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The long and short run forcing variables of purchasing power parity of ASEAN-5

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This study examines the long-run and short-run forcing variables of purchasing power parity (PPP) for ASEAN-5 currencies vis-a-vis the U.S. dollar, i.e., their real effective exchange rate (REER). This study uses the autoregressive distributed lag (ARDL) approach to co-integration over the period 1991:Q1 – 2006:Q2. Our empirical results suggest that the domestic money supply (M1) is a significant long run forcing variable for the REERs of Malaysia, Indonesia, the Philippines, and Singapore. However, the results suggest that the foreign interest rate (R*) is a long run forcing variable for Thailand's REER. The findings can derive policy implication for the monetary authorities in these ASEAN-5 countries.

INTRODUCTION

The ASEAN-5[1] countries are generally characterized to have relatively thin and shallow financial markets. Owing to these characteristics, Purchasing Power Parity (PPP) in these countries is proved to be misaligned among them. For instance, if a country chooses a floating exchange rate, it is possible that its exchange rate can be excessively volatile due to speculation. The volatility of exchange rate generates uncertainty that can affect domestic and foreign investor's investment decisions. This subsequently will undermine the ASEAN-5 economic growth prospects. On the contrary, if a country chooses a fixed exchange rate, it provides little space for its policy makers to maneuver and to realign with ASEAN-5 currencies.

The 1997 Asian Financial Crisis (AFC) plunged some of the most successful economies in the world particularly ASEAN-5 countries namely: Malaysia, Indonesia, Philippines, Thailand, and Singapore into financial chaos. This crisis caused collapse in these economies, i.e. the impact of the financial crisis was very severe not only on the financial sectors but also on the real sectors in these countries. Thus, the 1997 financial crisis was a critical point in the Asian economic history.

It was empirically and theoretically argued that the AFC caused the ASEAN-5 economies to become more sensitive to changes and fluctuations in the world economy- particularly the economy of USA. Therefore, the issue of the degree of sensitivity of ASEAN-5 to USA economy would be measured in this study since USA dollar is the dominant world reserve currency and the value of most countries' currencies were directly linked with the value of the U.S. dollar.

The objective of this study is: to determine the long-run and short-run forcing variables of PPP on ASEAN-5 REER over the study period and sub-periods. The Autoregressive Distributed Lag (ARDL) approach is employed here because it has several advantages such as: avoiding the classification of variable into I (0) or I (1), free from problems of endogeneity and yielding consistent estimates of the long-run coefficients. In this study also, the emphasis will be on the behavior of the (REER)[2]. The REER indicates how the weighted average purchasing power of a currency has changed relative to some arbitrarily selected base period.

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The findings of this study should be useful for the ASEAN-5 policy makers. In the light of the serious implication of the changes and fluctuations of exchange rates in ASEAN-5 economies, it is critically important to conduct a study on the PPP of Real Effective Exchange Rate (REER) determinants that have important impact upon the ASEAN-5 economic growth.

This study is organized as follows: the next section, section 2, surveys the selected literature on PPP, focusing on earlier theoretical and statistical frameworks. Section 3 discusses on the methodology. Section 4, discusses the finding, and finally, Section 5, and concludes the study.

Overview of Purchasing Power Parity (PPP)

The PPP theory was originally developed by a Swedish economist Cassel (1919), stating that the exchange rate of currencies between two countries would move proportionally to the ratio of the price level in the currencies concerned. "According to MacDonald (2001), Sarno and Taylor (2002), Cheung et al. (2004), and Che and Mansure (2006) point that" there are an array of approaches and related methodological frameworks available in the PPP literature, However, there are at least four (4) major competing PPP models that demand special attention (Cheung et al., 2004). They are: Absolute PPP and Relative PPP, Monetary Model of PPP, Portfolio Balance of PPP, and Uncovered Interest Parity (UIP) of PPP.

Absolute PPP and Relative PPP

In literature, there are two versions of PPP theory namely absolute PPP and relative PPP. While absolute PPP refers to the equity of price levels across countries, relative PPP refers to the equity of the rates of change in these price levels. The Law of Comparative Advantage (LCA) theorem of equilibrium exchange rate or the Law of One Price (LOP) of the capitalist system suggests that same basket of goods and services must sell the same price in different capitalist countries "(Cassel, 1919; Sarno and Taylor, 2002)". This measure the price of the basket of goods and service is essentially known as absolute PPP and has been repeatedly expressed in the literature "(Sarno and Taylor, 2002; Che and Mansure, 2006)" as:

$$S_t = P_t - P_t^*   \quad\quad (1)$$

Where, s_t is the spot REER expressed as the domestic price of the foreign currency, p_t is the domestic price level, while p_t^* is foreign price level and t denotes the

time period. MacDonald (2001) and Sarno and Taylor (2002) asserted that Equation 1, which represented the absolute PPP theoretical framework, should be specified as a testable regression equation expressed as:

$$s_t = S_0 + S_t(p_t - p_t^*) + V   \quad\quad (2)$$

Where S is constant variable and V is noise error term. Sarno and Taylor (2002) and Che and Mansure (2006) had transformed equation (2) as:

$$s_t = S_0 + S_1 v_t - S_2 p_t + S_3 p_t^* + V   \quad\quad (3)$$

Where $_t$ is the *ex- post* nominal exchange rate at time *t*.

They argued that if $_t$, p_t and p_{t^*} are nonstationary integrated process of I(1), the weak form (or random walk) PPP prevail, implying that the residual term: is I(0). Adding symmetry, strong and absolute version of PPP prevails, if $S_2 = 1$ and $S_3 = -1$ where "*homogeneity*" condition exist, theoretically.

Similar to absolute PPP, relative PPP looks at the relationship between exchange rates and prices in terms of growth rates. Relative PPP may still hold i.e. even if the exchange rate is not equal to the exact ratio of the price indices, it may at least be comparable to it. The Dornbusch (1976) and Frankel (1976) who pioneered the *relative* PPP suggested that the actual price levels must be considered under the new relative PPP theoretical framework instead of the price. The essence of their suggestions is that some of the actual domestic prices, i.e., commodity goods and services do not necessarily change in accordance to foreign prices. In simple, economics terms, the relative PPP "points out that" the changes in the foreign exchange rates must equal to the changes in relative domestic prices and Che and Abul Mansure (2006). These changes may be due not only to exchange rate but also money supply (M), real gross domestic products (RGDP), the level of interest rate (i,), and inflation rate (f), respectively "(Sarno and Taylor, 2002; Brissmis et al., 2005)."

Monetary models

Monetary models are considered standard exchange rate determination models. They are based on the view that the exchange rate is the relative price of foreign and domestic money so it should be determined by the relative supply and demand for these moneys. Money market equilibrium condition resides on purchasing power parity, which explains the monetary models with the assumption of flexible prices.

