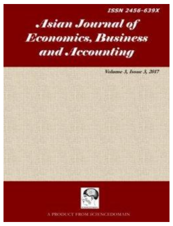

Asian Journal of Economics, Business and Accounting

6(4): 1-20, 2018; Article no.AJEBA.38008
ISSN: 2456-639X

Real Effective Exchange Rate Volatility and Its Impact on Foreign Direct Investment in Kenya

Wanyama Silvester Mackton[1*], Alphonce Odondo[1] and Destaings Nyongesa[1]

[1]*Department of Economics, Maseno University, Kenya.*

Authors' contributions

This work was carried out in collaboration between all authors. Author WSM designed the study, managed the literature searches, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors AO and DN managed the flow and analyses of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJEBA/2018/38008
Editor(s):
(1) Burçak Polat, Assistant Professor, Department of Economics, Nuh Naci Yazgan University, Turkey.
Reviewers:
(1) Ivan Milojević, University of Defence, Republic of Serbia.
(2) Juliet Libanda, Jiangsu University of Science and Technology, China.
Complete Peer review History: http://www.sciencedomain.org/review-history/24471

Original Research Article

Received 14th October 2017
Accepted 29th December 2017
Published 5th May 2018

ABSTRACT

A country's real effective exchange rate (REER) is an important determinant of the growth of cross-border trading and it serves as a measure of its international competitiveness. Studies that have focused on the relationship between REER volatility and FDI inflow have generated mixed results, thus, there is lack of clear-cut conclusion on the relationship. This study assessed the REER volatility and determined its impact on foreign direct investment in Kenya for the period 1972 – 2015. The study was guided by the Dornbusch over- shooting model and adopted correlation Research Design. It relied on secondary data. To overcome methodological deficiencies that could arise from using measures of unconditional volatility, the study focused on Generalized Autoregressive Conditional Heteroskedasticity (GARCH) technique which is a superior measure of uncertainty. Vector Error Correction Model (VECM) was used to establish the relationship between REER volatility and foreign direct investment. Augmented Dickey-Fuller and Phillip-Perron approaches were used to test for the presence of unit roots. The test for volatility conducted using the GARCH model showed that there is persistent volatility in the Kenyan shilling real effective exchange rate with that of the trading partner currencies for the period under consideration and the results of the VAR and VECM indicate a negative and significant impact of real effective exchange rate volatility

*Corresponding author: E-mail: swmackton@gmail.com;

on foreign direct investment in Kenya. Findings of this study will add value to the Dornbusch over-shooting model, production flexibility and risk aversion theories and partial and general equilibrium theories and will further help in the formulation of fiscal and monetary policies to address macro-economic shocks associated with REER shocks in the Kenyan economy.

Keywords: Real effective exchange rate; macro-economic shocks; foreign direct investment; generalized autoregressive conditional heteroscedasticity.

1. INTRODUCTION

The impact of real effective exchange rate volatility on some macroeconomic variables has become a subject of increasing debate in international macroeconomics and finance in the recent decades, in both developing and advanced countries. Advocates of fixed exchange rate argue that the exchange rate stability enhances cross-border trade and provides an attractive environment for the flow of international capital like foreign direct investment (FDI) and worsening the external competitiveness: [1-3] On the other hand, proponents of floating exchange rate regime believe that exchange rate flexibility helps automatic adjustments in response to external shocks [4,5].

The link between exchange rate volatility and FDI is regarded as one of the scant areas in literature. Foreign direct investment provides potential growth attributes like technology, specialized skills, and access to the international market [6] The host country must possess structures and mechanisms that can optimally absorb and retain these benefits, yet not all emerging markets possess this capability [7]. A host country's monetary policy is vital in playing the role of attracting foreign direct investment by creating a conducive economic environment. However, the characteristics of monetary policy present the impossible trinity, that is a problem where trade-offs must be done to maintain economic stability. Two of these anchors are inflation autonomy and exchange rate variability. These trade-offs can impact on the FDI inflow into a country [8]. The role of exchange rate in an open economy framework is important in the monetary transmission mechanism. Real exchange rates affect aggregate demand channel of the monetary transmission of the monetary policy. The direct exchange channel for monetary policy transmission affects inflation through the domestic price of imported goods and intermediate inputs, which are components of consumer price inflation [9].

Foreign direct investment has been (and is) regarded as one of the growth engines for countries with capital deficiency and technological backwardness. A foreign direct investment owner looking for a stable country for the sake of long term investment, a predictable macroeconomic environment and a strong institutional framework for contract enforcement were at the table, put forward by the foreign investor to commit to a long term investment. Africa, on the other hand, with unpredictable outbreak of wars adding to the instability of the investment environment, shaky macroeconomic policy and frame work is in need of the investment as a growth engine [10].

In addition to these factors, the collapse of the Bretton woods agreement introduced another worrisome factor to investors- a fluctuating and unpredictable exchange rate valuation due to market forces, named-volatility. This episode has also transferred itself to Africa. Exchange rate often interfered in by both the market factors (equating supply and demand of domestic and foreign currency) and a fragile macroeconomic frame work trying to control the exchange rate market has resulted in exchange rate volatility and uncertainty- another new risk factor to foreign investors in the continent.

Although the risk factors related to peace and insecurity, lack of strong contractual enforcement framework and others had been recognized and acted up on by both the foreign investor and the governments in these countries, the impact of exchange rate volatility on the foreign direct investment had been less recognized on the side of the macroeconomic analysts in these developing countries despite it serving as one of the push factors on the other side of investors when considering investment in the continent.

The Kenyan Government has made the attraction of FDI a clear policy priority and to this end established Ken invest as a semi-autonomous agency in 2004. Since that time, FDI inflows to Kenya have seen a steady increase, reaching US$ 141 million in 2009 and US$ 133 million in 2010. The exceptional inflows of US$ 729 million in 2007 are attributable to large privatization in telecommunications (Telkom Kenya and Safaricom) and investment in the railways (between 2005 and 2010 investment in the railways has reached US $404 million).

FDI from traditional sources such as Europe has been complemented by that from emerging markets. Investors from China (infrastructure development such as China Road and Bridge Construction Corporation, manufacturing and agriculture), India (ICTs such as Airtel and Yu), the Middle East (hotel and property development such as Fairmont) and South Africa (Rift valley Railways) are starting to make their presence felt.

Throughout the 1970s Kenya had been one of the prime candidates for Transnational Countries (TNCs} in eastern and southern Africa with relatively better infrastructure, market growth and openness at a time when many other countries had closed regimes. In 1975 FDI inflow appeared to be $ 17million with a sequentially rising it to $ 78million in 1980. Later, Kenya experienced fluctuations in terms of attracting FDI. The deterioration of economic performance coupled with growing corruption and mal-governance generated a low level of FDI in the 1980 which extends to date. For instance the mean annual flow of FDI into the country remained to be $60million in the 1970s falling to $30million in between 1980-1990. However, FDI begun to rise in the beginning of the 21st century especially with the licensing of mobile phone ventures for Kenyan-foreign investors pushing further the mean annual FDI inflow to $41 million in 2000-2008.

