Real Exchange Rate and Trade Balance Relationship: An Empirical Study on Malaysia

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Abstract

This paper attempts to identify the relationship between the real exchange rate and trade balance in Malaysia from year 1955 to 2006. This study uses Unit Root Tests, Cointegration techniques, Engle-Granger test, Vector Error Correction Model (VECM), and impulse response analyses. The main findings of this paper are: (i) long run relationship exists between trade balance and exchange rate. Other important variables that determine trade balance such as domestic income shows a long run positive relationship between trade balances, and foreign income shows a long run negative relationship (ii) the real exchange rate is an important variable to the trade balance, and devaluation will improve trade balance in the long run, thus consistent with Marshall-Lerner condition (iii) the results indicate no J-curve effect in Malaysia case.

Keywords: Exchange rate, Trade balance, Devaluation, Cointegration, Malaysian economy

1. Introduction

Depreciation of the currency has great impacts to trade balance but the impact may vary, probably due to different level of economic development. One of the prominent impacts is the Marshall-Lerner condition, which represents that real depreciation leads to increases the trade balance in the long run if sum up value of import and export demand elasticity exceed one. Real depreciation improves the trade balance through two different channels. Firstly, increase quantity of export. Depreciation of the currency reveals the domestic goods cheaper as compared to the foreign goods, thus making export more competitive. Secondly, quantity of imports decreases, as import is relatively more expensive. Alternatively, amount of export and import may not responsive at initial period of depreciation. Thus, trade balance may be worsening first due to decrease in value of export and increase in value of import but improves after some time. This make scenario knows as J-curve.

2. Objective of Study

The main objectives of this paper, therefore aims (i) to study the relationship between exchange rate and trade balance in Malaysia, and (ii) to investigate whether Marshall-Lerner condition and J-curve exist, both for the period 1955-2006. The rest of the paper is structured as follow: Section 3, there will have review on literatures. Section 4 will be the theoretical framework and methodology. Section 5 will be the result and interpretation and finally is Section 6 will be the conclusion from this study.

3. Literature Review

Hernan Rincon (1999) examined the relationship between trade balance and exchange rate test for Marshall-Lerner condition in Colombia using Johansen-Juselius method. His empirical results provided significant evident for the Marshall-Lerner condition. Shirvani and Wilbratte (1997), Akbostanci's (2002) and Liu, Fan and Shek (2006) also found Marshall-Lerner condition hold in their respective studies. Shirvani and Wilbratte (1997) examined the relationship between trade balance and real exchange rate in United States and the G7 countries of Canada, France, Germany, Italy, Japan, United Kingdom and United States, Akbostanci's (2002) in Turkey while Liu, Fan and Shek

(2006) in Hong Kong. Besides, Onafowora (2003) reported significant relationship exist for three ASEAN countries of Thailand, Malaysia, and Indonesia in their bilateral trade to United States and Japan. In contrast, Rose (1991) reported the Marshall-Lerner condition does not exist in five major OECD countries (United Kingdom, Canada, Germany, Japan, and the United States). Her results also showed insignificant relationship between trade balance and exchange rate, thus implying that devaluation could not improve trade balance in the long run. Rose (1991) predicted it would reveal significant through trade balance treated as exogenous with respect to the exchange rate. Using cointegration test, Hatemi and Irandoust's (2005) study showed Sweden did not satisfy Marshall-Lerner condition. This might be due to the trade balance in Sweden is not sensitive in real exchange rate but only sensitive in changes in income. Wilson and Kua (2001) examined the relationship case between Singapore and United States. Their result indicated exchange rate does not have significant impact on the bilateral trade balance. Liew, Lim, and Hussain (2003) studied the relationship between real exchange rate and balance of trade based in ASEAN countries. They suggested that trade balance is affected by a real money rather than the exchange rate. Thorbecke (2006) indicated that the change in the exchange rate could affect trade within Asia. His empirical studies demonstrated an appreciation in Indonesia, Malaysia, and Thailand would decline export.

