

An Empirical Relationship Between Real Effective Exchange Rate Volatility and Current Account Balances in Kenya

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ABSTRACT

Deficits in the current account balances have been a common phenomenon in Kenya. Some scholars have attributed this trend to the volatility of the Kenyan shilling. Previous literatures on this issue have generated mixed results on the relationship between Kenya's real effective exchange rate (REER) volatility and current account balances, and as such this study sought to resolve this controversy. This study investigated and mapped out the profile of Kenya's REER volatility for the period 1972 to 2015 and interrogated its impact on current account balances (CAB) to fill the gap. The study was guided by Mundell-Fleming-Dornbusch model to measure REER volatility and the elasticity approach to assess the relationship between REER volatility and CAB. The study employed GARCH technique to measure REER volatility and Vector Autoregressive (VAR) model to examine the impact of REER on Current Account Balances. The study adopted Quantitative Research Design. It relied on secondary data sourced from World Bank and International Monetary Fund. Unit root tests reported stationarity when variables were first differenced, while Cointegration test results based on Johansen's maximum-likelihood procedure indicated that there is no evidence of cointegration among variables under consideration. The results of GARCH revealed that REER was indeed volatile (t -statistic $32.90 > 1.96$). The results of multivariate VAR model analysis indicated that REER (-1) volatility impacted positively and insignificantly on CAB, while REER(-2) had a negative and insignificant effect on CAB for the sampled period. Findings of this study will help in the formulation of fiscal and monetary policies to address macro-economic shocks associated with REER volatility in the Kenyan economy. In light of these results, there is need to apply appropriate macroeconomic policy mix in the short run to mitigate the cyclical and short-term shocks that arise from REER volatility and correct the country's unsustainable external imbalances in the long run.

Keywords: Real effective exchange rate; conditional volatility; generalized autoregressive conditional heteroscedasticity; current account balances; international competitiveness.

INTRODUCTION

Being a developing small open economy, Kenya is prone to both external and internal shocks which can destabilize her economy. Kenya is confronted with the challenges of designing policies to spur economic growth, improve the balance of payments position, and at the same time mitigate against the effects arising from the implementation of both microeconomic and macroeconomic policies. These policies include fiscal policy, monetary policy and the exchange rate policy. Exchange rate policy is a determinant factor in the international transactions.

Exchange rates and their rates of change overtime have been more volatile than the relative price levels and rates of inflation (1). Exchange rate volatility has been witnessed in the Kenyan economy Since the adoption of flexible exchange rate in 1993 (2).

The exchange rate is measured as a unit of domestic currency vis-à-vis a unit of the currency of Kenya's trading partners and is normally against the US Dollar. This is measured in real terms as the real effective exchange rate (REER) whereby the rate of one currency against a weighted composite basket of the country's trading partner currencies is adjusted for inflation. Kenya trades with many countries, hence, the need to focus on the composite basket of trading partner currencies. This is the most appropriate measure of the real exchange rate for a study of this nature given its ability to capture and measure the international competitiveness of countries. It also has the advantage of eliminating the bias of the sample towards actual investors when bilateral exchange rates are used.

Real Effective Exchange Rate (REER) volatility refers to short term fluctuations of the REER about their longer term trends (3). 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 (4). Increased, REER volatility may lead to higher prices of internationally traded goods by causing traders to add a risk premium to cover unanticipated exchange rate fluctuations (5; 6).

Like other developing countries that face the challenges of improving the balance of payments and stimulating economic growth, Kenya has adopted some different exchange rate regimes over the last five decades. From a fixed exchange rate regime up to 1982 to crawling peg during the period 1983 to 1993 before a floating exchange rate regime was adopted in 1993. Following the liberalization of the foreign exchange market, Kenya attained monetary independence to control inflationary pressures but lost the nominal anchor to tie down domestic prices, and thus globalization effects are transmitted directly into the country through exchange rate volatility (7). External shocks require appropriate fiscal and monetary policies to prevent the emergence of unsustainable current account deficits, growing foreign debt burdens and steady losses of international competitiveness while at the same time keeping the domestic rate of inflation at low levels, conducting a strict monetary policy stance and maintaining positive real interest rates. This has been difficult in practice.

Throughout the economic adjustment agenda, exchange rate and trade reform occupy a core position. The real effective exchange rate, by its impact on international competitiveness of an economy, assumes an overriding importance among the cohort of policy variables. The real effective exchange rate is an active source of discussions in Kenya where questions have arisen both in the policy arena as well as within the public domain revolving around the possible reasons for persistent appreciation of the shilling real exchange rate against key currencies (7). Also, Kenya's economy is now experiencing a sharp decrease in the foreign exchange reserves. Kenya adopted a unified and flexible exchange rate in the early 1990s, as part of a market-based reform program designed to improve the investment environment and stir up economic growth (8). Since then, the exchange rate has witnessed continuous shocks and interventions.

The study investigated the impact of real effective exchange rate volatility on current account balances (CAB) in Kenya. The current account balances of a host country can be viewed as an indicator of the strength of its currency. A deteriorating current account balance is likely to lead to a depreciation of the host country's currency. It is possible that potential multinational investors view current account deficits negatively because such deficits may lead to inflation and exchange rate variations.

Theoretically, a current account deficit should cause the value of the local currency to fall. In this case, the value of imports into the importing country is higher than the value of exports sold to foreigners (9). Hence, the demand for foreign currencies to buy these imports is higher than the demand for the local currency to buy the exports. Simple supply and demand analysis, therefore, suggests that the value of the local currency should fall.

Kenya's overall balance of payments positions declined by US\$ 220.7 million from a surplus of US\$ 360million in May 2011 to a surplus of US\$ 139 million in May 2012 (10). The deterioration was largely due to narrowing of the current account. The current account deficit nearly doubled to 13.1% of GDP. Imports grew by almost 20%, while exports increased by 10%, thus representing a net export of -10%.

Deficits in the current account balances in Kenya have been a common phenomenon from the 1960s. Some scholars have attributed this trend to the volatility of the shilling. Previous literatures on this issue have generated mixed results, and as such this study sort to resolve this controversy. This study investigated and mapped out the profile of Kenya's real effective exchange rate (REER) volatility for the period 1972 to 2015 by employing the GARCH technique and interrogated its impact on current account balances to fill the gap.

Overall Objective of the Study

This study, in broad terms, empirically assessed the real effective exchange rate (REER) volatility and its impact on current account balances in Kenya.

Specific Objectives

1. To determine whether real effective exchange rate in Kenya has been volatile;
2. To investigate the impact of real effective exchange rate volatility on current account balances in Kenya.

Research Hypotheses

H_01 : The real effective exchange rate in Kenya has not been volatile.

H_02

: Real Effective Exchange Rate volatility has no impact on the current account balances in Kenya.

Theoretical Framework

Measuring Real Effective Exchange Rate Volatility

Theoretical models on measuring Real Effective Exchange Rate (REER) Volatility are mixed. Economists and financial experts are yet to agree on a single theory that defines the exchange rate.

An alternative to the simple monetary model is a disequilibrium macroeconomic model that considers the differential speeds of adjustment in asset and goods markets. This leads us to the sticky-price monetary approach to the exchange rate. The most common Sticky-Price Monetary Model (SPMM) is the Dornbusch (1976) over- shooting model, which is basically an extension of the Mundell-Fleming model (11; 12). Hence this model is also known as the Mundell-Fleming-Dornbusch model.

This study was anchored on the Mundell-Fleming-Dornbusch model to measure real effective exchange rate volatility in Kenya for the period under study.

In it, the nominal output prices are assumed to be sticky - they adjust slowly over time. The consequences for the short-run behavior of the exchange rate, given imperfect price flexibility, are to generate 'over - shooting'. That is, given an initial disturbance, the exchange rate first moves beyond its long run equilibrium level, and then in the longer run moves back. This provides an explanation of an empirical phenomenon which attracted much attention in the late 1970s and early 1980s.

Exchange Rate Volatility and Current Account Balance

As for the relationship between real effective exchange rate volatility and current account balance, this study employed the elasticity approach. This idea is summarized in the Marshall-Lerner condition, which states that devaluation will have a positive effect on a country's balance of payments if the sum of the elasticities of demand for its exports and imports is greater than unity. The converse holds if it is less than unity. Dornbusch (1988) also noted that the relative impact of adjustments to the REER on the current account depends on the extent to which domestic demand can switch from tradables to non-tradables, as well as the domestic economy's ability to generate additional output to meet export demand.

THEORETICAL REVIEW

Measuring Real Effective Exchange Rate Volatility

The Dornbusch model has the mixed features of the Mundell-Fleming model and the monetary model, though it stems from the former and, is sometimes called the Mundell-Fleming-Dornbusch model. The Dornbusch model is prominently featured by the sticky price assumption and overshooting. The sticky price assumption suggests that prices are neither totally flexible nor totally fixed. With this assumption, the aggregate supply curve is flat in the short term, the slope of the aggregate supply curve gradually becomes steeper and steeper with the time horizon and the curve is vertical in the long run. In the short term, increases in output are induced by shifts in aggregate demand; in the medium term, increases in out-put are caused by shifts in aggregate demand or shifts in aggregate supply or both; and in the long run, only a shift in aggregate supply changes output. Other assumptions of the Dornbusch model include that the exchange rate is flexible, agents have perfect foresight and the Uncovered Interest Rate Parity (UIRP) holds. The real interest rate differential model by Frankel (1979) is introduced as an attempt to bridge the opposite results and conflicting policy implications often produced by the flexible monetary model and the Dornbusch model.

