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ON THE LINKAGES BETWEEN EXCHANGE RATE, INFLATION AND INTEREST RATE IN MALAYSIA: EVIDENCE FROM AUTOREGRESSIVE DISTRIBUTED LAG MODELING

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ABSTRACT

To make broader policy decisions and have an economic glimpse, macroeconomic linkages are pertinent to the policy makers and the economists. The proper understanding of these interactions guides the monetary authorities to synthesize the appropriate monetary policy as well the as the political regimes to adopt feasible fiscal policy. Realizing the crucial importance of exchange rate, inflation and interest rate in an economy, this study investigates the interaction between the exchange rate and, inflation and interest rate in an important economy of Southeast Asia, Malaysia. Employing autoregressive distributed lags (ARDL) approach to co-integration and vector error correction model (VECM), we investigate the null hypothesis (H_0) of no long run relationship as well the direction of the causality in case of rejection of (H_0) in prior case. The findings suggest that the long run relationship is present between the interest rate and exchange rate, and inflation and exchange rate. Exchange rate experience the positive influence from interest rate whereas negative from inflation. Moreover, there is unidirectional causality from inflation and interest rate towards exchange rate.

KEYWORDS

Exchange rate; Interest rate; consumer price index; Granger Causality; ARDL.

1. INTRODUCTION

Opting appropriate policy for macroeconomic stability and optimal efficiency in the economy is much dependent on the economic system and the structure of the economy. The health of the economy originates from these economic systems and structures and can be observed through key macro-economic variables like gross domestic product, inflation rate, unemployment, etc. However economy, being a broader perspective, it is very difficult to promote or halt certain variables without the prior knowledge of the consequences of focusing or ignoring some certain macro-economic variables on the economy as a whole. To understand the whole economic system is very mystified and require much effort to comprehend the web of complex linkages among the macro-economic variables. Some economists argue that if we have in-depth comprehension of such complex linkages, we can avoid worse episodes like recent financial crisis (2007-2008) by taking preventive measures in advance. Speaking literally it is not simple to unveil the current complex economic system where individuals' households have freedoms in their choices and making a decision which are not always following economic theories based on the science of rationality.

To ease the thing and make what is attainable, instead of calming on complexity, the other way out is to consider the few important macro-economic variables and contemplate on the complex nexus among those few variables. This is the reason, that policy makers and economists are interested in understanding the relationship among only important macro-economic variables. For instance, the exchange rate is somewhat more evaluated, observed, and controlled measure of economic health of the economies and literature is numerous to spotlight its importance. After the downfall of Breton Woods fix exchange rate regime system, some economies opted the free exchange rate regime while others, particularly developing economies hesitated to adopt a full float exchange rate regime. Therefore, they introduce interventions in currency markets to keep their currencies stable. However, this lead to some very critical issues like currency speculations and ineffectiveness in market based mechanisms. On the other hand, float exchange rate lead to uncertainty and have some serious impacts on international trade. Either free float exchange rate regime is supportive or suppressing to international trade needs some research support for a particular economy. Therefore, the point is to understand the relationships between different important macro-economy variables to make appropriate policies. Current research following this strand, attempt to understand the relationship between the exchange rate, interest rate, and inflation in the Malaysian economy context. We postulate that understanding the interactions between these three variables is very helpful in the policy making.

In the last two decades, the Malaysian economy has experienced volatile and surged economic situations. In the early 1990s, the economy experienced growth in capital inflows and vibrant economic activities, however, then came the adverse advent of 1997-98 Asian economic crises. Consequently, speculative issues arose in the currency market and volatile capital outflows occurred. Again in the early 2000's, reviving after the Asian financial crisis, the economy again experienced surge in economic activities and huge inflows leading to a current account surplus. However, then economy suffered from another financial crisis (2007-08) originated from the US. To cope with these issues, Bank Negara Malaysia tried different exchange rate regimes starting with an open capital account and a managed float system by imposing limit on selective capital accounts and on the fixed exchange rate regime during Asian financial crises. This step improved the capital inflows and steadily this control the capital was lifted in 2000 and reinstated the managed floating system to deal with the considerable inflow of capital (Lim & Goh, 2011).

