Modeling the Effects of Exchange Rate Volatility on Thai Rice Exports

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ABSTRACT

This paper investigates the effects of exchange rate volatility on the rice export flows of Thailand to its major trading partners namely South Africa, China, United States of America, Indonesia, Singapore and Japan for the period 2001:1−2012:12. We use a six-month moving sample standard deviation of the growth of the real exchange rate which is then tested in a model of Thai milled rice exports. Cointegration and error-correction models are used to obtain the estimates of the cointegrating relations and the short-run dynamics, respectively. The results obtained in this paper, on the whole, provide evidence that the real exchange rate volatility has a significant negative effect on the volume of Thai rice exports.

I. INTRODUCTION

The increasing volatility of exchange rates after the fall of the Bretton Woods agreements has long been at the center of debate among academics and policymakers. It has bene argued that exchange rate risk increases transaction costs and reduces the gains to international trade. Surprisingly, however, macroeconomic evidence of the effect of exchange rate volatility on trade, and more generally on growth, has been quite mixed. For example, Cushman (1983), Thursby and Thursby (1987) and Bini-Smaghi (1991) find that an increase in exchange rate volatility leads to a reduction in the volume of international trade. In contrast, Frankel and Wei

(1995) and Sercu and Uppal (2003) claim that exchange rate volatilities may not have any effect on the volume of international trade. More recent work has emphasized that these results could be due to an aggregation bias (Broda and Romalis, 2010) and an excessive focus on richer countries with highly developed financial markets, since much more substantive negative effects of the exchange rate volatility on trade (Grier and Smallwood, 2007) and growth (Aghion et al., 2009) are found for developing countries.

A number of studies examined the effects of exchange rate volatilities on commodity trade flows using aggregate data (Akhtar and Hilton, 1984; Arize, 1995; Arize, 1998; Arize and Ghosh, 1997; Bahmani-Osookee, 2002; Chowdhury, 1993; Gotur 1985) and bilateral trade data (Bini-Smaghi, 1991; Cushman, 1983; Hooper and Kohlhagen, 1978; McKenzie and Brooks, 1997; Thursby and Thursby; 1997). Most of these studies examined the effect of exchange rate volatility on overall trade flows (i.e., total of trade in all sectors) rather than trade flows of a specific sector (e.g., agriculture) or specific commodity (e.g., wheat, corn). Sector specific studies mostly attempted to estimate the effects of exchange rate volatilities on trade of manufacturing goods (Di Vita and Abott, 2004; Klein, 1990; Maskus, 1986; Belanger et al. 1992, Chou, 2000). Only a few studies estimated trade flows (Cho et al. 2002, Sun et al. 2002, Kandilov, 2008; Giorgioni and Thompson, 2002, Villanueva and Sarker 2009). However, most of these studies (Cho et al., 2002, Kandilov, 2008; Giorgioni and Thompson, 2002) used aggregated agricultural commodity trade data of countries. Research on the effects of exchange rate volatility on specific agricultural commodities is limited.

This paper intends to shed additional light on a topic characterized by conflicting empirical evidences. The objective of this paper is to model the impact of exchange rate volatility on the trade flows of a developing country, Thailand for a specific agricultural commodity, rice.

The rest of the paper is organized as follows: Section 2 describes the variables and data sources. Empirical results of unit root tests, cointegration tests, and error-correction model estimates are presented and discussed in Section 3. Section 4 gives a summary and conclusion of the paper.

II. Variables and Data Sources

Drawing on the existing empirical literature in this area and the implications for dynamic specification of the possible existence of error-correcting mechanisms in the data generating process, we specify a standard long-run total export demand function for milled rice that takes the form (see, for example Arize (1998) , Chou (2000), Ekanayake (2010):

$$\ln X_t = \beta_0 + \beta_1 \ln Y + \beta_2 \ln R + \beta_3 \ln V_t \qquad (1)$$

where X_t is total export volume of rice in period t, Y_t is the real foreign income in period t, R_t is the real exchange rate (a proxy for relative prices) in period t, V_t is a measure of exchange rate volatility, and ε_t is a white-noise disturbance term.