The model proposed by Dornbusch (1976) has three basic building blocks: uncovered interest rate parity and expectations, demand for money or the money market equilibrium and

aggregate demand for the goods market equilibrium. The model is for a small open economy, so the foreign interest rate is exogenous and the long-run equilibrium interest rate for the domestic interest rate.

The first relationship in the model is UIRP, that the expected change in the foreign exchange rate is equal to the interest rate differential between the domestic country and the foreign country. In the case of a small open economy, the expected change in the foreign exchange rate is equal to the difference between the prevailing domestic interest rate and its long-run equilibrium rate:

$$E_t(\Delta e_{t+1}) = r_t - r^* \dots\dots\dots(1)$$

Where e_t = the exchange rate in logarithms, $\Delta(e_{t+1}) = e_{t+1} - e_t$, r_t is the domestic interest rate, and r^* is the long-run equilibrium interest rate where a time sub-script is not relevant.

The second building block of the model, the demand for money equation, is the standard version:

$$m_t - p_t = \emptyset y_t - \prec r_t \dots\dots\dots(2)$$

Where m_t = demand for money, p_t is the price level, y_t is real income, and all are expressed in domestic variables and are in logarithms; and $\emptyset > 0$ and $\prec > 0$ are coefficients representing the income elasticity of demand for money, and the interest rate semi-elasticity of money demand respectively.

The third element of the model is the price adjustment process through analyzing aggregate demand and excess demand. If we leave this part out and let the A simpler way proceeds as follows. Aggregate demand is:

$$y_t^d = y^- + \delta[(e_t - p^* - p_t) - (\bar{e} + p^* - \bar{p})] - \partial(r_t - r^*) \dots\dots\dots(3)$$

i.e., aggregate demand is its long-run equilibrium level plus the effects caused by the discrepancy between the real exchange rate and the long-run real exchange rate and the discrepancy between the prevailing interest rate and the long-run equilibrium interest rate. The price adjusts in proportion to the discrepancy between aggregate demand and its long-run equilibrium level.

First the long run equilibrium properties of the model are identical to those of the monetary approach (Asset Market Equilibrium lies at the center of the model) where the asset in question is money and, where the demand for money function is stable and the supply of money is determined by the monetary authorities (the Central Bank of the country). The economic interpretation of this is that as the exchange rate rises, aggregate demand rises as net exports respond to increased competitiveness. This is offset by a rising price level which reduces aggregate demand via two mechanisms. First, the increased price level reduces competitiveness and therefore net exports. Secondly, the increasing of the price level also has the effect of reducing the real money stock, therefore increasing the domestic interest rate (the 'Keynes effect') which also reduces aggregate demand.

The Dornbusch model is interesting for its properties of dynamic adjustment, once the crucial assumption is made that asset markets adjust more quickly than do goods markets and that in the short run, the price level is sticky, while goods prices are fixed in the short run and only

adjust gradually in the long run. Thus, an increase in the money stock increases real income in the short run, both because of the fall in the interest rate and because of the (overshooting) rise in the real exchange rate. In this guise, it is tempting to see the Dornbusch model as reconciliation between Mundel–Fleming as a short run exercise, and the monetary approach as the long run equilibrium to which it tends.

Despite its popularity, the Dornbusch model has methodological limitations when examined from micro-foundation perspective. First, the model lacks explicit choice-theoretical foundations, particularly concerning micro-foundations of aggregate supply (11). Its specification of the price determination is ad hoc. The model also is ill-equipped to capture current account dynamics or the effects of government spending, since it does not account for private or government inter-temporal budget constraints (11). In addition, it does not explicitly model the implicit bond market. Nevertheless, the model has played a dominant role in the literature on exchange rate dynamics and remains one of the basic building blocks of open economy macro-models.

Exchange Rate Volatility and Current Account Balance

Two broad approaches are typically used to explain the impact of real exchange rate changes on the current account. The first, the elasticities approach, holds that an appreciation (depreciation) in the REER should result in higher (lower) levels of imported goods and services, and lower (higher) exports, given that imports would have become cheaper (more expensive) while exports would have become relatively more expensive (cheaper). The extent to which these changes may be realized will depend on the relative elasticities associated with export and import commodities. If, for example, a country relies heavily on imported intermediate inputs, i.e., there are no close substitutes; depreciation in the nominal exchange rate may not stimulate changes in imports, as the price elasticity of demand is low.

According to this approach, the success of devaluation in improving the balance of trade, and then through it the balance of payment depends upon the demand elasticity of import and export of devaluing country. An improvement in the balance of trade will depend upon whether the demand for import and export is elastic. Devaluation makes import of the devaluing country costlier than before and in case her demand for imports is elastic, a higher amount will be adversely the balance of payment of the devaluing country. However, if her demand for exports is elastic then with a fall in the prices of exports as a result of devaluation, the foreigners, which in turn will help in resting equilibrium in her demand for imports is elastic, and then the imports of the country will be significantly reduced by devaluing country.

Let $Ex^d Em^d$ = price elasticity of demand for exports and imports respectively

$Ex^s Em^s$ = price elasticity of supply for exports and imports respectively.

Then according to Learners conditions, devaluation will increase a country's balance of trade, then

$Ex^d = Em^d = Em^d > 1$ gives infinite Em^s (4)

Review of Empirical Studies

Measurement of Real Exchange Rate and Real Effective Exchange Rate

As is commonly done in the empirical literature, the real exchange rate is proxied by the nominal exchange rate (E) multiplied by the relative prices of the domestic and foreign economies (P^*/P).

This is given as:

$$R_t = \frac{E_t P_t^*}{P_t} \dots\dots\dots(5)$$

The task of deciding which measure of the exchange rate is the most appropriate is usually faced with two sets of issues. According to (13), the first is between the theoretically applied measures and the real world counterparts. The second one is between using the most appropriate measure conceptually and using a measure based on the most readily available data. In short, the translation from the real exchange rate theory to real- world data is not straight forward, due to the fact that, in most cases, there are usually a problem in reconciling between what theory postulated and the available data to execute the same. For instance, at the empirical level, due to the problem of getting data on the relative prices of tradable goods to the prices of non-tradable goods, many authors continue to proxy the real exchange rate by nominal exchange rate adjusted for movements in the prices of foreign and domestic countries (14; 15; 16). That is as we have in equation 2.1 above.

Also, the empirical treatment of the real effective exchange rate typically abstract from how to measure exchange rates when countries engage in transactions with a number of partners. In such a case, equation 2.1 can be weighted to obtain the empirical measurement of real effective exchange rate. Real effective exchange rate is measured as below:

$$REER_t = \sum_{i=1}^n w_{it} \frac{E_{it} P_{it}^*}{P_t} \dots\dots\dots(6)$$

Where, $REER_t$ is the real effective exchange rate at time t , E_t is the nominal exchange rate, P_t is the domestic price while P_t^* is the foreign price at time t respectively, w_{it} is the weight attached to each trade partner.

Using geometric weighted method, real effective exchange rates is measured as:

$$REER_t = \prod_{i=1}^n w_{it} \frac{E_{it} P_{it}^*}{P_t} \dots\dots\dots (7)$$

The trade weight w_{it} of the trading partners is sum to 1(17). The weight to be given to each bilateral rate is commonly based on the share of total imports, exports or total exports and imports. When data from only major trading partners are used for the computation, the weight to be given to the ith country's bilateral rate is computed as the country's total import and

export to the domestic economy as a percentage of domestic country's total export and import from all the selected trading partners. The formula used for calculating the trade weights is given as follows:

$$w_{it} = \frac{M_{it} + X_{it}}{\sum_{i=1}^n X_{it} + \sum_{i=1}^n M_{it}} \dots\dots\dots (8)$$

Where; w_{it} = time varying weight of country i in the overall trade volume of the country.

M_{it} = imports of home from country i at time t , X_{it} = exports of home to country i at time t

$\sum_{i=1}^n X_{it}$ = Exports of home to the n selected trading partners at time t and $\sum_{i=1}^n M_{it}$ = Imports of home to the n selected trading partners at time t

Other issues involved in the measurement of effective exchange rate include the choice of price index and the choice of trade partners among others. In practice, the choice of prices to employ usually depends on the relative price that best reflect the relative price of tradable goods to non-tradable goods. The indices available are: the consumer price index (CPI), the producer price index (PPI), the wholesale price index (WPI), the export price index (EPI) and the GDP deflator (17). The most commonly used price series are consumer price index.

