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THE IMPACT OF EXCHANGE RATE VOLATILITY ON INDUSTRIAL EXPORT PERFORMANCE IN SRI LANKA: VECM APPROACH

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ABSTRACT: *Exchange Rate Volatility has had a significant effect on industrial export performance in Sri Lanka as a third world country. The Purpose of this paper is to examine the Exchange Rate Volatility on Export Performance based on the Industrial Sector in Sri Lanka for the Period of 2000 to 2017, using monthly data collected from EDB, CBSL, SLC & IMF. During the analysis VECM approach was incorporated into the study. Exchange Rate Volatility was calculated using SMA Model with LKR/USD return series. The study focused on 5 Export Trading Partners, United Kingdom, United States, India, Germany and Belgium with the limitation of five Export products. The main focus is to model Exchange Rate Volatility on Economic Growth using the determinants of Real Exports, Real Effective Exchange Rates, Real Exchange Rate Volatility, Weighted Average of Relative Price and Real Foreign Income for the analysis of Long Run Relationship. The resulting models may be used to produce forecasts in the Future. Results reveal that Real Effective Exchange Rates and Exchange Rate Volatility have a negative impact on Real Exports for the selected Exporting Partners in the long run. Finally, there is a significant relationship between Exports and the Exchange Rate Volatility.*

KEYWORDS: Exchange Rate Volatility, Industrial Exports, VECM Model, Economic Growth, SMA

INTRODUCTION

Current era, exports are playing essential role in Sri Lankan economic growth. Industrial exports are the most significant and rapidly growing contributor to Sri Lankan economy. All the internationally traded goods have global trade rules. The exchange rate movements have direct impact on the export competitiveness. Monetary policies are playing crucial role to avoid excessive volatility of the exchange rate. REER is a statistical measure for appreciation or depreciation of one currency against a basket of currencies of trade partner currencies[1]. In the modern competitive business world, this research study focuses on investigating factors & relationship between exchange rates and industrial export performance in Sri Lankan context during the period of 2000-2017.

Countries in the world operate under different exchange rate regimes. Sri Lanka is the 65th largest export economy in the world and the 115th most complex economy according to the Economic Complexity Index in 2016. From the beginning of 21st Century, inflation averaged 6.83% per annum during 2004 – 2018 and annual depreciation the exchange rate (LKR/USD) was by an average of about 7% per year in this period. In 1986 - 2018, the corresponding figures were 9.58% and 2.3% respectively. Exchange Rate Volatility has a direct impact on trade through adjustment costs and price uncertainty. Hence if Exchange Rate Volatility tries to limit the volume of exports, the volume of trade could be considerably higher. Exchange Rate Depreciation can also impact on government operations in the areas of revenue, expenditure, etc.

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It is important to explore the relationship between Exchange Rates and set of variables related to the Export Performance. This study is going to be finding whether there is a short run or long run relationship between selected variables focused on Export Performance with Exchange Rates. This Study contributes some insights to the existing Literature. As the purpose of the study it extends the Literature by examine the relationship between Exchange Rate Volatility towards the better Export Performance. In other hand automatically it investigates the factors affecting to the Export Growth based on the Exchange Rates.

EXPORT TRADE IN SRI LANKA

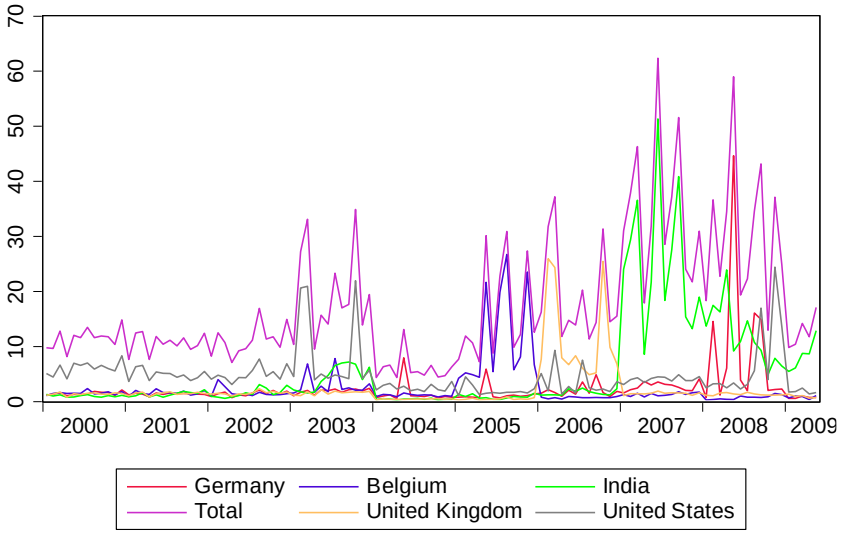

Figure 1: Industrial Export Volume during the Ethnic Crisis Period (M'kg)
Source: Author's Computations

