

## MACROECONOMICS AND HIGH INTEREST RATES IN ASIA BEFORE 1997

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*In this paper the author uses a vector autoregressive (VAR) model to examine the behavioural relationships between macroeconomic fundamentals in four Asian countries during the pre-1997 crisis period. The study shows that in each country an increase in domestic interest rates (or expansion in interest rate differentials) had a significant and long lasting effect on the country's macroeconomic fundamentals, such as exchange rate, GDP growth rate, and current account-GDP ratio. This result implies that, for developing countries with a low inflation rate and low government deficit, the cost of a higher interest rate relative to developed countries is much greater than the benefit. Thus, monetary authorities should pay more attention to both the absolute and relative levels of the interest rate, among other factors.*

A casual observation of movements in exchange rates and other economic indices throughout the East Asian countries reveals some interesting features that were not fully understood during the 1997 economic crisis. It is commonly stated that the Asian currency crisis was characterized by three features. First, the monetary authorities of the crisis countries adopted the de facto exchange rate policy of pegging their domestic currencies to the United States dollar. This system enhanced short term capital inflows by avoiding foreign exchange risks. The peg system also influenced the nations' current and capital accounts through yen-United States dollar movements. Takagi (1996) and Fukuda and Kano (1997) argue that the Asian economies were closely tied to yen-United States dollar fluctuations. Appreciation of the United States dollar after May 1995 had reduced the current account under the de facto dollar peg.<sup>1</sup>

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The author would like to thank Professors Ryuzo Miyao, Mitsuhiro Fukao, Satoru Kanoh, Tsutomu Miyagawa, Eiji Ogawa, Martin Schulz, Hajime Wago, Fumio Hayashi, Takatoshi Ito, and participants at the Japan Economic Association Conference for their comments. All remaining errors are mine.

<sup>1</sup> Among various studies, Ito, Ogawa and Sasaki (1998) discuss the notion that the excess weight of the dollar peg created an irreversible pressure on exports and in the real economy, which further aggravated the currency crisis.

Second, the currency crisis triggered the financial crisis. The IMF (1997, 1998) pointed out the vulnerability in the financial and capital market sectors in Asian countries. Large capital inflows to those countries with inadequate financial systems brought about the financial crisis. From this point of view, a large volume of literature has argued that the causes of the Asian crisis lie in structural problems such as weak banking sectors and fragile financial systems. In Corsetti, Pesenti and Roubini (1998a, b), the available empirical and theoretical models are focused on the phenomena of bank lending and bank runs in the course of the currency crisis.

Third, macroeconomic fundamentals had been sound before the crisis, except for the large current account deficits in Thailand, Malaysia, and the Republic of Korea. In contrast to the 1994 Mexican crisis, which was the immediate inspiration for much of the recent work on economic crises, no budget deficits or decreases in foreign reserves were found in Asia. Although the growth rate of export revenues had dropped abruptly, affected by the yen-United States dollar movement since 1996, the large capital inflows made these governments complacent about their current account deficits.

Examining statistics from the IMF and other evidence leaves little doubt that the massive capital inflows into this region during the early 1990s, followed by higher interest rates, played a major part in bringing about the Asian crisis.<sup>2</sup>

The emphasis on macroeconomics is somewhat limited so far in Asian currency crisis literature. Most of the existing literature is based on an analysis of the banking and financial sectors. Little attention has been paid, for example, to interest rates, GDP, and macroeconomic policy, except for the exchange rate regime during the pre-crisis period (Song, 1997). The crisis may have stemmed from fragility in the financial sectors, but the economic and social environment, which speculators relied on at the time, resulted from economic policy management by government authorities. Thus, it is worth looking closely at the macroeconomic interactions of these countries.

This paper documents the evidence in support of the hypothesis that economic fluctuations in each Asian country were attributable in some degree to its own macro-fundamentals, as well as to real yen-Asian exchange rate movements during the 1980s and 1990s.<sup>3</sup> This paper contributes to this line of reasoning by theoretically and empirically investigating the extent to which the macroeconomics in Asia during the pre-crisis period had been influenced by movements of interest rates and GDP growth rate, as well as by the real exchange rates against the Japanese yen. A vector autoregressive (VAR) model is employed to examine the dynamic relationships among variables in Indonesia, the Philippines, the Republic of Korea and Thailand. The

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<sup>2</sup> Ito (1999) characterizes the capital flows in Asia before and after the crisis in 1997 and shows that each country had its own idiosyncratic factors.

<sup>3</sup> Since these Asian countries adopted the de facto United States dollar peg system, the yen-United States dollar movements directly affected the yen-Asian exchange rates. There are studies on the yen-United States dollar rate and the Asian economies: Kwan (1998), and McKinnon and Ohno (1997), to name a few.

analysis indicates that an increase in interest rate differentials induces both depreciation pressure on exchange rates and a shrinking effect on current accounts in Asia.

The paper is organized as follows. Section I provides a theoretical description of a small open economy model. Section II uses time-series econometric methodology to test for and estimate non-stationary variables. Section III presents and interprets the estimated results for four Asian countries. The final section concludes the paper.

## I. THE MODEL

This section describes the macroeconomic model which will be used to interpret the empirical behaviour of the real exchange rate, real GDP growth, interest rate differentials and the current account balance in Indonesia, the Philippines, the Republic of Korea and Thailand. A very simple small open economy model can be extended to depict the overall Asian economy. For the remainder of this paper, the real exchange rate of each country is expressed in terms of the Japanese yen, and the interest rate differentials are expressed against the Japanese rate. We set Japan as the numeraire country because: (1) Japan is an important Asian economy and takes a leading role in trade, economic, and social linkages in Asia; and (2) the exchange rates of the countries were fixed to the United States dollar, which hardly gives any information.

### *Description of the economy*

Suppose that  $Y_t = f(R_t, r_t, r_t^f, CA_t)$  is the aggregate real product (GDP) per worker, where  $R$  is the yen-Asian exchange rate,  $r$  is the domestic interest rate,  $r^f$  is the Japanese interest rate, and  $CA$  is the current account.

Here, goods market equilibrium can be expressed as  $I(r_t; Y_t) - S(r_t; Y_t) + CA_t = 0$ ,

where  $I$  and  $S$  are net investment and net savings, respectively. The current account balance,  $CA_t = S_t - I_t$ , is therefore expressed as  $CA_t = CA(Y_t, r_t, r_t^f, R_t)$ . The usual FOCs apply to each function.<sup>4</sup>

### *The real exchange rate and the interest rate*

The issue of exchange rate determination has been discussed over many years, but the conclusion has been that exchange rates can actually be influenced by any factor among many economic and other variables. (Wei and Parsley, 1995, Rogers, 1995 and Chinn and Johnston, 1996). The real exchange rates have been found by Kawai and Oahara (1997) to be cointegrated with other real economic variables such as the terms of trade, real trade balance, and long-term real interest rate differentials

<sup>4</sup>  $I_k < 0, I_r < 0, S_r > 0, B_R > 0$ .

for the G7 countries. We assume here that the real exchange rate is a function of the domestic and Japanese interest rates, GDP, and the current account.

$$R_t = R(r_t, r_t^f, Y_t, CA_t).$$

We impose a somewhat stronger assumption on the determination of interest rates. Interest rates are a function of the yen-Asian real exchange rates, Japanese interest rate, current account balance, and GDP:  $r_t = r(R_t, r_t^f, CA_t, Y_t)$ .

### *Dynamic simultaneous equations*

The simultaneous-equation model of the economy described above applies to systems which include behavioural equations and an accounting identity as follows:

$$CA_t = CA(Y_t, r_t, r_t^f, R_t), \quad (1)$$

$$Y_t = f(CA_t, r_t, r_t^f, R_t), \quad (2)$$

$$r_t = r(CA_t, Y_t, r_t^f, R_t), \quad (3)$$

$$R_t = R(CA_t, Y_t, r_t, r_t^f). \quad (4)$$

The model introduced above includes four endogenous variables: the current account balance, GDP, interest rate and the real exchange rate. The exogenous variable is  $r_t^f$ : the foreign (Japanese) interest rate.

