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A Refinement of the Relationship between Real Exchange Rate, Real Interest Rate Variation, Foreign Direct Investment and Economic Growth: The Case for Developing Countries

Fadi Fawaz[1], Anis Mnif[2] and Yaseen S. Alhaj-Yaseen[3]

[1]Associate Professor of Economics, Department of Economics and Finance, College of Business, Tennessee State University, 330 10th. Ave. North, Suite K450, Nashville, TN 37203-3401. E-mail: ffawaz@tnstate.edu
[2]Director of Graduate Programs, Tennessee State University, College of Business, 330 10th Ave. North, Nashville, TN, 37203-34010. E-mail: amnif@tnstate.edu
[3]Associate Professor of Finance, Middle Georgia State University, 100 University Parkway, Macon GA, 31206, (478) 471-5718. E-mail: yaseen.alhajyaseen@mga.edu

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Abstract: This research aims to observe any prospect of a relationship between the real exchange rate, real interest rate variation from The London Interbank Offered Rate for developing economies, financial development and economic development. This research has used annual data started from 1986-2019. We use various econometric tools that include ADF test to find out the order of integration among variables; ARDL bound testing technique to find out the long and short-run association between variables. The Engle-Grange or Vector Error Correction Model (VECM) model employed to extract long-run causality and a Granger causality test used to extract short-run causality directions. Empirically, Granger causality empirical results indicate evidence of unidirectional causality running from GDP to RIR and GDP to FDI. These findings are robust to alternative specifications and inclusion of control variables. Overall, our study advises policymakers to consider incorporating RIR and FDI asymmetries within the design of optimal policy rules to avoid incorrect diagnosis of economic behavior.

Keywords: Real Interest Rate, Foreign Direct Investment, Economic Growth, ARDL, VECM, RL, Cointegration

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I. INTRODUCTION

Academic studies have targeted several variables that can provide supplementary evidence to identify the main determinants of economic growth. Our selection is based on the Barro-type framework (see Barro, 1991), where we examine FDI inflows, real exchange rate, and interest rate variation from LIBOR and their influences in economic performance.

It is evidenced that FDI could be considered as a channel that can affect the overall economic performance (Cakrani, 2014) by providing benefits that can enhance and stimulate the economic activity in a country. FDI is defined as equity inflows (World Bank, 2019) and have been rapidly increasing specially in developing economies (Opoku *et al.*, 2019), in which compared to other sources of capital, FDI can become a source of significant advantage for improving the overall labor market (World Bank, 2017), providing a more stable flow of funds, increasing productive capacity, and making domestic firms much more desired in foreign markets (Iamsiraroj & Ulubaþoðlu, 2015).

Several studies have argued that a possible determinant of FDI enhancement is exchange rate, particularly in favorable scenarios. These scenarios are presented according to the fluctuations of exchange rate where studies argue that undervalued currencies could put an economy on a developmental path (Gala, 2008) through channels like investments and trade (Aman *et al.*, 2017; Razin & Collins, 1997; Cakrani, 2014). The reason behind is that an undervalued currency will lower the cost of local products, and it will promote its competitive position in the international market; outside investors will find lower costs, which will translate into an opportunity for injection of foreign direct investment, hence stimulate economic development (Huong, 2019). Meanwhile, overvaluation will promote domestic products inflation, therefore, their attractiveness in the global market most likely will decrease (Selimi & Selimi, 2017).

Adding to the discussion of determinants of economic growth, interest rates can play a major role and can serve as a useful indicator to examine economic performance (Dotsey 1998/2012). Some researchers have targeted Interest rate differentials and its influence in macroeconomic variables by taking as a reference universal indexes such as the case of the LIBOR, important for the infrastructure of financial markets. In this particular case, several researches have studied different market rates and have argued that increase in spreads with LIBOR can potentially increase the cost of borrowing (Taylor & Williams, 2009) and have significant economic impact. We have evidenced that the study of this spread has had a special focus during the financial crisis, and even though the literature has deeply

examined the LIBOR behavior during this time, to our knowledge, the approach taken by the literature found hasn't go beyond this particular time period, where it focuses on a case-by-case basis, and as a result, we see complicated to sustain if this situation can hold across time.

To contribute with the ongoing debate, our study aims to fill the gap in the literature by observing and examining any prospect of a relationship between the real exchange rate, real interest rate variation from The London Interbank Offered Rate, financial development and economic development by setting a differentiator from other studies by focusing on developing economies across time. Section 2 of this research will examine the literature related with the studied variables. It includes similar approaches taken by other studies as well as discussions on the different findings. Section 3 will describe the methodology and model specification, and lastly, section 4 will discuss the findings and conclusion of the research.

II. LITERATURE REVIEW

A. Real Exchange Rate and Economic Development

The real exchange rate has been a point of discussion in many financial and economic researches. Its relationship with economic performance has been studied before and results showed scenarios where these variables are positively related, others where it was found a negative relationship or even the absence of any interaction (Missio *et al.*, 2015; Barguellil *et al.*, 2018). In developing countries, this relationship has been significantly studied using different timeframes as well as country selection.

