



TEST OF UNCOVERED INTEREST RATE PARITY FOR SRI LANKA- EVIDENCE FROM LKR/GBP RATE

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ABSTRACT

Interest rates and exchange rates are considered to be one of the most discussed areas under International Finance. When considering the main theories that explore on these two variables, Uncovered Interest Rate Parity (UIP) states that the interest rate differential is an unbiased predictor of the spot exchange rate changes. The impact on investors' attitude is that they would be indifferent towards the returns on domestic and foreign assets denominated in same currency thereby eliminating any short term arbitrage profits. Studies based on the relationship between these two variables are rare for developing countries like Sri Lanka. Therefore in order to bridge that gap identified through search for literature, this study is focused on testing UIP for Sri Lanka. The findings reveal that there is no evidence to prove the existence of UIP for the British Pound and the Sri Lankan Rupee.

KEY WORDS: Autoregressive Distributed Lags (ARDL) Model, Exchange Rates, Interest Rates, Uncovered Interest Rate Parity (UIP).

JEL: F31,F41,P45

1. INTRODUCTION

In an integrated financial system, global fund transfers are an apparent feature. Hence it is reasonable to expect efficiency in financial markets and the existence of active investors who respond to the pricing inefficiencies.

The theoretical explanation of the relationship between the exchange rates and interest rates comprise of Covered Interest Rate parity (CIP) and UIP. CIP Theory suggests that the forward premium associated with a foreign currency would be equal to the interest rate differential between risk free investments denominating the currencies. This assumes that the forward market is used to cover against the foreign exchange rate risk. Uncovered Interest Rate Parity Theory assumes that the investors are risk neutral and the forward market would not be used

simultaneously to cover against the foreign exchange rate risk. Therefore it is an equilibrium market condition where there is no opportunity for arbitrageurs. Investors would be indifferent towards the returns on domestic and foreign assets when denominated in same currency.

In an economic setting where UIP is found to hold, it implies of free capital movement among countries and subsequently the absence of exchange rate risk. Active investors would always seem to move their funds to investment opportunities: be it another country that yield a higher rate of return. Also the study of the relationship between forward exchange rates and interest rate differential becomes significant in determining the effectiveness of derivatives priced with forward exchange rates as a mode of capital investment.

The direction of foreign exchange rates between major trading partner, UK and Sri Lanka have been analyzed in this study in order to test whether insights could be drawn from interest rates for forecasting the future foreign exchange rates. The focus is to analyze the ability of interest rates to forecast the currency rates that would be important in trade with the world.

The organization of the paper is as follows. The next section provides a discussion about the existing literature on UIP. Section 4 describes the methodology adopted with including the theoretical derivation of UIP. Section 4 explains the data used for the estimation. Section 5 presents results and finally section 6 gives the conclusion.

2. RESEARCH PROBLEM AND OBJECTIVES

The main objective of this study is to test the UIP condition for Sri Lankan context and therefore to examine whether interest rates could be used as a tool in determining the foreign exchange rates for the major currencies involved highly in generating export income and import expenditure.

The research question had been decomposed into objectives systematically as follows.

- To examine the relationship between the interest rate differentials and the appreciation or depreciation of the expected exchange rate between British Pound and the Sri Lankan Rupee.
- To examine the relationship between the UIP forecasted exchange rates and the actual exchange rate between British Pound and Sri Lankan Rupee.

3. REVIEW OF LITERATURE

Some of the researchers have adapted a macroeconomic approach to analyze exchange rates. The other method used in the analysis of exchange rates is the incorporation of variables that were used in time series analyses in other studies.