The structural form of this model, consisting of the four equations (1)-(4), is

$$y_t' \Gamma + x_t' = \epsilon_t', \quad (5)$$

where  $y_t$  is the vector of the endogenous variables,  $x_t$  is the vector of the exogenous and predetermined variables,  $\epsilon_t$  is the structural disturbance, and  $\beta$  and  $\Gamma$  are the parameter matrices. The solution of the system of equations (5), which determines  $y_t$  in terms of  $x_t$  and  $\epsilon_t$ , is the reduced form of the model,

$$y_t' = -x_t' \beta \Gamma^{-1} + \epsilon_t' \Gamma^{-1}, \quad (6)$$

$$= x_t' \Pi + v_t', \quad (7)$$

where  $\Pi = -\beta \Gamma^{-1}$  and  $v_t' = \epsilon_t' \Gamma^{-1}$ . We assume for the remainder of this paper that the order and rank conditions are met.

A vector autoregressive (VAR) model is applied to these simultaneous and behavioural equations to interpret the current and lagged relationships between variables. The empirical investigation in the following sections uses four endogenous

variables: the yen-Asian real exchange rate, interest rate, real GDP, and current account balance. The real exchange rate and real GDP are logarithmic. The current account balance is expressed as GDP ratio. Interest rate is measured as the interest rate differential between the domestic and Japanese interest rates, in order to express the “relative” level.

## II. ECONOMETRIC METHODOLOGY

In this section procedures for evaluating short- and long-term relationships between non-stationary economic variables, within the framework of cointegration testing, are applied to the real exchange rate (per Japanese yen), interest rate differentials, real GDP, and current account-GDP ratio for each country. The presence of a cointegrating relationship would support the claim that real exchange rates have long-term, stable relations with real factors in the economy that do not diverge arbitrarily far from equilibrium.

As mentioned in section I, these four variables are endogenous. The VAR model can be used later if there is no cointegration, or the Vector Error Correction Model (VECM) if cointegrating relations are found.

### *Unit-root test*

Any empirical testing must be preceded by a test to determine whether the variables are non-stationary, and if so, what the order of integration for each variable is. The Augmented Dickey-Fuller unit-root test is applied, which is generated from the following regressions:

$$\Delta x_t = \alpha + \beta_t + (\phi_I - I) x_t - I + \sum_{j=1}^n \gamma \Delta x_{t-j} + v_t, \quad (8)$$

where  $x_t$  is any variable used in this paper (i.e., yen-Asian exchange rate, interest rate differentials against the Japanese rate, real GDP growth, and current account balance-GDP ratio),  $\Delta$  represents the first difference operator, and  $n$  is the lag length chosen by SIC statistics. The test statistics are computed with a time trend and constant term.

The test results are summarized in table 1, and the data are described in section III below. No series of the real exchange rate rejects the unit root null using ADF tests at the 5 per cent critical level. Real GDP growth in the Philippines is stationary at the 5 per cent critical level. The current account-GDP ratio is stationary for all of the four Asian countries. The null of a unit root cannot be rejected at the 10 per cent level for the real interest rate differentials in Thailand. Table 1.1 lists the unit-root test results for I(1) variables in first differences. The presence of a unit root can be rejected at the 5 per cent level, and therefore all of these variables in first differences are I(0).

**Table 1. Unit-root test**

level								
	<i>ADF lag</i>	<i>Indonesia</i>	<i>ADF lag</i>	<i>Republic of Korea</i>	<i>ADF lag</i>	<i>Philippines</i>	<i>ADF lag</i>	<i>Thailand</i>
Y1	1	-1.0241	3	-1.8876	1	-2.0891	1	-1.4206
Y2	1	-5.2391 **	1	-4.9815 **	1	-3.9412 **	1	-2.9319
Y3	1	-2.8238	3	3.2659	3	-5.8668 **	1	-1.4125
Y4	0	-6.4884 **	0	-3.3798 *	0	-4.2355 **	0	-3.4132 *

unit-root null rejection: \*\* : 5 per cent critical value for DF t-stat (with constand trend) is -3.50.

\* : 10 per cent critical value for DF t-stat (with const and trend) is -3.18.

**Table 1.1. Unit-root test**

fist difference				
	<i>Indonesia</i>	<i>Republic of Korea</i>	<i>Philippines</i>	<i>Thailand</i>
DY1	-5.6061 **	-5.7524 **	-5.5480 **	-6.0018 **
DY2	—	—	—	-9.2429 **
DY3	-8.5885 **	-12.6899 **	—	-4.8227 **

unit-root null rejection: \*\* : 5 per cent critical value for DF t-stat (with constand trend) is -3.50.

\* : 10 per cent critical value for DF t-stat (with constand trend) is -3.18.

D : fist difference

Y1 : bg of real exchange rates (against yen)

Y2 : real interest rate differencial (between the country and Japan)

Y3 : bg of real GDP

Y4 : current account-GDP ratio

Hence, we proceed assuming that most of the relevant series are I(1) in level. This confirms that cointegration theory can be applied.

### ***The Johansen likelihood approach***

There are several procedures for determining the cointegration rank. Among them are Johansen's (1988) procedure based on maximum-likelihood estimation of the VECM and the common-trend procedure of Stock and Watson (1993). These procedures allow us to test the null of  $h = h_0$ , where  $h$  is the number of the cointegration rank and  $h_0$  is some arbitrary integer between 0 and  $n-1$ , where  $n$  is the dimension of the vector process.

Another test suggested by Engle and Granger (1987) is based on the null hypothesis that  $h = 0$  (no cointegration), and the alternative is that  $h \geq 1$ . In this

paper only Johansen's trace statistic for testing  $H(r)$  against  $H(m)$  is covered, where  $r < m$ , because of the focus on multivariate systems in the estimation, so that the cointegrating vector is not statistically affected by the variable ordering in the static regressions.

Let  $x_t$  be a  $m \times 1$  vector of  $I(1)$  variables. Then the  $p$ -dimensional VAR system to be estimated is

$$x_t = \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \dots + \alpha_{p-1} x_{t-p+1} + \alpha_p x_{t-p} + z_t + u_t, \quad (9)$$

where  $\alpha_j = \alpha_1 + \dots + \alpha_{p-j}$ , and  $j = 1, 2, \dots, p-1$ .

The matrix  $\Pi$  is estimated by the Johansen maximum-likelihood procedure, subject to the hypothesis that  $\Pi$  has reduced rank (i.e.  $r < m$ ). That is,  $H(r)$ :  $\Pi = AB'$ . Here,  $A$  and  $B$  are  $m \times r$  matrices of the adjustment coefficients and cointegrating vectors, respectively. If  $r < m$ , then under certain conditions the  $B'x_t$  is stationary (i.e., the  $x_t$ 's are cointegrated).

The trace statistic for testing  $H(r)$  against  $H(m)$  is given by

$$trace = -T \sum_{j=r+1}^m \log(1 - \lambda_j), \quad (10)$$

where the  $\lambda_j$ 's are the solutions of a determinant equation involving residuals from a regression of  $x$  on first-difference terms.

The test results of equation (10) are listed in table 2, where asterisks indicate statistically significant results after adjusting for degrees of freedom. The results indicate that the null hypothesis of no cointegration is accepted at the standard 5 per cent level of significance.<sup>5</sup> These results suggest that no cointegrating relation exists in the 4-variate systems for the four countries. Since no cointegrating relations among

**Table 2. Johansen trace test**

	<i>Indonesia</i>	<i>Republic of Korea</i>	<i>Thailand</i>
rank 2			1.6521
rank 1	0.0574	2.8592	8.7921
rank 0	5.8301	9.2721	20.8140

see Hamilton (pp. 767) Table B. 10 case I

<sup>5</sup> In consideration of the large size distortions in small samples with Johansen's test, the author also performed Engle and Granger's residual-based Augmented Dickey-Fuller cointegration test on all pairs of variables for each country. No cointegrating relation is seen at the 5 per cent statistical level, consistent with the Johansen's test results. See Hayashi (2000) and Hamilton (1994).

the variables are found, the first difference of I(1) variables is taken to transform them to I(0). The dynamic systems can then be formed in a VAR model. The estimation results for VAR are summarized in section III.