The export variable is the total milled rice exports of Thailand to major markets, namely South Africa, China, United States of America, Indonesia, Singapore and Japan. Monthly data on total milled rice exports of Thailand were taken from Thai Rice Exporter, which represents 20% of Thailand's total export share.

The export variable is the total rice milled exports of Thailand. The data on export volume is taken from the Thai Rice Exporter. Economic theory suggests that the real income level of trading partner countries would affect the demand for exports positively. Therefore, a priori, it is expected that $\beta_1 > 0$. Since monthly gross domestic product (GDP) statistics are rarely found, a proxy for GDP is required. The real foreign income variable is proxied by the trade-weighted average of the monthly industrial production index (2000 M1=100) of Thailand's major export partners. The underlying series are obtained from Trading Economics database. The trade-weighted average of the industrial production index of Thailand's six major export partners was calculated as:

$$Y_t = \sum_{j=1}^{6} EX_{jt}^{w} x Y_{jt} \tag{2}$$

where Y_t is the real foreign income at time t, EX_{jt}^{w} is a weight of Thai exports (or export share) of to the j^{th} country at time t, and Y_{jt} is the industrial production index of the j^{th} country at time t. We only include the top six export partner countries of Thailand where a complete monthly data series are available such as South Africa, China, United States of America, Indonesia, Singapore and Japan.

The second explanatory variable is the real Thai exchange rate relative to the US dollar, which measures competitiveness. If the relative prices rise (fall), it would cause the domestic rice to become less competitive than imported rice and, therefore the demand for exports will fall (rise). Therefore, a priori, it is expected that the $\beta_2 < 0$.

The last explanatory variable is a measure of exchange rate volatility or risk. Various measures of real exchange rate volatility have been proposed in the literature. Some of these measures include (1) the averages of absolute changes, (2) the standard deviations of the series, (3) the deviations from trend, (4) the squared residuals from the ARIMA, ARCH, or GARCH processes, and (5) the moving sample standard deviation of the growth rate of the real exchange rate. We use a time varying measure of exchange rate volatility to account for periods of high and low exchange rate uncertainty. The variable is constructed by the moving sample standard deviation of the growth rate of the real exchange rate.

$$V_t = \left[(1/m)\sum_{i=1}^{m}(\log Q_{t+i=1} - Q_{t+i-2})^2 \ \right]^{1/2} \qquad (2)$$

where m= 6, the order of the moving average. This measure is similar to those used in much of the literature (e.g., Kenen and Rodrik (1986), Koray and Lastrapes (1989), Lastrapes and Koray (1990), Mohanty and Peterson (2002). Koray and Lastrapes (1989) have shown that this measure captures the temporal variation in the absolute magnitude of changes in real exchange rates, and therefore exchange rate risk over time. Monthly data on nominal Thai exchange rate is taken from Oanda Currency website. The real exchange rate is constructed by deflating the nominal exchange rate by the CPI. The effect of exchange rate volatility on exports is ambiguous and the international empirical evidence on the influence on exports is mixed. As Bredin et al. (2003) point out, the effects of exchange rate volatility on exports are also ambiguous from a theoretical point of view. Therefore, β_3 is expected to be either positive or negative.

III. Estimation Procedure and Results

This section reports the results of the estimating the impact of exchange rate volatility on Thai rice exports. The sample period runs from 2000:12 to 2012:12. Several observations at the beginning of the sample period are lost due to the construction of the volatility measure and use of lagged explanatory variables in the model. The estimation period runs from 2002: 05 2012: 12.

In order to establish whether there is a long-run equilibrium relationship among the variables in Equation (1), this study uses cointegration and error-correction models developed by Engle and Granger (1987). Some previous studies that used this methodology include

Ekanayake and Chatna (2010), Chou (2000), Asseery and Peel (1991), Vergil (n.d.), Holly (1995), Lastrapes and Koray (1990) and Koray and Lastrapes (1989). The cointegration approach requires testing the time-series properties of individual variables in Equation (1) for stationarity using unit root tests. If all variables in Equation (1) are integrated of the same order, then the equation is estimated by employing the multivariate cointegration methodology suggested by Johansen (1988) and Johansen and Juselius (1990).