To attain certain policy goals, it is very essential to understand the key forces in place in that context. For example, to curtail exchange rate fluctuations, its determinants are targeted, which include inflation and interest rate among many others (Madura, 2007). To devise proper policy therefore requires the proper understanding of the way these variables interacts with exchange rate and how exchange rate relates with these variables. The exposure to the nexus among the key variables (e.g. exchange rate, interest rate, inflation) is very important especially in the context of Malaysia where volatile situations are quite often as highlighted in the earlier passage. The purpose of this study is therefore to investigate the causal nexus of exchange rate, interest rate, and inflation through state-of-the-art methodology of autoregressive distributed lag modelling. The outcomes of the study would unearth the misalignment in nature of the relationship of exchange rate and its determinants from theory to practice, which would facilitate the associated stakeholder in formulating the policy approaches.

The organization of the remaining parts of the study is as follows. The next section provides a survey of empirical literature. Section 3 elaborates the research methodology, Section four offers stylized results. Section 5 concludes the paper.

2. LITERATURE REVIEW

Many scholars have examined the relationship between interest rate and exchange rate, but they could not reach consistent results. Hooper and Lowery (1979) illustrated the empirical representations, denoted that there is the short term and long-term relationship between these variables. When the exchange rate becomes an escalating function of the interest rate then high interest rate policy positively affect the spot exchange rate in the country. Sargent and Wallace (1981) concluded that high interest rate policy might directly boost up price level and decrease the currency demand. Furthermore, increase in the interest rate entails a surge in government liability. Resultantly, there will be depreciation of the exchange rate. Likewise, Hutchison and Pigott (1984) examined the association between exchange rate and interest rate for the purpose to discover its influence on budget deficiency. The study utilized Co-integration and Granger causality techniques to probe the association and conclude that increase in interest rate affect exchange rate positively. Sachs (1985) utilized granger causality analysis of inflation and exchange rate and found that there is a bi-directional relationship between these variables as they respond strongly to each other.

In another study, Allender and Adrangi (1995) explored the long run relationship between interest rate and exchange rate by utilizing Granger causality. Similarly, Deme and Fayissa (1995) conducted a study on the relationship between exchange rate and inflation in different countries like Egypt, Tunisia, and Morocco using annual data for the period of 1964-93. They found granger causality in Morocco but not in Egypt and Tunisia. The study of (Conway et al., 1998) analyzed that variations in exchange rate leads to further changes in inflation rate. In addition, a boost in interest rate can unfavorably influence the potential export performance, which will reduce the potential flows of foreign exchange reserves and hence, causes depreciation of exchange (Furman and Stiglitz, 1998). Kim (1998) acknowledged that there is some sort of association exists between inflation and interest rate. Furman and Stiglitz (1998) conducted a study in nine developing countries for the period of 1992-98 and analyzed the influence of a boost in inflation, interest rate, and other non-monetary issues on the exchange rate. The study concluded that higher interest rate was connected with a successive depreciation of exchange rate, although the consequence was more obvious in the countries with low inflation compared to countries with higher inflation.

Hasio (1999) investigated the gap in practice and theory by arguing that practically not all the determinants of exchange rate influence as these acknowledged in theory. The outcomes of the study discovered that even in the high interest rate period the worth of money did not increase in developing countries of Asia. Simon and Razzak (1999) presented a study on the relationship between variations in interest rate and fluctuations in exchange rate, and found that there is a constructive and significant connection between interest rate and fluctuations in exchange rate. Chow and Kim (2004) stated that most of the Asian countries do not utilize the interest rate program effectively to provide movement in the exchange rate after Asian crises of 1997. The study established no association between exchange rate and interest rate. Furthermore, Simpson et al. (2005) concluded that if the movements in inflation of the two countries are similar the positive variation in exchange rate is observed, but as compared to other country, domestic inflation continues to be low. Arshad and Zubair (2005) concluded that there is a relationship between inflation and interest rate. The study further analyzed that income distribution has a long-term direct association to exchange rate and money circulating in Pakistan. In addition, there is a common movement between exchange rate and interest rate, and understandings depend on the financial structure of the country. There are low co-movements between interest rate and exchange rate in the country having tough financial structure (Holtemoller, 2005).