### III. EMPIRICAL RESULTS

#### *The data*

The data used are quarterly for the period of 1983: Q1 to 1997: Q2. The real exchange rate is calculated using period-average spot market rates and consumer price indices, and is expressed in terms of the Japanese yen. Domestic interest rates are measured by money market rates in Indonesia, the Republic of Korea, and Thailand, and by the TB (Treasury Bill) rate in the Philippines. The Japanese interest rate is a money market rate. The data in this section are from the IMF International Financial Statistics. All the series, except for the interest differentials and the current account-GDP ratio, are in natural logarithmic form. The real GDP series of Indonesia and Thailand are interpolated using annual series.

#### *Granger causality*

Before proceeding to VAR estimation, table 3 lists results of Granger Causality F-tests on the 16 pairs of I(0) and first-differenced I(1) variables for each country. A statistically significant point estimate coefficient and a block exogeneity F-statistic show that the explanatory variable (e.g., the exchange rate per yen of country i) “Granger causes” the dependent variable (e.g., the current account-GDP ratio in country i). The results show that in Indonesia, the Republic of Korea and Thailand, the real exchange rates per yen “Granger cause” almost all the other variables, but not vice versa. The Philippines’ real exchange rate and the interest differentials provide two of the strongest Granger causalities in the system. Therefore, the ordering of the system is set as follows: the real exchange rate, the interest differentials, the GDP growth, and the current account-GDP ratio.

#### *VAR results*

Since all the series are I(0), examining the dynamics of  $y_t$ , which is presumed to be governed by a pth-order Gaussian vector autoregression can be continued.

$$\Delta y_t = c + \phi_1 \Delta y_{t-1} + \phi_2 \Delta y_{t-2} + \dots + \phi_p \Delta y_{t-p} + v_t,$$

with  $v_t \sim i.i.d. N(0, \Sigma)$ . That is, the VAR is the reduced form of the dynamic structural model, which can be written as

$$\Delta y_t' = \Delta x_t' \Pi + \hat{u}_t', \quad (11)$$

where  $\Delta x_t' = [I \Delta y_{t-1} \Delta y_{t-2} \dots \Delta y_{t-p}]$ .

The advantage of the VAR time-series approach is that it is an unrestricted reduced-form specification and thus avoids the possibility of misleading inferences due to incorrect model specification.

**Table 3. Granger causality F-test**

<i>Granger Causes</i>		<i>DY1</i>	<i>(D)Y2</i>	<i>(D)Y3</i>	<i>(D)Y4</i>
Indonesia	DY1		0.5788	2.17577	2.80582
	Y2	5.42128		4.84054	2.05051
	DY3	2.65573	2.08944		1.75697
	Y4	1.37743	3.92456	5.3388	
Republic of Korea	DY1		1.09682	0.35284	4.79159
	Y2	0.66595		1.10745	1.76068
	DY3	1.89264	1.32317		5.10423
	Y4	1.4785	0.13951	1.21004	
Philippines	DY1		4.4352	4.15624	0.79212
	Y2	3.51884		8.45145	2.81364
	Y3	7.09492	3.41752		5.05791
	Y4	1.47191	0.91853	16.09953	
Thailand	DY1		0.48695	1.16465	2.65927
	DY2	1.05193		12.679	1.34436
	DY3	0.66262	1.83276		2.56055
	Y4	0.67449	2.13613	0.30027	

significant at 1 per cent : 3.695426

significant at 5 per cent : 2.546273

significant at 10 per cent : 2.054058

significant at 25 per cent : 1.389996

D : first difference

Y1 : bg of real exchange rate (against yen)

Y2 : real interest rate differential (between the country and Japan)

Y3 : bg of real GDP

Y4 : current account-GDP ratio

**Parameter estimations**

The expected signs of each regression are summarized in table 4. Tables 5.1-5.4 show the VAR parameter estimates.

**Table 4. Expected sign of parameters**

	<i>regressor</i>			
	<i>Y1</i>	<i>Y2</i>	<i>Y3</i>	<i>Y4</i>
Y1		–	–	–
Y2	+		+	+
Y3	+	–		+ or –
Y4	+ or –	+ or –	–	

Y1 : bg of real exchange rate (against yen)

Y2 : real interest rate differential (between the country and Japan)

Y3 : GDP growth

Y4 : current account-GDP ratio

Table 5.1 gives the estimated coefficients for the regressions of exchange rate. The expected sign of the interest rate differentials is negative, because an increase in the interest rate relative to the United States and Japanese rates induces pressure for appreciation of the domestic currency. The sign of the GDP growth is also expected to be negative, since a growing GDP probably leads to a strong currency. The expected sign of the current account-GDP ratio is also negative, because a current account surplus results in exchange rate appreciation.

The test results show that most of the estimated coefficients are either not correctly signed or insignificant, except for the coefficient of the interest rate differential in Indonesia. This reflects the fact that Indonesia adopted the crawling peg system, which manages exchange rate movements in accordance with the United States inflation rate. Since the inflation rate in Japan has been very low and stable, the inflation rate differentials between the United States and Indonesia directly affect the behaviour of the interest rate differentials between Japan and Indonesia.

Table 5.2 shows the parameter estimates for the interest rate differential regressions. The expected sign of the exchange rate is positive, because the depreciation of a currency would induce a rise in the price of imported goods, which might induce inflationary pressure on the wholesale and/or consumer prices. The coefficient of GDP growth is expected to be positive, since the expansion of GDP may cause inflationary pressure and the domestic interest rate may rise. The estimated coefficient of the current account-GDP ratio is ambiguous.

Table 5.1. VAR result: dependent variable: (D)Y1

Indonesia				Republic of Korea				Philippines				Thailand			
	Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.
DY1(-1)	0.134	0.163	0.822	DY1(-1)	0.340	0.162	1.224	DY1(-1)	0.302	0.164	1.641	DY1(-1)	0.304	0.171	1.780
DY1(-2)	0.034	0.163	0.211	DY1(-2)	-0.271	0.170	-1.102	DY1(-2)	-0.404	0.181	-1.584	DY1(-2)	-0.231	0.183	-1.260
DY1(-3)	0.131	0.162	0.809	DY1(-3)	0.266	0.173	0.923	DY1(-3)	0.117	0.186	0.913	DY1(-3)	0.228	0.181	1.265
DY1(-4)	0.191	0.154	1.244	DY1(-4)	-0.111	0.184	0.296	DY1(-4)	-0.276	0.178	-0.850	DY1(-4)	0.034	0.179	0.190
Y2(-1)	-0.780	0.281	-2.779	Y2(-1)	-0.191	0.325	-0.563	Y2(-1)	-0.649	0.380	-0.731	Y2(-1)	-0.184	0.376	-0.489
Y2(-2)	-0.260	0.393	-0.662	Y2(-2)	-0.387	0.381	-1.299	Y2(-2)	0.037	0.378	1.322	Y2(-2)	-0.818	0.560	-1.460
Y2(-3)	-0.036	0.361	-0.099	Y2(-3)	0.605	0.636	0.591	Y2(-3)	0.193	0.329	-1.830	Y2(-3)	-0.477	0.637	-0.749
Y2(-4)	-0.212	0.334	-0.634	Y2(-4)	-0.309	0.610	-0.302	Y2(-4)	0.404	0.324	1.473	Y2(-4)	-0.652	0.621	-1.049
DY3(-1)	0.718	0.551	1.303	DY3(-1)	0.213	0.207	0.956	Y3(-1)	-0.195	0.181	-0.997	DY3(-1)	0.773	0.896	0.863
DY3(-2)	0.227	0.552	0.412	DY3(-2)	0.223	0.191	-0.392	Y3(-2)	0.303	0.153	2.124	DY3(-2)	-0.680	1.139	-0.597
DY3(-3)	0.305	0.540	0.564	DY3(-3)	0.175	0.186	0.774	Y3(-3)	-0.234	0.177	-1.890	DY3(-3)	0.633	1.090	0.580
DY3(-4)	-0.035	0.355	-0.099	DY3(-4)	0.312	0.192	0.000	Y3(-4)	-0.104	0.162	0.424	DY3(-4)	-0.941	0.847	-1.111
Y4(-1)	0.180	0.617	0.292	Y4(-1)	0.064	0.525	-0.391	Y4(-1)	0.184	0.404	-0.016	Y4(-1)	0.171	0.427	0.400
Y4(-2)	0.421	0.759	0.554	Y4(-2)	-0.003	0.546	0.041	Y4(-2)	-0.225	0.408	0.205	Y4(-2)	-0.373	0.504	-0.740
Y4(-3)	-0.786	0.741	-1.060	Y4(-3)	0.184	0.506	-0.611	Y4(-3)	0.046	0.437	0.076	Y4(-3)	0.346	0.464	0.746
Y4(-4)	0.105	0.694	0.152	Y4(-4)	-0.689	0.438	-0.229	Y4(-4)	-0.335	0.411	-0.485	Y4(-4)	-0.166	0.427	-0.389
C	0.085	0.049	1.712	C	0.007	0.048	0.779	C	0.166	0.074	1.666	C	0.013	0.032	0.412
adjR <sup>2</sup>	0.293			adjR <sup>2</sup>	0.037			adjR <sup>2</sup>	0.179			adjR <sup>2</sup>	-0.032		

