Exchange Rate Uncertainty and Import Demand of Thailand

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March 2013

NATIONAL INSTITUTE OF DEVELOPMENT ADMINISTRATION

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Working Paper

February 2013

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ABSTRACT

This study investigates the impact of real exchange rate uncertainty on import demand of Thailand. The period of study is during July 1997 to December 2011. The results from bounds testing for cointegration show that all variables are cointegrated. Even though there is no short-run impact, but the long-run negative impact of real exchange rate uncertainty on real imports is large and highly significant under the floating exchange rate regime. In the long run, a rise in real exchange rate uncertainty can improve the country's trade balance by substantially lowering import demand, but can harm industrial production at the same time. Therefore, stabilization of real effective exchange rate via major nominal exchange rates may deem necessary.

Key words: **exchange rate uncertainty, GARCH, imports, ARDL bounds testing**
JEL Classification: **F11, F17**

INTRODUCTION

The conventional equations are used to analyze the determinants of trade flows in earlier previous studies. Two important determinants in these equations (exports and imports) are real exchange rate and real income. Warner and Kreinin (1983) use the data from 19 developing countries to identify the determinants of trade flows. They find that the impact of real exchange rate is strong on exports, but ambiguous on imports. Miles (1979) examines the impact of devaluation on trade flows, but finds that the test results are not convincing. However, the reexamination by Himarios (1989) shows that real exchange rate significantly affects trade flows. Arize and Walker (1992) employ cointegration analysis to find the determinants of import demand in Japan and find that the omission of effective exchange rate can lead to insignificant results. Tang (2004) reassesses aggregate import demand function in the ASEAN-5 economies. The results from bounds testing for cointegration show that the volume of imports, national cash flow and relative price of imports are not cointegrated in Thailand and other two ASEAN countries. Hegerty *et al.* (forthcoming) give a thorough review of the Marshall-Lerner condition, which states that a depreciation of real exchange rate improves trade balance, and vice versa. They find that the evidence that supports the Marshall-Lerner condition is weak.

Earlier studies that focus on the impact of exchange rate volatility on trade flows have emerged since the 1970s. Hooper and Kohlhagen (1978) examine the impact of exchange rate volatility on imports of five advanced countries (Germany, Japan, UK, the US, Canada and France) during 1965 and 1975. They find that exchange rate volatility measured by the standard error of movements in nominal exchange rate positively affects imports of Japan, UK, the US and Canada. However, the negative impact is found for imports of Germany. De Grauwe (1988) posits that a positive relationship between exchange rate volatility and trade flows can be found when income effect dominates substitution effect. In addition, the degree of risk aversion of traders can play important role in this relationship. Caporale and Doroodian (1994) adopt a generalized autoregressive conditional heteroskedastic (GARCH) model to generate exchange rate volatility to examine the US imports from Canada during 1974 and 1992. They find that the impact of exchange rate volatility is negative. Arize (1998) also obtains the results of negative impact of exchange rate volatility on the US imports. Doroodian (1999) finds that exchange rate uncertainty imposes a negative effect on trade flows of India, Malaysia and South Korea. Siregar and Rajan (2004) find no relationship between exchange rate volatility and import flows in Indonesia. Zhang et al. (2006) find that trade volume tends to rise when exchange rate volatility surpasses a certain threshold point. Naseem *et al.* (2009) obtain the results showing that exchange rate volatility does not affect import flows of Malaysia before the 1997 financial crisis, but slightly imposes a positive impact on the import flows after the financial crisis. Akpokodje and Omojimite (2009) find that exchange rate uncertainty imposes a negative effect on imports of selected African countries. Coric and Pugh (2010) indicate that exchange rate variability seems to exert a negative impact on trade flows. Erdem *et al.* (2010) find the evidence of negative impact of exchange rate uncertainty on trade volumes with stronger impact on imports than exports. Alam (2012) also finds a negative impact of real exchange rate volatility on imports of Pakistan in the long run. It can be concluded that there is no consensus on the impact of exchange rate uncertainty on imports as evidenced from the results of previous studies.