As for literatures on the J-curve effect, Ahmad and Yang (2004) examined the hypothesis of J-curve on China's bilateral trade with the G-7 countries by using and found no evidence characterize of J-curve effect. Moffett (1989) examined empirical evidence for the trade price (price of the export and import) and the quantities (quantities of export and import) of the United States to determine whether J-curve exists or not from the period of 1967 to 1987. Reported result indicated that, dollar depreciation leads to import quantities decrease, but it simultaneous decrease in the quantities of export. Based on the J-curve theory, depreciation leads imports to decrease and exports increase. Exports decrease in this case, so, it resembles of sine wave rather than a J-shape. Rose and Yellen (1989), using ordinary least square (OLS) and cointegration test reported no response of the trade balance to the real exchange rate in the United States. Meanwhile, Bahmani-Oskooee and Ratha (2007) examined the bilateral trade between Sweden and her 17 trading partners and analyzed the real depreciation of short run effect and the long run effect. Their long run result concluded that real depreciation of the currency only sufficient in five cases, which is in the trade balance between Sweden and Austria, Denmark, Italy, Netherlands, and the United Kingdom. Short run result has effects on the trade balance in 14 out of the 17 cases. Nevertheless, Sugema (2005), examining the determinate of the trade balance and crisis adjustment in Indonesia through exchange rate make a caution point on the issue of effectiveness of exchange rate depreciation in improving trade balance in the long run. Sugema (2005) claimed that exchange rate might overshoot if the trade balance is not sensitive with the depreciation.

4. Theoretical Framework and Methodology

The modeling the trade balance in this paper follows similar equation chosen from Shirvani and Wilbratte (1997), Baharumshah (2001), Gomez and Alvarez-Ude (2006), which emphasized in exchange rate on bilateral trade balance evidence.

Equilibrium goods market in an open economy can be described by the following equations:

$$Y = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{r}) + G - IM(\underset{+}{Y}, \underset{-}{\varepsilon}) + X(\underset{+}{Y^*}, \underset{+}{\varepsilon})$$

which Y represents total domestic income, C represents consumer spending, and T represents income tax, I, represents investment, r known as interest rate, G represents government spending, ε represents real exchange rate, IM represents import, X represents export, and Y^* represents foreign income.

Signs in bracket (below the equation) indicate relationships for respective factors. Consumers spending *(C)* which function as total income subtract income tax, which it knows as disposal income *(Y-T)*. Higher disposal income lead to higher consumer spending besides to increase total domestic income, therefore, positive relationship incurs between total domestic income and consumer spending. Investment *(I)* is a function of total income and interest rate. Nations would investment more if increase in the total personal income. Thus, it shows positive relationship between investment and total income. Besides that, interest rate might effect investment decision. Lower interest rate reduces cost for capital, thus attracts more investor come and invests. For that reason it shows negative relationship between investment and interest rate. In other word, higher interest rate would decrease total domestic investment. For the real exchange rate equal the nominal exchange rate (E) multiple the foreign price level (P^*) and divided by the domestic price level. Nominal exchange rate (E) is defined as the number of unit domestic currency exchange for one unit of foreign currency, giving:

$$\varepsilon = (EP^*) / P \quad (1)$$

Import *(IM)* is influenced by domestic income or output (*Y*). Higher domestic income leads to high imports. So, it shows positive relationship. In additional, import has negative relationship with total domestic income; quantity of import also depends on the real exchange rate *(ε)*. Higher *(ε)* leads to lower quantity of imports because of the foreign goods relatively more expensive. Export (*X*) depends on the foreign income *(Y*)* and real exchange rate *(ε)*. High the foreign income leads to increase in foreign demand for all goods and services as a result increase exports. On the other hands, increase in real exchange rate, the relative price of foreign goods in terms of domestic goods also leads to increase in export. It is showing positive relationship between trade balance and foreign income, real exchange rate. As the objective is to examine trade balance (net export, NX) and exchange rate, other variables are assumed constant. The net export is:

