E C O N O M I C S   B U L L E T I N

# Exchange rate and trade balance in east asia: is there a J−curve?

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## *Abstract*

This paper examines the short run and long run effects of real exchange rate changes on the real trade balance of three ASEAN countries in their bilateral trade to the US and Japan within a cointegrating vector error correction model (VECM). Generalized impulse response funtions are estimated to investigate the response to shocks. VECM estimates suggest one long−run steady−state cointegrating relationship among real trade balance, real exchange rate, real domestic and foreign income in each country. Although considerable variations exist in the results, overall the generalized impulse response functions suggest that the Marshall−Lerner condition holds in the long−run with varying degree of J−curve effects in the short−run.

I would like to thank participants at the IABR Conference, Acapulco, Mexico, March, 2003 as well as an anonymous referee and the associate editor for their helpful comments and suggestions.
**Citation:** ONAFOWORA, OLUGBENGA, (2003) "Exchange rate and trade balance in east asia: is there a J−curve?." *Economics Bulletin,* Vol. 5, No. 18 pp. 1−13
**Submitted:** April 1, 2003. **Accepted:** November 24, 2003.
**URL:** http://www.economicsbulletin.com/2003/volume5/EB−03E00003A.pdf

## 1. Introduction

Many empirical analyses, both multi-country panel regressions and econometric models applied to individual countries, have been conducted into how exchange rate changes affect the trade balance of developing and developed countries[1]. Despite the plethora of theoretical and empirical research into how exchange rate changes affect trade balance, there is still considerable disagreement concerning the relationships between these economic variables and the effectiveness of currency devaluation as a tool for increasing a country's balance of trade. Consequently, the effect of exchange rate changes on trade balance must be considered an open question from both analytical and empirical perspectives. The premise that there is no clear resolution - neither analytical nor empirical- regarding the effectiveness of currency devaluation as a tool for increasing a country's trade balance calls for a fresh look at the issue using recent advancements in the field of time series econometrics.

The large exchange rate depreciations registered in a number of East Asian countries since mid-1990s offers an excellent opportunity for the question whether devaluations in by themselves have a significant impact on trade flows, and whether the Marshall-Lerner (ML) conditions hold. The aim of this paper is to examine the relationships between the real trade balance and real exchange rate for three ASEAN countries - Thailand, Malaysia, and Indonesia- in their bilateral trade to the US and Japan over the quarterly period 1980:1 to 2001:4 using cointegration analysis and a vector error correction model (VECM) framework which treats all variables in the model as potentially endogenous. We further investigate the dynamics of the trade balance by estimating generalized impulse response functions as introduced by Pesaran and Shin (1998) to investigate the effects of shocks and trace out potential J-curve effects in the data.

Evidence from the Johansen (1988) maximum likelihood tests for cointegration among bilateral real trade balance, bilateral real exchange rate, and real domestic and real foreign income in the sampled countries suggest that the variables are causally related in the long run with one cointegrating vector in the model for each country. Parameter stability tests based on the CUSUM of squares test developed by Brown, Durbin and Evans (1975) confirm that the long-run coefficients of the real trade balance equations are fairly stable, suggesting that the models can be used for policy simulation. Although considerable variations exist in the results, overall generalized impulse response analysis suggest that the ML condition holds in the long run with some degree of J-curve effects in the short run.

The rest of the paper is organized as follows. In Section 2 we present the basic model, explain the estimation technique of the study, and discuss the data and its transformation. The empirical results are analyzed in Section 3. Section 4 summarizes the main conclusions reached in the paper.

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[1] See for example, Wilson, 2001, on Malaysia, Korea and Singapore; Akbostanci, 2002, for Turkey; Hsing and Savvides, 1996, on Korea and Taiwan; Bahmani-Oskooee, 1996, for Korea, Pakistan, Philippines, Singapore, Greece and S. Africa; Bahmani-Oskooee, 1985, for India, Korea, Thailand and Greece; Himarios, 1989, for 15 LDCs; Edwards, 1986, for 12 LDCs, and Miles, 1979, for 14 LDCs including the Philippines and Sri Lanka; Leonard and Stockman, 2001, Bahmani-Oskooee and Brooks, 1999, Rose, 1990 and 1991, Krugman and Baldwin, 1987, and Rose and Yellen, 1989, for the US; Marwah and Klein, 1996, for the US and Canada; Lal and Lowinger, 2001, Guptar-Kapoor and Ramakrishnan, 1999, and Noland, 1989, for Japan; Boyd, Caporale, and Smith, 2001, and Bayoumi, 1999 for various industrial countries.