Within the monetary models, there the sticky-price monetary model with sluggish adjustment of prices in the goods markets. As deviations strictly from PPP appeared in the short-run, one of the major pillars of the flexible-price monetary model would be called into question. In response, Dornbusch (1976) constructed a sticky-price monetary model that allowed for short run PPP deviations,

thus, the underpinning of Dornbusch-Frankel Sticky Price Monetary Model (DFSP) model:

$$\Gamma_1 > 0, \Gamma_2 < 0, \Gamma_3 < 0, \Gamma_4 > 0, \Gamma_5 = \Gamma_6 = 0$$

The sticky price monetary model assumes that the PPP hold in the long run[3] but not in the short run due to the price stickiness. The DFSP is generally re-expressed[4] as:

$$s_t = \Gamma_0 + \Gamma_1 m_t + \Gamma_2 G_t + \Gamma_3 i + \Gamma_4 f_i + \ldots + v \qquad (4)$$

The monetary models of exchange rate determination are concentrated in terms of expected future value and the current exogenous variables. Taylor (1995) stated that exchange rate was a function of expectation of discounted future value of exogenous variables. There are different processes involved for exogenous variables to follow different paths of exchange rates. "According to Baillie and MacMahon (1990), Taylor (1995), and Che and Mansure (2006)", equation 4 can be reformulated for this study as follows:

$$S_t = \Gamma_0 + \Gamma_1 R + \Gamma_2 R^* + \Gamma_3 M + \Gamma_4 G + \Gamma_5 f + \Gamma_6 NFA + \Gamma_7 TOT + U_t \qquad (5)$$

Where S_t is real effective exchange rate in the ASEAN-4 countries with U.S, R is the domestic interest rate in the ASEAN-4 countries, R^* is the foreign interest rate, M is money supply in the ASEAN-4 countries,   is the inflation rate, NFA is the net foreign asset in the ASEAN-4 countries, G is the real gross domestic product in the ASEAN-4 countries, and TOT is the term of trade in the ASEAN-4 countries.

Portfolio balance model

Portfolio balance model is one of the major models based on PPP. According to the portfolio balance model, exchange rates are determined by the demand and supply of all domestic and foreign assets not just by the supply and demand of money as in the monetary model. The portfolio balance model is therefore a dynamic model of exchange rate determination based on the interaction of goods and services markets, current account balance, prices and the rate of asset accumulation.

The composite IS-LM model of Edwards (1989) had empirically observed that the key factors that could significantly influence the exchange rate of a country's currency were related to the country's stage of development and the state of openness of the economy. Earlier researchers, such as Clerk and MacDonald (1999), Stein (1999), Obstfeld and Rogoff (1995), Cavallo and Ghironi (2002) and Che and Mansure (2006), had attempted to integrate the earlier models together. These researchers further integrated the various theoretical effects upon PPP based on the Portfolio Balance Model and had also included the effects via interest rate, money supply (M), inflation rates and the portfolio

balance effects via economic growth rates, terms of trade (TOT) and net foreign assets (NFA), which had measured the openness of the economy. According to Che and Mansure (2006), the Portfolio Balance equation for this study could be reformulated as:

$$S_t = \Gamma_0 + \Gamma_1 R + \Gamma_2 R^* + \Gamma_3 M + \Gamma_4 G + \Gamma_5 f + \Gamma_6 NFA + \Gamma_7 TOT + U_t \qquad (6)$$

Uncovered Interest Parity Model

The Uncovered Interest Parity (UIP) model theory states that differences between interest rates across countries are explained by the expected change in currencies. In more recent empirical literature on exchange rates, a lot of effort has been devoted to testing international parity conditions, such as PPP and UIP, which have played an essential role in asset market models of the exchange rate MacDonald and Taylor (1990), Chaboud and Wright (2005). Such conditions are normally thought of as arbitrage relationships, which are held continuously especially in the case of UIP.
UIP equation is written as:

$$S_{t+k} = S_t + i_{t,k} \qquad (7)$$

Where S is the log exchange rate, i is the interest rate of maturity k and t is time to maturity. According to Bjorland and Hungnes (2002), and Che and Mansure (2006):

$$s_{t+1} - s_t = i_t - i^*_t$$
$$\therefore \Delta s^e_{t+1} = i_t - i^*_t \qquad (8)$$

Assuming that Δs^e_{t+1} is a function of deviation of s_t from its equilibrium value s_t, equation 8 can be rewritten as:

$$\Delta s^e_{t+1} = i_t - i^*_t = -\}(s_t - s_t) \qquad (9)$$

In the long run, the equilibrium exchange rate will be given by relative price according to PPP. Hence, substituting equation 1 ($s_t = p_t - p^*_t$) for the equilibrium exchange rate will result in the following equation:

$$s_t = p_t - p^*_t - (i_t - i^*_t) \qquad (10)$$

Bjorland and Hungnes (2002), and Che and Mansure (2006) transformed the equation 10 into a testable co-integration model yielding:

$$s_t = S_0 + X_1 p_t + X_2 p^*_t + S_3 (i_t - i^*_t) + v_t \qquad (11)$$

Where S and X are the coefficient parameters, and   is the speed of adjustment of interest rate differential and   = $1/\lambda$ suggesting that the real exchange rate is a function

of both the price level and interest rates differentials. Equation 11 suggests that all real shocks that force real exchange rate away from PPP have to be captured by the long-run market interest rates, where the rates appear to predict PPP and exchange rates level (MacDonald and Nagayasu, 2000; Caporalea et al., 2001; Bjornland and Hungnes, 2002; Jin 2003, Wang, 2004; and Che and Mansure 2006.

Methodology and sources of the data

The estimation of this study were based on the most up to date quarter data for the sample period 1991:1q - 2006:2q for Malaysia, Indonesia, The Philippines, Thailand and Singapore. The published quantitative financial and economic data were extracted from three main sources: the International Monetary Fund (IMF, various issues and home page), central banks of ASEAN-5 countries, various issues of reports published. The data acquired from the above sources compared with the data extracted from DataStream (UUM online library software).

All value entities are defined in terms of national currencies. The models' variables are generating to a percentage quarter data. Che and Abul Mansure (2006) believed that the span of selected period is long enough to empirically test the long run forcing variables influencing the co-integration PPP relationship in economies under review

Model Specification

In this paper, the exchange rate model applied to explore the forcing factors that determine REER to the ASEAN-5 countries. However, Frenkel (1978), Edison (1985), Dibooglu and Enders (1995), Baharumshah and Ariff (1997), Mehdi and Taylor (1999), Goh Soo and Mithani (2000), Azali and Zubaidi (2001), Taylor (2002), Sarno and Taylor (2002), Ahmad and Lim (2004), Chaboud and Wright (2005), and Che and Abul Mansure (2006) found that many empirical and earlier researchers on exchange rate adopted co-integration techniques.

Using the existing theoretical frameworks discussed earlier in Section 2. We can write PPP of equilibrium exchange rates based on the earlier empirical frameworks (models) as follows:

$$S_t = r_0 + r_1 R + r_2 R^* + r_3 M + r_4 G + r_5 f + r_6 NFA + r_7 TOT + v_t \quad (12)$$

where, St denotes real effective exchange rate in ASEAN-5 countries Via U.S[5], R denotes domestic interest rate in ASEAN-5 countries, R* denotes foreign Interest rate, M denotes money supply in ASEAN-5 countries, denotes inflation rate, NFA denotes net foreign asset, G denotes Real gross domestic product, and TOT denotes term of trade. The disturbance term is to capture the unobserved effects and is assumed to have zero mean and constant variance.

