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THE IMPACT OF EXCHANGE RATE VOLATILITY ON INDUSTRIAL EXPORTS: A CASE OF SRI LANKA

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Abstract

The developing world witnessed the exchange rate fluctuations enormously to instability and a lack of economic confidence over the years. The relationship between exchange volatility and industrial exports in Sri Lanka is a continuing matter in economic growth and development. Many developing countries are engaging in a wide range of cross-border transactions with developed and emerging economic countries. This situation has led countries to witness exchange rate fluctuations, and the unpredictability of exchange rates affects the export earnings. The relationship between exchange rate volatility and industrial exports in Sri Lanka is a continuing matter in economic growth and development. The aim of this study is to analyze the exchange rate volatility on industrial exports in Sri Lanka from 2001 to 2018. The motivation of this study is to investigate the relationship between exchange rate volatility in industrial export earnings in Sri Lanka after implementing floating exchange rate policy. The ARDL model is employed to examine this phenomenon and the study found a positive relationship between exchange rate volatility and industrial exports in Sri Lanka in the short run and long run.

Keywords: Exchange Rate, Industrial Exports, Earnings, Bilateral Trade, Volatility

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1. INTRODUCTION

Over the past year, exchange rates have fluctuated enormously leading to instability and a lack of confidence (Bartolini and Bodnar, 1996). Traditionally, the 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 achieve a further understanding of the effects that exchange rates pose. Only then, countries can become more proactive, explore possible benefits, and prevent potential economic threats. Based on the assumption that exporters and importers are likely to exhibit some degree of risk aversion associated with trade uncertainty, exchange rate fluctuations represent a potential concern. Ceylon was an open economy with a few commercial crops, among which tea dominated as the main source of foreign exchange earnings and generation of employment, albeit with a high concentration in the upcountry. Even after independence from British rule in 1948, the same economic structure continued until 1956 (Athukorala et al, 2017).

Sri Lanka changed from an administration of fixed exchange rate policy (1948-1967) to dual exchange (1968-1977) then dual exchange to managed floating (1977-2000), and then ultimately to a free-floating exchange rate. Sri Lanka has had a floating exchange rate system since 2001 which allowed the independent adjustment of the exchange rate according to the market forces of demand and supply. Though it is called free-floating in principle, the central bank intervenes whenever it fluctuates rapidly.

The impact of exchange rate volatility on exports is divided into two categories as positive impacts and negative impacts. It is depending on the assumptions used in relation to the definition of exchange rate volatility, market structure, the flexibility of production capacity, the presence or absence of a forward exchange market, and the risk preferences of traders (Hooper and Kohlhagen, 1978; Ethier, 1973; De Grauwe, 1988; Viaene and Vries, 1992; Sercu and Vanhulle, 1992; and De Grauwe, 1994). Viane and de Vries (1992) note the ambiguity of outcomes by observing that because importers and exporters are on opposite sides of a risky trading relationship; their respective roles are reversed, leading to a positive coefficient on the volatility variable for one partner. Broll and Eckwert (1999) also conclude that volatility increases the value of a trader's option to export; since this risk increases the potential gains from trade, the volume of trade increases accordingly. In the case of exports, it finds a negative effect of volatility in the short-run, but a positive impact in the long run. The positive impact on exports, in the long run, is particularly welcome, especially as many African countries have adopted the floating exchange rate regime as part of economic reforms.

The main objective of the study is to analyze the exchange rate volatility on export earnings in the Industrial sector in Sri Lanka from 2001 to 2019. The main proposition of the study is that exchange rate volatility may produce a slight influence on industrial export earnings in Sri Lanka.

In 2001, Sri Lanka began to implement a floating exchange rate system determining the exchange rate depending on the supply and demand of foreign exchange in the domestic foreign exchange market. The frequent changes in the exchange rate appear to have been based on either artificial or biased policy recommendations and have not eliminated anti-export bias in the manufacturing sector. This has led the country to witness exchange rate fluctuations and the unpredictability of exchange rates affects the country's industrial export earnings. Meantime Its the contribution of GDP is declined year by year. Moreover, the relationship between exchange volatility and industrial export earnings in Sri Lanka is a continuing matter in the country's economic growth and development.(Department of Commerce, 2017). Because exchange rate depreciation is favorable for exports but the exchange rate fluctuations bring out uncertainty to both domestic and international traders which may influence the earnings of exports leading to the research question, what is the effect of exchange rate volatility on industrial export earnings with reference to Sri Lanka's industrial export earnings? Therefore, this has necessitated the requirement for an empirical analysis of the above phenomenon in Sri Lanka.