Although there are theoretical reasons to prefer other types of price index when measuring competitiveness (18), CPIs have the advantage of being timely and available for a wide range of countries over a long period of time. According to Chinn (2002:119), for the purposes of calculating the relative price of tradable goods, the preferred measure is the exchange rate deflated by PPIs or WPIs. One drawback of using these indices is that, there is considerably more variation in how these price series are constructed across countries, than for the corresponding CPIs (13; 17). Concerning the choice of countries to include and their relative weights, in principle, all countries that trade with a domestic country should be included. In practice, data limitations tend to restrict the number of countries that can be considered. The actual selection is determined by practical considerations, efforts are made to ensure that the currencies included account for a high proportion of total trade of the country in question (17; 19).

Exchange Rate Volatility and Current Account Balance

As for the link between exchange rate volatility and trade volume, the literature has provided extensive evidence since the collapse of Bretton-woods system of fixed exchange rate. This is because fluctuations in the exchange rate may negatively affect the competitiveness of the tradable goods and in turn reduce the volume of trade and worsen the balance of payments position of an economy.

On the empirical front, the evidence on the impact of exchange rate volatility on trade failed to reach a consensus. A survey of previous literature on this issue yields negative and positive

impacts as well as inconclusive results. Some studies have found that exchange rate volatility exerts a negative impact on trade volume (20). Other empirical studies have found that exchange rate volatility has a positive effect on trade volume, (21) and (22), among others. Moreover, another group did not find any significant association between exchange rate volatility and trade (21); (22), among others, yet another group did not find any significant association between the variables. (21); (23); and (24) observed that the real exchange rate in Kenya experienced episodes of appreciations coupled with volatility in the 2005-2010 period. Studies like (25); (26); and (27) found a negative relationship between the variables. (28) held that the effect could be positive, negative or zero depending on the export prices. However, the relationship between the real effective exchange rate and current account balances for the Kenyan economy has not been adequately investigated.

METHODOLOGY

Data Type and Sources

The quarterly data set covering the period 1972 - 2015 was selected because since 1972 the exchange rate has seen policy interventions (such as changes from fixed exchange rate to floating exchange rate regimes) in Kenya. Also, by the end of the 1970s, the country had started to suffer from unfavourable economic situations. Moreover, this period was dictated by 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 other data included the current account balances measured as a ratio of CAB to GDP.

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. These data were posted to excel and transformed to quarterly values before being exported to EVIEWS for analysis.

Data Analysis

Real Effective Exchange Rate Volatility

Measuring exchange rate volatility is one of the controversial issues in the recent economic literature. Several measures of volatility have been employed in the literature, including standard deviations and Autoregressive Conditional Heteroscedasticity (ARCH) techniques. However, methods based on standard deviation suffer from many shortcomings. To correct for this apparent deficiencies, the ARCH was introduced by (29) and later modified by (30) as the GARCH. Ever since, different variants of the ARCH and GARCH models have emerged. One of the asserted superiority of the ARCH and its variants over the standard deviation measures is their ability to distinguish between predictable and unpredictable elements in the real exchange rate formation process, and are, therefore not prone to overstating volatility (31).

To overcome the methodological deficiencies of standard deviation methods, the study used the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) developed by (30). The advantage of the GARCH method over the standard deviation measures is their ability to discriminate between predictable and unpredictable elements in the exchange rate formation process, and therefore, they serve as accurate measures of volatility (31) and (32). (33) noted

that GARCH (1,1) is the most widely used specification in Autoregressive Conditional Heteroscedasticity (ARCH) family.

The study investigated the relationship between exchange rate volatility and current account balances during the period 1972q1–2015q4. The Vector Autoregressive (VAR) Model was used to establish the impact of exchange rate volatility on current account balances.

Therefore, the conditional variance of GARCH model could be specified as follows:

$$\ln REER_t = \alpha_0 + \alpha_1 \ln REER_{t-1} + e_t; \text{ where } e_t \sim (0, h_t) \dots\dots\dots (9)$$

$$h_t = \alpha + \beta e^2_{t-1} + \gamma h_{t-1} + \mu_t \dots\dots\dots (10)$$

This equation means that the conditional variance is a function of three terms: the mean, denoted by α ; that is information about volatility from the previous period, measured as the lag of the squared residual from the mean equation e^2_{t-1} (the ARCH term), and the variance of previous period's forecast error; denoted h_{t-1} (the GARCH term). Accordingly, the GARCH (1, 1) conditional variance on quarterly real effective exchange rate (REER) over the period 1972–2015 was estimated.

Model Specification for the Impact of REER Volatility on Current Account Balance

In order to test for a significant relation between exchange rate volatility and the current account balance, we estimate the following equation:

$$\frac{CA}{Y}_t = \alpha_1 + \delta X_t + \beta EX_t + \varepsilon_t \dots\dots\dots (11)$$

where the dependent variable is the ratio of the current account balances to GDP for country i at time t. The vector X includes a set of control variables affecting saving and investment. In particular, following the literature on the determinants of current account balance, they included the following variables: i) relative income; ii) relative income squared; iii) GDP growth; iii) FDI inflows; iv) Inflation; v) credit-to-GDP (financial deepening); vi) public deficit; vii) Openness viii) and capital controls.

Therefore as for the impact of exchange rate volatility on current account balance, the analysis followed (34) model (equation 12) by making some adjustments to suit the current study. Therefore, the adjusted estimatable current account equation is specified as follows:

$$CA_t = \delta EV_t + \varepsilon_t \dots\dots\dots (12)$$

For all the $\varepsilon_t \sim \text{IId} (0, \delta^2)$;

Where CA_t is the current account balance at time t; EV_t is REER volatility at time t and ε_t is the error term at time t. All variables in the model were used in logarithm form, except current account balance that bears negative signs in some years. According to economic theory, the impact of real effective exchange rate volatility on current account balance would be either negative or positive.

Integration properties (Unit root tests)

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. Hence, as is common in time series analysis, before estimating regression models, all series require to be tested for unit root to avoid spurious regression.

The existence of unit root(s) of each variable was tested by using Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests for a unit root in line with the econometric techniques. The PP test has an advantage over the ADF test as it gives robust estimates when the series has serial correlation and time dependent heteroscedasticity, and there is a structural break (35). Since the unit root tests are sensitive to the lag length, the study used the Akaike Information Criterion (AIC) to select the optimal lag length. The study utilized the quarterly time series data covering the period 1972-2015.

Based on the unit root results, evidence of cointegration among the variables was examined using the Augmented Dickey Fuller (ADF) test as advanced by (26). If the variables are cointegrated then, we have the long run information on exchange rate volatility. Therefore, an Error Correction Model (ECM) is 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. There are several ways of testing for the presence of unit root. The emphasis here is on using the Augmented Dickey-Fuller, and Phillip-Perron approaches to testing the null hypothesis that a series does contain a unit root (i.e. it is non-stationary) against the alternative of stationarity.

The Augmented Dickey-Fuller (ADF) Test

To illustrate the use of the Dickey-Fuller test, consider first an Autoregressive process of order one, AR (1) process.

$$Y_t = \mu + \rho y_{t-1} + \varepsilon_t \dots\dots\dots (13)$$

Where; μ and ρ are parameters and ε is assumed to be white noise. Y_t is a stationary series if $-1 < \rho < 1$. If $\rho = 1$, Y_t is a non-stationary series that exhibit a random walk with drift, μ . The hypothesis of stationary series can be evaluated by testing whether the absolute value of ρ is strictly less than 1. Dickey Fuller (DF) test takes the unit root as the null hypothesis $H_0: \rho = 1$ tested against the one sided alternative $H_1: \rho < 1$.

The test was carried out by estimating an equation with y_{t-1} subtracted from both sides of the equation (13), such that:

$$\Delta Y_t = \mu + \gamma y_{t-1} + \varepsilon_t \dots\dots\dots (14)$$

Where $\gamma = \rho - 1$ and the null and alternative hypotheses are $H_0: \gamma = 0$ and $H_1: \gamma < 0$, respectively. The test was carried out by performing a t-test on estimated γ . The t-statistics under the null hypothesis of unit root does not have conventional t-distribution. If the series is correlated at higher order lags, the assumption of white noise disturbance is violated (36; 37).

The Augmented Dickey Fuller (ADF) test makes a parametric correction for higher order correlation by assuming that the Y_t series follows an Autoregressive process of a higher order than one AR (p) and adjusting the test methodology. The ADF approach controls for higher order correlation by adding lagged difference terms of the dependent variable to the right hand side of the regression, such that:

$$\Delta Y_t = \alpha + \beta y_{t-1} + \delta t + \zeta_1 \Delta y_{t-1} + \zeta_2 \Delta y_{t-2} + \dots + \zeta_k \Delta y_{t-k} + \varepsilon_t \dots\dots\dots (15)$$

This augmented specification is then used to test the hypothesis that, $H_0: Y = 0$ and $H_1: Y < 0$. An important result obtained by (36) is that asymptotic distribution of the t-statistic on Y is independent of the number of lagged first differences included in the ADF regression. Moreover, while the parametric assumption that y_t follows an Autoregressive (AR) process may seem restrictive, (37) demonstrated that the ADF test remains valid even when the series has a moving average (MA) component provided that enough lagged difference terms are used to augment the regression.

