CHAPTER III

Purchasing Power Parity

3.1 Introduction

Purchasing Power Parity is one of the well known foundation to the study of long-run relationship between prices and exchange rates in an open economy. In this chapter, long-run relationship between exchange rate and inflation rate in Malaysia is examined by using cointegration technique based on the Purchasing Power Parity (PPP) theory. If the long-run Purchasing Power Parity model holds, we will then be able to estimate the equilibrium exchange rate of ringgit Malaysia (RM) after the RM has been pegged to United States dollar (USD) at RM3.80 per USD since 2 September 1999. This estimation will allow us to evaluate whether the ringgit Malaysia is over-valued or under-valued. Besides that, the short-run relationship between these variables is examined through error correction model.

3.2 Purchasing Power Parity Theory

Purchasing Power Parity (PPP) theory is a simple model to estimate equilibrium exchange rate when a nation has a balance of payments disequilibrium. The theory was elaborated and brought forcefully back into use by the Swedish economist Cassel in 1923 as stated in Salvatore's paper (1995). Cassel estimated the equilibrium exchange rate at which nation could return to the gold standard after the disruption of international trade and the large changes in the relative commodity prices in various nations caused by World War I. Today, we face more disruption in financial market with more volatility in share market via large amount of short term capital inflow. Without consideration of complexity intervention of government fiscal and monetary policies and short-run volatility in financial market, a simple model such as PPP will be able to give us the insight view of the long-run equilibrium exchange rate.

There are absolute and relative versions of the PPP theory. The absolute PPP postulates that the equilibrium exchange rate is equal to the ratio of the price levels in two nations. The absolute PPP model is as following:

$$R_{ab} = P_a / P_b$$

Where R_{ab} equals to exchange rate between the currency of country a and currency of country b. P_a and P_b are refer to general price level in country a and country b. The logic of the model is any homogenous or identical traded commodity would have the same price in both countries when expressed in terms of the same currency which is referred to as the law of one price.

There are two main shortages of the PPP model. Firstly, it appears to give the exchange rate that equilibrates trade in goods and services so that a nation experiences capital outflows would have a deficit in its balance of payments, while a nation receives capital inflows would have a surplus. But in the real world there are many obstructions to the free flow of trade and capitals. Secondly, existence of non-traded goods and services that are normally included in general price level in each nation will cause the PPP model unable to estimate equilibrium exchange rate.

The relative Purchasing Power Parity theory is a more refined model that postulates the change in the exchange rate over a period of time should be proportional to the relative change in the price levels in the two nations over the same time period.

$$R_{ab1} = \frac{(P_{a1} / P_{a0})\, R_{ab0}}{(P_{b1} / P_{b0})}$$

The subscript *0* refers to base period and *1* refer to subsequent period. The ratio of the price of non-traded goods and services to the price of traded goods and services is systematically higher in developed nations. This is mainly due to higher labor cost in developed nations. This will always cause the prediction of under-valued exchange rates for developed nations and over-valued exchange rates for developing nations.

The relative PPP theory may give fairly good approximation of the equilibrium exchange rate in the long-run and in the case of purely monetary disturbances, but not in the short-run when structural changes take place.

3.3 Literature Review for Purchasing Power Parity

The following literature reviews are covering topics of PPP. Most of the studies on PPP are focused on developed countries. Only after the late 1980s, there are more researches which study the PPP in developing countries.

Goh (1989) studied the behavior of real and nominal exchange rate of ringgit Malaysia. He used Dickey Fuller procedure to formally test for the presence of random walk by estimating an autoregressive regression with a linear trend. The finding of this paper showed that nominal and real exchange rate series of ringgit Malaysia can be characterized as being fundamental stochastic. Any shock that is affecting the foreign exchange market will have a long-lived effect on the future movement of exchange rate. The stochastic trend in real exchange rate is the deviation from PPP (absolute version) and it would not dissipate over time. Divergence from PPP is deemed to be basically structural.

Kim (1990) estimated a restricted version of Purchasing Power Parity equation:

$$s_t = \theta_0 + \theta_1 p_t + u_t$$

s_t is nominal exchange rate (the dollar price of foreign currency).

p_t is ratio of the United States Wholesales Price Index (WPI) to a foreign WPI or the corresponding ratio for the Consumer Price Index (CPI).

u_t is disturbance term.

All variables above are in logarithms form. Kim (1990) used cointegration test and unit root test on nonstationary and integration of two variables in the same order and stationary of the error term. Thus Kim (1990) preassumed that all variables in the power parity equation are nonstationary. For the PPP to hold in long-run, variables and error term have to be stationary.

Kim's model has included countries like Canada, France, Italy, Japan and United Kingdom by using data spanning most of the twentieth century. Kim's results strongly suggest, but not uniformly evidence in favour of PPP. Kim (1990) showed evidence in favour of PPP may hinge on the countries involved and the price series used in the model. He found that the PPP holds better when using wholesales price rather than consumer price. Kim (1990) attributed this to the higher proportion of non-traded goods is included in consumer price series.

In Kim's test (1990), all exchange rates and price series appeared to be integrated of first order except Canadian dollar. This might due to absence of large changes in the exchange rate and the price ratio over the sample period, as well as similarity of macroeconomic policies of Canada and United States. These have induced the results of exchange rate and price ratio not deviating from unity. The long-run exchange rate and price ratio may have been swamped by the short-run dynamics.

Kim (1990) concluded that PPP is less likely to hold when two countries have different productivity growth and demand patterns, and when price index used gives a significant weight to non-traded goods as does CPI.

Abuaf and Jorion (1990) re-examined on the PPP in the long-run. This paper casts serious doubt on the random walk hypothesis. In their opinion that most of the empirical tests of PPP have been unable to reject the hypothesis that the real exchange rate follows a random walk is due to poor power of test. They refined the econometric tests by pooling the data in system of univariate autoregressions and using Dicky and Fuller statistics. They were able to show improvement in the power of these statistics by employing Monte-Carlo experiments. But no definite conclusion is given yet, as the sample period is short and not possible to demonstrate more cycles of deviation from PPP. The results of their study show that deviation from PPP is substantial in the short-run, and it takes about three years to be reduced to half.

Macdonald and Taylor (1993) reexamined the monetary approach on the exchange rate from several perspective by using monthly data on the deutsche mark-United States dollar exchange rate for year 1970 till 1990. In their study, the static monetary approach to the exchange rate has some validity for long-run equilibrium condition. The full set of rational expectation restrictions imposed by the forward-looking monetary model are rejected; and the monetary model was used to generate a dynamic error-correction exchange rate equation that has robust in-sample and out-sample properties.

Macdonald and Taylor (1993) used the long-run version of Johansen's multivariate cointegration tests as the following:

$$s_t = w_0 + w_1 m_t + w_2 m_t^* + w_3 y_t + w_4 y_t^* + w_5 i_t + w_6 i_t^* + u_t$$

s_t is logarithm of nominal exchange rate, m_t is logarithm of domestic monetary supply, y_t is logarithm of domestic income and i_t is logarithm of interest rate. Asterisk denotes a foreign variable. The estimated speed of adjustment for the exchange rate to return to the equilibrium level after shocks was proved to be painfully slow.

Tang and Butiong (1994) in their research papers used cointegrating techniques to examine long-run relationship among exchange rates and inflation rates on Asian developing countries. Error correction model was used to estimate short-run impact of all variables in the model. The results showed that PPP holds as long-run constraint in the lower stage of economic development and characterized by underdeveloped capital market. The changes of exchange rate was deviated largely from PPP in countries that experienced substantial exchange rate speculations and capital movement. The results do not support a large share of non-tradable sector. Trade restriction and intensified government intervention in foreign exchange market would lead to divergence between actual exchange rate and PPP. Exchange rate of Malaysia was not cointegrated with CPI. This may be due to massive foreign investment inflows that cause the divergence from PPP.

Faruqee (1995) examined the long-run determinants of the real exchange rate from stock flow perspective. He explained PPP as a fixed steady-state condition rather than long-run equilibrium condition. The empirical analysis in his papers estimated a long-run relationship between the real exchange rate, net foreign assets and other factors that affecting trade flows. By using the postwar data for the United State and Japan, cointegration analysis supports the finding that the structural factors underlying each country's net trade and net foreign asset positions determine long run path for the real value of the dollar and the yen.