The research from Rodrik (2008) provides strong evidence in the case of developing countries. Rodrik (2008) discussed that the undervaluation of the currency stimulates economic growth. Rodrik studied the cases of China, India, South Korea, Taiwan, Uganda, Tanzania, and Mexico for the 1950-2004 period in which argued that tradable economic activities suffer disproportionately from the institutional and market failures that keep countries poor. Furthermore, real exchange rate depreciations increase the relative profitability of investing in tradables and act as economic alleviators for the economic cost of these distortions, Rodrik estates that episodes of undervaluation are strongly associated with economic growth. Similarly, Gala (2008) provides econometric evidence for the negative effects that currency overvaluation can have on economic growth. It discusses that an undervalued currency could put the economy on a developmental path by enhancing higher investments at the macro level and higher levels of capital accumulation.

It has been proved that the adoption of financial and economic policies in a government can play a significant role on the fluctuations of the exchange rate, particularly in developing countries (Rodrik, 2008). Barguellil *et al.,* (2018) examined the impact of exchange rate volatility on economic growth based on a sample of 45 developing and emerging countries for the 1958-2015 period. The research used the difference and system generalized method of moments estimator, and the findings suggest that the generalized autoregressive conditional heteroskedasticity-based measure of nominal and real exchange rate volatility has a negative impact on economic growth. Barguellil *et al.,* (2018) emphasized that the effect of exchange rate volatility depends on the exchange rate regimes and financial openness, in other words, volatility has a greater negative impact when countries adopt flexible exchange rate regimes and financial openness.

Huong (2019) argues that changes in the real exchange rate can cause alterations in the domestic product competitiveness in the international market. Undervaluation makes local products cheaper than imported, making domestic exports more competitive. As a consequence, value of imports may decrease, hence country's trade balance will improve, and GDP will grow. Huong (2019) studied the case of Vietnam to provide insights of the impact in the rate of economic growth caused by the exchange rates for the 2007 – 2017 period. The research implements a Vector Autoregressive estimation, Granger Causality test, and impulse response where results show a positive relationship between real exchange rate and economic growth.

Mazorodze & Tewari (2018) focuses on the link between real exchange rate undervaluation and sectoral growth in South Africa for the 1984-2014 period. Findings confirm a positive impact up to a point where further undervaluation can harm economic development. Razin & Collins (1997) considered investments and tradable products as channels that may affect economic growth. Their research concluded that considerably high overvaluation is associated with slower economic growth, while undervaluation appeared to be a stimulant for economic development. Di Nino *et al.,* (2011) analyzed the relationship between real exchange rate misalignments and economic growth in Italy for the 1861-2001 period. The results showed that there is positive relationship between undervaluation and growth. In addition, the study shows that there is a stronger influence in developing countries and a weaker influence for advanced countries.

Su & Wu (2017) contribute to the country-level research by examining the case of China for the years 1952-2014 while using a structural VAR model. The study focused on the mutual effect of the two studied variables in three different periods. Firstly, it shows that there is no obvious

relationship before China's reform and opening-up period. Secondly, there is a significant positive correlation in the sample of 1979-1993. Thirdly, thereafter 1994, the direction between exchange rate and real GDP becomes negative.

Selimi & Selimi (2017) focused on the Republic of Macedonia where they use the OLS approach as well as the dynamic VAR model and Granger causality test to determine the long-term linkage between real exchange rate and economic growth. Similarly to previous findings, the results indicate a positive relationship between real exchange rate and economic growth, additionally, they argue that the fix regime of exchange rate ensures macroeconomic stability of the country.

Cakrani (2014) argues that the effects of the real exchange rate on economic growth can be demonstrated through two transmission channels, trade and investment, similarly to Razin & Collins (1997) considerations. Cakrani (2014) examines any possible impact that the exchange rate can have on economic growth in Albania to determine if the real exchange rate can be used as an instrument of policy. By using a Johansen cointegration method and Vector Error Correction Model to identify the long-term and short-term impact of real exchange rate on economic growth. The results indicate that the real exchange rate has no significant impact on the Albanian economy, this suggests that short- and long-term economic growth policies should not rely on this variable.

B. Foreign Direct Investment and Economic Development

The World Bank (2017) in their recent report of Global Investment Competitiveness Report 2017/2018 concluded that the "foreign direct investment (FDI) benefits developing countries, brings technical know-how, enhance work force skills, increases productivity, generates business for local firms, and creates better-paying jobs". The report emphasized on the contribution of FDI towards the receiver countries and economic growth.

Iamsiraroj and Ulubaþoðlu (2015) in their study "Foreign direct Investment and economic growth: A real relationship or wishful thinking?" researched 140 countries for the 1970-2009 period. They acknowledged the sheer amount of studies that have been done in this area and pointed out that the different empirical results have caused these debates unsettled. However, their study results show that FDI positively affects economic growth. They concluded that this relationship holds globally as strongly as in the developing world. Furthermore, it is a regional variation rather within-country variation, and contemporaneous FDI rather than past FDI, which matters for growth.