## 2. Model and Estimation

Trade balance is usually measured as the difference between the value of total exports and total imports. In this study, we measure trade balance as the ratio of the bilateral exports value (X) to the bilateral imports value (M). The X/M ratio or its inverse has been used in many empirical investigations of the trade balance-exchange rate relationship (see for example, Lal and Lowinger 2001, Bahmani-Oskooee and Brooks 1999, and Gupta-Kapoor and Ramakrishnan, 1999). One reason for its use is that the ratio is not sensitive to the unit of measurement and can be interpreted as nominal or real trade balance (Bahmani-Oskooee, 1991). Furthermore, as noted by Boyd et al. (2001), the ratio in a logarithmic model gives the Marshall-Lerner condition exactly rather than as an approximation.

We specify the bilateral real trade balance as a function of real domestic income, real foreign income, bilateral real exchange rate, and a (0,1) dummy variable to capture shifts in the bilateral trade relation resulting from the 1997 Asian financial crisis. The reduced form of the equation is given as follows:

$$\ln(X/M)_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln Y_t^* + \alpha_3 \ln RER_t + \alpha_4 D_{97} + \varepsilon_t \qquad (1)$$

Where: *ln* is natural logarithm, $Y_t$ is real domestic income, $Y_t$* is real foreign income, $RER_t$ is bilateral real exchange rate, $D_{97}$ is a shift dummy variable that takes the value of zero for the period before 1997 and one otherwise, and å$_t$ is an error term. $RER_t$ is defined as $RER_t$ = (EP*/P), where E is the nominal effective exchange rate, and P* and P are the foreign and domestic price levels respectively.

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. So we expect á$_1$< 0 and á$_2$ >0. However, if the rise in real income is due to an increase in the production of import-substitute goods, imports may decline as income increases in which case á$_1$ > 0 and á$_2$ < 0. The impact of exchange rate changes on trade balance is ambiguous, that is, á$_3$ could be positive or negative. If there is a real depreciation or devaluation of the domestic currency, that is RER increase, then the increased competitiveness in prices for the domestic country should result in it exporting more and importing less (the "volume effect"). However, the higher RER also increases the value of each unit of import (the "import value effect"), which would tend to diminish the trade balance[2]. Krugman and Obstfeld (2001) argued that in the short run import value effects prevail, whereas the volume effects dominate in the longer run. á$_3$ > 0 satisfies the Marshall-Lerner condition. The sign on á$_4$ is ambiguous; it has to be determined empirically since it can be positive or negative.

"(1)" describes the long-run equilibrium relationship among the variables in the bilateral real trade balance model for each country. The next question is the pattern of dynamic adjustments that occur in the short-run to establish these long-run relations in response to various shocks to the system. In order to examine these adjustments, the following vector error correction model (VECM) is estimated for each country:

[2] The terms "volume effect" and "import value effect" are from Krugman and Obstfeld (2001).

$$\Delta Z_t = \sum_{i-1}^{k-1} \Gamma_i \Delta Z_{t-i} + \alpha\beta' Z_{t-1} + \mu + \varepsilon_t \qquad (2)$$

where, $Z_t$ is the vector of endogenous variables, viz., [X/M, Y, Y*, RER, $D_{97}$], $Ã_i$ is the matrix of coefficients for the growth rates of the variables, i is the lag order, k is the maximum number of the lag length, á is the vector of adjustment parameters, â' is the vector of cointegrating relationships (the long run parameters), ì is the vector of deterministic components, and $å_t$ is the vector of independently distributed error terms with constant variance.