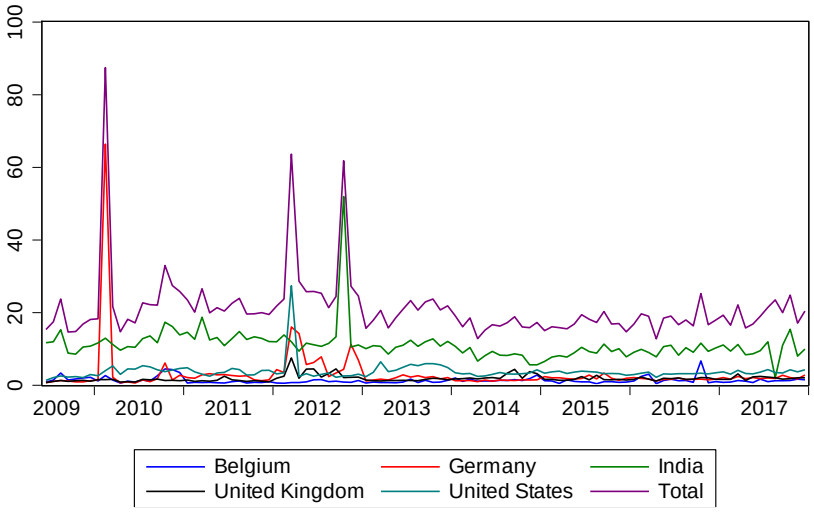

Figure 2: Industrial Export Volume during the Post Ethnic Crisis Period (M'kg)
Source: Author's Computations

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Considering previous studies, a few studies have been examined the impact of the volatility in exchange rate on trade Sri Lanka, none of the studies have focused on the impact of ERV on industrial sectorial trade in Sri Lanka yet. Therefore, this study utilized five export trading partners' namely United Kingdom, United States, India, Belgium and Germany with five products manufactured which were leads at top level in industrial sector in Sri Lanka to investigate the volatility on export trade. Rubber based Products, Apparel and Textiles, Food Feed and Beverages, Wood and Wooden Products and Non Metallic Mineral Products were the selected as the five products of industrial exports. Later on Apparel and Textiles started to play the most challenging role in Sri Lankan economy.

Volume of exports is divided into two categories. Figure 1 illustrates the volume of industrial products exported during the ethnic crisis of Sri Lanka, while Figure 2 indicates the products interchanged with the money after the post ethnic crisis.

Around 2013 onwards, Sri Lankan economy had been in a crisis due to the slowdown of economic growth rates, proceeding after the immediate post ethnic crisis from 2009 to 2011. Figure 2 illustrates the highest slope of industrial exports during that period. After 2013 onwards, it remains constant level of total exports with low level of ups and down. During the ethnic crisis, until 2006 industrial exports to India had a lowest trend compared to other four countries. After 2005, external sector crisis started, besides the increasing of exports. At the end of the ethnic crisis it started to play in the opposite direction which was the highest industrial export volume from Sri Lanka. Period of 2006-2010, exports are having high demand with achieving an average economic growth of 6.4 percent. 2012 onwards, export volume shows the double performance compared to the period of 2000-2002 with the same pattern of export growth.

LITERATURE REVIEW

ERV on Export Demand

Soos and Madurapperuma[2] pointed out the exchange rate regime and foreign policy is a significance measurement of the macroeconomic management in focusing the economic development by improving the export performance of the country. GARCH and Co-integration used to show that trading activities of Sri Lanka can be improved by maintaining a stable competitive real exchange rate. Trade openness which represents the trade obstacles between Sri Lanka and the global world shows a negative relationship with export demand for textiles and garments industry in Sri Lanka according to Ekanayake[3]. Hooy and Choong[4] suggested that Real exchange rate volatility was found to have a significant and negative impact on the export demand of most of the south Asian countries. This intends that higher exchange rate fluctuation does not encourage intra-regional trade within south asian region.

Vijayakumar[5] highlighted that the real exchange rate has significantly positive impact on the trade balance of Sri Lanka both in the short- run and the long-run. Anyway considering Sri Lanka and United States, there is no any J-curve effect on trade between those countries. Finally concluded with the trade balance is promoted by the devaluation in short- run and the long run. Regarding the trade, an active major role is played by bilateral exchange rate changes and exchange rate volatility. In measuring the overall imports and exports of two

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countries, it is impact by changes in the income very low. Senanayake and Alhayky[6] further suggest using trade between Sri Lanka and China, that the movements of exchange rate between two countries do have significant effects on total trade.

Weliwita and Tsujii[7] showed unceasing devaluation, the trade deficit continued to move in the wrong direction proposing that exchange rate policy was unable to create a favorable balance of trade position using Cointegration. Individual trade volumes also were not responsive to the changes in real exchange rates.

Relationship between Exchange Rates & SL Exports

Weliwita, Ekanayake and Tsujii[8] examined the effects of exchange rate volatility on Sri Lanka's exports to six developed countries during the flexible exchange rate regime. The Johansen-Juselius multivariate cointegration technique was used to test for the presence of long-run equilibrium relationships between real exports and its determinants. There is strong evidence to suggest that Sri Lanka's exports to the countries under investigation were affected opposite by the increased volatility in bilateral real exchange rates during the sample period. Abinaya and Jerinabi[9] stated that there is no causal relationship between Exchange Rates and Exports. It also resulted that exchange rate had a negative effect on Exports. There is a positive correlation of the Sri Lankan exports with the increase in domestic income. The growth of exports is positively correlated with the increase in income of the importing countries according to Weliwita and Tsujii[7].

