

# The Impact of Interest Rate and Inflation Rate Towards Exchange Rate: A Case of Sri Lanka

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**Abstract:** Exchange rate can be explained as one of the key factor, which emphasis countries macro-economic stability. As an emerging market Sri Lanka is mainly focused on international markets and highly depend on international trade. This study is on the influence of interest rate (Weighted Average Call Market Rate - CR) and inflation (Colombo Consumers' Price Index (CCPI) - INF), to the exchange rate (USD/LKR - NEXR). The research analysis monthly data of CR, NEXR and CF for the period of October 2000 to March 2013 based on Vector Error Correction Model. This research uses stationary test, cointegration test, stability test, impulse response function, residual test has generated to compile and analysis data. Results of the study proves that the exchange rate has negative relationship with interest rate for the given period. However, the exchange rate shows positive relationship with inflation. Those relationships are significant in long run causality, where it takes much more time to become equilibrium position. Further, there is no short run causality as well. The negative relationship between exchange and interest rates creates a favorable environment to capital inflows to the country. However, manipulation of exchange rate volatility by the relevant market players will lead to a change in the expected relationship of the variables. According to the results, policy makers should estimate most appropriate policy interest rate level in Sri Lanka to manage sustainable growth. Further, the regulatory authorities should manage appropriate intervention mechanisms to the foreign exchange market to control exchange rate to avoid market manipulations.

**Keywords:** Exchange Rates, Interest Rates, Inflation Rates, Vector Error Correction Model, Cointegration Test, Causality

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## 1. Introduction

### 1.1. Background of the Study

Behavior of the exchange rate is highly influencing on small open economies like Sri Lanka. Hence the exchange rate has become a most important measure where government is manipulating as per macro-economic objectives. With the time Central Bank of Sri Lanka (CBSL) introducing its regulatory restrictions on exchange rate market.

This study mainly focused on determining the relationship of the interest rate and inflation rate towards exchange rate. Volatility in the exchange rate might cause fluctuations in the relative prices of goods and services, and the expenditure level of individuals and firms when substantial levels of their wealth are in foreign currencies. Further the volatility of the exchange rates will depend on many other fundamental issues including country trade dependence, level of openness, especially capital account openness and institutional

development etc. So, it is important to identify the above relationship in advance before policy decisions.

In 1990's a few financial crises have occurred, mainly Asian financial crisis in our region changed many central banks commitment to fixed or hard pegged exchange rate systems. Even if a country does not face severe exchange rate movements, continuous interventions are increasingly costly and have limits in this rapidly globalizing financial world. Any way exchange rate volatility must be minimal to full fill border macroeconomic goals, interest rate policy, external balance and financial system stability.

If an exchange rate is volatile or fluctuating frequently there are so many macroeconomic issues to be crop up. Exchange rate risk is the major issue which creates uncertainty in international trade and problems will create over bank balance sheet as well. Foreign investors will not be able to forecast their investment returns. Even if they invest in funds that have constant returns in a foreign exchange, if that foreign currency is liable to higher volatilities in its value,

then the investment also gets unstable.

Directly influence on import and export market and create uncertainty over such business. Market creates more forward positions (hedging the risk) which create more derived expectations in the market. Once these forward rates used as a clue to take monetary policy decisions this will mislead whole economy. Further in a way foreign debt repayments also affected due to this par value of the exchange rate.

Normally floating exchange rate can mainly divide in to clean and dirty floats. In dirty floating which exists in real world, central bank retains the option of intervening in exchange rate market. This scenario manipulate real volatility of the exchange rate and direct where government expectation. Because of the above fact, in Sri Lankan context the influence of interest rate changes and inflation to the exchange rate will deviate from the expected behavior. Plenty of interventions direct longer lag to become equilibrium where Sri Lanka can be exhibited.

### **1.2. Research Problem**

Research problem of the study is mainly focus to determine.

‘What is the relationship between Interest Rate and Inflation towards Exchange Rate in Sri Lanka?’ Further this problem analysis the relationship is short run or long run.

### **1.3. Research Objectives**

In order to address the research problem few objectives are to be formulated. The main objective - Determination of the relationship between interest rate inflation rate and exchange rate in Sri Lanka. In addition to that identifying long run / short run causality of such variables will be a secondary objective of this study.

Specific objectives:

- 1) Identifying long run and short run causality of the interest rate inflation rate and exchange rate.
- 2) Determining relationship between foreign capital inflows and other variables (interest rate inflation rate and exchange rate).

Under these objectives hypothesis are testing for the:

- 3) the model has significant relationship among variables or no such relationship.
- 4) The relationships of the variables have short run dynamics or long run dynamics.

### **1.4. Research Methods**

Data for the study was gathered through secondary sources. Data collection is mainly through published data by Central bank of Sri Lanka and Censes and statistic department. Graphical interpretation (Graphs and Box plot diagrams) is the primary method followed to identify relationships among variables. Further simple statistical measures like correlation and slandered deviation are taken in to account to identify simple statistical behavior of the variables.

As secondary method of this research cointegration analysis is taken place. Based on the time series data which

are stationary at first difference, cointegration relationship of each variable is analyzed by performing Vector error correction model under that long and short run causality is determined by the generated output by performing ordinary least square (OLS) estimate over cointegrated equation. Further statistical verification of model is done by referring to major residual tests. in methodology following hypothesis are testing for significance:

- 1) The model has significant relationship among variables or no such relationship.
- 2) The relationships of the variables have short run dynamics or long run dynamics.

### **1.5. Limitations of the Study**

The main limitation of the study is the availability of data. Some of the variables which affect the exchange rate did not available in monthly basis most of them are in annual basis publications. The selected time period entails so many macroeconomic shocks which cannot be generalized for all time cases. Further the exchange rate is highly influenced by the regulatory authorities the output may vary due to such intervention.

### **1.6. Structure of the Research**

The study consists of five sections. The first section is on the overview of the research problem and research objectives, and it briefed on research method, limitation of the study and brief conclusion. The second section is on the review of literature where it mainly discussed based on the Sri Lankan evidence on my topic, Theories behind the exchange rate, policy formulations based on the exchange rate regimes and econometrics modeling used to identify exchange rate behavior. Followed by the third section which elaborates methodology of the research explained data collection and explanation on individual data, expected model on the variables and relevant theories and methods on econometric analysis. Basically, statistical formulation of unit root test, cointegration test, Vector error correction model and residual test are discussed. The fourth section addressed behavior on individual variables and their joint behavior under different macroeconomic environment. Further it discussed the economic theories and its relevance to the current environment in Sri Lanka. At the latter part of the section, it explains econometric output and its accuracy and relevancy to the domestic market with the comparisons of the similar studies. Section five and the final chapter conclude the study. This consisted of justification of the findings, suggested policy formulation and finally further studies.

## **2. Literature Review**

### **2.1. Background**

Exchange rates act a critical role in a country's level of trade, which is key to most of the free market economies in the world. Therefore, exchange rates are among the most observed, analyzed and manipulated economic indicator.

Most countries tried to manage their local currency fluctuations by imposing regulatory boundaries on exchange rate variations. Nevertheless, governing the exchange rate could be very harmful and worthless, when speculators attack on currency, even under government safeguard. Higher interest rate environment will block capital outflows but slow down economic growth.

## 2.2. Sri Lankan Experience on Exchange Rate Behavior

There are number of factors contributing to the fluctuation of an exchange rate for example the openness of an economy, money supply, exchange rate regimes, interest rate, central bank independence, inflation, income, output level and other unpredictable variables. But depending upon a country's economic condition the weight on such factors may vary. However, countries that are in process of transition are more vulnerable to being affected by these factors. Wanaguru provided empirical evidence that the fluctuation of exchange rate returns in Sri Lanka is mainly driven by outside sourced shocks [1]. Although this research subject to the few of such factors, according to empirical literature as follows discussed much on such variables. In Sri Lankan context there are very few attempts to investigate relationship on exchange rate and its variables.

Along the study through monetary stock, balance of payment and survey carried out among key import and export corporate Jayasena conclude there has had a significant impact on commercial banks and the corporate sector in the exchange rate volatility during 1995-2006 periods. This study covers two major exchange rate regimes where its conclusion [3] further ascertained by Harischandra on his findings explained the desertion of fixed exchange rate regime, coupled with open economic policies; inflation persistence influences a higher level, with increased monetary accommodation. Conversely, before the regime alteration, inflation reports lower persistence and lesser monetary accommodation [2].

Ratnasiri on his study which considered much border period, (1980-2005) compared to above two studies concluded that money supply increases and price growth are the main factors of inflation in Sri Lanka in the long run. Conversely, it is evident that exchange rate depreciation and output gap have no statistically significant on inflation [4]. Further, he elaborates in the short run, rice price is the primary variable as it is a completely endogenous factor. Nevertheless, money growth and exchange rate are not so crucial factors. Such observation on exchange rate volatility upon inflation determination is explaining the conclusion on Harischandra as much of the data collected during the fixed exchange rate regime [2].

During the period of 2001 to 2011 where there was flexible exchange rate regime, exchange rate movement as per the monetary model is bit doubtful according to the Jegajeevan [5]. Selected macroeconomic indicators have stated correct signs for the coefficients, as projected by theory. Accordingly, a rise in Sri Lankan money, depreciates USD/LKR exchange rate, while an increase in Sri Lankan income appreciates the USD/LKR exchange rate. Similarly, effect of money supply, a rise in Sri Lankan interest rate has a positive relationship with exchange rate.