The Phillip-Perron (PP) Test

(38) propose a non-parametric method of controlling for higher- order serial correlation in a series. The test regression for the Phillips-Perron (PP) test is the AR (1) process:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \varepsilon_t \dots\dots\dots (16)$$

While the ADF test corrects for higher order serial correlation by adding lagged differenced terms on the right-hand side, the PP test makes a correction to the t-statistic of the γ coefficient from the AR(1) regression to account for the serial correlation in ε_t (38).

The correction is nonparametric since an estimate of the spectrum of ε_t at frequency zero is used that is robust to heteroskedasticity and autocorrelation of unknown form. The asymptotic distribution of the PP t-statistic is the same as the ADF t- statistic. As with the ADF, test one has to specify whether to include a constant, a constant and a linear trend, or neither in the test regression. For the PP test, the truncation lag q for the Newey- West correction is specified (that is, the number of periods of serial correlation to include).

The Kwiatkowski, Phillips, Schmidt and Shin test

The alternative test introduced in 1992 by Kwiatkowski, Phillips, Schmidt and Shin, and called henceforth KPSS test has a null of stationarity of a series around either the mean or a linear trend; and the alternative assumes that a series is non-stationary due to the presence of a unit root. In this respect, it is innovative in comparison with the earlier Dickey-Fuller test, or Perron type tests, in which null hypothesis assumes presence of a unit root.

In the KPSS model, series of observations is represented as a sum of three components: deterministic trend, a random walk, and a stationary error term. The model has the following form:

$$y_t = \xi_t + r_t + \varepsilon_t \dots\dots\dots (17)$$

Where; $r_t = r_{t-1} + u_t$, y_t , $t = 1, 2, \dots$, t denotes a series of observations of variable of interest, t - deterministic trend, r_t is random walk process, ε_t - error term of the first equation, by

assumption is stationary. u_t - denotes an error term of the second equation and by assumption is a series of identically distributed independent random variables of expected value equal to zero and constant variation $\hat{\sigma}_u^2$. By assumption, an initial value r_0 of the second equation in (3.13) is a constant; and it corresponds to an intercept.

The null hypothesis of stationarity is equivalent to the assumption that the variance $\hat{\sigma}_u^2$ of the random walk process r_t in equation (3.13), equals zero. In case when $\xi=0$, the null means that y_t is stationary around r_0 . If $\xi \neq 0$, then the null means y_t is stationary around a linear trend. If the variance $\hat{\sigma}_u^2$ is greater than zero, then y_t is non-stationary (as sum of a trend and random walk), due to the presence of a unit root.

Subtracting y_t from both sides of the first equation in equation (3.13) we obtain:

$$\Delta y_t = \xi + u_t + \Delta \varepsilon_t = \xi + w_t \dots\dots\dots (18)$$

Where w_t , due to assumption that ε_t and u_t are independently identically distributed random variables, is generated by an autoregressive process AR (1), (see 39): $w_t = v_t + \theta v_{t-1}$. Hence the KPSS model may be expressed in the following form:

$$y_t = \xi + \beta y_{t-1} + w_t \dots\dots\dots (19)$$

Where $w_t = v_t + \theta v_{t-1}$, $\beta=1$

This equation expresses an interesting relationship between KPSS test and DF test checks $\beta=1$ on assumption that $\theta=0$; where θ is a nuisance parameter. (39) assume that β is a nuisance parameter, and test whether $\theta=1$, assuming that $\beta=0$. They introduce one-side Lagrange Multiplier test a null hypothesis $\sigma_u^2=0$ with assumption that u_t have a normal distribution and ε_t are identically distributed independent random variables with zero expected value and a constant variance σ_ε^2 .

The analysis concerning the KPSS test, due to its form and to the way of formulating null and alternative hypotheses, should be used jointly with unit root test, e.g. the DF or augmented DF test. Comparison of results of the KPSS test with those of unit root test improves quality of inference; (40). Testing both unit root hypothesis and the stationarity hypotheses helps to distinguish the series which appear to be stationary, from those which have a unit root, and those, for which the information contained in the data is not sufficient to confirm whether series is stationary or non-stationary due to the presence of a unit root.

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 (26). 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, results in 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. (26) have produced the cointegration

technique that incorporates both short run dynamics emanating from first order differences and common long run trend movements among variables. In this study the Engle-Granger two-step procedure is used to test for cointegration.

After establishing the order of integration, the next step was to establish whether the non-stationary variables are cointegrated. According to (26), individual time series could be non-stationary, but their linear combinations can be stationary if the variables are integrated of the same order. This is because equilibrium forces tend to keep such series together in the long-run. As such, the variables are said to be cointegrated and error-correction terms exist to account for the short – term deviations from the long-run equilibrium relationship implied by the cointegration. Furthermore, the differencing of non-stationary variables to achieve stationarity leads to loss of some long-run properties.

To test for cointegration among the non-stationary series can be carried out using either Engel – Granger two – step procedure or Johansen procedure. A more superior multivariate technique developed by Johansen and applied in (41) was used. (26) advocate ADF tests of the following kind:

$$\Delta \varepsilon_t = \mu \varepsilon_{t-1} + \sum \mu_i \Delta \varepsilon_{t-1} + \mu + \delta_t + s_t \dots\dots\dots (20)$$

Where $s_t \sim \text{NIID}(0, \sigma^2)$. 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 $\varepsilon_t \sim I(1)$ against the alternative that is integrated of order zero $\varepsilon_t \sim I(0)$. If some of the variables are in fact integrated of order two $I(2)$, then cointegration is still possible if the $I(2)$ series cointegrates down to $I(1)$ variable to cointegrate potentially with other $I(1)$ variables.

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;

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \varepsilon_t \dots\dots\dots (21)$$

Where ε_t is the error term, then;

$$Y_t - Y_{t-1} = \beta_1(X_{1t} - X_{1t-1}) + \beta_2(X_{2t} - X_{2t-1}) + \mu_t \dots\dots\dots (22)$$

Thus, if equation (3.17) is estimated instead of equation (3.18), according to (26), then the information about β_0 is lost. Thus, equation (3.18) 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 (3.18), will result in auto correlated error term if the relationship in equation (3.17) exists; and, if disturbance term ε_t is non autocorrelated then, the disturbance term μ_t in equation (3.18) is of simple moving average form such that it is auto correlated.

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 3.6.3 Techniques of Analysis

Measuring Real Effective Exchange Rate

The real exchange rate (RER) was obtained by adjusting nominal exchange rate (NER) with inflation differential between domestic economy, and foreign trading partner's economies. The derivation of the RER, therefore, requires that the data of the NER, domestic inflation and foreign inflation be obtained. Since the Kenyan shilling appreciated against some currencies and depreciated against others during the study period, the nominal effective exchange rate (NEER) is constructed.

The NEER was delivered by weighting the bilateral shilling exchange rate against its trading partners currencies using the value of Kenya 'trade (imports plus exports) with its respective trading partners. The data required to derive the NEER is the Kenya's bilateral exchange rates with respective trading partners. Since some of the data on bilateral exchange rates are originally expressed regarding United States (US) dollars, cross rates were obtained, so as to have all bilateral exchange rates expressed regarding Kenya shilling per foreign currency.

The calculation of NEER was achieved through the arithmetic mean approach that involves summing up the trade weighted bilateral exchange rates as shown in Equation 3.19 below.

$$NEER = \sum_{it}^n ER_{it} * W_{it} \dots\dots\dots (23)$$

Where ER_{it} is Kenya's bilateral exchange rate index with country i at time t while W_{it} is the bilateral trade weight for Kenya's i^{th} trading partner at time t . Each bilateral exchange rate index (ER_{it}) in Equation 23 is computed as follows:

$$ER_{it} = \left[\frac{NER_c}{NER_{t=0}} \right] * 100 \dots\dots\dots (24)$$

Where, the NER_c is an index of Kenya shilling exchange rate per unit of trading partner's currency in the base period (2007) while $NER_{t=0}$ is the index of Kenyan shilling exchange rate per unit of trading partner currency in the current period/ year. The choice of 2007 as the base year is rationalized regarding relative stability of the economy and low volatility in the domestic, foreign exchange market during the year. Kenya's Gross Domestic Product (GDP) growth rate during this period was 7.1%, the highest rate ever achieved during the 1972-2015-study period.