The role exchange rate volatility plays in foreign direct investment attraction/repulsion in developed countries has been widely recognized and documented in earlier empirical economic literature [11]. However, it remains less explored in countries across the African continent. This study contributed to the gap in empirical investigation of the matter for the Kenyan economy. This leads to the need to seek an answer to the question, “what is the impact of real effective exchange rate volatility on FDI in Kenya?”

1.1 Objective of the Study

The study, in broad terms, assessed empirically the real effective exchange rate (REER) volatility and its impact on foreign direct investment in Kenya.

1.2 Hypotheses of the Study

H_o 1: The real effective exchange rate in Kenya has not been volatile;
H_o 2: Real Effective Exchange Rate volatility has no impact on economic growth in Kenya;

2. THEORETICAL AND EMPIRICAL FRAMEWORK

Theoretically, the models that link between exchange rate volatility and FDI depends on two arguments. Production flexibility argument and risk aversion argument. According to production flexibility argument, exchange rate volatility fosters foreign direct investment since foreign producers are assumed to be able to adjust the use of one of their variable factors following the realization of stochastic put profits [13]. On the other hand, according to risk aversion theory, FDI decreases as exchange rate lower the certainty equivalent expected exchange rate, which in turn reduces FDI. The literature stated that using production flexibility approaches versus risk aversion approaches needs to distinguish between short-term exchange rate volatility and long-term misalignments [12]. That is, risk-aversion argument is more appropriate to short-run exchange rate volatility because firms are unlikely to be capable of adjusting factors in the short-run. The short-run factors of production are usually fixed; hence, firms will only be risk-averse to volatility in their future profits. Whereas, the production flexibility argument appears to be more appropriate for the long-term horizon because firms are now able to adjust their use of variable factors.

Through their irreversibility literature [14] established that exchange rate volatility negatively impacts on FDI, ceteris paribus, future cash flows to be derived from foreign direct investor will be more volatile if the exchange rate is volatile. [15] postulates that businesses invest in foreign countries to mitigate international trade costs that among other things embrace foreign exchange risk. Some firms prefer to meet the demand of foreign markets by setting production facilities rather than exports to mitigate foreign exchange risk.

Alexander & Murphy [16] were set to providing a formal theoretical and empirical basis for modeling the relationship between exchange rates and FDI, using US data. This study developed and provided a relatively comprehensive analysis of the effects of exchange rate changes on capital flows overtime. The internal rate of return theory for the purpose of comparing alternative investment returns was explored in the study. It represents a theoretical reasoning that suggests that exchange rate devaluation in the host economy increase FDI in such economy. Their results support the contention that US dollar devaluations induced FDI inflows into the economy.

The apparent weakness of these previous works led [17] to provide a more rigorous theoretical basis for the now apparent relationship between exchange rate and FDI. The author claimed that changes in the level of exchange rate may influence FDI because a depreciation of the exchange rate increases the relative wealth of the foreign investors, thereby increasing the attractiveness of the host country for FDI as firms are able to acquire assets in the host country relatively cheaply.

Contrary to this position, it is often argued that this matter for an investment decision is not the price of the assets, but only their rate of return. This argument is based on the premise that when the host country's currency depreciates about that of the host country, both the price and the nominal return of the assets in the host country currency falls. Given this scenario, it is believed that exchange rate movements should not affect FDI. [18] countered this argument with the submission that when capital markets are subject to information imperfections, exchange rate movements would, in fact, influence FDI. Information asymmetry causes a divergence between internal and external financing, making a latter more expensive than the former since the lenders incur monitoring costs and thus lend less than the full value of assets. Given this scenario, if foreign investors hold their wealth in foreign currency, then a depreciation of the local currency will increase the wealth position of foreign agents to domestic agents, therefore encouraging foreign investors to invest aggressively in domestic assets. The author used estimated results based on industry level data on the US inward FDI or the 1970's and 1980's to support their hypothesis.

By putting forth the hypothesis that an appreciation of the host currency would indeed increase FDI into the host currency, [12] differed completely from the earlier views of ([19] and [20]). Instead of focusing on the price of foreign assets, as [17] did, Campa's study was more along the lines of a production-based theoretical approach. According to him, a firm's decision to invest abroad depended on its expectations regarding future profit streams. Therefore, an appreciation of the host currency increases expectations of future profitability regarding the home currency. To test this hypothesis, foreign investors entering the US in the 1980s were thoroughly examined. Findings revealed that an appreciation in the United States' exchange rate stimulated FDI.

In summary, there appears to be a lack of clear-cut direction on the effect of appreciation and depreciation in the host country's exchange rate on FDI inflows. However, the nature of the effect of real exchange rate on FDI appears to depend on the nature and motive of the investments and the risk behavior of the investor.

Ochieng [21] and [22] found a weak positive relationship between exchange rate fluctuations and FDI inflows in Kenya for the period 1981 to 2010. While investigating the determinants of FDI in Kenya covering the period 1970 to 1999, [23] found that the exchange rate is one of the determinants of FDI inflows in Kenya. However, there are very few studies that have attempted to interrogate the impact of real effective exchange rate (REER) volatility on FDI based on Kenya's experience for the period under consideration. A few studies that have attempted this enquiry either focused only on levels of exchange rate or public investment, without considering the possible endogeneity between exchange rate volatility and FDI. This study will seek to measure the real effective exchange rate (REER) volatility using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model. Then employ the Two Stages Least Squares (2SLS) method to assess the impact of exchange rate volatility on foreign direct investment inflows in Kenya and help resolve lack of a clear-cut direction on the impact of REER on FDI.

3. METHODOLOGY

The impact of exchange rate volatility on foreign direct investment was estimated by the following equation:

$$FDI_t = \delta EV_t + \varepsilon_t \quad (1)$$

Where

FDI is the ratio of FDI inflow to GDP,
EV is the REER volatility and
ε is the stochastic error term.

In literature, a huge set of explanatory variables have been predicted as significant variables that attract FDI flow into the host country. However, for the purpose of this study, we focused on the impact of REER on FDI to the case of Kenya. All variables were expressed in logarithm form. The sign of real effective exchange rate volatility is inconclusive as most of the empirical studies offered ambiguous results.

3.1 Data Type and Sources

The quarterly data set covering the period 1972-2015 was selected because since 1972 the exchange rate has seen many policy interventions in Kenya. Also, by the end of the 1970s, the country had started to suffer from unfavourable economic situations. Moreover, this period ensures the availability of data on the variables under investigation. The data on REER included trade volume with major trading partners, real bilateral exchange rate, foreign price index calculated as the weighted CPI index and the domestic CPI.

The quarterly data series was sourced from various issues of the Central Bank of Kenya (CBK), Kenya National Bureau of Statistics, International Monetary Fund (IMF), UNCTAD and World Bank's world development indicators.

3.2 Measurement of Variables

3.2.1 An exchange rate

An exchange rate is the rate at which Kenyan currency may be converted into another currency. Among other things, the exchange rate determines how much the residents of Kenya pay for imported goods and services, and how much they receive as payments for exported goods and services.

3.2.2 Nominal exchange rate

Nominal exchange rate refers to the exchange rate of the Kenyan currency regarding another expressed in bilateral terms.