## 2.3. Exchange Rate, Interest Rate and Inflation

Numerous studies researching the relationship between inflation, interest rate and exchange rates have discovered that exchange rates affected inflation and interest rate, while other researches have failed to do so and generated mixed results. Some of the results might be spurious due to lack of usage in proper cointegration method. Kim found out that the US inflation, exchange rate, money supply, income, and interest rate are cointegrated and it have long run equilibrium relation [6]. The cointegration analysis shows that the dollar exchange rate has a substantial negative effect on the inflation determined by the producer price index. however other factors are positively correlated. Conversely to the Kim same study but on the international Fisher effect theory Utami, states interest rate differentials have positive but no significant effect on fluctuations in exchange rate for the USA, Singapore, and the UK relative to that of Indonesian through the regression results [7].

In Malaysian context contrasting to above two long terms relationship, interest rate changes positively, while inflation rate shows negative relationship towards exchange rate volatility in Malaysia. The implication of this research is that raising the interest rate can be competent in controlling exchange rate fluctuations. Hakkio with the analysis of US market explained the changes in the relationship between interest rate and exchange rate over the period of 1974-1996 [8].

Speech Deputy Governor of the Sveriges Riksbank, at a meeting concluded stronger krona dampens both inflationary pressures and resource utilization. In general, as per the selected empirical studies it can be observed that the relationship among above three variables depend upon countries environment. The studies by Rana and Dowling indicate that foreign inflation is the most influencing variable in describing the variation in domestic price level in nine less-developed countries of Asia for the period 1973-79 [9]. Kashif also concluded that there is a negative relationship amongst inflation and exchange rate [10]. By considering the inflation, interest rate and exchange rate in domestic and foreign International Fisher Effect theory is built up.

Both the Interest Rate Parity theory and the Purchasing Power Parity theory calculate the future expected exchange rate. The Purchasing Power Parity theory relates to exchange rate with inflation rates, while the Interest Rate Parity theory relates exchange rate with risk free interest rates.

$$\frac{e_t}{e_0} = \frac{(1+r_h)^t}{(1+r_f)^t} \quad (1)$$

Where,

$e_t$ –Future Spot Rate

$e_0$ –SpotRate

$r_h$  – Home interest rate

$r_f$  – Foreign interest rate

Currency with the lower interest rate expected to appreciate relative to one with a higher rate. International Fisher Effect theory can be explained under two scenarios<sup>1</sup>.

$$e_f = \frac{1+i_h}{(1+i_f)} - 1 \quad (2)$$

Where,

$i_h$ - Home interest rate

$i_f$ - Foreign interest

$e_f$ - Percentage change in the value of foreign currency denominating security.

**Table 1.** The expected scenarios of International Fisher Effect.

$i_h > i_f$	$i_h < i_f$
1) high and positive means low	1) low and negative means low
2) Low inflation in foreign country compared to home country	2) Higher inflation in foreign country
3) foreign currency will appreciate	3) Foreign currency will depreciate
4) Increase the foreign returns to investors in the home country.	4) Reduce the returns on foreign financial securities

#### 2.4. Monetary Policy and Exchange Rate

The effect of monetary policy shock on exchange rates has been a research title among researchers and policy makers. This study area has very important and crucial policy implications for the economy. Nonetheless, empirical research on this area produces inconsistent outcomes. The empirical research on the impact of monetary policy shocks on macroeconomic variables is commonly based on multivariate models. Ivrendi and Guloglu on his study of five Inflation Targeting Countries found that a contractionary monetary policy shock influence in reduction of price level, a decline in output, an appreciation in exchange rate, and short term improvement in trade balance [11].

All five countries<sup>ii</sup> considered on their model are developed countries. But Cavoli based open and developing economies<sup>iii</sup> for his study on exchange rate and optimal monetary policy rules which can be much appropriate to the domestic arena [12].

Further, according to the simultaneous analysis on both industrial economies and emerging markets Galati concluded for most industrial economies the exchange rate is considered in the process of decisions making of policymakers [13]. Conversely, in emerging market countries exchange rate plays an important role not only in countries with currency boards or explicit exchange rate objectives but also in countries who target inflation. With the recent trend in unconventional monetary policy Sri Lanka is in a transition period of monetary targeting to Inflation targeting monetary framework.

Whereas it is much suitable to go through monetary policy actions on exchange rates under interest-rate targeting as Neal, Roley, Sellon [14] discussed. The theoretical result from their models shows that the reactions of foreign central banks to US monetary policy alterations can have potentially large effects on the dynamic behavior of exchange rates. They assume both rational expectations and uncovered interest parity affect to appreciate in dollar for a few of future periods in response to a contractionary US monetary policy implementation. Hence based on such conclusion it can be assumed that the changing policy rate<sup>iv</sup> has moderate impact on exchange rate behavior.

with the suggestion of Mishkin, Hebbel that inflation targeting supports countries to attain lower inflation in the long run, have lesser inflation response to oil-price and

exchange-rate shocks, strengthen monetary policy independence, expand monetary policy effectiveness, and gain inflation rates to the target levels [15]. Hence, this might be a clue on shifting from existing monetary policy regime to inflation targeting.

#### 2.5. Exchange Rate Volatility

Volatility forecasting has been a vital research topic in financial economics for the past periods. Volatility can be explained as the level of uncertainty in a financial asset and is significant in risk management methods. For volatility forecasting moving average, Monte Carlo simulation, GARCH models, and existing quantile-based methods are commonly used. Exchange rate volatility has also been a major research subject these days. With the presence of trustworthy exchange rate volatility forecast mechanisms, the operations of central banks and governments in exchange markets can be more effective and costs for hedging in firms can be reduced.

Huang, Pen Peng, Jie Ke in their paper, explained a quantile regression approach for volatility forecasting in exchange rate. The paper presented the out performance of the implemented models are robust in different sub-periods for Japanese yen and Euro dollar, where their exchange rate volatilities structurally varied throughout sample period [16]. Further, they concluded quantile regression approach is the more sophisticated method compared to the other volatility approximation methods by adopting all such methods to their estimations.

West and Chob compared the out-of-sample forecasting performance of univariate homoscedastic GARCH, autoregressive, and nonparametric models for conditional variances, using five bilateral weekly exchange rates for the USD for the period of 1973-1989 on exchange rate volatility. They concluded that on the one-week horizon, GARCH models tend to get comparatively higher accurate forecasts [17]. Hence, such conclusion proved that Karras, Lee, Stokes arguments on volatility forecasting models are acceptable. Further, they identified significant rise in exchange-rate volatility since the end of the Bretton Woods<sup>v</sup> period. As per the VAR. The first period is 1957:1-1971:12, in the Bretton Woods system, when exchange-rate variability was low. The second period is 1973:1-2000:12, in floating exchange rates, with volatility rising instantly and significantly. Not like in Huang, Pen Peng, JieKe, this study was based on single volatility estimation and did not exist any comparison [18]. The results of Hua verify the shock of an economy's openness on exchange rate volatility when openness explains almost half of exchange rate variations. He states that trade integration and real exchange rate volatility is structurally related and that there is a negative correlation between them. However, Hau's results do not say anything about particular countries because each country is represented only by arithmetic mean values over the whole period [19].

#### 2.6. Exchange Rate: Policy

The exchange rate of an economy influences aggregate

demand through its effect on export and import prices, and policy makers. Adjusting exchange rates to manipulate the macro-economic environment is also considered as a sort of monetary policy mechanism. Alterations in exchange rates primarily influence into an economy via their impact on prices.

Different exchange-rate regimes<sup>vi</sup> introduced by the policy makers in given eras differ the behavior of macroeconomic indicators. The introduced exchange rate policy may not have been fully reliable, as variations in economic fundamentals have persisted as explained by the Knot and Haan in their study [20]. Considering the interest rate differentials in Germany for Austria, Belgium, and Netherlands they investigated theoretical models rather varies

from the actual situation. The conclusion showed very little is about the positive determinants of exchange rate regime choice. Further he concluded, size of the economy may positively associate with the floats and pure floats and negatively associate with the peg and hard peg exchange rate regimes.

### 2.6.1. Exchange Rate Regimes

The meaning of an exchange rate regime generally makes the severe difference between fixed and floating, or flexible, exchange rates. Considering the global arena there are so many exchange rate regimes that have been identified. According to Frankle the exchange rate classification is as follows [21].

**Table 2.** Exchange Rate Regime Classifications.

Floating Corner	Intermediate Regimes	Rigidly Fixed Corner
Pure Float	Band	Currency Board
Managed or Dirty Float	Crawling Peg	Dollar-and Euroisation
	Basket Peg	Commodity Standard
	Adjustable Peg	Monetary Union

In domestic context presently we are practicing free floating exchange rate regime which facilitates large budget deficit and the interest rate determination.

### 2.6.2. Exchange Rate Regimes – Sri Lanka

The Monetary Law Act, under which the CBSL was established. The Bank's responsibility is to maintain the stability of the external value of the Sri Lankan rupee in against foreign currencies in line with macro-economic

basics. Currently CBSL is responsible in maintaining price stability, economic stability and financial system stability while maintaining foreign reserves in the country. In the past six decades, the exchange rate system of Sri Lanka has progressed from a regime of fixed exchange rates to a managed float and finally to an independent float. Brief overview of the exchange rate regimes can be classified as shown in the following table.

