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THE EFFECTS OF EXCHANGE RATE VOLATILITY ON SRI LANKAN EXPORTS: AN EMPIRICAL INVESTIGATION

ABSTRACT

This paper investigates effects of exchange rate volatility on Sri Lankan exports to its major trading partners. In this paper, we use a generalized ARCH-type model (GARCH) to generate a measure of exchange rate volatility which is then tested in a model of Sri Lankan exports. Testing sectoral trade data allows us to identify whether the effect of exchange rate volatility differs depending on the types of the goods traded. The results obtained in this paper suggest that the impact of exchange rate volatility differs between different categories of goods although it remains difficult to firmly establish the nature of the relationship.

Key Words: exchange rate volatility, GARCH models, Sri Lanka

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INTRODUCTION

Over the past year, exchange rates have fluctuated enormously leading to instability and a lack of confidence. Traditionally, volatility of exchange rates has influenced the majority of all market participants either in a positive or negative way. Therefore, with the increasing instability of international economies, it is highly important to attain further understanding of the effects that exchange rates pose. Only then, countries can become more proactive, explore possible benefits, and prevent potential economical threats. Based on the assumption that exporters and importers are likely to exhibit some degree of risk aversion associated with the trade uncertainty, exchange rate fluctuations represent a potential concern.

The consequences of exchange rate volatility on real exports have long been at the center of debate among researchers. The empirical literature reveals that the effects of exchange rate volatility on exports are ambiguous. While a large number of studies find that exchange rate volatility tends to reduce the level of trade, others find either weak or insignificant or positive relationships.[1] Majority of these studies have focused on developed countries while developing countries have received little attention.

Exchange rate volatility may have a direct effect on trade through uncertainty and adjustment costs. Further, it may have an indirect effect through its effect on the structure of output and investment and on government policy. While the empirical research on the nexus between exchange rate volatility and volume of trade is inconclusive, a growing body of literature points towards exchange rate volatility causing a decline in trade. If exchange rate volatility tends to deter volume of exports, the volume of trade could be considerably higher in a more stable exchange rate setting. Those who argue that exchange rate volatility promotes exports point out that exchange rate volatility makes exporting more attractive.

In this paper, we investigate the effects of exchange rate volatility on aggregate export volume of Sri Lanka, during the period 1980-2007. The sample period coincides with the shift in the exchange rate regime and the initiation of significant reforms in economic and

[1] For example, Onafowara and Owoye (2008), Byrne, Darby, and MacDonald (2008), Choudhry (2005), Bahmani-Oskooee (2002), Arize et al. (2000), Arize (1995), Chowdhury (1993), Pozo (1992), Bahmani-Oskooee and Ltaifa (1992), Bini-Smaghi (1991), Perée and Steinheir (1989), and Koray and Lastrapes (1989) find evidence for negative effects. On the other hand, Doyle (2001), Chou (2000), McKenzie and Brooks (1997), Qian and Varangis (1994), Kroner and Lastrapes (1993), and Asseery and Peel (1991) find evidence for a positive effect for volatility on export volumes of some developed countries. In addition, Aristotelous (2001), Bahmani-Oskooee and Payestch (1993), Bahmani-Oskooee (1991), and Hooper and Kohlhagen (1978) have reported no significant relationship between exchange rate volatility and exports.

financial policies in Sri Lanka that started in 1978. From 1948 when Sri Lanka achieved its independence from Britain until 1977, the Sri Lankan rupee was closely linked to sterling pound. In November 1977, the government unified the exchange rate at a new devalued level after which the rupee was brought under managed floating system (White and Wignaraja, 1992). The exchange rate regime in 1977 was quickly followed by an unprecedented devaluation of rupee against the U.S. dollar in 1978. The rupee was devalued from 8.41 rupees per dollar in 1977 to 15.61 rupees per dollar in 1978, 85 percent depreciation within a single year. Between 1980 and 2007, the rupee depreciated by 555.7 percent against the U.S. dollar. During the same period, the real exports increased by 69.2 percent. The aforementioned factors provide enough justification for examining the effects of exchange rate volatility on disaggregated exports in Sri Lanka during the period 1980-2007. To this end, we first estimate the long-run export demand functions for Sri Lanka for the 1980Q1-2007Q4 period for top ten trading partners of Sri Lanka (the United States, the United Kingdom, India, Belgium, Germany, Italy, the United Arab Emirates, Japan, Russia, and France) by employing the cointegaration technique. We then examine the short-run dynamics of the long-run export demand by estimating error-correction models.