$$NX \equiv X - IM \tag{2}$$

By substituting the function of export and import into equation *(2)*, it shows

$$NX \equiv X(Y^*, \varepsilon) - IM(Y, \varepsilon) \tag{3}$$

After that, substitute equation *(1)* into equation *(3)*

$$NX = X(Y^*, \frac{EP^*}{P}) - IM(Y, \frac{EP^*}{P}) \tag{4}$$

Assume EP*/P is stationary, we can rewrite the equation *(4)* as

$$NX = NX(Y, Y^*, \varepsilon) \tag{5}$$

Therefore, equation (6) expresses the balance of trade as a function of the levels of domestic and foreign income and the real exchange rate.

$$\ln TB_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln Y_t^* + \beta_3 \ln RER_t + u_t \tag{6}$$

where *ln* represents natural logarithm, u_t is assumed to be a white-noise process, and trade balance, TB_t, represents as the ratio of exports to imports allows all variables to be explained in logarithm form and removes the need for appropriate price index to explain the trade balance in real term. In this research, real exchange rate, RER_t, expresses by Ringgit Malaysia (RM) against United States Dollar (US$) and Y^*_t expresses as gross domestic product of United States.

Following classical theory, the sign of β_1 could be either positive or negative. If the estimate of β_1 would be expected to be negative which means that an increase in Malaysian real income, Y_t, increases imports volume. However, if the estimate of β_1 would be expected to be positive which means that an increase in Y_t the is due to an increase in the production of import-substituted goods. Similarly the estimate of β_2 could be either positive or negative. It the sign of β_2 would be depended on whether the supply side factors dominate demand side factors. Marshall-Lerner theory holds when β_3 is positive indicating that depreciation leads to improve the trade balance for Malaysia.

The annual data used to model this equation from year 1955 to 2006 obtained from International Monetary Fund (IMF). During that period, Malaysia has some dramatic change in real exchange rate and trade imbalance. Hence this provides an excellent research condition to examine whether the changes in real exchange rate affect the volume of trade. The trade balance, domestic and foreign incomes are in real terms; the consumer price index (CPI) acts as the price deflator.

Unit root test is used to test of stationary. Following the work of Baharumshah (2001) and Sugema (2005), Augmented Dickey-Fuller (ADF) test and Philips-Perron (PP) test is applied for testing stationarity in economic data. If ADF test and PP test show different results, the Kwiatkowski-Philips-Schmidt-Shin (KPSS) test is used as decisive results. In order to solve the spurious regression problem and violation assumptions of the Classical Regression Model, cointegration analysis used to examine the long-run relationship between TB_t, RER_t, Y_t and Y^*_t. To test for cointegration, three methods are used. There are Engle-Granger Test, Error Correction Model, and Johansen-Juselius Test. In order to know the disequilibrium error, we rewrite equation (6) as:

$$u_t = \ln TB_t - \beta_0 - \beta_1 \ln Y_t - \beta_2 \ln Y_t^* - \beta_3 \ln RER_t \tag{7}$$

In order to perform Engle-Granger Test, the order of integration of the estimated residual, u_t, should be tested. If there is a cointegrating regression, then disequilibrium errors in equation (7) should form a stationary time series, and have a zero mean, the u_t should be stationary, I(0) with $E(u_t) = 0$.

The long run equilibrium may be rarely observed, but there is a tendency to move towards equilibrium. Thus, Error Correction Model is used to represent the long-run (static) and short-run (dynamic) relationships between trade balance, real exchange rate, domestic and foreign income. According to Baharumshah (2001), Onafowora (2003), Ahmad and Yang (2004) and Sugema (2005), Vector Error Correction Model is suitable to estimate the effect of exchange rate on trade balance. The equation (8) represents Error Correction Model as:

$$\Delta \ln TB_t = lagged(\Delta TB_t, \Delta RER_t, \Delta Y_t, \Delta Y_t^*) - \lambda u_{t-1} + v_t \tag{8}$$

where u_{t-1} represents the residual term at *t-1* in long term.