**Table 3.** Exchange Rate Regimes.

Date	Major Changes	Exchange Rate Regime
1949	Rupee was linked to sterling pound	Fixed
22 Nov 1967	Rupee was depreciated by 20%	Fixed
06 May 1968	Introduced Foreign Exchange Entitlement Certificate Scheme	Dual exchange rate system
01 Aug 1971	Rupee was linked to US dollar	– do –
10 July 1972	Rupee was linked to sterling pound	– do –
24 May 1976	Rupee was pegged to a weighted average basket of currencies	– do –
12 March 1977	Rupee was depreciated by 20%	– do –
16 Nov 1977	Dual exchange rate system was abolished and managed floating exchange rate system was introduced	Managed floating with crawling band
20 June 2000	Band was widened	Managed floating with horizontal band
03 Nov 2000	Band was widened	Managed floating with crawling band
23 Jan 2001	Central Bank stopped announcing its buying and selling rates in advance	Independent floating
10 Feb 2012	the Central Bank decided to limit its intervention in the forex market	Independent floating

Source: Central bank Of Sri Lanka

A managed float is very close to a pure float if the Central Banks only intervene rarely and in small amounts. It when that intervention more or less is on continuous basis it is something closer to an intermediate regime<sup>vii</sup>. This is the method which is practicing in Sri Lanka currently. As Sri Lankan economy also in a transition period after 30 years of internal conflict the country is searching for appropriate policies as emerging market. Apparently study on Drabek, Brada the concluded inappropriate exchange rate policies have headed to protectionist pressures in emerging economies. The major argument among researchers was on

more flexible controlling of the nominal exchange rate would be a desirable way of handling the real appreciation of these countries' currencies [22].

Foreign exchange market intervention by the Central Bank is more likely to be active in periods during which monetary authorities make reliable statements about undertaking conclusive policy action to influence the exchange rate as per Disyatat and Galati [13]. So, this evidence also much comprehensive on emerging market likes Sri Lanka where they accept much foreign exchange inflows.

## 2.7. Theoretical Background: Exchange Rate Behavior

There are several theories on determining exchange rates. The purchasing power parity approach to the exchange rate was a very significant way of reasoning about the exchange rate. Asset pricing view of the exchange rate or monetary approach is that agents have a portfolio choice decision between domestic and foreign assets. The idea on balance of payment is that there exists an exchange rate at which there exists internal and external equilibrium.

### 2.7.1. Purchasing Power Parity (PPP) Approach

The purchasing power parity approach to the exchange rate is one of the major techniques of distinguishing exchange rate movements. This states that identical goods should be sold at identical prices (theory is based on the 'law of one price'). The law of one price implies that exchange rates should vary to compensate for price differentials among countries.

*Example:* If we are in an apple-world (only apple exists), and an apple is sold in US at 1 USD, and the same apple is sold in Sri Lanka at 200 LKR, then the exchange rate has to be 200LKR per USD.

$$P_t = \frac{P_t^*}{e_t} \quad (3)$$

This is the absolute PPP approach. Where  $p$  shows local prices,  $p^*$  are foreign prices and  $e$  is the exchange rate. There is also the comparative PPP approach. It is the similar model but related to differences. The alteration in the exchange rate will offset for inflation differentials.

$$1 + \pi_t = \frac{1 + \pi_t^*}{1 + e_t} \quad (4)$$

Where,  $\pi$  - represents local inflation, foreign inflation and the depreciation.

### 2.7.2. Monetary Approach

Both Quantity Theory of Money<sup>viii</sup> (QTM) and Purchasing Power Parity (PPP) have been used to explain monetary approach of exchange rate. The QTM describes the direct relationship of the quantity of money and the price level of traded goods and services. Rise in the money supply leads to inflation, which influence to decline in the value of money or purchasing power. Hence, if we consider this scenario in international context.

A fast growth in the money supply (in the home currency) will put into effect the PPP, resulting in the depreciation of the country's exchange rate. A higher interest rate will also result in the currency's depreciation as of the positive relationship between interest rates and money circulation. If the local GDP grows faster than overseas GDP, the demand for money will rise by assuming there is a given supply of money, the exchanged rate will decrease, which is in direct contrast to the PPP approach.

### 2.7.3. The Balance of Payments (BOP) Approach

The idea is that there exists an exchange rate at which there exists internal and external equilibrium. The internal

equilibrium assumes that there is full employment: unemployment is in the natural rate of unemployment. The external equilibrium refers to equilibrium in the balance of payments. Sometimes, people look at the current account instead of the balance of payments.

In general, it is very difficult to conclude what is the exact natural rate of unemployment, which is the key drawback in this approach. This model can determine where the exchange rate has to converge to. However, it gives very little guidance to the short-term exchange rate fluctuations.

Markopoulos concluded his study on the foreign exchange market is not an efficient one [23]. As it has many determinants for exchange rates, it is difficult to proceed to a reliable estimation for future exchange rates. Further, there is no reliable technique to predict exchange rates, and we have further determined that the forward.

Marrewijk on his decision paper explained basic exchange rate theories where they included case studies and some statistics on such theories. Basic exchange rate theories explain on following topics (i) the elasticity and absorption approach, (ii) the (long-run) implications of the monetary approach, (iii) the short-run effects of monetary and fiscal policy under various economic conditions, and (iv) the transition from short-run to long-run in a sticky-price model with rational expectations.<sup>ix</sup> One of his conclusion was on euro area, the individual consumer price components have a much lower variability, that is a lower standard deviation and a lower range of changes than the exchange rate changes [24].

The Mundell – Fleming model investigates the connections between output, money, and interest bearing assets in an open economy. The efficiency of fiscal and monetary policy is influenced by three factors. They are exchange rate regime, the size of the country and the degree of capital mobility.

According to the current scenario which is monetary policy easing in Sri Lanka can be elaborated as follows,

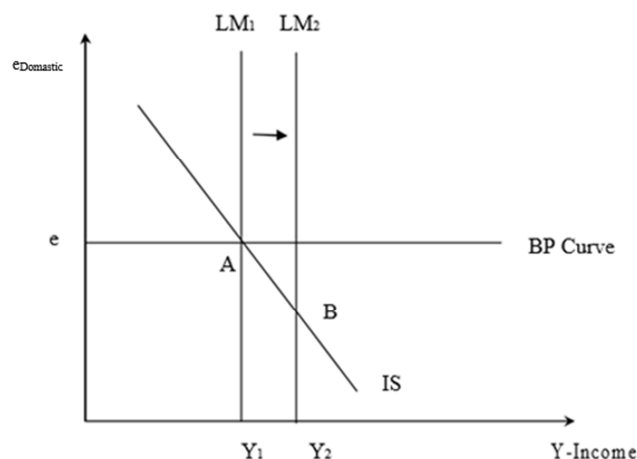


Figure 1. Mundell – Fleming (MF) Model –Flexible exchange rate regime.

MF model assumptions are small economy with perfect capital mobility, domestic interest rate equals foreign interest rate and IS curve is downward sloping. Monetary sector which is denominated by LM curve does not change with the exchange rate or in other words demand for money will not

response to the exchange rate change. LM curve is vertical. With the increasing money supply money demand goes down. In the bond market equilibrium collapses and bond demand goes up and supply goes down where bond prices increases. Since domestic interest rates goes down compared to foreign interest rate. Hence capital out flow is coming in to action. In the money market USD supply goes down and demand goes up which direct to domestic currency depreciation. Such depreciation leads to imports goes down and exports go up finally the income level goes up. Expansionary fiscal policy causes income levels to go down. Under MF model in flexible exchange rate expansionary monetary policy is more effective.

Under such approach Marrewijk build up short run analysis on such factors and explained it through the IS-LM model.

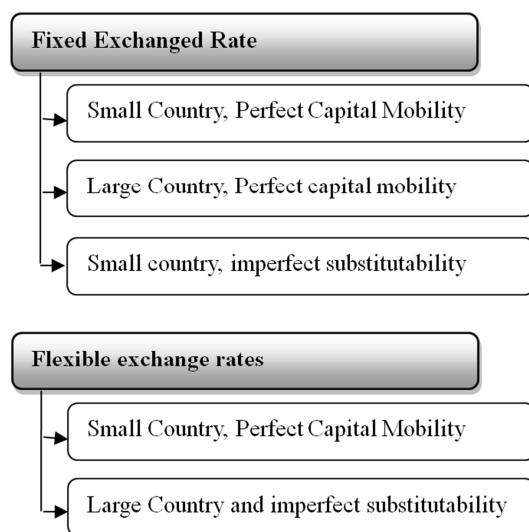


Figure 2. Marrewijk's analysis.

Presently, in 2013, all functions on exchange control Central Bank focused on more relaxation of foreign exchange transactions as per the current macroeconomic policy stance to encourage the competitive advantages of Sri Lanka in global business activities to enhance investor confidence, solidification of foreign reserves and to have stable foreign exchange market<sup>x</sup>.

Since the building up confidence and relaxed regulations FDI continued to be a major inflow to the financial account of the BOP despite sluggish global economic performance. As per the Marrewijk's analysis Sri Lanka is coming under Flexible exchange rate, small country, and perfect capital mobility category. International Economics by Husted Melvin discussed several few approaches on exchange rate compared to Marrewijk. With the development of the world economies as per the Husted Melvin it is difficult to rationalize some relations over exchange rate. They discussed basically Asset Approach, Sterilization, Exchange Rates and the Trade Balance Overshooting Exchange Rate, Currency Substitution, The Role of News and Foreign Exchange Market Microstructure.

As same as the Husted and Melvin MacDonald, on his book about Exchange rate economics elaborated lots of

existing exchange rate theories and its modern versions. In his book he analyzed each of the scenarios in economics terms using empirical evidence as well. Different versions of monetary models explained different features of the exchange rate. Since my key variables are in lined with inflation and interest rate among most of the exchange rate theories monetary approach would be better in case of considering the MacDonald [25].

#### Sri Lankan Scenario- Theoretical Analysis IS-LM Model

In Sri Lankan context we are having flexible exchange rate regime and imperfect capital mobility (ICM) condition. In present environment due to expansionary monetary policy since end 2012 following changes can be accepted under theoretical aspects.

