	0.7	0 0	3.8	39.2
	(3.7)	(1.9)	(1.8)	(1.9)	(1.2)	(1.7)	(0.8)	(1.3)	(1.2)	(0.8)		
6	83.2	1.8	2.4	4.2	0.9	2.5	1.6	2.2	0.7	0.1	7.1	43.3
	(4.6)	(1.8)	(1.9)	(2.5)	(1.4)	(1.8)	(1.7)	(2.1)	(1.2)	(1.1)		
9	82.6	1.9	2.4	4.2	0.9	2.7	1.9	2.2	0.7	0.5	8.0	46.0
	(4.9)	(1.8)	(1.9)	(2.5)	(1.4)	(1.8)	(1.7)	(2.1)	(1.2)	(1.1)		
12	82.5	1.9	2.4	4.2	1.0	2.7	1.9	2.2	0.7	0.6	8.1	46.0
	(4.9)	(1.8)	(1.9)	(2.5)	(1.4)	(1.8)	(1.7)	(2.1)	(1.2)	(1.1)		
24	82.4	1.9	2.4	4.2	1.0	2.7	1.9	2.2	0.8	0.6	8.2	46.3
	(4.9)	(1.8)	(1.9)	(2.5)	(1.4)	(1.8)	(1.7)	(2.1)	(1.2)	(1.1)		
36	82.4	1.9	2.4	4.2	1.0	2.7	1.9	2.2	0.8	0.6	8.2	46.3
	(4.9)	(1.8)	(1.9)	(2.5)	(1.4)	(1.8)	(1.7)	(2.1)	(1.2)	(1.1)		
48	82.3	1.9	2.4	4.2	1.0	2.7	1.9	2.3	0.9	0.6	8.4	46.9
	(4.9)	(1.8)	(1.9)	(2.5)	(1.4)	(1.8)	(1.7)	(2.1)	(1.2)	(1.1)		
					Dependent Variable: KR							
3	4.1	86.0	2.8	1.7	1.6	2.2	0.1	0.0	1.0	0.5	3.8	27.1
	(2.7)	(4.8)	(2.4)	(1.7)	(1.6)	(2.3)	(0.9)	(0.9)	(1.3)	(1.1)		
6	4.5	82.5	2.9	2.5	1.8	2.2	0.6	1.0	1.1	0.9	5.8	33.1
	(2.9)	(5.3)	(2.3)	(2.0)	(1.7)	(2.3)	(1.1)	(1.6)	(1.3)	(1.2)		
9	4.5	81.9	2.9	2.6	1.8	2.4	0.7	1.2	1.1	0.9	6.3	34.8
	(2.8)	(5.5)	(2.3)	(1.9)	(1.7)	(2.3)	(1.1)	(1.7)	(1.3)	(1.2)		
12	4.5	81.9	2.9	2.6	1.8	2.4	0.7	1.2	1.1	0.9	6.3	34.8
	(2.8)	(5.6)	(2.3)	(1.9)	(1.7)	(2.3)	(1.1)	(1.7)	(1.3)	(1.2)		
24	4.5	81.9	2.9	2.6	1.8	2.4	0.7	1.2	1.1	0.9	6.3	34.8
	(2.8)	(5.6)	(2.3)	(1.9)	(1.7)	(2.3)	(1.1)	(1.7)	(1.3)	(1.2)		
36	4.5	81.9	2.9	2.6	1.8	2.4	0.7	1.2	1.1	0.9	6.3	34.8

Table 17. Continued

	(2.8)	(5.6)	(2.3)	(1.9)	(1.7)	(2.3)	(1.1)	(1.7)	(1.3)	(1.2)		
48	4.5	81.9	2.9	2.6	1.8	2.4	0.7	1.2	1.1	0.9	6.3	34.8
	(2.8)	(5.6)	(2.3)	(1.9)	(1.7)	(2.3)	(1.1)	(1.7)	(1.3)	(1.2)		

Dependent Variable: KPS

3	0.1	1.5	93.2	0.3	0.1	0.2	0.5	2.6	0.4	1.3	5.0	71.4
	(1.1)	(2.4)	(4.0)	(1.1)	(0.9)	(1.0)	(1.1)	(1.8)	(1.1)	(1.5)		
6	0.2	1.6	85.9	0.5	0.5	1.9	0.7	2.4	0.9	5.6	11.5	80.4
	(1.2)	(2.1)	(5.1)	(1.3)	(1.4)	(1.7)	(1.2)	(2.0)	(1.5)	(3.3)		
9	0.2	1.7	83.2	1.0	0.8	1.9	1.0	2.3	1.0	6.9	13.1	78.0
	(1.2)	(2.3)	(5.9)	(1.4)	(1.6)	(1.7)	(1.3)	(2.1)	(1.6)	(3.7)		
12	0.2	1.8	82.5	1.1	0.9	1.9	1.0	2.3	1.1	7.2	13.5	77.1
	(1.2)	(2.3)	(6.2)	(1.4)	(1.8)	(1.7)	(1.3)	(2.2)	(1.7)	(3.9)		
24	0.2	1.8	81.3	1.2	0.9	1.9	1.0	2.5	1.7	7.5	14.6	78.1
	(1.2)	(2.4)	(6.7)	(1.5)	(2.0)	(1.7)	(1.4)	(2.4)	(1.9)	(4.2)		
36	0.2	1.8	80.4	1.3	0.9	1.9	1.1	2.7	2.2	7.5	15.4	78.6
	(1.2)	(2.4)	(6.8)	(1.5)	(2.0)	(1.7)	(1.4)	(2.5)	(2.2)	(4.2)		
48	0.2	1.8	79.4	1.4	0.9	1.8	1.2	2.9	2.9	7.5	16.3	79.1
	(1.2)	(2.4)	(7.0)	(1.6)	(2.0)	(1.6)	(1.4)	(2.6)	(2.6)	(4.2)		

Dependent Variable: KY

3	5.6	0.6	0.9	85.7	3.5	0.6	1.2	0.3	1.0	0.8	3.9	26.9
	(3.2)	(1.4)	(1.6)	(4.5)	(2.2)	(1.2)	(1.2)	(0.9)	(1.4)	(1.1)		
6	5.1	0.7	1.7	75.4	3.8	6.3	3.5	1.2	1.4	0.8	13.2	53.9
	(3.0)	(1.5)	(1.7)	(5.3)	(2.3)	(3.2)	(2.2)	(1.6)	(1.3)	(1.1)		
9	5.4	0.7	1.8	74.7	3.8	6.3	3.5	1.4	1.4	1.0	13.6	53.8
	(3.0)	(1.5)	(1.7)	(5.5)	(2.3)	(3.2)	(2.1)	(1.7)	(1.3)	(1.0)		
12	5.4	0.7	1.8	74.6	3.8	6.3	3.5	1.4	1.4	1.0	13.6	53.8
	(3.0)	(1.6)	(1.7)	(5.5)	(2.3)	(3.2)	(2.1)	(1.6)	(1.3)	(1.1)		
24	5.4	0.7	1.9	74.5	3.8	6.3	3.5	1.4	1.5	1.0	13.7	53.7
	(3.0)	(1.6)	(1.8)	(5.5)	(2.3)	(3.2)	(2.1)	(1.6)	(1.3)	(1.1)		
36	5.4	0.7	1.9	74.4	3.8	6.3	3.5	1.4	1.5	1.0	13.7	53.7
	(3.0)	(1.6)	(1.8)	(5.6)	(2.3)	(3.2)	(2.1)	(1.7)	(1.3)	(1.1)		
48	5.4	0.7	1.9	74.4	3.8	6.3	3.5	1.5	1.6	1.0	13.9	54.1
	(3.0)	(1.6)	(1.8)	(5.6)	(2.3)	(3.2)	(2.1)	(1.7)	(1.3)	(1.1)		

Dependent Variable: WY

3	1.5	2.5	0.8	0.8	88.2	2.7	1.0	0.6	0.5	1.6	6.4	53.3
	(1.7)	(2.7)	(1.7)	(1.6)	(4.8)	(2.3)	(1.3)	(1.2)	(1.1)	(1.8)		
6	1.6	3.0	1.0	1.3	85.7	3.1	1.2	1.1	0.6	1.5	7.5	52.1
	(1.7)	(2.7)	(1.9)	(1.9)	(5.4)	(2.3)	(1.4)	(1.6)	(1.2)	(1.8)		
9	1.5	3.0	1.1	1.3	85.1	3.3	1.4	1.2	0.6	1.6	8.1	54.0

Table 17. Continued

	(1.7)	(2.7)	(2.0)	(1.9)	(5.6)	(2.4)	(1.5)	(1.7)	(1.2)	(1.8)		
12	1.6	3.0	1.2	1.3	85.0	3.3	1.4	1.2	0.6	1.6	8.1	53.3
	(1.7)	(2.7)	(2.0)	(1.9)	(5.7)	(2.4)	(1.5)	(1.7)	(1.2)	(1.9)		
24	1.6	3.0	1.2	1.3	84.9	3.3	1.4	1.2	0.6	1.6	8.1	53.3
	(1.7)	(2.7)	(2.1)	(1.9)	(5.8)	(2.4)	(1.5)	(1.7)	(1.2)	(1.9)		
36	1.6	3.0	1.2	1.3	84.8	3.3	1.4	1.2	0.7	1.6	8.2	53.6
	(1.7)	(2.7)	(2.1)	(1.9)	(5.8)	(2.4)	(1.5)	(1.7)	(1.2)	(1.9)		
48	1.6	3.0	1.2	1.3	84.8	3.3	1.4	1.2	0.7	1.6	8.2	53.6
	(1.7)	(2.7)	(2.1)	(1.9)	(5.7)	(2.4)	(1.5)	(1.7)	(1.2)	(1.9)		

Table 17. Continued

B. Korea-Japan System(10 variables: ur)

Innovation to

Dependent Variable: KMS

h	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY	UR	VF	VFR
3	89.7	1.5	1.2	2.6	0.2	2.3	0.1	1.1	0.6	0 6	4.7	46.1
	(3.9)	(1.9)	(1.4)	(2.0)	(1.0)	(1.7)	(0.9)	(1.4)	(1.2)	(1.3)		
6	83.4	1.6	1.7	4.4	0.8	2.5	1.9	2.3	0.6	0.8	8.1	48.8
	(4.9)	(1.9)	(1.6)	(2.6)	(1.3)	(1.9)	(1.9)	(1.9)	(1.3)	(1.3)		
9	82.4	1.6	1.7	4.4	0.8	2.7	2.3	2.4	0.7	1.0	9.1	51.7
	(5.2)	(1.9)	(1.6)	(2.6)	(1.3)	(1.9)	(1.9)	(1.9)	(1.2)	(1.3)		
12	82.3	1.7	1.7	4.4	0.8	2.7	2.3	2.4	0.7	1.0	9.1	51.4
	(5.2)	(1.9)	(1.6)	(2.6)	(1.4)	(1.9)	(1.9)	(2.0)	(1.2)	(1.3)		
24	82.2	1.7	1.7	4.4	0.8	2.7	2.3	2.4	0.7	1.0	9.1	51.4
	(5.3)	(1.9)	(1.6)	(2.6)	(1.4)	(1.9)	(1.9)	(2.0)	(1.3)	(1.3)		
36	82.2	1.7	1.7	4.4	0.8	2.7	2.3	2.4	0.8	1.0	9.2	51.7
	(5.3)	(1.9)	(1.6)	(2.6)	(1.4)	(1.9)	(1.9)	(2.0)	(1.3)	(1.3)		
48	82.1	1.7	1.7	4.4	0.8	2.7	2.3	2.5	0.8	1.0	9.3	52.0
	(5.3)	(1.9)	(1.6)	(2.6)	(1.4)	(1.9)	(1.9)	(2.0)	(1.3)	(1.3)		

Dependent Variable: KR

h	KMS	KR	KPS	KY	WY	JMS	JR	JPS	JY	UR	VF	VFR
3	3.9	86.8	2.5	1.4	1.5	1.9	0.1	0.0	1.0	1.0	4.0	30.1
	(2.7)	(4.4)	(2.2)	(1.7)	(1.6)	(2.0)	(0.9)	(0.8)	(1.2)	(1.5)		
6	4.4	82.8	2.5	2.2	1.7	1.9	0.6	1.0	1.1	2.0	6.6	37.9
	(2.7)	(5.1)	(2.1)	(2.0)	(1.6)	(2.1)	(1.2)	(1.5)	(1.3)	(1.6)		
9	4.4	82.2	2.5	2.3	1.7	2.1	0.7	1.2	1.1	2.0	7.1	39.4
	(2.7)	(5.3)	(2.1)	(2.0)	(1.6)	(2.1)	(1.2)	(1.5)	(1.3)	(1.6)		
12	4.4	82.2	2.5	2.3	1.7	2.1	0.7	1.2	1.1	2.0	7.1	39.4
	(2.7)	(5.4)	(2.1)	(2.0)	(1.6)	(2.1)	(1.2)	(1.5)	(1.3)	(1.6)		
24	4.4	82.2	2.5	2.3	1.7	2.1	0.7	1.2	1.1	2.0	7.1	39.4
	(2.7)	(5.4)	(2.1)	(2.0)	(1.6)	(2.1)	(1.2)	(1.5)	(1.2)	(1.6)		
36	4.4	82.2	2.5	2.3	1.7	2.1	0.7	1.2	1.1	2.0	7.1	39.4
	(2.7)	(5.4)	(2.1)	(2.0)	(1.6)	(2.1)	(1.2)	(1.5)	(1.2)	(1.6)		
48	4.4	82.2	2.5	2.3	1.7	2.1	0.7	1.2	1.1	2.0	7.1	39.4
	(2.7)	(5.4)	(2.1)	(2.0)	(1.6)	(2.1)	(1.2)	(1.5)	(1.3)	(1.6)		