As implemented in this paper, estimation of the VECM follows four stages. Since the choice of the lag orders of the variables in the VECM specification can have a significant effect on the inference drawn from the model, as the first stage of the analysis we sequentially determine the appropriate lag length for each variable by using Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), and Adjusted Likelihood Ratio (ALR) tests. Once the optimal lag order has been determined, the next stage is to test for the presence of unit roots of each variable using the augmented Dickey-Fuller (ADF) unit root tests (Dickey and Fuller, 1981). Contingent on the outcome of the unit roots tests, the next stage is to test for cointegration by utilizing the Johansen (1988) and Johansen /Juselius (1990) maximum likelihood procedure.

A test for cointegration means looking for stable long-run equilibrium relationships among non-stationary economic variables. If the results indicate the absence of cointegrating vectors between the variables, it means that there is no long-run stable relationship between them. If cointegration exists, then it can be presumed that a one-way or two-way Granger causality exists in at least the stationary series, and further more a dynamic specification of the error correction mechanism is appropriate (Engle and Granger, 2000). If the variables are found to cointegrate, then we estimate the cointegrating vector(s) by applying the method suggested by Johansen (1988) and Johansen/Juselius (1990). As the final step in our empirical analysis, we estimate the VECM to generate the generalized impulse response functions and trace out the potential J-curve effects for each country.

For the econometric analysis, we use quarterly data covering the period 1980:1 to 2001:4 drawn from the IMF, *International Financial Statistics, 2002CD-ROM*, and IMF, *Direction of Trade Statistics Quarterly*. The bilateral real exchange rate against the US dollar is computed by multiplying the nominal exchange rate by the ratio of the US wholesale price index to the domestic price level. A similar procedure is followed to generate the real rate against the Japanese yen after computing the domestic currency value of the yen from the ratio of the domestic currency exchange rate against the US dollar to the yen rate against the US dollar. The real foreign income is proxied by the Japanese or the US quarterly real GDP. With the exception of Malaysia, where we use the index of industrial production, for all other countries the quarterly real GDP was used as proxy for the domestic real income. The industrial production was used to represent real income in Malaysia because of absence of quarterly GDP data covering the entire sample period.

## 3. Empirical Results

Prior to testing for cointegration, the optimal lag length on each variable in the VECM model was sequentially determined by applying the SBC, AIC, and ALR tests. The SBC suggested seven lags for Malaysia and Thailand, and eight lags for Indonesia. The AIC tended to indicate higher lag orders. The ALR indicated eight lags for each of the countries. On the basis of the ALR, the optimal lag length in the VECM was set to eight in all the models. The results for the ADF-unit root tests (available on request) indicated that all the variables are stationary at the first difference (I (1)) variables). Given the unit-root properties of the variables we proceed to implement the Johansen (1998) cointegration test procedures. The results of the cointegration tests, reported in Table 1, provide empirical support for the existence of a long-run cointegrating relationship between *ln* (X/M), *ln* (Y), *ln* (Y*), *ln* (RER), and $D_{97}$.

Since there is one cointegrating vector linking the variables, an economic interpretation of the results can be obtained by normalizing the cointegrating vector on *ln* (X/M). In Table 2, we report the estimated coefficients of the cointegrating vector, using the Johansen method. In all cases, the results indicate a positive long-run relationship between the real exchange rate and the real trade balance, as would be expected if a real depreciation leads to more quantities being exported and less being imported. The results for Indonesia-Japan, Indonesia-US, and Malaysia-US indicate that real trade balance has a negative long-run relationship with real domestic income and a positive long-run relationship with real foreign income. These signs are what we would expect if demand were the driving force in determining exports and imports. In the models for Thailand-Japan, Thailand-US, and Malaysia-Japan, the real trade balance has a positive long-run relationship with real domestic income and a negative long run relationship with real foreign income. These signs are what we would expect if an increase in real income were due to increased productivity or production of import substitute goods and supply is the driving force in determining exports and imports[3]. Finally, a statistically significant coefficient on the shift dummy variable is observed in all the equations. This suggests that the 1997 Asian financial crisis, and the reforms driven by the crisis, significantly impacted the real trade balance relation. However, the fact that we find evidence of cointegration in all the models leads us to conclude that the long-run stability of the real trade balance equation is not threatened by these episodes.