Owusu-Nantwi and Erickson (2019) investigates the impact of FDI on economic growth in countries of South Africa. The findings of this study support the idea of positive relationship between FDI and economic growth. The Pedroni's cointegration test established a long-run relationship between FDI and economic growth in a panel of ten countries in South Africa. The study finds a significant positive impact of FDI on economic growth in the region. The VECM results find a short-run bidirectional causality between FDI and economic growth. The error-term is negative and significant, this indicates the presence of long-run equilibrium relationship among the variables.

Opoku *et al.,* (2019) studied the impact of FDI on economic growth in Africa using the system generalized methods of moments. Their study reveals another positive relationship between FDI and economic growth, they argue that FDI positively and unconditionally spurs economic growth, its growth-enhancing effect is imaginary when the conditional sectoral effects are introduced. Opoku *et al.,* (2019) estates that on the channels of manifestation, the pass-through impact of FDI is only significant for the agricultural and service sectors.

Asid *et al.,* (2014) attempted to observe the impact of both, the real exchange rate and FDI towards the economic growth. They observed two different models and concluded that both models exhibited a strong long-run relationship towards economic growth. Moreover, they pointed out that the impact of foreign direct investment in the long run equation is positive and significant, whereas the impact of real exchange rate is not. In the short run, both exchange rate and foreign direct investment are significant but with a slightly minimal percentage effect.

Contrarily, Bermejo & Werner (2018) illustrate that FDI might not be the reason for economic growth in some scenarios. They examine the scenario of the large amount of FDI targeted to developed countries with already advanced educational system and financial markets. They used the example of Spain and observed the periods of 1984-2010. These periods illustrate the significant rise of FDI in Spain, and the results showed that all favorable circumstances had no relationship between FDI and stimulation of economic growth.

C. Real Exchange Rate, FDI and Economic Development

In their studies Gouider and Nouira (2014) observed a misalignment of real exchange rate, which appears to be the key factor of the FDI flows. The analysis was done over 52 developing counties for the period of 1980-2010. The results of this study show that the misalignment can have negative

impact on FDI, specifically a persistent overvaluation can increase the chance of capital flight in developing economies, which indicates discouragement of investors.

Basirat *et al.,* (2014) investigated the exchange rate fluctuations on economic growth while taking into account financial markets and their development. The observed period was 1986-2010 with a sample of 18 developing countries. In addition, they considered the effects of other variables such as previous period production, trading volume, and inflation. Their analysis found that the effect of both, financial development and effect of exchange rate fluctuations on economic growth is negative and significant. Nonetheless, the study pointed out another view that the mutual effect of both, financial development and exchange rate, is positive. The effect in observed countries is small and statistically insignificant. Aman *et al.,* (2017) studied the relationship between exchange rate and economic growth, the observation was based on annual data for the 1976-2010 period. The method used a two and three stage least square estimations. The findings suggest the connection between exchange rate and economic development where it identifies: (i) incentivization on export promotion, (ii) enhancement of FDI inflows, (iii) raise in investment volumes and (iv) use of import substitute industry.

In many countries, FDI becomes a globalization force that targets business, due to this fact, it becomes a critical factor of binding together economies and stimulating exchanges between them. Based on this analysis, FDI can bring new and improved technologies as well as new skills and expertise that can boost productivity and improve efficiency. However, these positive impacts occur only when the host country treats FDI rationally and prepares its business environment to increase the further yield on investment. If these conditions are not met, the situation can be harmful for the host country (Cheikh & Sofiane, 2018). To illustrate this relationship, the literature reveals the case of GCC countries where FDI plays a major role in economic development, and in the long run, these variables rely on each other (Habibi & Karimi, 2017; Khrawish & Siam, 2010; Khalil, 2015).

Comes *et al.,* (2018) studied panel data in countries of Central and Eastern Europe, the research found correlation between FDI and remittances on economic development while taking into consideration gross domestic product for the involved regions. Bekana (2016) observed factors for short- and long-run behind the FDI inflows in the Ethiopian economy. The study was conducted based on the analysis of developing and developed countries in relation to Ethiopia. The model estimation used various econometric tools such as error correction mechanism (ECM). Their

analysis concluded that the factors of FDI were present in both, short- and long-run models. Moreover, they emphasized on the crucial factors behind FDI such as GDP per capita, real interest rates, GDP growth rate and inflation. Moreover, the study pointed out the importance of overall economic stability in the country to attract FDI inflows.

Ouhibi *et al.,* (2017) analyzed the Mediterranean countries using generalized method of movement (GMM). The findings of the study showed the bidirectional causality between FDI and economic growth. Furthermore, it found the unidirectional causality between FDI and public debt. The economy is guided with correlation between FDI and series of macroeconomic variables to react in various ways. The linkage and complexity of FDI with other financial indicators is a major factor of an economy. The FDI can be viewed as the catalyst for economic development, it can help to positively affect reaction, and impulse the financial movements (Triandafil, 2011; Kakar & Khilji, 2011).