Both, Engle-Granger Test and Vector Error Correction Model (VECM), are test for whether the long-run relationship exists in equation only. Following the work of Shirvani and Wilbratte (1997), Baharumshah (2001), Onafowora (2003), Gomez and Alvarez-Ude (2006), Johansen-Juselius test is used to perform hypothesis tests about the number of the long-run relationship exists in equation. To use Johansen-Juselius's method, the Vector Autoregressive (VAR) of the form needed to turn first,

$$Z_t = \beta_1 Z_{t-1} + \beta_2 Z_{t-2} + \mathrm{K} + \beta_k Z_{t-k} + v_t, \qquad t = 1,\mathrm{K}\ ,T \tag{9}$$

into a Vector Error Correction Model (VECM), which can be written as

$$\Delta Z_t = \Pi\, Z_{t-k} + \Gamma_1\, \Delta Z_{t-1} + \Gamma_2\, \Delta Z_{t-2} + \ldots + \Gamma_{k-1}\, \Delta Z_{t-(k-1)} + v_t \tag{10}$$

The test for cointegration between the Z is calculated by looking at the rank of the Π matrix via its eigenvalues. The rank of a matrix is equal to the number of its characteristic roots (eigenvalues) that are different from zero. Π represents how many linear combinations of Z_t are stationary. The vector Z_t included of trade balance (*TB*), real exchange rate (*RER*), domestic income (*Y*) and foreign income (*Y**). Thus, $Z_t = [TB\ RER\ Y\ Y^*]$. We have chosen the number of lags based on Akaike Information Criterion (AIC) and Schwarz Criterion (SIC). Next, following Johansen-Juselius's approach, the number of cointegrating equilibrium relationship between the logarithms of trade balance, domestic and foreign national income and real exchange rate should be tested. Two statistics for cointegration used: the trace statistic, λ_{trace}, and the maximal-eigenvalue statistic, λ_{max}. Both test statistics are the estimated value for the *i*th ordered eigenvalue from the Π matrix. The r set from zero to $k - 1$, where $k = 4$ (k represents the number of endogenous variables in this research).

For trace statistic, the test statistic for cointegration is formulated as

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i)$$

where T represents the sample size, r represents number of long run relationship exist, and $\hat{\lambda}$ represents the eigunvalue. For trace statistic, the null hypothesis is the number of cointegrating vectors is less than equal to r against an unspecified alternative. If λ_{trace} equal to zero, all the λ_i equal to zero, so it is a joint test.

For maximal-eigenvalue statistic, the test statistic for cointegration is formulated as

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$

The null hypothesis for maximal-eigenvalue statistic is the number of cointegrating vectors is r against an alternative of $r + 1$.

Before forecasting with the final model, it is necessary to perform various diagnostic tests to verify the adequacy of representation of the model. To test the parameter, the t-test is used. In order to test the direction of causality between two variables, the Pairwise Granger Causality Test is used. For analyzing the residual, Portmanteau Autocorrelations (Q) test, Autocorrelation LM (LM) test, White heteroskedasticity (White), and Jarque-Bera residual normality test via Cholesky (JB_{CHOL}) and Urzua (JB_{URZ}) factorizations are applied. Impulse response analysis provides the information about interaction among the variables in the system, therefore used for forecast purpose. Impulse response functions seek the effects of a shock to endogenous variable on the other variables in the system. According to Gomez and Alvarez-Ude (2006), the impulse response function map out the dynamic response of trade balance to Cholesky one standard deviation real exchange rate innovation. Following works of Baharumshah (2001), Akbostanci (2002), Onafowora (2003), Sugema (2005) and Gomez and Alvarez-Ude (2006), Impulse Response Function used to determine whether J-curve theory exists in Malaysia.