Ngeow (1995) studied the PPP model between Singapore and other Asian countries namely Indonesia, Malaysia, Philippines and Thailand for years 1974 till 1991. His study showed that PPP holds in all these countries except Malaysia. This may be due to the wholesales price index used for the PPP model of other countries except Malaysia, and consumer price index used for the PPP model of Malaysia. Inclusion of non-tradable goods in the consumer price index may leads to rejection of long-run PPP relationship for Malaysia and Singapore.

Macdonald (1995) reviewed the literature that conducting a unit root test on the residual from a regression model using the nominal price and relative price. He also offers explanations on why the existence of some long-run exchange rate relationship does not accord exactly with a traditional representation. This paper strongly suggests the existence of "some form" of long-run exchange rate relationship.

The finding of Macdonald's paper (1995) is comprising of two different periods namely the recent floating period and the sample period that extend back before the start of the floating period. The recent floating period supported a long-run relationship between relative prices and exchange rate. This also means that these variables are cointegrated. However, the long-run relationship does not conform to the traditional PPP since the hypothesis of proportionality is often rejected.

There are three main reasons why PPP does not in the long-run. Firstly, this results may be due to measurement errors and traded or non-traded biases. Secondly, the econometric methods used may produce coefficient biases that is substantial in a small sample. Thirdly, there had been real disturbances and capital movement during the recent floating period that may upset the proportionality relationship.

The research of Macdonald (1995) is towards non-fundamental explanation of exchange rate. This may not generate true pictures on the economy. Without taking consideration on fundamental economic variables, important roles of fiscal and monetary policies on exchange rate determination will not be accounted.

Macdonald (1997) used the reduced form model of the real exchange rate. Multilateral cointegration methods for real effective exchange rate of the dollar, mark and yen from year 1974 to 1993 was used. Sources of trends in the long-run real exchange rate in his models are fiscal balances, net foreign assets and real interest rates. Significant long-run relationships for real effective exchange rate were shown by mark, dollar and yen. Short-run behavior was examined by calculating impulse response function of real exchange rate with respect to orthogonalised shocks in fundamental variables. The impulse response analysis provided a set of results which were statistically significant. The modeling exercise indicated that fundamental economic variables have an important and significant determination on both long-run and short-run exchange rate.

3.4 Cointegration Model for Purchasing Power Parity

Cointegration means despite being individually nonstationary, a linear combination of two or more time series can be stationary. Cointegration of two time series suggests that there is a long-run or equilibrium relationship between them. Many early econometrics practices ignored the stationary requirement. Regressions involving time series data include the possibility of obtaining spurious or dubious results in the sense that superficially the results look good but on further probing they look suspect. Spurious regression may due to inclusion of two nonstationary variables in a regression when these variables are actually unrelated. Therefore we need to prove all the series are stationary prior to cointegration test.

A stationary series has finite second moments and the mean value of the series and its correlation function is time invariant. It is called $I(0)$, denoting "integrated of order zero". The simplest example of a stationary $I(0)$ series is white noise. A series which needs to be differentiated n times to become stationary is said to be "integrated of order n", denoted as $I(n)$.

A stationary series tend to constantly return to its mean value and fluctuation around this mean has a broad constant amplitude. Therefore shock has only a temporary effect. On the other hand, nonstationary series has a mean varying over time and an infinitive variance. Shocks have permanent effects.

The simplest example of nonstationary process is the random walk.

$X_t = X_{t-1} + \varepsilon_t$ where $\varepsilon_t \sim \mathrm{IN}(0,\delta^2)$ (3.1)

If $X_0 = 0$

$X_t = \varepsilon_1 + \varepsilon_2 + \varepsilon_t$ (3.2)

When $t \rightarrow \infty$ and the variance of X_t, $t\,\delta^2 \rightarrow \infty$, it is also shown that a shock will have a permanent effect on X_t. Since X_t is simply a sum of past shocks, it is also clear that the first difference of equation of 3.1:

$X_t - X_{t-1} = \varepsilon_t$ (3.3)

is stationary. Therefore, a random walk time series is $I(1)$. If two series move parallel, even though they are individually nonstationary, the differences between them may be constant which means stationary. In such case, the two time series are called cointegrated.

In particular, if X_t, Y_t are $I(1)$ but there exist a linear combination

$Z_t = c + aX_t + bY_t$ (3.4)

And Z_t is $I(0)$, then X_t and Y_t are said to be cointegrated and (c, a, b) is called cointegration vector. In general, if Y is $I(d)$ and X is also $I(d)$, where d is the same value then these two series can be cointegrated.

Estimating the OLS equation for the above model and testing $Ho : \theta_1 = 1$ For PPP to hold in the long-run, ε_t is represented by a stationary autoregressive moving average (ARMA) process. The two variables s_t and p_t are said to be cointegrated if (i) the two nonstationary variables are integrated of the same order, (ii) there exists a long-run equilibrium relationship as in equation 3.4 and (iii) the error term is stationary. We presuppose the nonstationary of variables. If deviation from the presumed relationship have bounded variability, then cointegration exists and PPP holds in the long-run.

The cointegration model for Purchasing Power Parity in this study is based on Tang and Butiong's study (1994) of PPP in Asian countries. In flexible exchange rate regimes, relative inflation rate determines the exchange rate. The cointegration model for relative PPP in flexible exchange rate regime is as follows:

$$\ln E_t = \alpha + \beta \ln (P_t^d / P_t^f) + \varepsilon_t \qquad (3.5)$$

E_t is nominal exchange rate, P_t^d is domestic price index normally represented by local consumer price index or wholesales price index, P_t^f is foreign price index normally represented by foreign consumer price index or wholesales price index, and ε_t is residual of the model.

Whereas in fixed exchange rate regimes, domestic inflation is determined by foreign inflation. Under fixed exchange rate regimes the relative PPP version is as follows:

$$\ln P_t^d = \alpha' + \beta' \ln (E_t P_t^f) + \varepsilon_t^f \qquad (3.6)$$

If PPP exists in the long-run, then β and β' are closed to 1, and ε_t and ε_t^f should be stationary. Both equations above should be cointegrated. So rejection of cointegration if they are integration of different orders.

Augmented Dickey-Fuller (ADF) test is employed to test the level of integration of these variables. ADF test requires negative and significant test statistic. ADF test is as follows:

$$Z_t = c + aX_t + bY_t$$

We regress $\Delta Z_t = \alpha Z_{t-1} + \varepsilon_t$, where the null hypothesis is $\alpha = 0$ against $\alpha < 0$. We perform a t test to find whether α is significantly less than zero. t statistic on α is ADF statistic.

3.5 Error Correction Model

The cointegration model is used to test long-run equilibrium relationship between nonstationary time series. On the other hand, error correction model describes short-run dynamic process. It showed that if a set of variables is cointegrated then there exists an error correction representation which allows flexibility in short-run dynamic process while the model is constrained to return to long-run equilibrium.

Error correction representation can be expressed as following:

$$A(L)(1-L)\,X_t = -YZ_{t-1} + d(L)E_t$$

Where Z_t and X_t are vectors and $Z_t = \alpha\, X_t$; $A(L)$ is a finite order polynomial with $A(0)=I_N$ and $d(L)$ is a finite order lag polynomial.

