Chapter 5

The Impact of the Recent Currency Crisis on Malaysian Exports

A Co-integration and Error - Correction Analysis

5.1 Introduction

The exchange rate movements in Malaysia have been highly volatile and erratic in nature since the advent of the floating exchange rate regime in 1973. The increase in exchange rate variability has often been quoted as one of the major shortcomings of the floating exchange rate system since it increases the uncertainty and risk underlying international trade and financial transactions. Consequently, one of the major questions that have been asked is whether the increase in exchange rate variability affects international trade. With these respects, there has been widespread interest in the effect of exchange rate volatility on international trade.

The purpose of this paper is to investigate the influence of exchange rate volatility on exports, in case of Malaysia. The analysis is also extended to examine the influence of exchange rate variability on the exports of major agriculture and mining products as well as manufactured products. For agriculture and mining commodities the performance of rubber, palm oil, saw logs, sawn timber and petroleum are examined. Meanwhile for manufactured products, the performance of electronics and electrical products, textiles, wood products, chemical products and other manufactured products are evaluated.

5.2 Literature Review

Study on the impact of the change in exchange rate or real exchange rate on the growth of trade, either theoretically, empirically, or both, has receive extensive response from economists and researcher around the world. However, there is no definite consensus that, the movement of exchange rate influence growth of trade, mainly in case of developing countries. Some argued and claimed that the price factor is a main determinant of growth of international trade.

A.C Arize (1996), examine the effect of real exchange rate movement on real exports. He found that, the impact of exchange rate on trade (exports) is negative in the short run as well as in the long run. He concluded that there is no definite agreement regarding the impact of exchange risks on trade. This study is confirmed by Akhtar and Hilton (1984) which, concluded that exchange rate volatility does have an adverse effect on trade. Also, based on same data used by Akhtar and Hilton, Gotur (1985) re-confirmed the statement by Akthar and Hilton, that there is no statistically significant effect of exchange rate volatility on the trade flows.

A study by Peter B. Kenen and Dani Rodrik (1986) claimed that the short run volatility of real exchange rate actually depress the international trade. On the other hand, Paul De Grauwe (1988) analyzed the increased variability of exchange rates on growth rates of international trade. He found that the long run variability of real exchange rates contributed significantly to the slowdown in the growth of international trade. He stressed that 20 per cent of the decline in the growth rate of international trade attributed to the substantial increase in the long run variability of real exchange rate.

Mohsen Bahmani-Oskooee (1986) examine changes in exchange rates and price level on the magnitude and time path of the trade for seven developing countries. The study reveals that income and effective exchange rate have significant impact on the imports for some countries. He found that in the shorter time imports and exports response faster to the changes in exchange rate, rather than relative prices. However, in the long run trade flows are more responsive to changes in the relative prices than to changes in the exchange rates, and that the full adjustment of trade flows to price changes occurred within at most eight quarters.

A study by Andreas Savvides (1992) which examine the relationship between unanticipated exchange rate variability and the growth of international trades indicates that unanticipated exchange rate variability proves to be insignificant determinants of real export growth. He further asserted that, trading partners income, relative prices and the term of trade is significant determinants of real export growth.

The effect of exchange rate volatility on trade flow and export prices, also was examined by Hooper and Kohlhagen (1978). Their analysis covered the bilateral trade of Germany and the United States with other industrial countries. They found that there is no significant impact of exchange rate movement on the volume of trade although import and export prices appeared to be affected. However, base on same methodology adopted by Hooper and Kohlhagen, Cushman (1983) found that, there is mixed results regarding the impact of exchange rate volatility on trade flows and export prices. In some countries, the result indicates a significant negative effect while some countries showed significant positive trade effects.

Tegene Abebayahu (1991) study reveals that the responses of imports and exports are larger and the adjustment takes longer when relative prices caused a change in the international prices rather than exchange rates. He further claims that devaluation may have an initial adverse effect on the trade balance. A study by Carmen M. Reinhart (1995) found that relative prices are a significant determinant of the demand for export and import. This is confirmed study by Mohsin Khan (1974), which, implies that prices do affect the imports and exports of developing countries.

Chua and Sharma (1998) analyzed the responses of imports and exports to changes in domestic prices, foreign prices and real effective exchange rates, base on co-integration and vector error-correction models. They found that, in most cases, domestic and foreign prices have a greater impact on trade flows than real effective exchange rates. With regards the response time of import demand after shock to the prices and real effective exchange rates, they could not find any significant differences.

5.3 Model Specification

Most developing countries peg their exchange rates to one major currency or a basket of currencies. However, since the major currencies fluctuate against one another, this might cause the effective exchange rates to fluctuate and effecting the trade flows. Thus, the essential aim of this paper is to provide estimates of export demand in which the real effective exchange, relative prices and foreign income is included as determinants of export demand.

For the purpose of analysis, two models were constructed in log form. In the first model, we assume that, export demand depend on variability of exchange rate. In this study, real effective exchange rate is used as a measure of external shock. This implies that, changes in real effective exchange rate will induce changes in export demand (or influence change in the competitive level).

Model 1

$$X_{it} = f(REERx_t) \quad (1)$$

In natural log form,

$$\ln X_{it} = a + b \ln REERx_t + u_t \quad (2)$$

where, X_{it} = quantity of exports of country i

$REERx_t$ = real effective exchange rate for exports

u_t = random error term

Methodology of calculating REER for exports is shown below.

Nominal effective exchange rate for exports (NEERx) = Px. EERx (1-tx)

where,

Px = Malaysia export price index (1980 base year)

tx = export tax rate (average)

EERx = effective exchange rate index for export (weighted by share of exports of major trading partner to total exports (Malaysia). EERx calculated with the below formula:

$$EERx = \frac{e_{ci}(Sx_{ci}) + \ldots\ldots\ldots + e_{cn}(Sx_{cn})}{n}$$

where, e = exchange rate, RM against currency of major trading partner

C_n = major trading partner (namely, United States of America, Japan and Singapore)

Sx_{cn} = share of exports to major trading partner of country's total exports

n = number of major trading partner

$$REERx = \frac{NEERx}{CPI}$$

where, CPI = consumer price index (1990 base year)

In this model real effective exchange rate is used as measure of export competitiveness. An increasing REER rate will stimulate export demand, while a decreasing REER rate will slow down the export growth. The estimate coefficient of REER is expected to be negative (b<0).

In the second model we examines the influence of relative prices and income of trading partners on export demand. This model implies that, changes in relative prices and foreign income will lead to changes in export demand.

Model 2

$$\mathbf{X_{ijt} = f(RP_{jt}, FGDP_{jt})} \quad (3)$$

In natural log form,

$$\mathbf{In\ X_{ijt} = c + d\ In\ RP_{jt} + e\ In\ FGDP_{jt} + u_t} \quad (4)$$

where, X_{ijt} = quantity of exports of country i to trading partners j (j denote United States, Singapore and Japan)

RP_{ijt} = relative prices of Malaysia and trading partners j

$FGDP_{jt}$ = foreign income of trading partners j

u_t = random error term

Relative prices derived by dividing export price index with import price index. Export price index is calculated by assuming import price index of major trading partner of Malaysia as export price index, and weighted by share of exports to major trading partner of country's total exports. Calculation of the export price is shown below.

$$\mathbf{Px = \frac{Pm_{ci}(Sx_{ci}) + \ldots\ldots\ldots + Pm_{cn}(Sx_{cn})}{n}}$$

where, Pm = import price of major trading partner

c_n = major trading partner

Sx_{cn} = share of exports to major trade partner to total exports

n = number of major trade partner

The above same method applied in derivation of foreign income (FGDP). We average the value of GDP of major trading partner of Malaysia, as a proxy of foreign income. Then, the income weighted by Sx_{cn}.

$$\mathbf{FGDP} = \frac{\mathbf{GDP_{ci}\,(Sx_{ci}) + \ldots\ldots\ldots + GDP_{ci}\,(Sx_{ci})}}{\mathbf{n}}$$

The estimated coefficient of relative prices (price elacticites) are expected to be negative (d<0), which implies that, an increase in the relative prices will lead to decline in the export demand. The estimated coefficient of foreign income is expected to be positive (e>0), indicating that, an increase in foreign income will increase the demand for Malaysian export.