3.2.3 Nominal effective exchange rate

Nominal effective exchange rate is the rate of the Kenyan currency against a weighted composite basket of the Kenya's trading partner currencies.

3.2.4 Real exchange rate

Real exchange rate is expressed as the Nominal Exchange Rate adjusted for inflation.

3.2.5 Real exchange rate volatility

Real exchange rate volatility refers to short term fluctuations of the RER about their longer term trends. It also entails short-term (monthly, weekly, or even hourly) fluctuations in the exchange rates as measured by their absolute percentage changes during a particular period.

3.2.6 Real effective exchange rate

Real effective exchange rate is the rate of the Kenyan currency against a weighted composite basket of the Kenya's trading partner currencies adjusted for inflation.

3.3 Integration Properties (Unit Root Test)

The Classical Econometric Theory assumes that observed data are usually stationary in nature, whereby means and variances are constant overtime. However, the estimates of time series econometric models and historical records of economic forecasting invalidate such assumptions. To avoid spurious regression results, stationarity is important for empirical modeling.

In line with the econometric techniques, the existence of unit root(s) of each variable was tested by using, the Augmented Dickey Fuller (ADF), Phillip Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin, and called henceforth KPSS tests. Based on the unit root results we examined the evidence of cointegration among the variables using the Augmented Dickey Fuller (ADF) test as advocated by [24]. The variables were found to be cointegrated, thereby revealing the long run information on exchange rate volatility. Therefore, an Error Correction Model (ECM) was estimated. This model provided useful estimates of short run dynamics and long run relationships in the macroeconomic performance indicators.

In principle, it is important to test the order of integration of each variable in the model, to establish whether it is non-stationary and how many times the variable needs to be differenced to derive stationary series. This was done using the Augmented Dickey-Fuller and Phillips-Perron

Unit Root Tests, also referred to as the first generation tests (classical tests). The study also employed the second generation unit root tests, which included Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test of [25] and Elliot-Rothenberg-Stock unit root test.

3.4 Cointegration Analysis

Despite non- stationarity of the variables, there may exist a linear combination among the set of non-stationary variables, which is stationary, such that the variables are stationary. [24] If this is the case, then the variables are said to be cointegrating, implying that there is a long-run relationship between them such that they can be estimated in levels even if they are singly non-stationary. Failing to account for this long run relationship will result to the misspecification of the model. Thus, differencing the variables to be stationary is not a solution since it removes from them Long-run properties. Identification and estimation of cointegrating variables can be carried out using either Engle- Granger two-step procedure or Johansen procedure. [24] have produced the cointegration technique that incorporates both short run dynamics emanating from first order differences and common long run trend movements among variables. A more superior multivariate technique developed by [26] and applied in [27] was used.

[24] advocate ADF tests of the following kind

$$\Delta \varepsilon_t = \mu\varepsilon_{t-1} + \Sigma\mu_i\Delta\varepsilon_{t-1} + \mu + \delta_t + s_t \quad (2)$$

Where $s_t \sim$ NID $(0, \sigma^2)$

The residual based on ADF test for cointegration assumes that all the variables in the Ordinary Least Square (OLS) equation are all integrated of order one (1) such that the cointegration test gears to establish whether the error term is integrated of order one $\varepsilon_t \sim 1(1)$ against the alternative that is integrated of order zero $\varepsilon_t \sim 1(0)$. If some of the variables are in fact integrated of order two $1(2)$, then cointegration is still possible if the $1(2)$ series integrates down to $1(1)$ variable to cointegrate potentially with other $1(1)$ variables.

3.5 Error Correction Model (ECM)

If the variables are cointegrated, estimating the equation in first difference results in the loss of valuable information on the long run relationship between the levels of the variables. For example if;

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \varepsilon_t \quad (3)$$

Where ε_t is the error term, then;

$$Y_t - Y_{t-1} = \beta_1(X_{1t} - X_{1t-1}) + \beta_2(X_{2t} - X_{2t-1}) + \mu_{t...} \quad (4)$$

Thus, if equation (3) is estimated instead of equation (2), according to, then the information about β_0 is lost. Thus, equation (3) focuses purely on the short run relationship between Y and X. Hence, it is likely to provide a poor forecast for even a few periods ahead if a long run relationship exists but is ignored. Furthermore, the first differenced equation (3) will result in autocorrelated error term if the relationship in equation (3.1) exists; and, if disturbance term ε_t is non autocorrelated then, the disturbance term μ_t in equation (4) is of simple moving average form such that it is autocorrelated. Therefore, first differencing is an unsatisfactory method of dealing with the spurious problem. The appropriate method is to use Error Correction Model (ECM) that results in equations with first differenced and hence stationary dependent variables but avoid the problem of failing to make use of any long run information in the data. The result of cointegration test enables us to formulate an ECM. ECM relates short run changes in the dependent variable Y_t to short run changes in the explanatory variables (the impact effect), but also the long run effect through a feedback mechanism.

3.6 Vector Autoregression (VAR) Model

The Variance Decompositions (VDs) and Impulse Response Function (IRF) analysis were used to examine the dynamic relationship between exchange rate volatility and macroeconomic variables. The VDs approach identifies the proportion of the movements in the variable under study that are due to their shocks and shocks to the other variables. On the other hand, IRFs traces out the effect of a one standard deviation shock to the orthogonalized residuals of the equation on current and future values of the endogenous variables, thus, impulse responses measure the responsiveness of the dependent variables in the VAR to shocks to each of the variables. The analysis was conducted using unrestricted VAR model with FDI as endogenous variable and real effective exchange rate volatility.

It is worth mentioning that, the forecast error variance decompositions (VDs) and the impulse-response functions (IRFs) are derived from the vector autoregression model (VAR). Precisely, VDs and IRFs are the transformation of VAR model into its moving average (MA) representation [28]. The Vector autoregression (VAR) is an econometric model used to capture the linear interdependencies among multiple time series. VAR models generalize the univariate autoregressive model (AR model) by allowing for more than one evolving variable. All variables in a VAR are treated symmetrically in a structural sense (although the estimated quantitative response coefficients will not in general be the same); each variable has an equation explaining its evolution based on its own lags and the lags of the other model variables. VAR modeling does not require as much knowledge about the forces influencing a variable as do structural models with simultaneous equations: the only prior knowledge required is a list of variables which can be hypothesized to affect each other intertemporally.

A VAR model describes the evolution of a set of k variables (called endogenous variables) over the same sample period (t = I… T) as a linear function of only their past values. The variables are collected in a k x 1 Vector y_t, which has as the i^{th} element, $y_{i,t}$, the observation at time "t" of the i^{th} variable. For example, if the i^{th} variable is GDP, then $y_{i,t}$ is the value of GDP at time t.