Thailand is one of Asian countries that have liberalized trade policy. It is widely believed that import flow reacts more rapidly to trade liberalization compared to export flow. After a switching from fixed to floating exchange rate regime, the country has faced unpredictable movements in real effective exchange rate.

Figure 1. Index of real effective exchange rate, July 1997 to December 2011

Figure 1 shows the real effective exchange rate index after Thailand adopted the floating exchange rate regime. The real effective exchange rate dropped sharply after the financial crisis and recovered in 1998. For the rest of the period the real exchange rate moved up and down with the rising trend starting from 2005 onward. The Asian financial crisis led to pronounced swings in the real effective exchange rate and thus caused Thai importers to face unavoidable uncertainty with the relative prices of imported good, especially capital equipment. Figure 2 shows the real exchange rate uncertainty.[1]

[1] The uncertainty series is generated from the AR(1)-EGARCH(1,1) model specified in equations (3) and (4).

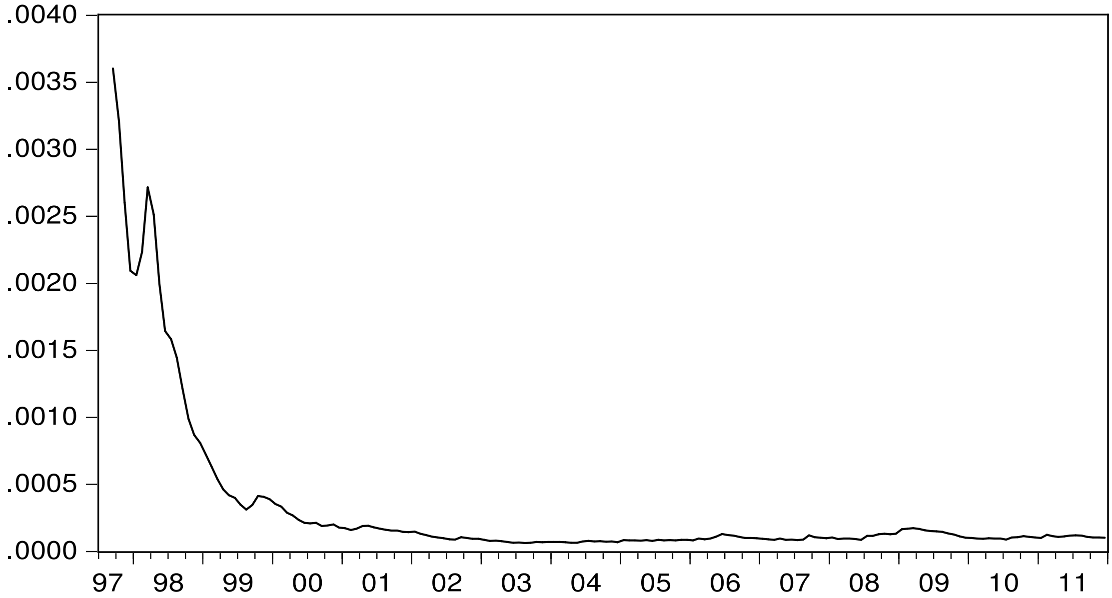

Figure 2. Volatility of the real effective exchange rate for Thailand

The real effective exchange rate uncertainty seemed to subside after four years of the floating exchange rate regime. However, this uncertainty might well effects real imports of the country. The results from this study are able to provide some implications regarding commercial policy that deals with trade imbalances. Whether or not revision of commercial policy is necessary, policymakers should know what factors determine the import demand function of the country, especially the impact of real exchange rate uncertainty.[2] The present paper provides an evidence of long-run negative impact of real exchange rate uncertainty on real imports of Thailand under the floating exchange rate regime. The paper is organized as the following. Section 2 describes the data and empirical model. Section 3 gives empirical results, and the final section gives concluding remarks.

DATA AND METHODOLOGY

Data

Monthly data from July 1997 to December 2011 are collected from the Bank of Thailand. The data consist of real imports, real effective exchange rate, and industrial production index used as a proxy of domestic real income.[3] The period of investigation is under the floating exchange rate regime, which can cause higher degree of exchange rate uncertainty (see Hassan and Wallace, 1996, Naseem, *et al.* 2009).