Table 17. Continued

Dependent Variable: KPS

3	0.1	0.6	92.1	0.2	0.3	0.3	0.7	2.9	0.3	2.7	6.9	85.2
	(1.5)	(1.7)	(4.1)	(0.8)	(1.1)	(1.1)	(1.2)	(2.0)	(0.9)	(2.0)		
6	0.3	1.1	87.0	0.2	0.3	1.8	0.9	3.5	0.5	4.5	11.2	85.5
	(1.8)	(1.7)	(5.5)	(1.0)	(1.5)	(1.8)	(1.3)	(2.6)	(1.2)	(3.3)		
9	0.3	1.1	85.9	0.2	0.3	1.8	1.0	4.2	0.7	4.5	12.2	86.5
	(1.8)	(1.7)	(6.0)	(1.0)	(1.6)	(1.8)	(1.4)	(3.1)	(1.3)	(3.3)		
12	0.3	1.0	85.4	0.2	0.4	1.8	1.0	4.6	0.8	4.4	12.6	86.9
	(1.8)	(1.7)	(6.2)	(1.0)	(1.7)	(1.8)	(1.4)	(3.4)	(1.4)	(3.3)		
24	0.3	1.0	84.4	0.3	0.4	1.8	1.1	5.1	1.4	4.4	13.8	87.3
	(1.8)	(1.7)	(6.5)	(1.0)	(1.7)	(1.8)	(1.4)	(3.4)	(1.4)	(3.3)		
36	0.3	1.0	83.4	0.3	0.4	1.8	1.1	5.4	2.0	4.3	14.6	88.0
	(1.8)	(1.7)	(6.8)	(1.1)	(1.8)	(1.8)	(1.4)	(3.9)	(2.1)	(3.2)		
48	0.3	1.0	82.4	0.4	0.4	1.7	1.1	5.7	2.6	4.3	15.4	88.0
	(1.8)	(1.7)	(7.2)	(1.1)	(1.8)	(1.8)	(1.4)	(4.1)	(2.6)	(3.2)		

Dependent Variable: KY

3	4.9	0.3	1.6	85.4	3.7	0.5	1.6	0.2	1.2	0.6	4.1	28.1
	(3.3)	(1.2)	(1.7)	(4.8)	(2.2)	(1.2)	(1.4)	(1.0)	(1.4)	(1.1)		
6	4.5	0.5	2.4	75.8	3.6	5.7	3.7	1.2	1.5	1.2	13.3	54.7
	(3.1)	(1.4)	(1.9)	(5.4)	(2.1)	(3.1)	(2.1)	(1.8)	(1.3)	(1.4)		
9	4.7	0.6	2.5	74.8	3.6	5.6	3.7	1.3	1.5	1.7	13.8	54.8
	(3.0)	(1.4)	(1.9)	(5.7)	(2.1)	(3.1)	(2.1)	(1.8)	(1.3)	(1.5)		
12	4.7	0.6	2.5	74.7	3.6	5.6	3.7	1.3	1.5	1.8	13.9	54.9
	(3.0)	(1.4)	(1.9)	(5.8)	(2.1)	(3.1)	(2.1)	(1.8)	(1.3)	(1.5)		
24	4.7	0.6	2.5	74.6	3.6	5.6	3.7	1.3	1.6	1.8	14.0	55.1
	(3.0)	(1.4)	(1.9)	(5.8)	(2.1)	(3.1)	(2.1)	(1.8)	(1.3)	(1.5)		
36	4.7	0.6	2.5	74.6	3.6	5.6	3.7	1.3	1.6	1.8	14.0	55.1
	(3.0)	(1.4)	(1.9)	(5.8)	(2.1)	(3.1)	(2.1)	(1.8)	(1.3)	(1.5)		
48	4.7	0.6	2.5	74.5	3.6	5.6	3.7	1.4	1.7	1.8	14.2	55.5
	(3.0)	(1.4)	(1.9)	(5.8)	(2.1)	(3.1)	(2.1)	(1.8)	(1.3)	(1.5)		

Dependent Variable: WY

3	1.9	1.8	0.9	0.3	86.2	2.4	0.6	0.8	0.7	4.3	8.8	64.2
	(2.0)	(2.2)	(1.7)	(1.3)	(4.9)	(2.2)	(1.1)	(1.2)	(1.1)	(2.7)		
6	1.9	2.6	1.6	0.8	82.8	2.6	1.1	0.9	0.9	4.8	10.3	59.9
	(2.0)	(2.5)	(2.1)	(1.7)	(5.5)	(2.3)	(1.3)	(1.4)	(1.2)	(2.7)		
9	1.9	2.6	1.6	0.8	82.0	2.8	1.4	1.1	0.9	4.8	11.0	61.5
	(1.9)	(2.5)	(2.2)	(1.6)	(5.7)	(2.4)	(1.3)	(1.5)	(1.2)	(2.6)		
12	1.9	2.6	1.7	0.8	81.9	2.8	1.4	1.1	0.9	4.9	11.1	61.3
	(1.9)	(2.5)	(2.3)	(1.6)	(5.8)	(2.4)	(1.4)	(1.5)	(1.2)	(2.7)		
24	1.9	2.6	1.7	0.8	81.8	2.8	1.4	1.1	0.9	4.9	11.1	61.3
	(1.9)	(2.5)	(2.4)	(1.6)	(5.8)	(2.4)	(1.4)	(1.5)	(1.2)	(2.6)		

Table 17. Continued

36	1.9	2.6	1.7	0.8	81.8	2.8	1.4	1.1	1.0	4.9	11.2	61.5
	(1.9)	(2.5)	(2.4)	(1.6)	(5.8)	(2.4)	(1.4)	(1.5)	(1.2)	(2.6)		
48	1.9	2.6	1.7	0.8	81.8	2.8	1.4	1.2	1.0	4.9	11.3	61.7
	(1.9)	(2.4)	(2.4)	(1.6)	(5.9)	(2.4)	(1.3)	(1.5)	(1.2)	(2.6)		

Notes: h is the forecast horizon. The numbers in parentheses are standard deviations.

Table 18

Variance Decompositions for Korean Variables
(Real Exchange Rate)

A. Korea-US system

Innovation to

h	KMS	KR	KPS	KY	RWD	UMS	UR	UPS	UY	VF	VFR
					Dependent Variable: KMS						
3	92.7	1.2	1.1	2.9	0.9	0.6	0.3	0.1	0.4	1.4	18.7
	(3.8)	(1.6)	(1.4)	(2.2)	(1.4)	(1.2)	(1.0)	(0.8)	(1.0)		
6	85.7	1.6	1.4	4.4	1.7	1.3	0.3	1.6	2 1	5.3	36.8
	(5.0)	(1.8)	(1.7)	(2.8)	(1.9)	(1.8)	(1.3)	(1.8)	(1.8)		
9	80.8	2.2	1.7	6.9	1.9	1.6	0.6	2.3	2.1	6.6	34.2
	(5.3)	(2.0)	(1.8)	(3.3)	(2.1)	(2.1)	(1.5)	(1.9)	(1.6)		
12	79.6	2.5	1.8	6.9	1.9	1.6	0.8	2.4	2.5	7.3	35.8
	(5.6)	(2.1)	(1.8)	(3.2)	(2.1)	(2.1)	(1.7)	(2.0)	(1.6)		
24	78.5	2.5	1.8	7.0	2.0	1.7	1.3	2.5	2.6	8.1	37.9
	(5.9)	(2.1)	(1.8)	(3.2)	(2.1)	(2.1)	(1.8)	(2.0)	(1.7)		
36	78.4	2.5	1.8	7.0	2.0	1.7	1.3	2.5	2.7	8.2	38.1
	(6.0)	(2.1)	(1.8)	(3.2)	(2.2)	(2.1)	(1.9)	(2.1)	(1.7)		
48	78.2	2.5	1.9	7.0	2.0	1.7	1.3	2.6	2.8	8.4	38.5
	(6.1)	(2.1)	(1.9)	(3.2)	(2.2)	(2.1)	(1.9)	(2.1)	(1.8)		
					Dependent Variable: KR						
3	7.0	85.4	2.8	2.4	1.3	0.4	0.5	0.1	0.0	1.0	6.9
	(3.5)	(4.8)	(2.0)	(2.1)	(1.8)	(1.0)	(1.2)	(1.0)	(0.9)		
6	7.2	74.6	2.6	4.5	1.7	1.5	2.9	1.9	3.1	9.4	37.0
	(3.3)	(4.8)	(1.7)	(2.8)	(2.0)	(1.8)	(1.9)	(1.8)	(2.2)		
9	6.5	68.1	3.0	9.6	2.3	2.7	3.0	2.0	2.9	10.6	33.1
	(3.0)	(5.1)	(1.8)	(3.9)	(1.9)	(2.2)	(2.0)	(1.8)	(2.0)		
12	6.8	66.8	3.2	9.9	2.6	2.9	3.1	2.0	2.9	10.9	32.6
	(2.9)	(5.2)	(1.8)	(3.9)	(1.9)	(2.3)	(1.9)	(1.8)	(1.9)		
24	6.8	65.9	3.2	10.1	2.6	2.9	3.2	2.2	3.0	11.3	33.2

Table 18. Continued

	(2.8)	(5.3)	(1.8)	(3.8)	(1.9)	(2.3)	(2.0)	(1.8)	(1.9)		
36	6.8	65.9	3.2	10.1	2.6	2.9	3.2	2.2	3.1	11.4	33.4
	(2.8)	(5.4)	(1.8)	(3.8)	(1.9)	(2.3)	(2.0)	(1.9)	(1.9)		
48	6.8	65.9	3.2	10.1	2.6	2.9	3.2	2.2	3.1	11.4	33.4
	(2.8)	(5.5)	(1.8)	(3.8)	(1.9)	(2.3)	(2.0)	(2.0)	(1.9)		

<u>Dependent Variable: KPS</u>

3	1.7	0.0	85.6	1.5	4.4	0.5	1.2	1.8	3.5	7.0	47.9
	(2.0)	(1.1)	(4.5)	(1.7)	(2.6)	(1.3)	(1.5)	(1.9)	(2.4)		
6	4.8	1.3	71.2	1.6	5.3	0.9	5.2	3.0	6.7	15.8	54.9
	(3.4)	(1.8)	(5.4)	(1.8)	(2.6)	(1.6)	(3.1)	(2.6)	(3.0)		
9	4.0	1.5	60.8	3.6	6.1	0.8	4.6	12.5	6.2	24.1	61.3
	(2.9)	(1.7)	(5.5)	(2.3)	(2.6)	(1.5)	(2.8)	(4.0)	(2.7)		
12	3.9	1.9	58.1	3.6	6.5	1.1	4.9	14.1	5.8	25.9	62.0
	(2.8)	(1.7)	(5.9)	(2.3)	(2.6)	(1.8)	(3.0)	(4.3)	(2.6)		
24	4.1	1.8	54.0	3.3	7.7	1.7	4.7	17.6	5.1	29.1	63.3
	(3.2)	(2.0)	(6.9)	(2.5)	(3.5)	(2.5)	(3.1)	(5.6)	(2.8)		
36	4.1	1.8	53.0	3.2	7.7	1.8	4.6	19.0	4.9	30.3	64.3
	(3.5)	(2.2)	(7.5)	(2.7)	(3.9)	(2.9)	(3.3)	(6.5)	(3.3)		
48	4.1	1.8	52.5	3.2	7.7	1.9	4.5	19.5	4.8	30.7	64.6
	(3.7)	(2.3)	(8.0)	(2.9)	(4.2)	(3.2)	(3.4)	(7.0)	(4.0)		

<u>Dependent Variable: KY</u>

3	5.1	0.4	0.5	89.7	0.4	1.0	0.5	1.4	1.0	3.9	37.9
	(3.2)	(1.2)	(1.4)	(4.4)	(1.0)	(1.3)	(1.1)	(1.4)	(1.4)		
6	6.4	0.5	0.7	82.8	0.9	2.2	3.1	1.5	1.9	8.7	50.6
	(3.3)	(1.5)	(1.6)	(5.1)	(1.6)	(2.4)	(2.1)	(1.6)	(2.0)		
9	6.5	1.0	1.2	79.8	1.0	2.4	3.6	2.0	2.6	10.6	52.2
	(3.3)	(1.8)	(1.7)	(5.3)	(1.8)	(2.3)	(2.3)	(1.8)	(1.9)		
12	6.4	1.3	1.4	77.6	1.4	2.4	4.3	2.1	3.2	12.0	53.3
	(3.2)	(1.9)	(1.7)	(5.4)	(1.8)	(2.2)	(2.4)	(1.8)	(1.9)		
24	6.7	1.3	1.6	76.2	1.5	2.8	4.3	2.2	3.4	12.7	53.4
	(3.2)	(1.9)	(1.8)	(5.9)	(1.8)	(2.3)	(2.4)	(1.8)	(1.9)		
36	6.7	1.3	1.6	76.1	1.5	2.8	4.3	2.2	3.6	12.9	53.8
	(3.3)	(1.9)	(1.9)	(6.1)	(1.9)	(2.3)	(2.4)	(1.8)	(2.0)		
48	6.7	1.3	1.6	75.9	1.5	2.8	4.3	2.3	3.7	13.1	54.1
	(3.4)	(1.9)	(1.9)	(6.2)	(1.9)	(2.3)	(2.4)	(1.9)	(2.1)		

<u>Dependent Variable: RWD</u>

3	0.3	0.4	19.1	1.3	75.8	1.3	0.7	0.3	0.9	3.2	13.2
	(1.3)	(1.3)	(5.0)	(1.8)	(5.4)	(1.7)	(1.6)	(1.0)	(1.5)		
6	0.7	0.4	17.6	7.2	65.9	1.3	2.2	3.2	1.4	8.1	23.8

