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The Impact of Exchange Rate Volatility on Exports in Sri Lanka: An Empirical Analysis from ARDL and Granger Causality Approaches

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ABSTRACT

After the implementation of freely floating exchange rate regime in Sri Lanka, exchange rate became highly volatile which had negative repercussions for trade, investment and growth. Therefore, this study investigated the impact of exchange rate volatility on exports in Sri Lanka using quarterly time series data from 2000 to 2020. ARDL Bounds testing approach was employed to identify the impact of exchange rate volatility on exports in Sri Lanka. This study adapted the moving average standard deviation method to calculate the Exchange rate volatility. The findings revealed that higher exchange rate fluctuation tends to reduce Sri Lanka's exports both in the short-run and in the long-run. Besides, real effective exchange rate depreciation affects exports negatively in the short run, but positively in the long-run which is consistent with the J curve effect. Moreover, the increase in real foreign income of Sri Lanka's major export trading partner countries has a significant and positive impact on Sri Lanka's exports in the long-run as well as in the short-run. In addition, as expected, relative price exerts a significant and negative effect on exports in the long-run. This implies that the quantity demanded for Sri Lanka's export falls as the price of export rises relative to the price of similar goods produced by Sri Lanka's major export competitors. These findings suggest some important policy implications in managing the exchange rate system and promoting exports of Sri Lanka

Keywords: Exchange rate, Volatility, ARDL Bounds testing, Export, Sri Lanka

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1. Introduction

The impact of exchange rate volatility on international trade becomes a highlighted concern among researchers in all over the world since higher fluctuation in exchange rate creates instability and a lack of confidence on international trade. Exchange rate volatility is a crucial element that needs to be considered in developing countries, which affects the trade extensively and create uncertainty. It is widely believed that the adoption of the floating exchange rate system, after the collapse of the Bretton Woods system in 1973 increased the uncertainty of exchange rates (Doganlar, 2002). Increased volatility in exchange rate causes

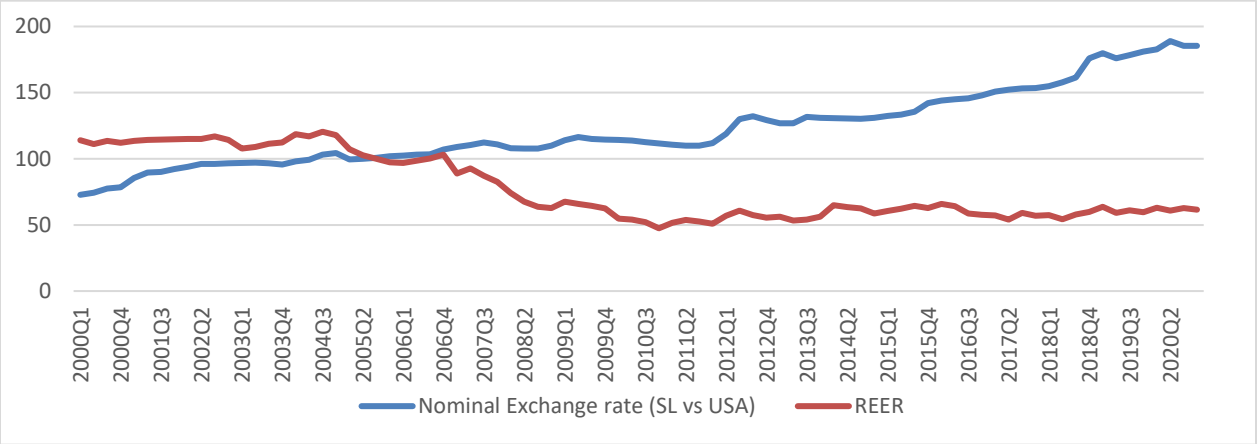
uncertainty for the future behavior of exchange rates. In other words, the volatility of exchange rate is often treated as a risk and an increase in volatility would raise cost for risk averse traders and depress the trade (Ethier, 1973). This is due to the fact that the exchange rate is agreed upon at the time of the trade contract, but payment is not made until the future delivery occurs. If exchange rates become unstable, it causes uncertainty about profits to be made and, as a result, reduces exports (Srinivasan and Kalaivani, 2012).

Contrary, Cote (1994) argued that the assumption of risk aversion does not always imply that exchange rate volatility affects trade volume. His argument is based on the fact that an increase in risk (exchange rate volatility) has two effects, namely a substitution effect and an income effect, which work in opposite directions. The substitution effect pushes risk-averse firms to decrease export activities as the expected marginal utility of export revenues decrease, while the income effect leads risk-averse firms to boost export performance to avoid severe falls in revenues. Therefore, based on general theory, exchange rate volatility could have either positive or negative impact on export volumes.

The consequences of exchange rate volatility on exports have long been at the centre of debate among researchers. Although the empirical literature reveals that the effect of exchange rate volatility on exports is ambiguous (eg; Thuy and Thuy, 2019; Todani and Munyama, 2005), a large number of studies have found that there is a negative relationship between exchange rate volatility and exports. These studies include Cushman (1988), Arize (1995), Chowdhury (1993), Doroodian (1999), Doğanlar (2002), Weliwita et al. (1999), Srinivasan and Kalaivani (2012), Yüksel et al. (2012), Arize et al. (2003), Vergil (2002), Thuy and Thuy (2019), Baak et al. (2002), Haseeb and Ghulam (2014), Ekanayake and Chatrna (2010) which found evidence for negative effects. On the other hand, Wong and Tang (2011), Todani and Munyama (2005), Bailey et al. (1986) and Asseery and Peel (1991) found a positive relationship between exchange rate volatility and exports. In addition, Aristotelous (2001), Yüksel et al. (2012) and Hooper and Kohlhagen (1978) have reported no significant relationship between exchange rate volatility and exports. Majority of these studies have focused on developed countries while developing countries have received little attention.