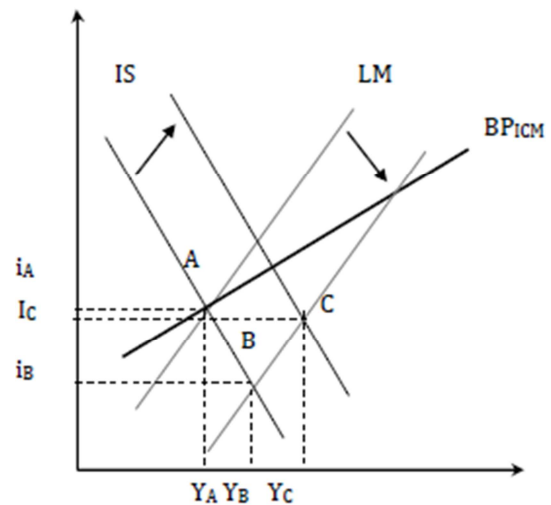


Figure 3. IS-LM model.

In this environment with the increasing money supply bond demand goes up. Hence bond prices go up and interest rate goes down compared to foreign countries where can observe balance of payment deficit. By the time the domestic currency depreciates imports goes up and exports goes down.

Even though Sri Lanka is practicing loose monetary policy stance the interest rate is high compared to the foreign countries. Further with the relaxation of exchange control regulations, favorable investment opportunities (risk free assets like Treasury Bills and Bonds, share market investments, expansion in infrastructure and manufacturing environment) and expenditure switching policies (domestic currency devaluation) Sri Lanka managed to maintain higher level of FDI inflows.

## 3. Methodology

### 3.1. Data Collection

Since this study mainly forced on to determine the relationship of the interest rate and inflation rate and exchange rate most of the data collected from the Central Bank of Sri Lanka (CBSL) and Department of Census and Statistics Sri Lanka. Inflation is measured by a number of indices in Sri Lanka. Colombo Consumers' Price Index is the

main measure. Call rate is calculated on an overnight basis considering overnight inter-bank call market rate. Key variables are collected for the period of October 2000 to March 2013 on a monthly basis. The main reason of the selection of this period is due to the flexible exchange rate regime and the lack of data in weighted average call rate.

Exchange rate also calculated by the overnight basis filtering SPOT transactions done by the interbank foreign exchange market. Further the Central Bank annual report was the basic source of data on analysis of macro-economic condition over year 2000 to 2013. Even though there was daily data on exchange rate and call rate inflation rate was in monthly. Hence, those daily data were taken as monthly averages to compatible in econometric analysis.

### 3.2. Data Collection of Key Variables.

#### 3.2.1. Inflation

During the selected period inflation faced two base changes one for 2002 and the other one for 2007. Inflation in Sri Lanka has largely remained in the double digits over 2004-2008 and be around nearly 20 per cent during 2007-08. Recently the inflation figures almost a line with the mid single digit. To avoid the base impact simple conversion to be done for the inflation data series to arrange it in to the single base period.

Monthly Average CCPI index on given month –  $K_t$

Monthly Average CCPI Index on month before - 12 month (12 months lag) –  $K_{t-12}$ .

$$CPI_t = \frac{K_t - K_{t-12}}{K_{t-12}} \quad (5)$$

#### 3.2.2. Interest Rate

As a key independent variable weighted average call money rate (WACMR)<sup>xi</sup> was selected for the study. The source of this data series is CBSL and the period is October 2000 to March 2013 monthly averages (149 observations). This rate is compiled by the Domestic operations department (CBSL) in daily basis.

#### 3.2.3. Exchange Rate

For this study exchange rate is selected as weighted average of SPOT rates in foreign exchange market (LKR/USD) in monthly basis. The source of this data series is CBSL and the period is October 2000 to March 2013 (149 observations). The volatility of the exchange rate can be simply determined through the standard deviation<sup>xiii</sup>.

The remaining data on Foreign Direct Investment (FDI), Balance of Payment (BOP), Treasury Bill rate and international reserve data were collected from the of the Central Bank publications.

### 3.3. Theory Behind the Analysis

#### 3.3.1. Correlation

The correlation between two variables measures the degree of linear association between them. The sample correlation between x and y.

$$S_{xy} = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y}) \quad (6)$$

$S_x, S_y$  – Standard Deviation of x and y variables, N – Sample number.

$$-1 \leq r_{xy} \leq 1$$

The closer r is to 1 the greater the linear relationship is with a positive slope. The closer r is to -1 the greater the linear relationship is with a negative slope.

#### 3.3.2. Expected Model

To verify the objective of the study Inflation (INF) weighted average Call Market rate (CR) taken as independent variable and Exchange rate (EXR) considered as dependent variable.

$$NEXR_t = f(CR_t, INF_t) \quad (7)$$

The set of variables are converted into the log form to interpret as growth rates. Log forms of each variable are defined CR as LCR, INF as LINF and NEXR as LNEXR.

#### 3.3.3. Unit Root

Augmented Dickey Fuller (ADF) test is the most commonly used test to check whether a time series data is stationary or not and to find the level of integration. The ADF value test statistics is smaller than the critical values, null hypothesis is accepted. Alternatively, the probability values can be used. The KPSS test is a good complement to the ADF test, as Monte Carlo simulations have found that the ADF test has low powers in distinguishing between a unit root process and a near unit root process.

If the generation of a data series on a particular variable is likely to have been subject to structural changes, a Phillips – Perron (PP) test is used for checking stationery. Such a structural changes may be due to a policy regime. The PP test, which is a modification of the Dickey – Fuller test, allows for fairly middle assumptions of the distribution of the error term that is, it allows the disturbance to the weakly dependent and heterogeneously distributed.

Once both mean and variance constant over time in given time series it is said to be stationary variable or do not have unit root problem. This measure is more important in time series analysis to identify its behavior. Augmented Dickey–Fuller test and PP test are used to find unit root test.

The PP test is more suitable for data where structural breaks are appearing. So, the variables used in this study are more likely to verify from PP test. To run a vector error correction model variables should nonstationary, mostly integrated to order one I (1).

#### Hypothesis testing

$H_0$ : Non Stationary data series

$H_1$ : Stationary data series

Reject null hypothesis if  $t_{\text{calculated}} > t_{\text{critical}}$  Nonstationary Data series

Assume if is the time series,

Stationary at level  $\Rightarrow I(0) \Rightarrow X_t$

Stationary at 1st Difference  $\Rightarrow I(1) \Rightarrow X_t - X_{t-1}$



### 3.3.4. Johansen Cointegration Test

Cointegrating relationship may also be seen as a long run equilibrium. It is possible that cointegrating variables may move away from their relationship in the short run, but their relationship would return in the long run.

Cointegration captures the idea of a long-run dynamics of economic model. Variables are increasing over time but do not have far deviations from each other. Necessary conditions for cointegration,

$Y_t$ ,  $X_t$ , and  $X_{2t}$  are variables where all three  $I(1)$ .

$$Y_t = \beta_1 + \beta_2 x_t + \beta_3 x_{2t} + \hat{u}_t \quad (8)$$

Estimated Model

$$Y_t = \hat{\beta}_1 + \hat{\beta}_2 x_t + \hat{\beta}_3 x_{2t} + \hat{u}_t \quad (9)$$

Then

$$Y_t - \hat{\beta}_1 - \hat{\beta}_2 x_t - \hat{\beta}_3 x_{2t} = \hat{u}_t \quad (10)$$

$$Y_t - \hat{\beta}_1 - \hat{\beta}_2 x_t - \hat{\beta}_3 x_{2t} = \hat{u}_t$$

$$\begin{array}{ccccc} \uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\ I(1) & I(1) & I(1) & I(1) & I(0) \end{array}$$

For set of variables to be cointegrated all variables must be of the same order and there should be exist at least one linear combination such that the linear combination is  $I(0)$ .

Acceptance of cointegration leads to vector error correction model. Johansen Cointegration Test determines the number of cointegration equations. If trace statistics is higher than the critical value at 5 per cent / 1 per cent, then the hypothetical number of cointegration equations, which is the

null hypothesis, is rejected. In this case, the number of hypothesized cointegrating equations given by the next level/raw become significant.

### 3.3.5. Vector Error Correction Model (VECM)

Kim and Ivrendi, Guloglu in their research on determination of exchange rate volatility mostly used vector error correction (VECM) model. Where they proved most of the variables they select was basically stationary at first difference [6-11]. VECM is a restricted VAR that has cointegration restrictions built in to the specification. So this is designed for use with non-stationary series that are known to be cointegrated. Cointegration is identified as the error correction term as the variation from the long run equilibrium is adjusted slowly via the series of partial short run corrections.

According to Rao he said 'the statistical analysis of cointegration vectors developed by Johansen is definitely the most extensively applied approach [26, 27]. Models that use in this approach are known to be Vector Error Correction (VECM) or cointegrating VAR (CIVAR) models. VECM is a scaled down version of VAR model in which the structural coefficients are identified.

If the time series is not stationary then the VAR structure requires to be adjusted to allow consistent estimation of the relationships among the series. The vector error correction (VEC) model is a specific case of the VAR for variables that are stationary in their differences. Normally VECM detect the short-term properties of the cointegrated variables.

Three time-series variables  $y_t$ ,  $x_t$  and  $z_t$ .

Dynamic relationships to these two interrelated variables are,

$$\begin{aligned} y_t &= \delta_1 + \sum_{i=0}^n \beta_i y_{t-i} + \sum_{i=0}^n \alpha_i x_{t-i} + \sum_{i=0}^n \gamma_i z_{t-i} + v_t^y \\ x_t &= \delta_2 + \sum_{i=0}^n \beta_i y_{t-i} + \sum_{i=0}^n \alpha_i x_{t-i} + \sum_{i=0}^n \gamma_i z_{t-i} + v_t^x \end{aligned}$$

When  $y$  and  $x$  are not stationary in their levels, but stationary in 1st differences  $I(1)$ ,

$$\begin{aligned} \Delta y_t &= \delta_1 + \sum_{i=0}^n \beta_i \Delta y_{t-i} + \sum_{i=0}^n \alpha_i \Delta x_{t-i} + \sum_{i=0}^n \gamma_i \Delta z_{t-i} + v_t^y \\ \Delta x_t &= \delta_2 + \sum_{i=0}^n \beta_i \Delta y_{t-i} + \sum_{i=0}^n \alpha_i \Delta x_{t-i} + \sum_{i=0}^n \gamma_i \Delta z_{t-i} + v_t^x \end{aligned}$$

Short term fluctuations between interest rate (independent variables) and inflation and the exchange rate (Dependent variables) will generate long run relationship.