Our sample covers a period over which the ASEAN countries experienced a number of major events affecting the variables included in the system[4]. Parameter stability over the sample period is therefore of critical importance to ensure reliability of policy simulations based on the model. To test for parameter constancy, we applied the cumulative sum of squares (CUSUMSQ) stability test developed by Brown, Durbin and Evan (1975) to the residuals of "(1)". Plots of the CUSUMSQ test statistics (presented in Figures A to F) reveal no evidence of major parameter instability in the models, since the CUSUMSQ statistics do not cross the 5% critical bounds. Stability of the estimated elasticities suggests that the models can be considered stable enough for forecasting and policy analysis.

Having established that the variables in the VECM for each country cointegrate and that the parameters are stable, we proceed to examine the dynamic responses in more detail by generating generalized impulse response functions showing the response of the trade balance to a permanent one-standard error depreciation in exchange rate, and trace out possible J-curve effects. With a real devaluation, an initial deterioration in a country' s bilateral real trade balance followed by an improvement would confirm the J-curve effects.

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[3] Supply can be a driving force when increases in domestic output outstrip increases in domestic consumption (due to a high marginal propensity to save in the home country or increased productivity or low domestic absorption), so that higher exports are used to dispose of some of the surplus.

[4] These include the shift from direct control measures to more market based measures to implement monetary policy in the mid-1980s; liberalization of interest rates and exchange rates and increased competition in the banking sector since early 1990s; a move away from import-substitution to export-oriented industrialization strategy and from a *de facto* dollar peg toward a managed float exchange rate system; major economic crisis in mid-1997.

Graphical representations of the generalized impulse response functions are presented in Figures 1 to 6. In Figures 1 and 2, the J-curve effect is observed for Indonesia in its bilateral trade with Japan and with the US. Following a real depreciation, Indonesia shows an initial short-run worsening in real trade balance that is then followed by a long run improvement. The initial deterioration in the real trade balance is more than 1 percent for a one standard deviation shock in real exchange rate. The deterioration lasts for about 3 quarters, after which the volume effects set in. A cyclical pattern emerges as the trade balance eventually settles to a new long run equilibrium level that is higher than the initial value.

Figures 3 and 4 show an initial deterioration in Malaysia's bilateral real trade balance with Japan and with the US following a one standard deviation shock to the real exchange rate. This was followed by an improvement in the trade balance and then by deterioration. Like in the case of Indonesia, a cyclical pattern emerges as the trade balance settles to a new long-run equilibrium level that is just slightly higher than the initial value. The initial negative effect of a real depreciation on Malaysia's trade balance with Japan and with the US is supportive of the J-curve hypothesis.

In Figure 5, it is observed that within 4 quarters of a real depreciation in the exchange rate, Thailand's real trade balance with respect to Japan improved 0.5 percent. This was followed by a worsening in the trade balance and then by an improvement after 10 quarters. Overall, it is observed that Thailand's trade balance with respect to Japan reacts positively to real depreciation both in the short run and long run. The positive short-run effect of a real depreciation on this trade balance is not supportive of the classic J-curve hypothesis. In contrast, a J-curve effect is observed for Thailand in its bilateral trade with the US. As can be seen in Figure 6, a real exchange rate shock initially worsened Thailand's real trade balance with respect to the US. The deterioration lasts for 3 quarters, after which the trade balance improved before falling again to a value lower than the initial value. Beyond 15 quarters there is an improvement as the trade balance settles to a new long run equilibrium level that is only slightly higher than the initial value.

How are these results compared to recent works using similar a methodology? Our findings for Malaysia-US bilateral trade are consistent with those of Wilson (2001). Wilson used a partial reduced form framework to examine the relationship between real trade balance and real exchange rate for Singapore, Malaysia and Korea in their trade to both the US and Japan over the quarterly period 1970 to 1996. The cyclical pattern of adjustments observed for these East Asian countries are also similar to the findings of Marwah and Klein (1996) for the US and Canada. They found that after a real devaluation that there was a tendency for the trade balance to first deteriorate and then to improve, but after several quarters, the trade balance worsens again.