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[2] Arize, *et al.* (2008) point out the importance of this issue for countries that switched from a fixed to a flexible exchange rate regime because they can experience higher degree of exchange rate fluctuations.

[3] The reasons for using a proxy are two folds. Firstly, industrial production is considered as real activity that stimulates growth in the country. Secondly, industrial production index is available in monthly series.

Empirical Models for Estimations

The model used in this study relies on the international trade theory. The generalized Marshall-Lerner condition can be investigated using the import demand function that emphasizes the role of real exchange rate and real domestic income. The linear functional form for import demand is specified as

$$LM_t = a_0 + a_1 LRER_t + a_2 LY_t + \varepsilon_t \tag{1}$$

where *LM* is the log of real aggregate imports, *LRER* is the log of real effective exchange rate as a proxy of relative import price, and *LY* is the log of domestic real income proxied by industrial production index.[4] If the generalized Marshall-Lerner condition holds, a depreciation of real effective exchange rate should reduce real demand for imports and vice versa. The impact of real income variable should be positive, i.e., an increase in domestic real income will induce more spending on imports and vice versa.

The empirical tests of equation (1) are well documented and many previous studies emphasize the role of relative prices rather than the role of effective exchange rate. However, some researchers have recently pay attention to the role of exchange rate uncertainty on import demand. The equation is specified as

$$LM_t = a_0 + a_1 LRER_t + a_2 LY_t + a_4 LV_t + e_t \tag{2}$$

where *LV* is the log of real exchange rate volatility, which is used as a measure of uncertainty in real effective exchange rate. The impact of exchange rate uncertainty on real import demand may be negative or positive as evidenced by the results from most previous studies.

Equation (2) is more relevant under the floating exchange rate regime.[5] When the floating regime is adopted, the degree of fluctuations in nominal bilateral exchange rates between the country and its trading partners should be more pronounced. Since the index of real effective exchange rate is constructed by the weighted average of major currencies, this index should be more fluctuating under the floating than fixed exchange rate regime.

Measuring Real Exchange Rate Uncertainty

The exponential generalized autoregressive conditional heteroskedastic (EGARCH) model developed by Nelson (1991) is used to estimate real exchange rate volatility (or uncertainty). This model is suitable because it includes past variance that affects the conditional variance and asymmetric effects.[6]

[4] Thailand's industrial production can play an important part in generating domestic real income because of the backward and forward linkages to other sectors.

[5] See Gotur (1985) and Kenen and Rodrik (1986).

[6] One of the most popular GARCH model is developed by Bollerslev (1986). However, there are some restrictions in the model and the model does not allow for testing for asymmetry.

The AR(p)-EGARCH(1,1) process is specified by the mean equation in equation (3) and the conditional variance equation in equation (4).

$$R_t = b_0 + \sum_{i=1}^{p} b_i R_{t-i} + \varepsilon_t \tag{3}$$

and

$$\log h_t = \alpha_0 + \alpha_1 \log h_{t-1} + \beta \left| \frac{\varepsilon_{t-1}}{h_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \tag{4}$$

where R is the rate of change in real effective exchange rate, which is a stationary series. The variable h is the conditional variance.

In equation (3), the autoregressive variables take the order of p and can be used to estimate the conditional mean of the variable R. Equation (4) is the EGARCH specification, which shows that the log of conditional variance depends on its past value. The coefficients are not restrictively non-zero. The log of GARCH variance series as a measure of real exchange rate volatility can be obtained from the estimate of AR(p)-EGARCH(1,1) model. If the coefficient γ is non-zero, the impact of uncertainty on real effective exchange rate is asymmetric. If γ is positive, an increase in real effective exchange rate will cause higher volatility and vice versa.