D. Real interest Rate measurement (Real Interest and LIBOR variation) and Economic Development

There is a wide and growing studies that examine the Real Interest Rate and the LIBOR in a separately manner using a variety of samples and time periods. The review on these variables is selective and focuses on researches that have examined their financial and economic implications. Considering economic growth as the main point to study, Dotsey (1998/2012) examined the predictive power of the yield curve spread between long- and short-term interest rates. Its research focused manly on reinforcing the view by providing statistical evidence that the spread is an useful indicator to predict future growth in real GDP. Obansa *et al.,* (2013) empirically studied the relationship among exchange rate, interest rate, and economic growth in Nigeria for the period of 1970-2010. The study was broken into two distcintions, regulation era and deregulation era, and the results indicated that exchange rate had a stronger impact compared to interest rates. It shows that interest rate had a positive impact but declines over the time horizon. Concludes that exchange rate liberalization was good to the Nigerian economy, while interest rate liberalization does not make a significant impact on economic development.

Alaoui *et al.,* (2015) studied the impact of the LIBOR on the Islamic Dubai Financial Market – UAE return using a discrete and continuous Wavelet technique. Results show that both markets, DFM-UAE, demonstrate a long-term conversion to the same level of risk and volatility with the Global Sukuk index. Azad *et al.,* (2018) studies the particular case of why the Islamic Interbank Benchmark Rate (IIBR) have failed, in

which they show that IIBR has failed to stablish a dependency from the LIBOR by using a standard Johansen cointegration method. Results suggest evidence of short-term and long-term dynamics between the two rates.

Several studies that examine the LIBOR behavior have focused mainly over the financial crisis periods and have tried to understand the behavior of LIBOR while making reasonable comparisons with other market rates. A study by Taylor & Williams (2009) examined the spread between market rates such us Overnight Interest Swap (OIS), Effective Federal Fund (EFF), Certificate of Deposits (CDs), Credit Default Swaps (CDS), and Repo rates and the term LIBOR during the crisis of 2007-2008. They argued that the sharp increase in these spreads raised the cost of borrowing, also, that increased counterparty risk between banks contributed to the rise in spreads. Moreover, they show that no empirical evidence supports that actions taken by the Federal Reserve such us the term auction facility (TAF) had success with reducing the spreads, as a conclusion, results represented implications for monetary policy and financial economics.

Fernandez Bariviera *et. al.* (2015) investigated deeply the LIBOR behavior during the financial crisis. The research reveals movements in the stochasticity of the 3-month UK LIBOR by implementing a Complexity Entropy Causality Plane (CECP). It reveals an anomalous behavior in the LIBOR rate during the time of the financial crisis, and they argue that could be the result of data manipulation. In addition, Fernandez Bariviera *et. al.* (2016) expanded their prevous research by studying the behavior of the LIBOR for seven maturities and four currencies using the same approach, Complexity Entropy Causality Plane. It confirmed an abnormal movement in 2007 that is also known as the "LIBOR scandal".

Tamakoshi & Hamori (2014) examined the volatility and mean transmission between the US dollar (USD) and euro (EUR) LIBOR-OIS spreads from January 2005 to June 2011. The study implemented the causality-in-variance and causality-in-mean tests and results show significant unidirectional causality-in-variance from the EUR to the USD spread during the global financial crisis period, as well as bidirectional causality-in-mean observed between the two spreads. The study also shows no significant causality-in-mean and causality-in-variance between the spreads during the European sovereign debt crisis. Lastly, and following a similar line of research, Imakubo *et. al.* (2008) examined the LIBOR-OIS spread, results reveal significant causality running from the US dollar (USD) spread to the euro (EUR) and Japanese yen (JPY) spread focusing on the financial crisis period.

III. METHODOLOGY AND MODEL SPECIFICATION

This research aims to observe any prospect of a relationship between the real exchange rate, real interest rate variation from The London Interbank Offered Rate[1] for developing economies, financial development and economic development. This research has used time series data started from 1986 to 2019 and had obtained from world development indicators of the World Bank, the International Monetary Fund and Macrotrends.net as they are a reliable and accurate source for the purpose of this research.

To analyze data STATA software was used. of formal analysis that starts from looking the optimal lag length that required to get efficient outcomes and for this reason a well know Schwarz information criteria (SIC) under Vector Autoregressive (VAR) framework used. After having the required lag length stationarity of the variables are tested through famous Augmented Dicky Fuller (ADF). Based on the outcome received from ADF test that shows some variable present different order of integration, an Autoregressive Distributed Lag Model (ARDL) used to track long and short-run association between variables. After analyzing the long and short-run association between variables, the study used the Vector Error Correction Model (VECM) to measure long and short-run causality. To check the stability of the estimated model various diagnostic tests like Jarque-Bera, heteroscedasticity, serial correlation LM and CUSUM test applied.

Econometric Model

$$GDP = f(RER, FDI, INF)$$

$$\ln GDP = \beta_1 + \beta_2 RER + \beta_3 \ln FDI + \beta_4 INF + \beta_4 RL + \epsilon_t$$

Where

ln: Natural Log

GDP: Gross Domestic Product Proxy for Economic Development

RER: Real Exchange Rate

FDI: Foreign Direct Investment (Net Inflows)

INF: Inflation (Consumer Price Index)

RL: Real Interest Rate - LIBOR

ϵ_t: Error Term

ARDL Model

After having results of unit root testing, it is essential to analyze the long and short-run association between and in this study different variables considered. This method developed by Pesaran and Shin (1999) and Pesaran

et al., (2001) and this method is a general vector autoregressive (VAR) method. There are various merits of this techniques, (i) this model does not require all the variables should be integrated on the same order but must be stationary at level and first difference only, (ii) ARDL technique produce efficient results irrespective of the sample size whether it is small data set or large, (iii) this method provides an unbiased outcomes for long-run (Harris and Sollis, 2003). We choose the maximum values for lags p and q of the unrestricted error correction model using the minimum values on Akaike Information Criterion (AIC), Schwarz (SBC), Hannan-Quinn (HQC) criteria. A prerequisite on ARDL models below is that errors are serially independent (should not be autocorrelated). Pesaran et al. (2001) mention that this assumption is important for choosing the maximum number lags.