Before we estimate Equation (1), all the variables must be tested for the presence of unit roots. We use the Augmented Dickey-Fuller (ADF) test suggested by Fuller (1976) and Dickey and Fuller (1981) to test for unit roots. The ADF test was performed on the time series of $\ln X$, $\ln Y$, $\ln R$, and $\ln V$, and the test results together with optimal lag lengths are presented in Table 1. The ADF test was conducted on both the level and the first difference of the variables. The results show that all the variables have unit roots, except for $\ln X$ and $\ln V$.

Having tested for unit roots, we then performed the trace test and the maximum eigenvalue test for the presence of cointegrating vectors for the model specification. Table 2 reports the results from the Johansen likelihood ratio test for cointegration. Both the trace test and the maximum eigenvalue test indicate that there are at least three cointegrating vectors in the model.

Table 1. Augmented Dickey-Fuller(ADF) Tests (all series are in logs)

Variable	Level		First Difference	
	ADF	k	ADF	k
$\ln X_t$	-8.3682*	1	-10.8874*	2
$\ln Y_t$	-1.9642	3	-13.3583*	2
$\ln R_t$	-1.4100	1	-6.1261*	1
$\ln V_t$	-3.5048*	1	-9.9937*	1

*Notes: k represents the optimal lag length as determined by Akaike information criterion (AIC).*denotes statistical significance at the 1% level. X is total rice milled exports of Thailand, Y is trade-weighted average of real foreign income, R is Thai real exchange rate, V is a measure of exchange rate volatility.*

Table 2. Results from Johansen cointegration test.

Null Ho	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
r = 0*	0.44	73.46	27.07	32.24
$r \leq 1$ *	0.31	46.63	20.97	25.52
$r \leq 2$ *	0.18	25.30	14.07	18.63
$r \leq 3$ *	0.10	13.64	3.76	6.65

** denotes rejection of the hypothesis at the 1% level.*
Maximum eigenvalue test indicates 4 cointegrating vectors at 1% level.

We take the results of the cointegration analysis as evidence that error-correction model is an appropriate structure to impose on the nonstationary processes for real foreign income and real exchange rate following the Engel-Granger Representation Theorem (Engle and Granger, 1987).

The Short-Run Dynamics

The short-run dynamics of the long-run export demand function can be determined by examining the error-correction model. For this we follow Henndry's (1987) general-to-specific modeling strategy. The process involves regressing the first-difference of on the current and lagged values of first-differences of each of the explanatory variables in Equation (1), lagged values of ln X, and one period lagged residuals from Equation (1). According to the Engle and Granger (1987) Representation Theorem, the presence of cointegration in a system of variables implies that a valid error-correction representation exists. The error-correction model for the cointegrating vector (lnX, lnY, lnR and lnV) can be written as:

$$\Delta \ln X = \alpha_0 + \alpha_1 EC_{t-1} + \sum_{i=1}^{n} \beta_i \Delta \ln X_{t-1} + \sum_{i=0}^{n} \gamma_i \Delta \ln Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \ln R_{t-i} + \sum_{i=0}^{n} \eta_i \Delta \ln V_{t-i} + \omega_t \quad (3)$$

where EC_{t-1} is the lagged error-correction term and is the residual from the cointegration regression Equation (1). The error-correction term represents the error-correction EC_t mechanism and α_1 gives the speed of adjustment towards the system's long-run equilibrium. If the variables have a cointegrating vector, then $EC_t \sim I(0)$ represents the deviation from equilibrium in period t. Generally, the error-correction term indicates how the system converges to the long-run equilibrium implied by the cointergrating regression. The coefficient α_1 in equation (3) represents the response of the dependent variable in each period to departures from equilibrium. This approach enables us to distinguish between the short-run and long-run export functions..