5. Research result

Table 1 reports the results of the ADF tests and PP tests for unit root on both the level and the first difference of the variables (for all tables, refer Appendix). The null hypothesis in ADF tests and PP tests are that the variables follow a difference stationary process is tested. Both ADF tests and PP tests show that *ln RER* and *ln Y* are integrated of order one in levels, I (1), and *ln TB* is stationary in level form, I (0). The result of ADF test shows that *ln Y** is integrated of order two in levels, I (2), in intercept without trend model; however, the result of PP test shows that *ln Y** is integrated of order one in levels, I (1), in intercept without trend model. In order to confirm the number of order integration for *ln Y**, the Kwiatkowski-Philips-Schmidt-Shin (KPSS) test was used. The null hypothesis in

KPSS tests is that the variables follow a stationary process is tested. The KPSS result shows that *ln Y** is integrated of order one in levels, I (1) in intercept without trend model (see Table 2). In conclusion, the test statistics indicate that *ln RER*, *ln Y*, and *ln Y** are integrated of order one in levels, I (1), while *ln TB* is stationary in level form, I (0).

The Engle-Granger long-run cointegration test the multivariate system to see whether there exist any linear combinations of the four variables that have common trend. In result, the error term in long run, u_t, is stationary in level form, *I* (0) (See Table 3). This means that has linear combinations between *ln TB*, *ln RER*, *ln Y* and *ln Y**. Thus, we conclude that long-run relationship exists between the variables in the model. The long term effect of trade balance on the normalizing variable is explained by the coefficient of variable in the cointegrating vector after normalizing for trade balance (see Table 4). The positive sign on the real exchange rate (*RER*) variable represents a devaluation of currency causes an improvement in trade balance in long run. Based on classical theory, the sign on domestic income (*Y*) to domestic trade balance is uncertain, it's depending upon whether it represents the level of economic activity or it may also be seen as a supply variable measuring the supply of exportable**.** The positive sign on the domestic income represents an increase in domestic income leads to an improvement in trade balance in the long run. Usually, the sign on the foreign income (*Y**) to domestic trade balance should be positive. Theory suggests that the volume of exports (imports) to a foreign country (domestic country) ought to increase as the real income and purchasing power of the trading partner (domestic economy) rises, and vice versa. However, the result shows that the negative sign on the foreign income (United States) implies that a rise in foreign income leads to a decrease domestic trade balance. This maybe because the rise in foreign real income is due to an increase in the foreign production of import-substitute goods, thus, their imports may decline as income increases.

After estimated the long run relationship between trade balance, real exchange rate, domestic income, and foreign income, the error correction model (ECM) used for estimation. Based on result, lag one is chosen based on Akaike Information Criterion (AIC) and Schwarz criterion (SIC). All variables (excluded constant term) is statistically significant at 95% confidence level. The result of error correction model (ECM) shown as:

$$\Delta \ln TB_t = -0.0295 + 0.2411\Delta \ln TB_{t-1} + 0.2572\Delta \ln RER_{t-1} - 0.6481\Delta \ln Y_{t-1} + 1.2616\Delta \ln Y^*_{t-1} - 0.5237u_{t-1}$$

$$t = (-0.8631)\ (2.0837)^{*}\quad (1.7934)^{*}\quad (-3.5955)^{**}\quad (2.3071)^{*}\quad (-4.9323)^{**}$$

where *, ** denote significance at the 5% and 1% level of significance respectively.

The result of diagnostic checking shown that well-behaved residuals in all period (see Table 5).The result of Pairwise Granger Causality shown that there is evidence statistically Granger causal effect running from the real exchange rate to the trade balance at 10 percent level. There has unidirectional causality from the real exchange rate to the trade balance exists. These result also suggest that the direction of causality is from the domestic income to the trade balance is significant at 1 percent level. There also shown that unidirectional causality from the domestic income to the trade balance exists. These results also shown that there is evidence statistically Granger causal effect running from the foreign income (United States) to the trade balance at 5 percent level and unidirectional causality from foreign income (United States) to trade balance. Since the Johansen-Juselius test is quite sensitive to the lag length selected, the most commonly used criterions such as AIC and SIC are utilized to determine the proper lag length, all of which suggest that one lag be included. The results of the Johansen-Juselius test are reported in Table 6. In Trace test, it indicates one cointegrating equation at the 5% and 1% level. In Max-eigenvalue test, it indicates one cointegrating equation at the 5% and no cointegration at 1% level.