Table 18. Continued

	(1.7)	(1.7)	(4.4)	(3.5)	(5.3)	(1.7)	(2.0)	(2.4)	(1.8)		
9	2.4	0.8	15.7	7.3	58.0	1.2	2.6	10.5	1.7	16.0	37.9
	(2.2)	(1.8)	(3.8)	(3.3)	(5.2)	(1.6)	(2.1)	(3.4)	(1.9)		
12	2.5	1.0	15.9	7.2	55.9	1.4	2.7	11.6	1.8	17.5	39.7
	(2.3)	(1.8)	(3.7)	(3.2)	(5.1)	(1.7)	(2.1)	(3.5)	(2.0)		
24	2.7	1.0	16.3	7.1	53.4	1.8	2.7	13.1	1.9	19.5	41.8
	(2.3)	(1.9)	(3.6)	(3.1)	(5.4)	(2.0)	(2.2)	(3.8)	(2.2)		
36	2.7	1.0	16.6	7.0	52.4	1.8	2.7	13.8	1.9	20.2	42.5
	(2.5)	(1.9)	(3.9)	(3.2)	(5.9)	(2.2)	(2.2)	(4.3)	(2.4)		
48	2.7	1.0	16.7	6.9	52.0	1.8	2.7	14.2	1.9	20.6	43.0
	(2.6)	(2.0)	(4.1)	(3.3)	(6.5)	(2.4)	(2.3)	(4.7)	(2.7)		

Table 18. Continued

B. Korea-Japan System

Innovation to

h	KMS	KR	KPS	KY	RWY	JMS	JR	JPS	JY	VF	VFR
					Dependent Variable: KMS						
3	83.4	4.1	1.5	3.4	2.1	3.0	0.2	2.4	0.4	5.4	32.7
	(4.6)	(2.6)	(1.7)	(2.4)	(1.7)	(2.0)	(1.0)	(1.6)	(1.0)		
6	69.5	3.5	2.5	6.1	2.4	4.0	2.0	3.6	6.6	16.0	52.5
	(5.3)	(2.2)	(1.9)	(3.1)	(2.1)	(2.2)	(1.8)	(1.9)	(3.1)		
9	60.2	5.1	3.8	7.3	2.7	6.5	3.0	3.7	7.8	20.9	52.5
	(5.1)	(2.4)	(2.2)	(3.1)	(2.3)	(2.6)	(2.0)	(2.0)	(3.0)		
12	57.9	5.3	3.9	8.2	3.2	6.4	3.4	3.9	8.0	21.7	51.3
	(5.0)	(2.4)	(2.2)	(3.2)	(2.3)	(2.5)	(2.1)	(2.0)	(3.0)		
24	54.0	5.2	4.9	8.6	3.5	6.9	4.6	4.1	8.1	23.7	51.6
	(5.2)	(2.4)	(2.2)	(3.2)	(2.2)	(2.4)	(2.4)	(2.0)	(2.8)		
36	53.5	5.3	4.9	8.7	3.6	6.9	4.7	4.1	8.3	24.0	51.6
	(5.5)	(2.4)	(2.3)	(3.3)	(2.3)	(2.4)	(2.6)	(2.0)	(3.0)		
48	53.5	5.3	4.9	8.7	3.6	6.9	4.7	4.1	8.3	24.0	51.6
	(5.8)	(2.5)	(2.4)	(3.6)	(2.4)	(2.5)	(2.8)	(2.1)	(3.1)		
					Dependent Variable: KR						
3	5.5	83.8	4.5	2.1	1.6	0.5	0.2	0.1	1.8	2.6	16.0
	(3.3)	(4.6)	(2.7)	(2.0)	(1.5)	(1.3)	(1.0)	(0.8)	(1.8)		
6	8.0	76.6	4.3	4.1	1.9	1.3	0.3	0.5	3.0	5.1	21.8
	(3.5)	(5.2)	(2.6)	(2.5)	(1.8)	(1.7)	(1.5)	(1.2)	(2.3)		
9	7.5	68.3	5.4	9.8	1.8	1.5	1.0	1.0	3.8	7.3	23.0
	(3.1)	(5.2)	(2.7)	(3.6)	(1.8)	(1.7)	(1.8)	(1.4)	(2.4)		
12	7.4	66.3	5.8	10.0	1.9	1.7	1.8	1.3	3.7	8.5	25.3
	(2.9)	(5.3)	(2.6)	(3.5)	(1.8)	(1.8)	(2.1)	(1.5)	(2.3)		
24	7.3	63.6	6.8	10.0	2.4	1.9	2.2	1.8	3.9	9.8	27.0
	(2.7)	(5.6)	(2.8)	(3.3)	(2.0)	(2.0)	(2.4)	(1.7)	(2.3)		
36	7.3	63.4	6.8	10.1	2.5	2.0	2.2	1.8	3.9	9.9	27.0
	(2.7)	(5.9)	(2.9)	(3.4)	(2.2)	(2.1)	(2.6)	(1.8)	(2.3)		
48	7.3	63.3	6.8	10.1	2.5	2.0	2.2	1.8	3.9	9.9	27.0

Table 18. Continued

	(2.7)	(6.4)	(3.0)	(3.6)	(2.3)	(2.3)	(2.8)	(1.9)	(2.5)		

Dependent Variable: KPS

3	0.2	1.5	91.1	0.5	0.1	0.4	1.3	3.1	1.8	6.6	74.2
	(1.3)	(2.1)	(4.2)	(1.2)	(0.8)	(1.0)	(1.4)	(1.8)	(2.0)		
6	3.5	5.8	78.9	2.1	0.3	1.4	2.0	3.2	2.9	9.5	44.8
	(2.9)	(3.6)	(5.4)	(2.1)	(1.3)	(1.7)	(1.8)	(1.9)	(2.2)		
9	3.2	7.3	72.5	5.7	1.6	1.5	1.9	3.1	3.2	9.7	35.3
	(2.8)	(3.7)	(5.7)	(3.3)	(1.6)	(1.6)	(1.8)	(1.8)	(2.2)		
12	3.2	7.7	72.2	5.9	1.7	1.5	1.9	2.9	3.0	9.3	33.5
	(3.0)	(4.0)	(6.1)	(3.6)	(1.9)	(1.7)	(1.8)	(1.8)	(2.1)		
24	3.3	7.8	70.0	6.4	3.1	1.5	2.0	2.9	3.1	9.5	31.6
	(3.5)	(4.1)	(7.1)	(3.9)	(3.7)	(1.8)	(1.9)	(2.0)	(2.5)		
36	3.4	7.7	69.6	6.4	3.3	1.6	2.1	2.8	3.2	9.7	31.8
	(3.8)	(4.2)	(7.6)	(4.0)	(4.2)	(1.8)	(1.9)	(2.2)	(2.7)		
48	3.4	7.7	69.4	6.5	3.3	1.6	2.1	2.9	3.3	9.9	32.1
	(3.9)	(4.2)	(7.9)	(4.1)	(4.4)	(1.9)	(2.0)	(2.3)	(2.9)		

Dependent Variable: KY

3	2.9	0.5	1.6	84.9	5.6	0.4	1.1	0.5	2.7	4.7	30.7
	(2.5)	(1.4)	(1.8)	(4.6)	(2.9)	(1.2)	(1.2)	(1.2)	(2.2)		
6	4.1	1.4	2.4	67.7	7.4	7.2	3.2	4.1	2.5	17.0	52.6
	(2.5)	(2.0)	(1.9)	(5.5)	(3.6)	(3.3)	(2.1)	(2.2)	(2.0)		
9	4.6	2.4	3.4	64.5	7.4	6.9	3.1	4.9	2.7	17.6	49.7
	(2.8)	(2.4)	(2.3)	(5.3)	(3.3)	(3.1)	(2.1)	(2.6)	(2.0)		
12	4.8	3.2	3.9	60.2	8.8	7.1	3.7	5.1	3.3	19.2	39.9
	(2.6)	(2.6)	(2.4)	(5.2)	(3.2)	(2.9)	(2.4)	(2.5)	(2.0)		
24	4.9	3.3	4.1	58.1	8.8	6.9	4.1	5.5	4.4	20.9	49.8
	(2.5)	(2.7)	(2.5)	(5.3)	(3.1)	(2.7)	(2.4)	(2.5)	(2.3)		
36	4.9	3.4	4.1	57.7	8.9	6.9	4.2	5.5	4.5	21.1	49.8
	(2.5)	(2.8)	(2.6)	(5.6)	(3.2)	(2.7)	(2.6)	(2.6)	(2.6)		
48	4.9	3.4	4.1	57.6	8.9	6.9	4.2	5.5	4.6	21.2	49.9
	(2.6)	(2.8)	(2.8)	(5.9)	(3.4)	(2.9)	(2.9)	(2.7)	(2.9)		

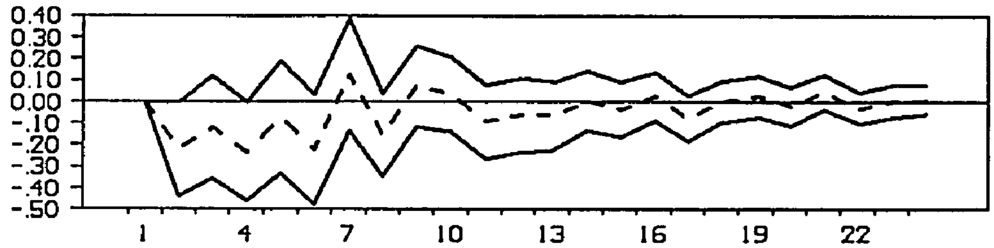
Dependent Variable: RWY

3	2.1	4.8	5.7	1.3	79.5	2.8	1.9	1.5	0.4	6.6	32.2
	(1.9)	(3.3)	(3.3)	(1.6)	(5.0)	(2.3)	(1.8)	(1.8)	(1.1)		
6	3.4	9.0	6.5	5.2	66.9	2.9	3.4	2.0	0.8	9.1	27.4
	(2.2)	(3.9)	(3.4)	(2.8)	(5.4)	(2.2)	(2.2)	(2.0)	(1.3)		
9	4.1	8.7	8.1	6.8	61.8	3.2	4.3	2.3	0.8	10.6	27.7
	(2.3)	(3.6)	(3.3)	(3.2)	(5.2)	(2.3)	(2.2)	(2.0)	(1.5)		
12	4.8	8.7	8.1	7.0	59.8	3.9	4.3	2.5	1.0	11.7	29.0

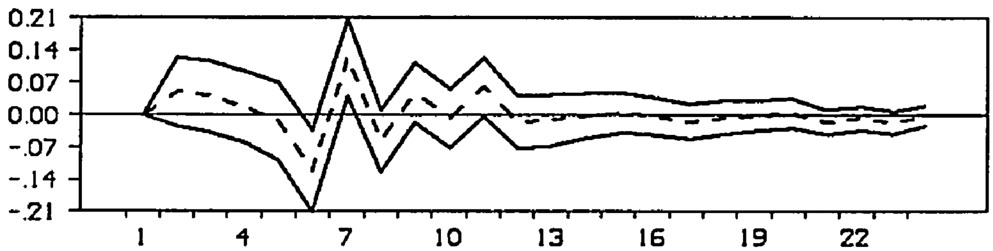
Table 18. Continued

	(2.6)	(3.4)	(3.2)	(3.3)	(5.1)	(2.3)	(2.1)	(2.0)	(1.5)		
24	5.1	8.7	8.4	7.1	58.5	4.1	4.3	2.7	1.2	12.3	29.6
	(2.7)	(3.3)	(3.2)	(3.0)	(5.0)	(2.2)	(2.2)	(2.0)	(1.6)		
36	5.1	8.7	8.5	7.1	58.3	4.1	4.3	2.7	1.2	12.3	29.5
	(2.7)	(3.3)	(3.3)	(3.1)	(5.2)	(2.3)	(2.3)	(2.0)	(1.7)		
48	5.1	8.7	8.5	7.1	58.2	4.1	4.3	2.7	1.3	12.4	29.7
	(2.7)	(3.3)	(3.4)	(3.1)	(5.4)	(2.4)	(2.4)	(2.0)	(1.9)		

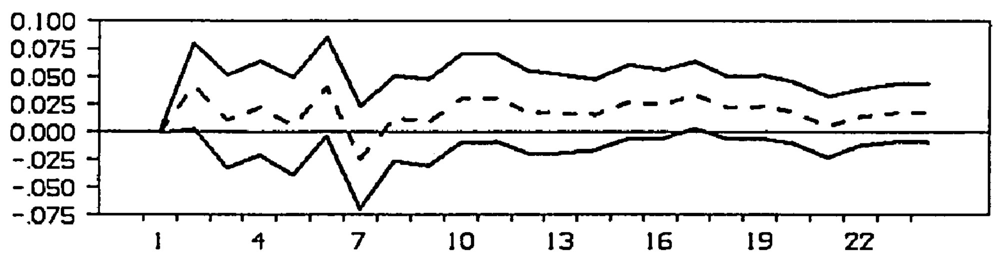
Notes: h is the forecast horizon. The numbers in parentheses are standard deviations. RWD and RWY indicate real exchange rates of won/dollar and won/yen respectively.