Random Walk Model is widely used as a univariate model due to its wide availability and simple predictions. Most of the researchers have concluded that the exchange rate forecasts have shown mixed results with justifying a simple random walk model. (Meese and Rogoff, 1983). In contrast, the argument of Savickas, Guo (2005) using quarterly data is that random walk model does not hold for the exchange rates. Multivariate models have been used often by researchers when analyzing the liberalized exchange rate policies and monetary policy actions of Emerging Market Economies (EMEs). Researchers like Calvo and Reinhart (2001 and 2002) and Eichengreen

(2005) have shown that there are differences evident in the analysis of advanced economies and emerging economies. These differences were identified as credibility problems, high rate of exchange rate pass through, liability dollarization, non stationarities in the inflationary process etc. EMEs are responsible for exchange rate flexibility up to a small degree. Bansal and Dahlquist (2000) have found that the UIP works systematically better for developing countries while for developed countries the UIP hypothesis is generally rejected.

The findings of the researchers reveal that the degree of exchange rate pass through is higher for EMEs than that for the advanced economies. It was also revealed that the trend in exchange rate pass through is recorded to be comparatively lower for Asian countries and to be higher in Eastern and Central Europe and Latin America. Shreshtha, A. (2005) found that UIP could exploit only a smaller variation in exchange rate changes for advanced nations such as Japan and no evidence was found for proving that UIP holds.

Basurto G. and Ghosh A. (2000) have conducted a study on the sharp exchange rate depreciations in the East Asian Crisis. The study revealed that tight monetary policies are associated with the appreciation of exchange rates in the countries under concern. (Indonesia, Korea and Thailand). The finding was that during the Mexican crisis, although the governments tightened the monetary policies, the exchange rates have continued to depreciate. They also unveiled that there is little evidence to say that a higher interest rate contributes to a widening of the risk premium.

Zhang J. and Dou Y. (2010) have revealed that the use of IRP generally works well in forecasting foreign exchange rates and the forecasting ability has been depleted in recent years when compared to the previous years..

Dharmadasa, C. (2010) has carried out a study regarding the Sri Lankan context covering the period from January 1990 to December 2011 using the Generalized Method of Moment (GMM) estimation. The outcomes revealed that UIP condition does not hold for Sri Lankan context. Nirmalee H. and Rajapakse R P C R(2016(b)), used monthly data on exchange rates and three month risk free

interest rates with regard to the United Kingdom for the period from 2001-and found that there is no evidence to prove the existence of UIP for the selected currency compared against the Sri Lankan Rupee.

After a careful study of the literature Nirmalee H. and Rajapakse R P C R(2016(a)), found that there exists a research gap for the Sri Lankan context on the conduct of studies concerning the involvement of exchange rates and economic variables like interest rates particularly for developing countries. Only a limited number of studies are available for analyzing the UIP for Sri Lankan context. (Dharmadasa C. (2010); Weerasinghe, et al. (2006); Sivaramasingham, et al. (2012); Nirmalee H. and Rajapakse R P C R(2016(b)).

4. METHODOLOGY - DATA COLLECTION

Secondary data on foreign exchange rates between LKR/GBP were collected from 2001 to 2014. monthly average of foreign exchange data and three month treasury bills rates to represent interest rates were used.

Foreign exchange rates were collected from the website www.usforex.com and interest rates were collected from International Financial Statistics.

4.1 Derivation of Uncovered Interest Parity

The derivation of UIP had been done based on the Covered Interest Parity (CIP) Condition. The derivation is based on the assumptions of unbiasedness, rational expectations of investors and risk neutrality assumptions. The CIP condition could be expressed as below.

$$f_t^n - s_t = i_t^d - i_t^* \dots \dots \dots (1)$$

Where f_t^n is the natural logarithm of forward exchange rate for maturity in n number of periods, s_t being the natural logarithm of spot exchange rate at time t , and, i_t^d and i_t^* are domestic and foreign interest rates respectively. Although the covered interest parity condition is not a reality in practice, it should be assumed to hold regardless of the investor perspective or preference.

