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DETERMINATION OF EQUILIBRIUM REAL EXCHANGE RATE IN SELECTED SEACEN COUNTRIES

Song Ouk Heon
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The South East Asian Central Banks
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FOREWORD

The real exchange rate (RER) plays an important role for undertaking a smooth macroeconomic policy mix. The RER can influence investment and capital accumulation and is also used as a measure of competitiveness in appraising the performance of the export sector. Thus, it is important for each country to maintain its real exchange rate at appropriate levels. However, with the rapidly changing environment of increasing liberalization of financial markets, it is increasingly harder to pinpoint the appropriate level of the real exchange rate without referring to its equilibrium rate. As such, this paper intends to investigate determinant factors influencing the equilibrium exchange rate. This paper also provides the misalignment degree between the actual and equilibrium real exchange rate.

This research project is undertaken by collaboration of Dr. Song Ouk-Heon and Mr. Lim Choon Seng. Dr. Song is a seconded staff from the Bank of Korea and Mr. Lim is a research staff of the SEACEN Centre. The authors would like to express a deep gratitude to Dr. Donnald Hanna, Managing Director, Citi Corp Hong Kong, who provided valuable comments. They wish also to extend their gratitude to all SEACEN member Banks for their useful comments and suggestions. The authors would also like to thank Dr. Subarjo Joyosumarto, Executive Director, and research colleagues, in particular Ms. Kanaengnid Tantigate-Quah, for their support.

Dr. Subarjo Joyosumarto
Executive Director
The SEACEN Centre

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EXECUTIVE SUMMARY

The objectives of this project are: to investigate determinant factors influencing the real exchange rate fluctuations; to measure the real exchange rate deviation from the equilibrium; and to provide some guidance for policymakers in implementing exchange rate policy. For the empirical study, five countries out of the eleven SEACEN countries were picked: Indonesia, Korea, Malaysia, the Philippines and Thailand. These countries experienced the recent Asian financial crisis. In the process of explaining the cause of the Asian crisis, an issue was whether the misalignment of the real exchange rate provided a motive to the Asian crisis. If there is no significant deviation of the real exchange rate from its equilibrium level, the triggering factors of the crisis might not be from exchange rate mismanagement but from other factors such as large short-term debts and weak financial system.

In this paper, movements of the real exchange rates in five crisis-hit countries were analyzed using the single equation approach (SEA). Major findings are as follows:

- First, most parameters of the long run and short run equations are the same as expected in theory or empirical regularity. The most commonly used variable is capital flows: a rise in capital flows appreciates the real exchange rate.

- Second, as fully efficient estimation and inference in the single equation approach are dependent upon the hypothesis of weak exogeneity, we tested the hypothesis. Among five countries, only the case of Thailand failed the test. We did re-estimation using the instrumental variables by the two-stage least squares method, the results of which are not much different from those of the OLS estimation.

- Third, three out of five countries—Indonesia, Malaysia and Thailand—seem to have sought to achieve a depreciation policy of the real exchange rate since the 1980s. Unlike three countries, the real exchange rates of Korea and the Philippines show the sharp depreciation in the first half of the 1980s, followed by a correcting appreciation.

- Lastly, The misalignment degrees before the crisis ranged from six to sixteen percent appreciation, which are not too much excessive, compared with those of other periods in each country. The misalignments do not appear to last long, especially before the crisis.

Based on the results of this paper, as the misalignment degree is not significantly large, it seems that five crisis-hit countries did not make any substantial mistakes in managing exchange rates. The triggering factors of the crisis might be sought from other sources such as a large short-term debt, a weak financial system and so on.

DETERMINATION OF EQUILIBRIUM REAL EXCHANGE RATE IN SELECTED SEACEN COUNTRIES

I. Introduction

The real exchange rate (RER) plays an important role for the practice of a smooth macroeconomic policy mix. Directly, RER can influence the amount of domestic and foreign investment and hence capital accumulation (Serven and Solimano, 1991). Since RER is also a measure of competitiveness, it can prove to be important for the performance of the export sector (Caballero and Corbo, 1989). It is also well recognized that countries that do well normally owe much of their success in maintaining their real exchange rates at appropriate levels (Edwards, 1994).

However, with the rapidly changing environment of increasing liberalization of financial markets, it is increasingly harder to pin-point the appropriate level of the real exchange rate without referring to its equilibrium rate. As such, this paper intends to investigate determinant factors influencing the equilibrium exchange rate. As pointed out by Williamson (1994), one of the leading authorities on exchange rate, "being able to make sensible estimates of equilibrium exchange rates is of key importance to rational, outward-oriented macroeconomic management of the sort that has been increasingly widely adopted in recent years."

In conducting monetary policy especially under flexible exchange rates, the equilibrium real exchange rate can be used to provide guidance for policymakers in judging the prevailing exchange rate and in directing exchange rate expectations. In many countries, as exchange rate is not the final target of monetary policy, countries implementing a flexible exchange rate regime have no official obligation to defend their currencies. However, when a large divergence from equilibrium occurs, it may be necessary to intervene. The question is when it is appropriate to act. In this regard, policymakers may find useful in knowing what factors are causing misalignment between the actual and equilibrium real exchange rate and how much the degree of misalignment is.

During the 1997-98 crisis, many analysts have argued that the recent financial turmoil and its contagion effects were intensified, among others, by "inappropriate" exchange rate policies resulting in misalignment of the real exchange rate. Misalignment is harmful in many ways. First, it can cause resource misallocation, a cost that has escalated with increased globalisation (Hinkle and Montiel, 1999). Second, persistent misalignment could also lead to what is termed as "misalignment volatility" by Razin and Collins (1997) and this can be destabilising to the economy. Third, misalignment in either direction could result in economic efficiency loss caused by wrong price signals (Edwards, 1988). In particular, large under-valuation may have the inflationary effect of high import prices in domestic currency and could lead to buildup of foreign debts as well as a decline in incentive to invest in tradable goods industries (Williamson, 1999).

In addition, many empirical results (among others, Macfarlane and Tease (1989), Edwards (1994) and the Monetary Authority of Singapore (1998)) note that even though the real exchange rate has a tendency for mean reversion, it can move in one direction for extended periods. In another words, it will take a very long-term horizon for the real exchange rate to adjust back to the equilibrium level.

The objectives of this project are: to investigate determinant factors influencing the real exchange rate fluctuations; to measure the real exchange rate deviation from the equilibrium; and to provide some guidance for policymakers in implementing exchange rate policy. For the empirical study, five countries out of the eleven SEACEN countries were picked: Indonesia, Korea, Malaysia, the Philippines and Thailand. These countries experienced the recent Asian financial crisis. In the process of explaining the cause of the Asian crisis, an issue was whether the misalignment of the real exchange rate provided a motive to the Asian crisis. If there is no significant deviation of the real exchange rate from its equilibrium level, the triggering factors of the crisis might not be from exchange rate mismanagement but from other factors such as large short-term debts and weak financial system. The paper is organized as the following. Section II explains methods of estimating the equilibrium real exchange rate and Section III introduces the methodology for estimating the real exchange rate and misalignment using a single equation approach. In Section IV, empirical estimation will be undertaken, which will be followed by concluding remarks in Section V.

II. Methods of Estimating the Equilibrium Real Exchange Rate

There are several ways to estimate the equilibrium real exchange rate. Among the popular methods are: (i) the Purchasing Power Parity Approach (PPP); (ii) the Trade Equation Approach (TEA); (iii) the Structural Model Approach (SMA); and (iv) the Single Equation Approach (SEA). Each approach has its own merits and demerits.

Purchasing Power Parity Approach (PPP)

Earlier studies of the equilibrium real exchange rate focus on PPP. PPP in its standard form is consistent with disturbances that are monetary in nature but the conventional PPP model does not take into account permanent real disturbances such as significant movement in a country's terms of trade. Therefore, in developing countries, because of frequent structural changes and permanent supply shocks, empirically, PPP does not perform as well as expected. For PPP to be useful, Frenkel and Goldstein (1986) suggest a "Manual Override Option" to take into account real disturbances to the system. However, such a device is highly subjective. Another weakness is that the estimation of RER is susceptible not only to the various definitions of price indices but also to different base years.

Trade Equation Approach (TEA)

The Trade Equation Approach (TEA), unlike the PPP does not assume that RER is a constant. Instead, with the TEA, RER is linked to a set of fundamental variables. With the TEA approach, the first step is to establish trade elasticities and explore the relationship between exports, imports and RER. It then uses estimated resource balances, adjusted for cyclical and policy changes to establish the equilibrium RER. Ahlers and Hinkle (1999) point out that TEA is easy, straightforward and requires minimum data. However, although not confined to TEA, the methodology requires ad-hoc specification of the resource balances. It also basically ignores more complex interactions amongst economic variables. For example, TEA does not take into account feedback between savings and Investments, capital flows and RER. Because of availability of data, TEA is most commonly used for industralised countries.

Structural Model Approach (SMA)

Like TEA, the Structural Model Approach (SMA) says that RER is determined by a matrix of macroeconomic variables, albeit a much more comprehensive set. SMA generally utilises a multi-sectoral general equilibrium methodology to derive the RER. It is therefore able to take into account the full range of macroeconomic influences such as the interaction amongst RER, money supply and stocks of assets accumulations. The SMA has several other advantages. Firstly, the model could be made forward looking, thus providing a useful linkage between expectation and exchange rates[1]. Secondly, the model is able to impose minimum restrictions and assumptions in the estimation of RER (Hinkle and Montiel, 1999), and thirdly, the implicit links between policy variables and macroeconomic variables are useful for required simulation and policy analysis.