The rest of the paper is organized as follows: Section 2 presents a brief discussion of recent literature. Section 3 presents the estimated model. Section 4 discusses the variable definitions and outlines the data sources. Empirical results of unit root tests, cointegration tests, and error-correction model estimates are presented and discussed in Section 5. Section 6 concludes the paper.

LITERATURE REVIEW

In this section we present a brief overview of some related work. Although there has been considerable research concerning the impact of exchange rate volatility on trade, we only present findings of some selected studies that analyze the effects of exchange rate volatility on trade flows.

A study conducted by Byrne, Darby, and MacDonald (2008) analyze the impact of exchange rate volatility on the volume of bilateral U.S. trade flows using sectoral data. The study utilizes annual data over the period 1989-2001 for a cross section of 6 countries and 22 industries. The study finds that pooling all industries together provides evidence of a negative effect on trade from exchange rate volatility. Moreover, the effects of exchange

rate volatility on trade is negative and significant for differentiated goods but insignificant for homogeneous goods suggesting that sectoral differences do exist in explaining the different impact of volatility on trade.

Gheong, Mehari and Williams (2005) analyze the relationship between exchange rate uncertainty, trade volumes, and price competitiveness. It discusses effects the UK will experience once Euro currency is implemented. Using sectoral data on UK manufacturing exports and the VAR models, the authors came to the conclusion that unexpected fluctuation in exchange rates is usually accompanied by increasing export prices and decreasing trade volumes. Because export/import traders prefer to avoid the increased risk associated with additional exchange rate volatility, they try to avoid it by adjusting both prices and quantity. Consequently, the UK companies will become less competitive and the overall international trade will be suppressed. Therefore, the authors recommend that the UK should adopt the Euro, since it will lower exchange rate volatility and will have a positive impact on the country's export trade and the overall economic performance.

Choudhry (2005) investigates the influence of exchange rate volatility on real exports of the U.S. to Canada and Japan using aggregate monthly data ranging from January 1974 to December 1998. The study uses conditional variance from the GARCH (1, 1) model as exchange rate volatility. The study finds significant and mostly negative effects of the exchange rate volatility on real exports.

Sukar and Hassan (2001) investigate the relationship between the U.S. trade volume and exchange rate volatility using cointegration and error-correction models. The study uses quarterly aggregate data covering the period 1975Q1 – 1993Q2 and a GARCH model was used to measure the exchange rate volatility. The study finds evidence for a significantly negative relationship between U.S. export volume and exchange rate volatility. However, the short-run dynamics of the relationship shows that the effect of exchange rate volatility is insignificant.

A study by McKenzie (1998) focuses on the effects of exchange rate volatility on Australian trade flows. The author used the ARCH and GARCH models to generate a measure of exchange rate volatility and then tested this measure in a model of Australian imports and exports. The study used both the aggregate and disaggregated sectoral quarterly trade data covering the period 1947Q1 to 1995Q4. Based on his research, the author came to the conclusion that the impact of exchange rate volatility does differ

between traded good sectors; however, he was unable to firmly establish the nature of the relationship. Overall, McKenzie suggested that in Australia exchange rate volatility has a positive impact on exports but negative impact on imports.

McKenzie and Brooks (1997) analyze the effects of exchange rate volatility on German-U.S. bilateral trade flows. They used annual data from 1973 to 1992 and the ARCH model to arrive to the exchange rate volatility measure. Based on their analysis, authors found the relationship between volatility and trade flows positive and statistically significant. Therefore, they believed that the exchange rate volatility may be beneficial rather than impeding to international trade. They emphasized the fact that volatility in the exchange rate was found to have a positive effect on imports and, therefore, on trade as a whole. At the end, authors also discussed the decision dilemma whether to use nominal or real exchange rate data. Nevertheless, they arrived to the same results under each scenario; therefore, they found the exchange rate data distinction irrelevant.