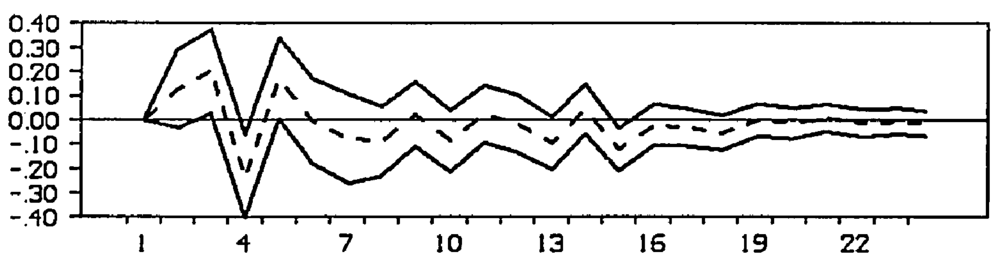
(a) Response of KMS to UMS Innovation



(b) Response of KR to UMS Innovation



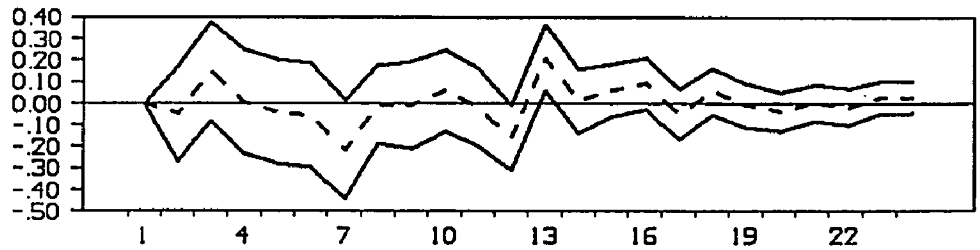
(c) Response of KPS to UMS Innovation



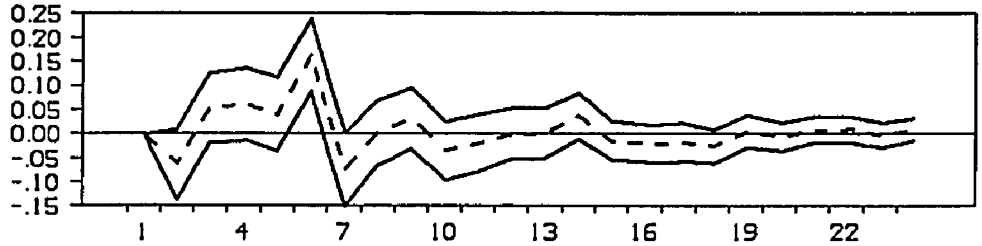
(d) Response of KY to UMS Innovation

Figure 1. Responses of the Korean Variables to the

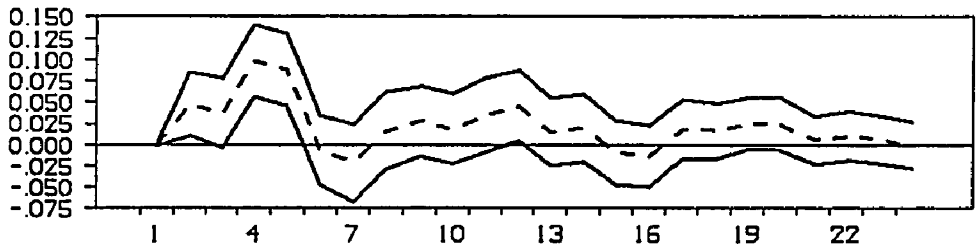
U.S. Money Supply Innovations



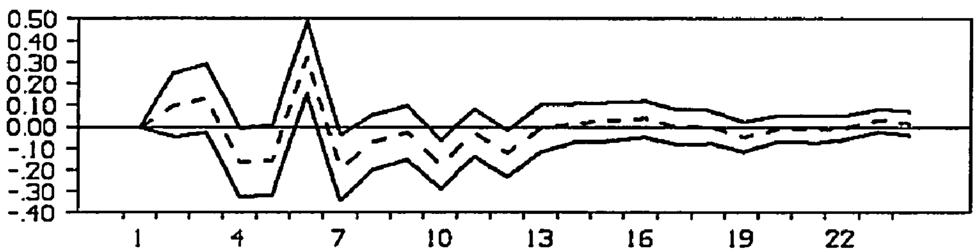
(a) Response of KMS to UR Innovation



(b) Response of KR to UR Innovation



(c) Response of KPS to UR Innovation



(d) Response of KY to UR Innovation

Figure 2. Responses of the Korean Variables to the U.S. Interest Rates Innovations

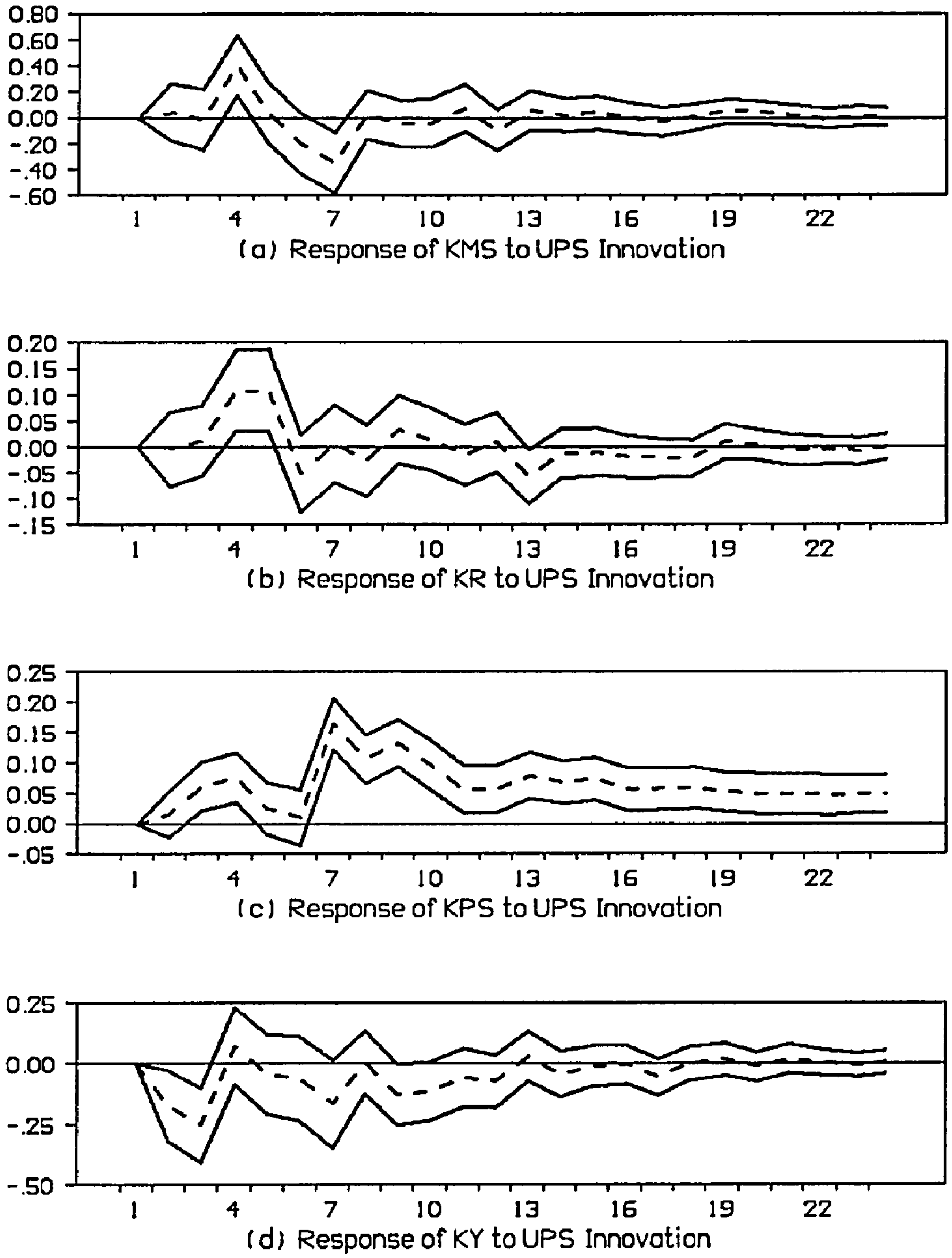
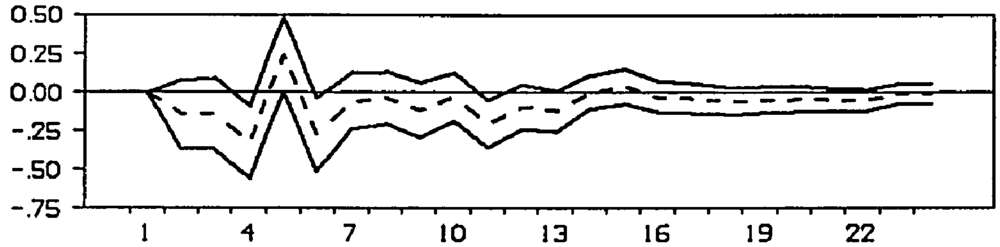
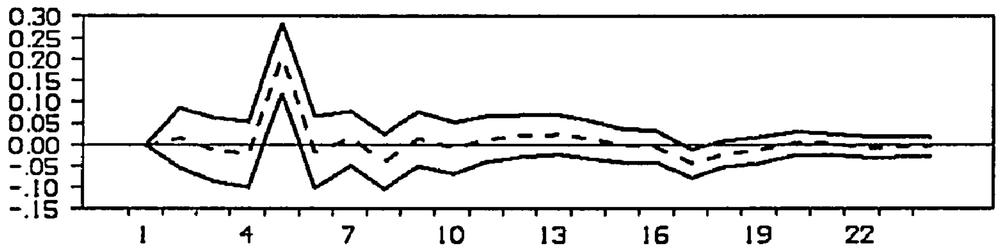


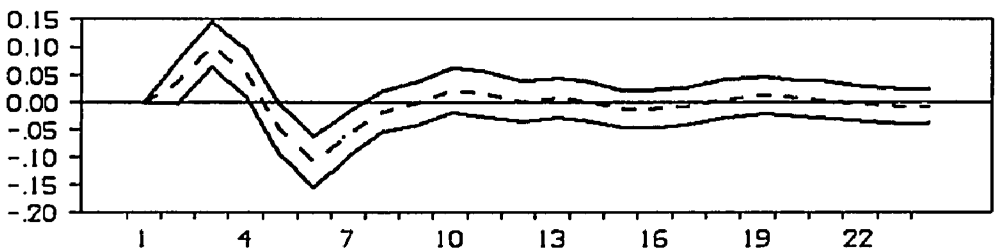
Figure 3. Responses of the Korean Variables to the U.S. Price Innovations



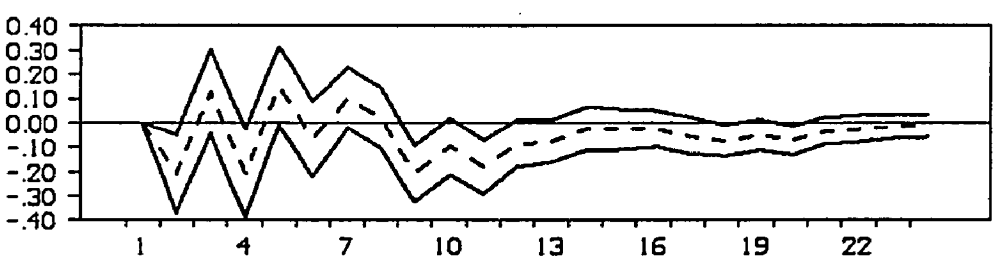
(a) Response of KMS to UY Innovation



(b) Response of KR to UY Innovation

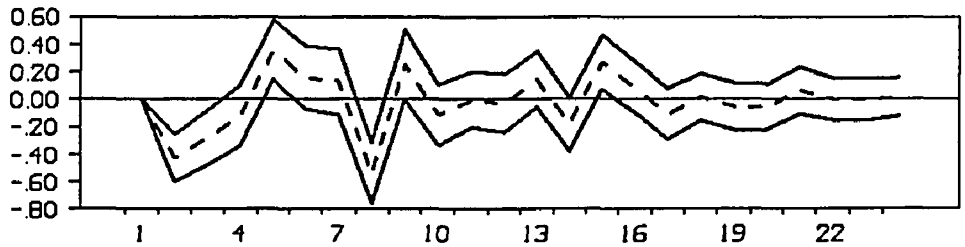


(c) Response of KPS to UY Innovation

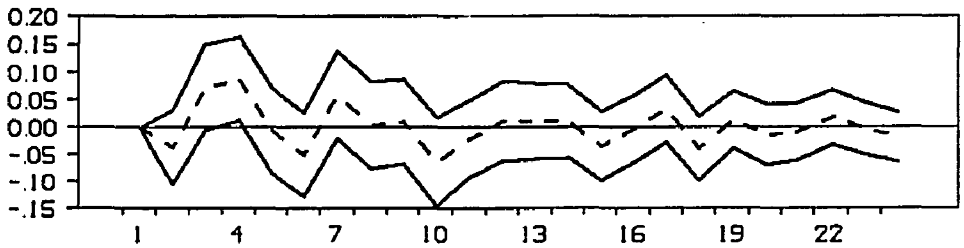


(d) Response of KY to UY Innovation

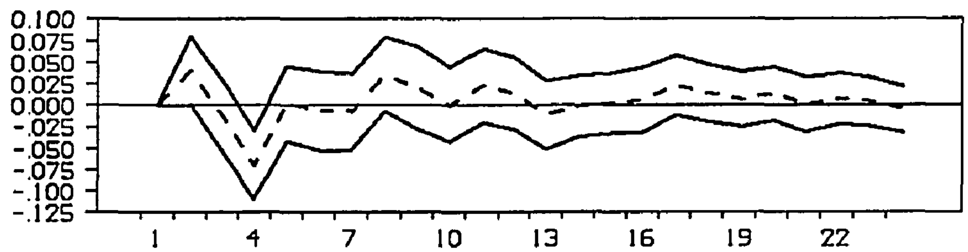
Figure 4. Responses of the Korean Variables to the U.S. Output Innovations