5.3.1 Hypothesis

The discussion of the estimates will be within the framework of testing the following hypothesis, namely that:

1. real effective exchange rate influence exports.
2. relative prices and foreign income are significant determinant of Malaysian exports.

5.3.2 Methodology

The main objective of this study is to assess the impact of exchange rate variability on Malaysian export demand. For the purpose of empirical analysis, three method of analysis was conducted. Firstly, the two models were constructed and estimated using ordinary least squares (OLS) for two observation periods (monthly and annually basis). Then the results were discussed to see whether the results are consistent with the hypothesis.

Secondly, co-integration technique is applied to examine the long-run relationship between the variables. In order to apply the co-integration technique, we first need to determine the degree of integration of each variable. Since most of time series variables are non-stationary, we run a unit root test to each variable by using Augmented Dickey-Fuller (ADF) test. The next step is to estimate stationary of the residuals. If the residuals are stationary, I(0), this implies that the variables are co-integrated. Finally, after confirming that there is co-integration between the variables, we apply error-correction model for the two models. This is to see whether the results are similar to results obtained by using ordinary least squares approach.

5.3.3 Data

The data used for this study includes export volume, real effective exchange rates, relative prices, major trade partner GDP and the export volume of major export of agriculture (rubber, saw log, sawn timber, palm oil and petroleum) and manufactured products (electronics and electrical, textiles, wood products, chemical products and other manufactured products). All the data obtained from the quarterly publication of Bank Negara Malaysia. Data on annual export price obtained from International Financial Statistics published by IMF and Bank Negara Annual Report. Since the unavailability of monthly data on export and import prices, we used proxy for the prices. For export price we used producer price index for good produced and marketed in the domestic economy. And the import prices based on producer import price index. Data for prices and GDP of trading partners were obtained from the International Financial Statistics published by IMF.

The sample for this study consists of two observation periods, that is on monthly basis (July 1997-November 1998) and annually (1975-1997). This time periods were selected to take into consideration the impact of exchange rate fluctuation on Malaysian export performance, particularly since the outbreak of currency crisis in mid-1997. All variables used in this study are expressed in log form.

5.4 Analysis on the Effect of Changes in Exchange Rate on Exports

Under this section, we will investigate and derive results of the impact of movement in exchange rate on exports (REERx), in total and by commodities. The analysis is conducted in two frame of time periods, that is annually (1975-1997) and monthly (during the economic crisis from July 1997- November 1998). Analysis base on annual data will highlight the main determinant of the export demand for Malaysia that is real effective exchange rate, relative price and foreign income. Another major question to be answered, is depreciation of ringgit since July 1997 increase competitiveness of Malaysian good in world market, In other word, is depreciation of ringgit help boost country's exports during the economy experiencing a depression.

As mentioned earlier in the previous section of this chapter, there are two models were developed to examine the above said statements. And, three methods of econometric analysis were employed that is, ordinary least square, unit-root and co-integration test (to examine whether the data used in the analysis is stationary or non-stationary) and error-correction models.

5.4.1 Ordinary Least Square Estimation

5.4.1.1 OLS Estimation Result For Total Exports

Table 5.1a: OLS Estimation Results

Model 1 (1975-1997)	R^2
$\ln X_t = 7.835263 + 1.3875 \ln REERx_t$ (13.582)	0.8978
Model 1 (July 1997-November 1998)	
$\ln X_t = 8.493189 + 0.2402 \ln REERx_t$ (6.491)	0.7374

*figures in parentheses indicates t-statistics

Based on Table 5.1a, the estimated regression results shows that for annually observation period the real effective exchange rates (REER) is significant and positively related to exports demand, which means that any changes in the REER will increase the demand for Malaysian exports by 1.38 per cent. As for monthly observation, the coefficient for REER appears to be significant and also show a positive relationship between real effective exchange rates and export demand. In this case, an one per cent increase in the real effective exchange rate will increase the export demand by 0.24 per cent. This means changes in exchange rate did influence export growth during the economic crisis.

Table 5.1b: OLS Estimation Results

Model 2 (1975-1997)	R^2
$\ln X_t = 2.129262 - 0.5355 \ln RP_t + 1.1590 \ln FGDP_t$ (-3.3961) (17.965)	0.9625

*figures in parentheses indicates t-statistics

On the other hand, the coefficient of relative prices (RP) and GDP is also significant and displays the expected sign (Table 5.1b). One per cent increase in the relative prices will reduce the demand for export by 0.5 per cent. Since the price elasticity value of 0.5 is less than 1 in absolute terms, we can conclude that the demand for Malaysian exports is price-inelastic. Foreign income also seemed to influence the exports. The export will increase by 1.15 per cent due to one per cent changes in the GDP. Thus, based on the OLS regression results, we can conclude that, REER and export demand is positively related in this case. Moreover, relative prices and foreign income also appears to a significant determinant of exports. The analysis on model 2 for monthly observation cannot be done, as there is no monthly data on relative prices and GDP.

5.4.1.2 OLS Estimation Results for Exports of Agriculture and Manufactured Products for Annual Observation

Table 5.2a: OLS Estimation Results for Exports Agriculture and Mining Commodities

Model 1	R^2
1) In Rubber $_t$ = 8.607161 - 0.359 In $REERx_t$ (-10.566)	0.8416
2) In Saw Log $_t$ = 13.22584 - 1.010 In $REERx_t$ (-1.778)	0.1308
3) In Sawn Timber $_t$ = 6.811986 + 0.353 In $REERx_t$ (4.165)	0.4524
4) In Palm Oil $_t$ = 4.116759 + 1.037 In $REERx_t$ (9.395)	0.8078
5) In Petroleum $_t$ = 7.236044 + 0.602 In $REERx_t$ (4.386)	0.4781

*figures in parentheses indicates t-statistics

The export of selected agriculture and mining commodities seems to have significant impact on the changes in the REER (Table 5.2a). Exports of rubber and saw log has a negative influence, in which, an one per cent increase in the REER will reduce the export of rubber by 0.35 percent. Meanwhile, the export of saw log will decline by 1.0 per cent to an increase of one per cent in REER. On the other hand, export of sawn timber, palm oil and petroleum has positive and significant impact. In which, the export of sawn timber will increase by 0.3 per cent if REER increase by one per cent. Also, it seems that an increase of one per cent in the REER will increase the export of palm oil by 1.0 per cent, while the exports of petroleum will increase by 0.6 per cent.

Table 5.2b: OLS Estimation Results for Exports of Manufactured Products

Model 1	R^2
1) In Electronics & Electrical $_t$ = -2.86664 + 3.584 In $REERx_t$ (11.614)	0.8652
2) In Textiles $_t$ = -0.148942 + 2.321 In $REERx_t$ (10.470)	0.8392
3) In Wood Products $_t$ = -0.88602 + 2.469 In $REERx_t$ (8.335)	0.7679
4) In Chemical Products $_t$ = -3.968435 + 3.163 In $REERx_t$ (9.746)	0.8189
5) In Other Manufactures $_t$ = -3.215718 + 2.807 In $REERx_t$ (4.180)	0.4542

*figures in parentheses indicates t-statistics

In the case of exports of manufactured goods, the export growth has a positive and significant correlation with REER. Change in REER will influence the performance of exports of manufactured goods (Table 5.2b). If the REER increase by one per cent, the export of electronics and electrical products will increase by 3.5 per cent, while export of textiles will increase by 2.3 per cent. Export of wood products will increase by 2.4 per cent if the REER increase by one per cent. Meanwhile the export of chemical products and group of other manufactured goods will increased by 3.1 per cent 2.8 per cent respectively.