D : first difference

Y1 : bg of real exchange rate (against yen)

Y2 : real interest rate differential (between the country and Japan)

Y3 : bg of real GDP

Y4 : current account-GDP ratio

Table 5.2. VAR result: dependent variable: (D)Y2

Indonesia				Republic of Korea				Philippines				Thailand			
	Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.
DY1(-1)	0.0057	0.1030	0.0551	DY1(-1)	-0.0573	0.0864	-0.5548	DY1(-1)	0.0789	0.0677	0.3517	DY1(-1)	-0.0599	0.0777	-0.7709
DY1(-2)	0.0147	0.1034	0.1425	DY1(-2)	-0.0099	0.0908	-0.2513	DY1(-2)	-0.2179	0.0744	-2.8124	DY1(-2)	0.0405	0.0834	0.4854
DY1(-3)	-0.0607	0.1024	-0.5928	DY1(-3)	-0.0017	0.0922	0.5542	DY1(-3)	-0.0036	0.0768	-0.6005	DY1(-3)	-0.0423	0.0822	-0.5147
DY1(-4)	-0.0384	0.0973	-0.3941	DY1(-4)	0.1374	0.0984	1.8395	DY1(-4)	-0.1007	0.0734	-1.3706	DY1(-4)	-0.0238	0.0814	-0.2922
Y2(-1)	0.2898	0.1778	1.6302	Y2(-1)	-0.0340	0.1734	-0.6269	Y2(-1)	0.1543	0.1565	0.0497	DY2(-1)	-0.5728	0.1713	-3.3450
Y2(-2)	0.3277	0.2489	1.3166	Y2(-2)	0.2191	0.2030	1.2331	Y2(-2)	0.0026	0.1556	0.2266	DY2(-2)	-0.5112	0.2549	-2.0052
Y2(-3)	-0.0205	0.2289	-0.0895	Y2(-3)	0.2039	0.3394	0.2756	Y2(-3)	-0.0845	0.1355	0.4178	DY2(-3)	-0.1233	0.2900	-0.4251
Y2(-4)	-0.1531	0.2116	-0.7236	Y2(-4)	0.2584	0.3255	0.5378	Y2(-4)	0.1785	0.1334	0.2713	DY2(-4)	0.4845	0.2829	1.7130
DY3(-1)	-0.8153	0.3490	-2.3362	DY3(-1)	-0.0190	0.1105	-1.0590	Y3(-1)	0.0263	0.0748	-1.2830	DY3(-1)	0.1462	0.4079	0.3584
DY3(-2)	0.1190	0.3494	0.3405	DY3(-2)	-0.0017	0.1020	0.9135	Y3(-2)	-0.1384	0.0632	0.3017	DY3(-2)	-0.0213	0.5184	-0.0410
DY3(-3)	0.0035	0.3423	0.0101	DY3(-3)	0.0502	0.0994	1.2592	Y3(-3)	-0.1036	0.0728	0.4337	DY3(-3)	-0.9420	0.4961	-1.8987
DY3(-4)	0.0850	0.2246	0.3784	DY3(-4)	0.0065	0.1024	-0.6927	Y3(-4)	0.1713	0.0666	-0.0714	DY3(-4)	0.5388	0.3857	1.3969
Y4(-1)	0.4593	0.3909	1.1750	Y4(-1)	0.0441	0.2798	-0.3011	Y4(-1)	-0.0320	0.1666	0.6141	Y4(-1)	-0.3824	0.1943	-1.9686
Y4(-2)	-0.3060	0.4807	-0.6365	Y4(-2)	-0.0958	0.2910	-1.0268	Y4(-2)	0.0023	0.1680	-0.6285	Y4(-2)	0.1631	0.2296	0.7102
Y4(-3)	-0.3233	0.4696	-0.6885	Y4(-3)	-0.0923	0.2701	0.5406	Y4(-3)	-0.2486	0.1803	-2.1605	Y4(-3)	0.3227	0.2111	1.5288
Y4(-4)	0.0793	0.4398	0.1803	Y4(-4)	0.0988	0.2335	0.5360	Y4(-4)	-0.1412	0.1693	-0.4223	Y4(-4)	-0.0582	0.1942	-0.2995
C	0.0541	0.0313	1.7272	C	0.0250	0.0255	0.6150	C	0.0988	0.0306	4.2067	C	0.0108	0.0147	0.7362
adjR^2	0.201			adjR^2	0.031			adjR^2	0.293			adjR^2	0.194		

D : first difference

Y1 : bg of real exchange rate (against yen)

Y2 : real interest rate differential (between the country and Japan)

Y3 : bg of real GDP

Y4 : current account-GDP ratio

The parameter estimates show that most of the coefficients of the interest rate differential regressions are not significant and/or correctly signed. This result stems from the fact that the level of the interest rate (except for the very short-term rate) is set by monetary authorities, not determined in the market. Thus, movements in other economic indicators do not directly appear in the interest rate behaviour.

Table 5.3 shows the regression results for GDP growth. The expected sign of the exchange rate is positive, reflecting the fact that the depreciation of a currency improves the terms of trade and further accelerates output growth. The coefficients of the interest rate differentials are expected to be negative, since an increase in the interest rate is likely to slow down investment and decrease production. The expected sign of the current account-GDP ratio is ambiguous.

The parameter estimates are listed in table 5.3. Most of the coefficients of the interest rate differentials are significant. There is a strong relationship between the interest rate differentials and GDP growth in the four countries. However, most of the coefficients are not correctly signed. The results show that an increase in domestic interest rates tends to expand economic activities by attracting foreign capital. This is consistent with the fact that the economic booms of the late 1980's and early 1990's occurred with high interest rates.

Table 5.4 shows the estimated coefficients for the regressions of current account-GDP ratio. The expected sign of the exchange rate is ambiguous, since the depreciation of a currency enhances both GDP and exports, but decreases imports. Thus, whether the depreciation increases the current account-GDP ratio or not depends on the elasticity of the GDP and current account. The estimated coefficients of the interest rates differentials are also ambiguous. An increase in domestic interest rates will reduce GDP and therefore may decrease both exports and imports. Whether the current account ratio decreases or increases depends on the elasticity of exports and imports. Thus, it is not clear whether a rise in interest rates will improve current accounts or not. The expected sign of the GDP is negative. A rise in GDP growth itself increases the denominator of the fraction, and it might decrease the current accounts through the export-import channel.