Jayasinghe and Tsui and Zhang[10] assumed that a firm's future operating cash flows is proxied by its market value, and the exposure coefficient would be able to efficiently measure the impact of exchange rate changes on a firm's return and its sensitivity to the changes. Based on the outcome of the multiple regression models, Aslam[11] confirmed that the exchange rate positively influenced on the economic growth in Sri Lanka at one percent significant level. The theory of exchange rate was defined that the high exchange rate promotes the economic growth of countries. Bhavan[12] investigated the determinants of the export performance of Sri Lanka over a period 1980 to 2013. He suggested that all variables are significantly influencing on the export in the long run using gross capital formation, foreign direct investment, interest payment, imports, weighted average per capita income.

Jongwanich[13] revealed that the growing importance in the export composition of parts and components within vertically integrated cross-border production processes has tended to weaken the nexus between real exchange rate and export performance. World GDP is played a leading role in determining demand of exports which consignment by thee income of buyers. It is also detected that the GSP and MFA had a positive and significant impact on the demand for textiles and garments of Sri Lanka. The global financial crisis and debt crisis had a negative impact on world demand for textiles and garments according to Ekanayake[14].

Kassie[15] revealed that the depreciation of the real effective exchange rate improves the export performance. Anyhow it encourages the country' imports. As a result even if there is higher growth of export after a depreciation of the real effective exchange rate, since the growth rate of imports outweigh, it is concluded that there is no improvement in the trade balance account.

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Theoretical Framework of the Research

Senhadhi and Montenegro[16] estimated export demand elasticity for a large number of developing and developed countries, using time series techniques that account for the non-stationary in the data. The average long run price and income elasticity were detected as 1:1 approximately. Exports are reacted to both the trade partners' income and to relative prices. Chit, Rizov and Willenbockel[17] explicitly recognized the specificity of the exports between the emerging East Asian and industrialized countries by using a generalized gravity model that combines a traditional long-run export demand model with gravity type variables. Results are robust across different estimation techniques and do not depend on the variable chosen to proxy exchange rate uncertainty. Mukhtar and Malik[18] showed that there exists a long run equilibrium relationship among real exports demand, relative export prices, exchange rate volatility and foreign economic activity using Cointegration and confirmed the stability of this equilibrium relationship among these variables using VECM.

METHODOLOGY

Conceptual Framework

Figure 3 illustrates the Conceptual Framework of the proposed Research.

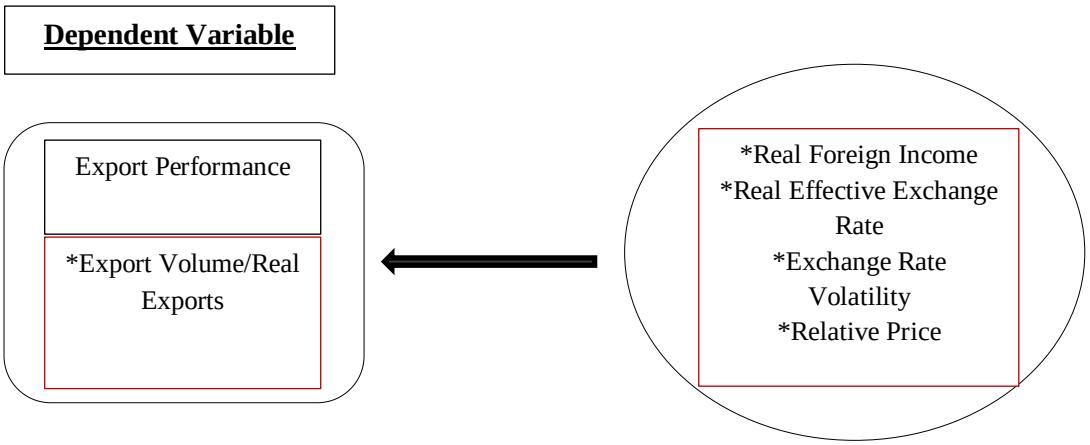

Figure 3: Conceptual Framework of the proposed Research
Source: Author's computations

This Conceptual framework is focusing on the variables Export Volume/Real Exports, Real Foreign Income, Real Effective Exchange Rate, Relative Price and Exchange Rate Volatility. For the Cause-effect Relationship, Export volume was taken as the Dependent Variable of this Research.

Variable Measurements

Exchange rate volatility is a crucial factor in affecting export performance, therefore determinants must be explicitly considered in estimating the export demand function for the volatility effect.

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As stated by Mukhtar and Malik[18], Real Exports are calculated by using nominal Exports divided by the Consumer Price Index of each trading partners.

The Real Effective Exchange Rate is defined as,

$$REER_t = \sum_{j=1}^{5} EX_{jt}^{W} \text{ x } [\frac{ERjt \text{ x } Pjt}{P_t^{SL}}]$$

Where $REER_t$ = Real Effective Exchange Rate, ER_{jt}=Bilateral Nominal Exchange Rate with country j at time t, EX_{jt}^{W} = Weight of Sri Lankan Exports to the j^{th} Country at time t, P_{jt}=Consumer Price Index of j^{th} country at time t and P_t^{SL} = Consumer Price Index of Sri Lanka. 2010=100 was taken as the base year for the calculations. Excluding Consumer Price Indices, NEER is computed[19].

EWMA and SMA are the two methods of calculating Exchange Rate Volatility. As stated by Chit, Rizov and Willenbockel[17], Volatility can be calculated using following formula.

$$ERV = [\frac{1}{m} \sum_{i=1}^{m} (e_{ijt + i-1} - e_{ijt + i-2})^2]^{1/2}$$

Where e_{ijt} = Log Bilateral Exchange Rate m = Order of Moving Average for the time t with Sri Lanka to the j^{th} country.