When consider the Sri Lankan context, immediately after the move to a floating exchange rate system in 1977 from fixed exchange rate system, exchange rate became highly volatile in Sri Lanka which had negative repercussions for trade, investment and growth. Between 1978 and 1996, the rupee was devalued by 272 percent against the U.S. dollar. Although the rupee was continuously devalued against all major currencies throughout the post 1977 period, the movements in real exchange rates have not been able to match the depreciation in the nominal exchange rates (see Figure 1). In 2001 January, Sri Lanka adapted the independently floating exchange rate system. According to Safuan (2017), countries that have adopted the freely floating exchange rate regime with open capital accounts are likely to experience tremendous fluctuations. Between 1980 and 2007, the rupee depreciated by 555.7 percent against the U.S. dollar. During the same period, the exports increased only by 69.2 percent (Ekanayake and Chatrna, 2010). Further, some agree that, a combination of high domestic inflation and often erratic depreciations and appreciations in real

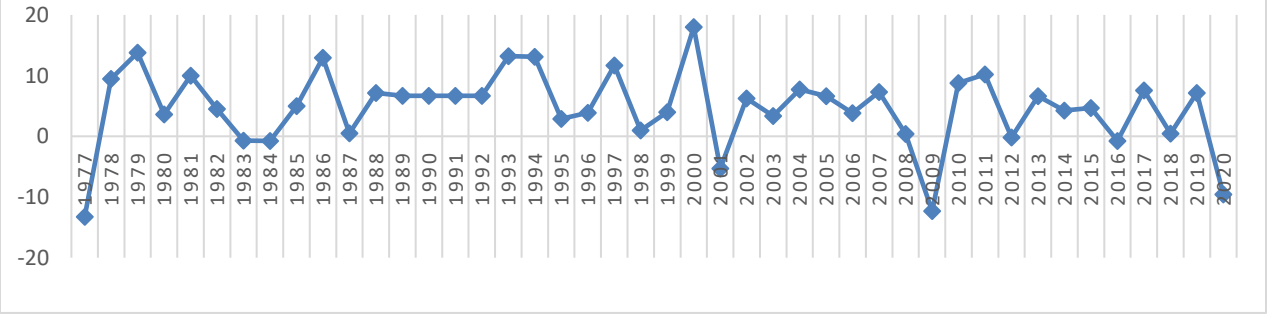
exchange rates create high volatility in real exchange rates which could significantly affect the volume of export (e.g. Weliwita et al., 1999; Ekenayake and Kankanamge, 2015).



Source: Authors' calculations based on International Financial Statistic of IMF (2021)

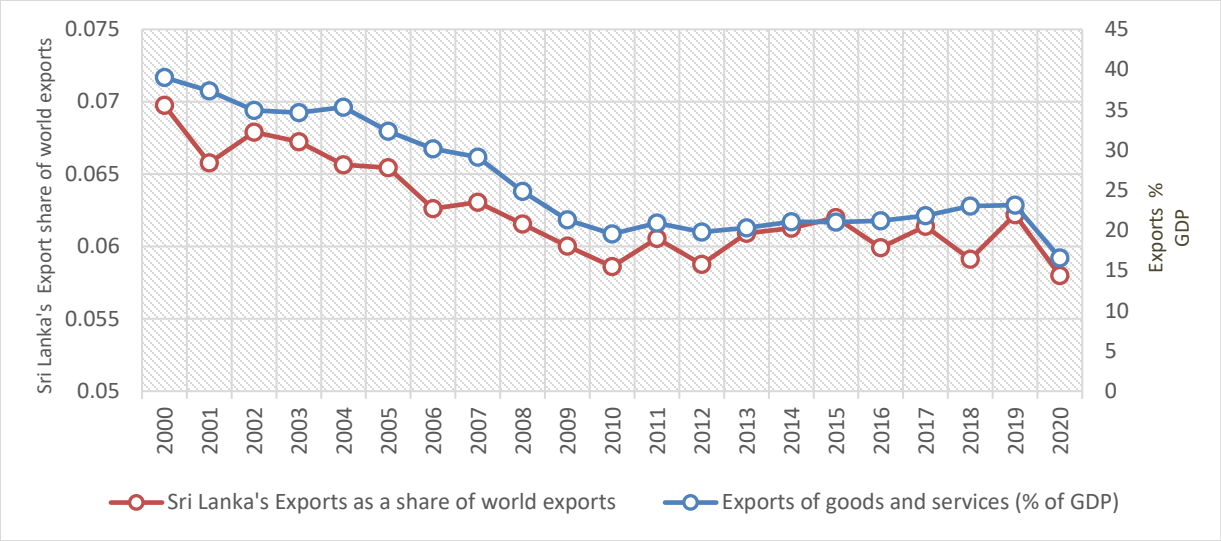
Figure 1: Trend in nominal exchange rate (Sri Lanka vs US) and real effective exchange rate movements

Current era, export plays an essential role in Sri Lanka's economic growth. After 1977, Sri Lanka followed more external-oriented policies such as liberalization of the economy, cancellation of multiple exchange rates and official exchange rates etc. and then since 1978 it has implemented many programs and strategies to upgrade export-oriented products of agriculture and industries. After implementing the open economic policy, Sri Lanka planned to develop the economy through improving the performance of export of the country. However, after the introduction of floating exchange rate system in 1977, Sri Lanka's exports has been fluctuating since then (See Figure 2). The country could not sustain that higher & positive growth rate for long-term and it experienced negative growth rates too. Further, Sri Lanka's export performance since 2000 has not been satisfactory (Kelegama, 2013). Sri Lankan exports share in global exports as well as Sri Lankan exports as a share of GDP have been on the decline trend, since after the implementation of the freely floating exchange rate regime in January 2001, which is shown in figure 3.



Source: World Bank Development Indicators (2021)

Figure 2: Annual Percentage of growth of Sri Lankan exports (1977-2020)



Source: World Bank Development Indicators (2021)

Figure 3: Sri Lanka's Exports share (2000 – 2020)

Therefore, it is important to explore the relationship between exchange rate volatility and volume of exports. Thus, this study attempts to fulfil the above research gap by empirically investigating the effect of exchange rate volatility on exports of Sri Lanka. The study is also very important in the way of how exports respond to exchange rate shocks in both the long-run and the short-run.

The rest of this paper is structured as follows: Section 2 depicts the research objective; Section 3 presents the review of relevant literatures; Section 4 analysis the methodology that has been used to conduct empirical research on; Section 5 is concerned with empirical results and discussion; and section 6 concludes the study and make evidence-based policy recommendations.

Research Objective

The general objective of this study is to identify the impact of exchange rate volatility on exports of Sri Lanka. The specific objectives are: (1) examine the short-run and long-run relationship between exchange rate volatility and exports of Sri Lanka and (2) identify the degree of impact of exchange rate volatility on exports compared to other variables in the export demand equation.