There appears to be evidence for a very weak relationship between the real exchange rate and the current account-GDP ratio. The parameter estimates of the exchange rate in the Philippines are one digit smaller than those of the other countries. This is due to the fact that the Philippines' largest trade partner is the United States, not Japan. Thus, the current account has not been influenced much by fluctuation in the yen exchange rate. The estimated coefficients of the exchange rate in the Republic of Korea are significant and positive, except for that of lag 1. This also provides evidence that the Republic of Korea and Japan are in a substitute relationship in trade. On the other hand, the coefficients of the exchange rate in Indonesia and Thailand are negative, which shows their complementary relationships with Japan.

Table 5.3. VAR result: dependent variable: (D)Y3

Indonesia				Republic of Korea				Philippines				Thailand			
	Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.
DY1(-1)	0.019	0.052	0.371	DY1(-1)	-0.004	0.139	0.433	DY1(-1)	-0.116	0.082	-1.373	DY1(-1)	0.050	0.039	1.272
DY1(-2)	-0.018	0.052	-0.344	DY1(-2)	0.050	0.147	0.336	DY1(-2)	0.127	0.090	1.062	DY1(-2)	0.002	0.042	0.041
DY1(-3)	0.031	0.052	0.611	DY1(-3)	0.066	0.149	0.268	DY1(-3)	-0.118	0.093	-0.738	DY1(-3)	0.049	0.042	1.180
DY1(-4)	-0.066	0.049	-1.355	DY1(-4)	0.103	0.159	-0.028	DY1(-4)	0.051	0.089	-0.042	DY1(-4)	-0.028	0.041	-0.670
Y2(-1)	0.466	0.090	5.204	Y2(-1)	0.876	0.280	8.780	Y2(-1)	-0.185	0.189	5.695	DY2(-1)	0.476	0.087	5.474
Y2(-2)	-0.144	0.125	-1.150	Y2(-2)	-0.008	0.328	-3.463	Y2(-2)	0.176	0.188	-2.597	DY2(-2)	-0.045	0.129	-0.348
Y2(-3)	-0.164	0.115	-1.427	Y2(-3)	-0.505	0.548	-1.182	Y2(-3)	0.294	0.164	-0.352	DY2(-3)	0.175	0.147	1.189
Y2(-4)	0.176	0.107	1.654	Y2(-4)	-0.702	0.526	-0.464	Y2(-4)	0.352	0.161	0.438	DY2(-4)	-0.110	0.144	-0.767
DY3(-1)	0.209	0.176	1.189	DY3(-1)	-0.338	0.178	3.159	Y3(-1)	0.096	0.090	7.483	DY3(-1)	0.846	0.207	4.088
DY3(-2)	-0.243	0.176	-1.382	DY3(-2)	-0.363	0.165	-0.219	Y3(-2)	0.193	0.076	-1.679	DY3(-2)	-0.269	0.263	-1.021
DY3(-3)	-0.002	0.172	-0.014	DY3(-3)	-0.378	0.161	-0.992	Y3(-3)	0.036	0.088	0.025	DY3(-3)	0.305	0.252	1.210
DY3(-4)	-0.235	0.113	-2.076	DY3(-4)	0.566	0.165	0.100	Y3(-4)	0.766	0.080	0.707	DY3(-4)	-0.211	0.196	-1.078
Y4(-1)	0.361	0.197	1.832	Y4(-1)	-0.463	0.452	-1.543	Y4(-1)	-0.014	0.201	1.022	Y4(-1)	-0.028	0.099	-0.286
Y4(-2)	-0.219	0.242	-0.904	Y4(-2)	0.127	0.470	1.316	Y4(-2)	-0.202	0.203	-0.235	Y4(-2)	-0.046	0.116	-0.397
Y4(-3)	0.655	0.236	2.768	Y4(-3)	0.447	0.436	0.679	Y4(-3)	0.089	0.218	0.856	Y4(-3)	0.047	0.107	0.442
Y4(-4)	0.061	0.221	0.275	Y4(-4)	0.133	0.377	-0.144	Y4(-4)	0.281	0.204	-0.767	Y4(-4)	0.033	0.099	0.337
C	0.022	0.016	1.391	C	0.060	0.041	1.593	C	-0.073	0.037	-1.368	C	0.006	0.007	0.864
adjR <sup>2</sup>	0.553			adjR <sup>2</sup>	0.919			adjR <sup>2</sup>	0.969			adjR <sup>2</sup>	0.465		

D : first difference

Y1 : bg of real exchange rate (against yen)

Y2 : real interest rate differential (between the country and Japan)

Y3 : bg of real GDP

Y4 : current account-GDP ratio

Table 5.4. VAR result: dependent variable: (D)Y4

Indonesia			Republic of Korea			Philippines			Thailand		
	Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.		Estimated Coefficient	Standard Error	t-stat.
DY1(-1)	-0.037	0.042	-0.874	DY1(-1)	-0.001	0.053	0.150	DY1(-1)	0.150	0.072	2.097
DY1(-2)	-0.044	0.042	-1.054	DY1(-2)	0.087	0.056	2.048	DY1(-2)	-0.086	0.077	-1.117
DY1(-3)	-0.041	0.042	-0.972	DY1(-3)	0.135	0.057	2.089	DY1(-3)	0.147	0.076	1.937
DY1(-4)	0.029	0.040	0.737	DY1(-4)	0.088	0.061	2.338	DY1(-4)	-0.008	0.075	-0.105
Y2(-1)	-0.179	0.072	-2.474	Y2(-1)	-0.033	0.107	0.429	DY2(-1)	-0.075	0.158	-0.474
Y2(-2)	0.016	0.101	0.153	Y2(-2)	-0.152	0.126	-0.670	DY2(-2)	-0.346	0.235	-1.474
Y2(-3)	-0.001	0.093	-0.012	Y2(-3)	0.136	0.210	-0.028	DY2(-3)	-0.041	0.267	-0.153
Y2(-4)	0.079	0.086	0.912	Y2(-4)	-0.116	0.201	-0.132	DY2(-4)	-0.389	0.261	-1.493
DY3(-1)	-0.124	0.142	-0.871	DY3(-1)	-0.029	0.068	-0.484	DY3(-1)	0.517	0.376	1.376
DY3(-2)	0.025	0.142	0.176	DY3(-2)	-0.064	0.063	-0.349	DY3(-2)	-0.525	0.478	-1.098
DY3(-3)	-0.354	0.139	-2.540	DY3(-3)	-0.027	0.062	0.707	DY3(-3)	0.538	0.457	1.177
DY3(-4)	-0.051	0.091	-0.560	DY3(-4)	0.041	0.063	-0.132	DY3(-4)	-0.811	0.356	-2.281
Y4(-1)	0.261	0.159	1.642	Y4(-1)	0.429	0.173	2.344	Y4(-1)	0.461	0.179	2.577
Y4(-2)	0.137	0.196	0.700	Y4(-2)	0.358	0.180	0.632	Y4(-2)	0.155	0.212	0.733
Y4(-3)	-0.282	0.191	-1.473	Y4(-3)	0.122	0.167	0.757	Y4(-3)	-0.283	0.195	-1.456
Y4(-4)	0.111	0.179	0.623	Y4(-4)	-0.016	0.145	1.860	Y4(-4)	0.346	0.179	1.932
C	0.000	0.013	0.026	C	0.009	0.016	0.158	C	-0.013	0.014	-0.945
adjR <sup>2</sup>	0.238303			adjR <sup>2</sup>	0.83374			adjR <sup>2</sup>	0.6562		

D : first difference

Y1 : bg of real exchange rate (against yen)

Y2 : real interest rate differential (between the country and Japan)

Y3 : bg of real GDP

Y4 : current account-GDP ratio

### *Impulse responses*

In this section we present results for the Choleski-decomposed impulse responses of the variables. Figures 1.1-4.4 show the estimated responses up to 20 periods (5 years). Figure 1 is for Indonesia; figure 2, the Republic of Korea; figure 3, the Philippines; and figure 4, Thailand. These figures indicate that the responses of economic variables in each country reflect idiosyncratic, individual factors within each country.