Relative Price was calculated as the weighted average of selected five countries.

$$RPt = ERt \text{ x } \frac{CPI\ jt}{CPIsl}$$

Where ER_t = Bilateral Exchange Rate CPI_{jt}= Consumer Price Index of j^{th} country at time t, CPI_{sl}=Consumer Price Index of Sri Lanka. 2010 = 100 was taken as the base year [17].

First Difference of the Logarithm of the Exchange Rate Values was considered as the Exchange Rate Return. Jayasinghe[20] stated that,

$$Exchange\_Rate\_Return = \ln\left[\frac{Rj,t}{Rj,t-1}\right] * 100$$

Where $R_{j,t}$ – Exchange Rates for Month t, $R_{j,t-1}$ – Exchange Rates for Month t-1.

According to Ekanayake and Chatrna[19] Real Foreign Income is considered as a Weighted Average of each exporting partners and it is computed as,

$$RFIt = \sum_{j=1}^{5} EX_{jt}^{W} \text{ x } Pjt$$

Where RFI_t = Real Foreign Income, EX_{jt}^{W} = Weight of Sri Lankan Exports to the j^{th} Country at time t and P_{jt}=Industrial Production Index (2010 = 100) of j^{th} country at time t.

For the Explanatory analysis with limited Resource availability, Five Export Partners and Five Industrial Product Categories were taken into the Account. Top five Export Partner Countries of Sri Lanka are United States, United Kingdom, India, Belgium and Germany. Rubber based Products, Apparel and Textiles, Food Feed and Beverages, Wood and Wooden Products and Non Metallic Mineral Products were the selected five Categories of Industrial Exports Goods.

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VAR/VECM Approach

Analysis of Multivariate Time Series, vector autoregression is the one of the most successful and easy to use methodology. VAR Model is also used for Structural inference and Policy Analysis. The vector error correction (VEC) model is a special case of the VAR for variables that are stationary in their differences.

VAR(1) can be expressed as,

$y_{1t} = \phi_{10} + \phi_{11}\, y_{1,t-1} + \phi_{12}\, y_{2,t-1} + e_{1t}$

If variables are cointegrated, we use Vector Error Correction Model(VEC) model. VEC can be expressed as,

$\Delta y_t = \phi_{y0} + \phi_{y1}\, \Delta y_{t-1} + \ldots\ldots + \phi_{yp}\, \Delta y_{t-p} + \gamma_{y1}\, \Delta x_{t-1} + \ldots\ldots + \gamma_{yp}\, \Delta x_{t-p} - \lambda_y\, (y_{t-1} - \alpha_0 - \alpha_1 x_{t-1}) + e_{1t}$

Model Specification

By using Selected Determinants, the empirical model is specified as follows:

RE= f (RP, REER, RFI, ERV)

where real exports (RE) from Sri Lanka to other Partners is a function of Consumer Price Index, Relative Price taken as Weighted Average of Five Country Relative Price Value(RP), Real Effective Exchange Rate of Sri Lanka selecting Top Five Partner Countries(REER) and exchange rate volatility (ERV). Taking different Factors as the impact of Exchange Rate Volatility, Export Demand Equation modeled as follows:

$$RE_t = \xi_0 + \xi_1 RP_t^{foreign} + \xi_2 RFI_t^{foreign} + \xi_3 REER_t + \xi_4 ERV_t + \vartheta_t$$

Where ϑ is error term; ξ_0 is intercept and ξ_1, ξ_2, ξ_3 & ξ_4 are coefficients of independent variables of time t.

ESTIMATION RESULTS

Graphical Representations

The Figure 4 shows the behavior of the selected variables over the time, a significant fluctuation in the behavior of Real Exports. It indicates a high steep slope for Real Exports in first quarter of 2010 with two clear moderate high slopes during the year 2013. After 2013 onwards exports are remained at same level.Exchange Rate Volatility time series assume generally to follow a deterministic trend.

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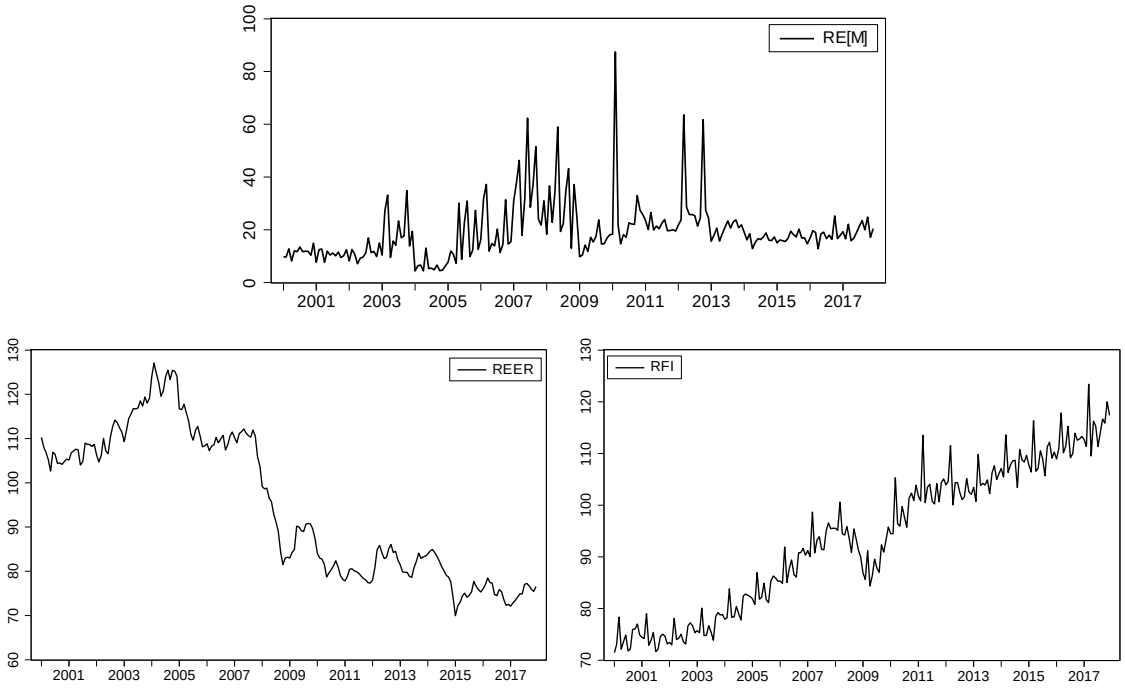