If the investors are risk averse, then the forward rate would necessarily contain a risk premium to compensate for the future risks and it is depicted by the following formula

$$E_t s_{t+1} - s_t = i_t^d - i_t^* - \mu_{t+1} \dots \dots \dots (2)$$

Where, s_{t+1} is the logarithm of future spot exchange rate, E_t represents expectations of

future exchange rate at time t and μ_{t+1} is the future risk premium.

The assumptions upon which the study is based on could be utilized for the formation of the UIP condition. Risk neutrality is one of the assumptions and it could be illustrated as follows.

$$\mu_{t+1} = 0$$

Rational expectations hypothesis could be illustrated as follows.

$$s_{t+1} = E_t s_{t+1} + \varepsilon_{t+1} \dots \dots \dots (3)$$

The derivation of UIP is subsequently arrived by substituting equation (2) to (3).

$$s_{t+1} - s_t = i_t^d - i_t^* + \varepsilon_{t+1} \dots \dots \dots (4)$$

The following equation is then derived for the UIP testing purposes.

$$\Delta s_{t+1} = \alpha + \beta (i_t^d - i_t^*) + \varepsilon_{t+1} \dots \dots \dots (5)$$

Δs_{t+1} is used to denote the logarithm of exchange rate yield or the percentage change in exchange rate changes, i_t^d denotes domestic interest rate and i_t^* denotes the foreign interest rate. The term α represents the intercept term and β represents the sensitivity of local interest rate to foreign interest rates.

The procedure of testing is based on the hypothesis testing where the null hypothesis:

$H_0: \alpha = 0$ and $\beta = 1$. In order to assure that UIP holds, the slope coefficient should be significantly negative.

The above formulae could be considered as the UIP relationship. Further, UIP is assumed to be a perfect assumption for financial markets with no capital restrictions. In this study, it is assumed that the countries in the sample have minimum capital restrictions. Although the capital account of the country is partially open to the world, the fact that Sri Lanka is a South Asian Developing country brings forward that it has minimum barriers to other countries in the capital flows. Based on this judgment, the UIP condition is tested for Sri Lankan context.

4.1.1 Autoregressive Distributed Lags Model

Stationarity of the data were checked using Augmented Dickey- Fuller (ADF) test and The Philips- Perron (PP)² test. The results reveal that the Exchange rate differential for USD are trend stationary I(0) and the interest rate differentials are integrated of order one I(1) and it compelled to choose an ARDL model to explain the relationship between the exchange rate differential and the interest rate differential.

To decide on the number of lags best suited for the model the study conducts models of lags 6 ,

lags 4 and lags 2 and check the Akaike Information Criterion (AIC) and the Schwarts Criterion (SC) . The best model is the one that gives the least value for the AIC and SC. Test is proceeded to check for the stability of this model (CUSUM test). According to the model, the

$$\text{LS D(LYGB) C D(LYGB(-1)) D(LYGB(-2)) D(LYGB(-3)) D(LYGB(-4)) D(LIRDGB(-1)) D(LIRDGB(-2)) D(LIRDGB(-3)) D(LIRDGB(-4)) LYGB(-1) LIRDGB(-1)}$$

A Wald test is conducted in order to test the long run relationship of the variable and having the following hypothesis (4 lags) in the case of GBP.

$$H_0: C(10) = C(11) = 0$$

$$H_1: C(10) \neq C(11) \neq 0$$

This was tested by using the Pesarans Bound Test at 5% significant level. (Lower bound 3.79 and upper bound 4.85). Depending on the outcome we run the long run models in order to understand the long run association of the variables.

$$LYGB = \alpha + \beta LIRDGB$$

Consequently, residuals of the model would be incorporated in order to decide on the speed at which the variables will come back to long run equilibrium, and subsequently test for the short-run causality between the exchange rate differential and the interest rate differential by applying a Wald test for the variables as follows for the GBP.

$$H_0: C(6) = C(7) = C(8) = C(9) = 0$$

number of lags appropriate for USD was 6 lags. The equation generated by the E Views software as shown below.