Econometric Method

This section showed the unit root test to test for Stationary by using the Augmented Dickey-Fuller (ADF) and the Phillips Perron tests. Autoregressive Distributed Lag (ARDL) to estimate the data for long and short run relationships.

The recent economic developments in econometrics warrant to examining the characteristics of time series. The researchers (Nelson and Plosser, 1982) stated that the application of standard methods of conventional non-stationarity data, contain any Unit Root problem, may lead to spurious correlation in the regression analysis. The stationary test commonly known as the unit root test is conducted to check the order of the integration of each of the variable that is the number of times they must be differenced before attaining stationary. In order to avoid the problem of spurious correlation in the regression analysis, the time series properties of the variables will use in the regression analysis of this study are investigated using the two most popular unit root tests proposed to examine the stationary, which are the Augmented Dickey-Fuller (ADF) and the Phillips Perron tests.

Autoregressive Distributed Lag (ARDL)

Pesaran et al. (1995, 1997, 1999, and 2001) developed a procedure, called Autoregressive Distributed Lag (ARDL). The ARDL approach also allows us to identify long-run and short-run dynamics explanatory variables on a dependent variable. It can be applied regardless of the stationary properties of the variables in the sample and it allows for inferences on long-run estimates, which is not possible under alternative co-integration procedures.

The first step in the ARDL procedure outlined by Pesaran and Shin (1999) is to test the long-run significance of the dependent variables, by computing the *F*-statistic test the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model. This is similar to testing the significance of the error correction term in an error correction model. It involves the testing of the joint long-run significance of all explanatory variables including the constant.

We apply the ARDL approach proposed by Pesaran *et al.* (2001) to estimate equation 12 The following ARDL model is estimated to examine the long-run relationship:

$$\Delta S = r_0 + r_1 R_{t-1} + r_2 R^*_{t-1} + r_3 M_{t-1} + r_4 G_{t-1} + r_5 f_{t-1} + r_6 NFA_{t-1} + r_7 TOT_{t-1} +$$

$$s_1 \sum_{i=1}^{n} \Delta S_{t-i} + s_2 \sum_{i=0}^{n} \Delta R_{t-i} + s_3 \sum_{i=0}^{n} \Delta R^*_{t-i} + s_4 \sum_{i=0}^{n} \Delta M_{i=0} + s_6 \sum_{i=0}^{n} G_{t-i}$$

$$+ s_7 \sum_{i=0}^{n} \Delta f_{t-i} + s_8 \sum_{i=0}^{n} \Delta NFA_{t-i} + s_9 \sum_{i=1}^{n} \Delta TOT_{t-i} + v \quad (13)$$

Table 1: The Selected ARDL Model: Long-Run Coefficient Estimation for Malaysia REER via U.S dollar.

	Dependent Variable REER (S)		
	Study period	**Pre AFC**	**During and post AFC**
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
R			.0449 [5.890]***
R^*		.0534 [3.062]**	-.0109 [-3.567]**
M1	-.3872 [-3.223]**	-.0967 [-3.938]**	-.0277 [-3.887]**
G	.5939 [3.117]**		
f			-.0430 [-5.476]***
NFA			.0106 [3.299]**
TOT	-.6879 [-3.261]**		.0770 [2.667]**
C	-.9618 [-1.707]*	.2802 [16.59]***	.3787 [6.843]***
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

Notes: Asterisks ***, **, * represent 1%, 5%, 10% significant levels, respectively. The t-ratios are reported in square brackets. The following notation applies: domestic interest rate (R), foreign interest rate (R*), domestic money supply (M), real gross domestic product (G), inflation rate (f), net foreign assets (NFA) and terms of trade (TOT).

where S is the real effective exchange rate (REER), R and R^* are domestic Interest rate and foreign Interest rate,respectively. M money supply, f inflation rate, NFA net foreign assets, G is growth rate of real gross domestic product in ASEAN-4 and TOT term of trade. Δ is the first difference, n is the lag number in the independence variables $\sum_{i=1}^{n}$ and V is the error term.

The main advantages of this procedure are: Firstly, there is no prior endo-exogenous division of variables; secondly, no zero restrictions are imposed, and finally, there is no strict economic theory within which the model is grounded. The ARDL approach also allows us to identify long-run and short-run dynamics explanatory variables on a dependent variable.

Empirical results

This section demonstrates the empirical results of this study including the unit root test results, the long run equilibrium estimation and Error correction Model (ECM) results.

Unit root test results

In this study, two most popular unit root tests were utilized , the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests, to check if the variables under consideration were integrated of I (0), I (1) or mutually integrated. It is widely known that if any variable in the model integrated of an order higher than I (1), the ARDL technique could not used to provide reliable estimates of the parameters of the model.

ADF and PP tests suggest that most of our variables for ASEAN-5 economies are integrated in order I(0) or I(1) which means that the null hypothesis of unit root rejected for all series in both ADF and PP tests. Thus, we relied on the ARDL approach to estimate and interpret the parameters of the models used in the present study.

The long-run results

This subsection showing the empirical findings of this study by using ARDL to estimate the data of ASEAN 5 as follows:-

Malaysia

Given the existence of a long-run relationship, the next step is to use the ARDL approach to estimate the parameters of this long run relationship. This method has the additional advantage of yielding consistent estimates of the long-run coefficients that are asymptotically normal irrespective of whether the variables under consideration are I (0), I (1) or factionary integrated, (Pesaran and Shin, 1999; Pesaran *et al.* 2001).

The results of an ARDL models are reported in table 1. As we can see from the table, most of the variables under consideration are significant and the signs are consistent with a priori expectations. Clearly, for Malaysia the key long- run forcing variables of PPP of REER against U.S dollar throughout the sub-period and whole period are observed to be the domestic money supply (M1), also the

Table 2: The Selected ARDL Model: Long-Run Coefficient Estimation for Indonesia REER Via U.S dollar.

| | Dependent Variable REER (S) | | |
	Study period	Pre AFC	During and post AFC
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
R	.8658 [1.821]*		
R*	.5717 [1.922]*	-.0208 [-3.138]**	
M1	-.7635 [-3.643]**	.0789 [6.919]***	-.2978 [-3.460]**
G	.6814 [8.456]***		.2302 [6.594]***
f		-.0218[-1.975]*	.0310 [3.191]**
NFA			.2032 [3.167]**
TOT		-.1023 [-2.458]**	.5670 [2.005]*
C	-.1138[-5.030]***	.2329 [10.90***	.5972 [6.227]***
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

result shown foreign interest rate (R^*), and terms of trade (TOT) jointly serve as the second forcing variables in determining Malaysia's long run PPP of REER, especially after the AFC.