Figure 4: Trend in selected determinants

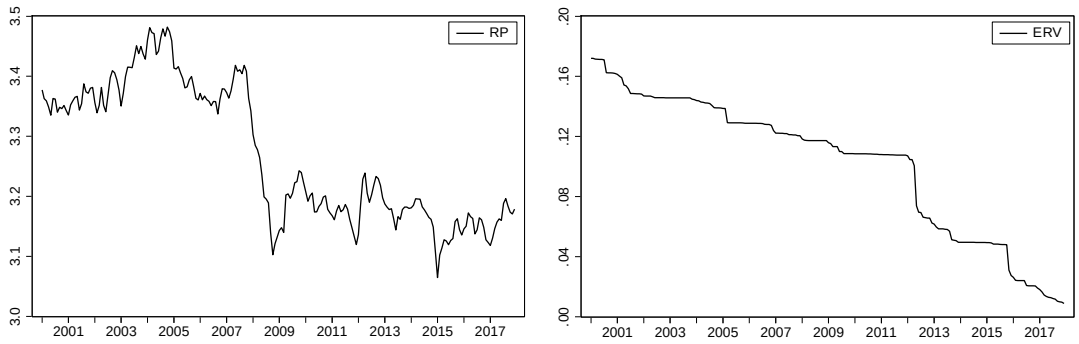

Figure 4: Trend in selected determinants (Cont.)

Correlation Matrix of the Determinants

The Table 1 presents the results of correlation analysis between study variables.

Table 1: Correlation between Real Exports & its Component

	RE	REER	RP	RFI
REER	-0.213			
	[0.002]			
RP	-0.197	0.985		
	[0.004]	[0.000]		
RFI	0.310	-0.852	-0.814	
	[0.000]	[0.000]	[0.000]	
ERV	-0.151	0.810	0.769	-0.918
	[0.026]	[0.000]	[0.000]	[0.000]

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The results reveal that Correlation Coefficient between Real Exports and Exchange Rate Volatility is statistically significant at 0.05 with 0.026, p-value, while other pairs are having significant relationship between each other in 95% confident interval most probably p-value, 0.0000. There is a negative linear relationship between RE & REER, RE & RP &, RE & ERV with REER & RFI, RP & RFI and ERV & RFI are having strong negative relationship. Considering positive linear relationship, REER & RP, REER & ERV and RP & ERV are correlated strongly positive except RE & RFI.

Unit Root Test

Table 2: Results of ADF Unit Root Test for 1st Difference of Log Data Series

	With Constant		With Trend & Constant	
	ADF Test	***PP Test***	***ADF Test***	***PP Test***
DLRE	-18.7418	-9.5845	-18.6989	-37.6341
	[0.0000]	[0.0000]	[0.0000]	[0.0001]
DLREER	-11.0335	-10.8781	-11.0118	-10.8521
	[0.0000]	[0.0000]	[0.0000]	[0.0000]
DLRFI	-3.5328	-40.4222	-3.5235	-40.3066
	[0.0081]	[0.0001]	[0.0396]	[0.0001]
DLRP	-11.0711	-10.9575	-11.0447	-10.9277
	[0.0000]	[0.0000]	[0.0000]	[0.0000]
DLERV	-10.76160	-10.91406	-11.58884	-11.59228
	[0.0000]	[0.0000]	[0.0000]	[0.0000]

(P-values in parenthesis)

Properties of the financial economic variables were examined using unit root tests such as the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. Since the data is monthly, lags up to 8 were included for correction of autocorrelation as proposed by the Akaike Information Criteria (AIC).

Table 2, From the ADF test and PP test result, we get that; the null hypothesis of a unit root will be rejected at each level. First differences of the Log series of determinant variables are stationary. Thus the real exports and other economic determinants are integrated of the same I(1).

Estimation of Linear Regression Model

The multiple regressions serve as analysis of the association between the modelled real exports and other selected determinants. Table 3 estimates results employing the ordinary least squares method. The adjusted R^2 value shows that 30.75 % variation in Real Exports can be explained by the model which is an indication of a moderate fit. The Durbin-Watson statistic of 1 indicates that the model has a positive auto correlation. As mentioned in the research methodology, the linear regressions model is considered to interpret the impact of exchange rate volatility on the industrial export performance. The regression outcomes are shown in the following table 3.