Chou (2000) estimates the effect of exchange rate fluctuations on total exports and exports of China by Standard International Trade Classification (SITC) category. The author used the conditional variance of the real effective exchange rate index from autoregressive conditional heteroscedastic (ARCH) models to estimate exchange rate variability. The sample data used are quarterly data for a period from 1981Q1 to 1996Q4. Estimation results show that exchange rate volatility has a long-run negative effect on total exports, exports of manufactured goods, and exports of mineral fuels, but not on exports of foodstuffs, beverages, and tobacco. Overall the study concludes that exchange rate variability currently impedes China's trade. He also suggested that this trend will continue to hinder Chinese international trade, until foreign traders will be able to avoid or minimize exchange rate fluctuations by hedging in the forward exchange market.

Weliwita, Ekanayake and Tsujii (1999) analyze the effects of real exchange rate volatility on Sri Lanka's exports to six developed countries during the flexible exchange rate regime. The study uses aggregated quarterly data over the period 1978Q1 to 1996Q2. The study uses two measures of exchange rate volatility. The study finds strong evidence to suggest that Sri Lanka's exports to the countries under investigation were adversely affected by the increased volatility in bilateral real exchange rates during the sample period.

Arize (1995) analyzes the effects of real exchange rate volatility on the proportions of bilateral exports of nine categories of goods from the United States to seven major industrial countries. The data are monthly series over the period February 1978 to June

1986. The volatility measure used is the standard deviation of the monthly percentage change in the bilateral exchange rate between the U.S. and the importing country over the period t and t-12. The study finds different effects of exchange rate volatility across categories of exports. The study also concludes that exchange rate uncertainty has a negative effect on U.S. real exports, and that it may have major impact on the allocation of resources.

Lastrapes and Koray (1990) investigate the relation between exchange rate volatility, international trade and the macroeconomy in the context of a VAR model. The model is estimated for U.S. multilateral trade over the floating rate period and includes a moving standard deviation measure of real exchange volatility. The study finds some evidence of a statistically significant relationship between volatility and trade, but the moving average representation of the system suggests that the effects are quantitatively small. The study also finds that exchange rate volatility is influenced by the state of the economy.

A study by Klein (1990) analyzes the effects of exchange rate volatility on the proportions of the bilateral exports of nine categories of goods from the United States to seven major industrial countries using fixed effects framework. The data are monthly series over the period February 1978 to June 1986. The study finds mixed evidence on the effects of exchange rate volatility on exports. In six categories the volatility of real exchange rate significantly affects the volume of exports and in five of these categories the effect is positive.

Koray and Lastrapes (1989) investigate the relationship between real exchange rate volatility and bilateral imports from five countries, namely, the United Kingdom, France, Germany, Japan, and Canada, using a vector autoregression (VAR) model. The study uses aggregate monthly data from January 1959 to December 1985. The findings of the study suggest that the effects of volatility on imports are weak, although permanent shocks to volatility do have a negative impact on imports, and those effects are relatively more important over the flexible rate period.

Finally, Cushman (1988) conducts a study to test for real exchange rate volatility effects on U.S. bilateral trade flows using annual data for the period 1974-1983. The study finds evidence for significant negative effects in five of six import flows, and in two of six U.S. export flows with one export flow showing a significant positive effect.

The current study uses the Sri Lankan quarterly disaggregated trade data covering the period from 1980Q1 to 2007Q4 focusing on major export products to top ten trading

partners. The methodology used in this study incorporates many of the recent developments in the literature, namely, cointegration and error-correction models, which may help to uncover the nature of the relationship. In addition, GARCH models are used to generate the exchange rate volatility variable which is used in the study.

MODEL SPECIFICATION

As indicated in the previous section, the main objective of this study is to assess the effects of exchange rate volatility on the disaggregated Sri Lankan exports to its major trading partners. Previous studies that have investigated the influence of exchange rate volatility on exports have used a measure of exchange rate volatility (or risk) as an explanatory variable in aggregate export demand function.