5.4.2.2 OLS Estimation Results for Exports of Agriculture and Manufactured Products Monthly Observation

Table 5.3a shows the OLS estimation results for the monthly observation for export of agriculture. Export of saw log, rubber and sawn timber appears to be have a negative impact on changes in the real effective exchange rates. This implies that, if the REER decrease the exports demand of the commodities will also decrease. Its means that during the economic crisis, with low exchange rate or depreciation of ringgit against the US dollar, the exports demand for saw logs and sawn timber and petroleum seems insignificant. On the other hand, export of palm oil and petroleum exerts a positive relationship, however, the correlation of the exports of selected primary commodities and REER are very low. This means that REER is a not the main determinant for export demand of major primary commodities. There are some other factors, which influence the growth of the exports of major primary commodities.

Table 5.3a: OLS Estimation Results for Agriculture and Mining Commodities

Model 1	R^2
1) In $Rubber_t$ = 5.354754 - 0.1419 In $REERx_t$	0.3002
(-2.536))	
2) In Saw $logs_t$ = 7.020114 - 0.1340 In $REERx_t$	0.0487
(-0.8768)	
3) In $SawnTimber_t$ = 5.830727 - 0.0632 In $REERx_t$	0.0337
(-0.7242)	
4) In Palm Oil_t = 6.416396 + 0.0095 In $REERx_t$	0.0008
(0.114)	
5) In $Petroleum_t$ = 6.190877 + 0.1690 In $REERx_t$	0.2112
(2.004)	

*figures in parentheses indicates t-statistics

For exports of manufactured products, variability of exchange rate on the demand of exports is less significant (5.3b). Only export of electronics and electrical products has a positive relationship with the REER. That is, an increase of one per cent in the REER will increase exports of electronics and electrical products by 0.2 per cent. However, the rest selected manufactured product has a negative correlation with REER where, export of textiles and wood products will decrease by 0.6 per cent and 0.8 per cent respectively due to an increase of one per cent in the REER.

Table 5.3b: OLS Estimation Results for Manufactured Products

Model 1	R^2
1) $\ln$ Electronics & Electrical $_t$ = 10.20350 + 0.1767 $\ln REERx_t$ (0.4188)	0.0115
2) $\ln$ Textiles $_t$ = 12.2678 - 0.6166 $\ln REERx_t$ (-5.802)	0.6918
3) $\ln$ Wood Products $_t$ = 13.36850 - 0.8455 $\ln REERx_t$ (-8.116)	0.8145
4) $\ln$ Chemical Products $_t$ = 12.56278 - 0.6469 $\ln REERx_t$ (-5.017)	0.6266
5) $\ln$ Other Manufactures $_t$ = 11.68247 - 0.5435 $\ln REERx_t$ (-7.211)	0.7761

*figures in parentheses indicates t-statistics

5.5 Unit Root Test and Co-integration Test

5.5.1: Unit root test

A time series data is usually claimed as being generated by a stochastic or random process. A stochastic process is said to be stationary if its mean and the variance are constant overtime and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed. If a time series is not stationary, it is called a non-stationary time series. In order to see if the time series is stationary or non-stationary a unit root test is applied. Two equations base on unit-root principle were form to test all the variables used in this study to examine whether the data is stationary or non-stationary. The first equation (as shown by equation 5) is without the intercept and trend, where as in the second equation (equation 6) the intercept and trend is included. We have to use equation 5 since the results base on equation 6 turn out to be insignificant and created difficulties in analyzing the error-correction model.

$$\Delta Y_t = \delta Y_{t-1} + U_t \qquad (5)$$

$$\Delta Y_t = \beta 1 + \beta 2 \text{ trend} + \delta Y_{t-1} + \sum_{i=1} \propto_i \Delta Y_{t-i} + U_t \qquad (6)$$

where, Δ = first difference operator

U = random error

Table 5.4a and 5.4b presents the ADF test based on equation (5) for the null hypothesis that each series in log first difference contains a unit root against the alternative that it is stationary. From the above ADF test, we are able to reject the null hypothesis of a unit root for all the variables, except for the export of electronics and electrical products (Log E) on monthly observation which, is not stationary even after first difference. Therefore, all the series are stationary and co-integrated of order one or I(1), except exports of electronics and electrical products.

Table 5.4a: ADF Unit Root Test Without Constant and Trend (1975-1997)

Variables	Level	First Difference
Log X	8.768	-2.003[a]
Log REER	2.126	-4.666
Log RP	-0.194	-6.189
Log GDP	3.414	-3.001
Log R	-1.045	-3.418
Log S	-0.522	-7.727
Log T	0.591	-4.962
Log PO	4.470	-2.579[a]
Log P	1.636	-5.905
Log E	6.132	-1.685[b]
Log TE	4.645	-2.645
Log W	1.028	-6.832
Log CP	3.911	-2.800
Log M	-0.035	-7.733

a statistically significant at 5 % level
b statistically significant at 10 % level

Table 5.4 b: ADF Test Without Constant and Trend (July 1997-November 1998)

Variables	Level	First Difference
Log X	1.859	-4.227
Log REER	2.853	-2.396[a]
Log R	-0.290	-7.368
Log S	-0.411	-5.607
Log T	- 0.471	-5.507
Log PO	-0. 688	-2.060
Log P	0.641	-5.204
Log E	0.826	-0.851
Log TE	-1.486	-3.761
Log W	-2.451	-2. 653[a]
Log CP	-1.046	-3.660
Log M	-1.015	-5.994

a statistically significant at 5 %

Table 5.5a and 5.5b presents the ADF test based on equation (6) for the null hypothesis that each series in log second difference contains a unit root against the alternative that it is stationary around a deterministic trend. Based on the ADF test, we able to reject the null hypothesis of a unit root for all the variables for the annually observation period. This implies that all the variables are significant when it is second differenced, which reflects no existence of unit root. However, for the monthly observation, real effective exchange rates, export of saw log, export of palm oil and export of electronics and electrical seemed to be non-stationary even after second difference, whereas the rest of the variables were stationary after the second difference. Therefore, it is concluded that all series are stationary after second difference (except those variables mentioned above), so they are integrated of order two or I(2).

Table 5.5a: ADF Unit Root Test With Constant and Trend (1975-1997)

Variables	Level	First Difference	Second Difference
Log X	-3.9671	-6.6557	-8.8465
Log REER	-1.5895	-3.0046	-5.2178
Log RP	-2.3946	-3.6692	-5.0530
Log GDP	-2.6635	-2.6110	-4.1593[a]
Log R	-1.9418	-2.5537	-4.0725[a]
Log S	-3.2768	-4.8789	-6.0938
Log T	-0.6131	-2.6194	-6.3465
Log PO	-1.7014	-5.8008	-5.9963
Log P	-0.1893	-3.9165	-6.1476
Log E	-4.6875	-4.9046	-4.9701
Log TE	-2.6755	-3.2542	-4.1737[a]
Log W	-2.8061	-4.4571	-5.8581
Log CP	-2.9217	-3.6623	-5.0756
Log M	-3.3204	-5.0780	-6.1656

a statistically significant at 5 % level

Table 5.5b: ADF Unit Root Tests (July 1997-November 1998)

Variables	Level	First Difference	Second Difference
Log X	-2.9104	-3.1518	-5.4045
Log REER	1.5346	-1.9030	-3.1971
Log R	-4.3038	-4.1726	-5.2798
Log S	0.0818	-3.3314	-3.5797
Log T	-2.2521	-3.4313	-4.6821
Log PO	-2.3603	-1.0501	-1.9056
Log P	-3.1875	-4.3356	-5.6711
Log E	-1.0224	0.2719	-0.7715
Log TE	-1.0219	-3.4557	-4.2840
Log W	-2.5158	-2.4825	-5.0923
Log CP	-1.1409	-2.8911	-4.5112
Log M	-1.4932	-3.7078	-5.6166

5.5.2 Co-integration Test - The Engle -Granger Approach

Co-integration theory determines whether two or more time series have a stationary relationship over the long run. Prior to the development of co-integration theory, many early practices of econometrics simply ignored the stationary requirement. It leads to a substantial literature of econometrics in dealing with the "spurious regression" which refers to the results obtained by using two non-stationary variable in a regression when the variables were actually unrelated. A series is said to be stationary if its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed. 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*).