Exchange rate, inflation and monetary policy trends have been viewed as a cohesively interactive economic mechanism. For example, Maswana (2005) illustrated the associations between exchange rate, monetary growth, and the price during the high inflation period in the Congo economy and found that exchange rate Granger caused inflation. Similarly, Ito and Sato (2006) found that there is a short term and unidirectional association between exchange rate and inflation rate in developing economies. Gul and Ekinci (2006) investigate the association between the interest rate and inflation utilizing high-frequency data of interest rate and inflation for Turkey. Their investigation provides an evidence of the long-term association between interest rate and inflation. However, the results denote that a causal association happened merely in one trend from interest rate to inflation exclusive of reverse causation. Ito and Sato (2006) reported that discrepancies in inflation and variations in exchange rate are interconnected.

3. METHODOLOGY

The variables involved in this study are exchange rate, inflation, and interest rate of Malaysia. This study use consumer price index (CPI) as a proxy for inflation over the annual period 1990-2011. The data of variables of interest is retrieved from World Development Indicators (WDI) published by World Bank. Stationarity of time series being an important issue, a battery of unit root tests are employed. We use dickey fuller, Phillips-Perron (PP) and Ng-Perron unit root tests to determine the stochastic or temporal dynamics in the series

The equation of dickey fuller is given as

$$\Delta Y_t = \alpha Y_{t-1} + (\text{constant, time trend}) + \mu_t \tag{1}$$

where Δy_t is the first difference of y whereas, y_{t-1} is the first lag of y. In the above equation u_t is the error term in the model. However, the problem with the dickey fuller test is that the error term u_t may contain serial correlation. In this case, the Dickey Fuller test would not give the accurate results about the stationarity of the given series. Therefore, in order to overcome this problem the lag differenced terms of y are introduced in the model given below termed as Augmented Dickey Fuller Test

$$\Delta y_t = \alpha y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + (\text{constant, time trend}) + \mu_t \quad (2)$$

where Δy_t is the first difference of y, whereas y_{t-1} is the first lag of y. Δy_{t-i} is the lag differenced terms of y in the Equation (2). In the above equation u_t is the error term which has been corrected for serial correlation. Therefore, ADF test is AR(p) process not an AR(1) process which may pose treat to the choice of exogenous variables in the ADF equation and number of lags used to overcome the serial correlation. In the next step, Phillips-Perron (PP) unit root test was used

$$\Delta Y_t = \alpha Y_{t-1} + (\text{constant, time trend}) + \mu_t \quad (3)$$

where Δy_t is the first difference of y, whereas y_{t-1} is the first lag of y and u_t is the error term corrected for serial correlation and heteroskedasticity by modifying the t_α statistic of ADF test. The modified PP test statistic is

$$Z_a = t_a \left(\frac{\gamma_o}{f_o} \right) \frac{1}{2} - \frac{T\left(f_o - \gamma_o\right)\left(SE\left(\hat{\alpha}\right)\right)}{2 f_o^{\frac{1}{2}} s} \quad (4)$$

The hypotheses in the ADF test are $H_0 : \alpha = 0$ $(Series\ have\ unit\ root)$ and $H_1 : \alpha < 0$ (The series does not have unit root. The one advantage of using PP test is that it removes the serial correlation and heteroskedasticity in the error term u_t, and no need to choose the lag length in PP test. In third step, The Ng-Perron unit root test is used to confirm the unit root existence for a small sample thus yielding consistent and reliable results. Four statistics are used in the Ng-Perron unit root test Modified PP Z_α, Modified PP Z_t, R1 statistic of Bhargava (1986) and ERS point optimal statistic with decision criteria of Ng-Perron statistics > C.V (critical value)

$$MZ_a^d = \frac{\left(T^1 y_T^d\right)^2 - f_o}{2k} \quad (5)$$

$$MZ_t^d = MZ_a * MSB \quad (6)$$

$$MSB = \left(\frac{k}{f_o} \right)^{1/2}$$

$$MZ_T^d = \frac{\left(c^{-2}k - \overline{c}T^1\right)\left(y^d T\right)^2}{f_o} \text{ if } x_t = \{1\} \quad (7)$$

$$MP_T^d = \frac{\left(c^{-2}k + \left(1-\bar{c}\right)T^1\right)\left(y^d T\right)^2}{f_o} \Rightarrow \text{if } x_t = \{1, t\} \quad (8)$$

$$k = \sum_{t-2}^{T} \frac{\left(y_{t-1}^d\right)^2}{T^2} \Rightarrow \bar{c} = -7 \text{ if } x_t = \{1\} \Rightarrow \bar{c} = -13.5 \quad (9)$$

if $x_t = \{1, t\}$.