Drawing on the existing empirical literature in this area, we specify a standard long-run export demand function for commodity i may take the following form (see, for example, Onafowora and Owoye, 2008; Doyle, 2001; Arize, 1995; Klein, 1990):

$$\ln X_{it} = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln RER_t + \beta_3 \ln V_t + \varepsilon_t \quad (1)$$

where X_{it} is real export volume of commodity i in period t, Y_t is the real foreign income in period t, RER_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.

Economic theory suggests that the real income level of the trading partners of the domestic country would affect the demand for exports positively. Therefore, *a priori*, it is expected that $\beta_1 > 0$. On the other hand, if the relative prices rise (fall), it would cause the domestic goods to become less (more) competitive than foreign goods and, therefore, the demand for exports will fall (rise). Therefore, *a priori*, it is expected that that $\beta_2 < 0$. This variable measures the competitiveness of U.S. exports. The last explanatory variable is a measure of exchange rate volatility. 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) 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. The effect of exchange rate volatility on exports is ambiguous and the international empirical evidence on the influence of volatility 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.

In order to establish whether there is a long-run equilibrium relationship among the variables in Equation (1), this study uses the cointegration and error-correction models developed by Engle and Granger (1987). Some of the previous studies that used this methodology include Onafowara and Owoye (2008), Choudhry (2005), Bredin et al. (2003), Sukar and Hassan (2001), Fountas and Aristotelous (1999), Arize (1995, 1998), 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).

DATA SOURCES AND VARIABLES

Quarterly data for the period from 1980Q1 to 2007Q4 were used for estimation. The analysis focuses on major export products of Sri Lanka to major markets for Sri Lankan exports, namely, the United States, the United Kingdom, India, Belgium, Germany, Italy, the United Arab Emirates, Japan, Russia, and France. Quarterly data on real export volume and prices were taken from various issues of the Central Bank of Sri Lanka, *Annual Report*. Quarterly data on real export volumes and prices were converted into export volume indices and export price indices with year 2000 as the base year. Thus the export volume index and export price index take the value of 100 in the base year. The study focuses on total exports of Sri Lanka as well as its seven major export sub categories, namely, industrial exports, tea, rubber, coconut products, minor agricultural products, gems, and other exports.

After a careful review of the research paper "Exchange Rate Variability and China's Exports" written by Chou (2000), we found the approach of examining the impact of exchange rate variability not only on total exports but also on specific export categories highly valuable and interesting. Therefore, to better understand the findings of our previous research and the results of empirical evidence pertaining to Sri Lankan trade, this study focuses not only on total exports of Sri Lanka but also on its seven major export

sub categories, namely, industrial exports, tea, rubber, coconut products, minor agricultural products, gems, and other exports.

The real foreign income variable is proxied by the trade-weighted average of the industrial production indices (2000=100) of Sri Lanka's major export partners. The underlying series were obtained from the International Monetary Fund (IMF)'s *International Financial Statistics database* and from the Organization for Economic Cooperation and Development (OECD)'s online database. The trade-weighted average of the industrial production index of Sri Lanka's 10 major export partners was calculated as:

$$Y_t = \sum_{j=1}^{10} EX_{jt}^{w} \times Y_{jt} \tag{2}$$

where Y_t is the real foreign income at time t, EX_{jt}^{w} is a weight of Sri Lankan exports (or export share) to the jth country at time t, and Y_{jt} is the industrial production index of the jth country at time t. The top 10 export partner countries of Sri Lanka are: the United States, the United Kingdom, India, Belgium, Germany, Italy, the United Arab Emirates, Japan, Russia, and France.

Following Sekkat and Varoudakis (2000), the trade-weighted real exchange rate, RER_t, was constructed as,

$$RER_t = \sum_{j=1}^{10} EX_t^{w} \times \left(\frac{ER_{jt} \times P_{jt}}{P_t^{SL}} \right) \tag{3}$$

where RER_t is the real exchange rate, ER_{jt} is the bilateral nominal exchange rate (the home currency price of a unit of foreign currency, for example, the number of Sri Lankan rupees per U.S. dollar) with country j at time t, and EX_{jt}^{w} is a weight of Sri Lankan exports (or export share) to the jth country at time t, P_{jt} is the consumer price index (2000=100) of the jth country at time t, and P_t^{SL} is the consumer price index (2000=100) of Sri Lanka. The monthly data on nominal exchange rates were taken from the IMF, *International Financial Statistics database*.