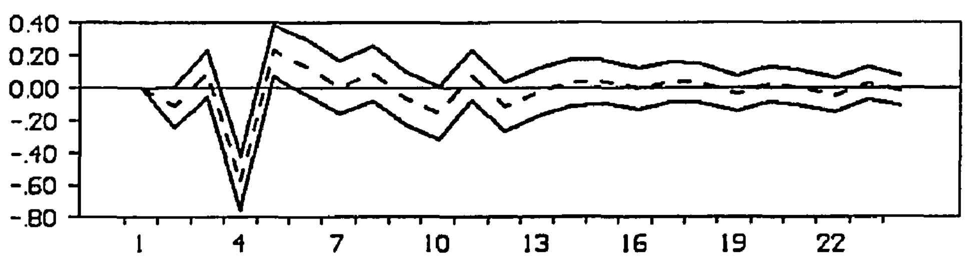
(a) Response of KMS to JMS Innovation



(b) Response of KR to JMS Innovation

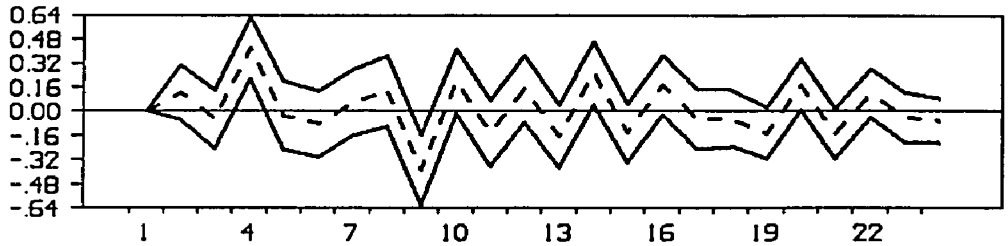


(c) Response of KPS to JMS Innovation

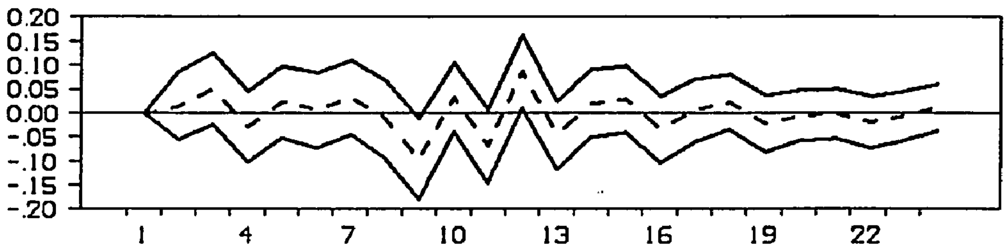


(d) Response of KY to JMS Innovation

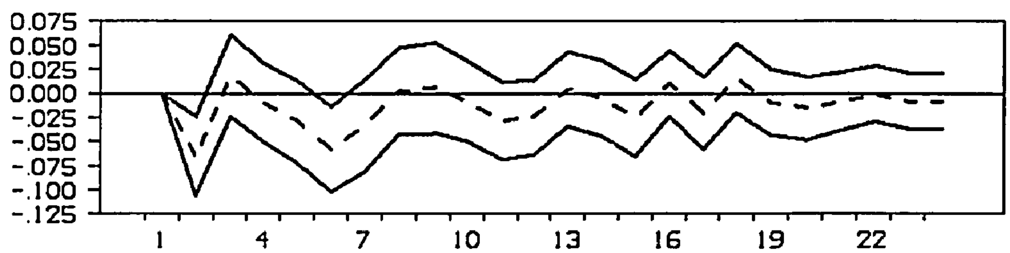
Figure 5. Responses of the Korean Variables to the Japanese Money Supply Innovations



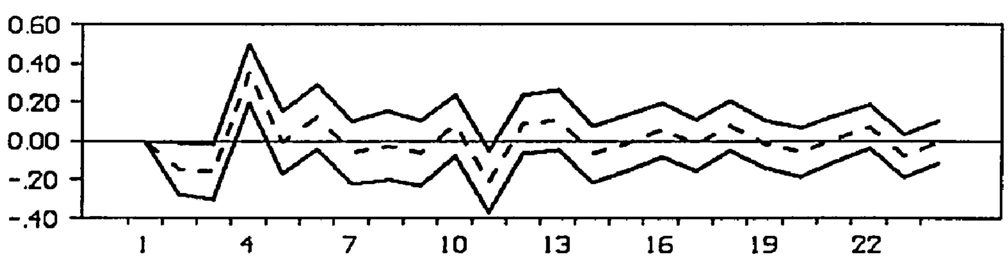
(a) Response of KMS to JR Innovation



(b) Response of KR to JR Innovation

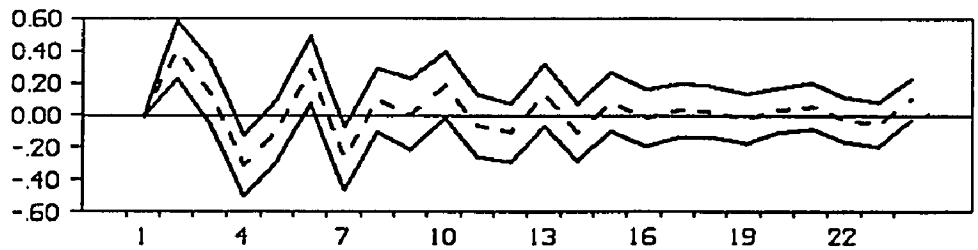


(c) Response of KPS to JR Innovation

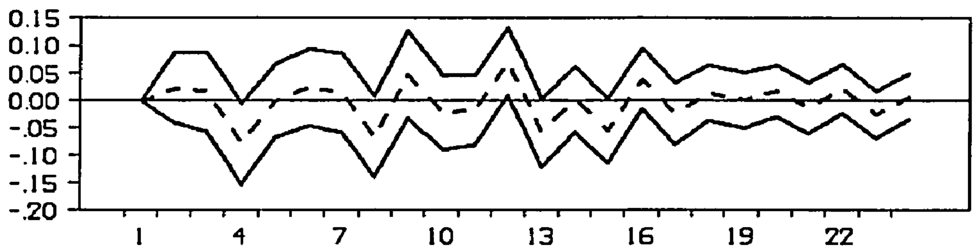


(d) Response of KY to JR Innovation

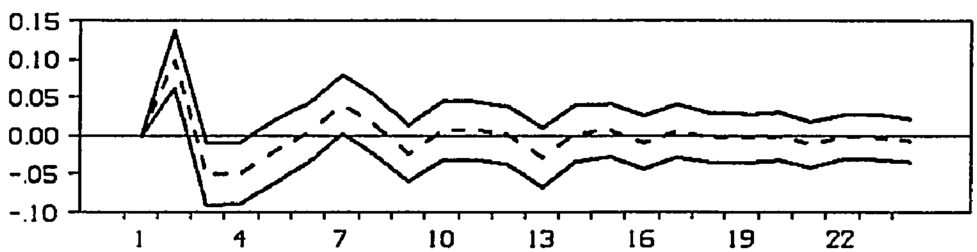
Figure 6. Responses of the Korean Variables to the Japanese Interest Rates Innovations



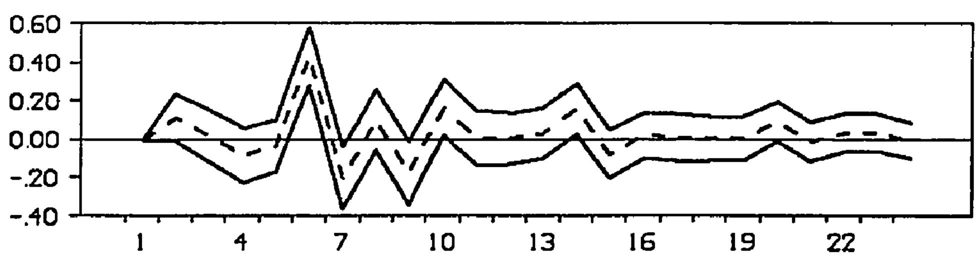
(a) Response of KMS to JPS Innovation



(b) Response of KR to JPS Innovation

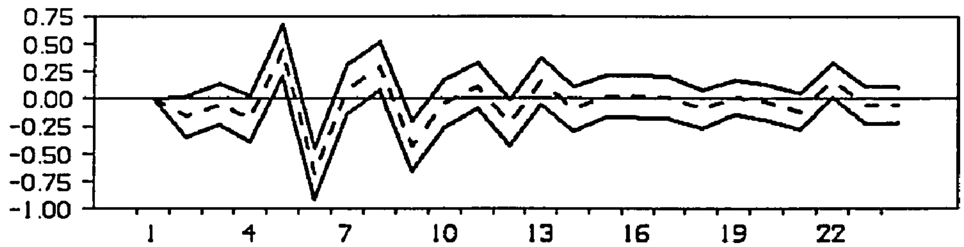


(c) Response of KPS to JPS Innovation

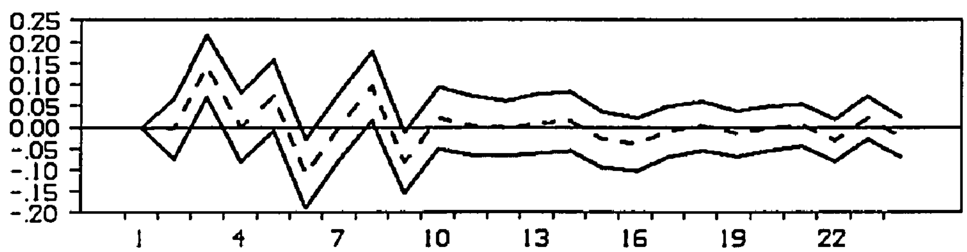


(d) Response of KY to JPS Innovation

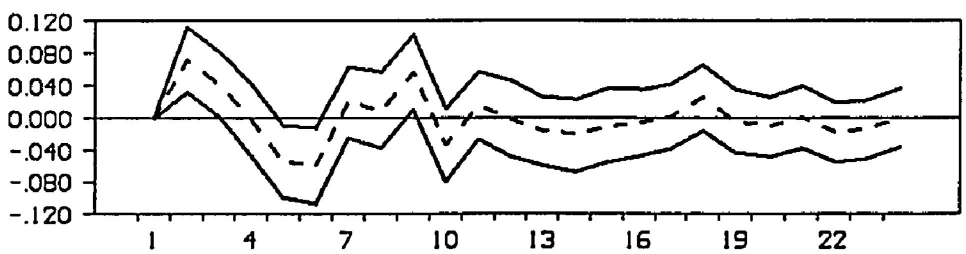
Figure 7. Responses of the Korean Variables to the Japanese Price Innovations



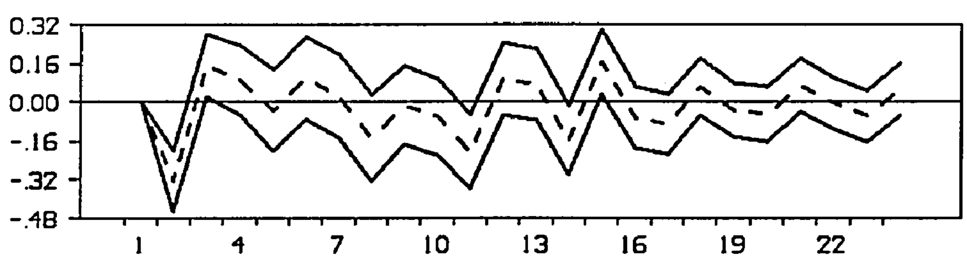
(a) Response of KMS to JY Innovation



(b) Response of KR to JY Innovation

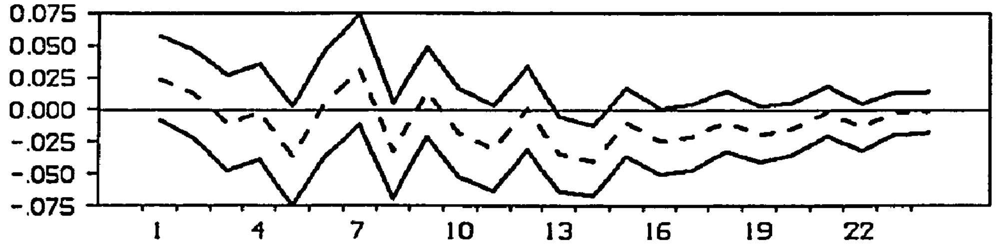


(c) Response of KPS to JY Innovation

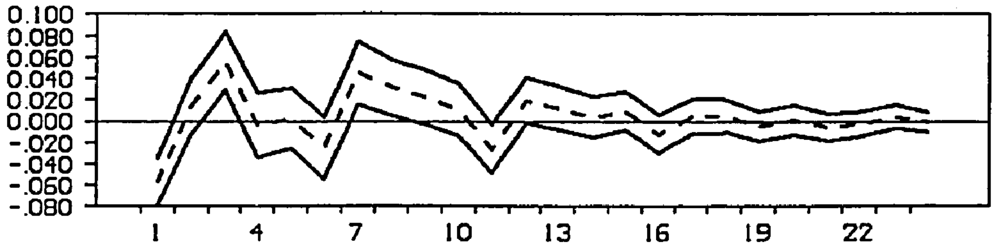


(d) Response of KY to JY Innovation

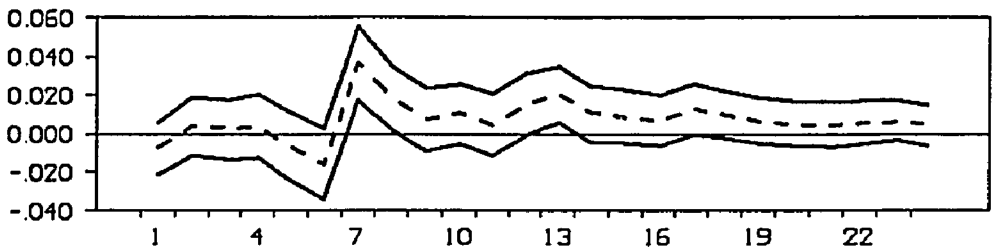
Figure 8. Responses of the Korean Variables to the Japanese Output Innovations