Bounds Testing for Cointegration

The conditional autoregressive distributed lag (ARDL) bounds testing for cointegration proposed by Pesaran *et al*. (2001) is used. The ARDL model for equation (2) is specified as the following equation.

$$\Delta LM_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta LM_{t-1} + \sum_{j=0}^{q} \gamma_j \Delta LRER_{t-j} + \sum_{k=0}^{r} \delta_k \Delta LY_{t-k} + \sum_{l=0}^{s} \phi_l \Delta LV_{t-l} + u_t \tag{5}$$

where p, q, r, and s are the optimal lagged differences of LM, $LRER$, LY and LV, respectively. Once the appropriate ARDL model is specified[7], adding the lagged level of variables into equation (5) will give the equation for testing for cointegration among variables.

$$\Delta LM_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \Delta LM_{t-1} + \sum_{j=0}^{q} \gamma_j \Delta LRER_{t-j} + \sum_{k=0}^{r} \delta_k \Delta LY_{t-k} + \sum_{l=0}^{s} \phi_l \Delta LV_{t-l} + \mu_1 LM_{t-1}$$
$$+ \mu_2 LRER_{t-1} + \mu_3 LY_{t-1} + \mu_4 LV_{t-1} + u_t \tag{6}$$

The computed F-statistic obtained from estimating equation (6) against equation (5) will be compared with the critical F-statistic. If cointegration exists, replacing the lagged level variables with one-period lagged residuals from the estimate of equation

[7] The ARDL model should be free of serial correlation.

(2) will give the coefficient of the error correction term. The short-run dynamic equation can be expressed as the following equation.

$$\Delta LM_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \Delta LM_{t-1} + \sum_{j=0}^{q} \gamma_j \Delta LRER_{t-j} + \sum_{k=0}^{r} \delta_k \Delta LY_{t-k} + \sum_{l=0}^{s} \phi_l \Delta LV_{t-l} + \lambda e_{t-1} + u_t \quad (7)$$

where e_{t-1} is the error correction term (ECT), which is the one-period lag of the error term of the estimate of equation (2). If the coefficient of the ECT is significantly negative and has the absolute value less than one, it implies that any deviation from the long-run equilibrium will be corrected. One of the advantages of this procedure is that re-parameterization of the model into the equivalent error correction model is not required.

EMPIRICAL RESULTS

Results of Unit Root Tests

The bounds testing for cointegration can be performed without prior knowledge of the degree of integration of each series. All series can be integrated at different order as long as the degree of integration of any series does not exceed one. All variables can be integrated of order zero, I(0), or of order one, I(1), or the mix between I(0) and I(1).

However, the unit root tests are performed to ensure that the order of integration of each variable does not exceed one. Table 1 shows the results of the Augmented Dickey-Fuller (ADF) and the Phillips and Perron (PP) tests.

Table 1 Results of unit root tests

Variable	ADF test with constant	ADF test with constant and trend	PP test with constant	PP test with constant and trend
Level				
LM	-0.883 (1)	-2.548 (1)	-1.067 (6)	-3.852**(5)
LRER	-3.158** (1)	-4.332*** (1)	-2.814* (2)	-3.957***(5)
LY	-1.355 (2)	-2.882 (0)	-1.291 (9)	-2.892 (1)
First difference				
LM	-21.429***(0)	-21.376***(0)	-21.606***(1)	-21.670***(1)
ERE	-9.574***(0)	-10.037***(1)	-9.368***(17)	-9.362***(17)
LY	-11.703***(1)	-11.771***(1)	-13.139***(8)	-13.151***(8)

Note: The number in parenthesis is the optimal lag. The optimal lag length of ADF tests is determined by Schwerz information criterion (SIC), and the optimal bandwidth of PP tests is determined by Bartlett kernel. ***, **, and * denotes significance at the 1%, 5% and 10%, respectively.

The results in Table 1 indicate that the log of real effective exchange rate (LRER) seems to be I(1) series while the PP test with a constant and a linear trend indicates that the log of imports (LM) is I(0) series. Even though the tests indicate stationarity of first differences of all series, but only the log of real income (LY) is I(1) series.

Therefore, it is likely that the three series are mixed between I(0) and I(1) and thus the use of bounds testing for cointegration should be suitable.