The equation generated by the E Views software as shown below.

$$H_1: C(6) \neq C(7) \neq C(8) \neq C(9) \neq 0$$

Finally a CUSUM test would be run in order to check the stability of the model.

5. ANALYSIS

5.1 Descriptive Statistics

5.1.1 Descriptive Statistics - Excess Returns

As a part of descriptive statistics, an informal approach was used to test the presence of UIP as per Ray (2012). In this case, excess returns are considered which is considered as below.

$$\{(i_{t,k}^* - i_{t,k}^d) - \Delta s_{t,t+k}\}$$

The equation shows the interest rate of currency k at time t. it could be observed that the excess returns are stable over time, it could be inferred that UIP holds and if excess returns are not stable over time, it could be inferred that UIP does not hold. The movement of the excess returns for the GBP is given below.



Figure 1: Monthly Excess Returns for GBP

The movement of the excess returns over time does not show stable condition relating to GBP and there is high volatility in excess returns throughout the time period considered.

5.1.2 Descriptive Statistics - Interest rate differentials and exchange rate yields

The interest and exchange rate differentials are compared with using the graphical approach. It

could be inferred that UIP holds if the two differentials are inversely related and if they are directly related, it would show that UIP does not hold.

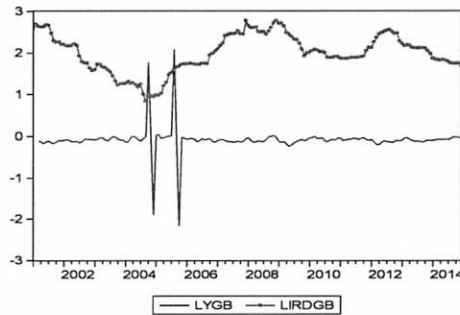


Figure II: Interest Rate Differentials and Exchange Rate Yields- UK

This relationship shows the existence of UIP but it could not be significantly identified from the graph if a close look is not given. The relationship had been not very strong especially between mid 2004 and 2006 where a huge appreciation occurred due to foreign inflows that resulted from inflows of funds for post Tsunami programs.

5.1.3 Descriptive Statistics - Actual Exchange Rates and UIP Forecasted exchange rates

Graphical approach is employed here. The forecasted exchange rate had always been higher than the actual exchange rate for the GBP. The movements of the forecasted rate coincide with the movements in the actual rate. This direct relationship is an average condition and it is not clearly distinguishable from the graph. This shows that UIP holds on average but not very strongly for the GBP.

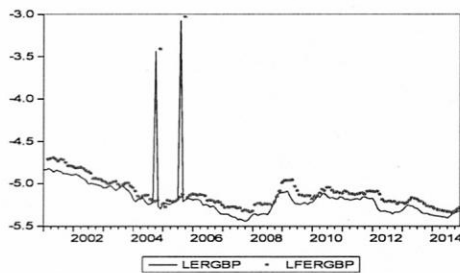


Figure III: Actual and Forecasted Exchange Rates- LKR/GBP

5.1.4 Descriptive Statistics on Interest Rates

When considering the interest rates of UK, taken on the 168 monthly observations, the mean interest rate had been 2.724643 with a maximum of 5.79 and a minimum of 0.22. This shows the heavy variation caused in interest rates during the period 2001-2014 with a standard deviation of 2.086397.

The maximum Sri Lankan interest rate was recorded as 21.30000 in December 2007 and the minimum was 5.740000 with an average of 10.79268. The range shows that there had been huge volatility during the period under concern which is also evident from the standard deviation figure of 3.965278. The reason behind the huge fluctuations could be attributed to many reasons such as the economic instability due to the war effects, natural disasters such as Tsunami etc.