The year 2007 also enjoyed macroeconomic stability, with an inflation rate that were not only low but also stable while the current account balance, as well as fiscal deficits, were considered to have been at sustainable levels. Each monthly bilateral trade weight in equation (23) was computed as a ratio of total trade (exports plus imports for each trading partner to the ratio of total trade (pus export imports) for all Kenya's trading partners. The formula to be used in deriving the trade weights is:

$$w_{it} = \left[\frac{\sum(X_{it} + m_{it})}{\sum(X_t + m_t)} \right] \dots\dots\dots (25)$$

Where X_{it} is the total value of Kenyan 's exports to i^{th} trading partner at time t . M_t is the total value of imports from Kenya's i^{th} trading partner also in time t . X_t are Kenya's total exports to

all trading partners at time t , and M_t are total imports to all trading partners at time t . In this study $i=1,2,\dots,n$. Where n is the total number of Kenya's trading partners which in this study will be 140. The NEER is obtained by combining equation 24 and equation 25 using the following formula:

$$NEER_t = \sum_{it}^n ER_t * W_t \dots\dots\dots (26)$$

Where ER_t is the bilateral exchange rate (equation 24) and W_t is the bilateral trade weight, n is the total number of countries which is 50. Based on equation 26 a decline in NEER represents an appreciation while an increase represents a depreciation of the NEER. This is because in the calculation of the NEER index, the base year (2007) exchange rate is taken as the denominator while the current exchange rate is taken as the numerator.

In order to obtain the real effective exchange rate (REER), the NEER was adjusted by the relative price indices of Kenya and the weighted average price indices of Kenya's trading partners. In an equation form, this is expressed as:

$$REER_t = NEER_t \left[\frac{P_{wt}}{P_{dt}} \right] \dots\dots\dots (27)$$

Where P_{dt} is the price level in Kenya proxied by consumer price index (CPI) at time t and P_{wt} is the weighted average price level of Kenya's trading partner countries proxied by weighting CPI at time t . The price level of Kenya's trading partner countries is obtained by adding all the trade weighted price levels proxied by CPI of Kenya trading partners.

This is shown in an equation form as follows:

$$P_{wt} = \sum_{it}^n P_{it} * W_t \dots\dots\dots (28)$$

Where P_{it} is the price level of Kenya's i^{th} trading partner country's proxied by CPI at time t . W_{it} is the trade weight of Kenya's i^{th} trading partner country at time t . These weights are the same as those in the derivation of REER.

Generalized Autoregressive Conditional Heteroscedasticity (GARCH)

Since its "discovery" by (29), ARCH modeling has become a growth industry, with all kinds of variations on the original model. One that has become popular is the generalized autoregressive (GARCH) model, originally modified by (30) as the GARCH. The simplest GARCH model is the GARCH (1, 1) model, which can be written as:

$$\delta_t^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \mu_2 \sigma_{t-1}^2 \dots\dots\dots (29)$$

Which says that the conditional variance of μ at time t depends not only on the squared error term in the previous time period as in ARCH (1) but also on its conditional variance in the previous time period? This model can be generalized to a GARCH (p, q) model in which there are p lagged terms of the squared error term and q terms of the lagged conditional variances. We will not pursue the technical details of these models, as they are involved, except to point out that a GARCH (1,1) model is equivalent to an ARCH (2) model and a GARCH (p, q) model is equivalent to an ARCH ($p + q$) model.

Financial time series, such as stock prices, exchange rates, inflation rates, etc. often exhibit the phenomenon of volatility clustering, that is, periods in which their prices show wide swings for an extended time period followed by periods in which there is relative calm. As (42) notes:

Since such (Financial time series) data reflect the result of trading among buyers and sellers at, for example, stock markets, various sources of news and other exogenous economic events may have an impact on the time series pattern of asset prices. Given that news can lead to various interpretations, and also given that specific economic events like an oil crisis can last for some time, we often observe that large positive and large negative observations in financial time series tend to appear in clusters.

Knowledge of volatility is of crucial importance in many areas. For example, considerable macro econometric work has been done in studying the variability of inflation over time. For some decision makers, inflation in itself may not be bad, but its variability is bad because it makes financial planning difficult.

The same is true of importers, exporters, and traders in foreign markets for variability in the exchange rates mean huge losses or profits. Investors in the stock market are obviously interested in the volatility of stock prices, for high volatility could mean huge losses or gains and hence greater uncertainty. In volatile markets it is difficult for companies to raise capital in the capital markets.

Vector Autoregressive (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 four endogenous variables, including economic growth, FD1, current account balance and 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 autoregressive model (VAR). Precisely, VDs and IRFs are the transformation of VAR model into its moving average (MA) representation (43). However, the main challenge of employing VDs and IRFs analysis is the selection of the order of the variables in the VAR system. This is because orthogonalisation involves the assignment of contemporaneous correlation only to specific series.

Specifically, the first variable in the ordering is not contemporaneously affected by shocks to the other variables, but shocks to the first one do affect the other variables in the system: the second variable affects the other variables contemporaneously (except the first one), but it is not contemporaneously affected by them; and so on. Therefore, this follows (43) work that

suggested starting with the most exogenous variable in the system and ending with the most endogenous one.

The Vector autoregressive (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 ($t = 1 \dots T$) as a linear function of their past values. The variables are collected in a $k \times 1$ 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 CAB, then $y_{i,t}$ is the value of CAB at time t .

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

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + \ell_t \dots\dots\dots (30)$$

Where the i – periods back observation y_{t-1} is called the i^{th} - lag of y , c is a $k \times 1$ vector of constants (intercepts), A_1 is a time-invariant $k \times k$ matrix and ℓ_t is a $k \times 1$ vector of error terms satisfying the following assumptions;

- 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 (a $k \times k$ positive-semi definite matrix);
- iii). $E(e_t e_{t-k}') = 0$ 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.

Order of integration of the variables: All variables have to be of the same order of integration. The following cases are distinct:

- All the variables are $I(0)$ (stationary): one is in the standard case, that is a VAR model in levels.
- All the variables are $I(1)$ (non-stationary) with $d > 0$:
 - The variables are cointegrated: the error correction term has to be included in the VAR. The model becomes a Vector Error Correction Model (VECM), which can be seen as a restricted VAR.
 - The variables are not cointegrated: the variables have first to be differenced d times and one has a VAR in difference.

Table 1: Prior Expectations

VARIABLE	MEASUREMENT	APPROPRIATE EXPECTATION
REER Volatility	Standard Deviation (Variance)	+ve / -ve
CAB	Ksh. Million	-ve

EMPIRICAL RESULTS

Descriptive Statistics

The first step of the analysis was to compute the descriptive statistics reported in Table 2. This was done in order to get a general view of the individual variables and to identify outliers. The current account balance as a percentage of GDP registered a mean of -6.1650 with a maximum of 0.888 and a minimum of -18.68.

The real effective exchange rate recorded a maximum of 128.0377, a minimum of 91.2429 and an average of 102.4101. This meant that the real effective exchange rate was very volatile. It recorded the highest fluctuation of 128 meaning that the Kenyan currency depreciated in relation to the World's major currencies during the study period. The null hypothesis of Jarque-Bera test states that "the data is not normally distributed". This null hypothesis was rejected for all univariate time series variables under study.

Table 2 also presents the results of normality test. Results indicated that CAB was normally distributed with Jarque-Bera test statistics of 816.1841 with p – value $0.0002 < 0.05$. REER was also normally distributed with 270.2337 as Jarque-Bera statistic and p – value $0.0000 < 0.05$.

Table 2: Descriptive Statistics

Variable	Mean	Std.Dev	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera	Probability
REER	102.410	6.4440	91.2429	128.0377	1.8212	7.8568	270.2337	0.0000
CAB	-6.1650	4.8034	-18.68	0.888	0.0000	0.1729	816.1841	0.0002

Source: Author's Survey, 2018

The plot of REER is presented in Figure 1. It shows that REER was trending during the period under study. This is in line with economic theory (44).