### 3.3.6. Residual Test

#### (i). Serial Correlation

When error terms from separate time phases or cross-section observations are correlated, it is known to be error term is serially correlated. Serial correlation appears in time-series investigations, where the errors coupled with a given time period carry over into future time periods. Use of incorrect functional form, neglect lag terms and manipulating time series data for smoothing purpose will impact on this statistical problem.

Breusch- Godfrey Test is much common method of

identifying serial correlation problem the regress the residual on the lagged residuals, multiply R-squared by  $N-1$ , and compare the resulting value of Chi-Squared under the null hypothesis, with the degrees of freedom equal to the order of serial correlation.

#### (ii). Heteroscedasticity

Disturbances are heteroscedastic when they have different variances. Heteroscedasticity usually arises in cross-sectional data when the explanatory power of the model varies over the observations. The errors are still assumed to be uncorrelated across observations. The reasons for such test is error learning models, violence of classical linear assumptions that incorrectly specified due to omitted variables, skewness of the distribution, incorrect data collecting techniques and incorrect data transformation.

The Breusch-Pagan test is very simple test of determining heteroscedasticity. There are three methods of correcting this error. If there is a specification error, eg. Omitted variables, then it can be corrected by correcting the specification.

### (iii). Normality Test

Tests which are testing for normality are built upon either on linking the empirical cumulative distribution with the theoretical normal cumulative distribution (Kolmogorov-Smirnov, Anderson-Darling, Chi-Square) or empirical quantiles with the theoretical normal quantiles (PPCC, Wilk-Shapiro). Conversely, the Jarque-Bera test is based on the sample skewness and sample kurtosis.

This test is only valid asymptotically, so it relies on obtaining a large sample size. Data sets, which are smaller than 100 observations must be cautious about using this test.

### (iv). F-Statistics

The F-Statistics tests the hypothesis that all of the slope coefficients (except the constant, or intercept) in the regression are zero. For OLS estimates the F-statistics computed as, Under the null hypothesis with normality distributed errors, this statistics has an F-distribution with K-1 numerator degrees of freedom and T-K denominator degree of freedom.

The P value given for the F-Statistics, indicated prob (F-statistics), is the marginal significance level of the F-Test. If the P value is less than the significance level the testing say at 5 percent level null hypothesis is rejected and all slope coefficients are equal to zero. F-Test is a joint test so that even if all the t-statistics are insignificant, the F-statistics can be highly significant.

## 4. Data analysis and Discussions

### 4.1. Econometric Analysis

#### 4.1.1. Unit Root Test

This study presents the unit test root test on each variable in order to test the stationary or non-stationary level of selected time series data. Since all three variables are subjected to structural changes, Phillips-Parron test is used to verify stationary. With reference to the following table unit root test proved all variables are stationary at 1st difference. So, because of test results all variables are stationary at 1st difference and suit for vector error correction model (Appendix 1 - Unit Root Problem in Data Series).

Table 4. Unit root test results.

Philips Perron test			
Variable		Level	First Difference
Inflation (INF)	Probability	0.2010	0.0201
	t- Calculated	-2.217414	-3.229133
	1% level <sup>xiii</sup>	-3.471987	-3.472259
	5% level	-2.879727	-2.879846
	10% level	-2.576546	-2.576610
Call market rate (CR)	Probability	0.1756	0.0000
	t- Calculated	-2.293417	-13.00963
	1% level	-3.477487	-3.477835

Philips Perron test			
Variable		Level	First Difference
Exchange rate (NEXR)	5% level	-2.882127	-2.882279
	10% level	-2.577827	-2.577908
	Probability	0.0605	0.0000
	t- Calculated	-2.802239	-8.024857
	1% level	-3.477487	-3.477835
	5% level	-2.882127	-2.882279
	10% level	-2.577827	-2.577908

#### 4.1.2. Lag Structure

Identified lag structure by generating unrestricted VAR for above three variables shown in table. With respect to the results generate from the criteria the selected lag order is 2.

Lower the value in each lag length criteria provides better model. According to the Ivanove, Kilian (2005) on their study on selection of lag length criteria for VAR models concluded, the AIC tends produce the most accurate implus response estimate for each sample size and further SC can reduce in mean squared error as major. For the vector error correction models the SC tends to be most accurate for all sample size. Hence all such criterias, FPE, AIC, SC and HQ suggests appropriate lag length for this model is two, the best fitted lag length is 2.

Table 5. VAR Lag Order Selection Criteria.

Endogenous variables: LNXR LCR LINF

Sample: 2000M10 2013M03

Included observations: 149

Lag	LogL	LR	FPE	AIC	SC	HQ
0	103.78	NA	4.41	-1.516	-1.450	-1.49
1	728.06	1211.00	4.23	-10.77	-10.51	-10.67
2	872.41	273.51	5.53	-12.80*	-12.35*	-12.62*
3	881.30	16.45	5.54	-12.80	-12.15	-12.54
4	888.6	13.19	5.69	-12.78	-11.93	-12.43
5	893.15	7.98	6.09	-12.71	-11.67	-12.29
6	896.99	6.59	6.60	-12.63	-11.39	-12.13
7	908.93	19.92*	6.33	-12.68	-11.24	-12.09
8	912.89	6.43	6.86	-12.60	-10.97	-11.94

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

AR root graph that all roots of AR characteristics polynomial of the series lay inside the unit circle which shows VAR is stationary<sup>xiv</sup>.

Table 6. AR Root Table.

Roots of Characteristic Polynomial

Endogenous variables: LNXR LCR LINF

Root	Modulus
0.98	0.98
0.3	0.94
0.3	0.94
0.91	0.91
0.31	0.31
0.05	0.05

No root lies outside the unit circle.

VAR satisfies the stability condition.

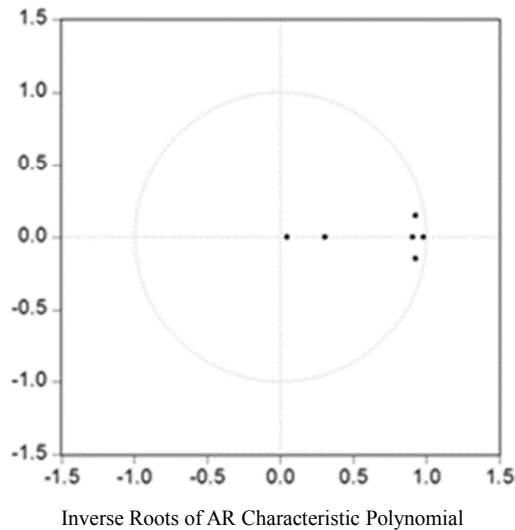


Figure 4. AR Root graph.

#### 4.1.3. Co-integrating Relations

Johansen cointegration test performed for I (1) variable

Table 7. Cointegration test results.

Sample (adjusted): 2001M02 2013M03

Included observations: 156 after adjustments

Series: LNEXR LCR LINF

Lags interval (in first differences): 1 to 2

Hypothesized		Trace	0.05	Max-Eigen	0.05
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Statistic	Critical Value
None *	0.15	33.96	29.80	22.83	21.13
At most 1	0.08	11.13	15.49	10.80	14.26
At most 2	0.00	0.33	3.84	0.33	3.84

Trace test indicates 1 cointegratingeqn(s) at the 0.05 level

\*denotes rejection of the hypothesis at the 0.05 level \*\*MacKinnon-Haug-Michelis (1999) p-values

#### 4.1.4. Unrestricted Vector Autoregressive Model – Impulse Response Function

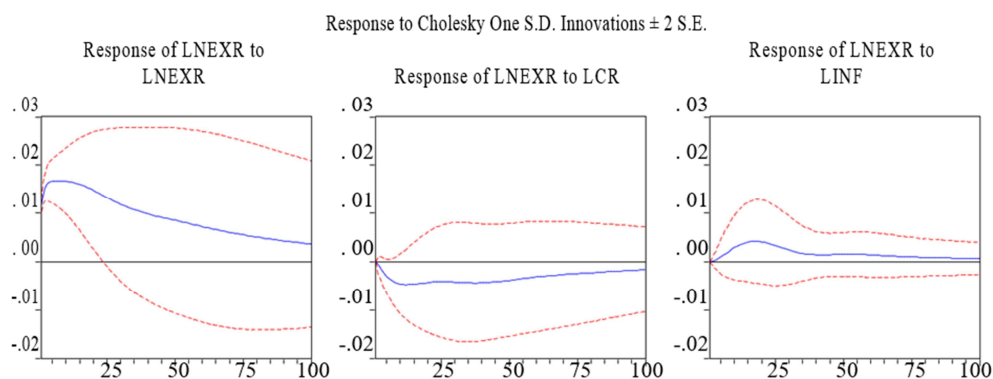


Figure 5. Impulse Response function.

Figure 5 elaborates the response of exchange rate to a standard deviation shock to the weighted average overnight call market rate and inflation. X axis denotes time period (up to 100 months) and y axis shows impulse sensitivity to the exchange rate. The graph shows the response of exchange rate growth has negative impact to the unit shock of interest rate. The impact maximizes at the level of 15 months and dies out

defined in the study. Trace statistic is higher than the critical value at 5 percent, where trace statistics indicates 1 cointegrating equation. It is proved that the Maximum –Eigen statistic, that the null is rejected at 5 per cent levels. This implies that there is a cointegrating relationship among the variables.