According to Che and Mansur (2006) this can be explained as follow. Malaysia historically earned its monetary policy independent in June 1967. Prior to the date, it began to develop its own financial system, diversify its economy and began to export more of its products to other countries, particularly United States, United Kingdom, Japan, and Europe, it thus began to accumulate a large amount foreign reserve, particularly, USD besides other currencies as its foreign reserves to stabilized its economy. Its dependent over US dollar was further manifested when its peg it Ringgit (MR) to US dollar, MR3.8 to US1 dollar, between September 1998 to May 2005.Malaysia has practically no PPP or exchange rate of its own since it fully depends on USD until it unpegged the MR to USD in May 2005, Che and Mansure (2006).

Indonesia

In table 2, the Indonesia results showed similar to Malaysia the key long- run forcing variables of PPP of REER against U.S dollar through out of the study sub-period and whole period are observed to be domestic money supply (M1). Also, it shown the variables, foreign interest rate (R^*), real gross domestic product (G), the inflation rate (f), and terms of trade (TOT) jointly serve as the second forcing variables in determining Malaysia's long run PPP of REER. The table also indicates AFC has left a notable negative impact upon Indonesia's long-term PPP, as well as its economy. The crisis has brought a sharp increase in Indonesia's inflation Che and Mansur (2006).

Philippines

The Philippines partly affected by AFC, where the results in table 3 showed key long- run forcing variables of PPP of REER throughout the sub-period and whole period of study are observed to be the domestic money supply (M1), domestic interest rate (R), foreign interest rate (R^*), and inflation rate (f). The result in table 3 seems to suggest it has too much money in circulation in the market, during the study as well as sub-period, this due to unstable socio-and political economic condition over long period Che and Mansur (2006).

Thailand

Thailand was the first ASEAN-5 economy attacked by the currency speculators in April 1996 and suffered as one of the worst victims among the ASEAN-5 members. Consequently, it was essentially forced to open its economy as one of the condition prescribed by the IMF and the World Bank in order to assist with recovery funds Che and Mansur (2006). The statistics in table 4 indicate that its significant long-run forcing variables of PPP of REER is observed to be the foreign interest rate (R^*), while the variables, domestic interest rate (R), inflation rate$f$, and net foreign assets (NFA) jointly as a second significant long-run forcing PPP of REER, especially after AFC.

Singapore

Singapore becomes a successful Centerport city-state after its independence in 1965. Although United States its major trading partners. Its strategic geographical location provides an opportunity for Singapore to be an

Table 3: The Selected ARDL Model: Long-Run Coefficient Estimation for Philippines REER Via U.S dollar.

	Dependent Variable REER (S)		
	Study period	Pre AFC	During and post AFC
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
R	.0543 [2.311]**	.0531 [1.833]*	.0449 [3.069]**
R^*	-.1648 [-3.186]**	.1243 [2.269]**	-.1910 [-10.98]***
M1	.9494 [4.972]***	-.5077 [-5.004]***	.2824 [4.724]***
G			.1077 [2.145]**
f	.0985 [1.825]*	-.9079 [-2.326]**	.1177 [6.697]***
NFA	-.2244 [-2.433]**		
TOT	.2282 [2.471]**		.0642 [1.834]*
C	.2067 [3.036]**	.2835 [5.099]***	.2925 [9.828]***
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

Table 4: The Selected ARDL Model: Long-Run Coefficient Estimation for Thailand REER Via U.S dollar.

	Dependent Variable REER (S)		
	Study period	Pre AFC	During and post AFC
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
R	-.2846[-3.429]**		.2000[3.440]**
R^*	.0713 [1.700]*	-.0153 [-2.324]**	-.1775[-2.668]**
M1			.2966 [.016]**
G			
f		.0346 [3.084]**	-.1580 [-3.450]**
NFA	.3726 [3.440]**		-.1072 [-2.442]**
TOT	.6815 [9.112]***		
C	.3232 [12.41]***	.2406 [41.26]***	.3734 [15.47]***
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

international wholesale intermediary with many economies Che and Mansur (2006). The Singapore results in table 5 indicated the long-run forcing variables of PPP of REER are observed to be the domestic interest rate (R). Variables, domestic money supply (M1), foreign interest rate (R^*), real gross domestic product (G), inflation rate (f), net foreign assets (NFA), and terms of trade (TOT) jointly serve as the second forcing variables in determining Malaysia's long run PPP of REER.

Error correction Model (ECM)

Error correction Model (ECM) has been used to estimate the short-run dynamic of the REER model for ASEAN-5 using the ARDL approach to co-integration proposed by Pesaran *et al. (*2001).The explanatory statistics in ASEAN-5 indicated that the REER equations were well specified. None of the statistics in the tables (6-10) were significant at the 5% significance level. Thus the explanatory statistics test results obtained revealed that all equations passed the tests successfully, i.e. the $\overline{R}^2$ showed that all the REER equations obtained best goodness of fits and the variation on the selected variables explained almost all the variations of the dependent variables for Malaysia, Indonesia, the Philippines, Thailand and Singapore against U.S under consideration. The Standard Error (S.E) obtained best goodness of fits of the data, while D.W showed normal distribution of the data for all ASEN-5 REER equations.

In general, the results of the REER models for each of the ASEAN-5 as shown in tables 6-10 indicate that the lagged error correction term ECM_{-1} carries the

Table 5: The Selected ARDL Model: Long-Run Coefficient Estimation for Singapore REER Via U.S dollar.

	Dependent Variable REER (S)		
	Study period	**Pre AFC**	**During and post AFC**
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
R	-.1610 [-4.323]***	.2819 [2.905]**	-.0538[-3.341]**
R^*		.5458 [10.63]***	.0188 [2.658]**
M1	-.7631[-2.712]**		.2067 [25.41]***
G	.8105 [7.884]***	.2902 [4.487]***	
f		-.1632 [-3.270]**	.1011 [2.822]**
NFA		-.7844 [-4.228]**	-.1751[-13.46]***
TOT	.2856 [1.835]*		.2150 [3.254]**
C	.2101 [2.828]**	-.4360 [-1.914]*	.1830 [3.642]**
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

Table 6: Error correction representation based on the ARDL Model: Short-Run Estimation for Malaysia REER via U.S dollar.