Finally, the series of exchange rate volatility were obtained using the estimated GARCH(1,1) model. We make use of real as opposed to nominal exchange rates in the measurement. As Choudhry (2005) points out, unlike other measures of exchange rate volatility which can potentially ignore information on the stochastic processes by which exchange rates are generated, ARCH-type models capture the time-varying conditional

variance as a parameter generated from a time-series model of the conditional mean and variance of the growth rate, and thus are very useful in describing volatility clustering.

The GARCH(1,1) model we estimate is based on an autoregressive model of order 2 (AR(2)) of the first difference of the real exchange rate and it takes the following form:

$$\ln RER_t = \beta_o + \beta_1 \ln RER_{t-1} + \beta_2 \ln RER_{t-2} + e_t, \quad \text{where} \quad e_t \sim N(0, u_t^2)$$

$$u_t^2 = \alpha_0 + \alpha_1 e_{t-1}^2 + \alpha_2 u_{t-1}^2 \tag{4}$$

The estimated conditional variance (u_t^2) from Equation (4) is used as our measure of exchange rate volatility.

EMPIRICAL FINDINGS

We first estimate Equation (4) for the period 1980Q1-2007Q4, and the results are shown in Table 1. The coefficients of α_0, α_1, and α_2 are all positive and $\alpha_1 + \alpha_2 = 0.76 < 1$. These results ensure that conditional variance is strictly positive, thus satisfying the necessary conditions of the ARCH model in Equation (4). These findings also show that the estimated coefficients of e_{t-1}^2 and u_{t-1}^2 are statistically significant at the 5% and 1% levels, respectively. Therefore, significant ARCH and GARCH effects appear to exist in the data. The predicted value of Equation (4) provides a measure of real exchange rate volatility.

Table 1: Estimation of real exchange rate variance as a GARCH (1, 1) process

$$\ln RER_t = \underset{(1.758)}{0.00701} + \underset{(3.373)*}{0.07024} \ln RER_{t-1} - \underset{(-0.966)}{0.13424} \ln RER_{t-2}$$

$$u_t^2 = \underset{(3.023)*}{0.00096} + \underset{(2.020)**}{0.09083}\, e_{t-1}^2 + \underset{(6.088)*}{0.66745}\, u_{t-1}^2$$

Log L = 498.35 N = 110

Note: The figures in parentheses are t-statistics; * and ** indicate the statistical significance at the 1% and 5% level, respectively.

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 $\ln X$, $\ln Y$, $\ln P$, and $\ln V$, and the test results together with optimal lag lengths are presented in Table 2. 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. However, the $\ln V$ variable is stationary at levels.

Table 2: Unit-root tests: Augmented Dickey-Fuller (ADF) test statistics

Variable	Level				First Difference			
	ADF1	(k)	ADF2	(k)	ADF1	(k)	ADF2	(k)
Y	-2.8798	(4)	-2.3798	(4)	-7.3870*	(3)	-8.0026*	(3)
V	-3.6065*	(0)	-4.1955*	(0)	-7.1682*	(0)	-6.9624*	(0)
RER	-2.3264	(1)	-2.3264	(1)	-9.8647*	(2)	-9.5982*	(2)
EXTotal	-0.4276	(8)	-0.4276	(8)	-5.7340*	(7)	-5.7029*	(7)
EXIndustrial	-1.3655	(4)	-1.3655	(3)	-11.0713*	(2)	-11.1757*	(2)
EXTea	-2.3053	(2)	-2.5053	(2)	-11.7778*	(1)	-11.7464*	(1)
EXRubber	-1.8259	(4)	-1.8259	(4)	-4.8565*	(3)	-4.9909*	(3)
EXCoconut	-2.4336	(2)	-1.5335	(3)	-11.0533*	(2)	-10.9994*	(2)
EXMinor Agric.	-2.3447	(5)	-2.1248	(8)	-9.5920*	(2)	-6.0715*	(7)
EXGems	-2.0390	(1)	-2.0391	(2)	-8.9682*	(1)	-8.8866*	(1)
EXOther	-1.5359	(3)	-2.5359	(3)	-8.9307*	(2)	-8.9027*	(2)