2. LITERATURE REVIEW

4.1 Positive Effects of Exchange Rate Volatility on Exports

An increase in exchange rate volatility may relate to either an increase or a decrease in the volume of exports, given possible alternative assumptions. Hsing (2006) examined movements in the real effective exchange rate for Venezuela by applying and extending the Mundell-Fleming model. The open macroeconomic model including three simultaneous equations is applied. This study found that more real M2, less deficit spending, a higher world interest rate, a higher country risk, and a higher expected inflation rate are expected to cause the real effective exchange rate to depreciate. Further, it was recommended that to maintain the value of the bolivar, Venezuela needs to reduce country risk by pursuing or maintaining political stability, economic growth, a healthy financial market, and other proper measures. According to Karadam (2015), the depreciation of the real exchange rate is contractionary in developing countries consistent with the balance sheet effect. The study's findings provided by fixed effects, common correlated effects, and system GMM estimations is that the depreciation of the real exchange rate is contractionary for developing countries while it has not any significant effect on the economic growth of industrial countries. Theories that rising volatility increases the value of exporting firms, thus encouraging exports. Viane and de Vries (1992) note the ambiguity of outcomes by observing that because importers and exporters are on opposite sides of a risky trading relationship; their respective roles are reversed, leading to a positive coefficient on the volatility variable for one partner. Broll and Eckwert (1999) also conclude that volatility increases the value of a trader's option to export; since this risk increases the potential gains from trade, the volume of trade increases accordingly. Tunc et al. (2018) suggested that while bilateral

exchange rate volatility depresses trade between two countries, external exchange rate volatility displays a significant positive contribution to the trade between them. However, the effect of the bilateral volatility is larger than the effect of the external volatility since the former one has direct effect while the latter one has an indirect effect. Further, the effects change depending on the trade weight between countries. Large trade weight magnifies the trade-depressing effect of the bilateral exchange rate volatility.

The real exchange rate volatility has a significant impact on exports to Sri Lanka's main export markets, the United States and the United Kingdom, both in the short and long run, according to the findings. Overall, the study's findings support the notion that Sri Lanka's export trading activities could be expanded by maintaining a stable competitive Real Exchange Rate (Francis and Ganeshamoorthy, 2017). Meantime AL Soos and Madurapperuma (2016) found that real exchange rate impact positively on export. Overall, the findings of these results show that trading activities of Sri Lanka can be improved by maintaining a stable competitive real exchange rate.

The short-run and long-run estimation results showed that exchange volatility has no significant effect in the short-run but has a positive and significant effect in the long-run on aggregate and sectoral exports. Senadza and Diaba (2017) found that the positive impact on exports, in the long run, is particularly welcome, especially as many African countries have adopted the floating exchange rate regime as part of economic reforms Meanwhile, employing the Johansen approach of co-integration and using Autoregressive Conditional Heteroskedasticity (ARCH) method to calculate volatility, Arize and Malindretos (1998) found mixed results for two Pacific-Basin countries: volatility is shown to depress New Zealand exports, while its impact is positive in the case of Australia.

4.2 Negative Effects on Exchange Rate Volatility on Exports

Several theoretical studies such as Ethier (1973); Clark (1973); Baron (1976); Cushman (1986); Peree and Steinherr (1989) have shown that an increase in exchange rate volatility will have adverse effects on the volume of international trade. The study that was surveyed by the International Monetary Fund (1984) did not yield consistent results, with a large majority producing little or no support for a negative relationship between export earnings, while bilateral studies seem to establish a negative relationship between the two variables. Viaene and Vries (1992) state that even in the occurrence of a forward market, exchange rate volatility can affect the volume of trade. They believe that an increase in exchange rate volatility may generate adverse effects on importers and exporters since they are located on opposite sides of the forward contract. Thus, depending on the net trade balance of the country, an upsurge in exchange rate volatility may operate to the loss or benefit for trade flows. Senadza and Diaba (2017) studied the effects of exchange rate volatility on exports and imports based on a sample of 11 floating-exchange rate Sub-Saharan African economies. In the case of exports, it finds a