3.1 Autoregressive Distributed Lag (ARDL) Bound Testing Approach to Cointegration

To find out the long run relationship among exchange rate, inflation and interest rate, various approaches are available in the literature e.g. Engle-Granger (1987) cointegration, Johansen (1990) cointegration, Autoregressive Distributed Lag proposed by Pesaran et al. (2001). However, we use ARDL bound testing approach to cointegration over other methods because ARDL can be applied regardless of the order of integration of the variables i.e. whether they are I(0) or I(1) or fractionally integrated and the model can estimate the short run and long run coefficients simultaneously. The unrestricted error correction model (UECM) of study as follows;

$$\Delta ER_\tau = \alpha_1 + \alpha_{ER} ER_{t-1} + \alpha_{INF} INF_{t-1} + \alpha_{INT} INT_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta ER_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta INF_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta INT_{t-k} + \mu_t \quad (10)$$

$$\Delta INF_\tau = \beta_1 + \beta_{INF} INF_{t-1} + \beta_{ER} ER_{t-1} + \beta_{INT} INT_{t-1} + \sum_{i=1}^{p} \beta_i \Delta INF_{t-i} + \sum_{j=0}^{q} \beta_j \Delta ER_{t-j} + \sum_{k=0}^{r} \beta_k \Delta INT_{t-k} + \mu_t \quad (11)$$

$$\Delta INT_\tau = \gamma_1 + \gamma_{INT} INT_{t-1} + \gamma_{ER} ER_{t-1} + \gamma_{INF} INF_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta INT_{t-i} + \sum_{j=0}^{q} \gamma_j \Delta ER_{t-j} + \sum_{k=0}^{r} \gamma_k \Delta INF_{t-k} + \mu_t \quad (12)$$

where $\alpha_{ER}, \alpha_{INF},$ and α_{INT} are the long run estimates whereas α_i , α_j , and α_k are the short run dynamics . ER represent exchange rate, INF represent inflation while INT represent interest rate. Δ is a difference opereator and μ_t is an error term. $\Delta ER_{t-j}, \Delta INF_{t-j}$ *and* ΔINT_{t-j} represent first differenced lagged terms of exchange rate, inflation and interest rate respectively. Meanwhile, the Lag length is calculated using SIC criteria because this method gives the most parsimonious lag length. To find out the cointegration, Wald test of joint significance was applied by testing the following hypothesis $H_0\colon \alpha_{ER} = \alpha_{INF} = \alpha_{INT}$ =0 implies (no long run relationship, $H_1\colon \alpha_{ER} \neq \alpha_{INF} \neq \alpha_{INT} \neq 0$ (have a long run relationship)

There are two asymptotic bounds given by Pesran et al. (2001) to find out the cointegration among the variables. If the estimated F-statistic is above the upper bound then the null hypothesis of no cointegration is rejected and incase F-statistic is below the lower bound the null hypothesis is not rejected. If the F-statistic is in between lower and upper bound then there is no conclusive proof of cointegration among the variables. Once the long run relationship is established through the bounds testing, we calculated the long run estimates by regressing the following equation;

$$ER_t = \alpha_1 + \sum_{i=1}^{p} \alpha_i ER_{t-i} + \sum_{j=0}^{q} \alpha_j INF_{t-j} + \sum_{k=0}^{r} \alpha_k INT_{t-k} + \mu_t \quad (13)$$

whereas,

$$B_{CONSTANT} = \frac{\alpha_1}{\left(1 - \sum_{i=1}^{p} \alpha_i\right)}$$

$$B_{INF} = \frac{\sum_{j=0}^{q} \alpha_j}{\left(1 - \sum_{i=0}^{p} \alpha_i\right)} \text{ and } B_{INT} = \frac{\sum_{k=0}^{r} \alpha_k}{\left(1 - \sum_{i=1}^{p} \alpha_i\right)} \quad (14)$$