A p^{th} - order *VAR*, denoted **VAR (*p*)**, is

$$\gamma_t = c + A_1\gamma_{t-1} + A_2\gamma_{t-2} + \ldots + A_p\gamma_{t-p} + \ell_t \ldots \quad (5)$$

Where the I – periods back observation γ_{t-1} is called the I^{th} - ***lag*** of y, c is a k x 1 vector of constants (intercepts), A_1 is a time-invariant k x k matrix and ℓ_t is a k x 1 vector of error terms satisfying

i. $E(e_t) = 0$ every error term has mean zero;
ii. $E(e_t e'_t -) = \Omega$__ the contemporaneous covariance matrix of error terms is Ω (ak x k positive-semidefinite matrix);
iii. $E(e_t e'_{t-k}) = ()$ for any non-zero k __there is no correlation across time; in particular, no serial correlation in individual error terms.

A p^{th} – order VAR is also called a VAR with p lags. The process of choosing the maximum lag p in the VAR model requires special attention because inference is dependent on correctness of the selected lag order.

4. EMPIRICAL RESULTS

4.1 Descriptive Statistics

The first step of the analysis was to compute the descriptive statistics reported in Table 1. This was done in order to get a general view of the individual variables and to identify outliers. Foreign investment direct inflow as a percentage of GDP reported a mean of 0.6177 with a maximum of 2.53 and a minimum of 0. Table 1 also presents the results of normality test. Results indicated that FDIR was normally distributed with Jarque-Bera statistic of 279.5347 with a p – value of 0.0000 < 0.05.

The plot of REER showed that it was trending. This was in line with economic theory [29]. Time series plot was also done for FDIR. The plot of FDIR indicated that there was a white noise process. This was in line with economic theory which shows that FDIR was an exogenous variable.

4.2 Correlation Analysis

After the time series variables were plotted, it was necessary to perform correlation analysis. This was done to measure the strength of association and establish the linear relationships that existed among the study variables. Results for correlation analysis are presented in Table 2. Results showed that foreign direct investment recorded a strong and positive association with REER where r = 0.2915.

4.3 Tests for Multivariate Normality

Having established the correlation levels that existed among the variables, it was necessary to test for multivariate normality. For this Doornik-Hansen test showed that the variables followed normal distribution and hence tests like z – distribution and t – distribution were suitable for the analysis. The χ^2 (14 df) = 345.230 Prob > χ^2 = 0.0000

4.4 Unit Root Tests

Having established the multivariate normality among variables, unit root tests were done on each of the individual time series and results are presented in Tables 3 and 4.

Table 1. Descriptive statistics

Variable	Mean	Std.Dev	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera	Probability
REER	-2.0572	1.1350	-4.6584	-0.2827	0.0004	0.2995	857.5843	0.0028
FDIR	0.6177	0.5581	0.0	2.53	0.0000	0.0001	279.5347	0.0000

Note: Sample, 1972q1 – 2015q4; N = 176
Source: Author, 2018

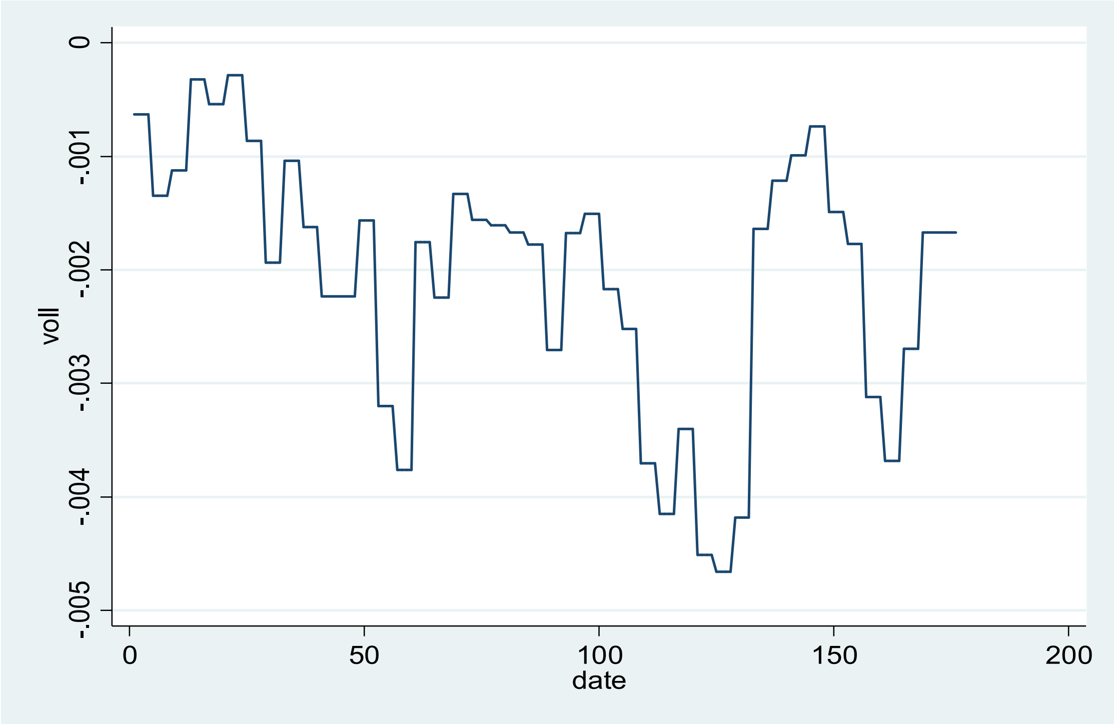

Figure 1. Time series plot for real effective exchange rate

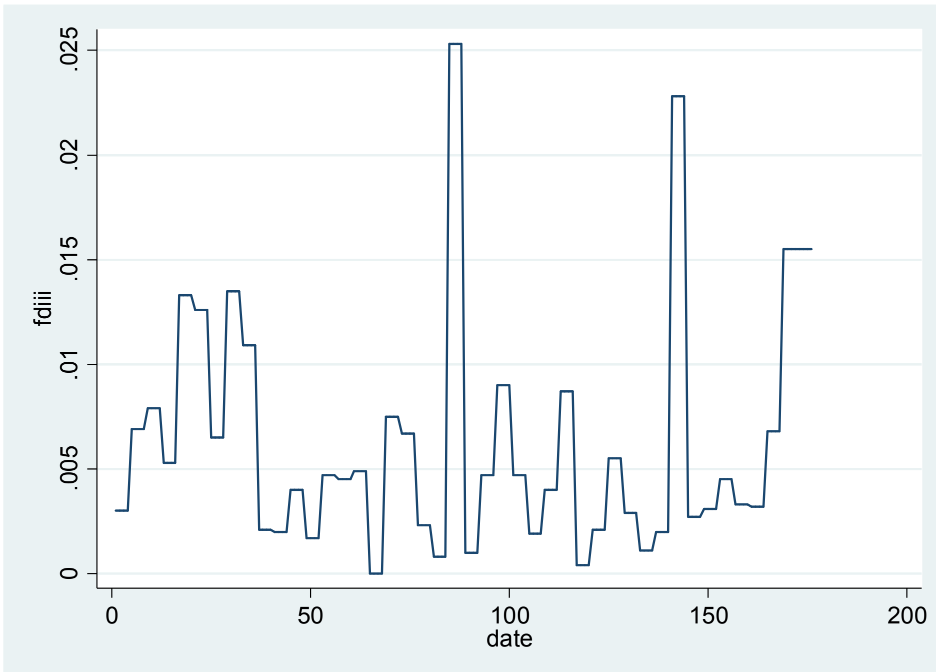

Figure 2. Time series plot for foreign direct investment (% of GDP)

Table 2. Correlation analysis

Covariance		
Correlation	**REER**	**FDIR**
REER	1.28E-06**	
	1.000000	
FDIR	0.000184**	0.309699
	(0.291485)	1.000000

Note: Sample, 1972q1 – 2015q4; N = 176
Source: Author's Research, 2017

4.4.1 Augmented dickey-fuller unit root test

Results of Augmented Dickey-Fuller presented in Table 3 showed that all the variables were integrated of order one *(I(1))*. The results of Augmented Dickey-Fuller rejected the presence of unit root in foreign direct investment with the Mackinnon p – values of 0.0233 and all were less than 0.05. Unit root was however present in real exchange rate volatility with the Mackinnon p – value of 0.0686 > 0.05. The critical values for Augmented Dickey-Fuller test were -3.628 at 1%, -2.950 at 5% and -2.608 at 10%.