However, the SMA suffers from all the shortcomings of large econometric models. SMA places a strong demand on economic theory (Montiel and Hinkle, 1999) and despite its large scale, it cannot adequately take into account systematic changes in the evolution of exchange rates. Furthermore for developing countries, due to lack of reliable data, such big-scale models may not be feasible. In addition, SMA proves to be not only hard to construct but also difficult to maintain.

1. This is particular relevant in the modelling of price behaviour of financial assets. (Frenkel and Goldstein, 1986).

Single Equation Approach (SEA)

As noted above, the determination of exchange rate is often based on expectation. Therefore, ideally, the real exchange rate should be estimated based on rational optimizing behavior of all market participants. However, in the case of developing countries, smaller models may be more appropriate. Data constraints aside, large models using the multi-dimensional approach may not be efficient for developing countries, as these economies are too small to exert any significant impact on the world economy (Williamson, 1994). As such, small and purpose built models to derive reduced form single equation estimation may be sufficient. SEA models have evolved from some straightforward models to ones that specify RER as forward looking (Elbadawi, 1994). Other recent works using SEA include Montiel (1997), Razin and Collins (1997) and Baffes and et al (1999).

With the recent innovation in econometrics such as the cointegration and error correction techniques, it is now possible to use single equation estimation to fully incorporate general equilibrium interaction of the fundamental variables. It is also now feasible to not only estimate the equilibrium real exchange rate but also to assess the gap between the real exchange rate and its equilibrium rate efficiently. Cointegration technique for SEA for developing countries is practical in at least two aspects. First, despite the availability of relative short sample period, empirical studies often show that cointegrating relationships exist and are consistent in various studies among a broad class of fundamentals as suggested by theories. Secondly, equilibrium exchange rate estimates derived from such models often show misalignment in periods consistent with those judged by other means. In addition, error correction models derived from the cointegration relationship often show that the estimated equilibrium exchange rate is a significant predictor of future movement in the actual real exchange rates.

Naturally, SEA method demands fewer data as only those variables that are specified in the reduced form equation are needed. In addition, the dynamic structure of the economy does not need to be imposed ex-ante (Hickle and Montiel, 1999). Theoretically, there is often consensus on the eligible set of fundamental variables to be used in the estimation of the real exchange rates. In consideration of these points, this paper will take the SEA method to analyze movements in the real exchange rates.

III. Methodology for Estimating the Real Exchange Rate and Misalignment using the Single Equation Approach

In single equation modelling using the cointegration approach, there are bascially four steps in this approach (Baffes et al., 1999):

(i) identifying the long run relationships using fundamental variables consistent with internal and external equilibrium, using either the Engle and Granger (1987) or the Johansen (1991) approach;
(ii) estimating a short-run equation for the real exchange rate using the error correction model;
(iii) using the estimated long run parameters to estimate the equilibrium real exchange rate;
(iv) and measuring misalignment comparing the actual real exchange rate with the equilibrium real exchange rate.

Theoretically, small scale models used in single equation estimation normally define the equilibrium real exchange rate as the value of the real exchange rate, when relevant variables such as taxes, the terms of trade, commercial policy technology, the external and internal balances are simultaneously in equilibrium (Edwards, 1994). As defined by Elbadawi (1994), internal equilibrium is achieved when "the market for non tradable goods clears in the present and is expected to clear in the future; external equilibrium holds when present and future current account balances are compatible with long run sustainable capital flows." Solving equations for internal and external sectors[2], one can then derive a set of independent fundamental variables (F) to be used in the single equation estimation with the real exchange rate (e) as the dependent variable:

2. In modelling real exchange rate for a small open economy, it is normal to assume that there is price and wage flexibility but as long as the focus is on long term equilibrium, this assumption is valid (Montiel,1999b).

$$ln(e_t) = \beta' F_t \tag{1}$$

where *ln* is the log function, β' is the matrix of estimated parameters. The independent variables (F^p) may include both nominal and real variables. The equilibrium real exchange rate (e^*) is then defined by the vector of permanent values (F^p) of the fundamentals:

$$ln(e_t^*) = \beta' F_t^p \tag{2}$$

Misalignment of the real exchange rate is defined as the gap between the actual and equilibrium real exchange rate.[3] According to Isard and Faruqee (1998), exchange rates may become substantially misaligned because of undesirable macroeconomic policies as the former tends to reflect economic fundamentals. On the other hand, it is also entirely possible that misalignment is a result of bubble factors (Montiel, 1999a). That is, misalignment can occur in the short and medium-term because the RER can be influenced by variables other than economic fundamentals. It is also entirely conceivable that such short-run disequilibrium outcome may be the result of optimising behaviour of agents and therefore such deviation cannot be improved by macroeconomic policies. Misalignment (γ_t) can be measured by:

$$\gamma_t = [ln(e_t) - \beta' F_t^p] \tag{3}$$

3.1 Variables used in the Model

In most models, there is a consistent set of dependent variables as in Edwards (1994), Elbadawi (1994), Montiel (1997), Razin and Colins(1997) and Baffes and et al. (1999). In the domestic sector, common variables are the composition of government spending and variables to proxy the measurement of the Harrod-Balassa-Samuleson (HBS) effect, while the external factors include the terms of trade as well and trade policy.

3. The equilibrium real exchange rate means "permanent values for the fundamentals."

3.1.1 Independent Variable

Actual Real Exchange Rate

The actual real exchange rate can be derived either externally and internally. As the name implies, for internal measures, only domestic prices in the country concerned are used. For example, the use of the ratio of domestic prices of tradable and non-traded goods to derive the real exchange rate. For developing countries, such a comprehensive set of prices of tradable and non-tradable goods is normally not readily available. Alternatively, the real exchange rate can be calculated by external means. For external measures, relative price differential between countries is used. It is common to use the ratio of foreign and domestic price indices such as the CPI (Relative Expenditure PPP based) and GDP deflator (Mundell-Fleming approach). With external measures, one has to decide which price indices to use and often there are trade-off between accuracy and availability[4]. For example, in theory, the use of unit labour cost can greatly improve the accuracy of RER but such data are either not accurately measured or not readily available. In view of data availability, Hinkel and Nsengiyumva (1999) note that RER calculated using domestic and foreign CPI is the most useful of the various external RER measures.

3.1.2 Dependent Variables

Domestic sector:

Government Spending

Among the important variables in the domestic sector is the spending pattern of the government sector. That is, the composition of government spending affects the equilibrium real exchange rate. For example, if the increase in the government spending is on

4. However, as movement of exchange rate tends to overwhelm movement in prices, real exchange rate derived by using different types of price indices may tend to move together (Hinkel and Nsengiyumva, 1999). Dominiguez and Frankel (1993) also note that movements in nominal exchange rates in almost all instances translate into movements in real exchange rates.

traded goods, the extra consumption may induce a trade deficit which would in turn require a real exchange rate depreciation to maintain the external balance. On the other hand, excess government spending on non-traded goods would require a real exchange rate appreciation to restore external equilibrium.

Productivity Differential

In theory, the real exchange rate movements are highly sensitive to productivity growth differentials. In the domestic sector, the supply-sided factor, i.e., the differential productivity shock, commonly known as the Harrod-Balassa-Samuleson (HBS) effect can come from two sources: (i) productivity growth differential between the domestic trade and non-trade sectors; and, (ii) productivity growth differential relative to trading partners. The HBS effect implies that there is a tendency for faster productivity growth in traded than non-traded sector. Such a productivity shock will tend to appreciate the real exchange rate as it will not only create excessive demand of non-traded goods but possibly a trade surplus due to increased production of traded goods. Similarly, countries with faster productivity growth relative to their trading partners can also be expected to experience appreciation of the real exchange rate.[5]

International Economic Environment:

Changes in Trade Policy

The effect of change in the international economic environment on the equilibrium real exchange rates depends on many factors, among others, the openness of the economy such as the domestic economy's financial linkages. A restricted trade regime would normally appreciate the real exchange rate by limiting imports.

5. Recent empirical work shows HBS effect to be small, according to NBER working papers.

Terms of Trade

Theoretically, the effect of improvement in the terms of trade on the real exchange rate is at best ambiguous. An improvement of trade would normally increase national income (the income effect), measured in terms of value of imported goods and this would raises the demand for all goods and hence appreciate the real exchange rate (Baffes et al., 1999). However, an improvement in the terms of trade can also lead to increased output in the exportable sector. The overall results depend on the elasticities of demand and supply.

Capital Flows

Some models treat capital flows as exogenous while others model them as endogenous. According to Montiel (1997), capital inflows are endogenous phenomena and thus are not normally treated as a fundamental variable in the estimation of the equilibrium real exchange rate. While the common argument is that capital flows may appreciate the real exchange rate, Montiel has the opinion that the manner in which the long-run real exchange rate reacts to capital inflows depends on the source of the triggering factor. For example, he notes that if the reduction in world interest rates triggered capital inflows, then the exchange rate may need to be depreciated if the reduction in world interest rate results in a reduction in national income. However, he also argues that when net capital inflows exceed debt-service obligations, then the real exchange rate may appreciate as in the case of large foreign direct investment inflows.

3.2 Empirical Studies of Single Equation Approach

As mentioned above, estimation of the real exchange rate using the single equation approach (SEA) utilises a rather similar set of data (see Table 1). Edwards (1994) uses variables such as the terms of trade, government consumption, total productivity growth and a proxy for capital controls in the estimation of the equilibrium real exchange rate. He concludes that only real (fundamental) variables influence the equilibrium real exchange rate in the long-run but in the short-run, changes in monetary shocks can be important determinants. He notes that inconsistent and expansive policies would eventually result in the real exchange rate overvaluation. Edwards also argues that misalignments, if left to their own, tend to correct themselves but rather slowly. However, he is of the opinion that in case of overvaluation, nominal devaluation if properly implemented could help to establish convergence towards the equilibrium real exchange rate. Edwards uses a panel study of 12 developing countries, which include the SEACEN member countries of Malaysia, Philippines, Sri Lanka and Thailand.