2. Literature Review

The literature review section is divided into two parts. One is the theoretical view behind the relationship between exports and exchange rate volatility. Second one is the empirical literature review of previous researches related to this topic.

Theory behind the relationship between exports and exchange rate volatility

In general, the theoretical link between volatility of exchange rates and export volumes can be explained by size of the "income and substitution effects". Regarding the impacts of exchange rate volatility and trade volumes, one of the leading theoretical analyses has been outlined by Hooper and Kohlhagen (1978) under the theory of uncertainty. They argue that if exporters are risk averse then elevated volatility in exchange rate is expected to reduce export flows. As explained by Arize, Osang, and Slottje (2000), exchange rate is determined by the exporter and importer at the time of trade contract. However, exporters do not receive their payments until the exported goods and services are delivered. Under the existence of high volatility, unpredictable exchange rates produce uncertainty about the future earnings and discourage exporters from selling their products abroad. This negative impact on trade volumes explains the "substitution effect" of volatility of exchange rates on trade. However, Ethier (1973) and Baron (1976) argue that if the forward markets are available and hedging is possible, exchange rate uncertainty does not produce any impact on trade flows. Viaene and DeVries (1992), on the other hand, point out that if the hedging is difficult and expensive, uncertainty has indirect impact on trade volumes, and substitution effect is still valid. Another possible impact of the volatility of exchange rate on trade volumes is explained by "income effect". According to the income effect, if exporters are risk averse, a higher volatility elevates the expected marginal utility of export revenue as a result of quick and massive decline of export volumes driven by substitution effect. Then, increasing marginal utility of export revenue stimulates exporters to increase their products that they sell abroad. This effect is known as "income effect" of the volatility of exchange rates on export flows. Consequently, the net effect is determined by the sum of the magnitude of the income and substitution effects. Based on the net impact, exchange rate volatility may produce either a positive or a negative impact on export volumes (Doganlar, 2002).

Empirical Literature Review

A significant number of literatures investigate the impact of exchange rate volatility on exports across various countries. For instance, Hooper and Kohlhagen (1978) examined the effects of exchange rate uncertainty on the volume of trade among developed countries. They measured exchange rate volatility (risk) by standard error of nominal exchange rate fluctuations. However, they could not establish any significant impact of exchange rate volatility on the volume of trade among developed countries. Cushman (1988) found a negative relationship between exchange rate volatility and volume of trade in the developed countries. Weliwita et al. (1999), Kurmar and Dhawan (1991), Bahmani-Oskooee and Ltaifa (1992), and Grobar (1993) provide strong evidence that greater uncertainty in exchange rates reduces developing country trade.

For the case of developing economies, Srinivasan and Kalaivani (2012) empirically investigates the impact of exchange rate volatility on the exports in India using the ARDL Bounds testing approach. Exchange rate volatility is calculated through Moving Average Standard Deviation. The findings of this study indicate that the exchange rate volatility has a significant negative impact on exports of India both in the short-run and in the long-run. Besides, Yüksel et al. (2012) examined the impact of exchange rate volatility on the export of Turkey

with its major trading partners. The results indicated that there was a negative relationship between exports and exchange rate volatility; however, this relationship was not statistically significant at a level of 5 percent. Aristotelous (2001) also reported an insignificant relationship between exchange rate volatility on the UK-US exports.

Arize et al. (2003) examined that does exchange rate volatility depress the export flows in case of ten developing countries over the quarterly period 1973 to 1998. This study used Johansen's multivariate procedure and Error correction mechanism (ECM) techniques. Results of the study shows as increase in the exchange rate volatility exert a significant negative effect upon export demand in both the short-run and long-run. Thuy and Thuy (2019) analyzed the impact of exchange rate volatility on exports in Vietnam and employed autoregressive distributed lag (ARDL) Bounds testing approach to the analysis of level relationships between effective exchange rate volatility and exports. This study found the volatility of exchange rate has a positive and significant short-run effect on exports whilst, in the long run, volatility adversely affects export performance in Vietnam.

However, some studies revealed as existence of a positive impact of exchange rate volatility on exports. McKenzie and Brooks (1997) analyzed the effect of exchange rate volatility on Germany-US bilateral trade flows. ARCH models are used to generate a measure of exchange rate volatility and are then tested against Germany's exports to, and imports from, the US. The findings of this paper differ from many papers previously published as the effects of volatility are found to be positive and statistically significant. Wong and Tang (2011) examined the effects of exchange rate variability on export demand for semiconductors in Malaysia. The findings of this study show that the long-run exchange rate variability elasticity is positive and it is statistically significant. It suggests that exchange rate variability has a positive influence on semiconductor exports in the long -run. Todani and Munyama (2005) employed ARDL bound test approach to examine the relationship between exports and exchange rate volatility in South Africa. The study revealed a positive relationship between South African exports and exchange rate volatility in both the long- run and short-run.

Bailey et al. (1986) investigated the effect of exchange rate volatility on export of leading OECD countries (Canada, France, Germany, Italy, Japan, UK and US). The study also revealed that exchange rate volatility has positive effect both in long run and short run. Assery and Peel (1991) examined the effects of exchange rate volatility on exports of the major five OECD countries namely, Australia, Japan, The United Kingdom, The United States and West Germany over the period 1972 to 1987. They found a significant positive relationship between exchange rate volatility and exports for all countries except the United Kingdom.

Contrary, Arize et al. (2000) investigated real exchange rate volatility on the exports of 13 less developed countries using Johansens multivariate procedure and error correction model. This study revealed a significant negative impact of volatility on export flows. Srinivasan and Wallack (2003) and Veeramani (2008) also found a negative and significant relationship between the real exchange rate and merchandise aggregate exports in India. Ahmed et al. (2017) examined the impact of exchange rate on exports in case of Pakistan

using with ARDL Bounds test conitegration method. This study found that exchange rate has negative but insignificant impact on exports of Pakistan.

In terms of Sri Lanka, Ekanayake and Chatrna (2010) examined the effects of exchange rate volatility on Sri Lankan exports to its major trading partners and tested the sectoral data to identify whether the effect of exchange rate volatility differs depending on the types of the goods traded. This study suggests that the impact of exchange rate volatility differs between different categories of export commodities of Sri Lanka. The results generally indicated that the measure of exchange rate volatility has a negative impact on exports of Sri Lanka. Ekenayake and Kankanamge (2015) examined the impact of exchange rate particularly on industrial exports in Sri Lanka. The findings of this study indicate that nominal exchange rate and exchange rate volatility have no significant impact on real industrial exports of Sri Lanka.