The error correction model for a flexible exchange rate regime is

$$\Delta \ln E_t = \sum_{i=1}^{n} \pi_i'\, \Delta \ln E_{t-i} + \sum_{i=1}^{n} \eta_i \Delta \ln(P^d_{t-i}/P^f_{t-i}) + \gamma\, [\ln E_{t-1} - \alpha$$

$$- \beta \ln(P^d_{t-1}/P^f_{t-1})] + \varepsilon_t$$

$$= \sum_{i=1}^{n} \pi_i\, \Delta \ln E_{t-i} + \sum_{i=1}^{n} \eta_i \Delta \ln(P^d_{t-i}/P^f_{t-i}) + \eta + \gamma\, [\ln E_{t-1}$$

$$- (\ln(P^d_{t-1}/P^f_{t-1}))] + \gamma_1 \ln(P^d_{t-1}/P^f_{t-1}) + \varepsilon_t \qquad (3.5.1)$$

The term following γ is the error correction term which shows the deviation from the nominal exchange rate with its PPP value. The coefficient γ is negative and significantly different from zero, then the exchange rate tends to move to restore the long-run PPP relationship. Similarly, the error correction model for a fixed exchange rate regime is as follows:

$$\Delta \ln P^d_t = \sum_{i=1}^{n} \pi'_1\, \Delta \ln P^d_{t-i} + \sum_{i=1}^{n} \eta'_1\, \Delta \ln(E_{t-i} P^f_{t-i}) + \eta' + \gamma'\, [\ln P^d_{t-1}$$

$$- \ln(E_{t-1} P^f_{t-1})] + \gamma' \ln(E_{t-1} P^f_{t-1}) + \varepsilon'_t \qquad (3.5.2)$$

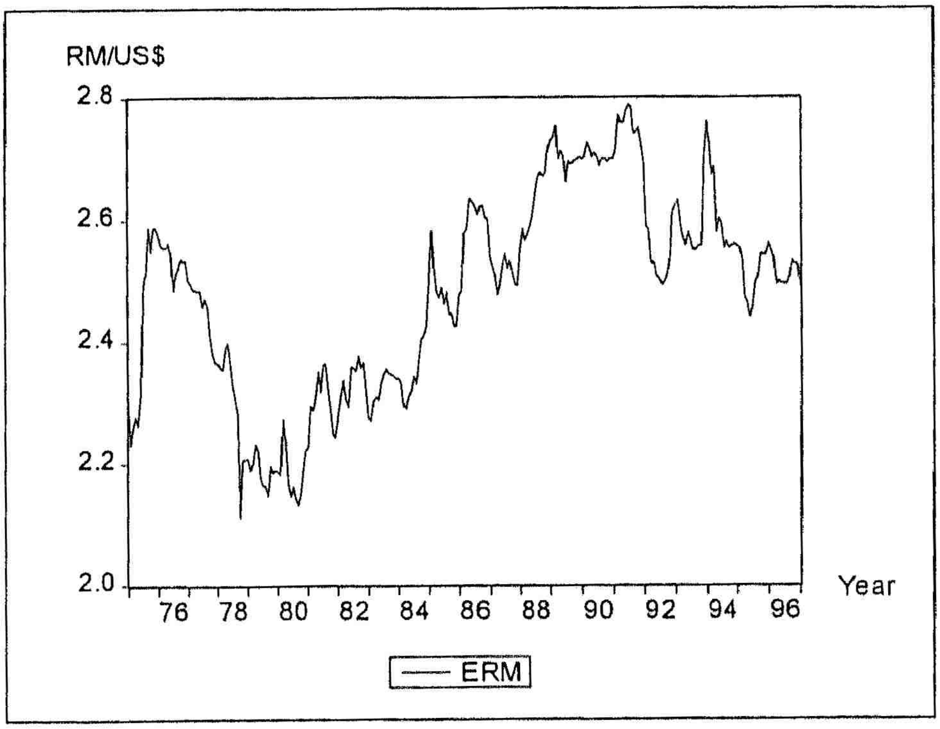
γ' is negative and significantly different from zero, the domestic price tend to adjust to its equilibrium.

3.6 Data

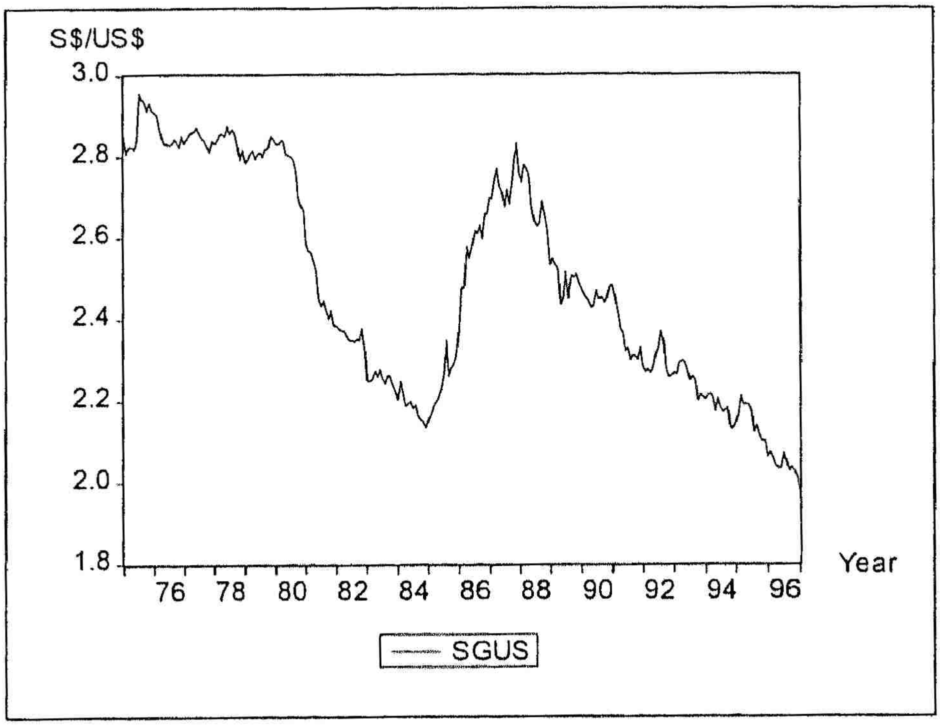
Data used for PPP models in this study are from three different sources. Monthly data from January 1975 till January 1997 is used for all countries in the study. Firstly, data of exchange rate for Malaysia is collected, as well as data for Japan, Singapore and United States is collected relatively for the comparative study of exchange rates. WPI data for Malaysia is not available during the sample period. CPI data of Malaysia is obtained from monthly bulletin central bank Malaysia. Consumer Price Index (CPI), Producer Price Index (PPI) or Wholesales Price Index (WPI) for Japan and Singapore are obtained from International Financial Statistics of International Monetary Fund. CPI and WPI data of United States are obtained from Bureau of Labor Statistic Data. Graph 3.1 to 3.5 show trends of the collected data namely exchange rate, CPI and WPI for Malaysia, Japan, Singapore and United States.

We can understand from the data that exchange rate of ringgit Malaysia against United States dollar shows an upward trend in Graph 3.1, which means ringgit Malaysia has been depreciated against dollar. Singapore dollar was fluctuated around S$2.80 against the United States dollar from year 1975 to 1980. Appreciation of Singapore dollar was shown from year 1980 to 1984. Then it was depreciated from year 1985 to 1987. After year 1987, Singapore dollar has appreciated till 1996. On the other hand, Japanese yen has shown a downward trend in Graph 3.3. In general, Japanese yen has appreciated against United States dollar from year 1975 to 1996.

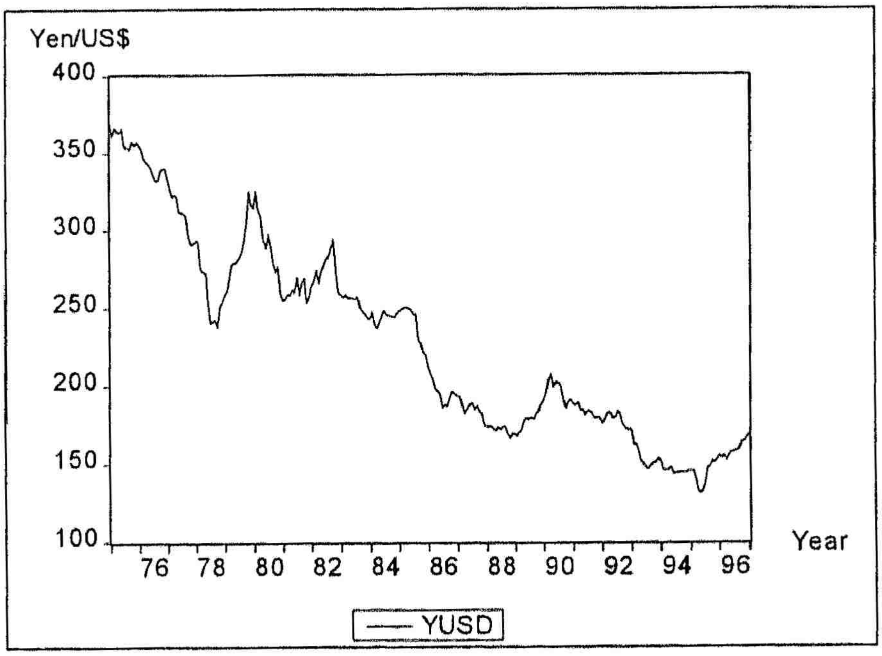
Graph 3.1 Exchange Rate of Ringgit Malaysia against United States Dollar