Meanwhile, Razin and Collins (1997) focus their estimation using a reduced form of the real exchange rate equation derived from a Mundell-Fleming model. Their model includes variables such as capital flows, terms of trade, money growth in excess of money supply and shock variables, modelled as deviations of GDP, domestic absorption and money supply derived from an ARMA (1,1) processes. Using panel data estimation, they estimate separate equations for developing and developed countries. They note that variables such as terms of trade, net trade and capital flows that are related to external sector are more important for less developed countries than for developed countries. They also conclude that large overvaluation of the real exchange rate is associated with slower economic growth. Razin and Collins cover 93 countries to include both industrial and developing countries. SEACEN countries in their sample include Indonesia, Malaysia, Korea, Philippines, Singapore and Thailand.

Unlike the above two studies, Elbadawi(1994), Montiel (1997) and Baffes et al. (1999) use cointegration techniques to estimate the equilibrium exchange rate. Elbadawi's estimation for Chile, India and Ghana uses fundamental variables such as terms of trade, net capital inflows relative to GDP, government consumption and export growth. In the case of Chile, he notes that capital inflows and government spending appreciate the equilibrium real exchange rate. Like Edwards, he also notes that in the case of overvaluation, nominal devaluation may accelerate convergence towards the real exchange rate equilibrium. His results, generally consistent across the three countries, show that the equilibrium real exchange rate is not constant, implying that PPP modelling of the equilibrium exchange rate can be misleading.

Montiel (1997) covers five SEACEN countries of Indonesia, Malaysia, Philippines, Singapore and Thailand. He notes that a cointegrating relationship can be found to link the real exchange rate to some subset of potential fundamental variables. Like Elbadawi (1994), he suggests that the cointegration technique is a superior method of estimating the real exchange rate over the PPP methodology. According to Montiel, significant variables include the HBS effect, the terms of trade variable and trade policy.

Baffes et al. (1999) estimate the equilibrium real exchange rate for two African countries, namely, Côte d'Ivoire and Burkino Faso. They note that the estimated parameters strongly support the theoretical model. According to their studies, the resource balance to GDP is significant, suggesting that an increase in net capital inflows raises domestic absorption and thus shifts potential output towards non-traded goods. They also concur with most studies, which suggest that an improvement in the terms of trade appreciates the real exchange rate, while trade liberalizing reforms depreciate the equilibrium real exchange rate. The Harrod-Balassa-Samuleson effect is also found to be significant.

Real Exchange Rate Misalignment

As mentioned above, prolonged misalignment of the real exchange rate can generate undesirable economic consequences. Is the crisis of 1997 triggered by misalignment of the real exchange rate? One way to answer this particular question is to investigate whether during the period prior to the crisis, there was any significant deviation of the actual rate from its equilibrium. If no significant misalignment is found, then we could conclude that the triggering factors of the crisis were due to other factors such as large short-term debts, weak financial systems and speculative capital movement. On the other hand, if the gap between the equilibrium exchange rate and the actual exchange proved to be 'non-trivially' large, then perhaps the crisis could originate from exchange rate misalignment.

According to Edwards (2000), the part in which overvaluation played in crisis creation has been well documented. For the Mexican case in 1994, overvaluation of the exchange rate was often cited as responsible for the crisis (Dornbusch, Goldfajn and Valdés, 1995). According to Ades and Kaune (1997), the Mexico peso was overvalued by 16 percent by the fourth quarter of 1994. Sachs, Tornell and Velasco (1996) also argue that during 1990-94, the peso was overvalued on average by almost 29 percent.

As for the SEACEN countries, empirical studies reveal that it is uncertain as to whether exchange rate misalignment was a major factor that triggered the crisis. In mid 1996, prior to the financial crisis of 1997, the US dollar began to strengthen against the Japanese yen. As many of the crisis-hit SEACEN countries de facto pegged to the US dollars, their currencies also appreciated in line with the strong performance of the U.S. dollar. Many debates were centered on whether, prior to the crisis, the real exchange rate was overvalued and if so, by how much.

Sachs, Tornell and Velasco (1996) note that although the current account deficits as a percentage of GDP were relatively large for Korea, Malaysia and Thailand, their real exchange rates were not excessively overvalued by late 1994. Meanwhile, Chinn (1998) argues that while the currencies of Korean and the Philippines were undervalued in the first quarter of 1997, those of Indonesia, Malaysia and Thailand were overvalued.

Meanwhile, Goldman Sachs (1997) notes that in June 1997, the real exchange rate overvaluation was within reasonable acceptable level in the five crisis-inflicted SEACEN countries.[6] The World Bank (1998) reports that during the 1990s, the real effective exchange rate appreciated by 5 percent in Indonesia, 13 percent in Malaysia, 18 percent in the Philippines and 9 percent in Thailand while Korea maintained a stable real exchange rate. Ohno(1999) argues that exchange rate overvaluation was not the primary cause of the Asian financial crisis, as the real exchange rates based on both consumer price index and wholesale price index detect no serious misalignment. Williamson (1999) also asserts that there was no sign of

6. Indonesia, Korea, Malaysia, The Philippines and Thailand

excessive overvaluation, as the exchange rates in most East Asian countries had appreciated only in modest terms during the 1990s and that exports had continued to grow in fact, except for Thailand, in volume terms during 1996.

Table 3-1 Summary of Empirical Results of Selected Studies Using the Single-Equation Approach 1/

Main Variables	Definition	Findings
	Dependent Variable	
Real Exchange Rate	Traded weighted index of foreign WPI and home country's CPI (Baffes, Edwards) Consumption good index of domestic relative to foreign prices (Razin) Traded weighted price level of country's trading partners (CPI) and domestic price level (CPI) Montiel	External RER Measures
	Domestic Factors	
Fiscal Policy 1. Government Investment 2. Government Consumption	Government expenditure to GDP (Edwards, Montiel) Government expenditure (Elbadawi) Fiscal deficit to lagged high powered money (Razin) Ratio of government investment to GDP (Montiel)	In general, excessive and unsustainable government expenditure leads to RER appreciation. It indicates that governments tend to devote more of their expenditure to non-traded goods than for their private sectors (Elbadawi) However, the variable is only significant in some countries as in the case of Chile (Elbadawi) and Thailand (Montiel). Montiel finds that in contrast, an increase in government investment is associated with RER depreciation.
Monetary Policy 1. Money Supply 2. Domestic Credit	Excess supply of domestic credit; domestic credit minus lagged real GDP (Edwards) Rate of Growth of Domestic Credit (Edwards) Money growth in excess of output growth (Razin)	In Edwards, excess money supply and excess domestic credit growth appreciate the RER. However, Razin finds that they are significant only for the less-developed countries, with the opposite signs to that of Edwards. But when it is is modelled as a shock variable (Shock M), the deviation of log of money supply from MA(1,1) process is significant in developed countries, with positive shock associated with RER appreciation.

Harrod-Balassa Samuelson Effect Productivity Gains, Technical Progress	Time trend (Elbadawi, Montiel) GDP per worker to OECD GDP per worker (Baffes) GDP growth (Edwards) Growth in output per worker (Razin)	An Increase in labour productivity appreciates RER (Baffes). However, in Edwards, Elbadawi and Montiel, the results contradict the theory. However, the use of time trend may reflect omitted variables in the case of Elbadawi and Montiel.
	International Factors	
Term of Trade	Export price index divided by import Price Index	Improvement of term of trade tends to appreciate the real exchange rate suggesting that spending/income effects dominate the substitution effect (Baffes, Edwards Elbadawi and Montiel). In Razin, the coefficient is larger for the less developed countries than developed countries.
Openness Trade Policy, Ttrade regimes etc	Nominal imports to nominal GDP, Real imports plus real imports divided by real GDP, Ratio of real imports to real domestic absorption (Baffes) Imports plus exports divided by GDP (Elbadawi) Ratio of trade tax receipt to total trade (Montiel)	Trade liberalising reforms depreciate real exchange rate (Baffes, Elbadawi). Implication is that open trade regimes require a more depreciated RER and that liberalization is not sustainable without RER depreciation (Elbadawi). However, In Montiel case, in Malaysia and Thailand, it appreciates RER.
Capital Flows	Real exports minus real imports divided by real GDP (Bafffles) Capital flows (Edwards) Import minus exports divided by GDP (Elbadawi) Long term capital inflows as share of GDP (Razin) Japanese unit labour cost (to capture foreign direct investment (FDI) from Japan as it was an important component of the initial wave of capital inflows (Montiel))	For Baffes, the interpretation is that an increase in net capital inflows (induces a decrease in resource balance) raises domestic absorption and shift composition of potential output towards non-traded goods. It suggests that capital inflows could lead to depreciation. However, in Elbadawi and Razin and Montiel, capital inflows result in the appreciation of the RER. In Razin, it is highly significant in less developing countries but insignificant in developed countries. However, in Edwards, the coefficients are not significant

Other Factors		
Nominal Devaluation	Nominal devaluation (Baffes, Edwards) Sum of monthly devaluations (Elbadawi)	Evidents suggest that there is some pass through of nominal devaluation to real exchange rate (Baffes). The results of Edwards suggest that nominal devaluation will be converted, even though less than one-to-one to real devaluation in the short-run. Results are mixed in Elbadawi but for Chile, it suggests that in case of overvaluation, a nominal devaluation could accelerate convergence towards RER equilibrium.
Foreign Price Level	Trade-weight ed index of foreign wholesale prices (Baffes) US inflation as measured by CPI (Montiel)	Baffes tests long run homogeneity. The results are inconclusive. In Montiel, it depreciates RER for the case of Malaysia, Singapore and Thailand but appreciates RER in Indonesia and the Philippines This could be explained in term of transaction cost, differentially impairing the productivity of the traded goods sector in the former group and in terms of non-trsaded goods in the latter group.
Speed of Adjustment	Derived from ECM Models	Baffes concludes that smaller economies appear to be more adaptive. The estimated coefficients range form 0.3-0.8 in Baffes and 0.7-0.8 in Elbadawi