The conclusion drawn from empirical literature is that earlier studies found insignificant relationship between export and exchange rate volatility. Later studies confirm that, although exchange rate volatility has a significant impact on exports, the effect can be either positive or negative. Hence, the effect of exchange rate variability on exports is still a debatable issue. In Sri Lankan context, only limited studies have been performed in this field, which provide rather blend results and they could not find significant relationship between the variables. Thus, further studies on the relationship between exchange rate volatility and export in Sri Lanka is required to identify the exact relationship between the variables and enhance the existing knowledge on the subject.

3. Research Methodology

Model Specification

In order to access the impact of exchange rate volatility on export, a simple export demand function is constructed including a proxy for a measure of exchange rate uncertainty. To that aim, volume of exports (REXP) is used as a dependent variable while real effective exchange rate (REER), real foreign income (RFI), relative price (RELP) and exchange rate volatility (VOL) were used as independent variables of this study. Exchange rate volatility, which is a measure of exchange rate uncertainty is calculated by using moving average standard deviation method. Following the some of the existing studies (e.g.: Arize, 1995; Wong and Tang, 2011; Doganlar, 2002; Todani and Munyama, 2006; Ekanayae,and Chatrna, 2010), the export demand function can be written as bellow:

$$LnREXP_t = \beta_0 + \beta_1 LnRFI_t + \beta_2 LnREER_t + \beta_3 LnRELP_t + \beta_4 LnVOL_t + \varepsilon_t \quad \text{..... (1)}$$

Where, REXP, RFI, REER, RELP and VOL are as described above, β_0 is intercept; $\beta_1, \beta_2, \beta_3$ and β_4 are slope coefficients; ε_t is white noise error term; and t represents the time period (t =1, 2, …..,T). All the variables are converted into natural logarithm which denoted by Ln in the above function.

In the above equation, we have the following expectations for the sign of the regression coefficients based on the existing empirical and theoretical literature. According to the gravity theory of international trade,

increases in foreign real income of trading partners would be expected to result in greater exports of host country, therefore, β_1 is expected to be positive ($\beta_1 > 0$) (e.g.: Arize, 1995; Wong and Tang, 2011; Srinivasan and Kalaivani, 2012). While, real effective exchange rate depreciation may lead to an increase in exports due to the relative price effect. Hence, the estimated parameter of real effective exchange rate, β_2 should be positive ($\beta_2 > 0$) (e.g.: Thuy and Thuy, 2019). Furthermore, the relative price is considered as a measure of price competitiveness. By assuming all else constant, if the price of exports rises (decreases) relative to prices of similar goods produced by Sri Lanka's major export competitors, it would cause the domestic goods to become less (more) competitive than foreign goods and, therefore, the quantity demand for Sri Lanka's exports will fall (rise). Hence, it is expected that the estimated parameter of relative price, β_3 should be negative ($\beta_3 < 0$), since a decrease in the export prices of a country should increase the quantity of exports demanded (e.g.: Wong and Tang 2011; Doğanlar, 2002). Finally, the effect of exchange rate volatility on exports is ambiguous and the international empirical evidence on the influence of volatility on exports is mixed. Thus, β_4 is expected to be either positive or negative (β_3>0 or β_3< 0) (e.g.: Srinivasan and Kalaivani 2012; Doganlar, 2002; Thuy and Thuy, 2019).

Data Source and Variables description

Quarterly data over the period of 2000 - 2020 has been used for this study. The choice of the sample period is based on the availability of data. The above research period coincides with the shift in the exchange rate regime, from the managed floating exchange rate system to freely floating exchange rate system and the initiation of significant reforms in economic and financial policies in Sri Lanka. For the explanatory analysis with limited resource availability, Sri Lanka's major five export partners were taken into the account. They are United States (24.83% of total Exports- $2.93B), the United Kingdom (8.93% of total Exports- $918M), India (6.11% of total Exports- $721M), Germany (5.71% of total Exports- $712M) and Italy (4.46% of total Exports- $474M) which comprise a significant portion of Sri Lanka's total exports (CBSL annual report, 2018).

Quarterly data for the volume of exports were collected from the International Financial Statistics of International Monetary Fund (IMF). The real foreign income is proxied by the trade-weighted average of the industrial production indices (2010=100) of Sri Lanka's major export partners. The data for trade weights (export share) and Industrial Production Indexes (IPI) were obtained from the Direction of Trade Statistics (DOTS) of IMF and from the Organization for Economic Cooperation and Development (OECD)'s online database. According to Ekanayake and Chatrna (2020), the trade-weighted average of the industrial production index of Sri Lanka's 5 major export partners was calculated as below:

$$RFI_t = \sum_{j=1}^{5} EXP_{jt}^{w} \times Y_{jt} \quad \text{..... (2)}$$

Where RFI_t = Real Foreign Income, EXP_{jt}^{w} = Weight of Sri Lankan Exports (or export share) to the jth Country at time t and Y_{jt} is a Industrial Production Index (2010 = 100) of jth country at time t. The top five export partner countries of Sri Lanka are United States, United Kingdom, India, Germany and Italy.

Following Ekanayake and Chatrna (2010) and Arachchi (2018) the trade-weighted real effective exchange rate, was constructed as below:

$$REER_t = \sum_{j=1}^{5} EXP_{jt}^{w} \times \left[\frac{ER_{jt} \times P_{jt}}{P_t^{SL}}\right] \quad (3)$$

Where $REER_t$ is the real effective exchange rate, EXP_{jt}^{w} is a weight of Sri Lankan exports (or export share) to the j[th] country at time t, P_{jt} is the consumer price index (2010=100) of the j[th] country at time t, P_t^{SL} is the consumer price index (2010=100) of Sri Lanka and 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. Quarterly average bilateral exchange rates were taken from the annual reports of Central bank of Sri Lanka. In this study, EURO is used as the main currency indicator for both Germany and Italy. Other three are US dollar (United States), Indian Rupees (India) and British Sterling Pound (United Kingdom). The quarterly data for consumer price index of Sri Lanka and its five largest export partners are obtained from the International Financial Statistics of IMF.