	Dependent Variable REER (S)		
	Study period 1991:Q1-2006:Q2	**Pre AFC 1991:Q1-1997:Q2**	**During and post AFC 1997:Q3-2006:Q2**
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
ECM(-1)	-.0529 [-2.197]**	- .6001 [-2.632]**	-.1268 [-8.751]***
R	.0620 [4.170]***		.0398 [10.78]***
R^*		.1636 [5.169]***	
M1			
G	.0620 [4.170]***	-.1164 [-3.790]**	
f		.0530 [2.237]**	-.0325 [-5.949]***
NFA	-.0705 [-3.477]**		
TOT		-.1373 [-3.688]**	
C	-.0193 [-1.110]	.3186 [14.10]***	.37226 [315.7]***
$\overline{R}^2$	.7439	.7783	.9730
S.E.	.0135	.0045	.0030
S.squared resid	.0102	.3952	.2898
F-statistic	5.840	7.583	409.8
DW-statistic	1.732	2.010	1.894
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

Notes: The *t*-ratios are represented in squire brackets. Asterisks ***, **, * represent 1%, 5%, 10% significance levels, respectively. Δ Denotes the first difference of each variable. The following notation applies: domestic interest rate (R), foreign interest rate (R^*), domestic money supply (M), real gross domestic product (G), inflation rate (f), net foreign assets (NFA) and terms of trade (TOT). $\overline{R}^2$ is Adjusted R-squared, (S.E) is the standard Error of regression, and Sum squared residual.

expected negative signs and is highly significant, which is supportive of the inference of a unique co-integration and stable long run REER relationship. Moreover, the results of the significant short- run forcing variable of PPP for ASEAN-5 through out of the sub-period and whole period are observed to be as follows. For Malaysia the key short- run forcing variables of PPP of REER

against U.S dollar through out of the sub-period and whole period are observed to be the domestic interest rate (R), real gross domestic product (G), and inflation rate (f). In table 7, Indonesia results showed the key short- run forcing variables of PPP of REER against U.S dollar through out of the study sub-period and whole period are observed to be the foreign interest

Table 7: Error correction representation based on the ARDL Model: Short-Run Estimation for Indonesia REER via U.S S dollar.

	Dependent Variable REER (S)		
	Study period	**Pre AFC**	**During and post AFC**
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
ECM(-1)	-.2878 [-2.563]**	-.4303 [-3.224]**	-.4599 [-3.255]**
R			
R*	.2233 [1.828]*	-.0140 [-2.569]**	.2416 [1.941]*
M1	-.2610 [-2.887]**	-.0323 [-1.737]*	-.2685 [-2.968]**
G	.1777 [3.443]**		
f		-.0087 [-3.048]**	.0413 [2.727]**
NFA	.1586 [3.0691]**		.1864 [4.408]***
TOT		-.0139 [3.803]**	
C	-.2337 [-2.205]**	.0997 [3.803]**	.6997 [7.598]***
$\overline{R}^2$	.84673	.7918	.7727
S.E	.0915	.9805	.1002
S.squared resid	.4522	.1538	.2913
F-statistic	7.569	5.204	9.405
DW-statistic	2.045	2.395	1.862
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

Table 8: Error correction representation based on the ARDL Model: Short-Run Estimation for Philippines REER via U.S S dollar.

	Dependent Variable REER (S)		
	Study period	**Pre AFC**	**During and post AFC**
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
ECM(-1)	-.1907 [-2.098]**	-.6284 [-5.876]***	-.5880 [-2.984]**
R	.0425 [3.087]**	.0449 [3.069]**	
R*		-.1910 [-0.985]***	
M1	.1660 [2.047]**	-.3240 [-1.726]*	.3101 [2.064]*
G		.1077 [2.145]**	
f		.1177 [6.697]***	.0876 [2.230]**
NFA	-.0433 [-1.825]*		
TOT	.06352 [1.805]*	.0642 [1.834]*	
C	.0557 [1.758]*	.2925 [9.828]***	.1833 [2.991]**
$\overline{R}^2$	.7510	.8321	.7152
S.E.	.0167	.0136	.0092
S.squared resid	.01487	.0050	.0013
F-statistic	2.945	6.525	3.974
DW-statistic	2.276	2.174	2.158
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

rate (R^*), and domestic money supply (M1). Variables, inflation rate (f), net foreign assets (NFA) jointly serve as the second forcing variables in determining Indonesia's short-run PPP of REER.

Table 9: Error correction representation based on the ARDL Model: Short-Run Estimation for Thailand REER via U.S S dollar.

	Dependent Variable REER (S)		
	Study period	Pre AFC	During and post AFC
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
ECM(-1)	-.4426 [-4.544]***	-.2804 [-1.945]*	-.4211 [-4.091]***
R	.0852 [3.435]**		.1353 [4.052]***
R^*	-.1589 [-2.896]**	-.0153 [-2.324]**	
M1			
G			-.5314 [-2.455]**
f		.0346 [3.084]**	
NFA	.0164 [2.723]**		
TOT	.3016 [4.505]***		
C	.1430 [4.096]***	.2406 [41.26]***	.2481 [4.413]***
$\overline{R}^2$	.7603	.7400	.7024
S.E.	.0167	.0032	.0150
S. squared resid	.0149	.2381	.0067
F-statistic	8.159	7.762	10.25
DW-statistic	1.757	1.829	1.755
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

Table 10: Error correction representation based on the ARDL Model: Short-Run Estimation for Singapore REER via U.S dollar.

	Dependent Variable REER (S)		
	Study period	Pre AFC	During and post AFC
Regressors	Coefficient [T-ratio]	Coefficient [T-ratio]	Coefficient [T-ratio]
ECM(-1)	-.2323 [-3.250]**	-.1807 [-3.000]**	-.4059 [-4.125]***
R	-.7733 [-1.750]*		
R^*	.0765 [1.979]*		
M1	-.1789 [-3.603]**		.0841 [2.224]**
G			
f			-.1870 [-2.609]**
NFA			
TOT		-.0901 [-2.738]**	
C	.1942 [2.232]**	.0228 [2.728]**	.0772 [4.471]***
$\overline{R}^2$	.7634	.7033	.7346
S.E.	.0372	.0024	.0035
S. squared resid	.0762	.1354	.3923
F-statistic	6.077	4.860	8.389
DW-statistic	1.733	2.034	2.323
The period	1991:Q2-2006:Q2	1991:Q2-1997:Q2	1997:Q3-2006:Q2
No.of Obs.	(61)	(25)	(35)

The results in table 8, Philippines results showed key short-run forcing variables of PPP of REER through out of the study sub-period and whole period are observed to be the domestic money supply (M1). The second forcing variables in determining Philippines short-run PPP of REER are foreign interest rate (R^*), inflation rate (f), and terms of trade (TOT) respectively. The statistics in Table 9 indicate that its significant short-run forcing
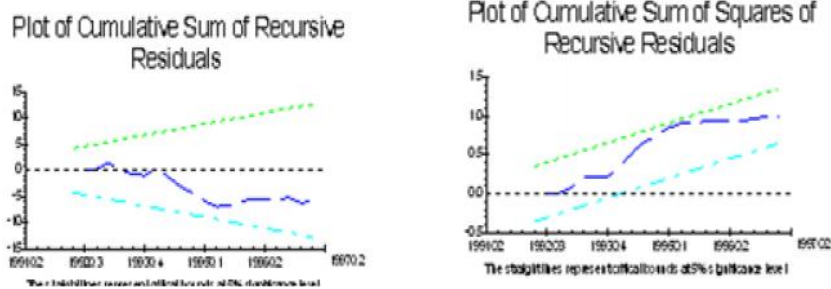
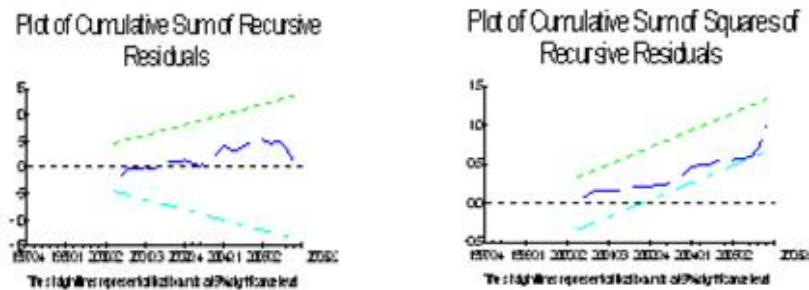**Figure 1.** Plots of CUSUM and CUSUMSQ statistics for Malaysia via U.S REER from 1991:q1-1997:q2.