In order to establish whether there is a long-run equilibrium relationship among the variables in models shown below. The concept of co-integration developed by Engle and Granger (1987) is used.

Model 1

$$\ln X_{jt} = a + b \ln REERx_t + u_t \qquad (7)$$

Model 3

$$\ln X_{ijt} = c + d \ln RP_{jt} + + u_t \qquad (8)$$

Model 4

$$\ln X_{ijt} = c + \beta \ln FGDP_{jt} + u_t \qquad (9)$$

Assuming all the variables in three models are non-stationary and integrated of same order, then the equations are estimated by ordinary least square (OLS) procedure. The residuals (Ut) from the models are then tested for unit roots based on following equation (10) and (11),

$$\Delta U_t = \delta U_{t-1} + \mu_t \qquad (10)$$

$$\Delta U_t = \beta 1 + \delta U_{t-1} + \sum_{i=1} \alpha_i \Delta U_{t-i} + \mu_t \qquad (11)$$

where, Δ = first difference operator

Rejection of a unit root indicates that the residuals are stationary or I(0) and consequently the variables in the models represents a co-integrating relation. After establishing long run relationship between the variables, the models are examined by using error-correction model to evaluate the short run relationship between these variables.

5.5.2.1 ADF Test on the Residual Based on Equation (10)

A) Co-integration Test for Annual Observation

In the following analysis, the co-integration test using Engle-Granger approach was applied to model (1), model (3) and model (4) for annual observation period and the results are reported in Table 5.6 a, 5.6b and 5.6c.

Table 5.6 a: The ADF Test on the Residual of Co-Integration Equations (1975-1997)

Model 1	DW	R^2	ADF
$\ln X_t = 7.835263 + 1.3875 \ln REERx_t + U_t$	0.932	0.897	-6.191

If the real effective exchange rates and export demand is co-integrated, the random error variables of U_t should be stationary. A unit root test was conducted on the error term based on equation (10) and the results are reported in Table 5.6 a. The results of the unit root test indicate the random error variables as significantly stationary and does not reflect the existence of unit root. Thus, we can conclude that, there is long run relationship between real effective exchange rate and export demand. This empirical evidence enables us to estimate the error-correction model for the first model.

Table 5.6b: The ADF Test on the Residual of Co-Integration Equations (1975-1997)

Model 3	DW	R^2	ADF
In X_t = 14.97945 - 0.0265 In $RP_t + U_t$	0.492	0.362	-3.986

For the third model, the residual, U_t also appears to be stationary and does not reflect existence of unit root (5.6b). Since the residual is stationary, therefore, we could conclude that there is long run relationship between export and relative prices of trading partners and this enable the estimation of error-correction model for this third model.

Table 5.6c: The ADF Test on the Residual of Co-Integration Equation (1975-1997)

Model 4	DW	R^2	ADF
In X_t = -1.321329 + 1.26519 In $FGDP_t + U_t$	0.687	0.940	-6.453

With reference to Table 5.6c, the results of the unit root test indicates the random error variable as significantly stationary and does not reflect the existence of unit root. Thus, it can be concluded that export demand and foreign income has a long run relationship.

Table 5.7a: The ADF Test on the Residuals of Co-Integration Equation for Exports of Agriculture and Mining Commodities (1975-1997)

Model 1	DW	R^2	ADF
1) $\ln R_t = 8.607161 - 0.359 \ln REERx_t$	1.134	0.841	-6.598
2) $\ln S_t = 13.22584 - 1.010 \ln REERx_t$	2.275	0.130	-8.112
3) $\ln T_t = 6.811986 + 0.353 \ln REERx_t$	0.714	0.452	-5.088
4) $\ln PO_t = 4.116759 + 1.037 \ln REERx_t$	0.560	0.807	-5.610
5) $\ln P_t = 7.236044 + 0.602 \ln REERx_t$	0.382	0.478	-5.121

Based on Table 5.7a, it is observed that, residuals for all the co-integration equations are stationary, I(0). This implies that, export of rubber, saw logs, sawn timber, palm oil and petroleum has a long run relationship with changes in the real effective exchange rate. Means that the export of selected agriculture and mining commodities are co-integrated with real effective exchange rates.

With reference to Table 5.7b, the results of unit root test indicates the random error variable as significantly stationary and does not reflect the existence of unit root. Thus, it can be concluded that export of electronics and electrical products, textiles, wood products, chemical products and other manufactured products established a long run relationship with real effective exchange rates.

Table 5.7b: The ADF Test on the Residuals of Co-Integration Equations for Major Exports of Manufactured Products

Model 1	DW	R^2	ADF
1) $\ln E_t = -2.86664 + 3.584 \ln REERx_t$	0.776	0.865	-5.194
2) $\ln TE_t = -0.148942 + 2.321 \ln REERx_t$	0.755	0.839	-5.662
3) $\ln W_t = -0.88602 + 2.469 \ln REERx_t$	0.412	0.767	-6.175
4) $\ln CP_t = -3.968435 + 3.163 \ln REERx_t$	0.684	0.818	-5.087
5) $\ln M_t = -3.215718 + 2.807 \ln REERx_t$	2.174	0.454	-7.945

a statistically significant at 5 % level

B) Co-integration Test for Monthly Observation

After analyzing the co-integration regression for annual observation period (1975-1997), then the co-integration regression was applied to monthly observation (July 1997-November 1998) based on model (1). The results are reported in Table 5.8a, 5.8b and 5.8c.

Table 5.8a: The ADF Test Applied to Residual of Co-Integration Equation for Monthly Observation (July 1997-November 1998)

Model 1	DW	R^2	ADF
$\ln X_t = 8.49318 + 0.2402 \ln REERx_t$	0.697	0.737	-3.986

With reference to Table 5.8a, the results of the unit root test indicate that the random error variable is stationary, which reflect non-existence of unit root. This also implies, for monthly observation, the real effective exchange rate and export demand is co-integrated. Thus, error-correction analysis can be applied to evaluate the short run impact of real effective exchange rate on export.

Table 5.8b: The ADF Test Applied to Residual of Co-Integration Equation of Major Exports of Agriculture and Mining Commodities (July 1997-November 1998)

Model 1	DW	R^2	ADF
1) $\ln R_t = 5.354754 - 0.1419 \ln REERx_t$	2.361	0.300	-7.494
2) $\ln S_t = 7.020114 - 0.1340 \ln REERx_t$	1.473	0.048	-5.366
3) $\ln T_t = 5.830727 - 0.0632 \ln REERx_t$	1.373	0.033	-5.399
4) $\ln PO_t = 6.416396 + 0.0095 \ln REERx_t$	0.802	0.001	-2.051[a]
5) $\ln P_t = 6.190877 + 0.1690 \ln REERx_t$	1.388	0.211	-5.406

a statistically significant at 5 % level

Based on Table 5.8b, it is observed, for monthly observation, the residuals for all the major export of agriculture and mining commodities are stationary. This implies that there is long run relationship between export of rubber, saw logs, sawn timber, palm oil and petroleum with real effective exchange rate. This enables the estimation of error-correction model.