When variables were first differenced results showed that they became stationary. Therefore it was concluded that the study variables were integrated of order one denoted by *I(1)* as per Augmented Dickey-Fuller test.

4.4.2 Results of phillips-perron unit root test

Results of Phillips-Perron are presented in Table 4. Results disagreed with Dickey-Fuller by showing FDI was stationary yet ADF showed that FDI had no unit root.

Table 3. Results of augmented-dickey-fuller unit root test

Variable	Intercept		Intercept and trend		None		Remark
	T – Stat	Prob	T – Stat	Prob	T – Stat	Prob	
			Level				
REER	-2.6278	0.0893	-2.6230	0.2707	-1.0867	0.2504	
FDIR	-2.6153	0.0913	-2.5135	0.3213	-0.7812	0.3764	
			First difference				
REER	-13.1175	0.0000	-13.1042	0.0000	-13.1530	0.0000	*I(1)*
FDIR	-9.1428	0.0000	-9.1592	0.0000	-9.1607	0.0000	*I(1)*

Source: Author, 2018

Table 4. Results of phillips-perron unit root test

Variable	Intercept		Intercept and trend		None		Remark
	T - Stat	Prob	T - Stat	Prob	T – Stat	Prob	
			Level				
REER	-2.7238	0.0720	-2.7585	0.2149	-1.0867	0.2504	
FDIR	-4.2898	0.0006	-4.2797	0.0042	-2.8885	0.0040	*I(0)*
			First difference				
REER	-13.1175	0.0000	-13.1042	0.0000	-13.1530	0.0000	*I(1)*
FDIR	-25.2947	0.0000	-27.2643	0.0000	-24.6334	0.0000	*I(1)*

Source: Author, 2018

The results of Philip-Perron rejected the presence of unit root in foreign direct investment; the Mackinnon p – values were 0.0196 and all were less than 0.05. The critical values for Philip-Perron test were also -3.628 at 1%, -2.950 at 5% and -2.608 at 10%.

The Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests, also referred to as the first generation tests (classical tests) cannot distinguish between unit root and near unit root stationary processes [30]. The power of the tests is low if the process is stationary but with a root close to the non-stationary boundary (1) i.e. $Y_t = 0.95Y_{t-1}+\mu_t$. The tests are poor at deciding, for example, whether φ = 1 or φ = 0.95, especially with small sample sizes. The study therefore also employed the second generation unit root tests, which included Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test of [25] and Elliot-Rothenberg-Stock unit root test.

4.4.3 KPSS and elliot-rothenberg-stock test

Results of KPSS unit root tests are presented in Table 5. Results were estimated with Newey-West Bandwidth automatic selection using Bartlett Kernel. The aim for this test is to remove deterministic trend of the series in order to make it stationary. Results indicated that real effective exchange rate and foreign direct investment as a percentage of GDP were non-stationary thereby supporting the findings of first generation unit root tests presented in section 4.4.1 and 4.4.2 above.

Results of Elliot-Rothenberg-Stock that were estimated with Schwarz Information Criteria (SIC) were similar to KPSS and also supporting first generation unit root test. The results of first difference series showed that the variables became stationary. Therefore it was concluded that the study variables were integrated of order one, denoted by *I(1).* This supports prior empirical studies [30,29,31,32] among others) and econometrics theory that indicates that macroeconomic variables were not stationary in levels but become stationary on first differencing [33-37].

4.5 Cointegration Analysis

Having established that the individual time series are integrated of order one, *I* (1), it then becomes necessary to check whether the variables are cointegrated. As explained earlier that even if there is no economic reason to suspect the variables to be cointegrated, it is important to ascertain that the foreign and the real effective exchange rate are not cointegrated to justify the appropriateness of the structural VAR, or else, the VAR model should be replaced by an error correction representation. Test results indicate that there is no evidence of cointegration among the variables under consideration.

Table 5. Results of KPSS and Elliot-Rothenberg-Stock Test

	Kwiatkowiski-phillips-schmidt shin test elliot-rothenberg-stock test				
	Intercept	Intercept with Tend	Intercept	Intercept with trend	Remark
			Level		
REER	0.4749	0.1218	4.8292	7.7434	
FDIR	0.1055	0.1061	2.7640	6.8451	
			First Difference		
REER	0.4154	0.0308	0.2784	1.0372	*I(1)*
FDIR	0.2631	0.2462	9.1196	34.6336	*I(1)*