Figure 2. Plots of CUSUM and CUSUMSQ statistics for Malaysia via U.S REER from 1997:q3-2006:q2.
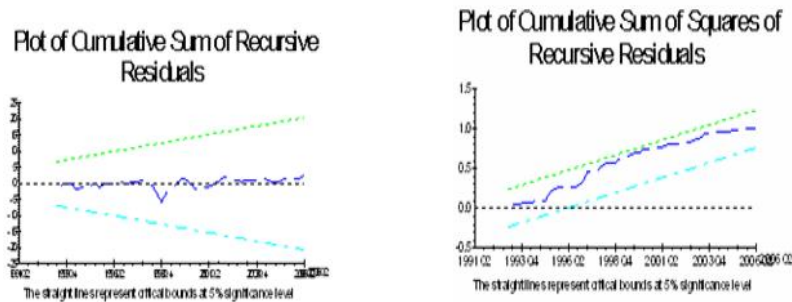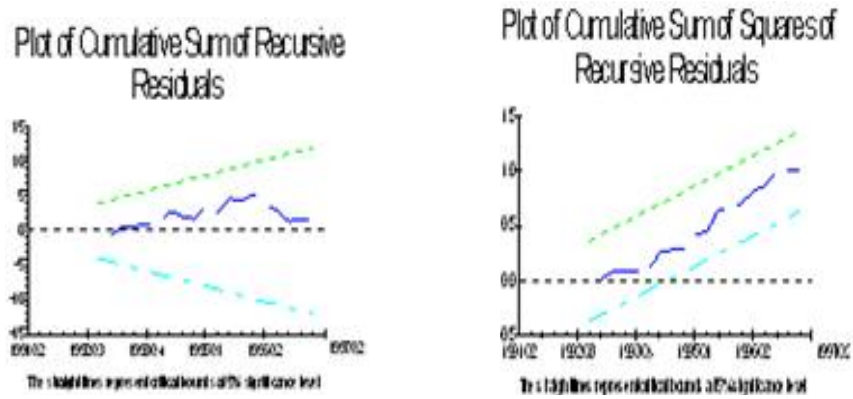

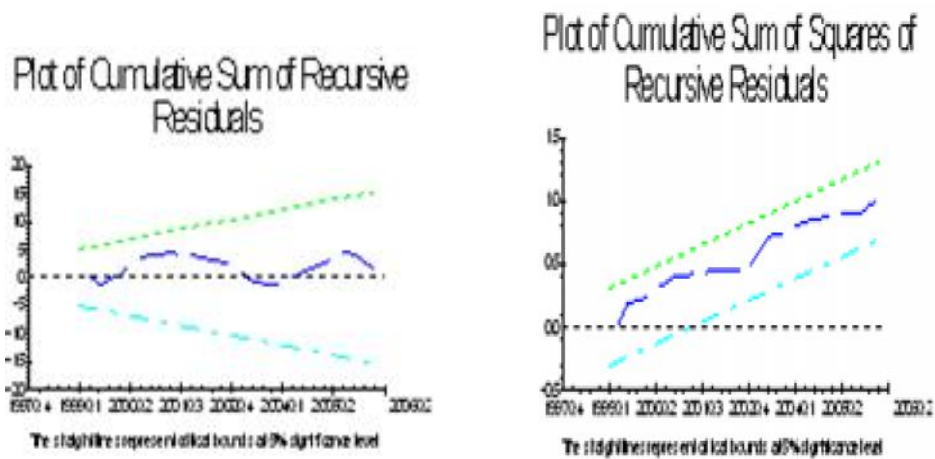**Figure 3.** Plots of CUSUM and CUSUMSQ statistics for Malaysia via U.S REER from 1991:q1-2006:q2.

variables on Thailand PPP of REER throughout the study sub-period and full period are observed to be the domestic interest rate (R),foreign interest rate (R*). May be because it was essentially forced to open its economy as one of the condition prescribed by the IMF and the World Bank in order to assist with recovery funds Che and Mansur (2006). In table 10, results indicated that the key short-run forcing variables of PPP of Singapore REER throughout the study sub-period and full period is observed to be the domestic money supply (M1), especially after AFC and full period.