Results of Measuring Real Exchange Rate Uncertainty

The model of AR(p)-EGARCH(1,1) model expressed in equations (3) and (4) is estimated. The lag order p of the mean equation is selected by SIC is 1. The estimated coefficient of log (h_{t-1}) is 0.958 and is significant at the 1 percent level. However, the estimated coefficient γ is -0.005 and is insignificant. Therefore, there are no asymmetric impacts. Nevertheless, the results indicate the existence of persistence of shocks to conditional variance or real exchange rate volatility.

Table 2 Result of AR(1)-EGARCH(1,1) model estimation
Panel A. Mean equation: $R_t = 0.001 + 0.327^{***}R_{t-1} + \varepsilon_t$ (0.621) (5.051)
Panel B. Conditional variance equation: $\log h_t = 0.492^{**} + 0.958^{***}\log h_{t-1} + 0.128\left\lvert\frac{\varepsilon_{t-1}}{h_{t-1}}\right\rvert - 0.005\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}$ (2.882) (59.283) (1.391) (-0.105) (t-statistic in parenthesis)
R^2 = 0.094, Log likelihood = 507.937
Q(4) = 4.724 (p=0.317), Q(8) = 4.938 (p=0.764) Q^2(4) = 5.040 (p=0.283), Q^2(8) = 10.228 (p=0.249)
Note: The number in parenthesis is t-statistic. *** denote significance at the 1% level.

The Box-Pierce Q(k) and Q^2(k) statistics do not indicate any serial correlation and further ARCH effect at 4 and 8 lags (or k=4 and k=8). Therefore, a higher order of ARCH process is not required. In other words, the estimated model passes diagnostic tests. Furthermore, the GARCH variance or exchange rate uncertainty series is stationary.

Results of ARDL Model Estimates

The results of ARDL bounds testing for cointegration are reported in Table 3.

Table 3 Results of ARDL bounds testing for cointegration.

Panel A: Estimated equation with LM_t as dependent variable

Variable	Coefficient	t-statistic	p-value
LM_{t-1}	-0.385***	-5.408	0.000
$LRER_t$	-0.057	-0.216	0.830
$LRER_{t-1}$	0.337	1.463	0.145
LY_t	0.532***	5.863	0.000
LY_{t-1}	-0.183	-1.409	0.161
LV_t	13.932	0.118	0.698
LM_{t-1}	-0.256***	-4.366	0.000
$LRER_{t-1}$	-0.040	-0.388	0.698
LY_{t-1}	0.245***	3.650	0.000
LV_{t-1}	-36.225***	-2.820	0.005

Constant	2.204***	3.125	0.002
$R^2 = 0.464$, $F = 13.846$, $\chi^2_{(2)} = 2.884$ (p=0.236)			
Panel B: Computed F-statistic			
F= 5.722			
Critical Value	5% Level		1% Level
	I(0) I(1)		I(0) I(1)
	2.86 4.01		4.29 5.61
Note: ***, **, and * denote significance at the 1%, 5% and 10%, respectively. The critical values are from Table CI iii, Case III (unrestricted intercept and no trend) of Pesaran et al. (2001). The lower bound critical value is for I(0) series, and the upper bound critical value is for I(1) series.			

The test results show that the restricted null hypothesis of the long-run coefficients ($H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4 = 0$) is rejected at the 1 percent level of significance.[8] This indicates that there is long-run relationship between imports and other variables (real effective exchange rate, real income, and real exchange rate uncertainty). The ARDL model passes diagnostic test because the Chi-square statistic [$\chi^2_{(2)}$=2.884(p=0.236)] indicates an acceptance of the null hypothesis of no autocorrelation in the residuals.

Results of Long-Run and Short-Run Estimates

The long-run relationship estimate is shown in Panel A of Table 4.