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Table 3: Results of the Estimated Simple Linear Regression Model

	LRE	LREER	LRFI	LRP	LERV	Constant
Coefficient	1	-0.536946	2.946344	2.612797	0.365235	3.542839
t-value		-0.469687	6.979646	0.522420	4.866215	1.125106
p-value		0.6391	0.0000	0.6019	0.0000	0.2618
Adjusted R^2			0.307510			
Durbin-Watson Statistics			1.194121			
SE			0.420229			
F-statistic			24.86843			

In the regression outcomes, the independent variables in the fitted model of this study are significant at five percent level. Real effective exchange rate is negatively influenced on the real exports. But, the relationship between the Real Exports and the other determinants are positive. The coefficient of the real exchange rate volatility in the estimated model is 0.365235 which mean if the Real Exports increases by one unit; the volatility will be increased by 40.365235 units while real effective exchange rate decreased by 0.469687 units. Estimating the regression model, real effective exchange rate and relative price are not significant predictors of real exports as the p-value less than 0.05.

Selection of Optimal Lag Length

Table 4: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	857.534	NA	0.000	-8.197	-8.117	-8.165
1	2169.325	2547.903	0.000	-20.570	-20.089	-20.376
2	2253.608	159.651	0.000	-21.140	-20.257*	-20.784
3	2303.636	92.360	3.57e-16*	-21.381*	-20.097	-20.862*
4	2318.503	26.731	0.000	-21.284	-19.599	-20.602
5	2331.310	22.413	0.000	-21.166	-19.080	-20.323
6	2350.345	32.396	0.000	-21.109	-18.622	-20.103
7	2375.048	40.854	0.000	-21.106	-18.218	-19.938
8	2399.472	39.220*	0.000	-21.101	-17.811	-19.771

There are four I(1) variables in the model as the ADF/PP test results suggested except real exports. Therefore it is better to identify the co-integration rank, since there may be having co-integration vectors more than one. First of all an unrestricted VAR is estimated by using log of variables to be identified the order of optimal lag for the VECM model evaluation.

The AIC, HQ and FPE show the optimal lag of 3, and the SBC suggest lag length of 2 beside the LR recommend the optimal lag of 8 as seen from Table 4. Thus the suggested lag lengths by the tests differ as in 3 ways. Therefore VAR residual serial correlation LM test is executed to choose the appropriate lag length of all the variables in levels of log form.

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Table 5: VAR Residual Serial Correlation LM Test

	2 lags		3 lags		8 lags	
Lags	***LM-Stat***	***Prob.***	***LM-Stat***	***Prob.***	***LM-Stat***	***Prob.***
1	90.9246	0.0000	27.5175	0.3305	40.1771	0.0280
2	75.8947	0.0000	25.6982	0.4238	42.4114	0.0162
3	46.4032	0.0058	34.2387	0.1029	34.2937	0.1018
4	36.3101	0.0670	31.0813	0.1863	37.4636	0.0521
5	26.4352	0.3847	25.4028	0.4400	46.7197	0.0053
6	43.6623	0.0118	29.7193	0.2350	55.8690	0.0004
7	54.3346	0.0006	47.2296	0.0046	37.2879	0.0542
8	30.6202	0.2019	30.7524	0.1974	21.9064	0.6411
9	43.3510	0.0128	33.8324	0.1115	30.0979	0.2206
10	48.2309	0.0035	26.7721	0.3674	20.0826	0.7425
11	33.5935	0.1169	31.6450	0.1685	27.1550	0.3482
12	178.9011	0.0000	166.8736	0.0000	99.8488	0.0000

As indicate in Table 4, 2, 3 and 8 lags were selected for carried out the VAR residual serial correlation LM test as the solution for the problem. Table 5 presents the results obtained from LM tests. 3 lags are most appropriate for the VAR order as results indicated. Thus the estimated VAR is VAR (3). Therefore, optimal lag of 3 is better to proceed, estimating the long run relationship for Real Exports and Exchange Rate Volatility.

Estimation of the Johanson Co-Integration Model

Once the order of optimal lag length of each of the variable is selected, co-integration test is conducted by using the level of log form. Generally, to be applied the co-integration test; all the variables must be in same pattern as the level of non-stationary and stationary 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 combination of the series is stationary.

Therefore, this study then 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 results for both Trace statistic and Maximal Eigen statistic tests are reported in Table 6. Table 6, above trace test shows that the existence of one co-integration relationships at 0.05 level. The maximum Eigen value test clearly confirms this result. The both trace and Eigenvalue test confirm the result that there exists the 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 normalised co-integrating coefficients with respect to export demand function of Real Exports.

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Table 6: Unrestricted Co-integration Test of Log Transformation Series

Hypothesized No. of CE(s)	Eigenvalue	Statistic	0.05 Critical Value	Prob.**
Trace Test				
None *	0.161431	85.36123	69.81889	0.0018
At most 1	0.091782	47.68479	47.85613	0.0519
At most 2	0.066578	27.08293	29.79707	0.0996
At most 3	0.052812	12.3387	15.49471	0.1414
At most 4	0.003394	0.727469	3.841466	0.3937
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
Maximum Eigenvalue				
None *	0.161431	37.67644	33.87687	0.0167
At most 1	0.091782	20.60186	27.58434	0.301
At most 2	0.066578	14.74423	21.13162	0.3072
At most 3	0.052812	11.61123	14.2646	0.1261
At most 4	0.003394	0.727469	3.841466	0.3937
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

Determination of VECM

VECM identifies distinction between long and short run determinants of Exchange Rate volatility. VECM can be established using the optimal lag length and some co-integrating relationships. Only one co-integrating equation is assumed to exist for the purposes of this study. This is due to the main objective of this study being the determination of which variables may cause Real Exports. It is used for estimating both short-term and long-term effects of Real Exports and other independent variables. The VECM is used to examine the short-run and long-run relationships among Real Exports and Exchange rate Volatility for the entire period of Eighteen years. It shows that negative sign indicates that each variable is negatively related to Real Exports on export growth while positive sign indicates that each variable positively related to the dependent variable, real Exports with some extended limitation.