Notes: Figures in parentheses are optimal lag lengths (k) as determined by Schwarz Information Criterion (SIC). * denotes statistical significance at the 1% level; ADF_1 tests H_0: $\theta_1 = 0$ in $\Delta \ln X_t = \beta_0 + \theta_1 \Delta \ln X_{t-1} + \sum_{j=1}^{m} \beta_j \ln X_{t-1} + \varepsilon_t$ (6); ADF_2 tests H_0: $\theta_2 = 0$ in $\Delta \ln X_t = \alpha_0 + \alpha_1 t + \theta_2 \Delta \ln X_{t-1} + \sum_{j=1}^{m} \alpha_j \ln X_{t-1} + \varepsilon_t$ (7); The critical values of ADF_1 and ADF_2 statistics at 1% level of significance are -3.49 and -4.04, respectively.

Having tested for unit roots, we then performed the trace test and the maximum eigenvalue test for the presence of cointegrating vectors for each model specification. The results of the cointegration tests are presented in Table 3 while the normalized cointegrating vectors are presented in Table 4. Both the trace test and the maximum eigenvalue test indicate that there is at least one cointegrating vector in each case. All the specifications yield correct signs for the coefficients. All of the coefficients are statistically significant either at 1% or 5% level of significance. Hence, we interpret these specifications as the long-run export demand relationships for Sri Lanka for the period covered in this study. Of the eight product groups, five of them have negative signs for the exchange rate volatility variable indicating that exchange rate volatility tends to deter exports in the long-run, for these five products.

Table 3: Results from cointegration tests for the series: X, Y, RER and V

Product	Maximum Eigenvalue Test				Trace Test			
	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$
Total Exports	30.95*	12.43	9.97	3.24	56.59*	25.64	13.21	3.24
Industrial	28.67*	14.94	11.04	2.94	57.61*	28.93	13.99	2.94
Tea	28.14*	13.96	8.51	3.11	53.71*	25.57	11.61	3.11
Rubber	28.58*	12.65	9.61	3.29	54.14*	25.55	12.90	3.29
Coconuts	32.45*	12.70	10.04	3.33	57.42*	25.07	13.37	3.33
Minor Agric.	28.53*	14.15	9.34	3.74	55.78*	27.25	13.09	3.74
Gems	28.01*	13.50	8.50	3.18	53.21*	25.20	11.69	3.18
Other	35.71*	12.93	10.89	3.36	62.90*	27.19	14.26	3.36
Critical value	27.58	21.13	14.26	3.84	47.85	29.79	15.49	3.84

Note: Critical values for the Maximum Eigenvalue Test and Trace Test are critical values at the 5% level of significance.

Table 4: Normalized cointegrating vectors

Product	Constant	Y	RER	V
Total Exports	0.2896	1.1281*	-1.5191*	-0.0495*
		(0.398)	(0.320)	(0.021)
Industrial	-0.3693	1.5376*	-1.4741*	-0.0669*
		(0.208)	(0.247)	(0.020)
Tea	-0.1067	1.3620*	-0.5624*	-0.0153*
		(0.246)	(0.195)	(0.005)
Rubber	0.1508	2.0811*	-1.0865*	0.0199
		(0.954)	(0.359)	(0.064)
Coconuts	4.8082	2.1040*	-1.4571*	0.8051*
		(0.574)	(0.556)	(0.382)
Minor Agric.	2.6550	3.4012*	-1.1343*	-0.4582*
		(1.035)	(0.457)	(0.136)
Gems	1.3464	4.1803*	-3.4577*	-0.2296*
		(1.376)	(1.132)	(0.091)
Other	1.3487	3.2719*	-1.6981*	0.2295**
		(1.910)	(0.576)	(0.122)

Note: Figures in parentheses are standard errors; * and ** denote statistical significance at the 1% and 5% levels, respectively. Figures in parentheses in normalized cointegrating vectors are standard errors.