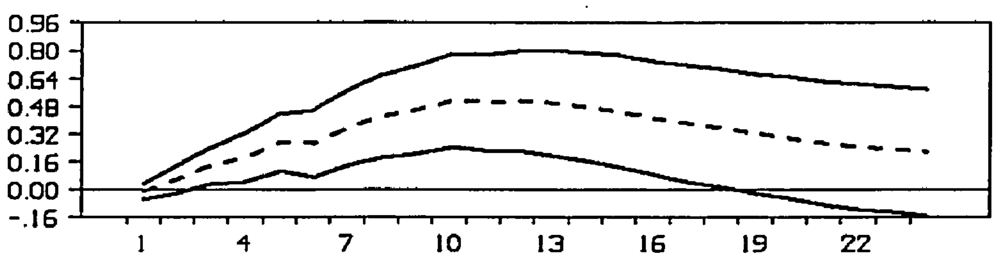
(a) Response of UMS to KMS Innovation



(b) Response of UR to KMS Innovation



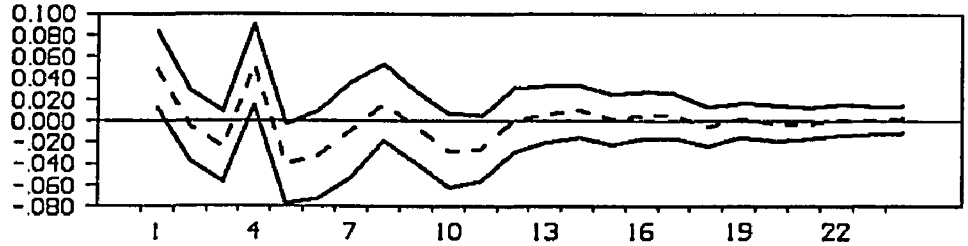
(c) Response of UPS to KMS Innovation



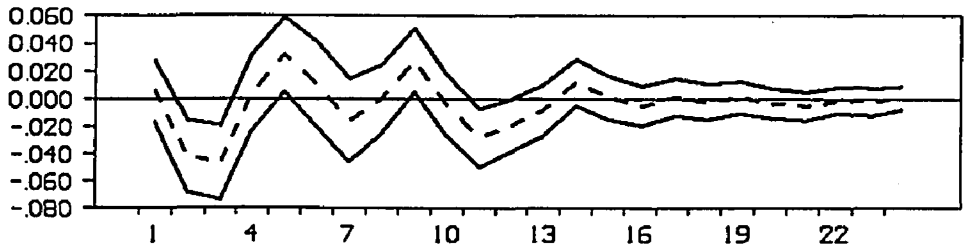
(d) Response of UY to KMS Innovation

Figure 9. Responses of the U.S. Variables to the

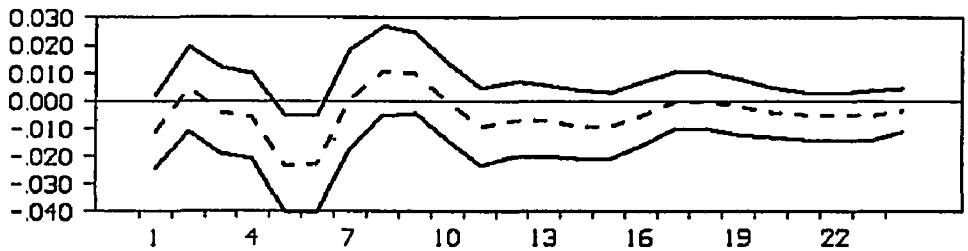
Korean Money Supply Innovations



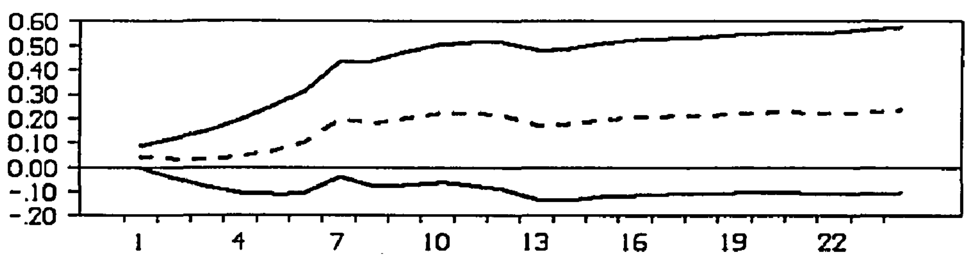
(a) Response of UMS to KR Innovation



(b) Response of UR to KR Innovation



(c) Response of UPS to KR Innovation



(d) Response of UY to KR Innovation

Figure 10. Responses of the U.S. Variables to the

Korean Interest Rates Innovations

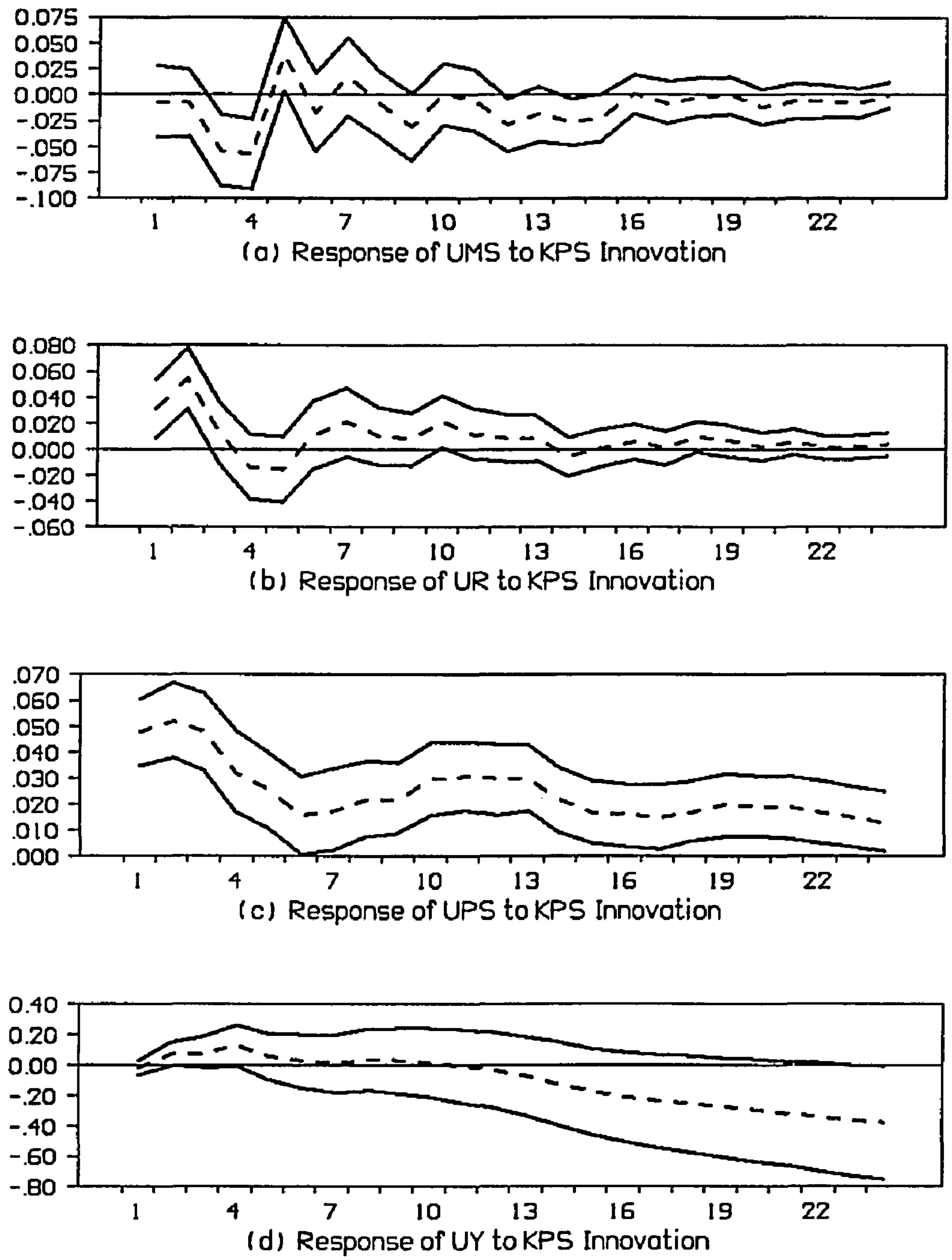
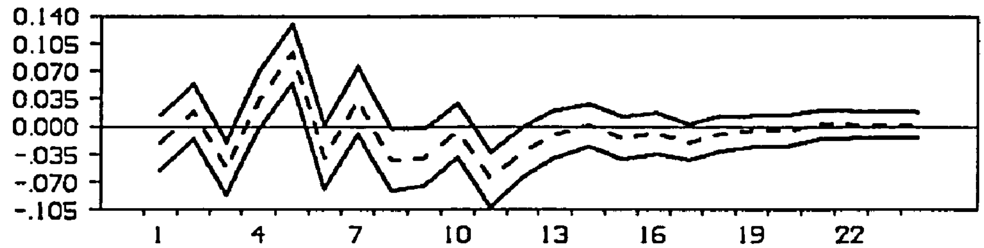
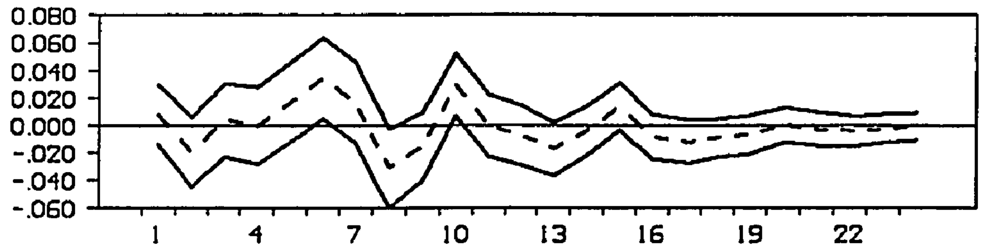