According to Ekanayake and Chatrna (2010), Relative Price was calculated as the weighted average of selected five country relative price value, which is denoted as follow:

$$RELP_t = ER_t \, X \, \frac{CPI_{j_t}}{CPI_{SL_t}} \quad (4)$$

Where $RELP_t$ is the relative price, ER_t is the bilateral nominal exchange rate, CPI_{j_t} is the Consumer Price Index of j[th] country at time t and CPI_{SL_t} is the Consumer Price Index of Sri Lanka at time t. 2010=100 was taken as the base year.

Finally, Exchange rate volatility is used as a proxy for exchange rate uncertainty which denotes the amount of uncertainty or risk about the size of changes in the exchange rate. In this study, the exchange rate volatility variable is measured by the moving average of the standard deviation of exchange rates, which is typically used by a number of scholars such as Doganlar (2002); Arize, Osang and Slottje (2000); Todani and Munyama (2006); Ekanayake and Chatrna (2010); Wong and Tang (2011); Srinivasan and Kalaivani (2012); Yüksel, Kuzey and Sevinc (2012); Arachchi (2018). The main characteristic of this measure is its ability to capture the higher persistence of real exchange rate movements in the exchange rate (Klaassen, 2004). This measure defines exchange rate volatility as,

$$VOL_t = \left[\frac{1}{m}\sum_{i=1}^{m}(REER_{it+i-1} - REER_{it+i-2})^2\right]^{\frac{1}{2}} \quad (5)$$

Where $REER_{it}$ is the real effective exchange rate at time t, m is the Order of Moving Average and the moving average chosen is 2 (m=2) in this study.

Data Analysis Method

ADF and PP unit root test methods were adapted to test that the variables used in this study are not integrated in order two [i.e. I(2)]. The Engel Granger method and Johansen method requires that the all of the variables

in equation (1) should be integrated in same order and the error term should be integrated in order zero in order to form the long run relationship between the variables. However, if variables in equation (1) have different order, that is I(1) and I(0) we can use new co-integration method which was developed by Pesaran et al., (2001). This procedure, also known as autoregressive distributed lag (ARDL) approach to co-integration which was employed to investigate the existence of a long-run cointegration relationship among variables in the study. The ARDL Bounds testing procedure is given by equation (2):

$$\Delta LnREXP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta LnREXP_{t-i} + \sum_{i=0}^{q_1} \alpha_2 \Delta LnRFI_{t-i} + \sum_{i=0}^{q_2} \alpha_3 \Delta LnREER_{t-i} + \sum_{i=0}^{q_3} \alpha_4 \Delta LnRELP_{t-i} + \sum_{i=0}^{q_4} \alpha_5 \Delta LnVOL_{t-i} + \delta_1 LnREXP_{t-1} + \delta_2 LnRFI_{t-1} + \delta_3 LnREER_{t-1} + \delta_4 LnRELP_{t-1} + \delta_5 LnVOL_{t-1} + u_t \quad \text{.....(6)}$$

Where, the terms associated with the summation signs, $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ in the above model represent the short-run dynamic coefficients, whereas $\delta_1, \delta_2, \delta_3, \delta_4, \delta_5$ are the long-run coefficients, p, q_1, q_2, q_3 and q_4 are the optimum lag lengths that can be used for each variables respectively and u_t is the white noise error term. To investigate the existence of cointegrating relationships between the variables, Bounds testing procedure is used, which is based on the F-test. A F-test is actually a test of the hypothesis of no cointegration among the variables (H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$) against the existence of cointegration among the variables (H_1: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$).

Once we identified the existence of cointegrating relationship among the variables then we can estimate long-run and short-run dynamic coefficients from the ARDL model. Thus, the equation (2) can be further transformed as in equation (3) to accommodate the error correction term with one period lagged (ECT_{t-1}) in order to identify the short-run dynamic coefficients and log-run equilibrium adjustment parameter:

$$\Delta LnREXP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta LnREXP_{t-i} + \sum_{i=0}^{q_1} \alpha_2 \Delta LnRFI_{t-i} + \sum_{i=0}^{q_2} \alpha_3 \Delta LnREER_{t-i} + \sum_{i=0}^{q_3} \alpha_4 \Delta LnRELP_{t-i} + \sum_{i=0}^{q_4} \alpha_5 \Delta LnVOL_{t-i} + \emptyset ECT_{t-1} + \mu_t \quad \text{..... (7)}$$

Where, $\emptyset$ is the speed of adjustment parameter which should have statistically significant and negative sign to support the co-integration between the variables and μ_t is the pure random error term. Then, beside ARDL Bounds test, the post estimation diagnostics are generated to establish how the export model (2) fits the data. Finally, this study used Granger causality test to determine the direction of the causality between the variables.

4. Results and Discussion

Unit root test results

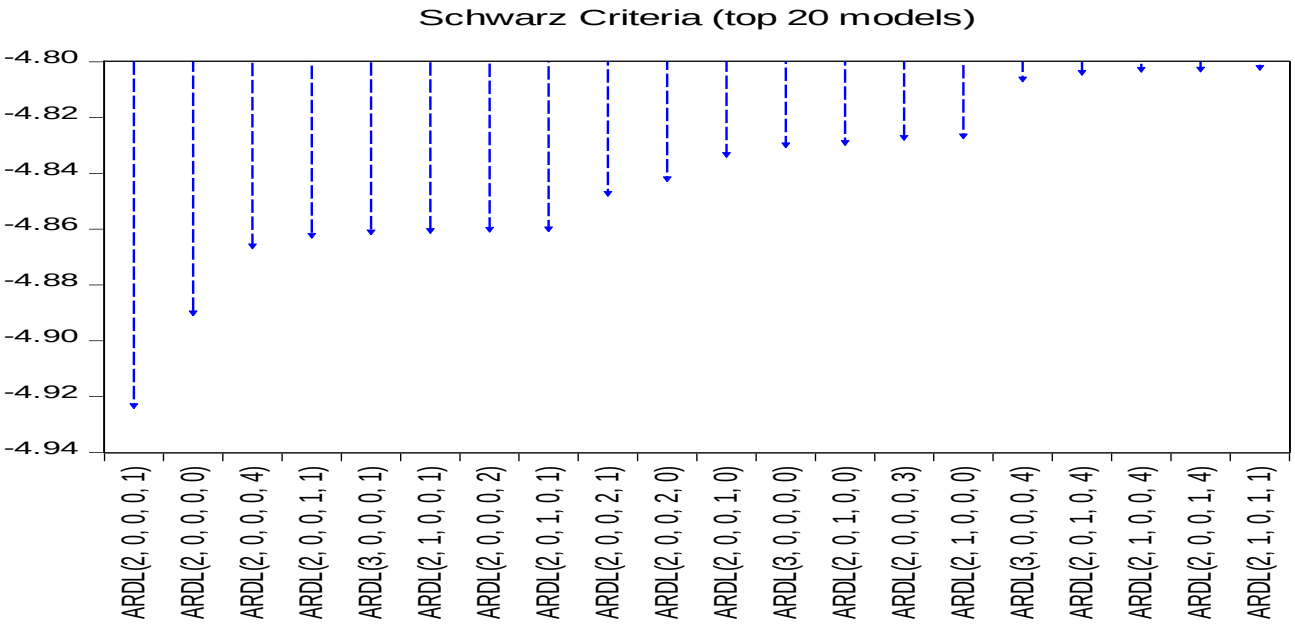
The results of ADF and PP unit root test (Table 1) indicate that the variables are integrated in order one (REXP, RFI, REER, RELP) and order zero (VOL). It also confirms that none of variables are I(2) or higher order. Thus, the ARDL approach is more suitable than other approaches for this dataset to examining relationships between the variables.