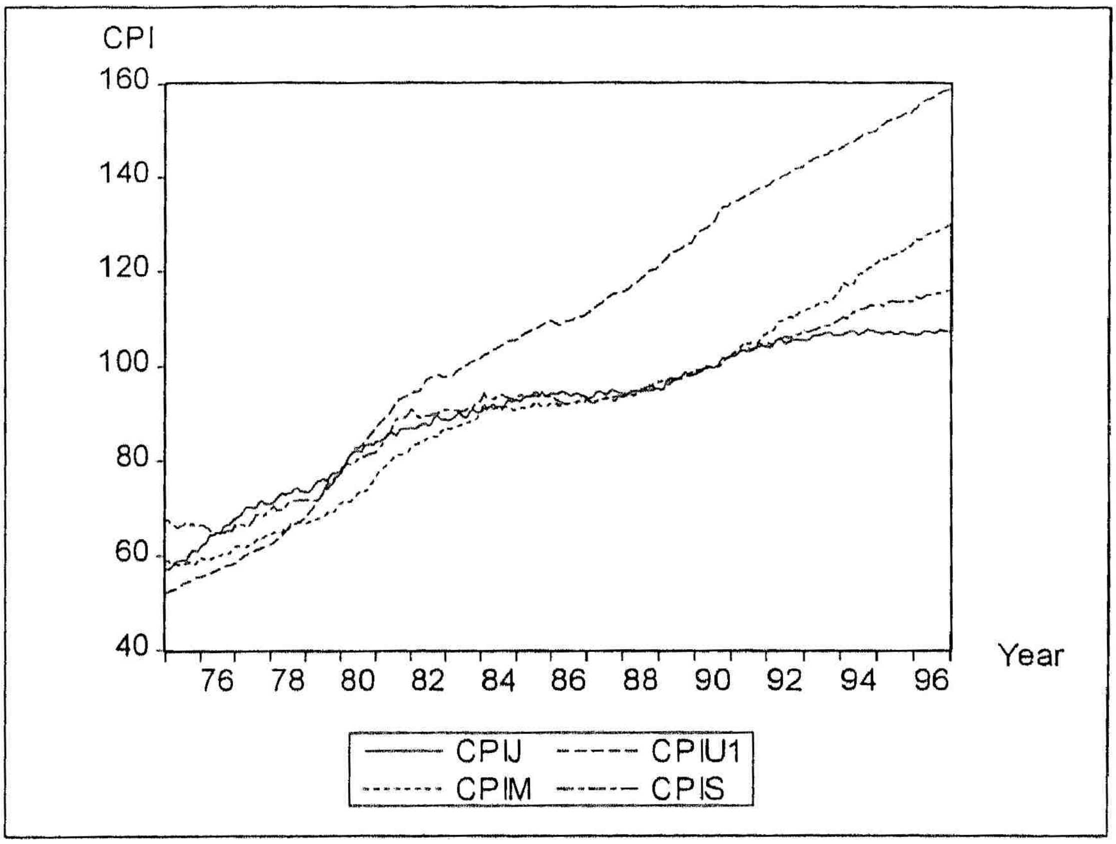
Graph 3.2 Exchange Rate of Singapore Dollar against United States Dollar



Graph 3.3 Exchange Rate of Japan Yen against United States Dollar



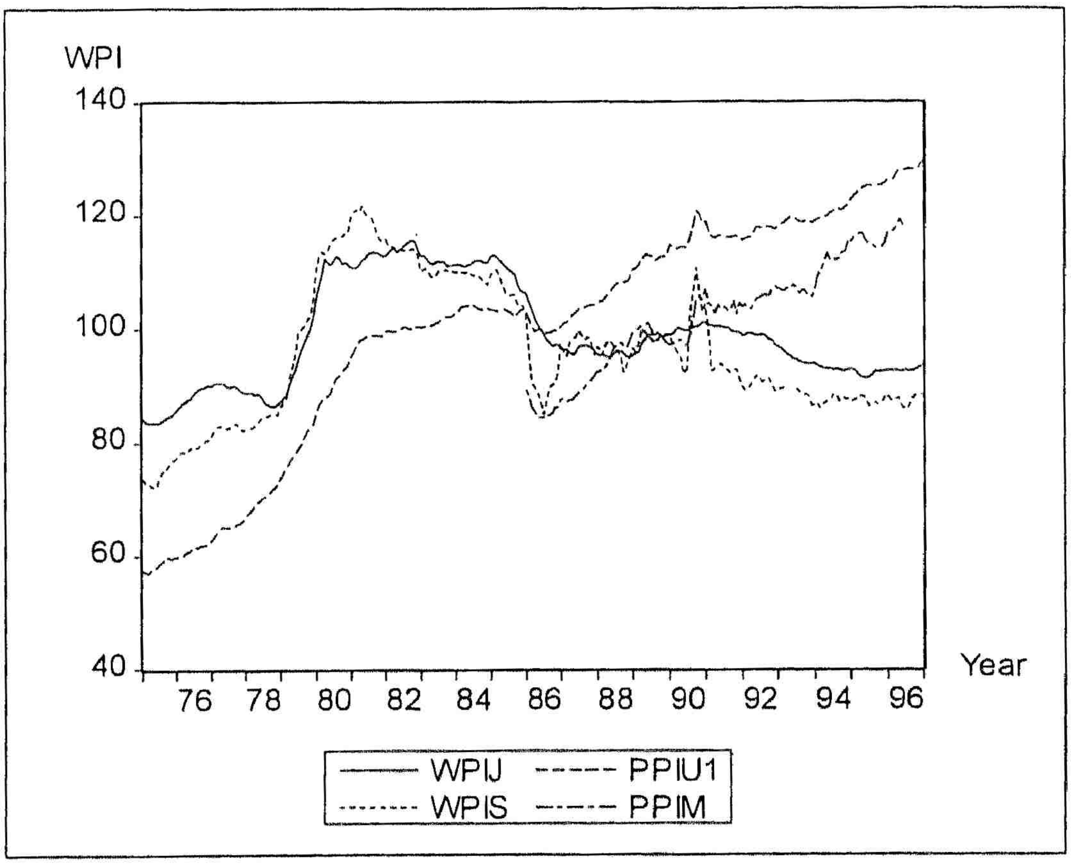
Graph 3.4 Consumer Price Index for Japan, Malaysia, Singapore and United States



Notes:

CPIJ	- Consumer Price Index of Japan
CPIM	- Consumer Price Index of Malaysia
CPIU1	- Consumer Price Index of United States
CPIS	- Consumer Price Index of Singapore

Graph 3.5 Wholesales Price Index of Japan, Singapore, Malaysia and United States



Notes:
WPIJ - Wholesales Price Index of Japan
WPIS - Wholesales Price Index of Singapore
PPIU1 - Producer Price Index of United States
PPIM - Producer Price Index of Malaysia

From Graph 3.4, we understand that CPI of Malaysia, Japan, Singapore and United States show upward trend. This also means that all these countries experienced inflation from year 1975 to 1996. On the other hand, WPI of Malaysia, Japan, Singapore and United States showed more fluctuations. Only

WPI of United States showed a clear upward trend. WPI or PPI of Malaysia, Japan and Singapore did not show a dollar upward or downward trend.

3.7 Cointegration Test Results

Prior to cointegration test, we need to prove that these variables are integrated of same orders. Augmented Dickey Fuller tests was used to test the stationarity of the variables. The results of augmented Dickey Fuller test confirmed that the variables are difference stationary or $I(1)$. These results were the same as the results obtainted by Tang and Butiong (1994). Table 3.1 shows the variables within one country from a cointegration set. The augmented Dickey Fuller test statistics for $I(0)$ of all variables are significant at 1% confidence level.