Impulse response function used to provide information about the short-term responses for trade balances. To test whether J-curve effects exist in Malaysia, we examine the response of trade balance to innovation in real exchange rate. If the response of trade balance to depreciation has shown a J-shape indicating that J-curve effects exist in Malaysia. This means that depreciation would worsen the trade balance first and then having improvements in trade balance after several periods. The impulse response function of trade balance to shock in the real exchange rate is shown in Figure 1. From Figure 1, we know that trade balance increases quickly to respond the innovation due to depreciation in next two year. After that, trade balance has improved slowly down from year 2 to year 7. And then, the shock has continuing effect permanently. From Figure 1, the impact does not follow the classical J-curve pattern. Thus, J-curve hypothesis is invalid for Malaysia case.

6. Conclusion

In order to test whether Marshall-Lerner condition and J-curve effects exist, this research studied the short run and long run effect of the real exchange rate on the Malaysian trade balance in a dynamic model. In this research, the results support the empirical validity of the Marshall-Lerner condition through VECM, indicating that depreciation has improved the trade balance. This result has further confirms through the empirical work reported by Baharumshah (2001). The empirical work for different set of countries that reported by Shirvani and Wilbratte

(1997), Sugema (2005), Akbostanci (2002) and Thorbecke (2006) are also suggested Marshall-Lerner condition exists.

However, VECM analysis does not find the evidence of the short term worsening of trade balance suggested by the J-curve effects. Thus, by using impulse response functions, the result show that Malaysian trade balance has not followed the J-curve pattern of adjustment or in another words, the result show no evidence for the J-curve hypothesis. This result is consistent with Baharumshah (2001). The empirical work for different set of countries that reported by Rose and Yellen (1989), Akbostanci (2002), Ahmad and Yang (2004), Gomez and Alvarez-Ude (2006), also suggested that no evidence of J-curve effects.

As implication, in order to achieve the desired effects on trade balance, the countries should depend on policy that focusing on the variable of real exchange rate, which is the nominal exchange rate to aggregate price level. At the same time, the devaluation-based policies (affected through changes in nominal exchange rate) must cooperate with stabilization policies (to ensure domestic price level stability) to achieve the desired level of trade balance. However, devaluation-based policies had caused some problem. Devaluation-based policies would cause increases in the cost of import. This might lead to import inflation that would damage the domestic firms that use imported inputs. Besides that, the devaluation-based policies may not effective in improving trade balance if other countries also apply the devaluation-based policies at the same time. On the other hand, the countries should implement the policy that focuses on the production of imported-substituted goods. Import-substitution policy may work well in improving domestic income and trade balance.

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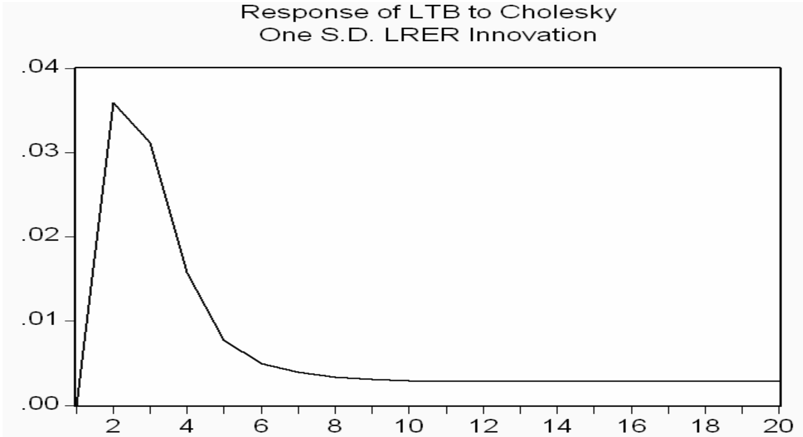