Nachega on his research on cointegration analysis of broad money demand accepts 1 percent level of cointegration which was strongly rejects null hypothesis [28]. Further he mentioned there are some evidences which accepts 10 percent level as well.

Kose to determine cointegration with inflation and interest rate the trace and maximum eigen value test statistics indicate that there is one co-integrating vector at the 10% significance level and there is one co-integrating vector at the 5% significance level to the maximum eigen value test which elaborate 5 percent level is accepted for this study to determine cointegration equation [29]. This indicates that there is a long-term relationship among the call rate inflation and exchange rate.

very slowly. Unit shock in inflation is positive and reaches maximum on 25th month. This shock also takes a long time to wave off. (Refer Appendix 2)

The study<sup>xv</sup> shows that the relationship between interest rates and the exchange rate is non-monotonic. In particular, the exchange rate reaction depends on the interest rate differentials and on the initial level. According to the previous study

Germany and US before 1990 having same impact where Sri Lanka having in interest rate shock to the exchange rate.

#### 4.1.5. Vector Error Correction Model

Given the above-mentioned variables are cointegrated, the next step is to estimate the VECM to study the short run dynamics of the system. Summary of the results of the VECM are presented as follows.

**Table 8. Vector Error Correction Estimates.**

Vector Error Correction Estimates

Sample (adjusted): 2001M02 2013M03

Included observations: 144 after adjustments

CointegratingEq:	CointEq1		
LNEXR(-1)	1.00		
LCR(-1)	2.80		
	(0.62)		
	[ 4.49]		
LINF(-1)	-1.38		
	(0.35)		
	[-3.99]		
C	1.10		
Error Correction:	D(LNEXR)	D(LCR)	D(LINF)
CointEq1	-0.003973	-0.033277	0.009423
	(0.00177)	(0.01109)	(0.00455)
	[-2.24994]	[-3.00016]	[ 2.07002]
D(LNEXR(-1))	0.351470	-0.772605	0.510616
	(0.08723)	(0.54790)	(0.22487)
	[ 4.02907]	[-1.41013]	[ 2.27070]
D(LNEXR(-2))	-0.125250	-0.131443	-0.398289
	(0.08848)	(0.55571)	(0.22808)
	[-1.41560]	[-0.23653]	[-1.74627]
D(LCR(-1))	-9.04E-05	0.050220	0.035213
	(0.01312)	(0.08238)	(0.03381)
	[-0.00689]	[ 0.60961]	[ 1.04144]
D(LCR(-2))	-0.012597	-0.199250	-0.011739
	(0.01296)	(0.08141)	(0.03341)
	[-0.97180]	[-2.44738]	[-0.35131]
D(LINF(-1))	-0.013859	0.558212	1.133030
	(0.03207)	(0.20143)	(0.08267)
	[-0.43214]	[ 2.77128]	[ 13.7052]
D(LINF(-2))	0.016635	-0.434681	-0.277284
	(0.03086)	(0.19380)	(0.07954)
	[ 0.53913]	[-2.24298]	[-3.48615]
C	-0.002887	-0.009561	-0.000535
	(0.00106)	(0.00664)	(0.00272)
e	[-2.73219]	[-1.44044]	[-0.19627]

The degree of each error correction term reveals how faster the deviation of each variable from long run equilibrium is corrected slowly towards the equilibrium level though a series partial short run adjustment. The error correction term has (-) sign where it is -0.004. The interpretation of this error correction term is that once the exchange rate deviates from the equilibrium value revealed by the fundamentals, the correction rate of the inflation rate is 0.4 percent on monthly basis. Comparatively, this is considered to be slow rate of adjustment.

The speed of return to the equilibrium of interest rate and inflation are 3.3 per cent and 1.0 per cent respectively. While signs of adjustment coefficients are positive in inflation and negative in interest rate. This implies that when inflation cases exchange rate to move away from the equilibrium rate

determined by the fundamentals, where interest rate to bring back to the equilibrium. This is the implication of having positive and negative values for the error coefficients. Coint. Equation's coefficients to be verified for the significance by running Ordinary Least Square Estimation. C (1) coefficient determines long run equilibrium or speed of adjustment toward long run equilibrium. Further C (2) to C (7) coefficients determine short run causality to the exchange rate by interest rate and inflation. The following table provides the details on significance of each coefficient in the required model.

**Table 9. OLS Estimate.**

Dependent Variable: D (LEXR)

Method: Least Squares

Sample (adjusted): 2001M02 2013M03

Included observations: 144 after adjustments.

27D(LEXR)=C(1)*(LEXR(-1)-2.79526523774*LCR(-1)+1.38162412399*LINF(-1) - 1.09904311107) + C(2)*D(LEXR(-1)) + C(3)*D(LEXR(- 2)) + C(4)*D(LCR(-1)) + C(5)*D(LCR(-2)) + C(6)*D(LINF(-1)) + C(7)*D(LINF(-2)) + C(8)				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.003973	0.001766	-2.249938	0.0261
C(2)	0.351470	0.087233	4.029069	0.0001
C(3)	-0.125250	0.088478	-1.415599	0.1593
C(4)	9.04E-05	0.013116	0.006891	0.9945
C(5)	0.012597	0.012962	0.971799	0.3330
C(6)	0.013859	0.032070	0.432144	0.6664
C(7)	-0.016635	0.030855	-0.539130	0.5907
C(8)	0.002887	0.001057	2.732192	0.0072
R-squared	0.194637	Mean dependent var		0.003635
F-statistic	4.488272	Durbin-Watson stat		1.902880
Prob (F-statistic)	0.000166			

#### (i). Long Run Relationship

From the error correction model to identify the long run and short run causality among variables the significance coefficient must be take into consideration. Since C (1) coefficient is negative in sign and significant at the level of 5 per cent it proves that there is a long run causality among independent variables towards dependent variable. Further, Rathanasiri according to study on inflation determination he considered 10 percent level also as significant [4].

#### (ii). Short Run Relationship

By performing Wald test to find short run causality among variables the outcome is as follows, in the model equation assuming coefficients relates to LCR is zero.  $H_0: C(4)=C(5)=0$ .

**Table 10. Wald Test for Call Rate.**

Test Statistic	Value	df	Probability
F-statistic	0.472234	(2, 130)	0.6247
Chi-square	0.944468	2	0.6236
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(4)		9.04E-05	0.013116
C(5)		0.012597	0.012962

According to the results Chi-square probability 0.6236 which is greater than 0.05 level we cannot reject null

hypothesis where it proves  $C(4) = C(5) = 0$  and there is no short run relationship/causality with call rate with exchange rate. Considering the inflation as second independent variable,  $H_0: C(6) = C(7) = 0$ .

**Table 11.** Wald Test for Inflation.

Test Statistic	Value	df	Probability
F-statistic	0.157747	(2, 130)	0.8542
Chi-square	0.315494	2	0.8541
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(6)		0.013859	0.032070
C(7)		-0.016635	0.030855

**Table 12.** Breusch-Godfrey Serial Correlation LM Test.

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	2.295083	Prob. F(2,128)	0.1049
Obs*R-squared	4.777451	Prob. Chi-Square (2)	0.0917

By observing Obs R-squared probability Chi-Square which is 0.2794, greater than 0.05 level says there is no Heteroskedasticity in the model.

#### Normality Test

0.8324 probabilities from Jarque-Bera statistics proves again residuals are normally distributed (Appendix 3).

With such conclusion on above three residual tests it proves that the model doesn't exist any statistical errors. VECM output can be interpreted as following equation. This exhibits the relationship of exchange rate, inflation and interest rate of Sri Lanka during the period of October 2000 to March 2013.

$$LNEXR = -2.80LNCR + 1.38LNINF + 1.10 \quad (11)$$

By considering t-statistics it proves that coefficients are significant. Coefficients are in logarithmic scale where it shows in percentage. According to the output, 1.00 per cent appreciation of weight average call market rate decreases exchange rate by 2.80 per cent where there is negative relationship. Similarly, one percent growth of inflation appreciates the exchange rate by 1.38 percent.

Even though these parameters do not exist short run relationships the long run relationship can be seen in the model. The similar results generated by the Kim in US market indicate that the US producer price index, dollar exchange rate, aggregate income, M2 money supply, and interest rate have a long-run equilibrium relation, even though they behave like random walks individually. But his cointegration estimates show that the inflation and the exchange rate are negatively related where the sign is converse to this study. It is further established that there is a significant causal relationship from the exchange rate to inflation [6].

Similar situation in cross country analyzed by the Utami, Inanga exhibited different cases in each country. Regression results for the period of 2003 – 2008, explain that interest rate differentials have positive but no significant influence on changes in exchange rate for the USA, Singapore, and the UK relative to that of Indonesian where it is the similar situation in Sri Lankan context as well. Further, interest rate differentials

As same as in the previous output Chi-square probability is 0.8541 which is greater than 0.05 level Null hypothesis is not rejected and can conclude that there is no short run relationship with exchange rate and inflation.

#### (iii). Model Verification

There are three statistical analyses (Residual Tests) to perform to verify does model exist any statistical errors or not. Instead of those two, the probability of the F-statistic (0.000166) is very significant.

#### Serial Correlation

Performing Breusch-Godfrey test

have negative significant influence on alterations in exchange rates for Japan. Regression results also show that, overall, inflation rate differentials have positive significant impact on interest rate differential [7].

Cointegration results generated from the Malaysia for the period of 1999 – 2009 elaborated the completely opposite signs for both independent variables. But similar to these results it also proves that there is a long-term relationship between the interest rate, inflation and interest rate.

The studies by Rana and Dowling indicate that foreign inflation is the largely influencing element in describing the change in local price levels in nine less-developed countries of Asia in the period 1973-79 [9]. Kashif concluded there is an insignificant and a negative link between inflation and exchange rate of USD and Pakistani Rupee [11]. But the results generated by Ahmad and Ali for the same research problem converse to the results generated by the Kashif [30, 11].