1/ Baffes and et al (1999), Techniques: Cointegration and error correction; Coverage: Côte d'Ivoire, Burkino Faso, 1965/70-93
Edwards(1994), Techniques: Pooled data, Instrumental Variable Procedure; Coverage: 12 countries, including Malaysia, Philippines, Sri Lanka and Thailand, 1960-85
Elbadawi(1994), Techniques: Cointegation, error correction, Coverage: Chile, Ghana, India, 1967-1988/1990
Montiel(1997), Technique: Cointegration approach; Coverage: Indonesia, Malaysia, Philippines, Singapore and Thailand, 1960-1994
Razin and Collins(1997), Technique: Panel Regression; Coverage: 93 countries, both industrial and developing countries, including Indonesia, Malaysia, Korea, Philippines, Singapore and Thailand,-1975-1992

IV. Empirical Estimation

In our empirical studies, we will attempt to estimate the equilibrium exchange rate as well as to assess the gap between the actual and the equilibrium real exchange rate. As the theoretical foundation of single equation modeling has been well established, we will make no attempt to formalize the model here. Instead, we will concentrate on a set of common variables to further investigate the determinant factors influencing exchange rate fluctuation. Out of these common sets of independent variables, attempts will be made to construct the best possible cointegrating equation for each country. Based on the estimated equations, we would then measure the misalignment of the real exchange rate from its equilibrium level.

4.1 Data and Unit Root Test

In empirical study, five countries' cases that experienced the recent financial crisis will be introduced: Indonesia, Korea, Malaysia, Philippines, and Thailand. Annual data are used from 1970 to 2000 and all variables are in logarithmic forms except capital flows. The variables included in the analysis are the real exchange rate (RER), terms of trade (TOT), capital flows (NKI), government consumption share (GCON), openness (OPEN), investment share (INV) and nominal exchange rate (NER).[7] Nominal exchange rate (NER) means here the nominal effective exchange rate (NEER), which is compiled by trade-weighted nominal exchange rates of major trade partners. The trade weight is based on exports and imports with five to seven major trade partners in 1993.[8] The year 1993 was chosen as the base year in the compilation of NEER, since balance of payments were relatively close to equilibrium in most of five countries. For

7. Besides these variables, the rate of growth of real GDP was used (Edwards, 1994) as a proxy to capture the HBS (Harrod-Balassa-Samuelson) effect but the results were not good. INV was also used as other fundamentals to influence RER in other empirical studies (Edwards, 1994; Baffes et al, 1999).

8. Major trade partners are Japan, U.S., Singapore, Korea, and Germany in Indonesia; U.S., Japan, Germany, Indonesia, Singapore, Australia, and Malaysia in Korea; Japan, U.S., Singapore, Germany, and U.K. in Malaysia; U.S., Japan, Singapore, Korea, and Germany in Philippines; Japan, U.S., Singapore, Germany, and Malaysia in Thailand.

empirical analysis purpose, the real exchange rate (RER) indicates the real effective exchange rate (REER). RER is defined as NER times foreign CPI (FCPI) divided by domestic CPI (DCPI): that is,

RER = NER * FCPI / DCPI.

Thus, an increase in RER implies depreciation of the real exchange rate. Terms of trade (TOT) is defined as the ratio of unit value of export to unit value of import. Capital flows (NKI) is the ratio of net capital flows to real GDP (RGDP), which are obtained from International Financial Statistics (IFS).[9] Government consumption share (GCON) is the ratio of government consumption in constant price to RGDP.[10] Openness (OPEN) is a variable acquired by the sum of exports and imports divided by RGDP. Investment share (INV) is the ratio of gross fixed capital formation in constant price to RGDP in IFS.[11]

As a first step, a unit root test was undertaken using the augmented Dickey-Fuller (ADF) test and Phillips-Perron (P-P) test. In the ADF test, the number of lagged first difference terms must be specified. The usual advice is to include lags sufficient to remove any serial correlation in the residuals. As annual data are used, four lags are chosen. Starting from lag four, the highest lag number (in bracket), whose coefficient is significant is chosen in the ADF table. The unit root tests are applied to the levels and the first differences of all the data series. The test is undertaken for both the case with constant, and the case with constant and trend. The main difference between two kinds of unit root tests is that ADF test adds extra elements to the regression model, while the P-P test takes into account the autocorrelation that would be present when these extra terms are omitted through a non-parametric correction to the standard statistics. The ADF test

9. In 1990s, the definition of capital flows in IFS has been changed, so it includes both net capital account and net financial account.

10. CPI is used to make Government consumption in constant price.

11. WPI is used to make gross fixed capital formation in constant price. In Malaysia, WPI series is not enough, so CPI is used instead.

aims to obtain the test results based on white noise errors in the regression model, but the P-P test modifies the statistics after estimation, in order to consider the effect of auto-correlated errors.

Indonesia

Table 4-1(I) shows the results of the unit root test for Indonesia. The first column is the unit root test in the level variable to include a constant; the second column, the test in the level variable to include a constant and linear trend; the third column, the test in the first-differenced variable with a constant; the fourth column, the test in the first-differenced variable with a constant and linear trend. In the ADF test, the number in parenthesis is that of lagged dependent variables. For the levels of all variables, the null hypothesis of a unit root cannot be rejected at 5% significance level, except capital flows (NKI). Although the null hypothesis is rejected for the level of NKI with a constant and trend, the null cannot be rejected for the level with a constant and NKI is a variable that fluctuates a lot, so that NKI is assumed to have a unit root. For the first difference of variables, the null hypothesis of a unit root is rejected at 5% significance level. Judging from the ADF and P-P test statistics, each variable is thought to have one unit root. Thus, first differencing is necessary to make each variable stationary.

Korea

In Table 4-1(K), ADF and P-P test statistics in the level variables indicate that the null hypothesis of a unit root cannot be rejected at the 5% significance level. For the first difference of variables, the null hypothesis of a unit root is rejected at 5% significance level, except investment share (LINV) in case of a constant and trend. For the first difference of LINV, the P-P test statistic cannot reject the null hypothesis only in case of a constant and trend, while ADF test statistic can reject the null hypothesis. LINV is a variable with a fluctuating characteristic, so that it is assumed to have one unit root. Thus, each variable is thought to have one unit root and is first differenced to make stationary.

Malaysia

The results of ADF and P-P test, (Table 4-1(M)) indicates that each variable has one unit root by failing to reject the null hypothesis of a unit root in the level and by rejecting the null hypothesis for the first difference of each variable at 5% significance level.

Philippines

In Table 4-1(P), ADF and P-P test statistics indicate that each variable has one unit root by failing to reject the null hypothesis of a unit root in the level and by rejecting the null hypothesis in the first difference of each variable at 5% significance level.

Thailand

In Table 4-1(T), ADF and P-P test statistics indicate that each variable cannot reject the null hypothesis of a unit root in the level variable at 5% significance level. For the first difference, the null hypothesis of a unit root is rejected at 5% significance level, except investment share (LINV). For the first difference of LINV in case of a constant, the test statistic can reject the null hypothesis but not in the case of a constant and trend. LINV is a variable with a fluctuating characteristic, so that it is assumed to have one unit root.

4.2 Cointegration Regression and Short-run Equation for The Real Exchange Rate

To test cointegration, Johansen's method (1991, 1995) using a vector error correction (VEC) model is applied here. Baffes et al. (1997) emphasize the difficulties of system estimation in small samples and argue that the signs and magnitudes of the estimates obtained by using the Johansen approach are less consistent with theory. Since the total number of data samples in this paper is at most 30 (from 1970 to 1999), the Johansen method is only taken to test the existence of cointegration relationship in this paper. After testing the cointegrating relationship, the Engle-Granger "two-step" method is applied to estimate the cointegrating parameters; that is,

Table 4-1(I) Unit Root Test for Indonesia

	Level (c)	Level (t)	Diff (c)	Diff (t)
[ADF Test]:				
LRER	0.10 [2]	-2.50 [0]	-5.26** [0]	-5.33** [0]
NKI	-2.18 [3]	-4.47** [0]	-6.56** [2]	-6.62** [2]
LGCON	0.12 [1]	-2.16 [0]	-7.21** [0]	-7.93** [0]
LINV	-2.65 [0]	-1.00 [2]	-3.32* [1]	-4.09* [1]
[P-P Test]:				
LRER	-0.25	-2.37	-5.23**	-5.30**
NKI	-2.02	-4.39**	-8.56**	-8.47**
LGCON	-0.69	-1.93	-7.33**	-9.55**
LINV	-2.63	-0.37	-2.65·	-3.24·

Note: ** denotes 1%, * 5%, and · 10% significance.

Table 4-1(K) Unit Root Test for Korea

	Level (c)	Level (t)	Diff (c)	Diff (t)
[ADF Test]:				
LRER	-2.47 [0]	-2.85 [0]	-4.70** [0]	-4.60** [0]
LINV	-1.87 [1]	-2.89 [1]	-4.55** [1]	-4.70** [1]
LTOT	-2.78 [1]	-2.74 [1]	-3.59* [0]	-3.50· [0]
NKI	-1.08 [2]	-1.19 [2]	-7.95** [1]	-7.78** [1]
[P-P Test]:				
LRER	-2.52	-2.91	-4.65**	-4.54**
LINV	-1.30	-1.57	-3.08*	-3.20
LTOT	-1.93	-1.97	-3.41*	-3.30·
NKI	-2.19	-2.40	-4.21**	-4.21**

Note: ** denotes 1%, * 5%, and · 10% significance.