In Indonesia, a one-unit shock in each variable does not induce a long lasting effect on other macroeconomic fundamentals. A shock in interest rate differential has the most influence inducing appreciation of the currency for the remaining 11 periods.

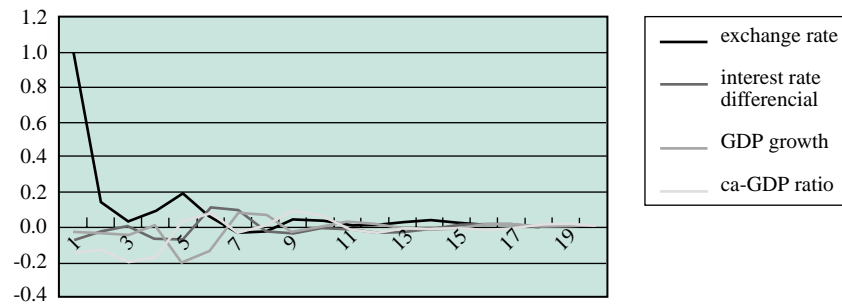
In the Republic of Korea, shocks in the exchange rate and interest rate differentials have significant effects on the current account-GDP ratio. A one-unit shock in exchange rate (depreciation) improves the current account-GDP ratio substantially, while the real GDP growth rate remains relatively constant. Thus, we can say that real exchange rate depreciation against the Japanese yen improves the current account through the export-enhancing and import-decreasing channel. On the other hand, a shock in interest rate differentials initially enhances the GDP growth rate but reduces it in the medium term. Given the foreign (Japanese) interest rate, an increase in the domestic interest rate reduces the current account-GDP ratio, which recovers to the initial level after 20 periods.

In the Philippines, the responses of the GDP growth rate show a different pattern compared to the other countries. Shocks in the exchange rate, interest rate differentials, and real GDP growth induce long lasting effects on real GDP growth. It is interesting that depreciation against the yen reduces the real GDP growth rate. Considering the trade relationship between Japan and the Philippines, gains from depreciation (e.g. enhanced exports due to declining export prices) are limited but the effect of depreciation, due to the rise in prices of imported goods, will be far larger.

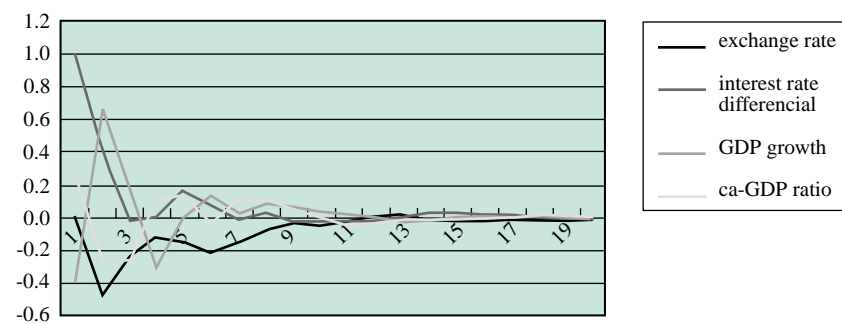
In Thailand, the current account-GDP ratio is improved by shocks in the real exchange rate (depreciation) and real GDP growth. On the other hand, a rise in domestic interest rates (or an expansion of real interest rate differential) induces appreciation pressure on the exchange rate and reduces the current account-GDP ratio for a long run, up to 18 periods.

In summary, the parameter estimates reflect the macroeconomic situations and trade relationships of the countries in question. For example, the current account in the Philippines reflects the fact that Japan is not its largest trade partner, and therefore fluctuations in the exchange rate against the yen are not very harmful to the Philippines. It can also be seen that Indonesia and Thailand have rather complementary relationships with Japan, whereas the Republic of Korea has a substitute relation with Japan.

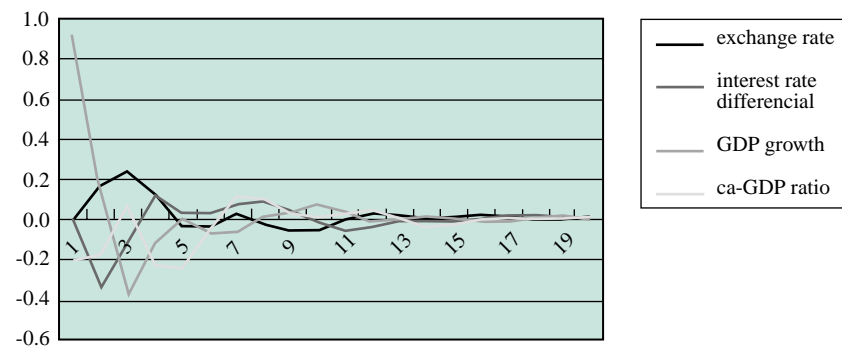
**Figure 1.1. Indonesia: Impulse responses to choleskifactored shocks in exchange rate**



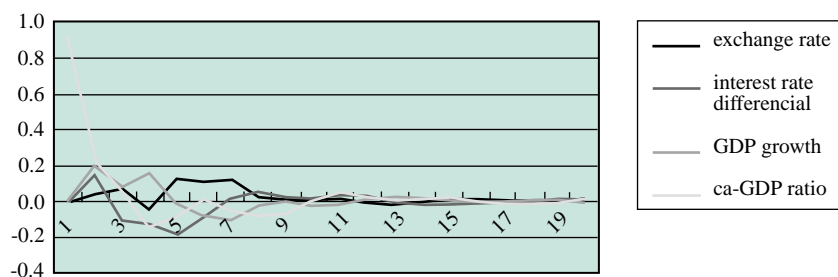
**Figure 1.2. Indonesia: Impulse responses to choleskifactored shocks in real interest rate differential**



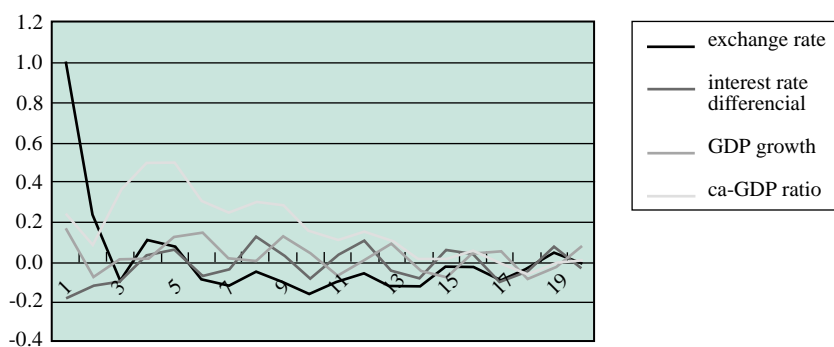
**Figure 1.3. Indonesia: Impulse responses to choleskifactored shocks in GDP growth**



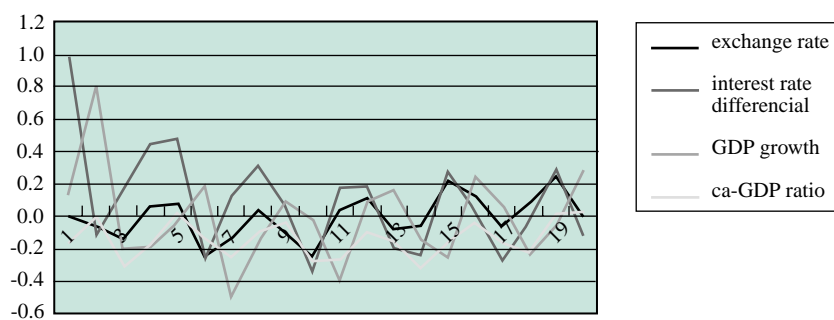
**Figure 1.4. Indonesia: Impulse responses to choleskifactored shocks in current account-GDP ratio**