Table 7: Normalised Co-integrating Vectors

	LRE	*LREER*	*LRFI*	*LRP*	*LERV*	*C*
Coefficient	1.000000	-3.803811	-2.974896	17.26469	-0.364276	-7.261476
t-value		[-1.10021]	[-2.27324]	[1.12691]	[-1.52779]	

There exists the long run dynamic relationship of real export variables on export performance in Sri Lanka. Rising on real exports decreases the real exchange rate volatility as it has the negative sign and statistically significant. Even though exchange rate volatility has an impact on real exports, but the degree of its relationship is very weakly compare with another

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variables. The relationship between real effective exchange and the real foreign income with the real exports are negative sign. By 1% increase of exchange rate would increases 17.26469 units of relative price. The coefficient of Error Correction Term of real foreign income as shown above is -2.974896. This indicates that 2.97% of the deviation from the equilibrium is corrected within a month. However, the exchange rate volatility values are statistically insignificant and impact of exchange rate on export growth has a negative effect both in short run and long-run.

Table 8: Coefficients of Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.00021	0.00174	-0.12263	0.90250
LRE(-1)	0.00208	0.00226	0.92030	0.35860
LREER(-1)	-0.00513	0.02561	-0.20047	0.84130
LRFI(-1)	0.11172	0.00826	13.51956	0.00000*
LRP(-1)	0.42307	0.10934	3.86916	0.00010*
LERV(-1)	0.00585	0.00189	3.09450	0.00230*
D(LRE(-1))	-0.00193	0.00231	-0.83520	0.40460
D(LRE(-2))	-0.00158	0.00215	-0.73527	0.46310
D(LRE(-3))	-0.00074	0.00173	-0.43148	0.66660
D(LREER(-1))	0.00356	0.07893	0.04509	0.96410
D(LREER(-2))	0.00622	0.08038	0.07742	0.93840
D(LREER(-3))	0.00811	0.07970	0.10172	0.91910
D(LRFI(-1))	-0.12594	0.02261	-5.56986	0.00000*
D(LRFI(-2))	-0.10959	0.02599	-4.21611	0.00000*
D(LRFI(-3))	-0.06676	0.02177	-3.06639	0.00250*
D(LRP(-1))	0.00842	0.28272	0.02978	0.97630
D(LRP(-2))	-0.13717	0.28055	-0.48892	0.62550
D(LRP(-3))	-0.12602	0.27882	-0.45197	0.65180
D(LERV(-1))	-0.00452	0.01592	-0.28393	0.77680
D(LERV(-2))	0.00417	0.01593	0.26144	0.79400
D(LERV(-3))	0.00108	0.01547	0.06977	0.94440
Mean dependent var	1.0000	S.D. dependent var		0.00000
S.E. of regression	0.0086	Akaike info criterion		-6.58749
Sum squared resid	0.0140	Schwarz criterion		-6.25500
Log likelihood	719.2741	Hannan-Quinn criter.		-6.45311
Durbin-Watson stat	0.1048			

(* indicates significant at 5%)

Table 8 indicates the short run movements of the co-integration relationship. For each variable is tested for lag length 1, 2 and 3. Exchange Rate Volatility; there is a positive relationship with the real export at the 5 percent significance for the short term period of time.

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Variance Decomposition

The results of the decomposition of the endogenous variables of the model are presented in Tables 9 for the real exports. The results provide proportion of the forecast error in each variable attributable to the innovations of the other variable over a time period. From Table 9, the variance of real exports in the second period decomposed into its own variance (91.72%), LREER (1.75%), LRFI (2.36%), LRP (4.14%), LERV and (0.02%). These contributions in the variance of exports increased in period 10.

In the first month, as predicted, there is no contribution from the other determinants to real exports. The second most important variable that influences real exports is relative price though it is marginal at 3.88% in the fifth month. In the eighth month, place of importance of each variable keep same continuously for the longer period of time as the third important to the real foreign income and least importance to the reach exchange rate volatility. However at the end of the period contribution of the real effective exchange rate increases to 2.19%, real foreign income increases to 2.56%, relative price decreases to 3.84% and volatility increases to 0.49% with real exports to the 90.92%.