Table 4-1(M) Unit Root Test for Malaysia

	Level (c)	Level (t)	Diff (c)	Diff (t)
[ADF Test]:				
LRER	0.17 [0]	-2.20 [0]	-4.43** [0]	-4.50** [0]
NKI	-2.19 [0]	-2.17 [0]	-4.89** [0]	-4.90** [0]
LOPEN	-1.76 [0]	-1.84 [0]	-4.47** [1]	-4.65** [1]
LGCON	-1.22 [0]	-3.38 [0]	-6.55** [1]	-6.42** [1]
[P-P Test]:				
LRER	0.19	-2.25	-4.37**	-4.44**
NKI	-2.44	-2.38	-4.88**	-4.89**
LOPEN	-1.76	-1.95	-3.66*	-3.76*
LGCON	-0.81	-3.34	-7.93**	-8.28**

Note: ** denotes 1%, * 5%, and · 10% significance.

Table 4-1(P) Unit Root Test for Philippines

	Level (c)	Level (t)	Diff (c)	Diff (t)
[ADF Test]:				
LRER	-1.39 [0]	-2.28 [0]	-5.84** [0]	-5.71** [0]
LGCON	-0.86 [1]	-1.30 [1]	-4.61** [0]	-4.65** [0]
LNER	-0.22 [0]	-1.52 [0]	-4.05** [0]	-3.96* [0]
NKI	-2.33 [0]	-3.18 [0]	-8.24** [0]	-8.13** [0]
[P-P Test]:				
LRER	-1.31	-2.34	-5.92**	-5.78**
LGCON	-0.80	-1.28	-4.61**	-4.62**
LNER	-0.31	-1.85	-4.09**	-4.01*
NKI	-2.24	-3.18	-8.45**	-8.36**

Note: ** denotes 1%, * 5%, and · 10% significance.

Table 4-1(T) Unit Root Test for Thailand

	Level (c)	Level (t)	Diff (c)	Diff (t)
[ADF Test]:				
LRER	-0.78 [0]	-3.26 [1]	-4.23** [0]	-4.15** [0]
LINV	-1.59 [1]	-2.37 [1]	-2.84· [1]	-2.84 [0]
NKIR	-2.85 [1]	-2.60 [1]	-4.36** [0]	-4.49** [0]
LOPEN	-2.14 [0]	-1.94 [0]	-4.35** [0]	-4.43** [0]
[P-P Test]:				
LRER	-0.79	-2.48	-4.12**	-4.03**
LINV	-1.21	-1.65	-2.81·	-2.77
NKIR	-1.84	-1.63	-4.27**	-4.42**
LOPEN	-2.17	-2.14	-4.33**	-4.40**

Note: ** denotes 1%, * 5%, and · 10% significance.

OLS is applied to a static regression relating the levels of the real exchange rate and its fundamentals. Cointegration implies that the residuals from this regression are stationary. In the second step, lagged residuals from the static regression are used as the equilibrium errors (i.e. error-correction term) in an error-correction equation.

Theoretical models and empirical regularity show the expected signs of each fundamental variable in determining the behavior of equilibrium RER are as follows: (Elbadawi, 1994; Edwards, 1994; Baffes et al., 1999):

$$\mathbf{RER} = f(\underset{(-)}{\mathbf{NKI}}, \underset{(-)}{\mathbf{TOT}}, \underset{(\pm)}{\mathbf{GCON}}, \underset{(+)}{\mathbf{OPEN}}, \underset{(+)}{\mathbf{INV}}, \underset{(+)}{\mathbf{NER}})$$

The positive sign of RER means RER depreciation while the negative sign is RER appreciation. An increase in net capital flows is likely to bring RER appreciation. The signs of TOT and GCON coefficients are theoretically ambiguous, but consistent empirical regularity shows that improved terms of trade and higher government consumption tend to lead to RER appreciation, because the income effect usually dominates its substitution effect and governments tend to have a higher propensity to spend on non-traded goods (Elbadawi, 1994). However, it is possible for GCON to increase, even when the share of non-tradables in government consumption is going down, indicating that the sign of GCON can be either positive or negative (Edwards, 1994). OPEN is used as a proxy for government policy on export and import taxes, as time series data on export and import taxes are not readily available (Elbadawi, 1994). The positive coefficient means that trade liberalizing reforms are expected to result in RER depreciation. A rise in INV is likely to shift spending towards traded goods, with other things equal (Baffes et al., 1997), so INV is expected to depreciate RER. The nominal effective exchange rate (NER) is also expected to have a positive sign: nominal depreciation of currency basket brings to RER depreciation.

In Johansen's method, the existence of cointegrating relation depends upon the likelihood ratio (LR) test statistic, which is compared with 1% and 5 % critical values. The LR statistic is defined as:

$$Q_r = -T\sum_{i=r+1}^{k} \log(1 - \lambda_i)$$

for r = 0,1,..., (k-1), where λ_i is the i-th largest eigenvalue (Eviews, 1994). Q_r is called the trace statistic and is used for the test of $H_0(r)$ against $H_1(k)$.

Indonesia

The result of Johansen's cointegration test for Indonesia is shown in Table 4-2(I). The first row of the table tests the null hypothesis of no cointegration, the second row tests the null hypothesis of at-most-one cointegrating relation, and so on, all against the alternative hypothesis of full rank, that is, all series in the VAR are stationary.[12] The first column shows the eigenvalues, while the second column presents the likelihood ratio (LR) test statistic. The trace statistic rejects the hypothesis of no cointegrating relation at the 1% critical value, and also rejects the hypothesis of at-most-one relation at the 5% critical value, indicating existence of two cointegrating relations.

Table 4-3(I) shows long-run and short-run equations of the real exchange rate for Indonesia. The long-run equation of the real exchange rate is estimated by the static regression. The coefficient of capital flows (NKI) is negative: a rise in NKI appreciates the real exchange rate (LRER), which is the same as expected. The coefficient of investment share (LINV) is positive: as investment share in GDP increase, RER depreciates. The sign of government consumption share (LGCON) is positive. The theoretical models and empirical regularity expect negative sign of LGCON; since LGCON is used as a proxy to the share of government consumption on non-tradable goods to GDP, a rise in the share of government consumption

12. Unlike the trace statistic, an alternative statistic, the maximum eigenvalue statistic tests H0(r) against H1(r+1).

on non-tradable goods appreciates LRER. As Edwards (1994) discussed, this reasoning is arguable, because it is possible for government consumption to increase even when the share of non-tradable goods in government expenditure is going down. The positive sign of LGCON implies here that an increase in government consumption does not lead to a rise in non-tradable goods prices and that it depreciates the LRER.

In the short-run equation of the real exchange rate, an error correction model (ECM) is estimated with the error correction term, as the Johansen method indicates existence of cointegrating relationship. In the ECM, the general-to-specific approach is used, in which regressors with insignificant coefficients are eliminated using t-statistics, starting from three lags. The coefficients of capital flows are negative and significant;[13] a rise in capital flows (DNKI) appreciates the real exchange rate (DLRER) as expected a priori. As expected, the coefficients of investment share (DLINV) are positive and significant. The net effect of coefficients of government consumption share (DLGCON) is, unlike the coefficient in long-run equation, negative and significant, which is the same as expected. The coefficient of error correction term (EC), which is interpreted as the adjustment speed to long-run equilibrium, is –0.32. Dummy variable, D98, is added, which is due to the Chow forecast test for parameter stability that is undertaken for two separated periods: T_1 (1970 to 1997) and the remaining T_2 (1998 to 1999). The Chow test rejects the hypothesis of parameter stability, so dummy variable is used here: one for 1998 and zero for the other periods. The coefficient of D98 is positive and significant. Among other diagnostic statistics, serial correlation test statistic (S. Corr.) uses the Breusch-Godfrey LM test statistic, which tests for higher order ARMA errors: the statistic indicates no serial correlation, with p-value of [0.22] in bracket.

13. A variable that needs first-differencing to be stationary is denoted with a capital letter, "D".

Korea

The result of Johansen's cointegration test for Korea is displayed in Table 4-2(K). The LR statistic indicates that there are two cointegrating relations by rejecting the null hypothesis of no cointegrating equation at 1% critical value and by rejecting the null hypothesis of at-most-one cointegrating relation at 5% critical value.

In the long-run equation of the real exchange rate in Table 4-3(K), the coefficient of capital flows (NKI) is negative: an increase in capital flows appreciates the real exchange rate (LRER). The coefficient of investment share (LINV) is positive: as investment share increases, LRER depreciates. The coefficient of terms of trade (LTOT) is negative, implying that an improvement in terms of trade would raise surplus in balance of payments, and appreciate LRER. These coefficients are consistent with those as expected in theoretical models and/or empirical regularity.

In the short-run equation of the real exchange rate, the coefficients of independent variables are the same as expected. An increase in capital flows appreciates the real exchange rates; a rise in the investment share depreciates the real exchange rates; an improvement in terms of trade appreciates the real exchange rates. As the Chow forecast test shows structural break, the short-run equation has a dummy variable, D98, which is significant. The adjustment speed to equilibrium, coefficient of error correction term (EC), is –0.55 and significant. The serial correlation test indicates existence of no serial correlation.

Malaysia

In Table 4-2(M), the result of Johansen cointegration test for Malaysia is shown. The null hypothesis of no cointegration is rejected at 1% significance level and that of at-most-one cointegration relationship cannot be rejected, indicating existence of one cointegrating relationship.

Long-run equation of the real exchange rate in Table 4-3(M) shows that the coefficient of each variable has the same sign as expected: a rise in capital flows (NKI) appreciates the real exchange rate (LRER); the positive coefficient of the openness variable (LOPEN) explains that trade-liberalizing reforms depreciate LRER; as a ratio of government consumption (LGCON) to GDP rises, LRER appreciates.