The study by Bredin, Fountas and Murphy's (2003) also used these tests to answer the question whether exchange rate volatility influenced Irish export functions. Even though the results of their research indicated that "exports were positively related to volatility for export divisions and overall exports", the authors also admitted that this positive correlation may actually have been caused by other economic changes such as the "increased integration into the world markets" and more specifically into the European Union. Therefore, the findings obtained from our tests, proving that exchange rate volatility deters rather than promotes exports, are actually in agreement with the authors' conclusions, as they have noted that "the decline in intra-EU exchange rate volatility, associated with the single currency, may have lead to a long-run fall in Irish exports to the EU" (Bredin et al., 2003).

The Short-Run Dynamics

The short-run dynamics of the long-run export demand functions can be examined by estimating error-corrections models for each case. For this we follow Hendry's (1987) general-to-specific modeling strategy. The process involves regressing the first-difference of $\ln X$ 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 ($\ln X, \ln Y, \ln RER, \ln V$) can be written as:

$$\Delta \ln X_t = \alpha_0 + \alpha_1 EC_{t-1} + \sum_{i=1}^{n} \beta_i \Delta \ln X_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta \ln Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \ln RER_{t-i} + \sum_{i=0}^{n} \eta_i \Delta \ln V_{t-i} + \omega_t \qquad (5)$$

where EC_{t-1} is the lagged error-correction term and is the residual from the cointegration regression Equation (1). The error-correction term EC_t represents the error-correction 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 regressions. The error-correction model enables us to distinguish between the short-run and long-run real exports functions.

The results of the estimated error-correction models are presented in Table 5. The results presented in Table 5 indicate that in all ten cases the error-correction term has the appropriate (negative) sign and is statistically 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 misspecified if the cointegration among the variables were overlooked. The speed of adjustment term (α_1) varies from -0.193 for coconuts exports to -0.969 for total exports, indicating that adjustment ranges from about 19.3% for coconuts exports to 96.9% for total exports toward the long-run equilibrium. In general, estimated models for all eight product groups provide satisfactory results.

The estimated coefficients on exchange rate volatility variable have the expected negative sign in the majority of the cases. Further, it is statistically significant in five out of eight products. Thus, in general, it appears that the measure of exchange rate volatility has a significant and negative impact on exports of Sri Lanka at either the 5% or 1% level of significance. For all products, except for industrial exports, minor agricultural exports, and gem exports, exchange rate volatility has a significantly negative impact on exports.

Table 5: Regression results for error-correction models

Product	Variables					
	Lag	EC_{t-1}	ΔX	ΔY	ΔRER	V
Total Exports	0				-0.971* (-2.66)	
	1	-0.969* (-3.66)		0.787* (2.87)		-0.031* (-2.18)
	2		0.857* (4.15)			
	3			1.020* (3.40)	-0.737* (-3.13)	
Industrial Exports	0				-1.866* (-5.23)	
	1	-0.699*(-6.25)	0.118* (-2.69)	1.221* (3.84)	-1.473* (-5.32)	0.153* (2.22)
	2			1.069* (2.94)	-1.165* (-5.03)	
	3					
Tea Exports	0		0.970* (2.95)			
	1	-0.712*(-7.21)			-0.923* (-3.95)	
	2					
	3			1.265* (3.17)	-0.622* (-3.08)	-0.120** (-1.97)
Rubber Exports	0		0.371* (2.12)			
	1	-0.740*(-4.20)		1.894* (3.35)	-2.564* (-4.01)	
	2					
	3				-1.436* (-3.52)	-0.356* (-2.51)
Coconuts Exports	0		0.832* (7.82)			
	1	-0.193*(-3.23)			-1.334* (-3.91)	-0.359 (-1.56)
	2		-0.715* (-5.88)	3.485* (2.52)		
	3			2.489* (2.18)		
Minor Ag Exports	0		0.818* (6.93)			
	1	-0.285*(-2.61)		1.615* (2.51)		
	2				-1.555* (-2.38)	
	3		-0.552* (-4.59)		-1.176* (-2.16)	0.265 (1.66)
Gems Exports	0					
	1	-0.223*(-2.21)	1.089* (5.78)	1.408* (2.55)		
	2		-0.761* (-3.86)			0.300 (1.52)
	3				-0.884* (-2.48)	
Other Exports	0					
	1	-0.504*(-5.54)			-1.868* (-3.35)	
	2			1.731* (2.42)		
	3		0.156** (1.98)	1.527* (4.47)		-0.856* (-2.54)

Note: The figures in parentheses are t-values for the regression coefficients; * and ** denote statistical significance at the 1% and 5% levels, respectively.