In the study of cointegration test of Malaysia and Singapore fall in the category of having exchange rate pegged to a basket of currencies or a single currency (US dollar) which were based on the following equation:

$$\ln P^d_t = \alpha' + \beta' \ln(E_t P^f_t) + \varepsilon^f_t$$

The exchange rate of Japan follows a managed float exchange rate regime. The equation for the system is

$$\ln E_t = \alpha + \beta \ln(P^d_t / P^f_t) + \varepsilon_t$$

Table 3.1 Time Series Properties of Variables

Country	Variable	ADF
Malaysia	CPI	5.926706
	ΔCPI	−3.999000[c]
	ER×USCPI	3.319172
	Δ(ER×USCPI)	−5.853095[c]
Singapore	WPI	0.539945
	ΔWPI	−6.158232[c]
	ER×USWPI	1.466574
	Δ(ER×USWPI)	−6.106873[c]
	CPI	4.328586
	ΔCPI	−4.304927[c]
	ER×USCPI	2.564636
	Δ(ER×USCPI)	−5.446272[c]
Japan	ER	−1.469358
	ΔER	−5.546016[c]
	WPI/USWPI	−0.759727
	Δ(WPI/USWPI)	−4.935976[c]
	CPI/USCPI	2.933006
	Δ (CPI/USCPI)	−5.109005[c]

Notes:
[a] Statistically significant at 10% level.
[b] Statistically significant at 5% level
[c] Statistically significant at 1%

CPI - Consumer Price Index
WPI - Wholesales Price Index
ER - Exchange Rate
USCPI - United States Consumer Price Index
USWPI - United States Wholesales Price Index
Δ - Changes

Cointegration test requires ε_t and ε_t^f to be stationary. All the residuals from the above models for Malaysia, Japan and Singapore are not stationary. This is described by the correlogram of residuals in Graph 3.6-3.11, as well as calculation of the White Heteroskedasticity test. The White test F statistics for the 3 countries are significant at 5% confidence level and these results prove that all residuals of the models are nonstationary. The results are shown in Table 3.2.

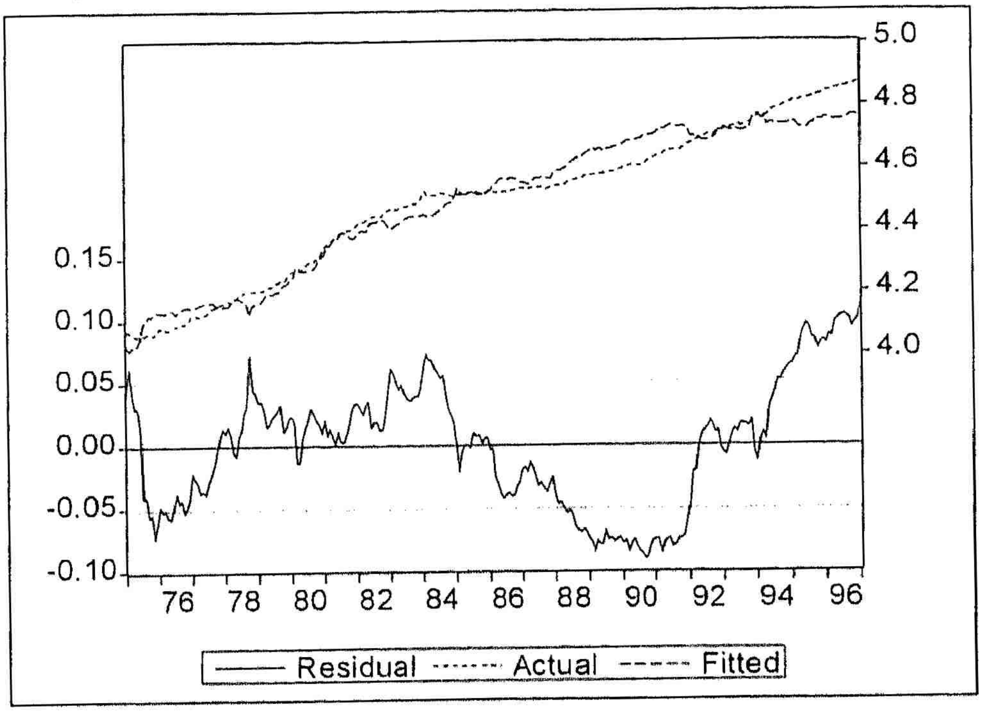
Table 3.2 Cointegration Regression Results (between Asia countries and United State)

Country	Price Index	Slope (t ratio)	Sample size (in months)	Period	R^2	White Test F Statistics
Malaysia	CPI	0.608908 (71.71284)	265	1975:01-1997:01	0.951348	68.0561[c]
Singapore	CPI	0.64263 (40.41098)	265	1975:01-1997:05	0.86129	17.47539[c]
	WPI	0.329589 (7.190459)	262	1975:01-1997:01	0.165872	45.56798[c]
Japan	CPI	1.5891 (39.66004)	265	1975:01-1997:01	0.856747	12.11043[c]
	WPI	1.28017 (66.16896)	265	1975:01-1997:01	0.943335	3.149792[b]

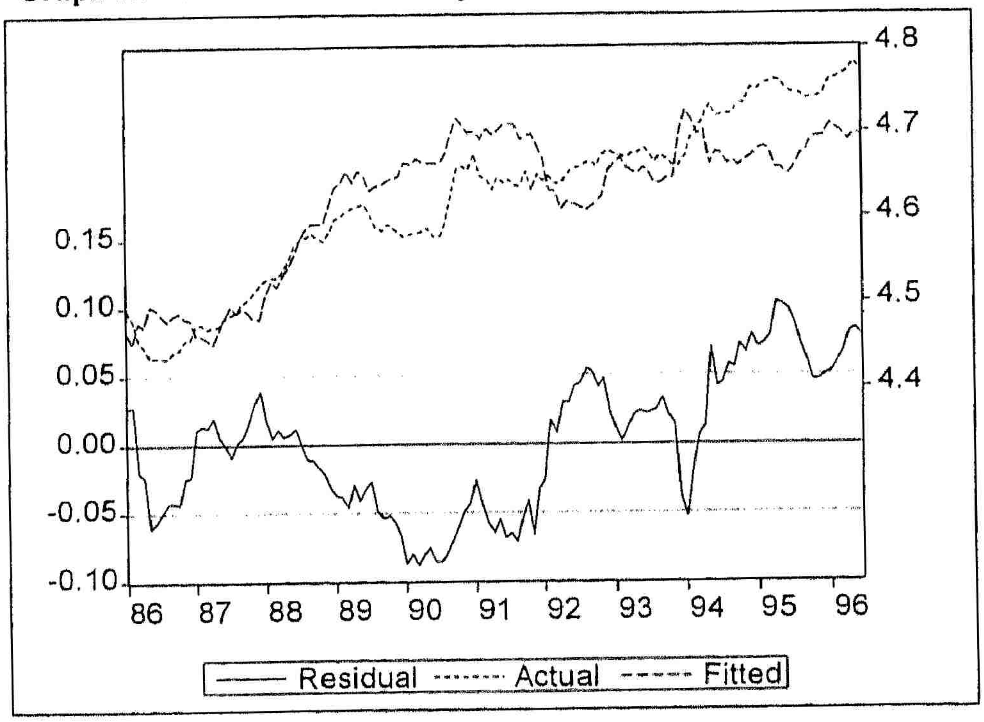
Notes:
[a] Statistically significant at 10% level.
[b] Statistically significant at 5% level
[c] Statistically significant at 1%

Source :
1. International Monetary Fund, International Financial Statistics, various version
2. Bureau of Labor Statistics Data, United States
3. Monthly Bulletin of Central Bank Malaysia