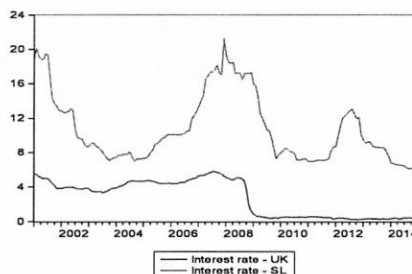


Figure IV: Interest Rate Behavior

5.1.5 Descriptive Statistics on Exchange Rates

The maximum and the minimum exchange rates between UK and Sri Lanka had been 0.046163 and 0.004332 respectively with a

median of 0.005437. The standard deviation is lower at 0.003840 showing low volatility over the sample period. The volatility rate of the exchange rate between Sri Lanka and UK is high as shown by the standard deviation of 0.003840.

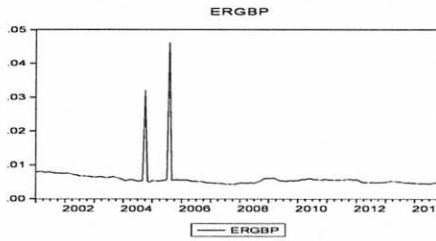


Figure V: Exchange Rate Behavior

5.2 Correlation Analysis

Pearson correlation coefficient between the exchange rates forecasted and the actual exchange rates (.027) is weak but positive. This shows that there is a positive relationship between the actual and forecasted exchange rate. But the relationship is weak. Since the significance (.727) is greater than 0.05, it could be concluded that there is no statistically significant correlation between two variables.

When considering the differentials of interest rates and exchange rates, Pearson correlation is weak and negative (-.102). There is a negative relationship. Therefore when the home interest rate increase, home currency depreciates and vice versa. But the relationship is weak. It was also notified that there is no statistically significant correlation between two variables because the significance (.192) is greater than 0.05.

5.3 Autoregressive Distributed Lags Model (ARDL Model)

5.3.1 Test of Stationarity

The following table examines the stationarity of the variables.

Table 1: Test of stationarity

Interest Rate Differential								
Augmented Dickey Fuller Test				Phillips-Perron Test				
Level Test	Critical value at 5%	First Difference	Critical value at 5%	Level Test	Critical value at 5%	First Difference	Critical value at 5%	
GBP	-1.8686	-2.87882	-9.28746	-2.8788	-1.814	-2.878	-9.6555	-2.8788
Exchange Rate Yields								
Augmented Dickey Fuller Test				Phillips-Perron Test				
Level Test	Critical value at 5%	First Difference	Critical value at 5%	Level Test	Critical value at 5%	First Difference	Critical value at 5%	
YGBP	-9.4628	-2.87972	-9.62650	-2.8800	-9.462	-2.878	-9.6265	-2.879

Source: Author's own estimations

Augmented Dickey Fuller Test and Phillips-Perron Test (PP)² had been used here. Decisions were made following the null hypothesis (H₀) of presence of the unit root and the alternative hypothesis (H₁) of stationarity. It is expected that three variables i.e. domestic interest rates, foreign interest rates and exchange rates are to be integrated order I(1) and interest rates differentials and exchange rate yields should be at order I(0). The hypotheses are as below.

H₀: series has unit root & H₁: series has no unit root

According to the statistics, the interest rate differentials are not stationary in the level form and it becomes stationary only when the first difference is tested. The case is different with the exchange rate yields and it becomes stationary in the level form itself as shown in theory. Therefore the alternative hypothesis is being rejected in the level form test done for exchange rate yields while it is rejected in the first

difference case with regard to the interest rate differentials for all of the currencies.

With considering this feature, the most suitable analysis model for the study had been identified

as the Autoregressive Distributed Lags (ARDL) Model.

The choice of the best number of lags for the ADRL Model for GBP had been justified as shown below.