Finally, we examine the stability of the long run

parameters together with the short-run movements for each equation. To this end, we relied on cumulative sum (CUSUM) and cumulative sum square (CUSUMSQ) tests proposed by Brown et al. (1975). The same procedure was applied by Pesaran and Pesaran (1997) and Bahmani-Oskooee and Ng (2002) to test the stability of the long-run coefficients. The tests applied to the residuals of the ECM models (Tables 6-10) along with the critical bounds are graphed in figures. As can be seen in Figures 1-15, the plots of CUSUM and CUSUMSQ statistics stayed within the critical 5% bounds for all equations. Neither CUSUM nor CUSUMSQ plots crossed
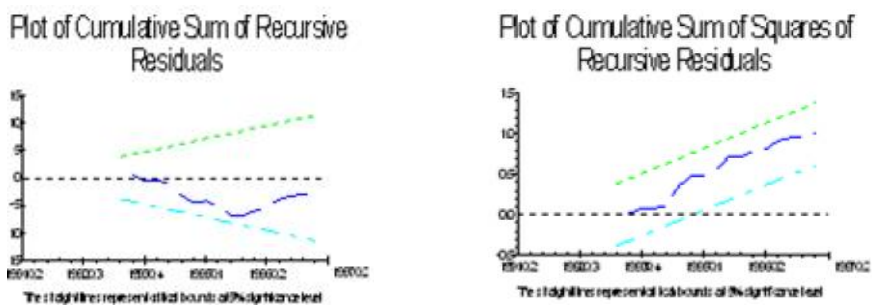
Figure 4. Plots of CUSUM and CUSUMSQ statistics for Indonesia via U.S REER from:1991:q1-1997:q2.
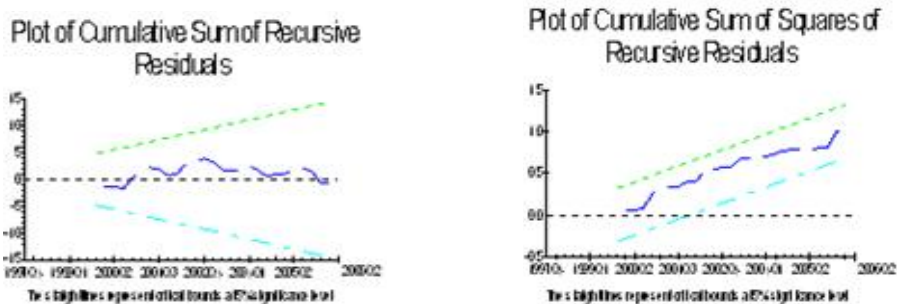
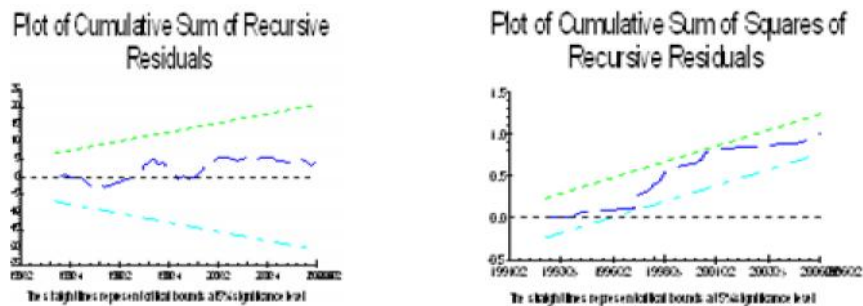**Figure 5.** Plots of CUSUM and CUSUMSQ statistics for Indonesia via U.S REER from :1997:q3-2006:q2.
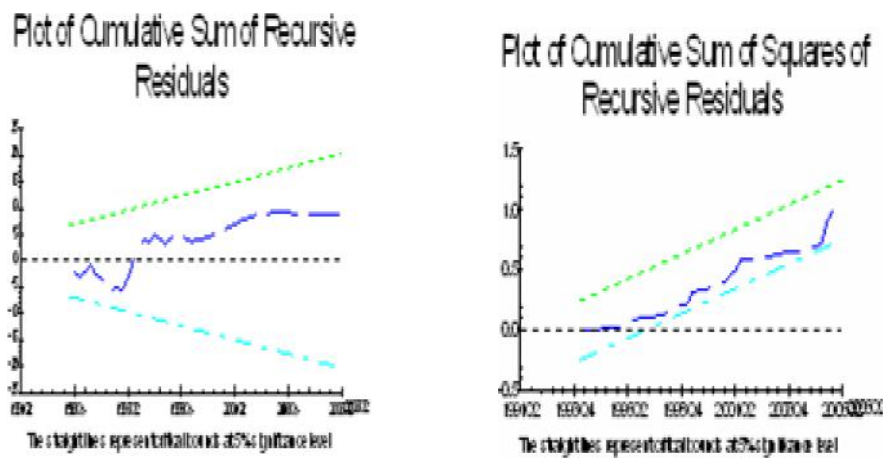
Figure 6. Plots of CUSUM and CUSUMSQ statistics for Indonesia via U.S REER from 1991:q1-2006:q2.
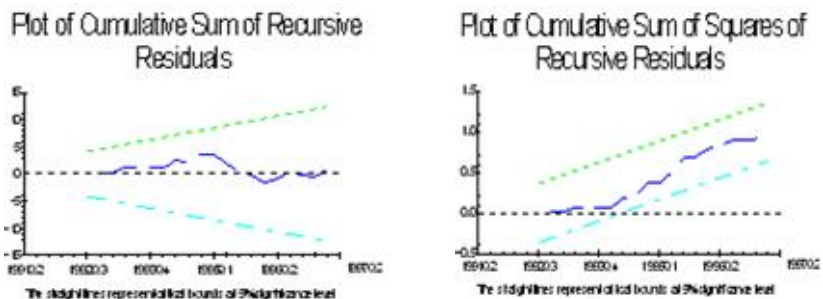
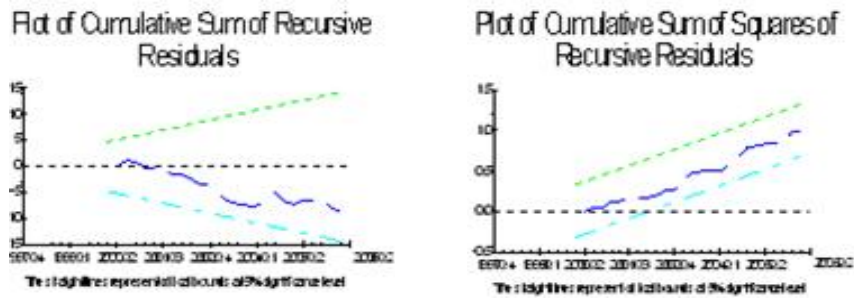**Figure 7.** Plots of CUSUM and CUSUMSQ statistics for Philippines via U.S REER from 1991:q1-1997:q2.

Figure 8. Plots of CUSUM and CUSUMSQ statistics for Philippines via U.S REER from 1997:q3-2006:q2
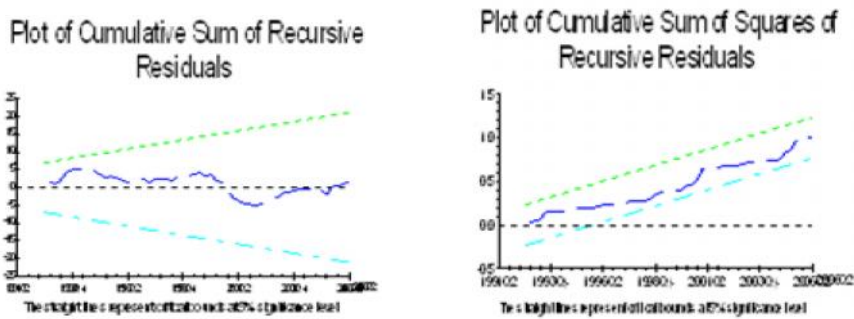

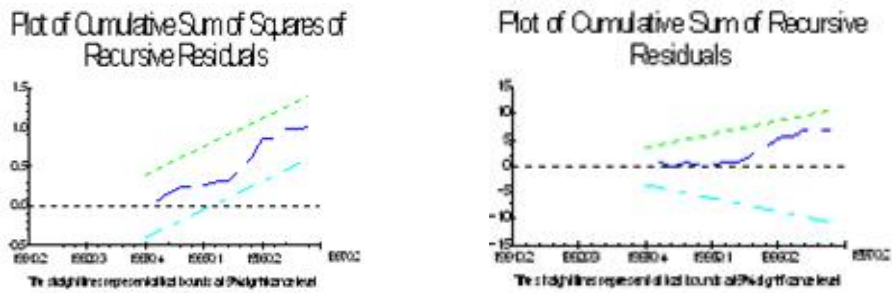**Figure 9.** Plots of CUSUM and CUSUMSQ statistics for Philippines via U.S REER from 1991:q1-2006:q2.