Source: Author, 2018

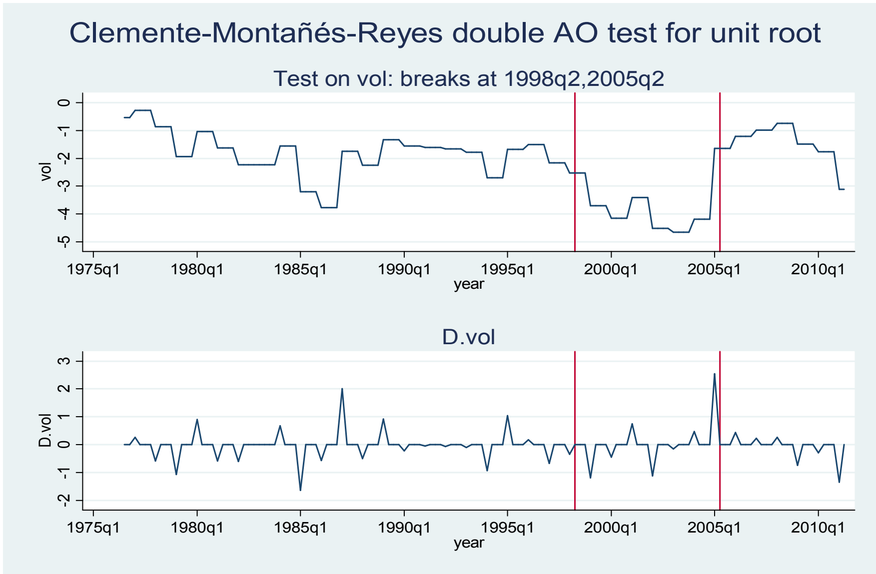

Figure. 3. Structural breaks of REER volatility

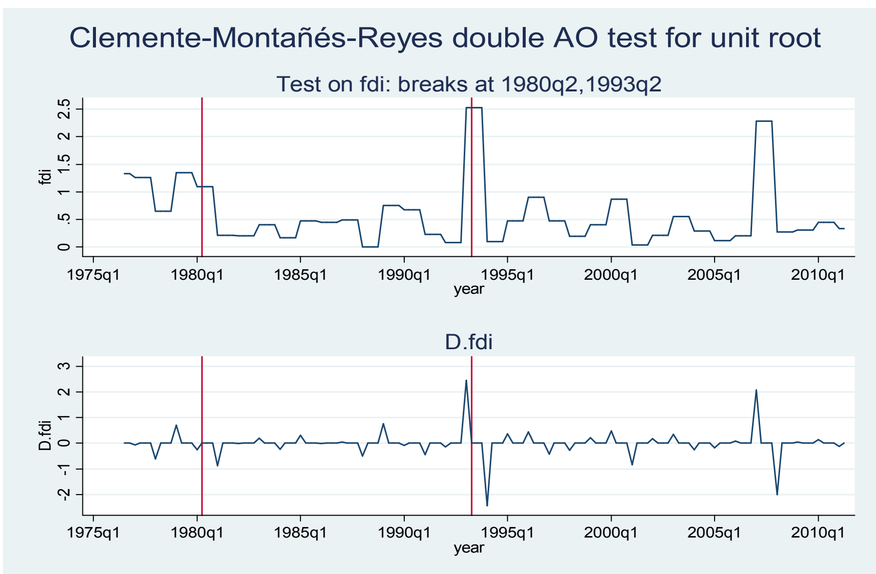

Figure 4. Structural breaks of Foreign direct investment

Before we estimate the VAR model we have to decide on the maximum lag length, K. Including too many lags will consume degrees of freedom, not to mention introducing the possibility of multicollierity [38]. Including too few lags will lead to specification errors [38]. The lag order is selected by some pre-specified criterion and based on in the construction of VAR estimates. To decide on this Final Error Prediction, Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC), the Hannan-Quinn Criterion (HQC) and the general-to-specific sequential Likelihood Ratio test (LR). Results indicated that optimum lag length was one. All information criteria selected lag length of one (1) indicated by (*) in Table 6.

The use of VAR models is a theory-free method of estimating economic relationships (Sims, 1980). Foreign direct investment as a percentage of GDP is treated as an endogenous variable and real effective exchange rate which is influenced by external factors. The results of the VAR models are presented in Table 7. The results indicate that the independent variable (REER) account for 0.8698 of the variations in the dependent variable on average.

4.6 Diagnostic Tests and Model Checking

There is normally a large number of parameters that are involved in the unrestricted VAR models which usually give rise to imprecise estimators. It is therefore more appropriate to limit the dimensionality of the parameter space by imposing some restrictions. The restrictions may be derived from non-sample information such as economic theory and from statistical procedures.

4.6.1 Stability test

This study tried to analyze the reverse roots of characteristic polynomial by carrying out a VAR stability condition check test. The results show that the moduli of the eigenvalues are actually less than one. The stability condition of VAR is confirmed by Figure 5 whose results indicate that no root lies outside the unit circle.

Table 6. Selection of optimum lag length

Lag	LL	LR	DF	P	FPE	AIC	HQIC	SBIC
0	-2421.16				72804.1	28.2228	28.2673	28.3326
1	-1696.14	1450*	36	0.000	24.1426*	20.211*	20.5228*	20.9795*
2	-1689.66	12.974	36	1.000	34.0768	20.5541	21.1333	21.9815
3	-1680.73	17.845	36	0.995	46.8602	20.869	21.7154	22.9551
4	-1667.03	27.418	36	0.847	61.1528	21.1282	22.2419	23.8731

Source: Survey Data, 2018

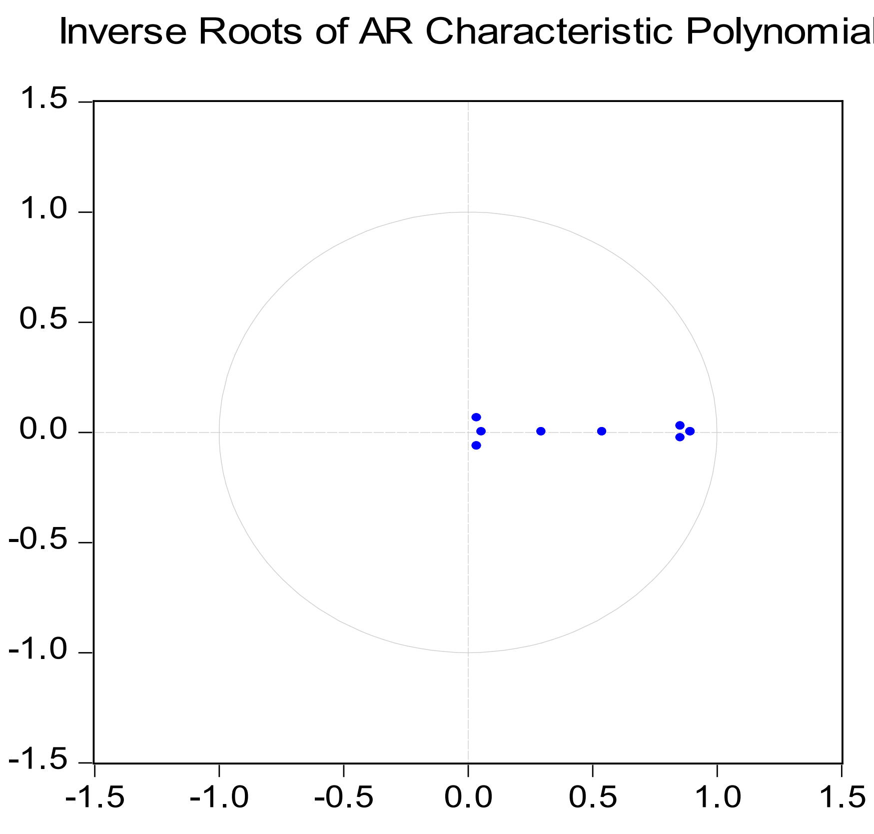

Figure 5. Roots of the companion matrix
Source: Author, 2018

Table 7. Results of vector autoregression model

Vector Autoregression Estimates
Sample (adjusted): 1972Q3 2015Q4
Included observations: 174 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	REER	FDIR
REER(-1)	-0.905030	28.83278
	(277.000)	(71.0183)
	[-0.00327]	[0.40599]
REER(-2)	-24.29463	12.39717
	(274.820)	(70.4592)
	[-0.08840]	[0.17595]
FDIR(-1)	0.078408	0.905137
	(0.30687)	(0.08849)
	[0.25551]	[10.2284]
FDIR(-2)	-0.067290	-0.155099
	(0.30744)	(0.07882)
	[-0.21888]	[-1.96773]
Constant	0.790778	0.259831
	(0.40716)	(0.10439)
	[1.94219]	[2.48907]
R-squared	0.747654	0.581415
Adj. R-squared	0.735419	0.561120
Sum sq. resids	345.8008	22.73034
S.E. equation	1.447675	0.371160
F-statistic	61.10808	28.64820
Log likelihood	-306.6476	-69.81946
Akaike AIC	3.628133	0.905971
Schwarz SC	3.791532	1.069370
Mean dependent	4.168966	0.621379
S.D. dependent	2.814439	0.560258
Determinant resid covariance (dof adj.)		2.39E-07
Determinant resid covariance		1.93E-07
Log likelihood		357.3769
Akaike information criterion		-3.693988
Schwarz criterion		-3.040390

Source: Author, 2018

4.6.2 Normality test

Having determined that the residuals are indeed stationary, a Jarque-Bera test for normality was also carried out on the residuals of the VAR models. A multivariate version of the Jarque-Bera test was conducted using the residuals that were standardized by a Cholesky Decomposition of the variance-covariance matrix for the centred residuals. The results of the Jarque-Bera test are presented in Table 8. The results fail to reject the null hypothesis that the errors in our models are normally distributed.