Table 5.8 c: The ADF Test to Residuals of Co-Integration Equations of Major Exports of Manufactured Products

Model 1	DW	R^2	ADF
1) $\ln E_t = 10.220350 + 0.1767 \ln REERx_t$	1.285	0.012	-0.908
2) $\ln TE_t = 12.2678 - 0.6166 \ln REERx_t$	0.883	0.691	-4.501
3) $\ln W_t = 13.36850 - 0.8455 \ln REERx_t$	0.592	0.814	-2.539
4) $\ln CP_t = 12.56278 - 0.6469 \ln REERx_t$	0.433	0.626	-4.660
5) $\ln M_t = 11.68247 - 0.5435 \ln REERx_t$	1.522	0.776	-7.319

With reference to Table 5.8c, the result of the unit root test indicates that the random error term is significantly stationary and does not reflect the existence of unit root. Except for export of electronic and electrical products, the export of other manufactured products are co-integrated with real effective exchange rates. With this we are able to estimate error-correction model for above co-integration equations except for the export of electronics and electrical products.

5.5.2.2 ADF Test on the Residual Based on Equation (11)

A) Co-integration Test For Annually Observation

In the following analysis, the co-integration test was applied to model 1, model 3 and model 4 for annual observation period. However, the ADF test on the residuals is based on equation (11).

Table 5.9a: The ADF Test on the Residual of Co-Integration Equation (1975-1997)

Model 1	DW	R^2	ADF
$\ln X_t = 7.835263 + 1.3875 \ln REERx_t + U_t$	0.932	0.897	-3.3981[a]

a statistically significant at the 5 % level

The results of the unit root test indicate that the error variable is significantly stationary and does not reflect the existence of unit root. Thus we can conclude that there is long run relationship between export and real effective exchange rate (5.9a). This empirical evidence enables us to estimate the error-correction model for the first model.

Table 5.9b: The ADF Test on the Residual of Co-Integration Equation (1975-1997)

Model 3	DW	R^2	ADF
$\ln X_t = 14.97945 - 0.0265 \ln RP_t + U_t$	0.492	0.362	-3.802

For the third model, the residual, U_t also appears to be stationary and does not reflect existence of unit root. Since the residual is stationary, therefore, we could conclude that there is long run relationship between export and relative prices of trading partners and this enable the estimation of error-correction model for this third model.

Table 5.9c: The ADF Test on the Residual of Co-Integration Equation (1975-1997)

Model 4	DW	R^2	ADF
$\ln X_t = -1.321329 + 1.26519 \ln FGDP_t + U_t$	0.687	0.940	-3.175

a statistically significant at 5 % level

With reference to Table 5.9c, the result of the unit root test indicates the random error variable is significant and this implies that there is no unit root problem in the variable. This shows that there is significant long run relationship between foreign income and export level. This enables the estimation of error-correction model for this model.

Based on model 1, co-integration test was conducted to evaluate the long run relationship between major export of agriculture and mining commodities with real effective exchange rate. With reference to Table 5.10a, it is observed that, residuals for all the co-integration equations based on model 1 are stationary, except for export of petroleum, the residual appears to be insignificant. Export of major agriculture and mining commodities have a significant long run impact on the changes in the real effective exchange rates or in other words the exports of agriculture and mining commodities are co-integrated with real effective exchange rates. This enables estimation of error-correction model for all the commodities except for export of petroleum.

Table 5.10a: The ADF Test on the Residuals of Co-Integration Equations for Exports of Agriculture and Mining Commodities (1975-1997)

Model 1	DW	R^2	ADF
1) $\ln R_t = 8.607161 - 0.359 \ln REERx_t$	1.134	0.841	-4.685
2) $\ln S_t = 13.22584 - 1.010 \ln REERx_t$	2.275	0.130	-5.233
3) $\ln T_t = 6.811986 + 0.353 \ln REERx_t$	0.714	0.452	-2.902^b
4) $\ln PO_t = 4.116759 + 1.037 \ln REERx_t$	0.560	0.807	-3.394
5) $\ln P_t = 7.236044 + 0.602 \ln REERx_t$	0.382	0.478	-2.587

b statistically significant at 10 % level

Table 5.10b: The ADF Test on the Residuals of Co-Integration Equations for Major Exports of Manufactured Products

Model 1	DW	R^2	ADF
1) $\ln E_t = -2.86664 + 3.584 \ln REERx_t$	0.776	0.865	-3.152^a
2) $\ln TE_t = -0.148942 + 2.321 \ln REERx_t$	0.755	0.839	-2.695^b
3) $\ln W_t = -0.88602 + 2.469 \ln REERx_t$	0.412	0.767	-4.044
4) $\ln CP_t = -3.968435 + 3.163 \ln REERx_t$	0.684	0.818	-2.823^b
5) $\ln M_t = -3.215718 + 2.807 \ln REERx_t$	2.174	0.454	-5.067

a statistically significant at 5 % level
b statistically significant at 10 %

On the other hand, Table 5.10b represents the co-integration regression estimates as well as the ADF for residual of the co-integration equations of major export of manufactured products. It is observed that, all the residuals are stationary, I(0) and this implies that there is long run relationship between exports of major manufactured products such as electronics and electrical, textiles, wood products, chemical products and other manufactured goods and real effective exchange rates.

Based on the co-integration regression estimates for three models as well as the co-integration equation for the exports of major agriculture and manufactured products, we can conclude that there is long run relationship exists among the variable, which was estimated. The results also shows that, beside real effective exchange rates, relative prices and income of the trading partners also play an important role in determining the demand for Malaysian export. On the other hand, co-integration estimates for major exports of agriculture commodities and manufactured products shows that, exports of the major commodities and manufactured products are co-integrated with real effective exchange rates or, they establish a long run relationship with real effective exchange rates

B) Co-integration Test for Monthly Observation

After analyzing the co-integration regression for annual observation period (1975-1997) using ADF test on residuals based on equation (11), then the co-integration regression was applied to monthly observation (July 1997-November 1998) based on model (1). The results are reported in Table 5.11a, 5.11b and 5.11c.

Table 5.11a: The ADF Test Applied to Residual of Co-Integration Equation (July 1997-November 1998)

Model 1	DW	R^2	ADF
$\text{In } X_t = 8.493189 + 0.2402 \text{ In } REERx_t$	0.697	0.737	-2.597

With reference to Table 5.11a, the results of the unit root test indicate that the random error variable is not stationary, which reflect existence of unit root problem. This also implies, for monthly observation, the real effective exchange rate and export demand is not co-integrated (based on equation 11). Thus, error-correction analysis cannot be applied to evaluate the short run impact of real effective exchange rate.

The residual for major export of agriculture commodities appears to be stationary following ADF test, except residual for export of palm oil (Table 5.11b). This indicates that, there is long run relationship between export of agriculture commodities and real effective exchange rates (except export of palm oil). With this, we estimate error-correction model for the co-integrating variables.