Table 1: Unit Root test results

Variable	Augmented Dickey-Fuller test				Phillips-Peron test				Order of Integration
	At level		First Difference		At level		First Difference		
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	
LnREXP	-1.335	-3.195*	-4.589***	-4.530***	-1.588	-2.594	-4.638***	-4.583***	I(1)
LnREER	-0.949	-1.294	-7.689***	-7.639***	-0.966	-1.408	-7.689***	-7.639***	I(1)
LnRFI	-1.469	-1.182	-8.928***	-8.989***	-1.393	-1.049	-8.964***	-9.038***	I(1)
LnRELP	-0.606	-2.747	-6.454***	-6.477***	-0.561	-2.086	-6.482***	-6.477***	I(1)
LnVOL	-6.21***	-6.313***	-0.715***	-0.745***	-6.215***	-6.389***	-0.715***	-6.389***	I(0)

Note: '***', '**' and '*' represent 1 percent, 5 percent and 10 percent level of significance respectively. The optimum lag length of ADF test is determined by using the Schwarz Information Criterion (SIC) and the bandwidth of PP test is selected by using Bartlett kernel (Newey-West automatic)
Source: Authors' calculation

Further, the appropriate lag lengths were selected on the basis of the Schwarz Criterion (SC) and it suggested that to use ARDL (2, 0, 0, 0, 1) model, as a best model among top 20 models, for this analysis.



Source: Results of EViews 10

Figure 3: Model selection criteria graph

ARDL Bounds test

Once the optimum lag length of the ARDL modal is identified, the existence of cointegration relationship between the variables is checked using ARDL Bounds test. The results are given below:

Table 2: Results of ARDL Bounds test

Model	Number of Regressors	Estimated F-test value	Level of Significance of Critical Values of Bounds-Narayan (2005) Unrestricted Intercept and no Trend					
	K	F- Statistic	10%		5%		1%	
			I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
ARDL (2,0,0,0,1)	4	6.8697***	2.2	3.09	2.56	3.49	3.29	4.37

Note: *** indicate that computed F statistic falls above the upper bound value at 1% significant level.

Source: Results of EViews 10

The above results reveal that the computed F- statistic of 6.8697 is obviously greater than the upper bound critical value of 4.37 at the one percent significant level. Thus, the null hypothesis of no cointegration is rejected, indicating there exists a stable long-run cointegrating relationship between exports, real foreign income, real effective exchange rate, relative price and exchange rate volatility.

Estimation of Long-run and short-run relationship

Once the existence of cointegrating relationship among the variables is confirmed, the long-run coefficients of the selected ARDL (2, 0, 0, 0, 1) model was estimated and its results are presented in Table 3.

Table 3: The Long-run results of ARDL (2, 0, 0, 0, 1) model

Dependent Variable: LnREXP				
The results of Long-run coefficients				
Constant	LnRFI	LnREER	LnRELP	LnVOL
1.4590	1.3711***	1.4325***	-1.0757***	-0.0248**
(0.0437)	(0.0000)	(0.0000)	(0.0000)	(0.0236)

Note: '***' & "**' indicate significance at 1 percent level and 5 percent level respectively. Probability values are in Parenthesis.

Source: Results of EViews 10

Thus, the long-run export demand equation of the conditional ARDL (2,0,0,0,1) model is presented as,

$$LnREXP = 1.4590 + 1.3711LnRFI + 1.4325LnREER - 1.0757LnRELP - 0.0248LNVOL$$

According to the results in Table 3, the impact of exchange rate volatility on exports is negative and statistically significant at 5 percent level, which suggests that higher exchange rate fluctuation tends to reduce the volume of exports in Sri Lanka in the long-run. The estimated coefficient of the exchange rate volatility -0.0248 implies

that a one percent increase in the exchange rate volatility reduces Sri Lanka's export by 0.0248 percent. This result reveals that the risk associated with exchange rate fluctuation (exchange rate uncertainty) discourage economic agents from trading across borders. Exchange rate volatility increases cost on risk-averse investors and therefore, responds by favouring to trade at the margin. As a consequence, the volume of exports from Sri Lanka to its trading partners reduces. Our findings support the notion that a raise in exchange rate risk leads to a reduction in the level of export, which is consistent with Hooper and Kohlhagen (1978); Arize (1995); Srinivasan and Kalaivani (2012); Alsoos and Madurapperuma, (2016) and Thuy and Thuy (2019). Even though exchange rate volatility has a significant impact on exports, the degree of its relationship is very weak to compared to other variables.

Moreover, the impact of real effective exchange rate on export is positive and statistically significant at 1 percent level in the long-run, implying that the depreciation of currency is more effective in stimulating the growth of exports in Sri Lanka. This is in line with the theory and many empirical studies (Srinivasan and Kalaivani, 2012; Thuy and Thuy, 2019) suggesting that the REER value represents the competitiveness of Sri Lanka's goods in the international market. The long-run coefficient of real effective exchange rate confirms that volume of export increases by 1.4325 percent for every 1 percent increase in real effective exchange rate. This is because a weak domestic currency makes a nation's exports more competitive (relatively cheap for foreigners) in global markets, and enhances the demand for exports, during the depreciation of currency. This is related to the findings of Srinivasan and Kalaivani (2012); Thuy and Thuy, 2019.