Figure 11. Responses of the U.S. Variables to the

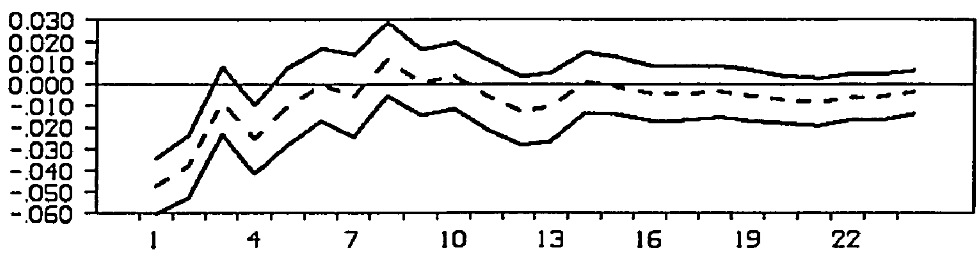
Korean Price Innovations



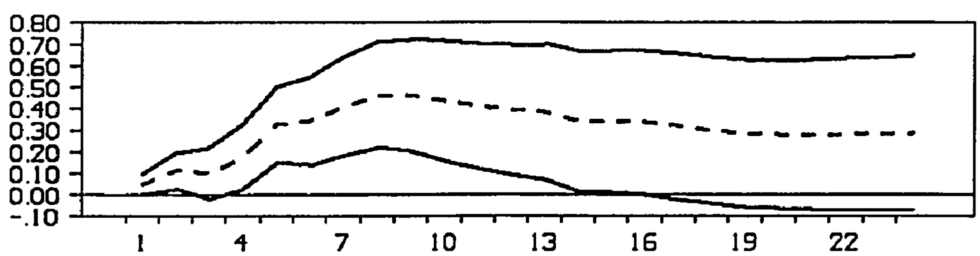
(a) Response of UMS to KY Innovation



(b) Response of UR to KY Innovation



(c) Response of UPS to KY Innovation



(d) Response of UY to KY Innovation

Figure 12. Responses of the U.S. Variables to the Korean Output Innovations

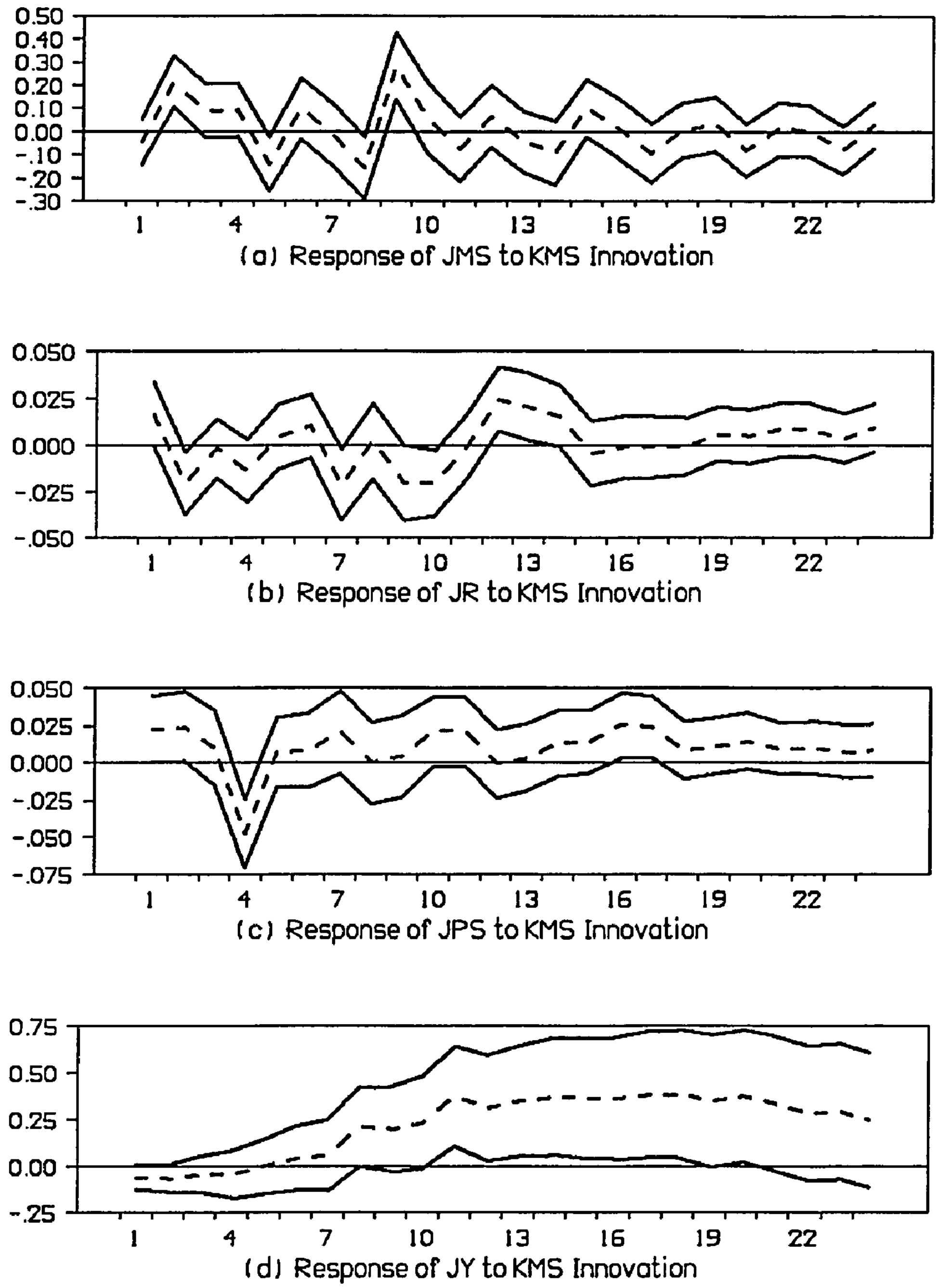
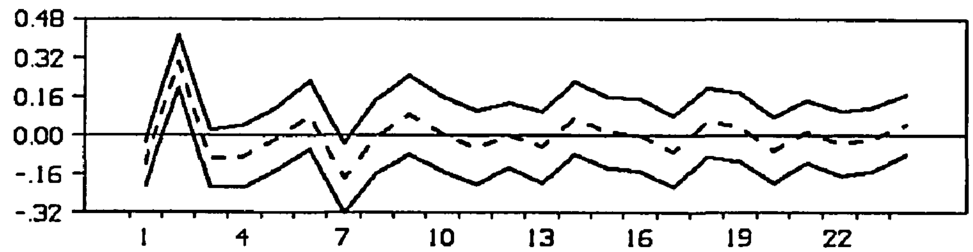
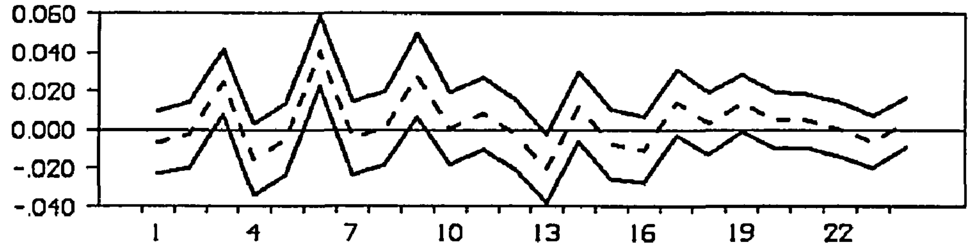


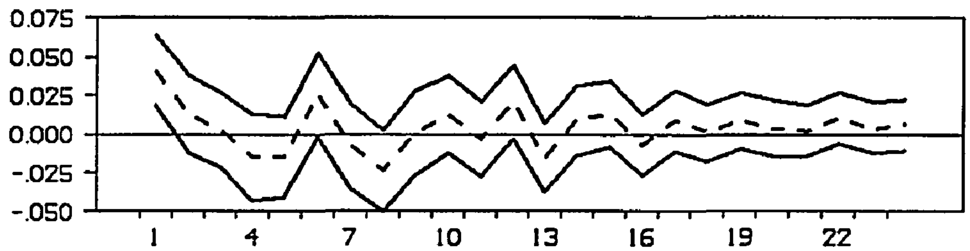
Figure 13. Responses of the Japanese Variables to the Korean Money Supply Innovations



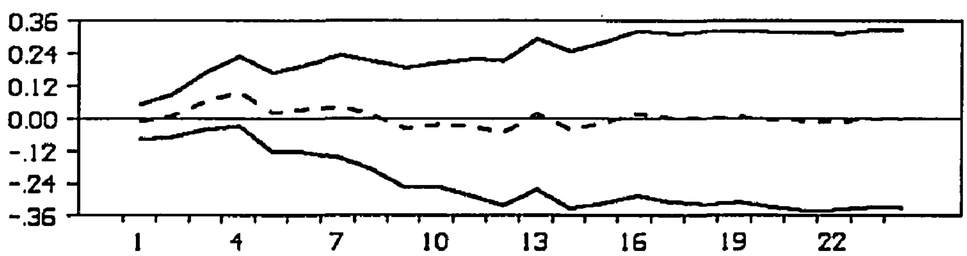
(a) Response of JMS to KR Innovation



(b) Response of JR to KR Innovation

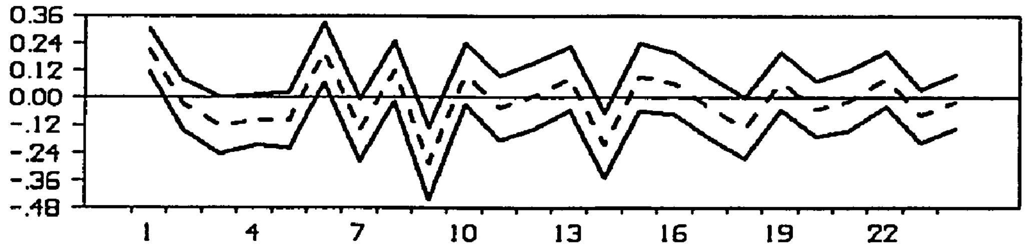


(c) Response of JPS to KR Innovation

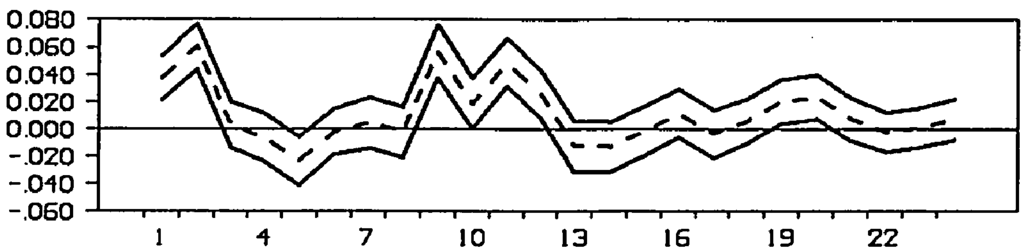


(d) Response of JY to KR Innovation

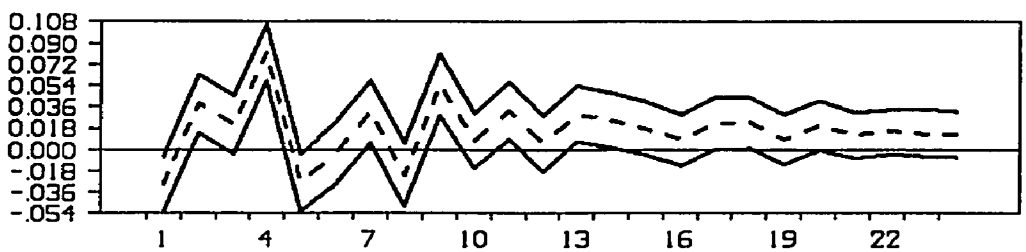
Figure 14. Responses of the Japanese Variables to the Korean Interest Rates Innovations



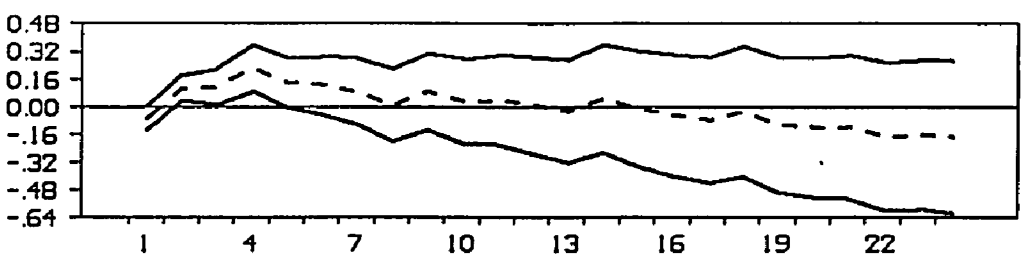
(a) Response of JMS to KPS Innovation



(b) Response of JR to KPS Innovation

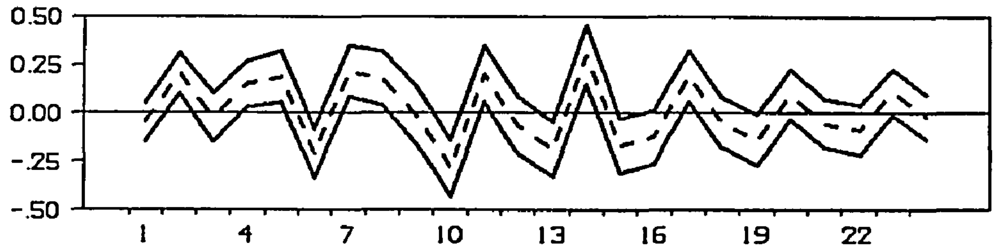


(c) Response of JPS to KPS Innovation

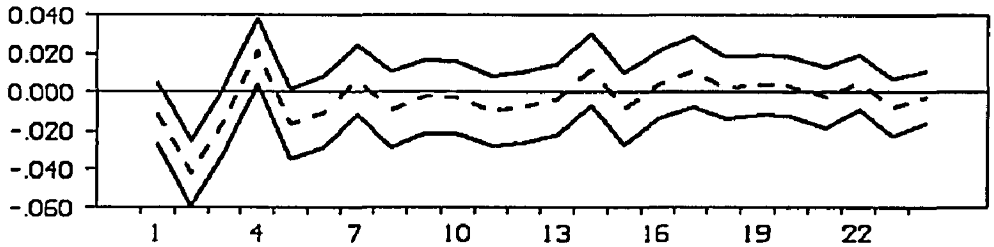


(d) Response of JY to KPS Innovation

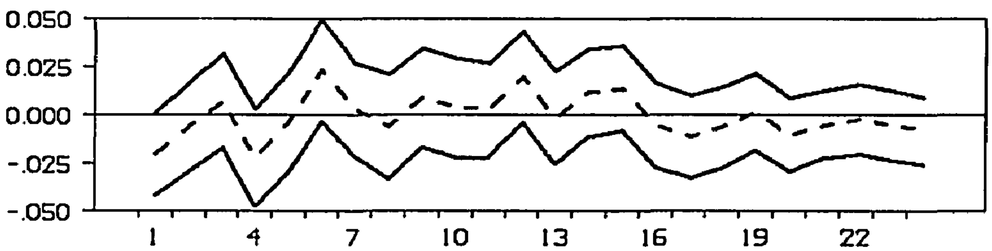
Figure 15. Responses of the Japanese Variables to the Korean Price Innovations