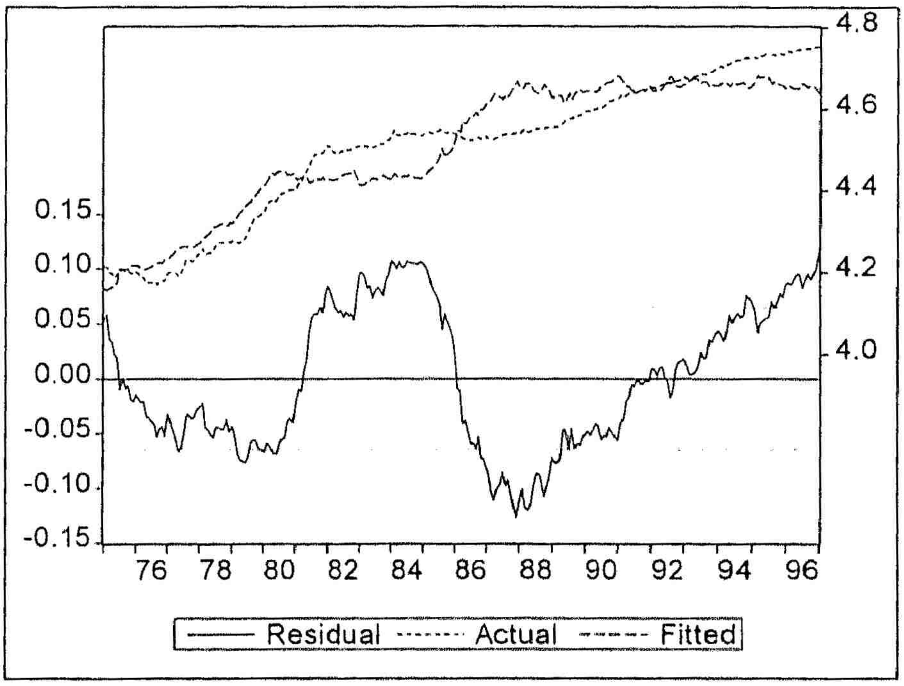
Graph 3.6 PPP Model for Malaysia and United States (based on CPI)



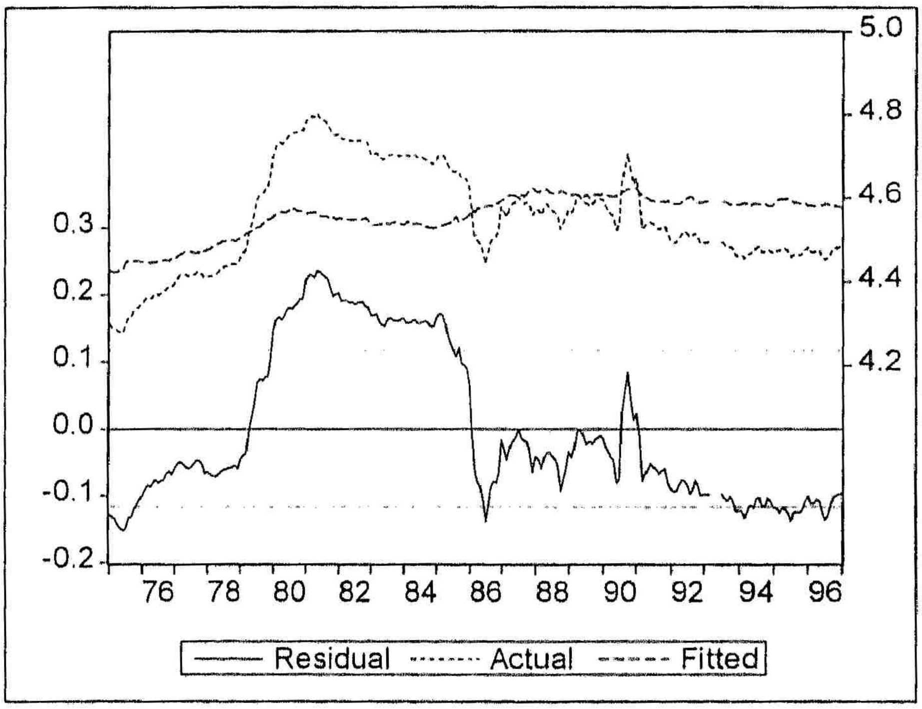
Graph 3.7 PPP Model for Malaysia and United States (based on PPI)



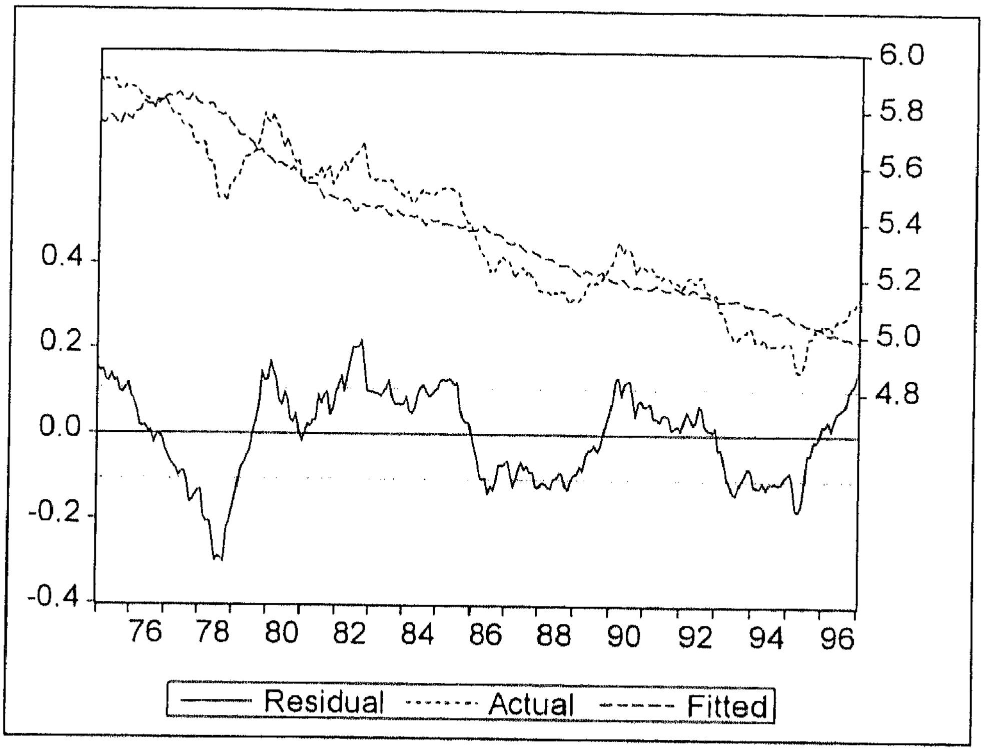
Graph 3.8 PPP Model for Singapore and United States (based on CPI)



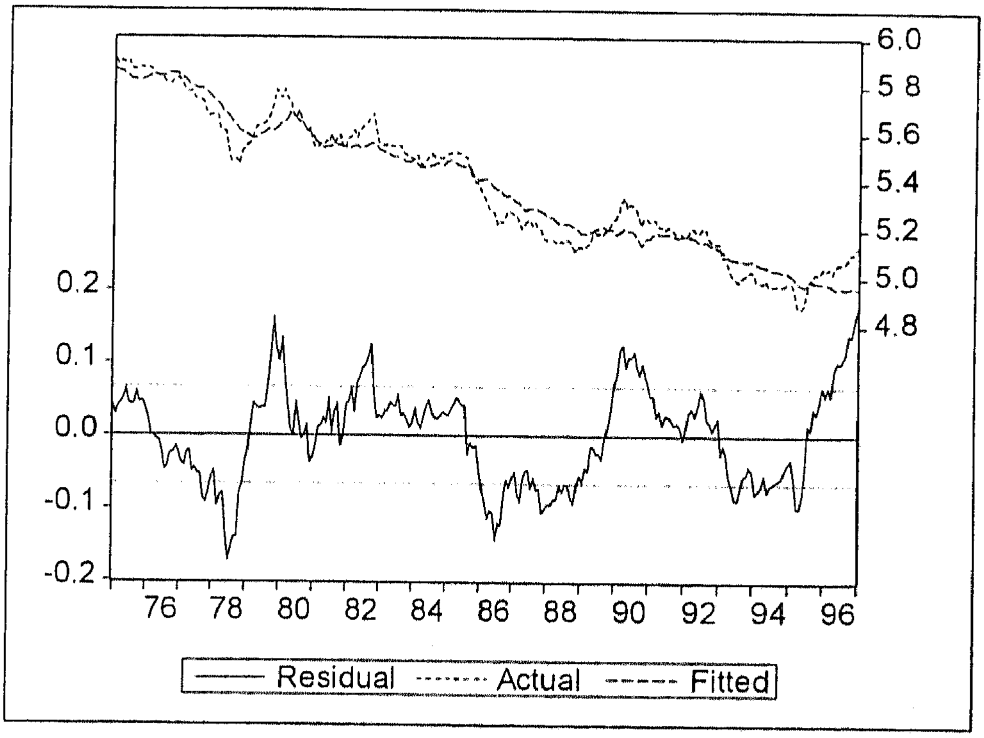
Graph 3.9 PPP Model for Singapore and United States (based on PPI)