4.6.3 Serial correlation test

The Breusch-Godfrey LM (Lagrange-Multiplier) test and Portmanteau Test for Autocorrelations were used to test for the presence of serial correlation in the models. The results fail to reject the null hypothesis of no presence of autocorrelation in the models.

The plots of the residuals of Portmanteau Test for Autocorrelation are presented in Table 9 which shows that there is no residual autocorrelation up to lag two.

4.7 Interpretation and Discussion of VAR Estimates and Test of Hypotheses

Results of VAR for REER and FDIR are presented in Table 10. Results of Model 1 that has FDIR as a dependent variable showed that coefficient of both lagged values were significant determinants of current FDIR. The first lag was positive and significant with coefficient of 0.8489 and t-statistics of 11.1191 > 1.96. The second lagged value, however, was negative and significant. Therefore based on these findings the

Table 8. VAR residual normality tests

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 09/21/17 Time: 13:58
Sample: 1972Q1 2015Q4
Included observations: 174

Component	Skewness	Chi-sq	df	Prob.
1	0.901049	23.54478	1	0.0000
2	-0.900753	23.52933	1	0.0000
3	1.370624	54.47970	1	0.0000
4	0.095624	0.265176	1	0.6066
Joint		101.8190	4	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	12.68632	680.2293	1	0.0000
2	15.34596	1105.064	1	0.0000
3	19.82538	2052.428	1	0.0000
4	21.88603	2585.945	1	0.0000
Joint		6423.667	4	0.0000

Component	Jarque-Bera	df	Prob.
1	703.7741	2	0.0000
2	1128.593	2	0.0000
3	2106.908	2	0.0000
4	2586.211	2	0.0000
Joint	6525.486	8	0.0000

Source: Author, 2018

third null hypothesis that REER volatility has no significant impact on FDIR in Kenya was rejected. This findings support prior studies by [30] and [22] but contradicts [23].

4.8 Cointegrating Coefficients

To test for cointegration Johansen normalization restrictions were imposed. The second cointegrating relationship showed that real effective exchange rate volatility distorts equilibrium relations in the long run significantly. Similarly foreign direct investment disturbs positively the equilibrium relationships. Results indicate that real effective exchange rate corrects the deviations in the long run. The coefficient was negative and significant. Thus the speed of adjustment of FDIR was 48.35 per cent and 8.13 for REER.

4.9 VECM Long Run Relationships

4.9.1 VECM short run relationships

In model 1, cointegrating equation for D(GDPR) was negative and significant. However, for model 2, cointegrating equation for D(FDIR) was positive and significant.

4.10 Variance Decomposition

Variance decomposition shows the contribution of each shock to the n-period-ahead forecast error of the variable. It typically shows the proportion of the forecast error variance which can be attributed to its own shocks and the innovations that emanate from other variables in the model. The results of variance decomposition for real effective exchange rate are reported in Table 13. From the results it is seen that REER is 100 per cent explained by its own innovations in the first period, but its explanatory power declines over time to 93.7 per cent during the 10-th period. It is also clear that the decline is persistent and reduces marginally. Real effective exchange rate is explained by innovations of GDPR, FDIR and CABR in the proportion of approximate mean of 0.42%, 0.67% and 1.70% for each series respectively, that is, they have a significantly weak influence over the ten period time.

Table 9. VEC residual portmanteau tests for autocorrelation

VEC Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Sample: 1972Q1 2015Q4
Included observations: 173

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	0.597368	NA*	0.600841	NA*	NA*
2	0.836471	NA*	0.842741	NA*	NA*
3	7.455564	1.0000	7.578641	1.0000	28
4	70.56678	0.0067	72.18361	0.0047	44
5	73.40213	0.1146	75.10335	0.0906	60
6	75.18341	0.5049	76.94863	0.4480	76
7	76.07672	0.8848	77.87960	0.8531	92
8	143.4803	0.0127	148.5512	0.0059	108
9	145.6856	0.0892	150.8775	0.0506	124
10	145.9768	0.3476	151.1866	0.2448	140
11	147.9163	0.6656	153.2578	0.5471	156
12	204.8918	0.0439	214.4800	0.0154	172

**The test is valid only for lags larger than the VAR lag order, df is degrees of freedom for (approximate) chi-square distribution*
Source; Author, 2018

Table 10. VAR results of FDIR and REER

Vector Autoregression Estimates
Date: 09/15/17 Time: 12:01
Sample (adjusted): 1972Q3 2015Q4
Included observations: 174 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	FDIR	REER
FDIR(-1)	0.848874	2.29E-05
	(0.07634)	(8.7E-05)
	[11.1191]	[0.26409]
FDIR(-2)	-0.157450	2.07E-05
	(0.07682)	(8.7E-05)
	[-2.04967]	[0.23695]
REER(-1)	26.66405	0.955814
	(67.9363)	(0.07715)
	[0.39249]	[12.3892]
REER(-2)	15.69045	-0.037426
	(67.5230)	(0.07668)
	[0.23237]	[-0.48808]
Constant	0.283059	-0.000201
	(0.07813)	(8.9E-05)
	[3.62284]	[-2.26657]
R-squared	0.580482	0.867266
Adj. R-squared	0.570552	0.864124
Sum sq. resids	22.78105	2.94E-05
S.E. equation	0.367150	0.000417
F-statistic	58.46072	276.0552
Log likelihood	-70.01333	1109.809
Akaike AIC	0.862222	-12.69895
Schwarz SC	0.953000	-12.60818
Mean dependent	0.621379	-0.002074
S.D. dependent	0.560258	0.001131
Determinant resid covariance (dof adj.)		2.32E-08
Determinant resid covariance		2.19E-08
Log likelihood		1040.578
Akaike information criterion		-11.84572
Schwarz criterion		-11.66417

Source; Author, 2018

Table 11. Vector error correction estimates

Vector Error Correction Estimates Sample (adjusted): 1972Q4 2015Q4 Included observations: 173 after adjustments Standard errors in ( ) & t-statistics isn [ ]	
Cointegrating Eq:	**CointEq1**
FDIR(-1)	-14.76680
	(2.51625)
	[-5.86856]
REER(-1)	2.976169
	(1.11219)
	[2.67596]
C	0.008567