Dreer

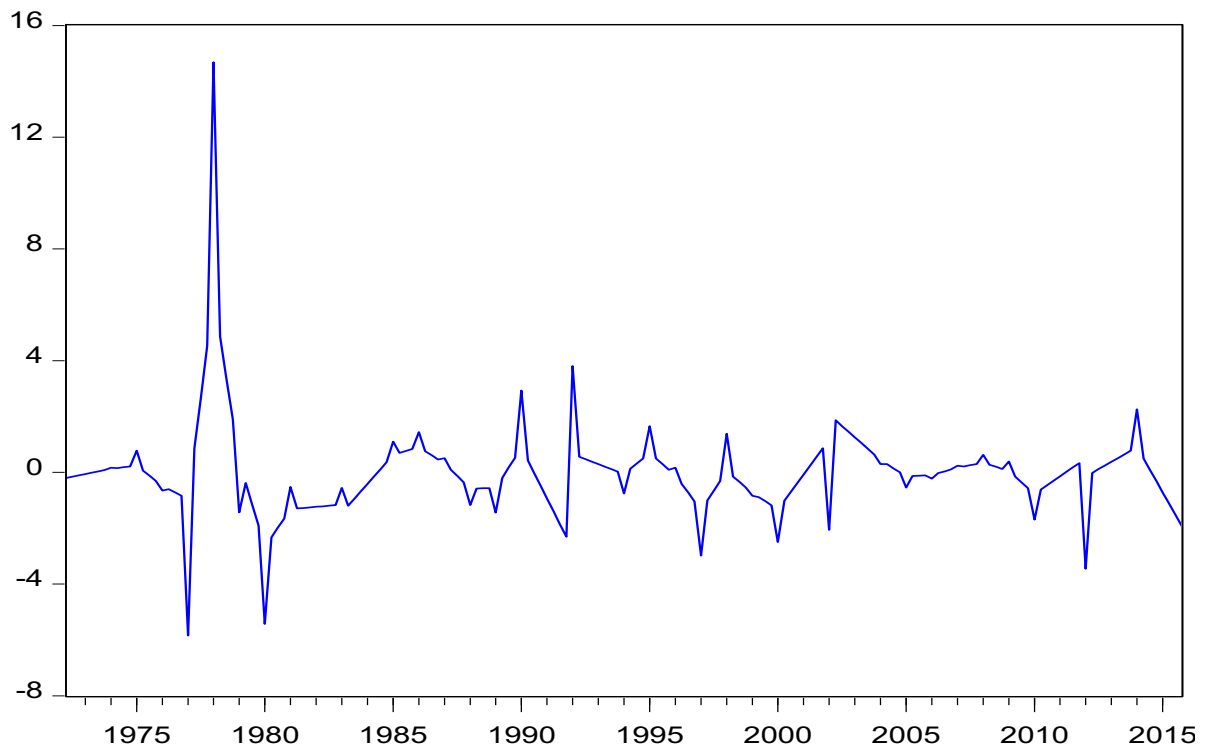


Figure 1: Time series plot for Real Effective Exchange Rate
Source: Author's Survey, 2018

The plot of CAB presented in Figure 2 showed that it was trended and was increasing over time, during the period under consideration.

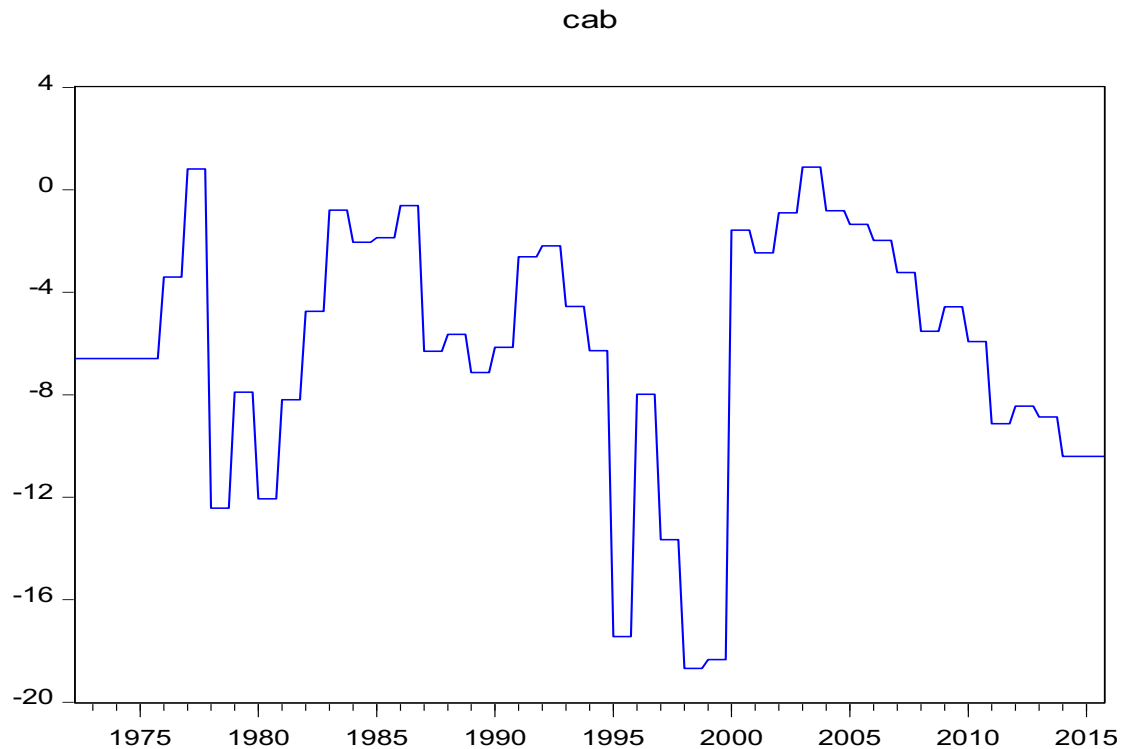


Figure 2: Time series plot for Current Account Balance (% of GDP)

Source: Author's Survey, 2018

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 bivariate association that existed among the study variables. Results for correlation analysis are presented in Table 3. The sample period is 1972q1 to 2015q4. Results showed that real effective exchange rate (REER) has a negative and strong association with the current account balance (CAB) with a p-value of 0.000 and a Correlation Coefficient of -0.128759 at 5% level of significance.

Table 3: Correlation Matrix

Covariance		
Correlation	REER	CAB
REER	1.000000	6.98E-07
CAB	(-0.128759)	1.000000

**** Indicate the association is significant; values in parentheses are Spearman's Correlation Coefficient.**

Source: Author's, Survey, 2018

Test for Multivariate Normality

Having established the correlation levels that existed among the variables, it was necessary to test for multivariate normality. The results of Doornik-Hansen test presented in Table 4 showed

that the variables followed normal distribution and hence tests like z – distribution and t – distribution were suitable for the analysis. The χ^2 (14df) = 345.230; Prob. > χ^2 = 0.000. This showed that the study variables were multivariate normal therefore inferences can be drawn by applying parametric tests such as t-statistics; and F-Statistics.

Table 4: Results of Doornik-Hansen test for Multivariate Normality

Type of Test	Df	χ^2	Pob > χ^2
Doornik-Hansen	14	345.230	0.000

Source: Author's Survey, 2018

Unit Root Tests without Structural Breaks

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 5 and 6.

Augmented Dickey-Fuller Unit Root Test

Results of Augmented Dickey-Fuller presented in Table 5 showed that Current account balance (CAB) was integrated of order zero when the test was done with intercept.

The results of unit root tests are presented in Tables 5 and 6. The results of Augmented Dickey-Fuller showed that Unit root was present in real exchange rate volatility and current account balance with the p – values of 0.2504 and 0.0637 all > 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. The Mackinnon p-values were 0.0233 and all were less than 0.05 Therefore, as per Augmented Dickey-Fuller test, it was concluded that the study variables were integrated of order one denoted by $I(1)$. Other studies have also shown that macroeconomic time series variables are normally integrated of order one (Greene, 2012).

Table 5: 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	
CAB	-3.1926	0.0221	-3.2089	0.0861	-1.8335	0.0637	
First Difference							
REER	-13.1175	0.0000	-13.1042	0.0000	-13.1530	0.0000	<i>I(1)</i>
CAB	-13.1161	0.0000	-13.0832	0.0000	-13.1530	0.0000	<i>I(1)</i>

***Mackinnon p – values 0.0233**

Source: Author's Survey, 2018

Results of Phillips-Perron Unit Root Test

Monte Carlo simulation has shown that the power of the ADF test is very low (20). Therefore, in practice it is recommended that researchers should use more than one unit root test in order to compare the performances and facilitate robustness. The ADF test is unable to distinguish clearly between non-stationary and stationary series with a higher degree of autocorrelation

and is quite sensitive to breaks (20). To overcome this limitation, the semi-parametric Phillips-Perron test, which gives robust estimates when the series has serial correlation and time dependent heteroskedasticity, was used to supplement the ADF test.

Results of Phillips-Perron are presented in Table 6. The results of Philip-Perron rejected the presence of unit root in real effective exchange rate and current account balance when all of them were first differenced, thereby conforming with the ADF results. 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 (35). The power of the tests is low if the process is stationary but with a root close to the non-stationary boundary. The tests are poor at deciding, for example, whether $\phi = 1$ or $\phi = 0.95$, especially with small sample sizes (45).

In general, the ADF and PP tests have very low power against $I(0)$ alternatives that are close to being $I(1)$. Since these tests cannot distinguish between unit root and near unit root stationary processes, the study employed the second generation unit root tests, which included Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test of (39) and Elliot-Lothenberg-Stock unit root test proposed by Elliot, Rothenberg and Stock (1996).

Table 6: 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	
CAB	-3.2633	0.0181	-3.2758	0.0737	-1.6910	0.0859	
First Difference							
REER	-13.1175	0.0000	-13.1042	0.0000	-13.1530	0.0000	$I(1)$
CBA	-13.6060	0.0000	-13.5993	0.0000	-13.6508	0.0000	$I(1)$

***Mackinnon p – values 0.0196**

Source: Author's Survey, 2018

KPSS and Elliot-Rothenberg-Stock Test

Results of KPSS unit root tests are presented in Table 7. Results were estimated with Newey-West Bandwidth automatic selection using Bartlett Kernel. The aim of this test is to remove deterministic trend of the series in order to make it stationary.