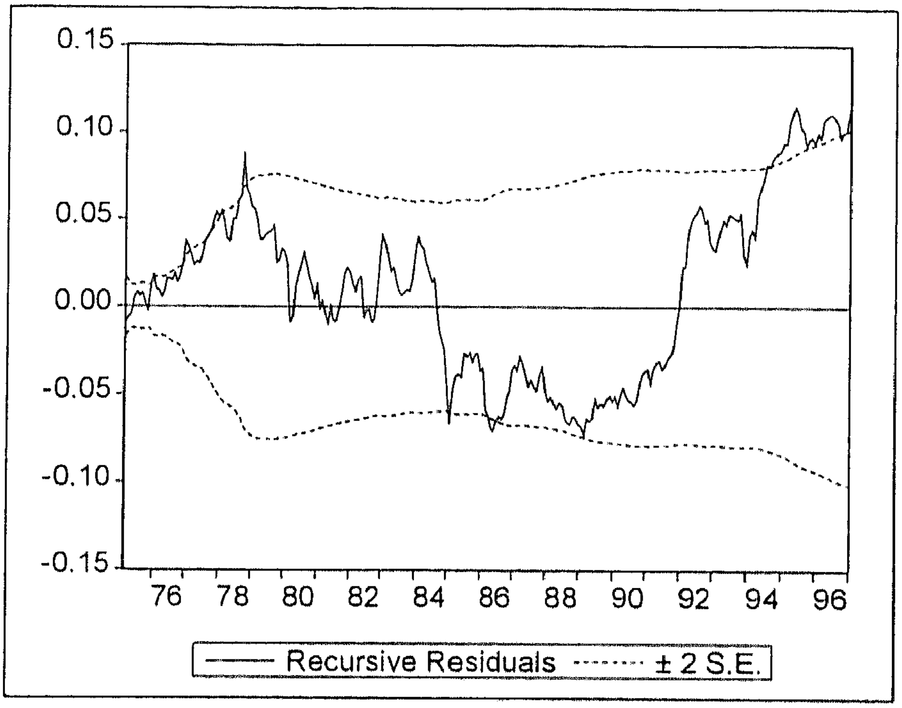
Graph 3.10 PPP Model for Japan and United States (based on CPI)



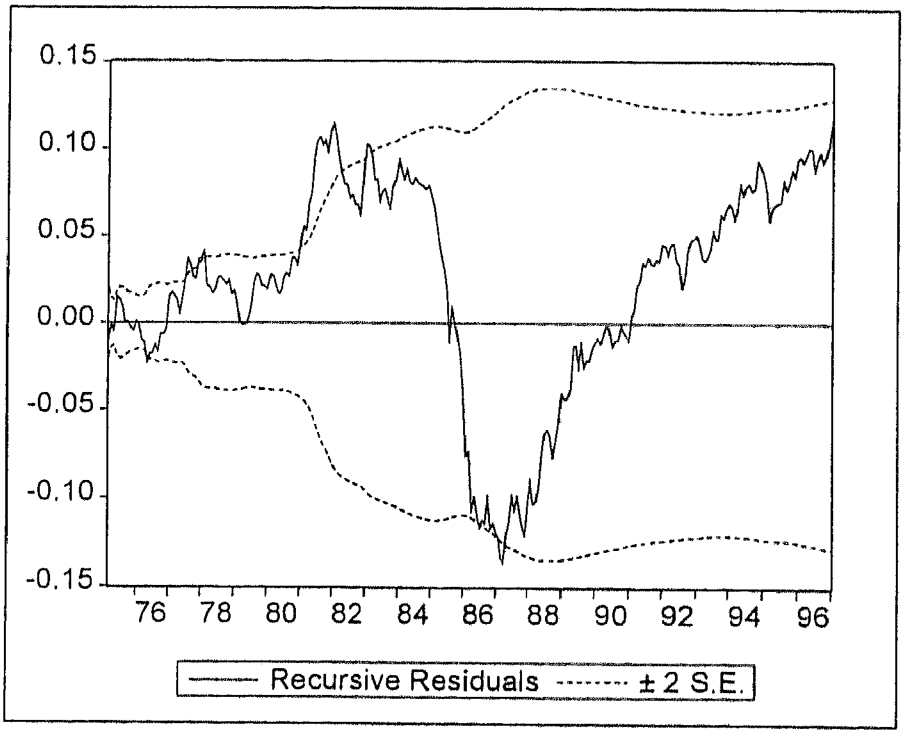
Graph 3.11 PPP Model for Japan and United States (based on WPI)



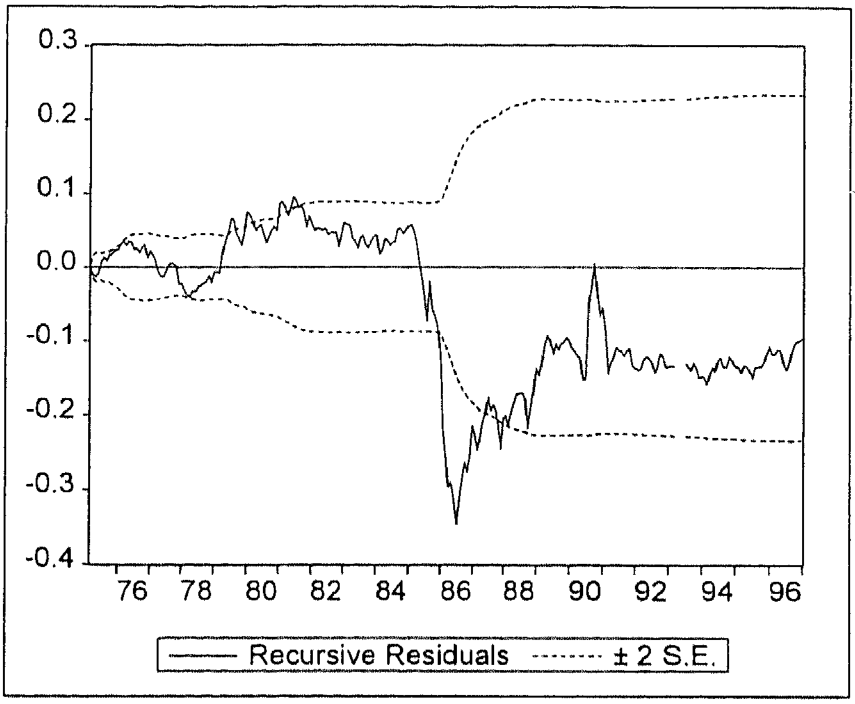
Graph 3.12 Recursive Estimates Stability Test of PPP Model for Malaysia and United States (based on CPI)



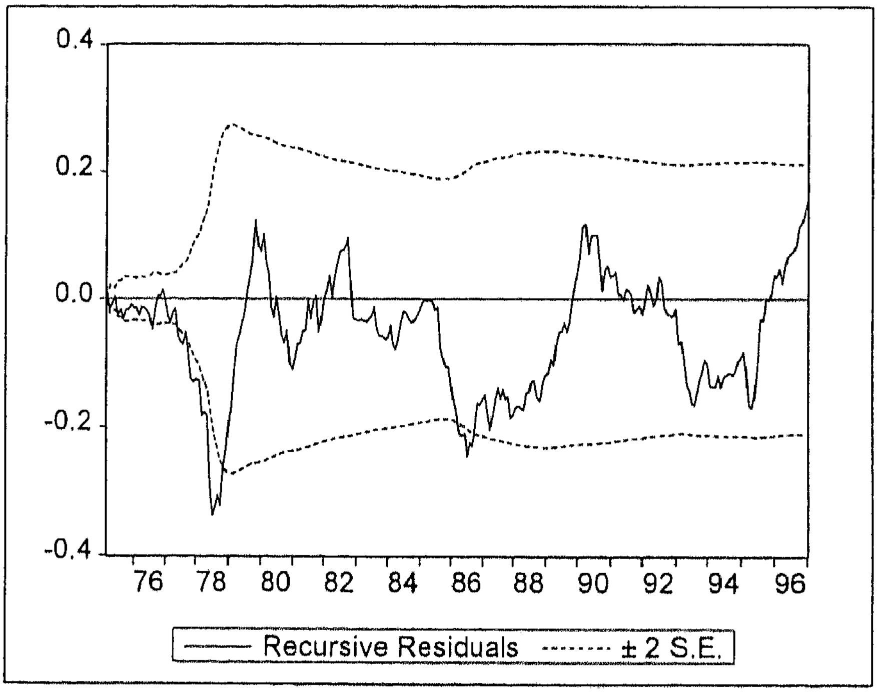
Graph 3.13 Recursive Estimates Stability Test of PPP Model for Singapore and United States (based on CPI)