negative effect of volatility in the short-run, but a positive impact in the long run. Akhtar and Hilton (1984), suggest that exchange rate variability reduces the volume of international trade in manufactured goods. On the other hand, recent studies suggest no clear-cut relationship between exchange rate volatility and trade flows. Viaene and Vries (1992) stressed that even in the presence of a forward market; exchange rate volatility can indirectly affect the volume of trade. They show that an increase in exchange rate volatility may generate adverse effects on importers and exporters since they are located on the site sides of the forward contract. Thus, an increase in exchange rate volatility may operate to a loss or benefit for trade flows, depending on the net trade balance of the country. A study by Kroner and Lastrapes (1993) examined the impact of exchange rate volatility on the exports of five developed countries for the monthly period of 1973- 1990, using multivariate GARCH models. The results of the study indicated that exchange rate volatility has statistically significant effects on export volumes for all countries. The signs and magnitudes of the volatility coefficients differ widely across the countries, negative for the U.S. and U.K. and positive for Germany, Japan, and France. Arize et al. (2000 and 2008) estimated export models to examine the effect of real exchange rate variability on export flows of 13 less developed countries and 8 Latin American countries, respectively. They used Johansen's multivariate cointegration and error correction techniques over the quarterly periods 1973-1996 and 1973-2004 to measure the long-run and short-run dynamic impacts of exchange rate volatility on exports. The major results showed that increases in exchange rate volatility impose significantly negative effects on exports both in the long run and in the short run in all countries.

On the other hand, many researchers assumed that higher exchange risk lowers the expected revenue from exports, and therefore reduces the incentives to trade. The exchange rate is the only source of risk for the decision-maker without the availability of hedges (forward contracts, options and portfolios of options) (Gonzaga & Terra, 1997). In the empirical part, export supply equations including real exchange rate volatility as one of the explanatory variables are estimated for Brazil by Gonzaga & Terra (1997). For most specifications, the real exchange rate volatility coefficients are negative. This can be concluded that a decline in exchange volatility associated with single currency (euro) will lead to a long run fall in Irish exports to the market. Aurangzeb et al. (2005) examined the impact of exchange rate volatility on Pakistan's exports to its major trading partners over the monthly period 1985-2001. Long-run and short-run export models were estimated by utilizing Johansen's multivariate cointegration and error correction approaches.

Exchange rate volatility is measured by using an ARCH-type model. The long-run results provided a negative and insignificant impact of volatility on exports in all cases. The results of the short-run models, however, suggested a negative causality running from volatility to exports in all cases except for the UK. Hall et al (2010)

examined the impacts of exchange rate volatility on exports of 10 emerging market economies (EMEs) and 11 other developing countries in their study. They used panel data, covering the period 1980: Q1–2006: Q4 and two different estimation methods – the generalized method of moments (GMM) and a time-varying coefficient (TVC). The result suggested that there is a negative and significant effect of exchange volatility on exports for the non-EMEs, while there is no negative effect for the EMEs. Another study, Rose (2000), which also employed the gravity approach, used a data set covering 186 countries for the five years 1970, 1975, 1980, 1985, and 1990 to test the impact of exchange rate volatility on trade. The estimation results also confirmed a negative relationship between exchange rate volatility and bilateral trade, with the volatility effect being relatively small (a coefficient of - 0.13). This implied that reducing exchange rate volatility by one standard deviation around the mean would increase bilateral trade by 13%. However, when random effects are taken into account in the estimation procedure, the size of the effect of exchange volatility falls significantly to 4 percent. Tenreyro (2003) used a panel data set covering a period from 1970 to 1997 for a large number of countries to address the relationship between exchange rate volatility and bilateral trade. This study carried out different estimation methods to overcome statistical problems that were faced by the previous studies and obtained values for the coefficients of exchange volatility ranging between 2 and 4 percent. This implied that eliminating all exchange rate volatility would increase trade by a maximum of 4 percent. However, when endogeneity is taken into consideration by the use of instruments, volatility seems to lose its significant effect on trade.

4.3 No Significant Effects on Exchange Rate Volatility on Exports

The research work conducted by Hooper and Kohlhagen (1978) examined the impact of exchange rate volatility on aggregate and bilateral trade flows for all G-7 countries except Italy. They measured the exchange rate volatility by the absolute difference between the current period spot exchange rate and the forward rate of the last period, as well as the variance of the nominal spot exchange rate and the current forward rate. They found basically no evidence of any negative relationship. There are also studies that employ an augmented version of the gravity model to investigate the relationship between exchange rate volatility and trade flows. These studies also failed to establish any systematic relationship between the two variables. Frankel and Wei (1993) looked into the relationship between exchange rate volatility and bilateral trade flows between 63 industrial and developing countries by using cross-section data for 1980, 1985, and 1990. The empirical results found that exchange rate volatility has negative and significant effects on trade in 1980 and positive and significant effects in 1990. As well as Oskooee and Hegerty (2007) have found that the increase in exchange-rate volatility has indeterminate effects on international trade flows. The rationale of this assumption is that forward exchange markets are just in infancy or even not appear in developing economies. In addition, transaction hedging may prove relatively expensive and challenging for some manufacturing firms with a long time between order and delivery.