The ARDL and VECM models are described as follows:

$$1.\quad D(\ln(GDP_t)) = \beta_{01} + \beta_{11}\ln(GDP_{t-1}) + \beta_{21}Ln(RER)_{t-1} + \beta_{31}\ln(FDI_{t-1}) + \beta_{41}\ln(INF)_{t-1} + \beta_{51}\ln(RL)_{t-1} + \Sigma_{i=1}^{p}\alpha_{1i}D(\ln(GDP_{t-1})) + \Sigma_{i=1}^{q}\alpha_{2i}D(\ln(RER)_{t-1}) + \Sigma_{i=1}^{q}\alpha_{3i}D(\ln(FDI_{t-1})) + \Sigma_{i=1}^{q}\alpha_{4i}D(\ln(INF)_{t-1})\Sigma_{i=1}^{q}\alpha_{5i}D(\ln(RL)_{t-1}) + \epsilon_{1t}$$

The ARDL test main depends upon a combined F-testing approach and classified its hypothesis[2] As no cointegration and cointegration respectively. The analysis order of the ARDL method is to estimate all the above equations and should test jointly through F-statistics with null hypothesis is H_0: $\beta_{1i} = \beta_{2i} = \beta_{3i} = \beta_{4i} = \beta_{5i} = 0$ against the alternative hypothesis H_0 : $\beta_{1i} \neq \beta_{2i} = \beta_{3i} = \beta_{4i} = \beta_{5i} = 0$. This test produced two sets of critical bound one known as lower bound and showing variables are integrated at the level, and another with upper bound showing variables are integrated at first difference. If the resultant value of F-statistics is falling beyond the upper and lower limits, the null hypothesis is rejected, and hence evidence of long-run association prevails, and in case value falls within the critical limits the ARDL model remain inconclusive.

VECM Method

Vector Error Correction Model is used to find out long, and short-run causality between variables and following system of equations explained well in detail. Vector Error Correction Model is used to find out long, and short-run causality between variables and following system of equations explained well in detail. The existence of dynamic restricted error correction model derived by melds below does not necessarily imply that the estimated coefficients are stable. Thus, Pesaran *et al.* (1995, 2001) suggested the stability test of estimated parameters on estimated models of Brown *et al.* (1975) known as cumulative sum (CUSUM) and cumulative square sum (CUSUMSQ).

2. $$D(\ln(GDP_t)) = \beta_0 + \Sigma_{i=1}^{p}\beta_{1i}D(\ln(GDP_{t-1}) + \Sigma_{i=1}^{q}\beta_{2i}D(\ln(RER)_{t-1}) + \Sigma_{i=1}^{q}\beta_{3i}D(\ln(FDI_{t-1})) + \Sigma_{i=1}^{q}\beta_{4i}D(\ln(RL)_{t-1}) + \Sigma_{i=1}^{q}\beta_{4i}D(\ln(INF)_{t-1}) + \mu_t$$

Our paper focuses on the relationship between RIR, RER, FDI, Inflation with economic growth. We use an econometric model established and starts with the VAR model to identify the optimal lag length through the SIC method since it is crucial for the efficient outcome of modeling. To find whether under study variables are stationarity or not, a well-defined ADF method used and based on its outcome an ARDL approach used to find out the long and short-run association between variables. Furthermore, to check long and short-run causality a VECM method used and additionally a Granger causality test also employed. The consistency of estimated model supported by residuals diagnostic test that includes Jarque-Bera test, serial correlation LM test, Ramsey reset test, heteroscedasticity test, CUSUM stability test, and CUSUM square test. An impulse response function also employed to review the behavior of GDP when a shock given to the error term. This research also used variance decomposition method to examine variation in GDP in the extended period. To this end, we perform ADF, PP and DF-GLS unit root tests on the first differenced transformations of the time series and report the findings in Table 1. The reported test statistics summarized in Table 1 unanimously reject the null hypothesis of an I(2) process at significance levels of at least 10 percent for all series and this findings holds regardless of whether the test is performed with a drift or inclusive of a trend. The results of unit root test that is ADF presented in table 1, it shows a mix stationarity trend. The variables GDP, RER, and FDI integrated at first difference; however, INF and RIR are stationary at level. From unit root results where three variables are I (1), and two are I (0), an ARDL recommended.