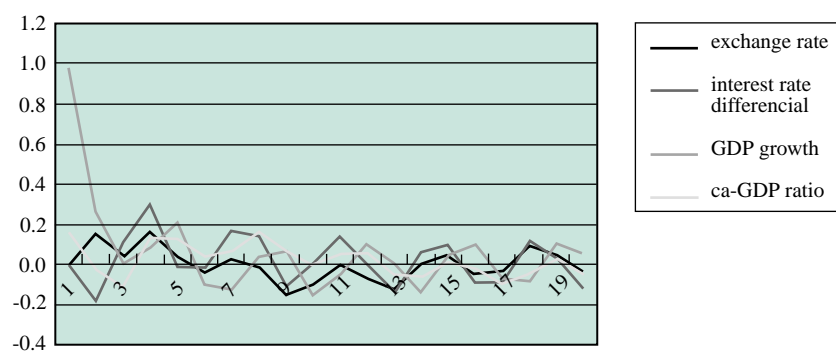
**Figure 2.1. Republic of Korea: Impulse responses to choleskifactored shocks in exchange rate**



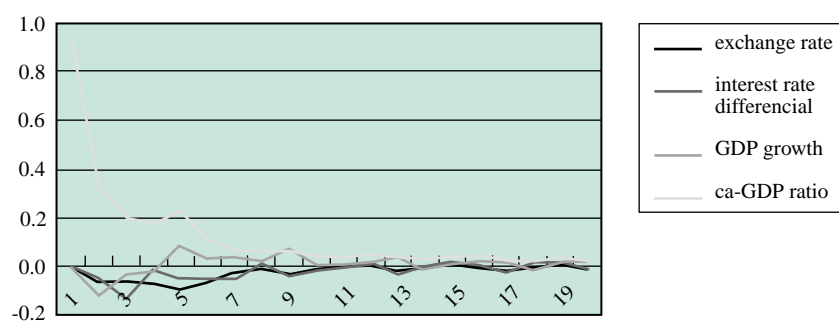
**Figure 2.2. Republic of Korea: Impulse responses to choleskifactored shocks in real interest rate differential**



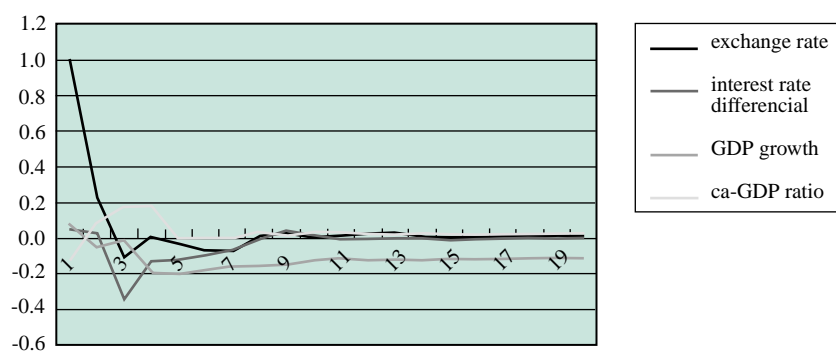
**Figure 2.3. Republic of Korea: Impulse responses to choleskifactored shocks in GDP growth**



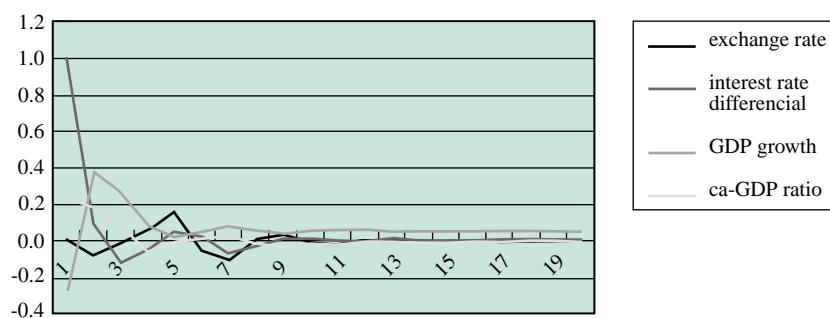
**Figure 2.4. Republic of Korea: Impulse responses to choleskifactored shocks in current account-GDP ratio**



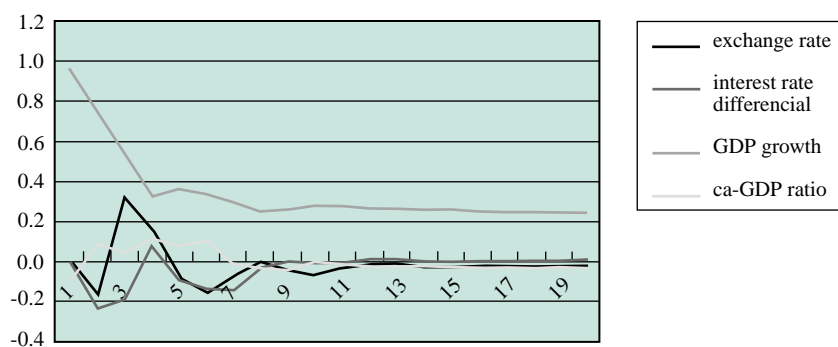
**Figure 3.1. The Philippines: Impulse responses to choleskifactored shocks in exchange rate**



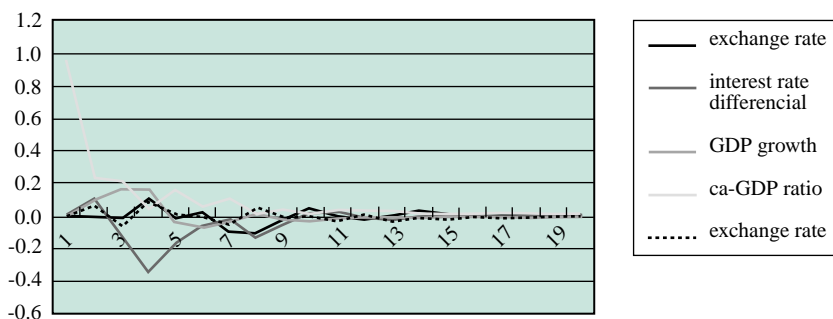
**Figure 3.2. The Philippines: Impulse responses to choleskifactored shocks in real interest rate differential**



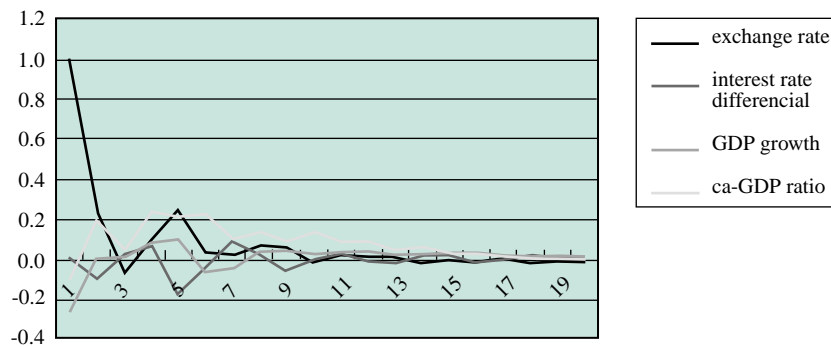
**Figure 3.3. The Philippines: Impulse responses to choleskifactored shocks in GDP growth**