Table II: Akaike info criterion and Schwarz criterion for LKR/GBP

Number of Lags	Akaike info criterion	Schwarz criterion
6	0.247475	0.536694
4	0.209958	0.440596
2	0.310784	0.443645

Source: Author's own estimations

The Akaike information criterion shows the minimum value when four lags are incorporated into the model and the Schwarz criterion shows its minimum value at four lags. The results are consistent in the two models and thus the study

chooses four lags for the estimation model. The model for estimating the association between the interest rate differential and exchange rate yields could be represented in the linear format as below.

$$\gamma = \alpha + \beta x_n + \varepsilon$$

$$\gamma = 0.105139 + 0.105139 x_1 + 0.43379x_2 + 0.460422x_3 - 0.006601x_4 - 0.178499x_5 - 0.091090x_6 - 0.474690x_7 - 0.201642x_8$$

In the equation, the last two variables are aimed at the long run association and the first four variables are aimed at testing the short run association. First, the long run association would be tested.

5.3.2 Long run Association

The long run association between the variables: the interest rate differential and the exchange rate yield would be tested using the method of least squares. The Wald Test is used for testing the significance of the long run model. The Wald Test was used to test the significance of the coefficients.

Wald test here is used to test the joint significance of a subset of coefficients, namely, interest rate differentials and exchange rate

yields with respect to GBP. These two variables are individually insignificant based on t-tests with very high p values. But being cautious, the study tests the joint significance of them using Wald test.

Pesarans critical value at 5% level unrestricted intercept and no trend is 3.79 in lower bound and upper bound value is 4.85. Since the F statistic (31.05) is more than the upper bound value, it paves the way to reject the null hypothesis. The two variables depict a long run relationship and thus move together in the long run.

The identified association for the long run is then tested with using an ordinary least squares approach with the aim of identifying the causal relationship between the variables.

$$LYGB = 0.031725 - 0.057042 (LIRDGB)$$

(t = 0.29) (t = -1.068048)

The regression result shows that there exists a negative relationship as defined by UIP. Constant is not zero. (Therefore reject null hypothesis that constant equals to zero). Slope is different from one. (Therefore reject the null hypothesis that slope equals to one).

T statistic is greater than 0.05 for the coefficient. Therefore the results are insignificant. T statistic for the slope of the equation is less than the level of significance and hence it is significant. R squared is low indicating that the level of explanation of the changes in dependent variable by the changes in the independent variable is very low. F test measures the overall significance of a multiple regression model or a test of significance of R squared. Therefore the model is significant. The probability of the model being insignificant is 28.9%.

Durbin Watson statistic is used to see whether the variables in the model are co integrated. It suggests about the long run relationship between the variables. According to Durbin Watson statistic, there is evidence for the non-existence of first order serial correlation.

5.3.2 Impact of Residuals within the model

Before examining the short run association between the interest rate differentials and exchange rate yields, the significance of the residuals within the model had been identified.

Table III: Long run model with the impact of residuals- GBP

Dependent Variable: D(LYGB)				
Method: Least Squares				
Included observations: 160 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.105139	0.095202	1.104379	0.2712
D(LYGB(-1))	1.146083	0.208119	5.506852	0.0000
D(LYGB(-2))	0.433791	0.172981	2.507731	0.0132
D(LYGB(-3))	0.460422	0.118580	3.882794	0.0002
D(LYGB(-4))	-0.006601	0.079375	-0.083160	0.9338
D(LIRDGB(-1))	-0.178499	0.286576	-0.622868	0.5343
D(LIRDGB(-2))	-0.091090	0.297987	-0.305685	0.7603
D(LIRDGB(-3))	0.474690	0.297195	1.597237	0.1123
D(LIRDGB(-4))	0.201642	0.291116	0.692651	0.4896
LYGB(-1)	-2.109747	0.247526	-8.523329	0.0000
LIRDGB(-1)	-0.139057	0.049028	-2.836314	0.0052
ECT(-6)	-0.227930	0.079344	-2.872673	0.0047
R-squared	0.685310	Mean dependent var		0.000725
Adjusted R-squared	0.661921	S.D. dependent var		0.445864
S.E. of regression	0.259246	Akaike info criterion		0.209958
Sum squared resid	9.946834	Schwarz criterion		0.440596
Log likelihood	-4.796604	Hannan-Quinn criter.		0.303612
F-statistic	29.30041	Durbin-Watson stat		1.983091
Prob(F-statistic)	0.000000			