IV. RESULTS

Table 1: Unit Root Test

Variables	*Augmented Dicky Fuller*			
	I(0)		*I(1)*	
	ADF Stat	*P-Value*	*ADF Stat*	*P-Value*
GDP	-0.35	0.85	-5.88*	0.00
RER	-1.39	0.62	-5.29*	0.00
FDI	-2.48	0.14	-6.23*	0.00
INF	-3.61*	0.01	-6.13	0.00
RL	-5.58*	0.00	-6.49	0.00

* indicates significance at 1%, **indicates significance at 5%, ***indicates significance at 10%.

Table 2 presents results of the long run estimates based on the Schwartz Bayesian criteria (SBC). The selected ARDL (1, 1, 1, 1, 1,) passes the standard diagnostic test (serial correlation, functional form, normality and heteroscedasticity). The coefficients indicate the long run elasticities. Table 2 b shows that the value of F-bounds test is 24.16 and that is not falling between the lower and upper bound at any significance level (10%, 5% & 1%). Therefore, evidence of long-run relationship exists between variables and the null hypothesis of no level relationship is rejected. The value of goodness of fit also indicates a 89% contribution of predictors in GDP and value of the Durban-Watson test additionally ensure that the estimated model is free from autocorrelation. The value of f statistic and subsequent p-value also ensured the overall significance of the model.

The error correction regression in table 4 also confirms the short-run relationship between variables because the ECT coefficient term is negative and statistically significant. The short-run outcomes are in line with existing studies (Barguellil *et al.* 2018; Mgammal, 2012).

Table 2: Long-Run Estimates ARDL (1, 1, 1, 1, 1)

F-Bounds Test = 24.16		
Significance	*I(0)*	*I(1)*
	Lower Bound	*Upper Bound*
10%	2.62	3.70
5%	2.83	4.18
1%	3.99	5.339

Ho: No Level Relationship
R-Square = 0.89
Durban-Watson Stats = 1.91
F-Test = 76.88
(P-Value= 0.00)

The last step in the ARDL bound approach is to estimate an Error Correction Model (ECM) to capture the short-run dynamics of the system. The ECM generally provides the means of reconciling the short-run behavior of an economic variable with its long-run behavior. The error correction regression in table 3 also confirms the short-run relationship between variables because the ECT coefficient term is negative and statistically significant. The short-run outcomes are in line with existing studies (Barguellil *et al.* 2018; Mgammal, 2012).

Table 3: ARDL Error Correction Regression (Short-Run Results)

Error Correction Term	*Coefficient*	*SE*	*t-Stats*	*P-Value*
ECT (-1)	-0.042	0.001	-13.605	0.000

R-Square = 0.91
Durbin-Watson Stats = 2.21

Table 4 reports the results of various residual diagnostic tests for the estimated ARDL model. From the table, the results show that the estimated model passes the Langrangean multiplier test of residual serial correlation. Also, the estimated model passes the tests for Functional Form Misspecification using square of the fitted values. The model also passed the Normality test based on the Skewness and Kurtosis of the residuals. Thus, the residuals are normally distributed across observations. Finally, the estimated model passes the test for heteroscedasticity test based on the regression of squared residuals on squared fitted values. In all these tests we are unable to reject the null hypothesis meaning that the estimated model does not have the issue of serial correlation and heteroscedasticity. The outcome of the JB test also indicates that the residuals of variables are normally distributed, and the Ramsey test endorses the correct form of the model. This shows that there is no apparent non-linearity in the regression equation and it would be concluded that the linear model is appropriate.

Table 4: Residual Diagnostic Tests[3]

Tests	*Stats*	*P-Value*
Serial Correlation LM	0.67	0.41
Heteroscedasticity	9.77	037
Jarque – Bera	1.22	0.54
Ramsey Reset	0.24	0.63

Pesaran and Pesaran (1997) suggests that the test for the stability for parameters using cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) plots be conducted after the model is estimated. This is done to eliminate any bias in the results of the estimated model due to unstable parameters. Also, the stability test is appropriate in time series data, especially when one is uncertain about when structural changes might have taken place.

The results for CUSUM and CUSUMSQ are depicted in Figures 1 and 2 respectively. The null hypothesis is that coefficient vector is the same in every period and the alternative is that it is not. The CUSUM and CUSUMSQ statistics are plotted against the critical bound of 5 percent

significance level. If the plot of these statistics remains within the critical bound of the 5 percent significance level, the null hypothesis that all coefficients are stable cannot be rejected.