Source; Author, 2018

Table 12. Results of VECM (short run relationships)

Error Correction:	**D(FDIR)**	**D(REER)**
CointEq1	0.020456	-0.006059
	(0.00385)	(0.00444)
	[5.31093]	[-1.36431]
D(FDIR(-1))	0.141789	-0.041732
	(0.07854)	(0.09056)
	[1.80536]	[-0.46083]
D(FDIR(-2))	0.141789	-0.041732
	(0.07854)	(0.09056)
	[1.80536]	[-0.46083]
D(REER(-1))	-0.020163	0.005835
	(0.06976)	(0.08044)
	[-0.28903]	[0.07254]
D(REER(-2))	-0.020163	0.005835
	(0.06976)	(0.08044)
	[-0.28903]	[0.07254]
C	5.40E-06	-5.49E-06
	(2.9E-05)	(3.3E-05)
	[0.18939]	[-0.16696]
R-squared	0.147518	0.011292
Adj. R-squared	0.100448	-0.043300
Sum sq. resids	2.28E-05	3.03E-05
S.E. equation	0.000374	0.000431
F-statistic	3.134043	0.206837
Log likelihood	1124.789	1100.152
Akaike AIC	-12.88773	-12.60292
Schwarz SC	-12.70546	-12.42065
Mean dependent	7.23E-06	-6.01E-06
S.D. dependent	0.000394	0.000422
Determinant resid covariance (dof adj.)		3.12E-25
Determinant resid covariance		2.46E-25
Log likelihood		3919.714
Akaike information criterion		-44.80594
Schwarz criterion		-44.00395

Source; Author, 2018

The results of variance decomposition for foreign direct investment inflow as a percentage of GDP are indicated in Table 14. The results reveal that FDIR is 97.19 per cent explained by its own innovations in the first period which then declines to 91.42 percent during the 10-th period. Whereas REER accounts for approximately 5% of FDIR, GDPR and CABR have a significantly weak explanatory power of less than 2%.

Table 13. Variance decomposition of REER

Variance decomposition of REER:					
Period	**S.E.**	**REER**	**GDPR**	**FDIR**	**CABR**
1	0.000418	100.0000	0.000000	0.000000	0.000000
2	0.000574	99.94756	0.000227	0.037482	0.014736
3	0.000678	99.54139	0.053117	0.196251	0.209242
4	0.000756	98.80389	0.180308	0.422707	0.593099
5	0.000817	97.89138	0.339281	0.647568	1.121766
6	0.000866	96.91193	0.497266	0.837670	1.753131
7	0.000907	95.92543	0.637031	0.985802	2.451736
8	0.000940	94.96360	0.751859	1.096083	3.188456
9	0.000968	94.04353	0.840991	1.175852	3.939628
10	0.000991	93.17470	0.906686	1.232304	4.686305

Source: Author, 2018

Table 14. Variance decomposition of FDI (% of GDP)

Variance decomposition of FDIR:					
Period	**S.E.**	**REER**	**GDPR**	**FDIR**	**CABR**
1	0.371160	1.029398	1.779001	97.19160	0.000000
2	0.487491	1.449577	1.997437	96.54956	0.003424
3	0.531932	2.104925	2.033693	95.82340	0.037978
4	0.549373	2.857770	2.024966	95.01891	0.098358
5	0.557148	3.612344	2.012991	94.21448	0.160180
6	0.561379	4.312727	2.005279	93.47470	0.207298
7	0.564156	4.934746	2.002110	92.82736	0.235784
8	0.566215	5.473115	2.002981	92.27493	0.248979
9	0.567843	5.931787	2.007215	91.80840	0.252599
10	0.569173	6.318524	2.013897	91.41555	0.252028

Source: Author, 2018

5. CONCLUSION AND POLICY RECOMMENDA-TIONS

This study examined the real effective exchange rate volatility and its impact on foreign direct investment in Kenya between 1972 and 2015 using the Vector Autoregressive Model, Vector Error Correction Model, Granger causality, block Exogeneity tests , impulse response functions and variance decomposition technique. First descriptive statistics were computed. Foreign direct investment fluctuated throughout the study period and had a minimum of zero while real effective exchange rate volatility had a mean of -2.057. However, the low standard deviation showed that there were no large variations. Foreign direct investment was stationary while real effective exchange rate was non-stationary. Results of unit root test with structural breaks indicated that all the variables had significant breaks that were variable specific. These breaks were associated with various economic episodes both domestic and foreign. The variables were found to be cointegrated. There were both significant short run and long run relationships.

The result of the unit root test indicates that all the variables are integrated of order one *I* (1). The test for volatility conducted using the GARCH model showed that there is persistent volatility in the Kenyan shilling real effective exchange rate with that of the trading partner currencies for the period under consideration. This result is in consonance with the findings of ([38-41]). The result of the VAR and VECM indicate a negative and significant relationship between real effective exchange rate volatility and foreign direct investment in Kenya. This result corroborated the findings [40-43,39] and [38]. Specifically, the following recommendations are made based on the results obtained in this study:

Enhance an entrenched macroeconomic stability in the country through pursuit of appropriate *monetary and fiscal policies*: Given that a country's exchange rate policy is one of the components of the overall economic policy, its effectiveness will, in many ways, depend on the efficiency of the macroeconomic policy environment. The Kenya government and the Central Bank of Kenya should design policies and programs that will enhance the stability of a shilling in relation to other currencies especially that of the US Dollars, the Euro, the Sterling Pound in general and that of other trading partners in particular. This will promote the FDI inflow into Kenya.

Creation of a conducive investment environment which would attract foreign direct investment (FDI) through medium term policy measures: FDI is a more effective means of dealing with short-term capital and financial inflows into a country. Such policy measures as observed by [44] would ameliorate the extent of REER appreciation. It would also limit sudden and often wider REER volatility during periods of instability in Kenya whose foreign exchange markets are characterized by capital and financial flows that are usually of short-term nature;

Pursue export diversification strategy as a deliberate growth strategy to enable the economy to insulate itself from the sharp and unexpected changes in terms of trade and, by extension, stabilize domestic incomes and employment. First and foremost, reducing exchange rate volatility is quite crucial to mitigate its negative impact on FDI inflows, output growth and current account balance deficits. A lot more attention should be paid to factors that stimulate exchange rate fluctuations like high inflation and budget deficit. Thus, policymakers should consider adopting inflation targeting as a strategy in addition to the autonomy of the monetary policy. Furthermore, authorities should try to avoid systematic currency devaluations in order to maintain the exchange rate volatility at a rate that allows adjustment of the current account balance in particular and the balance of payments in general.

The economy requires an effective exchange rate policy in order to prevent the unfavorable impact of declining foreign reserves. Therefore, an encouraging exchange rate should be offered for foreign transactions and transfers to attract flows of foreign capital such as FDI and migrants' remittances. In addition, diversification of the economy should be considered as a top priority within the development agenda. In this respect, managing a competitive exchange rate would be a crucial tool to enhance FDI inflow.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/24471