Furthermore, the long-run coefficient of real foreign income exerts a significant and positive impact on exports of Sri Lanka at 1 percent level of significance which indicate if real income of the major export trading partner countries of Sri Lanka goes up by 1 percent, the export volume of Sri Lanka increases by 1.3711 percent. This finding is consistent with the studies of Arize, 1995; Wong and Tang, 2011; Doğanlar, 2002; Todani and Munyama, 2006; Yüksel et al. 2012. Moreover, the relative price has a significant negative impact on exports of Sri Lanka at 1 percent level of significance. The estimated negative relative price term, in other word price elasticity term, implies that by assuming all else constant, if the price of exports of Sri Lanka, relative to prices of similar goods produced by Sri Lanka's major export competitors, goes up by 1 percent, the export volume of Sri Lanka goes down by 1.0757percent. Our findings support the notion that a raise in the price of export relatively to the price of similar goods produced by export competitors reduce the quantity of export demanded, which is consistent with Arize, 1995; Todani and Munyama, 2006; Doğanlar, 2002; Wong and Tang, 2011.

Next, the results of short run dynamic and long run adjustment coefficients are estimated using Equation (3), which is presented in Table 4.

Table 4: Error Correction Representation of ARDL (2, 0, 0, 0, 1) Model

Dependent variable: Δ LnREXP			
Variables	Lag order		
	0	1	2
Δ LnREXP		0.8127*** (0.000)	-0.1960 (0.1053)
Δ LnRFI	0.5293*** (0.0000)		
Δ LnREER	-0.5310*** (0.0000)		
Δ LnRELP	0.4212*** (0.0002)		
Δ LnVOL	-0.0045** (0.0281)	-0.0039** (0.0365)	
Constant	0.000189		
ECT(-1)	-0.810737*** (0.0003)		
R-squared	0.668677		
Adjusted R-squared	0.649184		
F-statistic	9.558759*** (0.0000)		
Durbin-Watson stat	1.972671		

Note: Probability values are given in the parenthesis. '***' & '**' represent 1 percent & 5 percent level of significance respectively

Source: Results of EViews 10

Table 4 reports the results of the short run dynamics coefficient of ARDL-ECM. Accordingly, as expected, the current and one period lagged value of exchange rate volatility has significant negative impact on exports of Sri Lanka in the short-run. To sum up, the exchange rate volatility has negative and significant impact on exports of Sri Lanka both in Short-run and long-run. One possible explanation for the fall in the volume of exports in both short-run and long-run is the absence of hedging opportunities which cause risk-averse profit maximisation firms to reduce their exports in the face of high uncertainty due to higher fluctuation in exchange rate. The estimated short-run coefficient of the real foreign income exerts a significant positive impact on exports of Sri Lanka in short-run as well.

Surprisingly, the negative coefficient of REER implies that real effective exchange rate has a negative and significant impact on exports in the short-run. Contrary, the long-run coefficient of the REER variable is positive and highly significant. Thus, a depreciation of the domestic currency affects exports negatively in the short run, but positively in the long run, consistent with the J curve effect. It is followed by the results of Srinivasan and Kalaivani, 2012; Thuy and Thuy, 2019. This is because that domestic currency price of imports normally rises faster than prices of exports immediately after the real exchange rate depreciation. This in turn increase the price of export and affects export revenue in short-run, as our country's export sector is highly depended on imported raw materials and intermediate goods. Therefore, trade balance deficit increases in

short-run but in long-run the quantities of imports fall and quantity of export rises and eventually the trade balance moves towards surplus. This development of current account is called as J-curve effect (Yarbrought and Yarbrought, 2003).

Moreover, the relative price has a significant positive impact on exports in short-run, which is related to the findings of Arachchi (2018) and Arize et al. (2000). Surprisingly, this result is contrast to our expectation. The positive effect of relative price in the short run can certainly be the result of poor data quality typical for developing countries. Although, the relative price has significant and positive impact on export in the short-run, it has expected negative sign in the long-run. Further, the coefficient of Error Correction Term (ECT) carries an expected negative sign, which is highly significant, indicating that the dependent variable exports can get back towards the long-run equilibrium path at the speed of 81.07percent in each period one period after the exogenous shocks which is further evidence of co-integration relationships among the variables in the model.

Diagnostic test results

The diagnostic tests result of the selected ARDL (2, 0, 0, 0,1) model is presented in table five.

Table 5: Diagnostic tests results

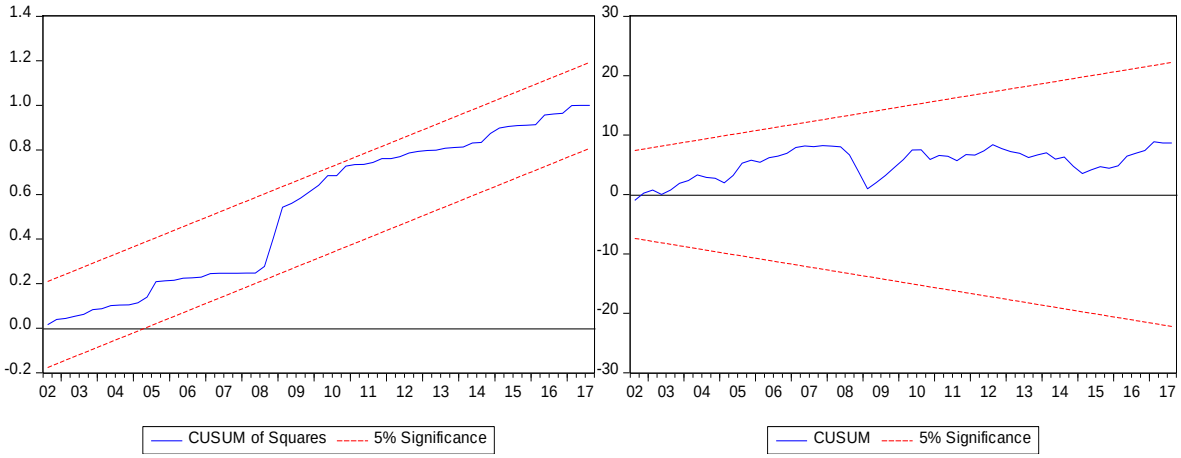
Diagnostic tests	Test Statistics (F-Statistic)	Prob. value
Serial Correlation test (LM Test: $\chi^2_{(df)}$)	0.815667	0.3952
Heteroscedasticity (ARCH Test) test	0.007997	0.9277
Omitted Variable test (Ramsey's RESET Test)	0.664674	0.5088
Breusch-Pagan-Godfrey test for Heteroscedasticity	0.627687	0.7043