## 5. Conclusion

### 5.1. Summary on Econometric Analysis's Findings

According to the IS-LM model in certain fixed economic variables, in open capital account higher domestic interest rate attract foreign capital inflow to the country which leads appreciation of domestic currency. The outcome of the 1 percent increase of domestic interest rate 2.80 percent decrease in foreign exchange rate can be seen. The higher the interest rate, the lower the USD/LKR value or appreciate the domestic currency which is in line with the model which is suitable under open capital account small economy.

The outcome of such a scenario is capital inflow which means foreign currency inflow to the domestic money market appreciates the domestic currency. This relationship is further proven by the overall increasing trend in annual foreign direct investments during the past decade. Recently, Securities Investment Accounts (SIA) have shown an increasing trend.

Some limitations imposed by the government to the foreign investors on domestic securities would reduce participation, which should be more relaxed. But to maintain the foreign exchange rate at a desirable level the central bank has to intervene in the market. Which results, increase in money supply to sterilize excess foreign currency from the market. This mechanism is costly, but capital inflow is 67 risky on one hand where such scenario must be taken place in a country where they expect rapid development.

In practical world interest rate is not the only factor which leads to an increase in capital inflow. Countries political stability, stable economic parameters, regulations, and investment opportunities directed increase in quality and quantity of the capital inflows.

The relationship between the exchange rate and inflation is positive as per the cointegration equation. The theory of Purchasing Power Parity put emphasis on that “under free international trade, perfect information and free-floating exchange rate the prices of traded goods, when expressed in a common currency, are equalized across two countries”. While at the macro level the theory predicts a clear-cut relationship between nominal exchange rate and domestic and world price levels.

According to such theory it says increasing domestic price level decreases the exchange rate assuming constant level of foreign exchange rate. But the results generated from the model say it has positive relationship in Sri Lankan case. As a rule, a country with a consistently lower inflation rate exhibits a rising currency value, as its purchasing power increases relative to other currencies.

Genberg on his findings said ‘central bank intervention on exchange rate control can be viewed as able to move market opinions, albeit in a way which is different for two markets’ [31]. Which can be elaborate as, intervention on the domestic money market by the central bank deviates the market expectation. Whereby, it changes price level expectation, which leads to actual price level. This phenomenon can be the major reason to the outcome of the contrasting sign for the inflation. Further because of some fatal external and internal shocks appeared to the inflation may distort the acceptable relationship over exchange rate.

Speed of adjustment is significant. But it takes fairly long time to adjust to the equilibrium level. Some short run variables are not significant to the given variables called those variables are weakly exogenous.

## **5.2. Macroeconomic Environment and Research Findings**

As a whole both domestic and global macroeconomic environment has undergone a enormous revolution during the period of 2000 to 2013. Mainly in global context most of the countries have undergone financial crisis since 2007 it almost considered as depression. In the domestic arena it was mostly on sudden inflationary shocks like oil price boom, T-Sunami natural disaster, critical period of latter part of internal

conflict and structural problems arisen from some financial institutions.

Those factors wildly hit macro-economic variables in Sri Lanka. At a glance it shows almost 40 percent depreciation in LKR compared to USD and volatility of price levels, interest rate and foreign reserves. Further balance of payment figures showed the external sector developments as well.

With such a uncertain period in the long run the relationship between the exchange rate and interest rate exist at a significant level where it elaborate effective policy measures taken by the central bank. Further since we are in a way of rapid growth the price level change over exchange rate movement also accepted.

## **5.3. Policy Measures over Findings**

The inverse relationship with the exchange rate and the interest rate shows it creates a favorable environment to capital inflow which is an achievement for a developing country. According to that even though Sri Lanka need to maintain lower interest rate or monetary easing to accommodate economic growth it is necessary to facilitate foreign investment opportunities as well. So, the monetary policy decision should cover that part as well. Further liberalization of exchange control regulations to enhance capital account openness will create more attractive domestic investments.

But the most important part is to address the risk arising from such investments. For that regulatory authorities must be capable of designing macro prudential risk control policies to neutralize such risk with minimum shock to the financial market.

Inflation as the other dependent variable it is much more difficult to manage inflationary pressure with rapid growth. But by performing efficient monetary operations the Central bank can achieve such price stability. Rather than intervene in the foreign exchange market directly now it is time to seek alternative policies which manage the exchange rate. Hence policy makers should pay more attention to monetary and financial stability integration. Efficient management of each sector will generate an opportunity to make impossible trinity in foreign investments a possible trinity.

With the current political stability and speedy development after the war, lots of foreign inflows are expected. Depending on the above information the intervention to the exchange will be abridged and it will generate the correct relationship with the inflation and interest rate in future.

## **5.4. Further Studies**

For future studies, researchers can attempt to use panel data and cover longer study duration of above 10 years by using other variables under different exchange rate regimes.

## Appendix

### Appendix 1. Unit Root Testing

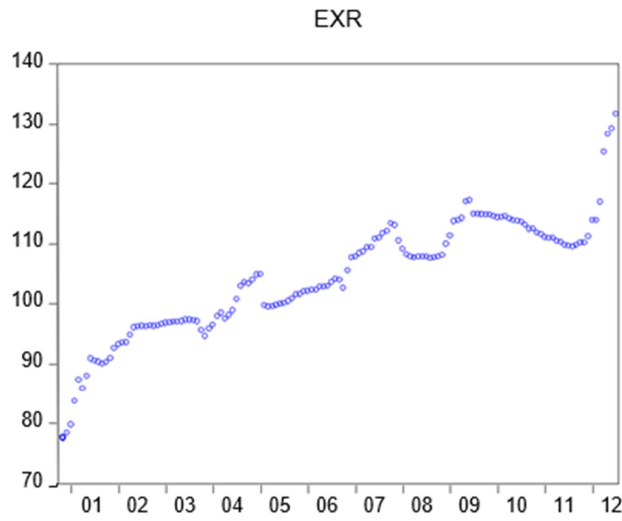


Figure 6. Exchange Rate Movement at level –nonstationary.

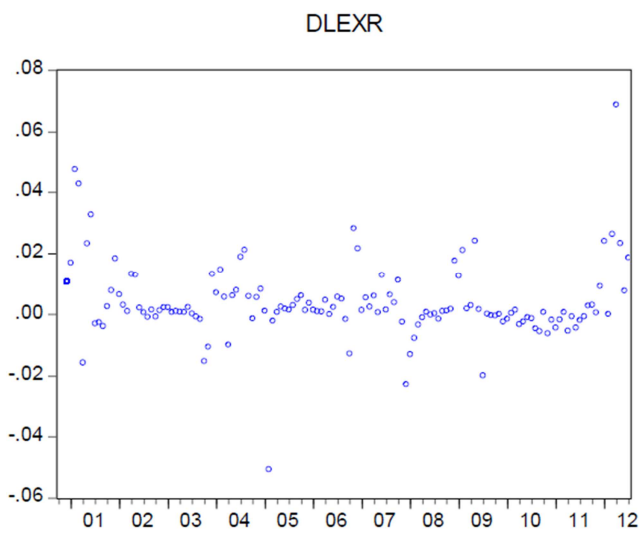


Figure 7. Exchange Rate Movement at 1st – stationary.

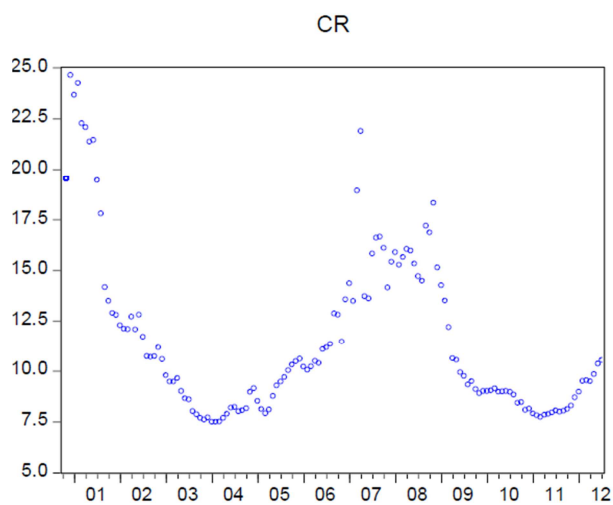


Figure 8. Call Rate Movement at level –nonstationary.

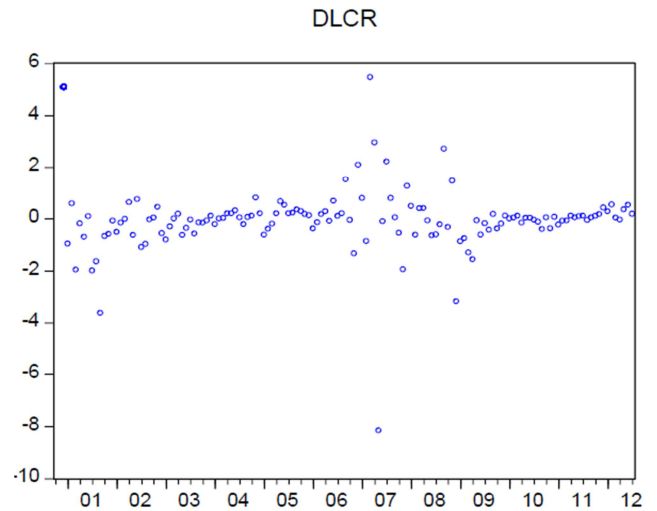


Figure 9. Call Rate Movement at 1st – stationary.