Table 5.11b: The ADF Test Applied to Residual of Co-Integration Equations of Major Exports of Agriculture and Mining Commodities

Model 1	DW	R^2	ADF
1) $\ln R_t = 5.354754 - 0.1419 \ln REERx_t$	2.361	0.300	-4.584
2) $\ln S_t = 7.020114 - 0.1340 \ln REERx_t$	1.473	0.048	-3.069[a]
3) $\ln T_t = 5.830727 - 0.0632 \ln REERx_t$	1.373	0.033	-3.510[a]
4) $\ln PO_t = 6.416396 + 0.0095 \ln REERx_t$	0.802	0.001	-1.569
5) $\ln P_t = 6.190877 + 0.1690 \ln REERx_t$	1.388	0.211	-4.163

a statistically significant at 5 % level

In the case of the selected export of manufactured products, the results of the unit root test indicate the random error variables are not stationary for the export of selected manufactured products except for the export group of other manufactured products (5.11c). This implies that there is no long run relationship between exports of electronics and electrical, export of textiles, export of wood products and export of chemical products and real effective exchange rates. Only export group of other manufactured products has a long run relationship with real effective exchange rates and this would allow the estimation of error-correction model for this variable.

where, E_{t-1} = error-correction term

$\alpha 1$, $\alpha 2$, $\alpha 3$ and $\alpha 4$ = parameter

L_t = random disturbance

The speed of adjustment coefficients, $\alpha 2$ are of particular interest in that they have important implications for the dynamics of the system. From equation (12), it is clear that for any given value of E_{t-1}, a large value of $\alpha 2$ is associated with a large value of ΔY_t. If $\alpha 2$ is zero, the change in Z_t does not at all respond to the deviation from long run equilibrium in (t-1). If $\alpha 2$ and $\alpha 3$ is zero, then it can be said that ΔY_t does not Granger cause ΔZ_t. One or both of these coefficients should be significantly different from zero if the variables are co-integrated.

In the following analysis, three error-correction model were constructed based on equation (12) to represent model 1 (equation 13), model 2 (equation 14) and model 3 (equation 15) as shown below,

$$\Delta \ln X_t = \alpha 1 + \alpha 2\, \delta_{t-1} + \sum_{i=1} \alpha 3\, \Delta \ln X_{t-i} + \sum_{i=1} \alpha 4\, \Delta \ln REERx_{t-i} + E_t \qquad (13)$$

$$\Delta \ln X_t = \beta 1 + \beta 2\, \delta_{t-1} + \sum_{i=1} \beta 3\, \Delta \ln X_{t-i} + \sum_{i=1} \beta 4\, \Delta \ln RP_{t-i} + E_t \qquad (14)$$

$$\Delta \ln X_t = \phi 1 + \phi 2\, \delta_{t-1} + \sum_{i=1} \phi 3\, \Delta \ln X_{t-i} + \sum_{i=1} \phi 4\, \Delta \ln FGDP_{t-i} + E_t \qquad (15)$$

in which the short run components are $\alpha 3$, $\alpha 4$, $\beta 3$, $\beta 4$, $\phi 3$ and $\phi 4$, while the long run components are δ. To save space only the derivation of long run components for first three models (annual observation) were shown below. This method is applied to rest of the equations for the exports of major agriculture and manufactured products. For example the long run components are derived as follows,

$$\delta_t = \ln X_t - 1.3875 \ln REER_t \qquad (16)$$

$$\delta_t = \ln X_t + 1.9084 \ln RP_t \qquad (17)$$

$$\delta_t = \ln X_t - 1.2651 \ln FGDP_t \qquad (18)$$

If the two variables, namely export (X) and the real effective exchange rate (REER) are co-integrated, the coefficients of the error-term will be significantly different from zero.

5.6.1 For ADF Test based on Equation (10)

A) Estimates of Error-Correction Model for Annual Observation

The estimation of error-correction model is conducted on ADF test based on equation (10) and equation (11). This is because, the co-integration estimation based on equation (10) provides a better result and consistent with the hypothesis. While, the co-integration estimation based on equation (11) is mostly not significant or not co-integrated.

Table 5.12a shows the result of error-correction model between export and real effective exchange rate. The long-run component displays positive and marginally significant result. This implies that there is positive long-run relationship between exports and REER. On the other hand the short-run component also display

Table 5.12a: Estimates of Error-Correction Model (1975-1997)

Model 1
$\Delta \ln X_t = -0.3035 + 0.039\ \delta_{t-1} - 0.324 \ln X_{t-1} + 0.033 \ln REERx_{t-1}$ **(0.663)** **(-1.027)** **(0.497)**

*figures in parentheses indicates t-statistics

a positive but marginally significant relationship between exports and REER. This results also similar to results obtained by OLS estimation, in which there is positive, but marginally significant short-run relationship between export and real effective exchange rate.

Table 5.12 b: Estimates of Error-Correction Model

Model 2
$\Delta \ln X_t = 0.1068 + 0.01420\ \delta_{t-1} - 0.2355 \ln X_{t-1} - 0.0526 \ln RP_{t-1}$ **(0.569)** **(-1.027)** **(-0.713)**

*figures in parentheses indicates t-statistics

Based on Table 5.12b, the empirical evidence reflects that there is relationship between export and relative prices of trading nation. The long run relationship between relative prices and real effective exchange rate is positive but it is only marginally significant. On the other hand, the short-run component shows that there is negative and significant short run relationship between export and relative prices. One per cent increase in relative prices will lead to reduction in export by 0.05 per cent. This result are similar to that are obtained by using OLS estimation.

Table 5.12c: Estimates of Error-Correction Model

Model 3
$\Delta \ln X_t = -0.508 - 0.129\ \delta_{t-1} - 0.251 \ln X_{t-1} + 0.075 \ln FGDP_{t-1}$ (-1.609) (-1.248) (2.473)

*figures in parentheses indicates t-statistics

With reference to Table 5.12c, it is notice that there is significant and negative long run relationship between export and foreign income. There is also a positive and significant short run relationship between export and foreign income. This result are similar to result obtained by OLS estimation, in which an one per cent increase in foreign income would led to increase in export by 0.07 per cent.

The error-correction model for annual observation was also extended to examine the short run performance of major agriculture and manufactured products. Based on Table 5.13a, it is observed that all the coefficients of long run component for major export of agriculture and mining commodities appear to be significant and negatively correlated with REER, except for the export of sawn timber which is not significant. However, the short run relationship between the exports and REER

Table 5.13a: Estimates of Error-Correction Model for Major Export of Agriculture and Mining Commodities (1975-1997)

a) Agriculture and Mining Commodities
1) $\Delta \text{ In } R_t = 4.9744 - 0.5685\ \delta_{t-1} + 0.2762 \text{ In } R_{t-1} - 0.796 \text{ In } REERx_{t-1}$
(-2.486) (1.389) (-2.467)
2) $\Delta \text{ In } S_t = 17.331 - 1.1828\ \delta_{t-1} + 0.1438 \text{ In } S_{t-1} - 4.850 \text{ In } REERx_{t-2}$
(-4.017) (0.764) (-2.782)
3) $\Delta \text{ In } T_t = 0.3956 - 0.0019\ \delta_{t-1} + 0.0313 \text{ In } T_{t-1} + 0.2057 \text{ In } REERx_{t-2}$
(-0.008) (0.214) (1.208)
4) $\Delta \text{ In } P_t = 1.2768 - 0.0856\ \delta_{t-1} - 0.1077 \text{ In } P_{t-1} - 0.191 \text{ In } REERx_{t-1}$
(-0.958) (-0.662) (-2.625)
5)) $\Delta \text{ In } PO_t = 0.6559 - 0.078\ \delta_{t-1} - 0.061 \text{ In } PO_{t-1} - 0.058 \text{ In } REERx_{t-1}$
(-0.972) (-0.247) (-1.275)

*figures in parentheses indicates t-statistics

appears to be negative except for the export of sawn timber the correlation is positive. But there is no long run relationship between the export of sawn timber and REER. This is because the long run component is not significant

Table 5.13b: Estimates of Error-Correction Model for the Major Export of Manufactured Products (1975-1997)