## 4. Conclusions

The objective of this paper has been to examine the short run and long run effects of real exchange rate changes on the real trade balance for three ASEAN countries - Thailand, Malaysia, and Indonesia- in their bilateral trade with both the US and Japan and to determine whether the Marshall-Lerner conditions hold. Using a cointegration vector error correction framework that treats all the variables in the model as potentially endogenous we estimated generalized impulse response functions to trace out the potential effects of real bilateral exchange rate shocks on the bilateral trade ratio. In all cases, cointegration analysis indicated that there is a long run steady-state relationship among real trade balance, real exchange rate, real domestic income, and real foreign income. CUSUMSQ parameter stability tests confirmed that the models are fairly stable over the period of analysis.

For Indonesia and Malaysia in their bilateral trade to both the US and Japan, and for Thailand in its bilateral trade to the US, our findings suggest that there are short run J-curve effects. With a real depreciation there is an initial worsening in the trade balance that lasts about 4 quarters but this is followed by an improvement in the long run. Thailand has the opposite movement in its bilateral trade to Japan: a real exchange rate devaluation shock initially improved then worsened and then improved the trade balance. This pattern does not support the classic J-curve hypothesis but is consistent with the S-curve pattern described by Backus et al (1994) and Marwah and Klein (1996).

Overall, the results of the generalized impulse response analyses suggest that the Marshall-Lerner condition holds in the long run with varying degree of J-curve effects in the short run. These finding have some implications for these East Asian countries bilateral trade with Japan and with the US. Based on the Marshall-Lerner condition, a continued depreciation of these East Asian countries currencies against the US dollar and Japanese yen is likely to lead to an improvement in their trade balance with the US and Japan. However, this improvement will occur only 3 or 4 periods after a real devaluation.

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Table 1. Johansen's Maximum Likelihood Cointegration Procedure

Cointegration LR Test based on the Maximum Eigen Values of the Stochastic Matrix: X/M, Y, Y*, RER, $D_{97}$

| | Eigen-value | Likelihood ratio statistic | 5 % critical value | 1% critical value | Hypothesized No. of CE(s) |
|---|---|---|---|---|---|
| Indonesia/Japan | 0.481 | 96.94 | 68.52 | 76.07 | None ** |
| | 0.245 | 43.70 | 47.21 | 54.46 | At most 1 |
| | 0.126 | 20.89 | 29.68 | 35.65 | At most 2 |
| | 0.085 | 10.00 | 15.41 | 20.04 | At most 3 |
| | 0.034 | 2.82 | 3.76 | 6.65 | At most 4 |
| Indonesia/US | 0.616 | 122.22 | 68.52 | 76.07 | None ** |
| | 0.218 | 44.58 | 47.21 | 54.46 | At most 1 |
| | 0.177 | 24.64 | 29.68 | 35.65 | At most 2 |
| | 0.082 | 8.89 | 15.41 | 20.04 | At most 3 |
| | 0.228 | 1.87 | 3.76 | 6.65 | At most 4 |
| Malaysia/Japan | 0.421 | 87.85 | 68.52 | 76.07 | None ** |
| | 0.208 | 43.61 | 47.21 | 54.46 | At most 1 |
| | 0.172 | 24.64 | 29.68 | 35.65 | At most 2 |
| | 0.093 | 9.38 | 15.41 | 20.04 | At most 3 |
| | 0.019 | 1.52 | 3.76 | 6.65 | At most 4 |
| Malaysia/US | 0.449 | 97.69 | 68.52 | 76.07 | None ** |
| | 0.290 | 49.43 | 47.21 | 54.46 | At most 1 |
| | 0.112 | 21.67 | 29.68 | 35.65 | At most 2 |
| | 0.102 | 12.04 | 15.41 | 20.04 | At most 3 |
| | 0.040 | 3.31 | 3.76 | 6.65 | At most 4 |
| Thailand/Japan | 0.741 | 125.53 | 68.52 | 76.07 | None** |
| | 0.521 | 44.70 | 47.21 | 54.46 | At most 1 |
| | 0.383 | 27.89 | 29.68 | 35.65 | At most 2 |
| | 0.250 | 13.73 | 15.41 | 20.04 | At most 3 |
| | 0.116 | 3.53 | 3.76 | 6.65 | At most 4 |
| Thailand/US | 0.471 | 84.76 | 68.52 | 76.07 | None** |
| | 0.212 | 33.77 | 47.21 | 54.46 | At most 1 |
| | 0.073 | 14.69 | 29.68 | 35.65 | At most 2 |
| | 0.064 | 8.63 | 15.41 | 20.04 | At most 3 |
| | 0.041 | 3.35 | 3.76 | 6.65 | At most 4 |

Note: ** denotes rejection of null hypothesis at 5 percent level.