Real exchange rate volatility has a significant negative impact on exports in both the short and long run. According to the study's findings, the real exchange rate has a positive impact on export. Overall, the findings of these results show that maintaining a stable competitive real exchange rate can improve Sri Lanka's trading activities (Madurapperuma, 2018).

The studies on exchange rate variations and their economic impacts on export earnings have resulted in mixed results. Some studies received positive impacts as well as negative impacts. Existing empirical literature is mainly grounded on all export earnings. There is therefore a gap as far as studying exchange rate volatility versus industrial export earnings. Further, this study wanted to fill this gap by examining the impacts of exchange rate volatility on export earnings with an emphasis on Sri Lankan industrial exports.

3. METHODOLOGY

The methodology of the study is based on a quantitative-method approach by analyzing exchange volatility and industrial exports dollar earnings. The study was mainly based on quantitative data. Sri Lankans' aggregate export was collected for the period of 2001 to 2018. Because Sri Lanka adopted the floating exchange policy regime in 2001 onwards with the observations of the Central Bank. The data set consisted of monthly observations for the interest variables used in the analysis. The study used real effective exchange rate statistics monthly basis from the Central Bank of Sri Lanka. The data on exports, industrial export value indexes, and GDP of each country are obtained from International Financial Statistics available on the internet sites of the IMF. All real values are measured through the base of the year 2000. All these series will be expressed in US dollar terms.

4.4 The Econometric Model Specification

According to microeconomic theory, conventional demand functions are homogeneous degree zero in terms of price and income (Deaton and Muellbauer 1980). To examine the impact of exchange rate volatility on exports, this study adds an exchange rate volatility variable to the traditional export demand function comprising consumers' income (or GDP) and relative price, which has been used in many previous studies such as Salas (1982); Gafar (1995); Matsubayashi and Hamori (2003); Ekanayake et al. (2010). Following Backman (2006) the relationship for the export side is presented by the following equation:

$$EXPt = \beta 0 + \beta 1\ REER + \beta 2IPI + \beta 3EVOLt + Ut \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where EXP represents the natural logarithm of monthly Sri Lanka's industrial export earnings to Sri Lanka Million USD; REER is the real effective exchange rate index; IPI is industrial production index and EVOL is the exchange rate volatility

measured using the methodology discussed below. The study used a multiple regression model to run a regression, in order to reveal whether volatility has an effect on industrial export earnings. With regard to the functional form, Khan and Ross (1977) suggest that a log linear specification is better than a standard linear one on both empirical and theoretical grounds. That is, the former allows the dependent variable to react proportionally to an increase or decrease in the regressors and exhibits interaction between elasticities.

As open-economic "macro-level" regressions rely on monadic export equations where a country's change in total exports is the dependent variable with the REER as the main variable export demand changes encountered by the country. Despite considerable progress in the econometric aspects, the fundamental specification of McGuirk (1986), which derives its regression specification from Armington (1969), has remained virtually unchanged over the past few decades. The supply-side situation mainly reflects the GDP. The reason for not utilizing GDP is that it consists of agriculture and service sectors as well. 4.3 Data and Data Sources Since this study adopts a multisite, the methodology for the study is based on a quantitative-method approach by analyzing exchange volatility and industrial exports dollar earnings. The study was mainly based on quantitative data. Sri Lankans' aggregate export was collected for the period of 2001 to 2018. Because, Sri Lanka adopted the floating exchange policy regime in 2001 onwards with the observations of the Central Bank. The data set consisted of monthly observations for the interest variables used in the analysis. The study used real effective exchange rate statistics on a monthly basis from the Central Bank of Sri Lanka. The data on exports, industrial exports value indexes, and GDP of each country are obtained from International Financial Statistics available on the internet sites of the IMF. The GDP deflator of sample countries will be collected from the online sources of the world outlook data bank website, while real effective exchange rate will be obtained from the monetary authorities of sample countries. All real values are measured through the base of year 2000. All these series will be expressed in US dollar terms.