Model 1
1) $\Delta \text{ In } E_t = 0.250 - 0.093\ \delta_{t-1} + 0.1908 \text{ In } E_{t-1} + 0.1739 \text{ In } REERx_{t-1}$
(-1.415) (0.818) (0.862)
2) $\Delta \text{ In } TE_t = 0.2545 - 0.019\ \delta_{t-1} - 0.073 \text{ In } TE_{t-1} - 0.178 \text{ In } REERx_{t-2}$
(-0.212) (-0.253) (-0.619)
3) $\Delta \text{ In } CP_t = -0.785 - 0.159\ \delta_{t-1} - 0.060 \text{ In } CP_{t-1} - 0.748 \text{ In } REERx_{t-2}$
(-1.214) (-0.212) (-1.834)
4) $\Delta \text{ In } W_t = -0.484 - 0.321\ \delta_{t-1} - 0.319 \text{ In } W_{t-1} + 0.589 \text{ In } REERx_{t-1}$
(-2.008) (-1.261) (1.133)
5) $\Delta \text{ In } M_t = -5.908 - 1.119\ \delta_{t-1} - 0.005 \text{ In } M_{t-1} + 2.719 \text{ In } REERx_{t-1}$
(-3.364) (-0.026) (2.803)

* figures in parentheses indicates t-statistics

Table 5.13b presents the estimates of error-correction model for major export of manufactured products. The result shows that all the export of manufactured products have a negative and significant long run relationship with the real effective exchange rate except for the export of textiles and chemical products. However in the short run, only export of electronics and electrical, wood products and group of other manufactured good displays a positive sign or correlation with the movement in REER, and the relationship seems to be significant. While the short run relationship between exports of textiles and REER is not significant.

B) Estimates of Error-Correction Model for Monthly Observation

Table 5.14:Estimates of Error-Correction Model

Model 1
$\Delta \ln X_t = 7.454 - 0.826\ \delta_{t-1} - 0.1405 \ln X_{t-1} - 0.6897 \ln REERx_{t-1}$ **(-3.899)** **(-0.733)** **(-4.069)**

With reference to Table 5.14a, it is observed that the error-term displays a negative and significant result. This indicates that there is significant long run relationship between real effective exchange rate and export, however the result is against our hypothesis, that the coefficient of REER should be positive. On the other hand the short run component also reveal a negative and significant results. This result is contrast to result obtained by OLS analysis, in which the estimation provided a positive and significant result on the impact of the real effective exchange rate on export.

Based on Table 5.15a, it is observed that selected primary commodities have a negative relationship with REER except for the export of saw logs. This implies that there is significant short run relationship between exports of selected primary commodities and REER. Meanwhile, the long-run component also displays a negative and significant result for all the commodities.

Table 5.15a: Estimates of Error-Correction Model for Major Export of Agriculture and Mining Products

Model 1
1) $\Delta \text{ In } R_t = 9.388 - 1.644\,\delta_{t-1} + 0.1266 \text{ In } R_{t-1} - 1.969 \text{ In } REERx_{t-1}$
(-3.591) **(0.435)** **(-3.639)**
2) $\Delta \text{ In } S_t = 6.868 - 1.019\,\delta_{t-1} + 0.132 \text{ In } S_{t-1} + 1.004 \text{ In } REERx_{t-2}$
(-2.920) **(0.548)** **(1.842)**
3) $\Delta \text{ In } T_t = 7.340 - 1.318\,\delta_{t-1} - 0.0669 \text{ In } T_{t-1} - 1.169 \text{ In } REERx_{t-2}$
(-6.205) **(-0.448)** **(5.151)**
4) $\Delta \text{ In } PO_t = 3.542 - 0.515\,\delta_{t-1} + 0.5641 \text{ In } PO_{t-1} - 0.551 \text{ In } REERx_{t-1}$
(-1.883) **(1.164)** **(-1.955)**
5) $\Delta \text{ In } P_t = 7.287 - 1.039\,\delta_{t-1} + 0.053 \text{ In } P_{t-1} - 0.991 \text{ In } REERx_{t-1}$
(-3.041) **(0.220)** **(-3.133)**

*figures in parentheses indicates t-statistics

The long run component for export of textiles, chemical products and group of other manufactured products displays a significant result in the long run. However the relationship with REER are negative for the export of chemical products and group of other manufactured products. The output shows that in the short run, only the export of textiles and wood products indicated a positive long run relationship with REER, however the relationship between the export of wood products and REER is not significant (Table

5.15b). It seems that the movement of REER influences the performance of export of textiles in short run as well as in long run.

Table 5.15b: Estimates of Error-Correction Model for Major Export of Manufactured Products

Model 1
1) $\Delta \ln TE_t = -1.930 + 0.2193\ \delta_{t-1} - 0.5203 \ln TE_{t-1} + 0.6667 \ln REERx_{t-2}$
(0.555) (-1.151) (1.786)
2) $\Delta \ln W_t = 0.9616 - 0.0583\ \delta_{t-1} + 0.1908 \ln W_{t-1} + 0.5071 \ln REERx_{t-2}$
(-0.293) (0.560) (2.222)
3) $\Delta \ln CP_t = 3.4276 - 0.2175\ \delta_{t-1} - 0.0217 \ln CP_{t-1} - 0.4752 \ln REERx_{t-1}$
(-0.707) (-0.056) (-0.887)
4) $\Delta \ln M_t = 3.4470 - 0.269\ \delta_{t-1} - 0.3845 \ln M_{t-1} - 0.472 \ln REERx_{t-1}$
(-0.502) (-0.998) (-0.563)

*figures in parentheses indicates t-statistics

5.6.2 For ADF Test based on Equation (11)

A) Estimates of Error-Correction Model for Annual Observation

Table 5.16a: Estimates of Error-Correction Model (1975-1997)

Model 1
$\Delta \ln X_t = -0.3035 + 0.039\ \delta_{t-1} - 0.324 \ln X_{t-1} + 0.033 \ln REERx_{t-1}$
(0.663) (-1.027) (0.497)

*figures in parentheses indicates t-statistics

Table 5.16a shows the result of error-correction model between export and real effective exchange rate. This result is same as the result obtained in section 5.6.1 (for ADF test based on equation 10). The long-run component displays a positive and marginally significant result. This reflects that there positive long run relationship between exports and REER. The short-run component also displays a positive relationship between exports and REER.

Table 5.16b: Estimates of Error-Correction Model

Model 2
$\Delta \ln X_t = 0.1068 + 0.01420\ \delta_{t-1} - 0.2355 \ln X_{t-1} - 0.0526 \ln RP_{t-1}$ **(0.569)** **(-1.027)** **(-0.713)**

*figures in parentheses indicates t-statistics

Based on Table 5.16b, the empirical evidence reflects that there is relationship between export and relative prices of trading nation. This result is also similar the result obtained in section 5.6.1. The short-run component shows that there is negative and significant relationship between export and relative prices. This implies that an one per cent increase in relative prices will led to reduction in export by 0.05 per cent. Meanwhile, the long-run component displays a positive relationship between relative prices and exports demand.

Table 5.16c: Estimates of Error-Correction Model

Model 3
$\Delta \ln X_t = -0.508 - 0.129\ \delta_{t-1} - 0.251 \ln X_{t-1} + 0.075 \ln FGDP_{t-1}$ **(-1.609)** **(-1.248)** **(2.473)**

*figures in parentheses indicates t-statistics

With reference to Table 5.16c, it is notice that there is negative and significant long run relationship between export and foreign income. There is also a positive and significant short run relationship between export and foreign income. This result is similar to results obtained in section 5.6.1. Thus it can be concluded that there short-run as well as long-run relationship between foreign income and export demand.