Figure 1: CUSUM Test for Stability

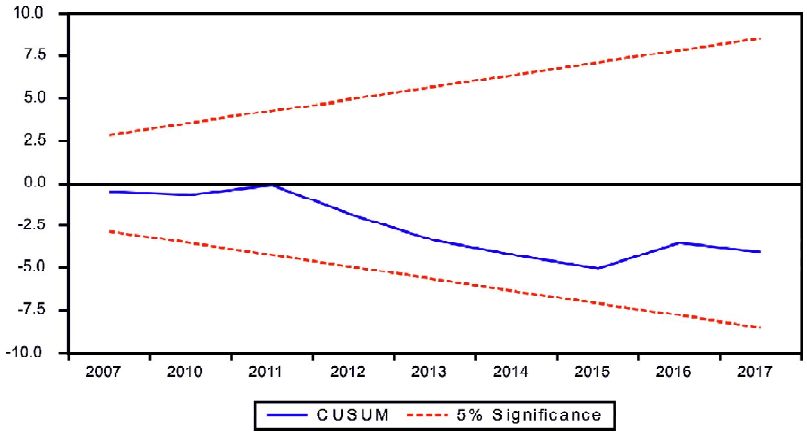


Figure 2: CUSUM-Square Test for Stability

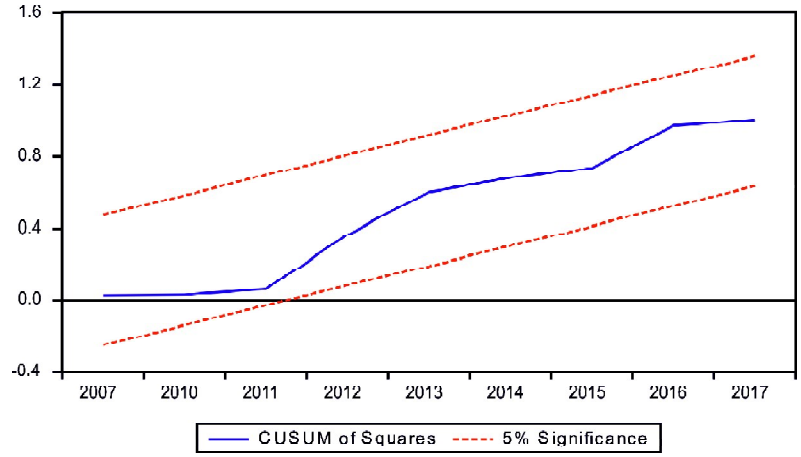
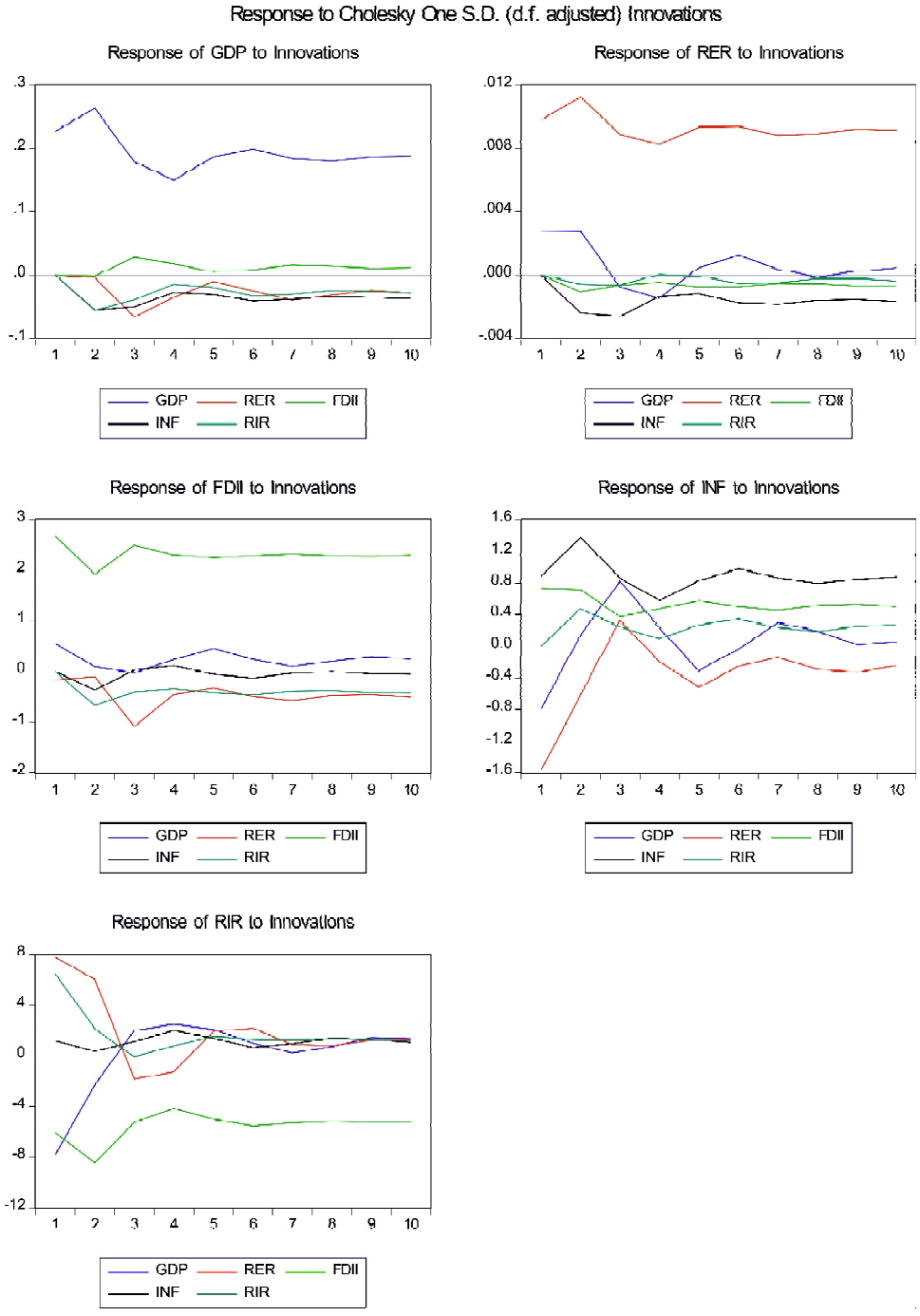