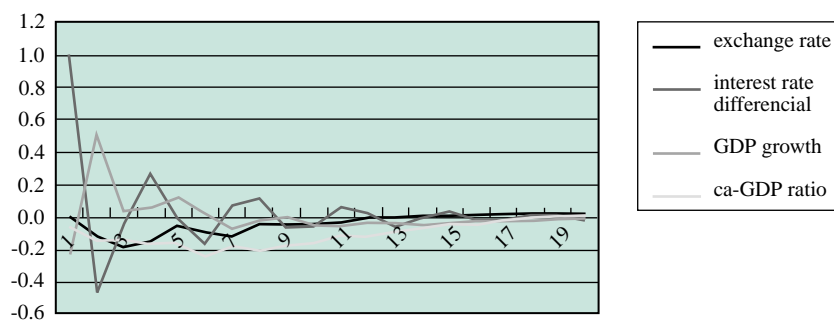
**Figure 3.4. The Philippines: Impulse responses to choleskifactored shocks in current account-GDP ratio**



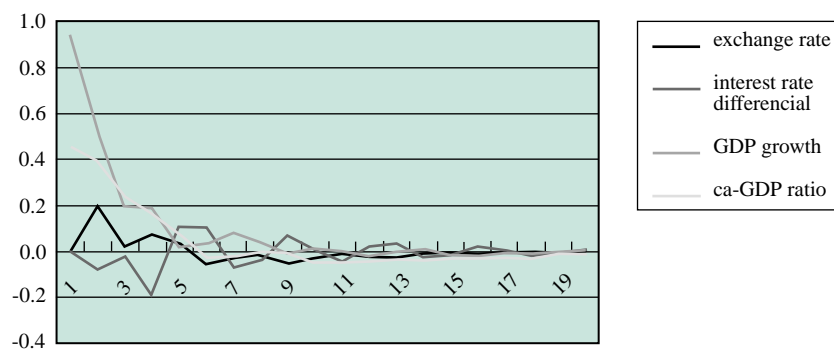
**Figure 4.1. Thailand: Impulse responses to choleskifactored shocks in exchange rate**



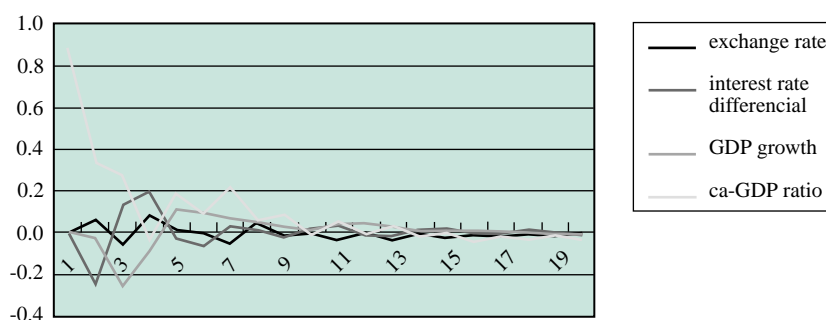
**Figure 4.2. Thailand: Impulse responses to choleskifactored shocks in real interest rate differential**



**Figure 4.3. Thailand: Impulse responses to choleskifactored shocks in GDP growth**



**Figure 4.4. Thailand: Impulse responses to choleskifactored shocks in current account-GDP ratio**



The impulse responses indicate that a rise in (or high) interest rates induces both depreciation pressure on the exchange rate and a shrinking effect on the current account in these countries. In the Republic of Korea, a rise in interest rates also decreases the GDP growth rate. Of course, the effect of the real exchange rate on the current account cannot be neglected, but it is worth noting that the most significant and long lasting effects on the current account, exchange rate, and GDP growth were from a shock in interest rates. This result shows the importance of monetary policy under a pegged exchange rate system.

Monetary authorities in developing countries tend to set interest rates high to avoid capital flight. This study indicates that interest rate management should be careful, since it directly affects the macro-fundamentals. High domestic interest rates themselves reduce the incentives for necessary investment, which might reduce GDP in the long run. Also, a higher interest rate relative to foreign interest rates may put appreciation pressure on the exchange rate, which causes the trade balance to deteriorate. A high interest rate also increases the probability of short-term capital inflows into the country, which can lead to economic vulnerability, one of the causes of speculative attacks.

## V. CONCLUDING REMARKS

This paper econometrically investigated the macroeconomic interactions for four countries in Asia. The parameter estimates reveal each country's idiosyncratic factors and trade linkages within Asia. VAR results show that in each country an increase in domestic interest rates (or an expansion in the interest rate differential) has a significant and long-lasting effect on the country's macroeconomic fundamentals, such as the exchange rate, GDP growth rate, and current account-GDP ratio.

The implications of this study are that a higher interest rate relative to foreign developed countries should be carefully managed, especially in countries with

a relatively low inflation rate and low government deficits. For these countries, the cost of a high interest rate is much greater than the benefit. Monetary authorities should pay more attention to both the absolute and relative levels of the interest rate, among other variables.

## REFERENCES

- Chinn, M. and L. Johnston, 1996. *Real Exchange Rate Levels, Productivity and Demand Shocks: Evidence from A Panel of 14 Countries*, NBER Working Paper, No. 5709.
- Engle, C. and J.H. Rogers, 1995. *Regional Patterns in the Law of One Price: The Roles of Geography vs. Currencies*, NBER Working Paper, No. 5395.
- Engle, R.F. and C.W.J. Granger, 1987. "Co-integration and error correction: representation, estimation and testing", *Econometrica*, vol. 55, No. 2, pp. 252-276.
- Fukuda, S. and T. Kano, 1997. "International price linkage within a region: the case of East Asia", *Journal of the Japanese and International Economies*, vol. 11, pp. 643-666.
- Hamilton, J.D., 1994. *Time Series Analysis*, Princeton University Press.
- Hayashi, F., 2000. *Econometrics*, Princeton University Press.
- International Monetary Fund, 1997. *International Capital Markets: Developments, Prospects, and Key Policy Issues*, Washington DC, International Monetary Fund.
- , 1998. *International Capital Markets: Developments, Prospects and Key Policy Issues*, Washington DC, International Monetary Fund.
- Ito, T., 1999. Capital Flows in Asia, NBER Working Paper, No. 7134.
- Ito, T., E. Ogawa, and Y.S. Nagataki, 1998. "How did the dollar peg fail in Asia?", *Journal of the Japanese and International Economies*, vol. 12, pp. 256-304.
- Johansen, S., 1988. "Statistical analysis of cointegrating vectors", *Journal of Economic Dynamics and Control*, vol. 12, No. 2, pp. 231-254.
- Kawai, M. and H. Ohara, 1997. "Non-stationarity of real exchange rates in the G7 countries: are they cointegrated with real variables?", *Journal of The Japanese and International Economies*, vol. 11, pp. 523-547.
- Kwan, C.H., 1998. "The theory of optimum currency areas and the possibility of forming a yen bloc in Asia," *Journal of Asian Economics*, vol. 9, No. 4.
- Lothian, J.R. and M.P. Taylor, 1996. "Real exchange rate behavior: the recent float from the perspective of the past two centuries", *Journal of Political Economy*, vol. 104, No. 3, pp. 488-509.
- Mckinnon, R. and K. Ohno, 1997. *Dollar and Yen*, MIT Press.
- Obstfeld, M. and K. Rogoff, 1996. *Foundations of International Macroeconomics*, The MIT press.
- Song, C.Y., 1997. "The real exchange rate and the current account balance in Japan", *Journal of the Japanese and International Economies*, vol. 11, pp. 143-184.
- Stock, J.H. and M.W. Watson, 1993. "A simple estimation of cointegrating vectors in higher order integrated systems", *Econometrica*, vol. 61, No. 4, pp. 783-820.
- Takagi, S., 1996. *The Yen and Its East Asian Neighbors, 1980-95: Cooperation or Competition?*, NBER Working Paper, No. 5720.
- Wei, S.J. and D.C. Parsley, 1995. *Purchasing Power Disparity During The Floating Rate Period: Exchange Rate Volatility, Trade Barriers And Other Culprits*, NBER Working Paper, No. 5032.
- The World Bank, 1993. *The East Asian Miracle: Economic Growth and Public Policy*, Oxford University press.