As stated by Rizov and Willenbockel in 2008, EWMA and SMA are the two methods of calculating Exchange Rate Volatility. Therefore, the following formula can be used to calculate the volatility of the exchange rate.

$$ERV = [\ 1\ m \sum (eijt+i-1\ m\ i=1 - eijt+i-2)2]\ 1/2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

Where "eijt" means Log Bilateral Exchange Rate and "m" indicate the order of moving standard deviation for the time "t" with Sri Lanka to the "j"th country. A moving standard deviation over 12 months method has commonly been used in previous studies (Huchet-Bourdon, M. and J. Korinek, 2011). For each month, this measure is the standard deviation of the previous 12 observations ending that current month in the first case. Where m = 12 is the order of the moving average (Chowdhury 1993). Further, according to McKenzie (1999) study, the most widely

used exchange rate volatility is the moving average of the standard deviation of the exchange rate. Therefore, empirical results are based on 1a 2-month standard deviation in the study.

4. RESULTS AND DISCUSSION

The study sought to establish the effect of exchange rate volatility on export earnings with reference to the most used foreign currency, the United States Dollar. The findings were as shown below. The regression analysis is related to the spreading of the average value of one random variable as the other variables which need not be random are allowed to take different values. A multivariate regression model was applied. The regression model mainly related the average values of the dependent variable to various values of the independent variables.

The unit root test: since the assumptions for the classical regression model require that both variables be stationary and that errors have a zero mean and finite variance. A type of stochastic process that has gained a great understanding of concentration and analysis by time series analysts is the so-called stationary stochastic process. The econometric consequences of nonstationary can be quite severe, leading to least squares estimators, test statistics, and predictors that are unreliable. The stationarity of a time series data can be tested with a unit root test (Hill et al. 2001).

$$\Delta Y_t = \theta Y_{t-1} + V_t \quad \ldots\ldots (3)$$

Where;

$\Delta Yt = Yt - Yt{-}1$ is the first difference of time series,

$Yt{-}1$ is lag(first) of variable

Vt is a random disturbance with mean zero and constant variance σ_V^2

The unit root test was utilized in case there was more than one trend in the series. The study employed Augmented Dickey-Fuller (ADF) to test the stationarity since it is the most commonly used test for each variable. The null hypothesis was that the variable contained a unit root, and the alternative hypothesis was that the variable was generated by a stationary process.

According to the results, industrial export earnings turn out to be time-series integrated of order zero. On the other hand, the rest of the variables are nonstationary time series. Then taking the first differences of nonstationary time series, all variables become stationary variables. The first differences between the real effective exchange rate, industrial production index, and exchange rate volatility made them stationary.

Table 1: Unit Root Test (ADF)

	At Level	**INEX**	**IPI**	**REER**	**VOL**
With Constant	t-Statistic	-0.8598	-2.5868	-2.3866	1.5401
	Prob.	0.7992	0.0973	0.1467	0.9994
		n0	*	n0	n0
With Constant & Trend	t-Statistic	-3.2565	-3.9289	-1.9953	0.0746
	Prob.	0.0767	0.0125	0.6002	0.9969
		*	**	n0	n0
Without Constant & Trend	t-Statistic	1.6471	-1.0024	-0.0063	2.7961
	Prob.	0.9758	0.2832	0.6795	0.9988
		n0	n0	n0	n0
	At First Difference	**d(INEX)**	**d(IPI)**	**d(REER)**	**d(VOL)**
With Constant	t-Statistic	-4.5889	-19.0054	-14.8245	-13.6557
	Prob.	0.0002	0.0000	0.0000	0.0000
		***	***	***	***
With Constant & Trend	t-Statistic	-4.5729	-18.9612	-14.9265	-13.8324
	Prob.	0.0015	0.0000	0.0000	0.0000
		***	***	***	***
Without Constant & Trend	t-Statistic	-4.1226	-19.0342	-14.8524	-13.2920
	Prob.	0.0001	0.0000	0.0000	0.0000
		***	***	***	***

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant, Null Hypothesis: the variable has a unit root, b: Lag Length based on SIC, c: Probability-based on MacKinnon (1996) one-sided p-values.

Source: Author Estimations (2019)

The unit root test was utilized in case there was more than one trend in the series. The study employed Augmented Dickey-Fuller (ADF) to test the stationarity since it is the most commonly used test for each variable. The null hypothesis was that the variable contained a unit root, and the alternative hypothesis was that the variable was generated by a stationary process. According to the results, industrial export earnings turn out to be time-series integrated of order zero. On the other hand, the rest of the variables are nonstationary time series. Then taking the first differences of nonstationary time series, all variables become stationary variables. The first differences between the real effective exchange rate, industrial production index, and exchange rate volatility made them stationary.