Figure 1. Response of LTB to Cholesky One S.D. LRER Innovation

Appendix

Table 1. Testing for Unit Root (ADF & PP test)

	ADF stat.		PP stat.	
Variables	Intercept & no trend	Intercept & trend	Intercept & no trend	Intercept & trend
ln TB	-4.0302**	-3.9965*	-4.0030**	-3.9081*
	(0.0027)	(0.0151)	(0.0029)	(0.0187)
ln RER	-0.8049	-2.2823	-0.6402	-2.2851
	(0.8091)	(0.4355)	(0.8520)	(0.4341)
ln Y	0.6961	-2.7771	0.5595	-2.8662
	(0.9910)	(0.2122)	(0.9872)	(0.1818)
*ln Y**	-1.0674	-0.4965	-0.8322	-0.7387
	(0.7215)	(0.9806)	(0.8012)	(0.9644)
Δ*ln TB*	-4.8441**	-4.8861**	-8.9251**	-8.8943**
	(0.0003)	(0.0014)	(0.0000)	(0.0000)
Δ*ln RER*	-7.3252**	-7.2673**	-7.5435**	-7.6354**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Δ*ln Y*	-5.7823**	-5.7587**	-5.7317**	-5.7092**
	(0.0000)	(0.0001)	(0.0000)	(0.0001)
Δ*ln Y**	-2.0718	-4.2251**	-4.2324**	-4.3117**
	(0.2566)	(0.0082)	(0.0015)	(0.0065)

*Note: *, ** denote significance at the 5% and 1% level of significance respectively.*

( ) denotes the p-value.

Table 2. Kwiatkowski-Philips-Schmidt-Shin (KPSS) test (Intercept without trend)

Variable	KPSS Stat.	1%CV	5%CV	10%CV
Δ*ln Y**	0.2514	0.7390	0.4630	0.3470

Note: 1%CV, 5%CV, and 10%CV stand for 1% critical values, 5% critical values, and 10% critical values.

Table 3. Result of Engle-Granger Test

Variable	ADF stat.	
	t-statistic	Prob.
u	-3.9711	0.0002

Table 4. Estimated Cointegrated Vectors in Johansen

	ln TB	*ln RER*	*ln Y*	*lnY**	*Constant*
Msia/US	-1.0000	0.0851	0.0992	-0.1324	0.0401

Note: The estimated coefficients were obtained by normalizing the trade balance variable.

Table 5.Diagnostic Checking

A. Residuals-Diagnostic Views

H_0: non autocorrelation		H_0: normality		H_0: homoscedasticity
Q	LM	JB_{Chol}	JB_{Urz}	White
18.95	13.70	184.68	323.46	230.56

B. Pairwise Granger Causality Result Based on VECM [Msia/US(lag 1)]

x^2-statistics (p-value)

	Δln TB	*Δln RER*	*Δln Y*	*Δln Y**
Dependent Variable				
Δln TB	-	3.21(0.07)*	12.92(0.00)***	5.32(0.02)**
Δln RER	0.11(0.73)	-	0.00(0.99)	0.07(0.78)
Δln Y	0.20(0.64)	0.75(0.38)	-	1.95(0.16)
*Δln Y**	0.30(0.58)	0.10(0.91)	0.04(0.82)	-

*Note: The x^2 (Wald) statistics for the joint significance of each of the other lagged endogenous variables in that equation. ( ) denotes the p-value. *, **, *** denote significance at the 10%, 5% and 1% level of significance respectively.*

Table 6. Testing for Cointegration (Full Sample) lag 1

H_0	H_1	5%CV	1%CV	**Trace stat.**
r≤0	*r*>0	47.21	54.46	57.4729**
r≤1	*r*>2	29.68	35.65	26.4101
				λ Max
r=0	*r*=1	27.07	32.24	31.0627*
r=1	*r*=2	20.97	25.52	16.4820

*Note: * (**) denotes rejection of the hypothesis at 5 %(1%) level. 5%CV and 1%CV stand for 5% critical values and 1% critical values. Chosen r to denote number of cointegrating equation under both tests.*