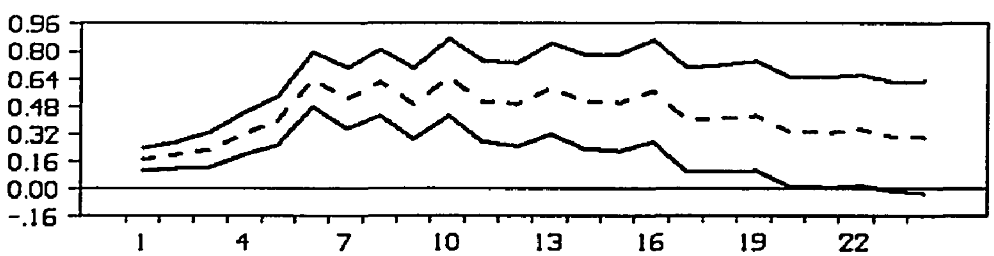
(a) Response of JMS to KY Innovation



(b) Response of JR to KY Innovation

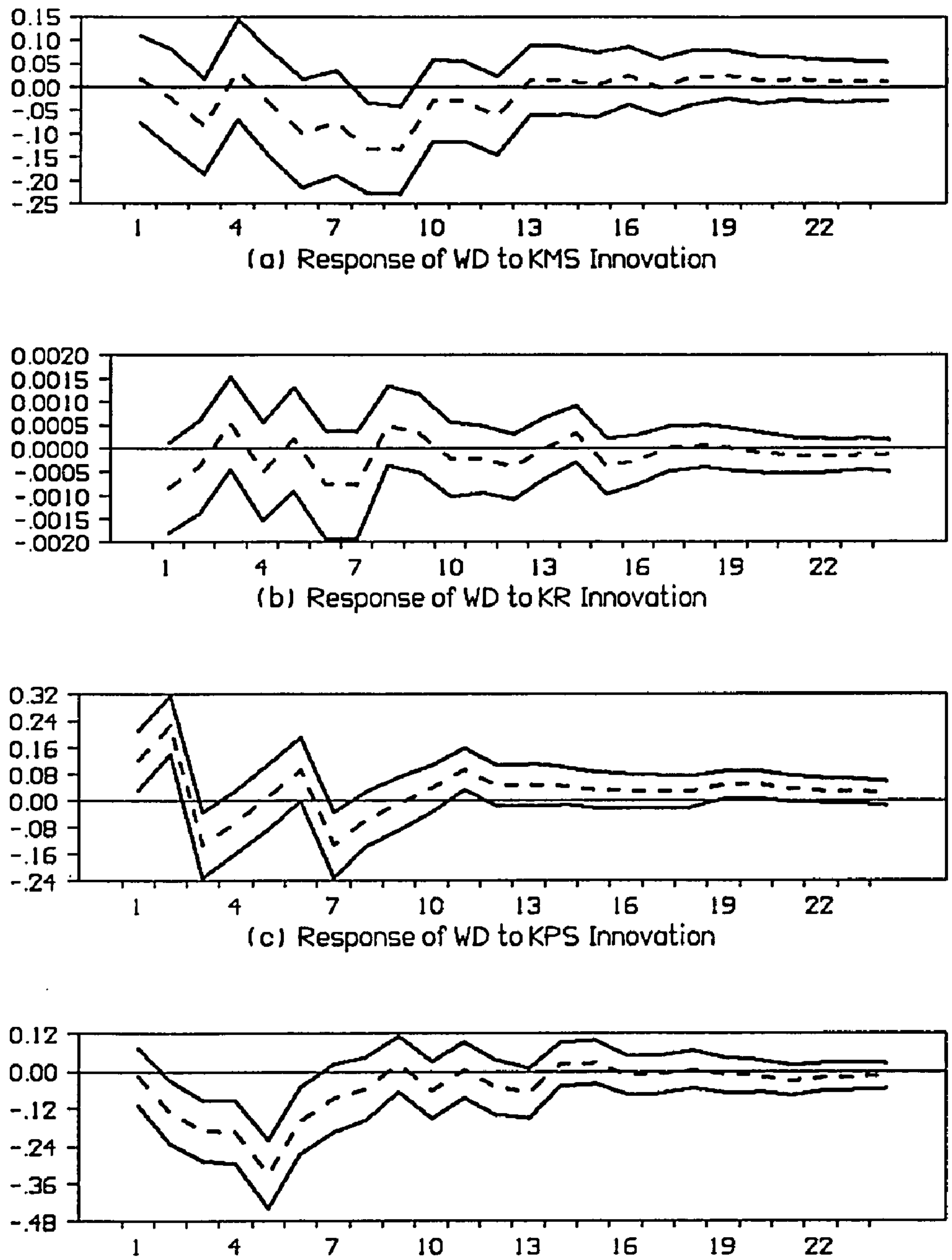


(c) Response of JPS to KY Innovation



(d) Response of JY to KY Innovation

Figure 16. Responses of the Japanese Variables to the Korean Output Innovations



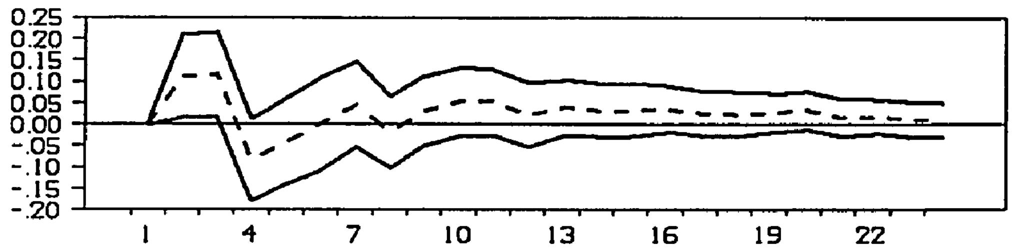
(a) Response of WD to KMS Innovation

(b) Response of WD to KR Innovation

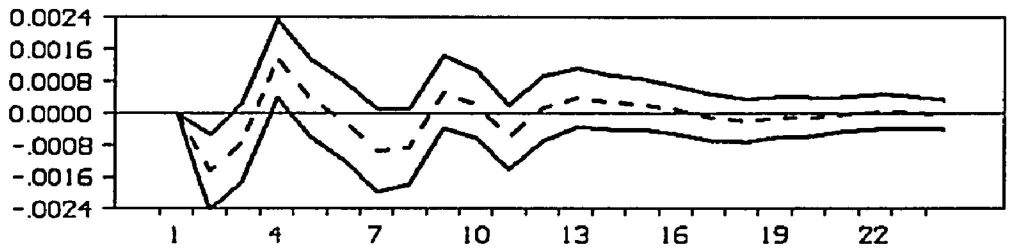
(c) Response of WD to KPS Innovation

(d) Response of WD to KY Innovation

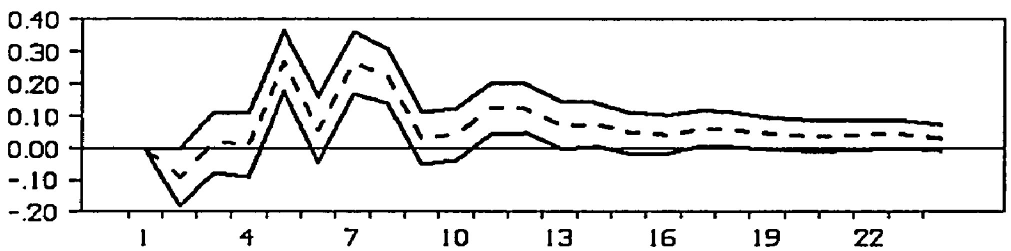
Figure 17. Responses of WD to the Korean Variables Innovations



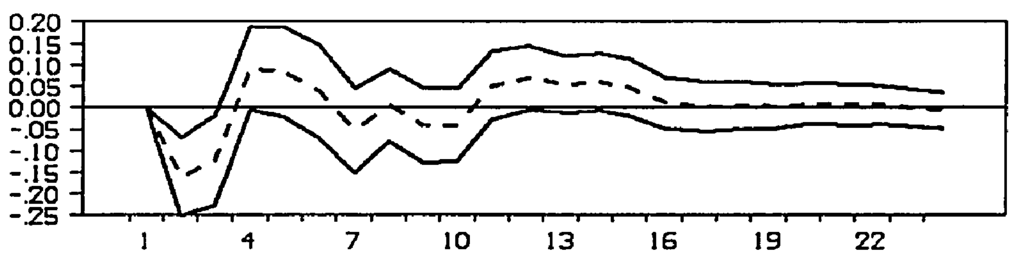
(a) Response of WD to UMS Innovation



(b) Response of WD to UR Innovation

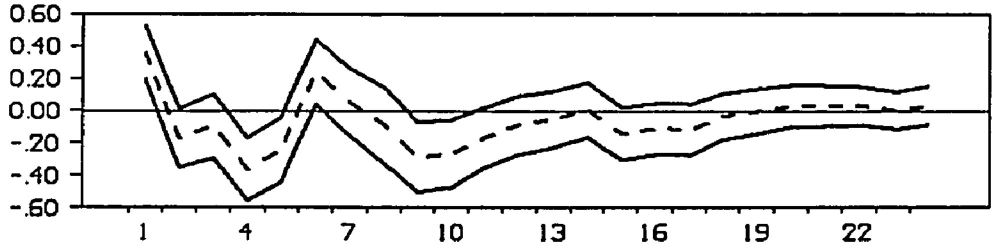


(c) Response of WD to UPS Innovation

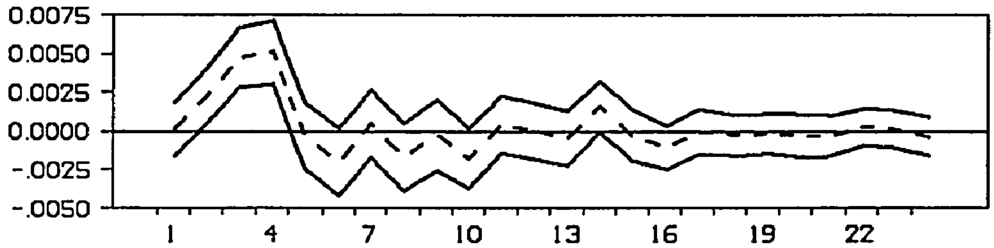


(d) Response of WD to UY Innovation

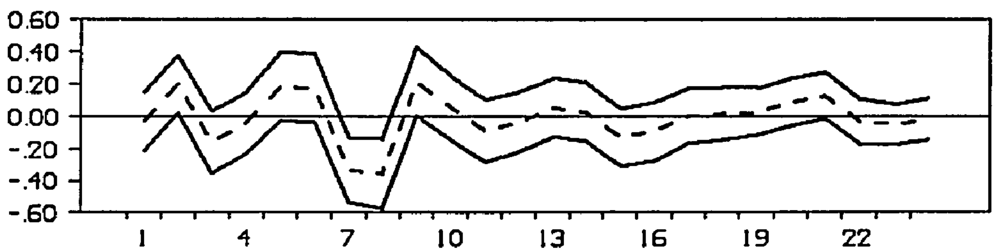
Figure 18. Responses of WD to the Korean Variables Innovations



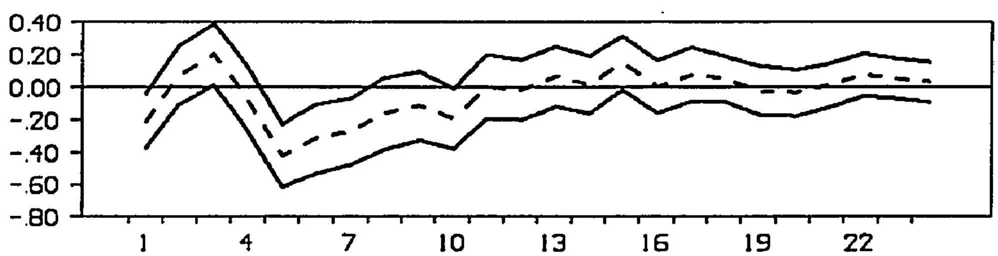
(a) Response of WY to KMS Innovation



(b) Response of WY to KR Innovation

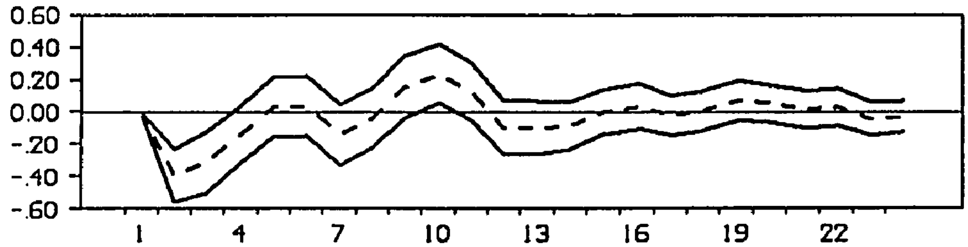


(c) Response of WY to KPS Innovation

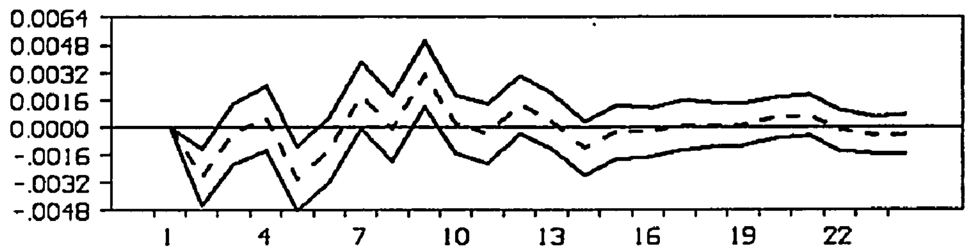


(d) Response of WY to KY Innovation

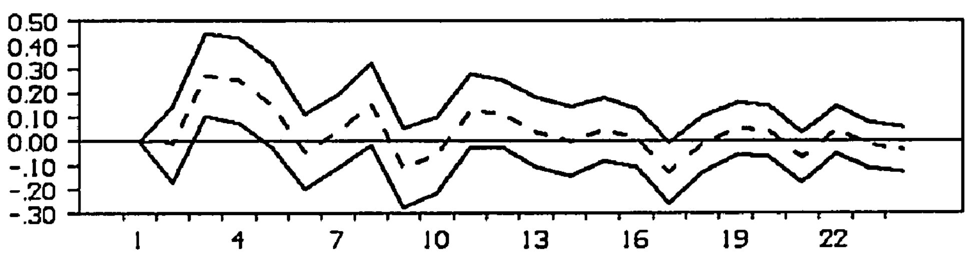
Figure 19. Responses of WY to the Korean Variables Innovations



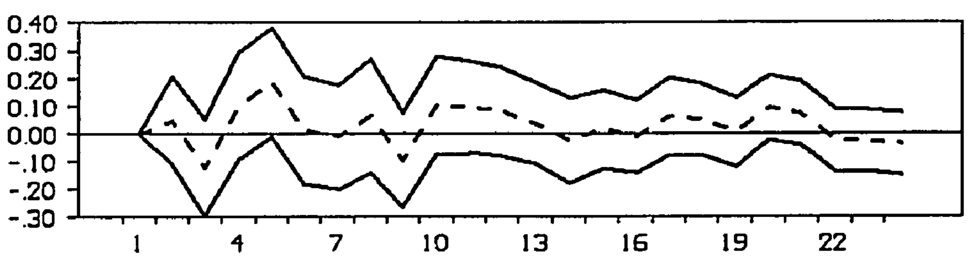
(a) Response of WY to JMS Innovation



(b) Response of WY to JR Innovation



(c) Response of WY to JPS Innovation



(d) Response of WY to JY Innovation

Figure 20. Responses of WY to the Japanese Variables Innovations

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DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Jai-Ki Lee

Major Field: Economics

Title of Dissertation: Three Essays on International Linkages of the Korean Economy

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

December 9, 1991