Table 2: Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None	0.127337	45.42612	47.85613	0.0831
At most 1	0.038373	16.68677	29.79707	0.6631
At most 2	0.026216	8.430710	15.49471	0.4206
At most 3	0.013300	2.825228	3.841466	0.0928
Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.127337	28.73934	27.58434	0.0354
At most 1	0.038373	8.256063	21.13162	0.8874
At most 2	0.026216	5.605482	14.26460	0.6642
At most 3	0.013300	2.825228	3.841466	0.0928
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.0 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):				
INEX	**REER**	**IPI**	**VOL**	
-8.528634	0.087875	-0.062624	3.354722	
1.608387	-0.079850	-0.018134	-3.448977	
-2.599571	-0.023519	0.020006	2.765224	
-0.396022	-0.050316	0.016106	7.366771	

Source: Author Estimations (2019)

According to the above results, the null hypothesis of a unit root is rejected. Meantime, real effective exchange rate, industrial production index, and exchange rate volatility became time series integrated of order one indicating stationarity. The results demonstrate that all the series are I (1), with the exception of the exchange rate volatility IPI and INEX which is I (0). It means that unit root tests indicate that the dependent variables are I (1) and the independent variables are a combination of I(0) and I(1). Therefore, the ARDL approach is more appropriate than other econometric approaches for investigating relationships in levels of variables. Once the order of optimal lag length of each of the variables is selected, a co-integration test is employed by using the level of log form. Usually, to be applied to the co-integration test; all the variables must be in the same pattern as the level of non-stationary and stationery of the first difference series in the original form or

converted log form. The existence of co-integration would imply that even though individual series may be non-stationary and one or more linear combinations of the series is stationary.

Then, this study applies the Johansen co-integration tests to investigate the long-run relationships among the selected determinants of real exports with the usage of lag length as lag 3.

The first block reports the trace statistics and the second block reports the maximum eigenvalue statistics. For each block, the first column is the number of cointegrating relations under the null hypothesis, the second column is the ordered eigenvalues of the matrix in (55.3), the third column is the test statistic, the fourth column is the 5% critical value, and the last column is the p-value. The (nonstandard distribution) critical values are taken from MacKinnon-Haug-Michelis (1999) so they differ slightly from those reported in Johansen and Juselius (1990). The results for both Trace statistic and Maximal Eigen statistic tests are reported in Table 2. Table 2, the above trace test, indicates the existence of one co-integration relationship at a 0.05 level. The maximum Eigenvalue test confirms this result. Both trace and Eigenvalue tests confirm the result that there exists a long-run association among variables. Hence the null hypothesis of no co-integration has been rejected. Once the existence of one co-integrating relationship is established, the next step is to estimate the Error Correction Model to identify the normalized co-integrating coefficients.

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4.1 Bounds Testing for Level Relationships

An autoregressive distributed lag (ARDL) model is an ordinary least squares (OLS) based model which is applicable for both non-stationary time series as well as for times series with mixed order of integration. The main assumption in the Bounds Testing methodology of Pesaran et al. (2001) is that the errors of the Equation employed must be serially independent. This requirement may also be influential in the choice of optimal lags for the variables in the model. The result indicates that at

the 5 percent significance level, we cannot reject the null hypothesis. The study employed the LM test to test the null hypothesis of no serial correlation.

Table 3: LM Test

Breusch-Godfrey Serial Correlation LM Test: Pesaran et al. (2001)			
F-statistic	0.590126	Prob. F (2,203)	0.5552
Obs*R-squared	1.231234	Prob. Chi-Square (2)	0.5403

Source: Author Estimations (2019)

The selected model is suitable to test the cointegration relationship between the variables. As can be seen from the table, Since the null hypothesis is that the residuals are serially uncorrelated, the F-statistic p-value of 0.5552 indicates that the model will fail to reject this null. Then the study concludes that the residuals are serially uncorrelated.

Table 4: F-Statistics to Test the Existence of Long-Run Relationships

Test Statistic	**Value**	**K**
F-statistic	4.951348	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Source: Author Estimations, (2019)

According to the calculated F-statistic of 4.9513 it exceeds the upper bounds, this situation brings the existence of level relationships between industrial exports, industrial production index, real effective exchange rate, and exchange rate volatility in the export equation.

The selected ARDL model is rewritten as a single error correction model to identify long-run and short-run relationships.