The short-run equation of the real exchange rate is estimated in the form of the error correction model (ECM), according to the result of Johansen cointegration test. The coefficients of DNKI and DLGCON are consistent with those of theory and/or empirical regularity. The net effect of the coefficients of DLOPEN is negative but insignificant, while the coefficient of LOPEN in the long-run equation is positive. After the Chow forecast test is done, a dummy variable, D98, is included, which is significant. The adjustment speed, coefficient of error correction term (EC), is –0.25 and significant.

Philippines

In Table 4-2(P), the result of Johansen's cointegrating test for the Philippines is displayed. The null hypothesis of no cointegration is rejected at 1% critical value and the null hypothesis of at-most-one cointegrating relation is not rejected, indicating that there exists one cointegrating relation.

Table 4-3(P) displays the estimation result of long-run equation of the real exchange rate for the Philippines. The coefficient of capital flows (NKI) is negative: a rise in capital flows appreciates the real exchange rate (LRER). The coefficient of nominal exchange rate (LNER) is positive: depreciation of LNER leads to depreciation of LRER. The sign of government consumption share (LGCON) is negative.

In the short-run equation of the real exchange rate for the Philippines, the coefficient of capital flows (DNKI) is negative and significant, as expected. The coefficients of nominal exchange rate (DLNER) have positive and significant impact on the real exchange rate. The coefficients of government consumption share (DLGCON) have positive effect on the real exchange rate. The adjustment speed to equilibrium, coefficient of error correction term (EC), is –

0.55 and significant. Serial correlation test indicates no serial correlation and the Chow forecast test implies no structural break.

Thailand

In Table 4-2(T), the result of Johansen cointegration test is shown for Thailand. The null hypothesis of no cointegrating relation is rejected at 1 percent significance level and that of at-most-one cointegrating equation cannot be rejected, implying that there exists one cointegrating relation.

Table 4-3(T) displays the estimation result of long-run equation of the real exchange rate for Thailand. There are two kinds of equations: one is the result of OLS estimation, the other is that of instrumental variable (IV) estimation, which will be described in the next section. In the OLS estimation, the coefficients of explanatory variables are the same as expected. An increase in capital flows (NKI) brings appreciation of the real exchange rate (LRER). As investment share (LINV) rises, LRER depreciates. As the market opens (LOPEN) more and trade liberalizes, LRER depreciates.

In the short-run equation of the real exchange rate for Thailand, error correction model is estimated, in consideration of the result of Johansen cointegration approach. The coefficients of explanatory variables are the same as expected. The adjustment speed, coefficient of error correction term, is –0.43 and significant. The coefficient of investment share (DLINV) is positive and significant: an increase in investment share depreciates the real exchange rate. The signs of capital flows (DNKI) are negative and significant, indicating that an increase in capital flows leads to appreciation of the real exchange rate. The coefficient of openness (DLOPEN) is positive and significant, which is expected. Serial correlation test indicates no serial correlation. Chow forecast test statistic has 10% in p-value based log likelihood ratio (LR), but another statistic using F-statistic is 1.53 with p-value of 0.25, which is higher than LR.

Table 4-2(I) Cointegration Test for Indonesia

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE
0.753	69.42	47.21	54.46	r=0**
0.565	33.07	29.68	35.65	r≤1*
0.337	11.45	15.41	20.04	r≤2
0.028	0.75	3.76	6.65	r≤3

Table 4-3(I):
Long-run and Short-run Equations of the RER for Indonesia

Long-run Equation			Short-run Equation		
Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	7.73	7.81	C	-0.03	-0.88
NKI	-26.32	-4.61	DLRER(-2)	0.48	1.63
LINV	1.94	6.15	DNKI	-6.31	-1.77
LGCON	0.23	0.54	DNKI(-2)	-5.88	-1.38
			DLINV(-1)	0.75	2.18
			DLINV(-3)	0.94	1.88
			DLGCON	-0.99	-2.00
			DLGCON(-2)	0.60	2.07
			D98	0.39	1.97
			EC(-1)	-0.32	-1.92
R-sq	0.68		R-sq	0.74	
Adj. R-sq	0.64		Adj. R-sq	0.59	
D.W.	1.15		D.W.	1.54	
			S. Corr.	2.99 [0.22]	

Table 4-2(K) Cointegration Test for Korea

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE
0.640	61.12	47.21	54.46	r=0**
0.597	33.54	29.68	35.65	r≤1*
0.221	8.99	15.41	20.04	r≤2
0.080	2.25	3.76	6.65	r≤3

Table 4-3(K):
Long-run and Short-run Equations of the RER for Korea

Long-run Equation			Short-run Equation		
Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	7.33	10.69	C	-0.01	-1.14
NKI	-3.12	-4.85	DLRER(-1)	0.20	1.18
LINV	0.13	3.94	DLRER(-2)	0.37	2.07
LTOT	-0.56	-3.71	DNKI	-2.09	-3.66
			DNKI(-2)	1.14	1.65
			DLINV	0.22	1.72
			DLTOT(-3)	-0.24	-1.50
			D98	0.18	3.25
			EC(-1)	-0.55	-2.58
R-sq	0.63		R-sq	0.76	
Adj. R-sq	0.58		Adj. R-sq	0.65	
D.W.	1.08		D.W.	1.72	
			S. Corr.	2.53 [0.28]	

Table 4-2(M) Cointegration Test for Malaysia

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE
0.779	67.01	47.21	54.46	r=o**
0.429	26.28	29.68	35.65	r≤1
0.331	11.17	15.41	20.04	r≤2
0.01	0.32	3.76	6.65	r≤3

Table 4-3(M):
Long-run and Short-run Equations of the RER for Malaysia

Long-run Equation			Short-run Equation		
Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	3.73	10.43	C	-0.005	-0.34
NKI	-1.77	-2.12	DLRER(-2)	0.32	1.37
LOPEN	0.26	5.54	DLRER(-3)	0.40	1.74
LGCON	-0.57	-2.98	DNKI	-0.64	-1.42
			DLOPEN(-2)	-0.13	-0.85
			DLOPEN(-3)	0.10	0.73
			DLGCON(-2)	-0.39	-2.45
			DLGCON(-3)	-0.30	-2.04
			D98	0.16	2.72
			EC(-1)	-0.25	-2.26
R-sq	0.84		R-sq	0.70	
Adj. R-sq	0.82		Adj. R-sq	0.54	
D.W.	0.89		D.W.	1.85	
			S. Corr.	1.15 [0.56]	

Table 4-2(P) Cointegration Test for Philippines

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE
0.729	65.25	53.12	60.16	r=0**
0.422	30.01	34.91	41.07	r≤1
0.345	15.22	19.96	24.60	r≤2
0.131	3.78	9.24	12.97	r≤3

Table 4-3(P):
Long-run and Short-run Equations of
the RER for Philippines

Long-run Equation			Short-run Equation		
Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	3.50	17.12	C	-0.04	-3.10
NKI	-0.02	-3.41	DLRER(-3)	-0.21	-1.44
LNER	0.22	10.59	DNKI	-0.01	-2.17
LGCON	-0.09	-0.80	DLNER	0.51	6.25
			DLNER(-1)	-0.22	-2.80
			DLNER(-3)	0.40	3.02
			DLGCON(-1)	0.34	2.34
			DLGCON(-2)	-0.24	-1.48
			DLGCON(-3)	0.32	2.23
			EC(-1)	-0.55	-3.98
R-sq	0.83		R-sq	0.92	
Adj. R-sq	0.81		Adj. R-sq	0.88	
D.W.	0.98		D.W.	1.92	
			S. Corr.	0.78 [0.68]	
			Chow	2.28 [0.32]	

Table 4-2(T) Cointegration Test for Thailand

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE
0.786	76.25	53.12	60.16	r=0**
0.517	33.04	34.91	41.07	r≤1
0.274	12.68	19.96	24.60	r≤2
0.125	3.73	9.24	12.97	r≤3

Table 4-3(T):
Long-run and Short-run Equations of the RER for Thailand

Long-run Equation (OLS)			Long-run Equation (IV)		
Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	4.41	20.95	C	4.31	9.93
NKI	-0.03	-4.27	NKI	-0.03	-3.51
LINV	0.39	3.24	LINV	0.34	1.56
LOPEN	0.15	4.06	LOPEN	0.17	2.09
R-sq	0.84		R-sq	0.82	
Adj. R-sq	0.82		Adj. R-sq	0.80	
D.W.	0.91		D.W.	0.89	

Short-run Equation (OLS)			Short-run Equation (IV)		
Variable	**Coefficient**	**t-Statistic**	**Variable**	**Coefficient**	**t-Statistic**
C	-0.01	-0.59	C	-0.07	-1.75
DLRER(-1)	0.65	2.58	DLRER(-1)	0.64	1.98
DNKI	-0.01	-2.98	DNKI	-0.02	-2.58
DNKI(-1)	-0.02	-2.88	DNKI(-1)	-0.03	-3.48
DNKI(-3)	-0.02	-1.67	DNKI(-3)	-0.02	-1.41
DLINV(-1)	0.64	3.92	DLINV(-1)	0.77	3.35
DLOPEN(-1)	0.12	1.19	DLOPEN(-1)	0.26	1.23
EC(-1)	-0.43	-2.50	EC(-1)	-0.13	-1.64
R-sq	0.70		R-sq	0.49	
Adj. R-sq	0.59		Adj. R-sq	0.29	
D.W.	1.67		D.W.	1.31	
S. Corr.	0.59 [0.74]		S. Corr.	2.00 [0.37]	
Chow	4.56 [0.10]		Chow	0.26 [0.77]	

4.3 Weak Exogeneity

One problem in this empirical study is that sample sizes are small (around 30), since some data series used here are available only annually from national accounts. Small sample size implies that the statistical properties of estimators may be poor and that testing procedures are likely to have low power. Another issue is that small sample size limits the scope for systems-based estimation, which leads to an alternative of a single-equation estimation. Fully efficient estimation and inference can take place conditional on the fundamentals in a *single-equation* setting, if fundamentals are *weakly exogenous* for the parameters of interest (Engle, Hendry, and Richard, 1983).