Table 9: Variance Decomposition of LRE

Period	S.E.	LRE	LREER	LRFI	LRP	LERV
1	0.356442	100	0	0	0	0
2	0.386918	91.72149	1.75841	2.359635	4.140953	0.01951
3	0.395595	91.67408	2.026161	2.278974	3.99212	0.02867
4	0.419028	92.07031	1.80893	2.415065	3.638929	0.066764
5	0.427385	91.6778	2.005942	2.321567	3.879509	0.115178
6	0.435081	91.75897	1.968065	2.38473	3.752268	0.135967
7	0.441403	91.79524	1.990856	2.342958	3.715129	0.155814
8	0.445282	91.60294	2.115949	2.357302	3.671151	0.252656
9	0.450069	91.24563	2.125098	2.522901	3.757329	0.349038
10	0.453645	90.91955	2.186191	2.559007	3.842141	0.493114

Residual Diagnostic Function

The necessity of diagnostic testing involves checking residuals of the series for any problems. Problems be present, this may indicate that the model is inefficient, and that parameter estimates may be biased. Diagnostic checks included for the purposes of this investigation are tests for serial correlation LM test, secondly autoregressive conditional heteroscedasticity effect, then normality and finally correlogram of squared residuals.

The Lagrange Multiplier (LM) test was employed to test for the presence of autocorrelation. The null hypothesis of the LM test is that there is no serial correlation in the residuals. Serial correlation is present when residuals are shown to have correlations with past values. The p-value for the LM test is 0.6585 for lag two as indicated in Table 10 below. The null hypothesis of no serial correlation may therefore be rejected, as the p-value exceeds the 5% level of significance. There is therefore no serial correlation in the time series.

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Table 10: Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.418661	Prob. F(2,190)	0.6585
Obs*R-squared	0.930174	Prob. Chi-Square(2)	0.6281

Testing for heteroscedasticity in time series can be done both graphically and numerically to reveal any potential autoregressive conditional heteroscedasticity (ARCH) effects in the data.

Table 11: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.113754	Prob. F(20,191)	0.3381
Obs*R-squared	22.14191	Prob. Chi-Square(20)	0.3329
Scaled explained SS	36.99292	Prob. Chi-Square(20)	0.0117

Table 11 illustrates the results obtained from conducting Breusch-Pagan-Godfrey for heteroscedasticity. The p-value of 0.3381 indicates that the null hypothesis of homoscedastic residuals can be rejected. This reveals that the residuals have no serial correlation, they are homoskedastic and are normally distributed since all the p-values are greater than 0.05.

The Jarque-Bera (JB) test is conducted to test for normality in the series. The null hypothesis is that residuals are normally distributed. The results for the JB test are presented in Figure 5 below.

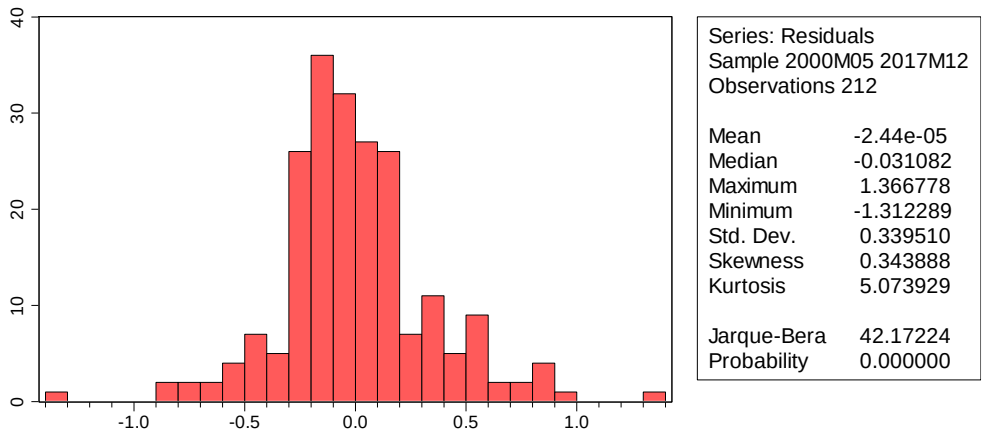

Figure 5: Normality Test of Results

As Figure 5 illustrates, the null hypothesis of normal distribution may be rejected due to the p-value is less than 0.05. This means that the residuals are not normally distributed based on the Probabilities of Skewness(0.34388) and kurtosis(5.0739). However, this does not influence the results of the co-integration and VECM tests to be not valid. The estimated model is not normally distributed. Based on the terms of no serial correlation and no heteroscedasticity, the model is considered to be efficient one.

CONCLUSION

This Research paper is an attempt to analyze the movements of exchange rates on economic growth based on the industrial sector export products to be exported to the top 5 trading

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partners in Sri Lanka. VECM Model was used incorporating the Real Exports as the dependent variable with Real Foreign Income, Real Effective Exchange Rate, Exchange Rate Volatility and Relative Price as the independent variables for the modelling Exchange Rate Volatility. The model is applied to the Industrial Sector exports on a monthly basis from 2000 to end of 2017 for the five largest recipient countries across the World with engaging four different Currency Rates. EURO is the main currency indicator for both Germany and Belgium. Other three are US dollar, Indian Rupees and British Sterling Pounds. The aim of this thesis is to investigate the performance of Industrial Sector Performance. Sri Lanka is producing different kinds of Goods and Services for the purpose of exports. Implications of some different categories will provide the broad picture about the Sri Lankan Export Performance with alternative ways of financial Time Series approaches. SMA was used for the calculating Exchange Rate Volatility

The overall results imply that the Exchange Rate movements are highly influenced on the Sri Lankan Industrial export demand and competitive conditions. Therefore it was finally concluded that Real Exports are negatively influenced on the Exchange rate volatility while positively influenced on the Real Effective Exchange Rates. However, the effect is still significant from data year, 2000.

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