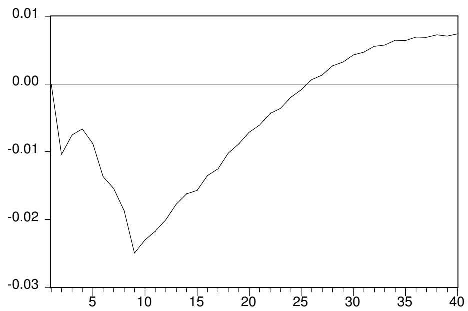
Table 2. Estimated Cointegrating Coefficients Derived by Normalizing on ln (X/M)

| Country | *ln* (X/M) | *ln*Y | *ln*Y* | *ln* RER | $D_{97}$ | Constant |
|---|---|---|---|---|---|---|
| Indonesia/Japan | 1.000 | -0.532 | 1.269 | 0.351 | -3.957 | -5.981 |
| | | (0.193) | (0.049) | (0.147) | (0.541) | |
| Indonesia/US | 1.000 | -0.722 | 1.428 | 0.243 | 2.117 | -4.459 |
| | | (0.249) | (0.548) | (0.121) | (0.395) | |
| Malaysia/Japan | 1.000 | 1.155 | 0.479 | 1.252 | -0.625 | -1.395 |
| | | (0.157) | (0.068) | (0.251) | (0.240) | |
| Malaysia/US | 1.000 | -0.804 | 0.614 | 0.644 | -0.312 | -3.503 |
| | | (0.092) | (0.046) | (0.095) | (0.138) | |
| Thailand/Japan | 1.000 | 0.961 | 0.722 | 1.082 | 1.306 | 7.939 |
| | | (0.112) | (0.252) | (0.082) | (0.103) | |
| Thailand/US | 1.000 | 1.089 | -0.429 | 1.665 | -0.346 | -2.546 |
| | | (0.167) | (0.136) | (0.223) | (0.097) | |

Note: Standard errors are enclosed in the parentheses.

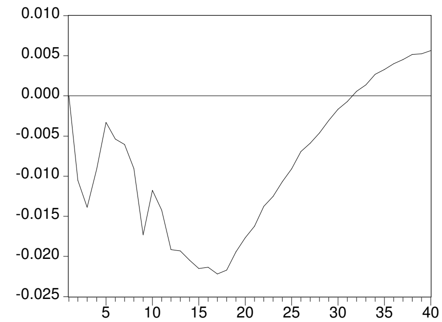
# Plots of the Generalized Impulse Response Functions