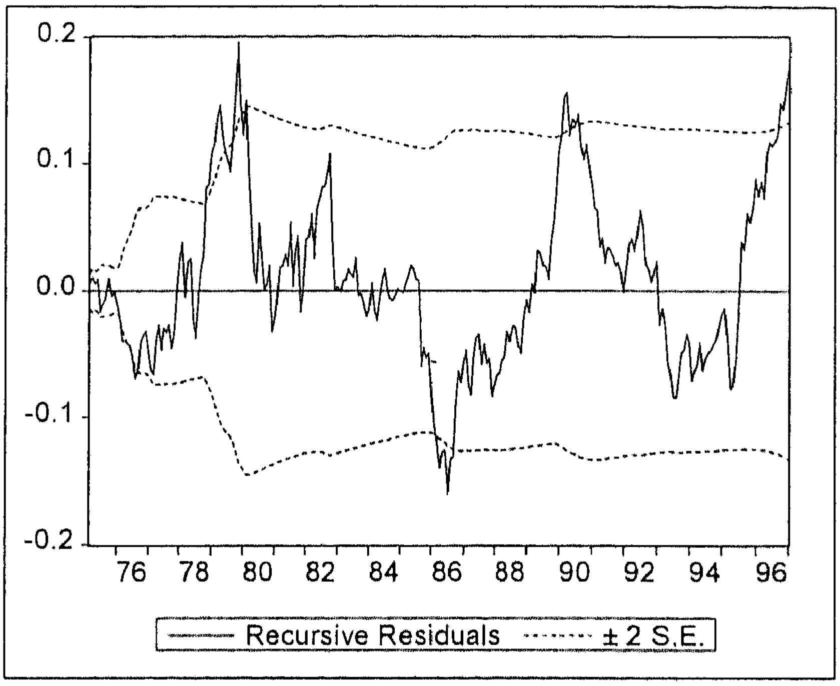
Graph 3.14 Recursive Estimates Stability Test of PPP Model for Singapore and United States (based on WPI)



Graph 3.15 Recursive Estimates Stability Test of PPP Model for Japan and United States (based on CPI)



Graph 3.16 Recursive Estimates Stability Test of PPP Model for Japan and United States (based on WPI)



We can conclude from the result of White Heteroskedasticity test that PPP does not hold in Malaysia, Japan and Singapore. Recursive estimates stability test as given in Graph 3.12-3.16 also show that PPP model is not stable for all the above countries. There are many reasons why PPP does not hold for the above countries. Firstly, government intervention in foreign exchange market as well as commodity market such as higher duty and tax on imported products. This can bid up or down the price of foreign exchange away from equilibrium exchange rate of PPP. Secondly, trade restrictions are imposed on imported goods rather than exported goods also will result in an exchange rate divergence from PPP. Thirdly, speculation in foreign exchange market and long-run capital movement are increasing due to liberalization of government policy on developing countries to encourage more capital inflow. Furthermore, Singapore and Japan are major regional financial countries. Malaysia had experienced massive foreign investment inflows with financial liberalization and government policy that encourage foreign investment during the sample period. All these factors lead to a divergence of exchange rate from PPP.

3.8 Short-run Impact of Inflation on Exchange Rates

Short-run relationship between prices and exchange rates can be described by error correction model. The error correction model for flexible exchange rate regimes is:

$$\Delta \ln E_t = \sum_{i=1}^{n} \pi_i' \, \Delta \ln E_{t-i} + \sum_{i=1}^{n} \eta_i \, \Delta \ln(P^d_{t-i}/P^f_{t-i}) + \gamma \, [\ln E_{t-1} - \alpha$$

$$- \beta \ln(P^d_{t-1}/P^f_{t-1})] + \varepsilon_t$$

$$= \sum_{i=1}^{n} \pi_i \, \Delta \ln E_{t-i} + \sum_{i=1}^{n} \eta_i \, \Delta \ln(P^d_{t-i}/P^f_{t-i}) + \eta + \gamma \, [\ln E_{t-1}$$

$$- (\ln(P^d_{t-1}/P^f_{t-1}))] + \gamma_1 \ln(P^d_{t-1}/P^f_{t-1}) + \varepsilon_t \qquad (3.8.1)$$

The term following γ is the error correction term which shows the single period response of the exchange rate when the relative inflation departs from the percentage changes of the exchange rate in previous period. If γ is small and insignificant, it means that the exchange rate in the short-run is not affected by inflation shock. Short-run disturbances on inflation do not adjust to correct the departure from the long-run equilibrium of exchange rate. If γ is negative and significantly depart from zero, then an increase in relative inflation rate in the country concerned compared with United States would induce depreciation of domestic currency, and will converge to it long-run equilibrium.

On the other hand, the error correction model for fixed exchange rate regimes is:

$$\Delta \ln P^d_t = \sum_{i=1}^{n} \pi'_i \ln P^d_{t-i} + \sum_{i=1}^{n} \eta'_i \Delta \ln(E_{t-i} P^f_{t-i}) + \eta' + \gamma' [\ln P^d_{t-1}$$

$$- \ln(E_{t-1} P^f_{t-1})] + \gamma' \ln(E_{t-1} P^f_{t-1}) + \varepsilon'_t \qquad (3.8.2)$$

We estimated equation (3.8.1) for Japan (CPI and WPI) and equation (3.8.2) for Malaysia (CPI) and Singapore (CPI and WPI) using ordinary least square method. The estimated results for the error correction equations are summarized in Table 3.3 as following:

Table 3.3 Error-Correction Model

Name of Variables	[logE-log(WPI/USWPI)]$_{-1}$	[logE-log(CPI/USCPI)]$_{-1}$	[logCPI-log(E×USCPI)]$_{-1}$	[logWPI-log(E×USWPI)]$_{-1}$	No. of Lags	R^2	DW
Malaysia Log CPI			−0.0048 (−0.7976)		12	0.206441	2.002993
Singapore Log CPI			−0.0165[c] (−2.9664)		12	0.262421	2.010752
Singapore log WPI				−0.0143 (−1.6164)	12	0.265543	1.978929
Japan log CPI		−0.0374[b] (−2.1113)			12	0.152925	1.996381
Japan log WPI	−0.04114 (−1.1398)				12	0.124240	2.00237

Notes:
[a] Statistically significant at 10% level.
[b] Statistically significant at 5% level
[c] Statistically significant at 1%

For Japan, the deviation from PPP is measured by exchange rate minus the difference between two inflation rates. The term is significant for the model where price is denoted as CPI. However it is not significant for WPI case. Both terms show correct sign but the value is very small. This also means that the exchange rate is only adjusted by about 4% of the inflation rates difference between Japan and United States when inflation is measured in CPI or WPI.

Malaysia and Singapore belong to a regime of pegging exchange rate. For Malaysia, the small coefficient –0.005 indicates that foreign inflation and short term disturbances of exchange rate have only a small and insignificant impact on changes in the domestic price level. Singapore also experienced the same situation, the small coefficient of –0.016 and –0.014 for price indicated in CPI and WPI respectively, shows that inflation of United States does not have significant impact on changes in the domestic price level.

3.9 Conclusion

This study tested the theory of PPP for Malaysia with comparison to two other Asian countries namely Japan and Singapore, using the cointegration method and error correction modeling. The diagnostic test showed that all relevant variables were integrated of order $I(1)$. The nonstationarity of the relevant variables in level form ruled out directly the usage of OLS estimation techniques to test the PPP model. The cointegration test indicated that the null hypothesis of no cointegration among the relevant variables could not be rejected for Malaysia, Japan and Singapore.

Error correction modeling was employed to reconcile the short-run and long-run dynamics of PPP. The results from error-correction model in Table 3.3 indicated that the actual exchange rate was diverged from its long-run PPP value in subsequent periods following one unit deviation during the current period.