Cointeq = LOG(INEX) - (0.1665*LOG(REER) -0.0992*LOG(IPI) + 0.4686 *LOG(VOL) + 0.8159)…… (4)

Table 5: ARDL Cointegrating and Long Run Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(INEX(-1))	-0.39047	0.081012	-4.81985	0.0000
DLOG(INEX(-2))	-0.18661	0.065994	-2.82772	0.0052
DLOG(REER)	0.055847	0.017488	3.193499	0.0016
DLOG(IPI)	0.021695	0.018339	1.183005	0.2382
DLOG(VOL)	0.157193	0.058955	2.666306	0.0083
CointEq(-1)	-0.33548	0.074245	-4.51858	0.0000

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(REER)	0.16647	0.040397	4.120829	0.0001
LOG(IPI)	-0.0992	0.028666	-3.46055	0.0007
LOG(VOL)	0.46856	0.142617	3.285435	0.0012
C	0.815943	0.34215	2.384754	0.018
R-squared	0.533026	Mean dependent var		0.003776
Adjusted R-squared	0.510347	S.D. dependent var		0.172496
S.E. of regression	0.132458	Akaike info criterion		-1.162999
Sum squared resid	3.509010	Schwarz criterion		-1.019071
Log likelihood	130.5334	Hannan-Quinn criter.		-1.104808
F-statistic	19.09372	Durbin-Watson stat		2.016216

Note: Note: *** are respectively significant of 1%, the standard errors are in parenthesis
Source: Author Estimations (2019)

The estimated coefficient of VOL is about +0.46 percent, pointing toward that the exchange rate volatility has a positive impact on industrial exports. A one percent rise in volatility increases Sri Lankas' industrial exports by about 0.46 percent. Further, a one percent change in exchange volatility results in a 0.166 percent decrease real effective exchange rate and a 0.099 percent decrease in the industrial Production Index.

Table 6: The ECM for the Selected ARDL Model of Output Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D(INEX(-1))	-0.322038	0.224434	-1.434890	0.1529
D(IPI)	0.001402	0.000779	1.800695	0.0733
D(REER)	0.002893	0.003150	0.918389	0.3595
D(VOL)	-0.074678	0.350777	-0.212893	0.8316
ECM(-1)	-2.665731	1.397377	-1.907668	0.0579
ECM(-2)	-1.430873	1.103044	-1.297204	0.1961
ECM(-3)	-0.181550	0.417965	-0.434367	0.6645
ECM(-4)	-1.611345	0.414558	-3.886901	0.0001
C	0.005925	0.009379	0.631793	0.5282

Source: Author Estimations (2019)

The above table presents the summary of the error correction representation of the estimated ARDL model. The empirical outcomes indicate that the error correction term has the correct sign (negative) and is statistically significant. This is added evidence of co-integration relationships among the variables in the model. The estimated value of the error correction term implies the speed of adjustment to the long-run equilibrium in response to the disequilibrium caused by short-run shocks.

Table 7: Causality Tests Results

Null Hypothesis:	Obs	F-Statistic	Prob.
IPI does not Granger Cause INEX	214	6.35749	0.0021
INEX does not Granger Cause IPI		6.36959	0.0021
REER does not Granger Cause INEX	214	1.37486	0.2552
INEX does not Granger Cause REER		2.63785	0.0739
VOL does not Granger Cause INEX	214	5.26622	0.0059
INEX does not Granger Cause VOL		0.18302	0.8329
REER does not Granger Cause IPI	214	0.66674	0.5145
IPI does not Granger Cause REER		0.32407	0.7236
VOL does not Granger Cause IPI	214	2.06196	0.1298
IPI does not Granger Cause VOL		0.04428	0.9567
VOL does not Granger Cause REER	214	0.87476	0.4185
REER does not Granger Cause VOL		0.00360	0.9964

Source: Research Findings (2019)

According to the above results, the study cannot reject the hypothesis that IPI does not Granger cause, and INEX does not Granger cause IPI. REER does reject the hypothesis that REER does not Granger cause INEX, but INEX does not reject the hypothesis at a 10 percent significance level. Therefore, it appears that Granger causality runs one way from INEX to REER and not the other way. VOL to INEX also shows the same result respectively. Further, another combination of the variables rejects the hypothesis that does not have a Granger cause.

This is in line with the theoretical models. Since this risk increases the potential gains from trade, the volume of trade increases accordingly. At the macro level, this result is consistent with Broll and Eckwert (1999), Asseery and Peel (1991), McKenzie and Brooks (1997). In addition to that, Senadza and Diaba (2017) found that the positive impact on exports, in the long run, is particularly welcome, especially as many African countries have adopted the floating exchange rate regime as part of economic reforms.

The econometric model utilized is aimed to reveal whether short-run changes in industrial export earnings. According to the results, all of the determinants create a statistically significant impact on industrial export earnings. Exchange rate volatility (lvol) is positively associated with both industrial export earnings, indicating the positive relationship between industrial export earnings and exchange rate volatility. This positive relationship implies that an increase in exchange rate volatility increases Sri Lankan industrial export earnings. On the other hand, it can be explained as exporters who export industrial goods can adjust to exchange rate fluctuations at the time of occasion, which is consistent with Hsing (2006), Karadam (2015), Viane and de Vries (1992), Broll and Eckwert (1999) and Asseery and Peel (1991) etc.