Weak exogeneity is testable. Engle and Granger (1987) suggest testing for weak exogeneity by introducing the error-correction term into the equations of the marginal model and applying asymptotic t-tests to the hypothesis that the coefficients are zero. Weak exogeneity holds with respect to the long-run parameters if the cointegrating vector does not enter the marginal model for the fundamentals. Failure of weak exogeneity limits the scope for fully efficient conditional inference and the investigator faces a choice between systems estimation and limited-information methods such as two-stage least squares (or instrumental variable estimation).

To explain weak exogeneity, we describe the p-th order vector autoregression (VAR) as expressed by equation (4-1):[14]

$$\Delta x_t = \Gamma x_{t-1} + \sum_{j=1}^{p} A_j \Delta x_{t-j} + \varepsilon_t \qquad \varepsilon_t \sim IN(0,\Sigma) \tag{4-1}$$

where $x_t = [ln\ e_t,\ w_t'\ ]'$, e_t is the real exchange rate, and w_t the macroeconomic determinants of the real exchange rate. Without loss of generality, we can factorize equation (4-1) into the conditional distribution of $ln\ e_t$ and the associated marginal distribution of w_t' :

14. This example is summarized from Baffes et al. (1999).

$$\Delta \ln e_t = \Sigma_{12}(\Sigma_{22})^{-1} \Delta w_t + (\Gamma_1 - \Sigma_{12}(\Sigma_{22})^{-1}\Gamma_2)x_{t-1} + \sum_{j=1}^{p}(A_{1j} - \Sigma_{12}(\Sigma_{22})^{-1} A_{2j}) \Delta x_{t-j} + \xi_t \tag{4-2a}$$

$$\Delta w_t = \Gamma_2 x_{t-1} + \sum_{j=1}^{p} A_{2j}\Delta x_{t-j} + \varepsilon_{2j} \tag{4-2b}$$

where the numerical subscripts refer to the blocks of appropriately partitioned matrices (so that, for example, Γ_1 is the first row of Γ and Σ_{22} the (n-1)x(n-1) lower-diagonal bloc of Σ). By construction, the disturbance term in equation (4-2a), $\xi_t=\Sigma_{11}-\Sigma_{12}(\Sigma_{22})^{-1}\Sigma_{21}$ is uncorrelated with all of the variables on the right-hand side of that equation.

Equation (4-2a) is a single-equation conditional the error-correction model. For the case of non-stationary but cointegrated variables, Urbain (1992) and Johansen (1992) show that w_t is weakly exogenous for the long-run parameters and adjusment speed if $\Gamma_2=0$, or equivalently if the cointegration vector does not enter the marginal model.

In the test of weak exogeneity, the hypothesis of weak exogeneity holds with respect to the long-run parameters in four countries (Indonesia, Korea, Malaysia and Philippines). In Thailand, however, we reject weak exogeneity at the 5 percent level in the case of OPEN. Rejection of the hypothesis provides problems with inference in the error correction model (ECM): the long-run parameter estimates remain super-consistent, but standard errors are biased and inconsistent (baffes et al, 1999). To solve this, we re-estimate the ECM by instrument variables (IV) through the two-stage least squares method, using lagged TOT variables as instruments for OPEN. The results of IV estimation in the Table 4-3(T) do not change the conclusions on the whole.

4.4 Exchange Rate Misalignment

The real exchange rate is dependent upon fundamental factors, which are affected from permanent and temporary factors. The permanent values for the fundamentals must be extracted from fundamentals. In this paper, the permanent values are obtained by a smoothing method of data series, here through Hodrick-Prescott filter, which is widely used to get a smooth estimate of the long-term trend component of a series. The degree of misalignment is simply the percentage difference between the real exchange rate (RER) and its equilibrium value, i.e. permanent value (PV): that is,

$$Misalign = (RER\text{-}PV)*100 \ / \ PV.$$

Indonesia

Indonesia undertook extensive macroeconomic reforms during the mid-1980s to liberalize its economy and increase its export, which is clearly seen, in Figure 4-1, by depreciating the real exchange rate for a few years after 1985. In this reform, the nominal exchange rate management policy played an important role: two major discrete devaluations of the rupiah against the U.S. dollar were implemented; i.e., in March 1983 by 27 percent and in September 1986 by 31 percent (Montiel, 1997). The misalignment degree from the equilibrium tells in Table 4-4(I) that the real exchange rate reached 30.6 percent undervaluation in 1988.

The next period, 1989-95, showed a stable movement of the real exchange rate; in 1994, the degree of misalignment recorded 0.65 percent. Before the Asian financial crisis, it recorded appreciation of 16 percent and then depreciated 67.2 percent in 1998 due to the shocks of the crisis. Overall, the graph indicates that the government has sought to achieve depreciation of the real exchange rate since the 1980s.

Korea

Since the early 1980s, the government shifted the macroeconomic policy focus from growth to stability. With stable economic foundation in place from 1986, Korean economy recorded a rapid growth of more than 10 percent each year and the current account registered a surplus of thirty billion U.S. dollars in total for three years, thanks to the "Three Lows"–low value of the U.S. dollar against the yen, low oil prices, and low international interest rates. The expanding surplus on the current account, however, increased pressure for appreciation of the Korean won, since the worsening trade imbalances with the United States and the European Community aggravated trade disputes and intensified demands for Korean market opening (BOK, 2000). In Figure 4-1, the real exchange rate movements show a rapid depreciation in the early 1980s till 1987 and then a fast appreciation until 1989. During this period, the degree of misalignment in Table 4-4(K) points that the real exchange rate depreciates about 16 percent in 1986 and appreciates around 11 percent in 1989.

In 1993, the current account records 0.8 billion U.S. dollars, which is close to equilibrium of balance of payments and subsequently, the current account shifts into deficit until the country faces the Asian financial crisis. During the 1990s, the highest appreciation of the real exchange rate is 6 percent in 1996 before the crisis and its highest depreciation reaches 25 percent in 1998. The competitiveness is still being kept based on the criteria of the real exchange rate in 1999. The movements of the real exchange rate explain the changes in current account relatively well.

Malaysia

In Figure 4-1, Malaysia's real exchange rate displays a relatively stable pattern in the first half of the 1980s. From 1985 to 1991, the real exchange rate depreciates sharply, which was largely the result of the U.S. dollar's depreciation against the currencies of Malaysia's trading partners and a strengthening of the price level differential in favor of Malaysia (Montiel, 1997). In 1992, the real appreciation is due to the persistence of capital inflows. Malaysia has maintained a flexible exchange rate regime till September 1998, when the country adopted pegging of the ringgit to the U.S. dollar. Under the flexible regime, the central bank's intervention in the foreign exchange market was only to moderate day-to-day fluctuations in the value of the ringgit (BNM, 1999). Overall, the graph shows that the government has sought to achieve depreciation of the real exchange rate since the 1980s.

The degree of misalignment indicates in Table 4-4(M) that the real exchange rate depreciated up to 14 percent in 1988 from the equilibrium value; it changed direction, recording 9.5 percent of appreciation in 1997; and the Asian crisis depreciated the real exchange rate by 10 percent from the equilibrium with the adoption of a fixed exchange rate regime.

Philippines

Since the early 1980s, the Philippines also experienced a rapid depreciation of the real exchange rate, which is shown, from 1982 to 1987, in Figure 4-1. This was achieved by a sharp depreciation of the nominal effective exchange rate (NEER), even if the domestic inflation was substantially higher than those of its trading partners (Montiel, 1997). From 1988 to 1996, the real exchange rate appreciated, until it changed the pattern to a rapid depreciation right after the Asian financial crisis. The country experienced a significantly higher domestic inflation over its trading partners through 1999 partly due to a depreciated peso as well as the prolonged dry spell arising from the El Niño weather phenomenon, which is shown clearly among 5 countries.[15] Accordingly, the degree of misalignment points that the real exchange rate recorded 8.6 percent appreciation from the equilibrium level in 1985, depreciated up to 19.8 percent in 1987, and changed a direction, appreciating about 13.8 percent in 1996. Unlike the cases of other countries, the Asian crisis did not seem to have much impact on the real exchange rate, and misalignment degree is only 2.7 percent from the equilibrium level in 1998.

Thailand

Thailand recorded a large depreciation of the real exchange rate in the mid-1980s in Figure 4-1, which was achieved by a 15 percent devaluation of the baht in November 1984. After 1987, the real exchange rate was stabilized until the Asian crisis. Overall, the graph displays that the government has sought to achieve depreciation of the real exchange rate since the 1980s.

15. The comparison of CPI inflation, 1996 CPI divided by 1980 CPI, shows that the Philippines has 5.98 times, Indonesia 3.77 , Korea 2.60, Malaysia 1.72, and Thailand 2.06 times.

The degree of misalignment from the equilibrium level shows in Table 4-4(T) that the real exchange rate depreciated 15.8 percent in 1987, and then showed a relatively stable pattern. The real exchange rate remained a sharp appreciation of 11 percent in 1996, right before the Asian crisis depreciated the real exchange rate.