Source: Authors' calculation

Diagnostic tests results indicate that the selected ARDL (2,0,0,1) model pass all the diagnostic tests. According to the Breusch- Godfrey Serial Correlation LM test, the null hypothesis of errors are not serially correlated cannot be rejected. Both the ARCH test and the Breusch-Pagan-Godfrey test of Heteroscedasticity suggest that the errors are homoscedastic and independent of the regressors. The Ramsey's RESET results confirm that there is no specification error in the estimated model.

Then, the stability of the long-run coefficients along with the short run dynamics are evaluated by applying the CUSUM and CUSUMSQ plots.

As shown in below figure, both plots of CUSUMSQ statistics and CUSUM statistics stay within the critical Bounds of the 5 percent significance level. These tests indicate no evidence of any significant structural instability. Therefore, the estimated results are stable over the studied time period.



Source: Authors' calculation

Figure 4: Plot of cumulative sum of squares of recursive residuals and cumulative sum of recursive residuals

Finally, Granger causality test detected only the unidirectional causality that running from exchange rate volatility to real effective exchange rate and volatility in exchange rate to relative price at the 5 percent level of significance. This implies that higher fluctuation (uncertainty) in exchange rate leads to greater exchange rate depreciation and higher price competitiveness in Sri Lanka. Further, this study also found one-way causal relationship that stemming from volume of export to relative price (REXP to RELP), real exchange rate depreciation to relative price (REER to RELP), exchange rate volatility to real effective exchange rate (VOL to REER) and exchange rate volatility to relative price (VOL to RELP) at the 5 percent level of significance (See Appendix 1).

5. Conclusion

This study aims to examine the impact of exchange rate volatility on export performance of Sri Lanka during the period from the first quarter of 2000 to the fourth quarter of 2020. To achieve this objective, an export demand function is estimated using real effective exchange rate, real foreign income, relative price and exchange rate volatility as explanatory variables. This study uses the Moving Average Standard Deviation (MASD) Method to measure the exchange rate volatility (uncertainty). The ADF and PP unit root test results reveal that all the variables are I(1) except exchange rate volatility (LnVOL), which is only I(0). The appropriate lag length was selected on the basis of the Schwarz Information Criterion (SIC) which suggested to use ARDL (2, 0, 0, 0, 1) model for the analysis. The ARDL Bounds testing approach confirm the existence of long-run co-integrating relationship between the variables.

The findings reveal that the exchange rate volatility has a significant and negative impact on exports both in the short-run and in the long-run. Thus, it is clear that higher exchange rate fluctuation tends to reduce Sri Lanka's exports and depress the export sector performance in Sri Lanka. This result is consistent with the findings of Arize et al. (2003); Srinivasan and Kalaivani (2012) and Alsoos and Madurapperuma, (2016). Even though exchange rate volatility has a significant impact on exports, but the degree of relationship is very weak

compare to other variables. Moreover, the coefficient of real effective exchange rate (REER) is positive and statistically significant in long-run which implies that the depreciation of exchange will stimulate exports in long-run. This finding is in line with the theory and many empirical studies suggesting that the REER value represents the competitiveness of Sri Lanka's goods in the international market. Nonetheless, the short-run coefficient of the REER is negative and highly significant. Thus, the real effective exchange rate depreciation affects exports negatively in the short run, but positively in the long-run, which is consistent with the J curve effect. Moreover, the increase in real foreign income of Sri Lanka's major export trading partner countries has a significant positive impact on Sri Lanka's exports in long-run as well as in short-run. In addition, relative price exerts significant and negative effect on exports in the long-run, as expected. Further this model confirms that whole system can get back to long-run steady state line at speed of 81.07percent in each quarter one period after the exogenous shocks.

Based on the theoretical grounds, the present study recommends that the Central Bank of Sri Lanka (CBSL) should pursue sustainable and stable exchange rate policy measures to promote greater exchange rate stability that would help to enhance the export of the country. Most importantly, the policy makers in Sri Lanka should consider both the existence and the degree of exchange rate volatility while implementing suitable trade and exchange rate policies for the growth of export demand. Exchange rate monitoring and export diversification could be used to enhance the performance of the Sri Lanka's exports sector. Further, the study insists on the need for a foreign trade policy that is in tune with the changed realities of the world economic activity in the short-run due to the alarming global economic crisis.

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Appendix 1:

Null Hypothesis	F-Statistic	Probability value
LNREER does not Granger Cause LNREXP	0.06220	0.8038
LNREXP does not Granger Cause LNREER	1.94880	0.1673
LNRFI does not Granger Cause LNREXP	0.01459	0.9042
LNREXP does not Granger Cause LNRFI	0.17545	0.6766
LNRELP does not Granger Cause LNREXP	0.15425	0.6957
LNREXP does not Granger Cause LNRELP	5.02292**	0.0283
LNVOL does not Granger Cause LNREXP	0.36115	0.5499
LNREXP does not Granger Cause LNVOL	2.59455	0.1120
LNRFI does not Granger Cause LNREER	0.02209	0.8823
LNREER does not Granger Cause LNRFI	0.00892	0.9250
LNRELP does not Granger Cause LNREER	1.53528	0.2196
LNREER does not Granger Cause LNRELP	6.31179**	0.0144
LNVOL does not Granger Cause LNREER	4.68668**	0.0340
LNREER does not Granger Cause LNVOL	0.40953	0.5244

LNRELP does not Granger Cause LNRFI	0.00832	0.9276
LNRFI does not Granger Cause LNRELP	1.11464	0.2948
LNVOL does not Granger Cause LNRFI	1.34415	0.2505
LNRFI does not Granger Cause LNVOL	0.60850	0.4381
LNVOL does not Granger Cause LNRELP	4.84910**	0.0312
LNRELP does not Granger Cause LNVOL	0.47289	0.4941

Note: '**' represent 5 percent level of significance (P-value< 0.05 α value)