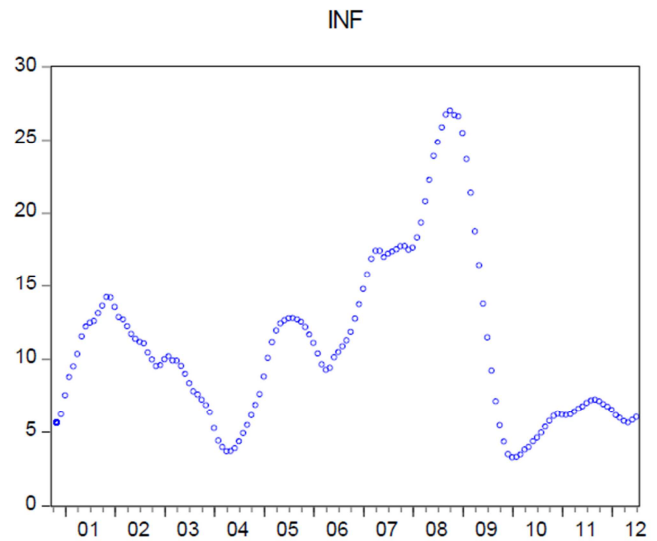


Figure 10. Inflation Movement at level –nonstationary.

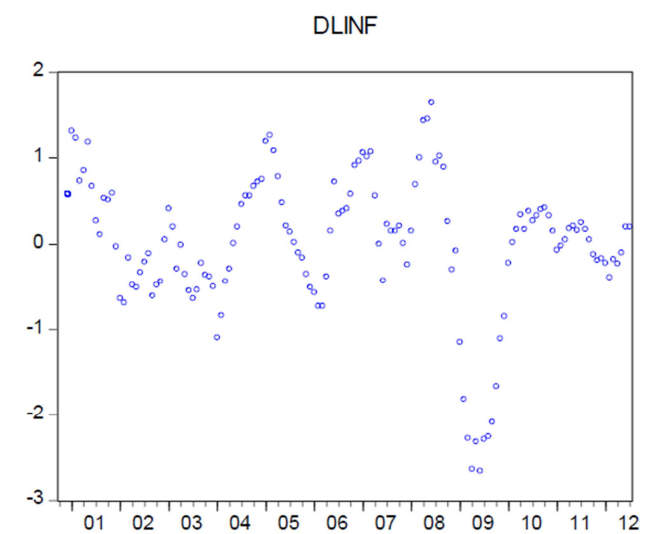
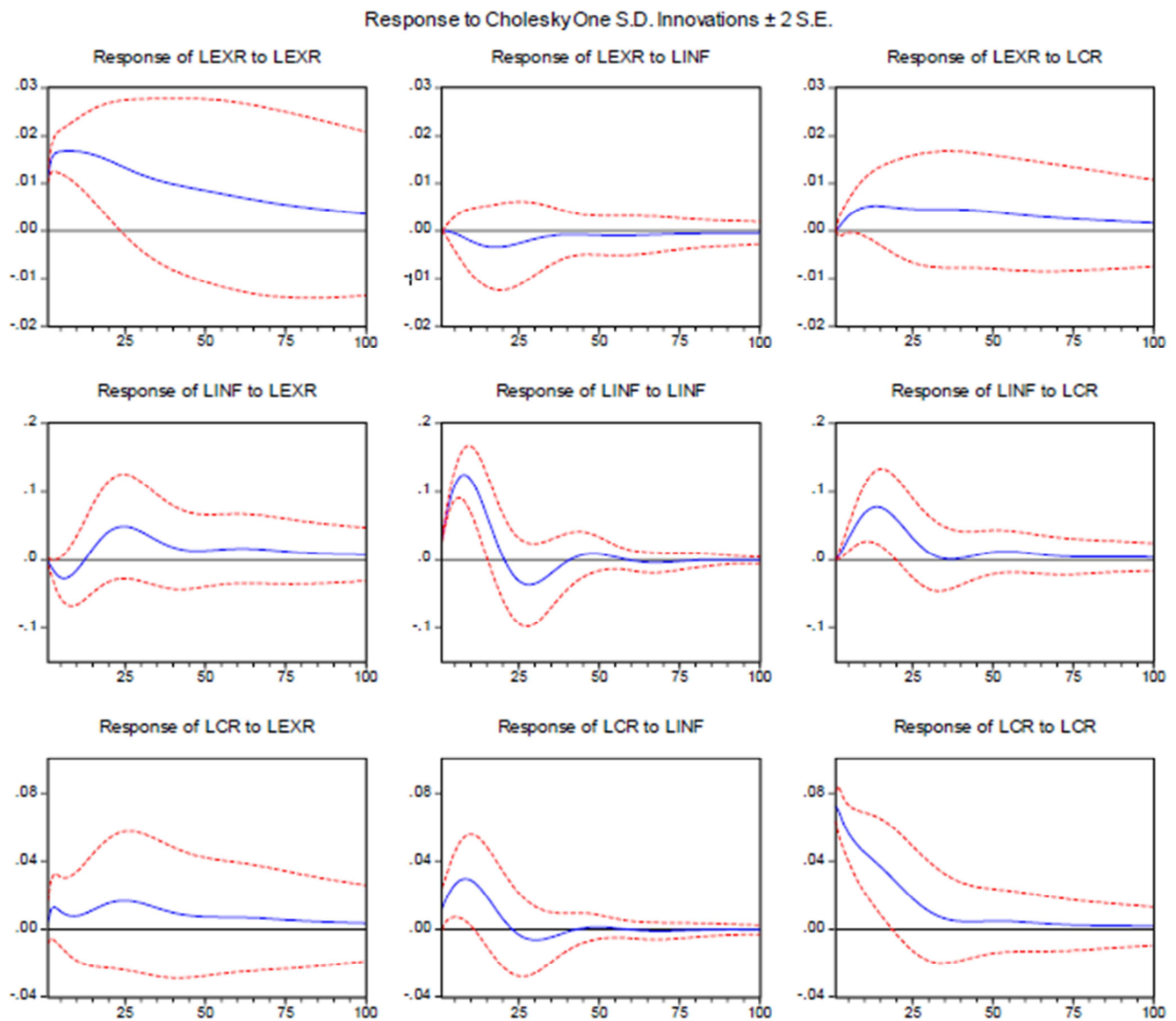
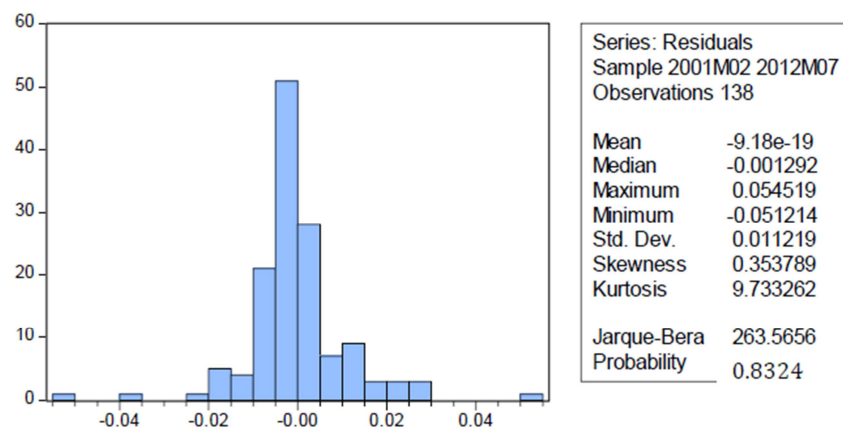


Figure 11. Inflation Movement at 1st – stationary.

**Appendix 2. Impulse Response Function-Unrestricted VAR****Figure 12.** Impulse Response Function-Unrestricted VAR.**Appendix 3. Normality Test****Figure 13.** Normality Test.



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i Further break down on IFE and its implications can be found under Exchange Rates, Interest Rates, and Inflation Rates in Indonesia: The International Fisher Effect Theory by Siti Rahmi [7].

ii Under Utami (2009) considered following countries Australia, New Zealand,

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Canada, Sweden, United Kingdom for his study.

iii Cavoli (2008) used Developing economies of Asia to elaborate his study on exchange rate rules and monetary policy.

iv Policy rates announce by the Central Bank of Sri Lanka on their monetary policy reviews – Standing Deposit Facility Rate and Standing Lending Facility Rate.

v landmark system for monetary and exchange rate management established in 1944. The Bretton Woods Agreement was developed at the United Nations Monetary and Financial Conference held in Bretton Woods, New Hampshire, from July 1 to July 22, 1944.

vi Exchange-rate regimes are the way an authority manages its currency in relation to other currencies and the foreign exchange market. It is closely related to monetary policy and the two are generally dependent on many of the same factors.

vii Exchange rate regimes and intervention by the central bank is included in the study on Exchange rate economics by Mac Donelds (2007) in detail.

viii  $MV = PYM$ : Money supply/demand, V: Velocity of circulation (the number of times money change hands) P: Average price levels Y: GDP.

ix 11 Basic four exchange rate theories were considered by Charles van Marrewijk (2005) on his study in detail to analysis of euro area.

x External sector development and foreign exchange rate position is explained under Chapter II, Central Bank of Sri Lanka Annual Report - 2013

xi The inter-bank call money market is an overnight market and mainly serves commercial banks in meeting their immediate liquidity maintenance by lending and borrowing as well as to cover up their required reserve. Hence, an important task of the call money market is to facilitate liquidity management in the economy. Weighted average call market rate considered as market signaling rate since it is highly sensitive to the policy rate changes.

xii Standard deviation is a statistical term that measures the amount of variability or dispersion around an average.

xiii Significant levels are given as 1%, 5% and 10% where for this study it uses 5% as the significant level.

xiv The Main Determinants of Inflation in Sri Lanka A VAR based Analysis by H. P. G. S. Ratnasiri.

xv Interest rates and exchange rates: A non-monotonic-tale by Viktoria Hnatkovska, Amartya Lahiri, Carlos A. Vegh (2008 April).