Exchange rate volatility indicates the huge effects of economic changes in trade flows, world commodity prices, and capital flows between economies that are highly integrated, both with each other and with goods, services and also financial instruments. Hence exchange rate volatility affects specially with exports goods and services and firms with assets and liabilities denominated in foreign currencies.

5. CONCLUSION AND POLICY RECOMMENDATION

This study provides an analysis of the relationship between exchange rate fluctuations and industrial export earnings in Sri Lanka. The research study investigated the impacts of exchange rate volatility on industrial export earnings from the period of 2001 to 2018. In this study, the dependent variable was industrial export earnings in US dollars and the independent variables were exchange rate volatility, industrial production index, and real effective exchange rate. This study mainly deals with data on the industrial exports that are exporting to all over the world. Being the dependent variable of the model with three main individual variables made a particular model for the study. Each variable to test for unit roots cautiously, so as to avoid the issue of spurious regressions. The study has been

implemented with aggregate monthly data over the period between January 2001 and December 2018, consisting of 216 observations.

According to the empirical results, the relationship between exchange rate volatility and industrial export earnings is determinate and statistically significant. The effects of exchange rate volatility in the short run are positively associated with industrial export earnings and positively in the long run as well. Hence this situation is a natural phenomenon because the exporters cannot immediately adjust the volume of their trade in accordance with fluctuations in the exchange rate. This positive relationship implies that an increase in exchange rate volatility increases Sri Lankan industrial export earnings. On the other hand, it can be explained as exporters who export industrial goods can adjust to exchange rate fluctuations at the time of occasion, which is consistent with Hsing (2006), Karadam (2015), Viane and de Vries (1992), Broll and Eckwert (1999) and Asseery and Peel (1991) etc.

On the other hand, this negative relationship provides the idea to be positive when admitting the fact that exporters being aware of the earlier period variations made appropriate decisions regarding the earnings of their exports. As mentioned by many researchers, it will create an efficient impact for the exchange rate to extremely fluctuate if all fundamental macroeconomic variables are equally volatile. It is not variated equally, there will be abnormal profit opportunities that arise for investors that smooth exchange rate movements. The exchange rate of the country cannot pertain to any contained pattern or indications about future exchange rates, it would be used to gain a profit. In addition to that, the exchange rate volatility is a risk for the companies which are manufacturing industrial export products since it is a variable that cannot be predicted.

Then policymakers need to take steps to reduce the risks from exchange rate fluctuations, the exporting companies can practice the forward exchange rate, which is quoted and traded today but delivered and paid on a specific future date. This method is one of several special methods implemented in the actual financial market. In many cases, it should be strong and clear enough and that depending on traders' risk aversion, exchange rate fluctuations also increase the costs to protect against those risks.

Exports in the present context are not limited to goods and the export of services is an important element. The country needs to attract Foreign Direct Investment into export industries. It is necessary to understand the need for economic reforms to boost exports. There is a need for across-the-board reforms for increasing exports without delay. The Government should create a conducive environment and take appropriate policy measures to facilitate and develop the export industries in Sri Lanka.

According to the empirical results, the relationship between exchange rate volatility and industrial export earnings is positively associated. This relationship might be natural, as the exporters cannot immediately adjust the volume of their exports in accordance with variations in the exchange rate.

Exports in the present context are not limited to goods and the export of services is an important element. The country needs to attract Foreign Direct Investment into export industries. It is necessary to understand the need for economic reforms to boost exports. There is a need for across-the-board reforms for increasing exports without delay. The Government should create a conducive environment and take appropriate policy measures to facilitate and develop the export industries in Sri Lanka. many researchers, it will create efficient impact for the exchange rate to be extremely fluctuate if the all-fundamental macroeconomic variables are equally volatile

The study did not take into account all of the factors that influence industrial export earnings. Due to the availability of data, it was primarily focused on exchange rate volatility and a few independent variables. Because the data was not easily accessible to the public, the researcher had to negotiate with the appropriate authorities for permission to access the previously mentioned data. Meantime, the period of the study was seventeen years from 2001 to 2018. This period mainly deals with a floating exchange rate regime without the COVID-19 pandemic impact and the current economic downturn. This situation might be changed after 2019. This would have improved further research problems which could serve as a reason for further research.

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