Figure 10. Plots of CUSUM and CUSUMSQ statistics for Thailand via U.S REER from 1991:q1-1997:q2
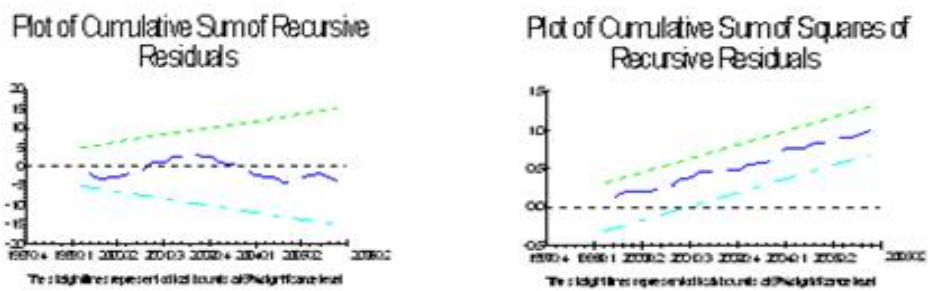
Plot of Cumulative Sum of Recursive Residuals

Plot of Cumulative Sum of Squares of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Figure 11. Plots of CUSUM and CUSUMSQ statistics for Thailand via U.S REER from 1997:q3-2006:q2

Plot of Cumulative Sum of Recursive Residuals

Plot of Cumulative Sum of Squares of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Figure 12. Plots of CUSUM and CUSUMSQ statistics for Thailand via UK REER From 1991:q1-2006:q2.

Plot of Cumulative Sum of Squares of Recursive Residuals

Plot of Cumulative Sum of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Figure 13. Plots of CUSUM and CUSUMSQ statistic for Singapore via U.S REER From 1991:q1-1997:q2

Plot of Cumulative Sum of Recursive Residuals

Plot of Cumulative Sum of Squares of Recursive Residuals

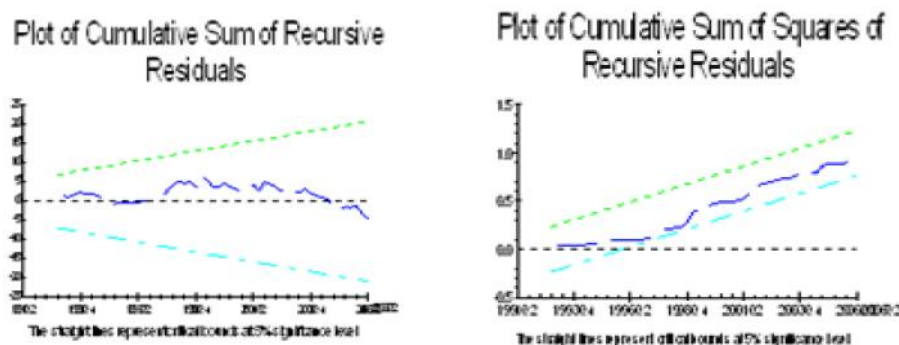The straight lines represent critical bounds at 5% significance level

Figure 14. Plots of CUSUM and CUSUMSQ statistic for Singapore via U.S REER from 1997:q3-2006:q2.

Figure 15. Plots of CUSUM and CUSUMSQ statistic for Singapore via U.S REER from 1991:q1-2006:q2.

the critical bounds, indicating no evidence of any significant structural instability. These results were the same no matter which selection criterion was chosen, which indicated that REER functions in the ASEAN-5 countries against U.S were stable. They appeared to be unaffected by the recent financial crisis over the sample sub-period.

Conclusions

The long-run and short-run forcing variables of domestic interest rate, foreign interest rate, inflation rate, domestic money supply, net foreign assets, terms of trade (TOT) and real gross domestic product (RGDP) upon REER in ASEAN -5 countries were examined**.** The long-run and short-run forcing variables of PPP for ASEAN-5 differ due their different economic environment and this tandem with Che and Mansure (2006).

It should be mentioned that the estimated long-run parameters of Malaysia's exchange rate model show that most of the variables carried the correct expected signs and their coefficients are statistically different from zero at conventional significant levels. The results suggested that domestic money supply (M1) is the greatest forcing variable of PPP for Malaysia's REER for the three periods, while in the short-run results suggest that domestic interest rate (R), real gross domestic product during (G), and inflation rate (f) have forcing of PPP for Malaysia's REER during the sub-periods and full period. The impact of the M1 on Malaysia PPP in long run is due to developing its own financial system, as an open and small economy.

Moreover, the estimated results of the long-run and the short-run forcing variables of the REER model for Indonesia, the Philippines, and Singapore had suggested that domestic money supply (M1) is the highest forcing variable of PPP on Indonesia and the Philippines REER's for the periods of the study. Meanwhile, the impact of M1 on the Indonesia's PPP is due to major export of natural resources. Whereas, Singapore results suggested that

domestic money supply (M1) has significant influence on Singapore's PPP only during the entire period and sub-period of 1997:q3-2006:q2. The impact of M1 upon Singapore's PPP is due to the fact that Singapore is an open and small economy, and the financial sector in Singapore is the well-developed sector in the region and followed by Malaysian financial sector compared to other ASEAN-5 financial markets. The statistics in table 4 and 9 suggested that the long-run and short-run forcing variables of PPP in the Thailand's REER is foreign interest rate (R^*) and jointly with domestic interest rate (R). In this regard, the impact of R^* on Thailand's PPP is due to the condition imposed by International Monetary Fund (IMF) and World Bank on Thailand to open its traditional closed economy before it can be assisted.

Finally, the empirical results of this study are in line with the World Bank researchers' findings that found that the developing economies, in general, are heterogeneous. Thus, the long run forcing variables of PPP should be differed according to countries economic environment. The results are also similar to the empirical findings of Frenkel (1976, 1978), MacDonald and Taylor (1994), Chinn and Meese (1995), Kanas (1997), Husted and MacDonald (1998), Dutt and Gosh (1999), Francis et al. (2001), Caporalea, et. al. (2001), Rapach and Wohar (2002), Groen and Kelbergen (2003), and Chaboud and Wright (2005). Consequently, the policy makers in the respective ASEAN-5 economies need to keep constantly identifying the long-run forcing variables from time to time. The long run forcing variables are essential to the policy makers to assess mange and develop financial sector in order to play a vital role in promoting their respective economies growth.

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End Notes

1. ASEAN-5 consist of Malaysia, Indonesia, the Philippines, Thailand and Singapore. They are the initial members of the economic group when it was first established.
2. The term real effective exchange rate (REER) is defined as the real price in the domestic currency of one real unit of another (foreign) currency. Hence, the nominal exchange rate is part of the REER.
3. MacDonald and Taylor (1994), Chinn and Meese (1995), Kanas (1997), Husted and Kelbergen (1998), Dutt and Gosh (1999), Francis et al. (2001), Rapach and Wohar (2002), and Groen and Kelbergen (2003).
4. Baillie and MacMahon (1990), Taylor (1995), and Che and Mansure (2006).
5. According to Dufrenot and Yehoue (2005), and Che and Mansur (2006), REER was defined as the ratio of the domestic CPI to the foreign CPI. The deflator employ by researchers are varies: some employ Trade Weighted Average (TWA), GNP deflator and so on.