The short run estimates are calculated using error correction model

$$\Delta ER_t = \alpha_1 + \sum_{i=1}^{p} \alpha_i \Delta ER_{t=i} + \sum_{j=1}^{q} \alpha_j \Delta INF_{t-j} + \sum_{k=1}^{r} \alpha_k \Delta INT_{t-k} + ECT_{t-1} + \mu_t \quad (15)$$

where ΔER_t is the first difference of exchange rate, $\Delta ER_{t-i}, \Delta INF_{t-j}$ *and* ΔINT_{t-k} are first differenced lag terms of exchange rate, inflation and interest rate respectively. μ_t is the error term. While ECT_{t-1} is the speed of adjustment from the short run to long run. α_j , α_k are the short run coefficients that tell the impact of inflation and interest rate on exchange rate in the short-run. Consequently, we executed, Serial correlation, Normality, Arch heteroskedasticity and White heteroskedasticity and Ramsay reset tests to make sure assumptions are persistent. To check the stability of the long run parameters CUSUM and CUSUMQ test are applied with the criteria that if the plot of statistic is between the 5% critical bounds, then the model passes the long run parameter stability test.

3.2 Vecm Granger Causality

If the long term relationship is established among exchange rate, inflation and interest rate, then we proceed with the vector error correction model to check the causality direction both in the short run and long run. In equation 16, $(1-L)$ is the difference operator while ECT_{t-1} is the first lag of error correction term. The significance of t-statistic of error correction term is used to check the long run causality while the short run causality is checked by finding the joint significance of first differenced lag variables.

$$(1-L)\begin{bmatrix} ER_t \\ INF_t \\ INT_t \end{bmatrix} = \begin{bmatrix} \phi 1 \\ \phi 2 \\ \phi 3 \end{bmatrix} + \sum_{i-1}^{p} (1-L) \begin{bmatrix} \alpha_{11i} & a_{12i} & a_{13i} \\ b_{21i} & b_{22i} & b_{23i} \\ c_{3i1} & c_{32i} & c_{33i} \end{bmatrix} \begin{bmatrix} ER_{t-i} \\ INF_{t-i} \\ INT_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon 1 \\ \varepsilon 2 \\ \varepsilon 3 \end{bmatrix} \left\lfloor ECT_{t-1} \right\rfloor + \begin{bmatrix} u1 \\ u2 \\ u3 \end{bmatrix} \quad (16)$$

4. RESULTS

In a time series modelling, detecting unit root in a stochastic process that involves the autoregressive statistical model is important since it diagnoses the dynamics of a series for model errors. In investigating the causal nexus among inflation, exchange rate, and interest rate, as a first step, unit roots tests are employed. The Table 4.1 provides the results for ADF, PP and Ng-Perron unit root tests. The results of ADF and PP unit root tests indicate that exchange rate, interest rate, and inflation are stationary at the first difference at 1% significance level. While the results based on the Ng-Perron test indicate that exchange rate and inflation are stationary at the first difference at 5% significance level while interest rate is stationary at the first difference at 1% significance level. Summarizing the unit root results, all the variables of interest are integrated at I(1) order.

Table 4.1
Results of the ADF, PP and Ng-Perron unit root test.

	ADF	PP	Ng-Perron				
	I(1)	I(1)		MZa	MZt	MSB	MPT
ER	-4.358*	-4.518*	ΔER	-2.175**	-1.748	0.580	12.529
INF	-6.456*	-3.854*	ΔINF	-12.512**	-2.558	0.201	1.477
INT	-3.952*	-9.567*	ΔINT	-17.557*	-2.012	0.598	1.985

*Note: * and ** show significance at 1% and 5% levels respectively, Δ first difference operator, Whereas, ER represents exchange rate, INF represents inflation and INT represent interest rate.*

Table 4.2
VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-15.411	NA	0.001	2.045	2.194	2.066
1	38.744	84.243*	1.05e-05*	-2.971	-2.378*	-2.889
2	44.624	7.186	1.66e-05	-2.624	-1.586	-2.481
3	48.934	3.830	3.75e-05	-2.103	-0.619	-1.899
4	68.757	11.013	2.30e-05	-3.306*	-1.377	-3.040*
5	-15.411	NA	0.001	2.045	2.194	2.066

*Note * 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*

In a second step of our analysis, we selected the lag length using different techniques as reported in Table 4.2. Lag order is selected using Vector auto regression (VAR) lag order selection criterion. The results in Table 4.2 indicate that LR, FPE, and SC criterion are in favor of lag order 1 while AIC and HQ are in favor of lag order 4. As the Schwarz information criterion (SC) gives, the most parsimonious lag order and LR and FPE are also supporting the result of SC so the finally selected one lag order for our analysis.