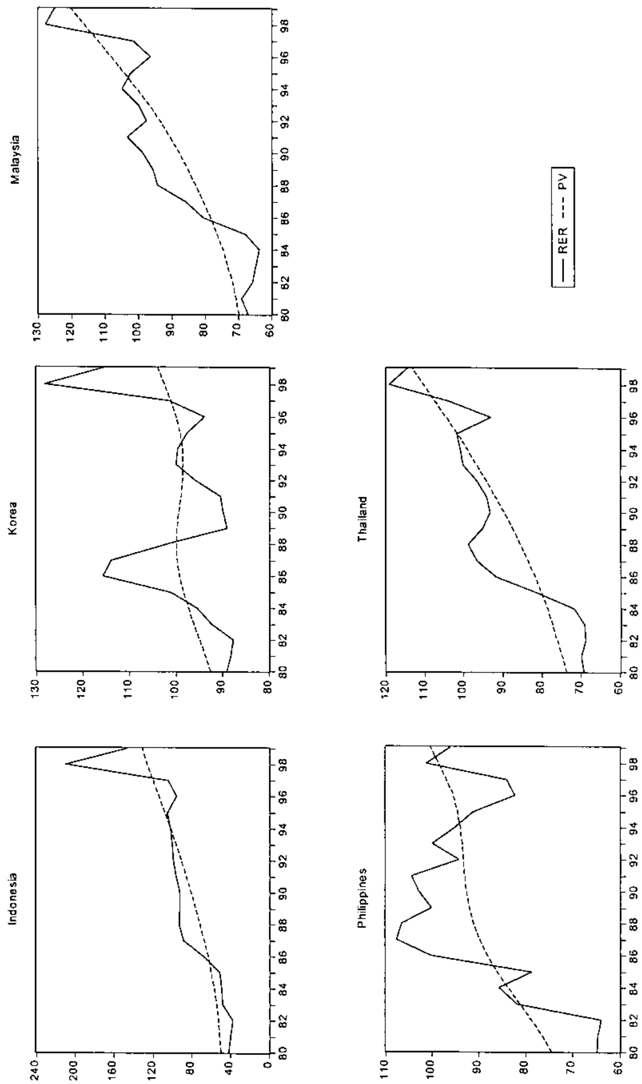

Fig 4-1 Real Exchange Rate and its Permanent Value (PV)

Table 4-4(I):
The Real Exchange Rate and its Misalignment for Indonesia

	RER	Fitted	H-P	Misalign
1980	42.23	47.95	50.03	-15.58
1981	40.29	70.64	51.18	-21.28
1982	37.51	42.03	52.49	-28.54
1983	47.76	40.58	54.23	-11.93
1984	49.42	46.08	56.54	-12.60
1985	51.38	65.42	59.45	-13.58
1986	67.72	57.91	62.87	7.71
1987	88.74	57.03	66.77	32.91
1988	92.84	79.14	71.07	30.63
1989	92.32	90.06	75.61	22.11
1990	92.31	82.78	80.28	14.98
1991	96.01	83.81	85.15	12.76
1992	98.87	80.56	90.29	9.51
1993	100.00	88.78	95.76	4.43
1994	102.18	116.79	101.52	0.65
1995	104.95	78.85	107.48	-2.35
1996	95.52	87.18	113.69	-15.98
1997	104.40	174.18	119.90	-12.92
1998	209.96	167.20	125.61	67.15
1999	146.99	85.23	130.86	12.33

Table 4-4(K):
The Real Exchange Rate and its Misalignment for Korea

	RER	Fitted	H-P	Misalign
1980	89.13	88.39	92.62	-3.77
1981	88.17	91.23	93.72	-5.92
1982	87.72	92.07	94.90	-7.56
1983	92.27	96.80	96.11	-3.99
1984	95.45	95.50	97.27	-1.87
1985	101.08	97.39	98.31	2.82
1986	115.69	103.57	99.14	16.69
1987	113.87	110.73	99.66	14.25
1988	101.96	105.60	99.81	2.15
1989	88.99	103.10	99.65	-10.70
1990	89.90	99.05	99.29	-9.45
1991	90.43	94.97	98.87	-8.53
1992	95.82	95.10	98.54	-2.76
1993	100.00	100.39	98.41	1.61
1994	99.74	92.74	98.55	1.21
1995	97.69	88.41	99.04	-1.37
1996	93.95	89.76	99.93	-5.99
1997	101.57	107.38	101.14	0.43
1998	128.10	110.74	102.48	25.00
1999	115.55	106.87	103.86	11.26

Table 4-4(M):
The Real Exchange Rate and its Misalignment for Malaysia

RER	Fitted	H-P	Misalign	
1980	67.01	69.85	69.66	-3.81
1981	68.98	66.37	70.64	-2.35
1982	65.65	65.27	71.76	-8.52
1983	64.72	71.31	73.09	-11.45
1984	63.74	75.80	74.63	-14.60
1985	67.87	74.99	76.38	-11.13
1986	80.65	73.83	78.33	2.97
1987	85.84	84.60	80.47	6.68
1988	94.15	88.99	82.74	13.80
1989	95.70	86.09	85.12	12.43
1990	98.71	88.47	87.66	12.60
1991	103.27	86.70	90.42	14.22
1992	97.54	88.22	93.45	4.38
1993	100.00	89.63	96.78	3.33
1994	104.99	106.68	100.39	4.59
1995	102.21	103.19	104.18	-1.89
1996	96.43	107.07	108.10	-10.80
1997	101.45	113.99	112.13	-9.52
1998	127.73	119.30	116.20	9.92
1999	125.05	120.84	120.27	3.97

Table 4-4(P):
The Real Exchange Rate and its Misalignment for Philippines

RER	Fitted	H-P	Misalign	
1980	64.75	68.90	74.44	-13.01
1981	64.72	71.49	76.45	-15.35
1982	63.91	70.02	78.75	-18.85
1983	81.89	82.19	81.25	0.79
1984	85.70	87.36	83.75	2.33
1985	78.70	90.23	86.10	-8.60
1986	100.39	94.87	88.16	13.86
1987	107.61	95.20	89.84	19.78
1988	106.55	95.76	91.11	16.94
1989	100.07	93.65	92.00	8.78
1990	102.85	93.67	92.57	11.10
1991	104.51	94.68	92.94	12.45
1992	94.29	93.25	93.19	1.19
1993	100.00	94.96	93.44	7.02
1994	95.10	90.32	93.82	1.37
1995	91.18	90.39	94.45	-3.47
1996	82.28	78.25	95.45	-13.79
1997	84.01	88.53	96.87	-13.27
1998	101.27	107.22	98.59	2.72
1999	96.13	111.39	100.42	-4.27

Table 4-4(T):
The Real Exchange Rate and its Misalignment for Thailand

RER	Fitted	H-P	Misalign	
1980	69.29	75.42	73.73	-6.03
1981	69.86	74.72	74.81	-6.62
1982	68.75	76.05	75.94	-9.47
1983	69.10	77.08	77.17	-10.45
1984	71.72	77.77	78.50	-8.64
1985	81.15	77.76	79.98	1.46
1986	91.82	80.75	81.61	12.51
1987	96.56	83.22	83.39	15.79
1988	98.78	84.56	85.32	15.78
1989	95.05	87.28	87.36	8.81
1990	93.08	92.37	89.51	3.99
1991	94.02	91.95	91.73	2.49
1992	96.45	95.48	94.04	2.55
1993	100.00	97.30	96.45	3.68
1994	100.81	98.91	98.96	1.87
1995	101.64	92.96	101.62	0.01
1996	92.98	96.45	104.46	-10.98
1997	103.71	119.59	107.41	-3.44
1998	119.11	115.26	110.34	7.95
1999	114.40	109.82	113.24	1.03

V. Concluding Remarks

In this paper, movements of the real exchange rates in five crisis-hit countries were analyzed using the single equation approach (SEA). The long run and short run equations of the real exchange rate were estimated for the period of 1970 to 1999. Then the misalignment degrees were calculated in comparison of the actual real exchange rate with the permanent value obtained from the fitted values smoothed by Hodrick-Prescott (H-P) filter. Main concern of the project was whether these five countries managed their exchange rates well, and how significantly different the misalignment of the real exchange rate was from its permanent value. Another issue was whether the Asian crisis was triggered by the misalignment of the real exchange rate. Major findings are as the following:

- First, most parameters of the long run and short run equations are the same as expected in theory or empirical regularity. The most commonly used variable is capital flows: a rise in capital flows appreciates the real exchange rate. The short run equation using the error correction model (estimated with an error correction term) is significant.

- Second, as fully efficient estimation and inference in the single equation approach are dependent upon the hypothesis of weak exogeneity, we tested the hypothesis. Among five countries, only the case of Thailand failed the test. We did re-estimation using the instrumental variables by the two-stage least squares method, the results of which are not much different from those of the OLS estimation.

- Third, three out of five countries—Indonesia, Malaysia and Thailand—seem to have sought to achieve a depreciation policy of the real exchange rate since the 1980s, which is seen from the Figure 4-1. Unlike three countries, the real exchange rates of Korea and the Philippines show the sharp depreciation in the first half of the 1980s, which are followed by a correcting appreciation.

- Lastly, the real exchange rate of each country recorded appreciation before the Asian crisis and depreciated substantially from the permanent value right after the crisis, then coming back to the permanent value with a mean reversion trend. The misalignment degrees before the crisis ranged from six to sixteen percent appreciation, which are not too much excessive, compared with those of other periods in each country. The misalignments do not appear to last long, especially before the crisis.

As the misalignment degree is not significantly large, it seems that five crisis-hit countries did not make any substantial mistakes in managing exchange rates, based on the results of this paper. The triggering factors of the crisis might be sought from other sources such as a large short-term debt, a weak financial system and so on. The judgment for the misalignment here is, however, based on only one criterion, that is, a smoothing technique by the Hodrick-Prescott filter, which applied to a fitted value taken from the static regression. Thus, more research might be necessary to obtain the permanent value using different methodologies, in order to make a judgment for misalignment.

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