Table 4 Results of long-run relationship and short-run dynamics			
Panel A. Long-run relationship: LM_t is dependent variable			
Variable	Coefficient	t-statistic	p-value
$LRER_t$	-0.269*	-1.987	0.069
LY_t	1.020***	27.679	0.000
LV_t	-62.692***	-3.871	0.000
Constant	8.702***	14.097	0.000
$R^2 = 0.906$, $F = 537.766$			
Panel B. Short-run dynamics: LMt is dependent variable			
Variable	Coefficient	t-statistic	p-value
LM_{t-1}	-3.079***	-5.412	0.000
$LRER_t$	-0.187	-0.754	0.452
$LRER_{t-1}$	0.380*	1.704	0.090
LY_t	0.551***	6.166	0.000
LY_{t-1}	-0.191	-1.536	0.127
LV_t	82.351	1.536	0.127
e_{t-1}	-0.257***	-4.486	0.000
Constant	0.006	1.156	0.249
$R^2 = 0.455$, $F = 19.408$			
Note: ***, **, and * denote significance at the 1%, 5% and 10%, respectively.			

[8] The computed F-statistic is 5.722, which is greater than the upper bound critical value of 5.61. Thus the null hypothesis of no cointegration is rejected at the significance level of 1 percent.

The result shows that the estimated coefficient of real effective exchange rate is negative and significant at the 10 percent level while that of domestic real income is positive and significant at the 1 percent level. The two determinants of import demand have the opposite and correct signs as stipulated by the theory of international trade. The estimated coefficient of real effective exchange rate implies that a 1 percent increase in real exchange rate (or real depreciation) leads to a decline in real imports by 0.269 percent and vice versa. This result seems to support with the Marshall-Lerner condition, but with a weak support by the size of the coefficient and the 10 percent level of significance. For domestic real income, a 1 percent increase in real income induces an increase in real imports by 1.020 percent and vice versa. Similar to other developing countries, the impact of domestic real income is not surprising because Thailand relies on a high import portion of capital goods and raw materials in order to assist its export-led growth and import substitution strategies. The increasing importance of industrial sector has been observed since the 1990s. The negative impact of exchange rate uncertainty on real imports is large and significant at the 1 percent level. The result implies that an increase in this kind of uncertainty by 1 percent will significantly reduce real imports by almost 63 percent and thus improve the country's balance of trade, but can harm industrial sector at the same time.
The result of short-run dynamics is shown in Panel B of Table 4. The estimated coefficient of the error correction term (λ) is -0.257 and significant at the 1 percent level. This result indicates that the speed of adjustment to the long-run equilibrium is rapid. In other words, any deviation from the long-run equilibrium will be temporary. In addition, there seems to be no relationship between real effective exchange rate and import demand in the short run. Furthermore, there is a positive relationship between real imports and domestic real income. Also, exchange rate uncertainty does not impose any impact on real imports in the short run.

It should be noted that the presence of higher uncertainty in real effective exchange rate in the short run cannot induce a large number of manufacturing firms to increase or decrease their imports of capital equipment and raw materials so as to hedge against real depreciation in the near future. However, the effect of higher uncertainty in real effective exchange rate will induce most firms to delay their imports in the long run. In other words, importers will tend to import less when facing with higher real exchange rate uncertainty. The result from the present study seems to support the idea that importers are risk averse and substitute domestic for foreign goods (De Grauwe, 1988). In addition, importers will reduce imports when they encounter unpredictable exchange rates, which cause uncertain profits (see Gotur, 1985, among others).

CONCLUDING REMARKS

This study investigates the impact of real exchange rate uncertainty on import flows of Thailand during the floating exchange rate regime. The AR(1)-EGARCH(1,1) model is used to generate the log of GARCH variance series. The ARDL bounds test is used to test for cointegration between real imports and other variables (real effective exchange rate, real domestic income, and real exchange rate uncertainty). The results show the existence of level relationship among the four variables, i.e., real imports, real effective exchange rate, real income and real exchange rate uncertainty. The variable of real exchange rate uncertainty imposes a negative impact on real import in the long run. In addition, the results from the estimation of short-run dynamics shows that the coefficient of the error correction term is significantly negative and has the absolute value of less than one, which implies that any deviation from the long-run equilibrium will be corrected rapidly. The findings obtained from this study give some implications for policymakers. First, an appreciation of real effective exchange rate will induce more imports and lead to deterioration of balance of trade in the long run, and vice versa. Second, an increase in real sector production will induce more imports and vice versa. Third, stabilization of major nominal exchange rates to reduce exchange rate uncertainty and the design of appropriate trade policy seem to be necessary.

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