Source: Author's own estimation

The value obtained for the ECT variable is negative and is justified with a high R squared of 68.5% and an adjusted R squared of 66% which could be considered as a precise estimation. Here most of them are insignificant and it does not mean that model is bad they are cointegrating as shown from the F statistic in the previous table so they are found to be effecting each other in long run. The Durbin Watson statistic is 1.983091. DW table value is 1.791 in the upper bound. Computed value in the model is higher than table value. Considering all these factors,

this model could be assumed to have minimum influence by the residuals and thus could be considered as a good model. 22.7% is the speed of adjustment to long run equilibrium.

5.3.3 Short run Association

Short run association would be tested with using the Wald test done for the interest rate differentials. It assumes that the coefficients are zero and the test is run with keeping it as the null hypothesis.

LYGB = 0.000431	-	0.674911 (LIRDGB (-1))	-	0.239036 (LIRDGB (-2))
(t=0.012573)		(t=0.012573)		(t=0.012573)
+1.195299 (LIRDGB (-3))	-	0.472356 (LIRDGB (-4))		
(t=2.461609)		(t=-1.008107)		

The null hypothesis states that c(6)= c(7)= c(8)= c(9)=0. Null hypothesis cannot be rejected and hence the variables do not have a relationship in the short run. The whole system gets adjusted towards the long run equilibrium at the speed of 22% at an outcome of the ARDL having lag 4.

The probability of the F statistic is high implying that the model best explains the variables included in it. Wald Test is used to test whether the coefficient is significant. The null hypothesis tested here is whether the coefficient is equal to zero. F statistic is greater than the test

statistics estimated in the Wald Test. Therefore it could be concluded that the coefficient is not equal to zero. This could be taken for concluding that a short run association does not exist among the interest rate differentials and the exchange rate yields.

5.4 CUSUM Test- LKR/GBP

The CUSUM Test tests the level of stability in the model. The result shows that there is no issue of recursive residuals in terms of mean and in terms of variance.

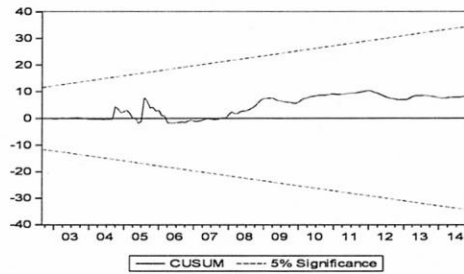


Figure VI: CUSUM Test- GBP
Source: Author's own calculations

6. SUMMARY AND CONCLUSIONS

The aim of this research was to test the UIP for GBP/LKR. The overall test results show a rejection of UIP hypothesis within the given time frame for GBP /LKR. This is in line with the previous findings. ARDL model shows no relationship between the two variables either in the short run or in the long run implying that UIP condition between interest rate and exchange rate is weak.

Several implications can be drawn from this study. The conclusion that the interest rates do not cause the foreign exchange rates implies of an arbitrage opportunity between Sri Lanka financial market and the United Kingdom financial market considered in the study. This conclusion is based on the assumption of zero risk premium and perfect capital mobility.

When considering the actual situation, there are many controls and also the risk premium in Sri Lanka is high as perceived by potential investors mainly due to the terrorist environment existed half way through the selected time frame. That could make investors reluctant to invest into the Sri Lankan money market, leading to abnormal returns among few investors to be present even though the extraordinary profit could be made in interest arbitrage.

The fact that the Sri Lankan financial markets are not well developed and the existence of the macroeconomic disturbances such as the instability in the financial markets due to the partial opening of the capital account to the outside world has been major reasons for the lower predictability of the exchange rate. The underlying cause for the disequilibrium had been the information asymmetry.

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