Table 4.3
Results of ARDL Cointegration Test

Variables	**ER**	**INF**	**INT**
F-statistics(Wald test)	6.899**	4.789	3.153
[a]Critical values	1% level	5% level	10% level
Lower bounds	6.34	4.87	4.19
Upper bounds	7.52	5.85	5.06
[b]Critical values			
Lower bounds	5.333	3.710	3.008
Upper bounds	7.063	5.018	4.150
R^2	0.730	0.608	0.526
Adj-R^2	0.586	0.352	0.305
F-statistics	3.188*	2.668**	3.356*

*Note: *, ** and *** show the significance at 1%, 5% and 10% level respectively. [a] Critical values bounds are from Pesaran et al. (2001) with unrestricted intercept and unrestricted trend. [b] refer critical values by Narayan (2005) for small samples.*

Table 4.3 indicates the results of ARDL cointegration test. In the first step, the exchange rate is taken as dependent variable to see the convergence over independent variables (Inflation and interest rate) and subsequently uses wald test. The resultant F-statistic (F_{stat}=6.899) is greater than the 5% upper bound value (i.e. 5.018). Therefore, the statistics shows that there is a long run relationship among the exchange rate, interest rate, and inflation. The results of inflation equation also reject the null hypothesis of no long run relations at 10% level of significance. However, the results of having a long run relationship is inconclusive in case of interest rate equation.

Table 4.4
Long-Run and Short-Run Analysis

Short-run results				**Long-run results**		
Constant	**ΔINF**	**ΔINT**	ECM_{t-1}	**Constant**	**INF**	**INT**
1.122(1.021)	-1.122 (-2.021)*	4.865 (3.021)*	-.074 (-3.715)*	6.823 (15.537)*	-.465 (-4.858)*	.375 (3.377)*
Diagnostics tests						
Test	F-statistic					
χ2 normal	.665(.225)					
χ2 serial	.265(.486)					
χ2 arch	.765(.654)					
χ2 white	.885(.334)					
χ2 remsay	.543(.627)					

*Note: * and ** show significance at 1% and 5% levels respectively. The values in parenthesis are t-statistics in case of the short run and long run results and probability values in case of diagnostics.*

The long run and short-run estimates are given in Table 4.4. It is evident from the estimates that Inflation has a negative impact on exchange rate in the long run. One unit increase in inflation accounts a 0.465-percent change in exchange rate of Malaysia in relation to the exchange rate of its trading partners. Moreover, when inflation rate is low, then the exchange rate tends to increase while interest rate has a positive impact on exchange rate of Malaysia in the long run. One unit increase in interest rate will bring a 0.375-percent increase in exchange rate. The second part of Table 4.4 explains the short run estimates. In the short-run, the inflation and interest rate have a negative impact on the exchange rate in the short run. The negative and significant speed of adjustment indicates that shocks in the short run are corrected by 7-percent towards the long run equilibrium. The last portion of Table 4.4 gives the diagnostic tests. The model passes all the diagnostic tests of normality, Remsay test, and serial correlation, white and ARCH heteroscedasticity.