Table 7: Results of KPSS and Elliot-Rothenberg-Stock Test

	<u>Kwiatkowski-Phillips-Schmidt Shin Test Elliot-Rothenberg-Stock Test</u>				
	Intercept	Intercept with Tend	Intercept	Intercept with Trend	Remark
<i>Level</i>					
REER	0.4749	0.1218	4.8292	7.7434	
CAB	0.0730	0.0640	1.3932	4.9563	
<i>First Difference</i>					
REER	0.4154	0.0308	0.2784	1.0372	<i>I(1)</i>
CAB	0.0544	0.0459	0.2784	1.0357	<i>I(1)</i>

Source: Author's Survey, 2018

Therefore it was concluded that the study variables were integrated of order one, denoted by $I(1)$. This supports prior empirical studies (35; 44; 46; 47 among others) and econometrics theory that indicates that macroeconomic variables are generally not stationary at levels but become stationary on first differencing (45; 48; 49; and 50).

Unit Root Tests with Structural Breaks

The next step of the analysis was testing for unit root with structural breaks and results are presented in Table 8. Clemente-Montanes-Reyes identified structural break in CAB in 1995q2 and in 2000q2.

Table 8: Unit Root Test with Structural Breaks

Variable	Breaks	Coef	T-Stat	P-Value	Year
REER	<i>D1</i>	-2.1547	-12.120	0.000	1998q2
	<i>D2</i>	1.9216	9.413	0.000	2005q2
CAB	<i>D2</i>	-17.0785	-7.845	0.000	1995q2
	<i>D2</i>	8.5708	9.195	0.000	2000q2

Source: Author's Survey, 2018

The results for structural breaks for CAB are shown in Figure 3. Current account balance had first significant structural break in 1995q2. This structural break was positive and significant (p - value $0.000 < 0.05$). This was attributed to trade liberalization and implementation of floating exchange rate regime (51). Another positive and significant structural break for CAB (p - value $0.000 < 0.05$) occurred in 2000q2. This was attributed to Foreign Trade and Balance of Payments (BOP), which continued to be favorable for the last several years, received a jolt during the first eight months of the FY2002/03, with the imposition of quantitative restrictions and procedural difficulties on four items of export to India under the renewed Trade Treaty (52).

This is further attributed to poor growth performance in 2002 and 2003 that was accompanied by deteriorating economic fundamentals including a huge domestic debt, a worsening fiscal deficit and rising inflation (53).

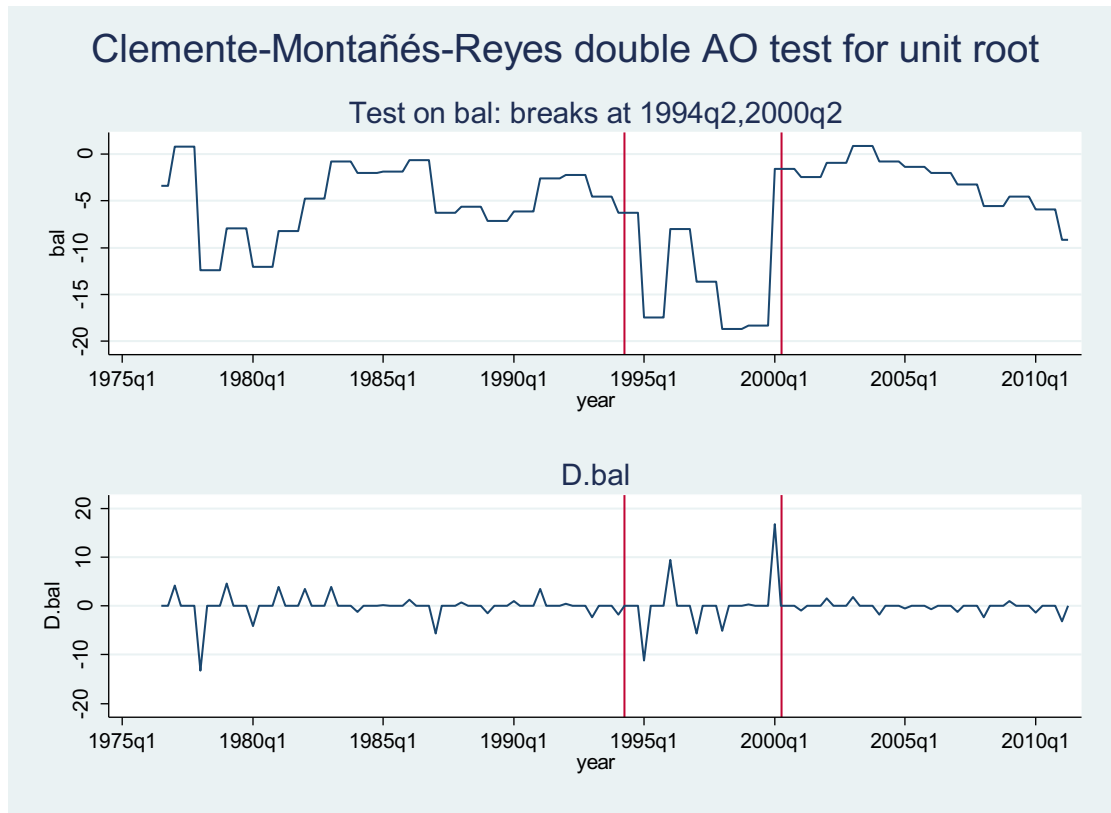


Figure 3: Plots of Structural Breaks of Current Account Balance
Source: Author's Survey, 2018

The results for structural breaks for REER are also shown in Figure 4. Real effective exchange rate had first significant structural break in 1998q2. This structural break was positive and significant ($p - \text{value } 0.000 < 0.05$). Another positive and significant structural break for REER ($p - \text{value } 0.000 < 0.05$) occurred in 2005q2. This was explained by increased trade as a result of increased manufactured exports to COMESA countries and USA under Africa Growth Opportunities Act ((AGO) (54).

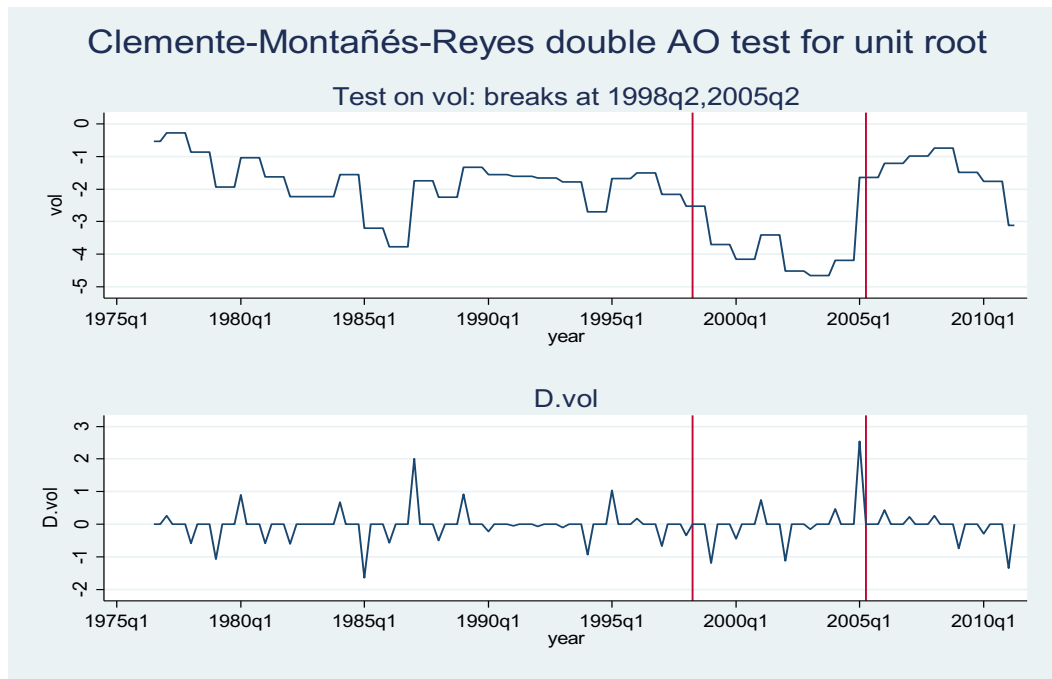


Figure 4: Plots of Structural Breaks of REER
Source: Author's Survey, 2018

Cointegration Analysis

Johansen's Cointegration Test

Having established that the individual time series were integrated of order one, ($I(1)$), it then became necessary to check whether the variables were 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 current account balances 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.

To determine Johansen's cointegration test, there was need to estimate appropriate lag length and to estimate unrestricted VAR model. The log likelihood object provided a general, open-ended tool for estimation of a broad class of specification by maximizing likelihood function with respect to parameters of the model. In this regard the study used AIC lag specification procedure. There are several techniques for estimating cointegrating relationships. Of these techniques, the (41) maximum-likelihood test procedure is the most efficient as it tests for the existence of a third cointegrating vector.

This procedure gives two likelihood ratio tests for the number of cointegrating vectors: (i) the *maximal eigen value test*, which tests the null hypothesis that there are at least r cointegrating vectors, as against the alternative that there is $r+1$, and (ii) the *trace-test*, where the alternative hypothesis is that the number of cointegrating vectors is equal to or less than $r+1$. As for the implementation of the Johansen's procedure, the optimal lag length in the VAR system need to be determined.