Figure 1. Indonesia-Japan



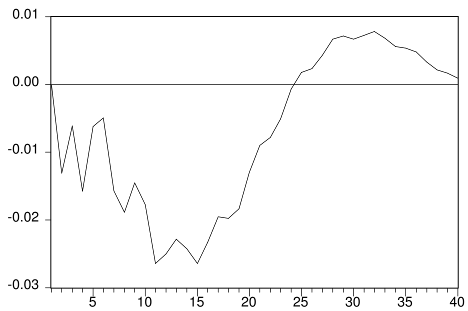

Response of X/M to One S.D. Depreciation in Exchange Rate

Figure 2. Indonesia-US



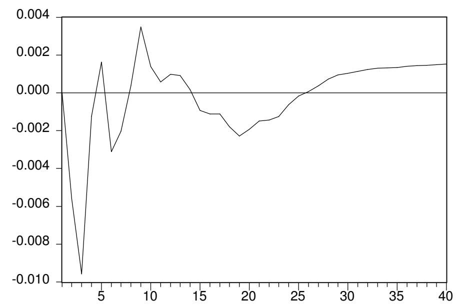

Response of X/M to One S.D. depreciation in Exchange Rate

Figure 3. Malaysia Japan



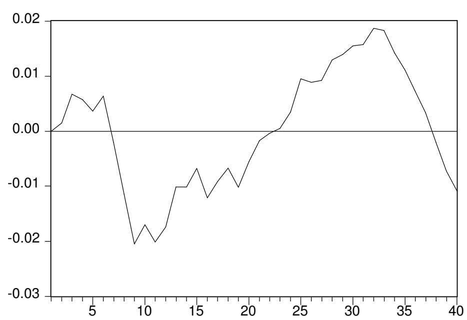

Response of X/M to One S.D. depreciation in Exchange Rate

Figure 4. Malaysia-US



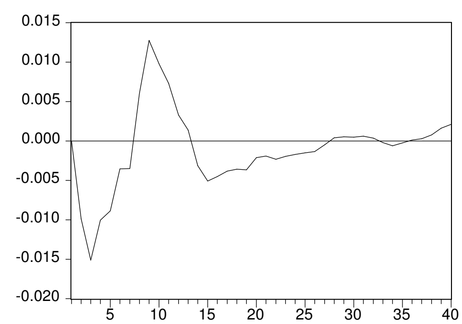

Response of X/M to One S.D. depreciation in Exchange Rate

Figure 5. Thailand-Japan




Response of X\M to One S.D. depreciation in Exchange Rate

Figure 6. Thailand-US




Response of X/M to One S.D. Depreciation in Exchange Rate

## Plots of the CUSUM of Squares Stability Test Statistics

Figure A. Indonesia-Japan

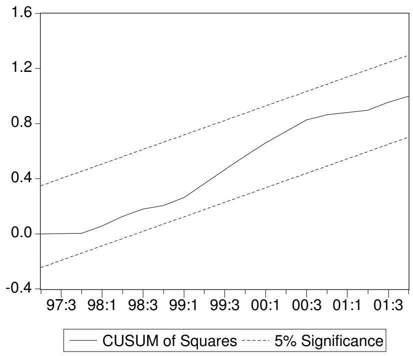



Figure B. Indonesia-US

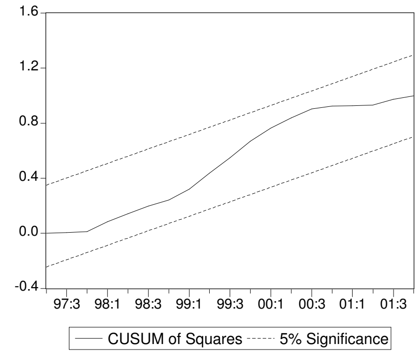



Figure C. Malaysia-Japan

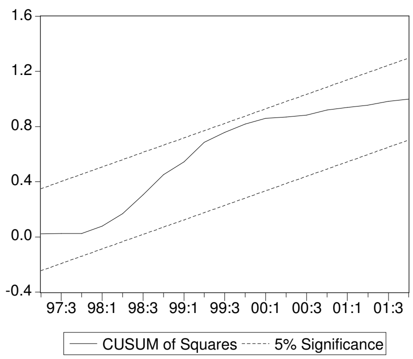



Figure D. Malaysia-US

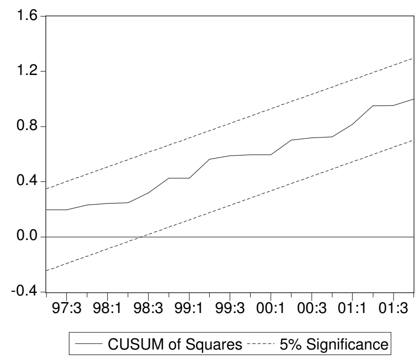



Figure E. Thailand-Japan

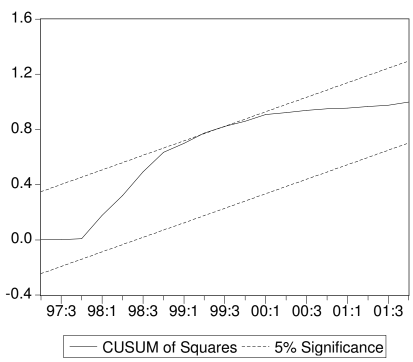



Figure F. Thailand-US