Table 5: VECM Model (Long-Run Causality Outcomes)

Long RunTerm	*Coefficient*	*SE*	*t-Stats*	*P-Value*
ECT (-1)	0.01	0.03	0.18	0.86

Adjusted R-squared = 0.37
Durbin-Watson stat = 2.51
F-statistic = 1.60
P- Value = 0.21
ECT: Error Correction Term

Figure 3: Impulse Response



After establishing the long and short-run relationship, it is essential to find out the causality between variable and in this regards VECM model used and table 5 representing the error correction term, which is positive and insignificant meaning that there is no long-run causality existing in the model. These findings are similar to Mazenda, 2014.

Table 6: Granger Causality Test (Short-Rum Outcomes)

Null Hypothesis	*F-Stat*	*P-Value*
GDP does not Granger Cause RER	9.073*	0.005
GDP does not Granger Cause FDI	5.59*	0.03

*, **, *** are 1, 5 & 10% level of Significance

The outcomes of the granger casualty test, in table 6, show a few pieces of evidence of unidirectional causalities. For instance, evidence of unidirectional causality existing from GDP to RER and another causality running from GDP to FDI.

Figure 3 represents comprehensive combined outcomes of the impulse response function. It is important to note when an impulse is given to GDP (own shock) the FDI movement for next ten period is positive, and however, for rest of the variables, it is in negative zone. When a shock has given to RER, the outcomes shows a positive trend of GDP ahead. The study further has given a shock to FDI, and in response, RL and GDP remain positive in the future. In addition to this inflation is having a mix of behavior. Surprisingly when a shock has given to inflation, all variables remain positive in coming ten years except RER. Finally, in the response of RL, all variables are positive except GDP.

Table 7: Variance Decomposition of GDP

Period	*SE*	*GDP*	*RER*	*FDI*	*INF*	*RL*
1	0.23	100.00	0.00	0.00	0.00	0.00
2	0.36	94.98	0.02	0.00	2.48	2.52
3	0.41	90.65	2.66	0.46	3.39	2.83
4	0.44	90.53	2.98	0.56	3.35	2.58
5	0.48	91.37	2.56	0.48	3.24	2.35
6	0.52	91.43	2.40	0.43	3.36	2.38
7	0.56	91.10	2.62	0.45	3.43	2.40
8	0.59	91.15	2.65	0.46	3.42	2.33
9	0.62	91.32	2.55	0.44	3.42	2.28
10	0.65	91.34	2.51	0.43	3.45	2.27

Variance decomposition of GDP outcomes are presented in table 7, and it shows that the error variance of GDP is declining over the period, however, the pace is quite slow. However, in the case of INF, the error variance is increasing over the period but at a slower speed. RER, FDI and RL are showing a mix of trend up to the seventh period but a consistent decline afterward.

V. SUMMARY AND CONCLUSION

The purpose of the present study is to empirically examine the association between the real exchange rate, foreign direct investment, and the economy of developing economies. This study has used annual data started from 1986 to 2019 and had obtained from WDI of World-Bank. To observe the relationship, this study considered the gross domestic product, real exchange rate, foreign direct investment, inflation, and the real interest rate variation. This research has used graphical representation to gauge the fundamental nature of the data in step two formal econometric approaches employed and started from a selection of optimal lag through SIC method under the VAR framework. To check the stationary of variables the ADF test used and under their outcomes, a well-linked ARDL method used to determine the long and short-run relationship between variable. In response to the existence of a long-run association between variables, the VECM model used to find out long-term causality impact of variables over each other and for the short-run purposes, a common granger causality test employed. To analyze the efficacy of estimated models, a various residual diagnostic test used that includes serial correlation LM test, JB test, Ramsey Test, Heteroscedasticity test, CUSUM and CUMUM square tests for stability of the model.

This study also used impulse response function and variance decomposition tests to evaluate the future movement of the data. The unit root results show a mixed trend of few integrated variables at first difference and rest of them are at level. The results of the ARDL test supports a long and short-run association between variables; however, the VECM method does not endorse any evidence of long-run causality. The outcomes of Granger causality test briefed with a unidirectional causality running from GDP to FDI and RER. The residual diagnostic tests have also come up with the required supporting results.

Notes

1. 12-month Libor rate.
2. *Ho: No Cointegration.*
   H1: Cointegration

3. Hypotheses: (LM test, H0: No Serial Correlation), (Heteroscedasticity, H0: No Heteroscedasticity), (Jarque-Bera, H0: Residuals of Variables are Normally Distributed), (Ramsey Test, H0: Functional Form of Model is Correct)
4. The data that support the findings of this study are available in world development indicators of the World Bank, the International Monetary Fund and Macrotrends.net. These data were derived from the following resources available in the public domain: [World Development Indicators | DataBank (worldbank.org), Macrotrends | The Long Term Perspective on Markets]

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