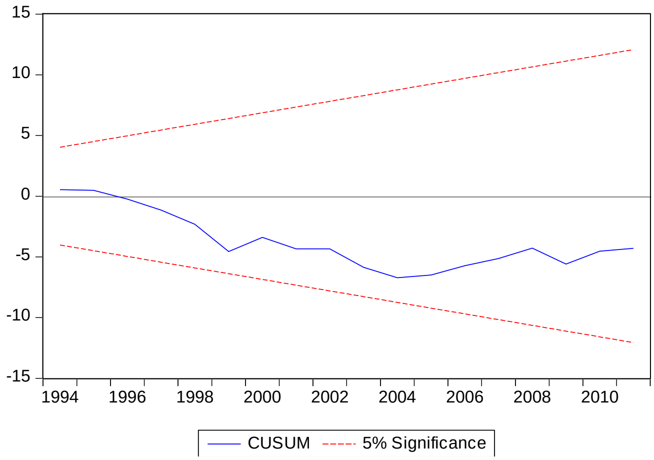

Figure 1: Cumulative Sum of Recursive Residuals

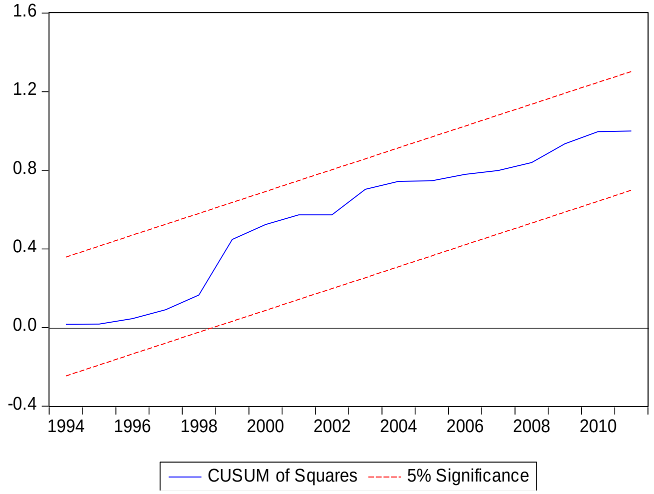

Figure 2: Cumulative Sum of Square Residuals

The stability of the long run parameters are checked using CUSUM and CUSUMQ test as shown in Fig 4.1 and Fig. 4.2 respectively. As the plot of the residuals is in between 5% critical bounds, therefore, it is evident that the long run parameters are stable. The Table 4.5 present the results of the vector error correction model to describe the short and long run causality among exchange rate, inflation, and interest rate. Estimates signify that there is long run uni-directional causality from interest rate and inflation to exchange rate. Further is depicted that there is short-run bi-directional causality running from inflation to exchange rate and unidirectional causality from interest rate to exchange rate. While a short run unidirectional causality running from inflation to interest rate.

Table 4.5
Results of VECM Granger Causality Test

Variables	Short-run Causality			Long-run Causality
	ER	**INF**	**INT**	**ECT_{t-1}**
ER	-	7.458* (0.002)	2.875*** (.0562)	-0.599** (-3.456)
INF	3.885** (.0540	-	1.458 (.214)	-0.552 (-1.9840
INT	1.752 (.562)	2.852** (.056)	-	-0.675 (-.352)

*Note: *, ** and *** show significance at 1%, 5% and 10% levels respectively. Figure in the parentheses is the p-value for variables and t-statistic for ECT*

However, from the analyses and previous literature, it is quite evident that diverse pattern has been visualized on the causal nexus among exchange rate, inflation, and interest rate in economic and finance literature. Theoretically, these variables are highly correlated; however, the evidence varies from country to country. The interrelationship between inflation, exchange rate and interest rate is quite complex since the individual attributes of these macroeconomic variables do not solely define the relationship rather the relationship has been transmitted through different economic channels such as demand expectations, liquidity, financial market stability and monetary conditions etc. Additionally, high interest rate policy may direct a decline in money demand, which in turn lead inflation through government debt and subsequently government debt tends to be financed by seigniorage (Sargent & Wallace, 1981). The findings of this study have moderate support to previous researches. Chow and Kim (2004) have the view that following the Asian financial crisis, the majority of the Asian countries do not utilized the interest rate policy to accommodate the movement of exchange rate. Moreover, Ito and Sato (2006) reported the unidirectional short-term significant relationship of exchange rate and inflation rate in the post Asian financial crisis.

5. CONCLUSION

This study explores the exchange rate, inflation, and interest rate nexus in the Malaysian economy. Autoregressive Distributed Lag Modelling is used to check the long run relationship among the variables. Further, the impact of inflation and interest rate on exchange rate is also checked in the long run as well as in the short run. CUSUM and CUSUMQ stability test are applied to check the reliability and constancy of long run parameters in the model. The VECM Granger Causality is used to find the long and short run causality among the variables. The study concludes that, both interest rate and inflation have a long run well as a short run relationship with exchange rate. Our results suggest that interest rate has positive relationship with exchange rate and inflation has negative relationship both in the short run and long run respectively. In addition, it is noted that there is long run unidirectional causality from inflation and interest rate towards exchange rate. Further, there is unidirectional causality running from inflation to interest rate and from interest rate to exchange rate in short run. Further, it is noted that bidirectional causality running from inflation to exchange rate in short run only. Exchange rate volatility is a major area of concern for an economy, so special measures need to be taken by the Bank Negara Malaysia to manage the exchange rate, as flexible exchange will provide a support against internal and external shocks in the economy. The monetary authorities should take steps to increase foreign reserves in the short and medium term. High inflation is also an area of concern, such policies should be designed, which can retain inflation at a suitable level.

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