Table 5.17a: Estimates of Error-Correction Model for Major Export of Agriculture and Mining Commodities (1975-1997)

Model 1
1) $\Delta \text{ In } R_t = 4.9744 - 0.5685\ \delta_{t-1} + 0.2762 \text{ In } R_{t-1} - 0.796 \text{ In } REERx_{t-1}$
(-2.486) **(1.389)** **(-2.467)**
2) $\Delta \text{ In } S_t = 17.331 - 1.1828\ \delta_{t-1} + 0.1438 \text{ In } S_{t-1} - 4.850 \text{ In } REERx_{t-2}$
(-4.017) **(0.764)** **(-2.782)**
3) $\Delta \text{ In } T_t = 0.3956 - 0.0019\ \delta_{t-1} + 0.0313 \text{ In } T_{t-1} + 0.2057 \text{ In } REERx_{t-2}$
(-0.008) **(0.214)** **(1.208)**
4) $\Delta \text{ In } PO_t = 0.6559 - 0.0786\ \delta_{t-1} - 0.0610 \text{ In } PO_{t-1} - 0.0580 \text{ In } REERx_{t-1}$
(-0.972) **(-0.247)** **(-1.275)**

*figures in parentheses indicates t-statistics

The error-correction model for annual observation was also extended to examine the short run performance of major agriculture and manufactured products. Table 5.17a presents the estimates of error-correction model for export of agriculture and mining commodities based on equation (11). With reference to Table 5.17a, it is notice that the results are similar to results obtained in section 5.6.1. The only difference that the result for the export of petroleum is not given because the residual test based on equation (11) did not display a significant result. This result indicates that, there is negative and significant long run relationship between export of selected primary commodities and REER, except for the export of sawn timber. On the other hand, the short run components also displays a negative and significant results for export of selected primary commodities except for the export of sawn timber which exerts a positive and significant short-run relationship with REER.

Table 5.17b: Estimates of Error-Correction Model for the Major Export of Manufactured Products (1975-1997)

Model 1
1) $\Delta \ln E_t = 0.250 - 0.093\ \delta_{t-1} + 0.1908 \ln E_{t-1} + 0.1739 \ln REERx_{t-1}$
(-1.415) (0.818) (0.862)
2) $\Delta \ln TE_t = 0.2545 - 0.019\ \delta_{t-1} - 0.073 \ln TE_{t-1} - 0.178 \ln REERx_{t-2}$
(-0.212) (-0.253) (-0.619)
3) $\Delta \ln CP_t = -0.785 - 0.159\ \delta_{t-1} - 0.060 \ln CP_{t-1} - 0.748 \ln REERx_{t-2}$
(-1.214) (-0.212) (-1.834)
4) $\Delta \ln W_t = -0.484 - 0.321\ \delta_{t-1} - 0.319 \ln W_{t-1} + 0.589 \ln REERx_{t-1}$
(-2.008) (-1.261) (1.133)
5) $\Delta \ln M_t = -5.908 - 1.119\ \delta_{t-1} - 0.005 \ln M_{t-1} + 2.719 \ln REERx_{t-1}$
(-3.364) (-0.026) (2.803)

* figures in parentheses indicates t-statistics

Table 5.17b presents the estimates of error-correction model for major export of manufactured products. The result shows that all the export of manufactured products have a significant and negative long run relationship with the real effective exchange rate. On the other hand, the short run components also reflect that the export textiles and chemical products have a negative and significant short-run relationship with REER. While the export of electronics and electrical, wood products and group of other manufactured goods displays a positive correlation with the changes in REER.

B) Estimates of Error-Correction Model for Monthly Observation

As for monthly observation, the error-correction model for the first model (the relationship between real effective exchange rate and export) is not analyzed because the co-integration estimates did not indicates existence of relationship between real effective exchange rate and export demand. However, error-correction models were estimated for the major export of agriculture and manufactured products.

With reference to Table 5.18a, it is witnessed that, the coefficient of long-run component for the selected major export of agriculture and mining commodities are significant and negatively correlated with the changes in REER. On the other hand, the short-run component also displays a significant and negative correlation with REER except for the export of saw log, which displays a positive and significant

Table 5.18a: Estimates of Error-Correction Model for Major Export of Agriculture and Mining Products

Model 1
1) $\Delta \ln R_t = 9.388 - 1.644\, \delta_{t-1} + 0.1266 \ln R_{t-1} - 1.969 \ln REERx_{t-1}$
(-3.591) **(0.435)** **(-3.639)**
2) $\Delta \ln S_t = 6.868 - 1.019\, \delta_{t-1} + 0.132 \ln S_{t-1} + 1.004 \ln REERx_{t-2}$
(-2.920) **(0.548)** **(1.842)**
3) $\Delta \ln T_t = 7.340 - 1.318\, \delta_{t-1} - 0.0669 \ln T_{t-1} - 1.169 \ln REERx_{t-2}$
(-6.205) **(-0.448)** **(5.151)**
4) $\Delta \ln P_t = 7.2879 - 1.039\delta_{t-1} + 0.0534 \ln P_{t-1} - 0.9913 \ln REERx_{t-1}$
(-3.041) **(0.220)** **(-3.133)**

***figures in parentheses indicates t-statistics**

short run relationship with REER. The error-correction model was not conducted for export of palm oil as the residual test for co-integration displays an insignificant result.

Table 5.18b: Estimates of Error-Correction Model for Major Export of Manufactured Products

Model 1
$\Delta \ln M_t = 3.4470 - 0.269\, \delta_{t-1} - 0.3845 \ln M_{t-1} - 0.472 \ln REERx_{t-1}$ **(-0.502)** **(-0.998)** **(-0.563)**

Based on Table 5.18b, it is observed that, estimation of error-correction model was only conducted for export of group of other manufactured products and real effective exchange rate. This is because the rest export of manufactured goods did not indicate any relationship with the real effective exchange rate based on co-integration estimation (for monthly observation). However, the estimates of error-correction model displays that the long run as well as the short run component is not significant. This suggests that there is no long run as well as short run relationship between export of other group of manufactured goods and real effective exchange rate.

Generally, it is noted that most of analysis of error-correction model based on ADF test on equation (11) does not display a significant result compared to error-correction model based on equation (10).

5.7 Conclusion

In this study, we have examined the impact of exchange rate variability (REER) on Malaysian exports. For the purpose of analysis, two models were constructed to examine the long run and short run relationship between the changes in the real effective exchange rates and export. The first model examine the relationship between real effective exchange rate and export, while the second model examine the influence of relative prices and foreign income on Malaysian export demand. The analysis involve two observation period, that is annually (1975-1997) and on monthly basis (July 1997-November 1998). This is to see how Malaysian export sector has responded to recently outbreak of currency crisis in mid-1997. The empirical analysis was conducted based on ordinary least squares, co-integration and error-correction model.

Based on the co-integration analysis, it was found that long run relationship exists between REER and exports for annually observation period, but this did not happens for monthly observation On the other hand, relative prices and foreign income also provided a significant relationship with export. This result allows for the estimation of error-correction model. The error-correction model suggests that the long-run relationship between real effective exchange rate and export are only marginally significant. However, it did not provide any short run relationship. As for the relationship between relative prices and export, both long run and short run components did not display any significant relationship. However, the relationship between foreign income and export exerts a positive and significant long run as well as short run relationship. This empirical evidence seems to be different from that is obtained by A.C Arize (1996). He examined the relationship between exports and real effective exchange rate uncertainty for Korea using multivariate co-integration and error-correction techniques. The major result suggests that real exchange rate uncertainty have a negative effect on exports in the short run as well as the long run.

Thus, based on the empirical evidence, we could conclude that there is no real consensus regarding the relationship between exchange rate fluctuation and exports, in which some empirical evidence displays a positive relationship, while some displays a negative relationship. In this situation, one thing that seem to be certain that, to some extent, exchange rate depreciation does have a significant impact on the exports. This implies that exchange rate depreciation might help to increase the performance of exports of Malaysia and eventually improve trade balance. Latest indicators as released by the government had shown that, Malaysia has registered trade surplus for consecutive 17 months since the outbreak of East Asian currency crisis in mid-1997.