SUMMARY AND CONCLUSIONS

The aim of this study is to attain a further understanding of the impact of exchange rate volatility on Sri Lanka's international trade, more specifically its exports. The empirical research offers ambiguous conclusions regarding this relationship; nevertheless, a larger portion of the empirical evidence inclines towards the belief that exchange rate fluctuations impede rather than enhance international trade. This trend is often associated with the risk-averse behavior of exporters (see, for instance, Choudhry, 2005 or Chou, 2000).

In this paper we have examined the dynamic relationship between exports and exchange rate volatility in Sri Lanka in the context of a multivariate error-correction model. Estimates of the long-run export demand functions were obtained by employing Johansen and Juselius maximum likelihood cointegration technique to quarterly date for the period 1980-2007. The sample period coincides with the shift in the exchange rate regime and the initiation of significant reforms in economic and financial policies in Sri Lanka.

First, the results of Equation (4) have satisfied the necessary conditions of the ARCH model and also indicated that ARCH and GARCH effects exist in the data. Then, based on the results of the Augmented Dickey-Fuller test, we have concluded that all the variables have unit roots; however, the lnV variable is stationary at levels. Finally, we have performed the trace and the maximum eigenvalue tests and have come to the conclusion that there is at least one cointegration vector in each case.

Since all of the coefficients are statistically significant either at 1% or 5% level of significance, we have interpreted these specifications as the long-run export demand relationships for Sri Lanka for the period 1980Q1 - 2007Q4. Of the eight product groups specified in Table (4), the following five had negative signs for the exchange rate volatility variable: total exports, industrial exports, tea exports, minor agriculture exports, and gems exports. Therefore, we have concluded that exchange rate volatility tends to deter exports in the long-run for these five product groups.

Lastly, we have examined the short-run dynamics of the long-run export demand functions by estimating error-correction model in Equation (5). The results generally indicated that the measure of exchange rate volatility has a significant and negative impact on exports of Sri Lanka at either the 5% or 1% level of significance. The error-correction results indicate that, in the short-run, exchange rate volatility has a significant negative impact on exports of Sri Lanka in most of the cases.

The cointegration results clearly show that there exists a long-run equilibrium relationship between real exports and real foreign economic activity, real exchange rate, and real exchange rate volatility. Of the eight product groups, five of them have negative signs for the exchange rate volatility variable indicating that exchange rate volatility tends to deter exports in the long-run, for these five products. The error-correction results indicate that, in the short-run, exchange rate volatility has a significant negative impact on exports of Sri Lanka in most of the cases.

Considering that the majority of previous researches estimating the effects of exchange rate volatility on exports have generally indicated a negative relationship, the present findings appear to be promising. After all, we can conclude that the results we have obtained are favorable to the hypothesis that exchange rate uncertainty depresses Sri Lanka's export volumes. Broadly speaking, the findings in this paper suggest that stabilization of Sri Lankan rupee along with the exchange rate is certainly in the country's best interest. Therefore, Sri Lanka should employ tight monetary policy, such as the increase of interest rates, to attain these objectives. However, it is important to note that Sri Lankan rupee can enjoy currency stabilization and currency valuation only if it occurred through nominal appreciation rather than through high inflation (see, for instance, Goldfajn and Gupta, 2003). Hence, further research of possible actions would need to be conducted to properly assess the potential outcomes and impeding side effects on Sri Lankan economy as a whole. Nevertheless, economic policies which are aimed at stabilizing the exchange rate should be employed. Then, alongside with deflated rupee, the country's exports should most certainly realize a great abundance.

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