The results of the estimated error-correction model (ECM) are presented in Table 3 and indicate that the error-correction term has the appropriate (negative) sign and is statistically highly significant. This result confirms the validity of an equilibrium relationship among the variables in the cointegrating equation and implies that the underlying dynamic structure of the model would have been misspecified if the cointegration among the variables were overlooked. The speed of adjustment term α_1 for total export volume is -0.62, indicating that adjustment occurs in a month toward the long-run equilibrium.

The estimated coefficients on real foreign income (Y) and real exchange rate (R) variables in the ECM have the expected signs and are statistically significant. These coefficients show how the average speed of total export volume adjustment may differ depending on whether the adjustment is in response to foreign income or exchange rate shocks.

Of particular interest is the finding that the estimated exchange rate volatility has the expected negative sign and is statistically significant. Thus, in general, it appears that the measure of exchange rate volatility has a significant and negative impact on exports of Thailand at 1% level of significance. This result confirms earlier findings of Akhtar and Hilton (1984), Kennen and Rodrik (1986), Cushman (1988), Arize (1995), Weliwita, Ekanayake and Tsujii (1999), Sukar and Hassan (2001), Choudhry (2005) and contradicts the results reported in Gotur (1985), Asseery and Peel (1991), McKenzie and Brooks (1997), and McKenzie (1998).

Table 3 . Regression results for Error Correction Model: 2002:05 – 2012:12.

Dependent Variable: D(LNXQ)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.023852	0.019515	1.222240	0.2240
$\Delta \ln X_{t-1}$	-0.025705	0.069308	-0.370883	0.7114
$\Delta \ln Y_{t-3}$	0.454289	0.163341	2.781228	0.0063
$\Delta \ln R_{t-1}$	-2.811649	1.224588	-2.295996	0.0234
$\Delta \ln V_{t-1}$	-26.88567	9.641325	-2.788587	0.0061
EC_{t-1}	-0.622498	0.065750	-9.467580	0.0000

R-squared	0.481869	Mean dependent var	0.018414
Adjusted R-squared	0.460634	S.D. dependent var	0.285229
S.E. of regression	0.209477	Akaike info criterion	-0.242667
Sum squared resid	5.353423	Schwarz criterion	-0.108978
Log likelihood	21.53069	F-statistic	22.69235
Durbin-Watson stat	2.073288	Prob(F-statistic)	0.000000

IV. Summary and Conclusion

This paper analyzes the dynamic relationship between the Thai volume of export and a measure of exchange rate volatility in the context of multi-variate error-correction model.

Monthly data on exchange rate from 2002 to 2012 is used to estimate the exchange rate volatility for Thailand and its major rice trading partners such as China, Indonesia, Singapore, Japan, USA and South Africa. A simple long-run equilibrium export demand equation is formulated as a function of real foreign income, real exchange rate and exchange rate risk. The behavioural equations are specified in logarithmic form of the dependent and independent variables. We use a time-varying measure of exchange rate variability. In order to capture the temporal variation in absolute magnitude of changes in real exchange rate, the exchange rate risk is estimated as a moving, six-month average of the standard deviations of changes in real exchange rate.

We use an error correction model to assess the impact of real exchange rate and its volatility on rice trade. The properties of the individual time series are initially established prior to testing for cointegration. Knowledge of order of integration is a prerequisite for cointegration because series that are integrated of a different order cannot be cointegrated. Based on the results of the Augmented Dickey Fuller-Test, we conclude that most of the variables have unit roots except for $\ln X$ and $\ln V$. Next, we perform the trace and maximum eigenvalue tests and have come to conclusion that there are at least four cointegrating vectors in each case.

Lastly, we examine the short-run dynamics of the long-run export demand function by estimating ECM in equation (3). The results indicate that the measure of exchange rate volatility has a significant and negative impact on exports of Thai milled rice at the 1% level of significance. The error-correction results indicate that in the short-run, exchange rate volatility has a significant negative impact on rice milled exports of Thailand.

Considering that market participants are risk averse, these results imply that exchange rate volatility causes them to reduce their activities, change prices, or shift sources of demand and supply in order to minimize their exposure of the effects of exchange rate volatility.

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