The lag length of the chosen VAR was 2. Our procedure for choosing the optimal lag length was based on the Akaike, Schwarz and Hannan-Quinn information criteria as well as the liquidity ratio test (AIC, SC, HQ, and LR, respectively). Tables 9 through to Table 13 present cointegration test results based on Johansen's maximum-likelihood procedure. Test results indicate that there is no evidence of cointegration among the two variables under consideration.

To determine the relationship that existed among the study variables for the study period, the current study used (41) cointegration technique. This technique was chosen because it is applicable where we have multivariate relationships as opposed to Engle-Granger technique that applies to bivariate relationships (44; 46). This analytical technique also has advantages over other cointegration methods because it does not suffer from a normalization problem and is robust to departures from normality (44; and 35). It also supports other superior properties in relation to other techniques (44; and 35).

The optimality of the (41) has been shown by (56) in terms of symmetry, unbiasedness and efficiency property (57; and 35). This involved estimation of cointegration relationship between current account balances and real effective exchange rate volatility. The determination of Johansen cointegration procedure involve use of two test statistics, first, trace statistics and second, maximum eigenvalue statistics (48). The coefficient of cointegration relationships are reported in Tables 9 and table 10.

Table 9: Unrestricted Cointegration Rank Test (Trace)

Sample (adjusted): 1973Q2 2015Q4

Included observations: 171 after adjustments

Trend assumption: Linear deterministic trend

Series: REER CAB

Lags interval (in first differences): 1 to 4

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.127306	58.14534	47.85613	0.0040
At most 1 *	0.098862	34.86014	29.79707	0.0120
At most 2 *	0.057670	17.05966	15.49471	0.0288
At most 3 *	0.039560	6.902263	3.841466	0.0086

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Survey, 2018

Table 10: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.127306	23.28520	27.58434	0.1616
At most 1	0.098862	17.80048	21.13162	0.1375
At most 2	0.057670	10.15740	14.26460	0.2018
At most 3 *	0.039560	6.902263	3.841466	0.0086

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Survey, 2018

While the existence of a cointegration relationship between current account balances and real effective exchange rate is a necessary condition to sustain CAB, it is not an adequate condition. For besides it, the slope coefficients obtained from the equations derived from the series should also be equal to 1, so as to stipulate clearly that current account balances are indeed sustainable. Otherwise, failure to fulfill the second condition (sufficient condition), then the sustainability of current account balances is considered with doubt. As for the case under study, the results showed that the cointegrating coefficients were not significantly equal to 1. Thus, the null hypothesis of $\beta = 1$ was rejected. It is therefore concluded that current account balances in Kenya are not on a stable path and may not be sustained in the long run unless the real effective exchange rate volatility is fixed.

The results of unrestricted adjustment coefficients are presented in Table 11. The results showed that the adjustment coefficients of REER Volatility were all negative and significant (p – value 0.000123 for CAB < 0.05). This was a clear indication that REER Volatility is principle determinant of CAB in the long run.

Table 11: Unrestricted Adjustment Coefficients

Unrestricted Adjustment Coefficients (alpha):

D(VREER)	4.15E-05	5.09E-05	-5.28E-05	5.51E-05
D(CAB)	-0.464239	-0.081501	-0.331331	-0.169338
1 Cointegrating Equation(s):	Log likelihood		401.0313	
Normalized cointegrating coefficients (standard error in parentheses)				
REER	GDP	FDI	CAB	
1.000000	-0.000123	-0.005946	-0.000226	
	(0.00021)	(0.00123)	(0.00011)	
Adjustment coefficients (standard error in parentheses)				
D(REER)	-0.019080			
	(0.01504)			
D(CAB)	213.6832			
	(76.0165)			

Source: Author's Survey, 2018

Table 12: Unrestricted Adjustment Coefficients

Unrestricted Adjustment Coefficients (alpha):

2 Cointegrating Equation(s):	Log likelihood	409.9316
Normalized cointegrating coefficients (standard error in parentheses)		
REER	CAB	
1.000000	-0.000254 (0.00012)	
0.000000	-0.226185 (0.15348)	
Adjustment coefficients (standard error in parentheses)		
D(REER)	-0.029597 (0.01635)	2.52E-05 (1.5E-05)
D(CAB)	230.5127 (83.2492)	-0.062778 (0.07450)

Source: Author's Survey, 2018

Table 13: Unrestricted Adjustment Coefficients

Unrestricted Adjustment Coefficients (alpha):

3 Cointegrating Equation(s):	Log likelihood	415.0103
Normalized cointegrating coefficients (standard error in parentheses)		
REER	CAB	
1.000000	0.000126 (8.8E-05)	
0.000000	-0.004718 (0.13640)	
0.000000	0.059405 (0.02465)	
Adjustment coefficients (standard error in parentheses)		
D(REER)	-0.079963 (0.03465)	2.13E-05 (1.5E-05)
(CAB)	-85.30438 (175.604)	-1.086475 (0.45565)

Source: Author's Survey, 2018***Specification Lag Order Selection and Estimation***

Having tested for unit root the next step was to select the optimum lag length and results are presented in Table 14. Before we estimate the VAR model we have to decide on the maximum lag length, K. This is an empirical question. There were 176 observations in all. Including too many lags will consume degrees of freedom and too few lags will lead to model specification errors, not to mention introducing the possibility of multicollinearity (50).

One practical problem in the estimation of VAR models relates to the number of variables to be included in the model and the maximum lag length to be applied (45). Different lag orders can critically influence the substantive interpretation of the estimates, especially when the differences are large enough. Therefore, selection of the correct lag order for each VAR was the first and vital step in this study. The lag order is selected by some pre-specified criterion and is 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) were used. The sample period used by selection order criterion was 1973q1 to 2015q4 after lagging. Therefore, the number of observations is 172. The endogenous variables were real effective exchange rate and current account balance.

Results indicated that optimum lag length was one. All information criteria selected lag length of one (1) indicated by (*) in Table 14.

Table 14: 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	-1667.03	27.418	36	0.847	61.1528	21.1282	22.2419	23.8731

Source: Author's Survey, 2018

Vector Autoregressive Model

The VAR model, being an alternative to the “incredible identification restrictions” in structural models, is an econometrics model that is employed to cater for the evolution and interdependencies between multivariate time series by generalizing the univariate AR models (45). An equation for each variable explains its evolution based on its own lags and the lags of all other variables in the model (46). The use of VAR model is a theory-free method of estimating dynamic economic relationships among macroeconomic variables (43).

Following (43), all the variables were treated as endogenous. Therefore, current account balances as a percentage of GDP were clear endogenous variables. REER Volatility was also treated as endogenous variable despite the fact that it is influenced by external factors in order to utilise the essence of VAR Model as stated by (43) that all macroeconomic variables are jointly determined. The results of the VAR models are presented in Table 15. The results of Multivariate VAR Model indicated that the independent variables account for 87% of the variations in the dependent variables on average (Table 15).

REER Equation

Results showed that lagged GDP had a positive and significant effect on changes in REER t-statistics of $10.9934 > 1.96$. The lagged coefficient of GDP was 0.858225 indicating that a one-unit change in lagged value of GDP growth rate causes REER volatility to change by 0.858225 units. This implied that GDP growth rate had a significant effect on REER volatility which is in line with macroeconomic theory. It is also important to note that economic fluctuations (business cycles) are cyclical in nature causing REER volatility. The other covariates were not significant (Table 15).

CAB Equation

Further, lagged value of REER volatility did not have a significant effect on CAB.. Similarly, REER(-2) had a positive and insignificant effect on CAB. As for the CAB Equation, the results revealed that lagged values of CAB had a positive and significant effect on the current CAB as indicated by t-statistic of $10.2868 > 1.96$. These results further indicated that a one-unit increase in Lagged value of CAB leads to 0.910147 increase in current level of CAB (Table 15). This shows that univariate time series variables under consideration were related.

Table 15: Results of Vector Autoregressive Model

Vector Autoregressive Estimates

Sample (adjusted): 1972Q3 2015Q4

Included observations: 174 after adjustments

Standard errors in () & t-statistics in []

	REER	CAB
REER(-1)	-0.905030 (277.000) [-0.00327]	120.1098 (436.314) [0.27528]
REER(-2)	-24.29463 (274.820) [-0.08840]	-152.7023 (432.879) [-0.35276]
CAB(-1)	-0.012652 (0.05069) [-0.24960]	0.910147 (0.08848) [10.2868]
CAB(-2)	0.032596 (0.05098) [0.63938]	-0.058059 (0.08030) [-0.72302]
Constant	0.790778 (0.40716) [1.94219]	-0.343415 (0.64133) [-0.53547]
R-squared	0.747654	0.787492
Adj. R-squared	0.735419	0.777189
Sum sq. resids	345.8008	857.9535
S.E. equation	1.447675	2.280289
F-statistic	61.10808	76.43039
Log likelihood	-306.6476	-385.7033
Akaike AIC	3.628133	4.536820
Schwarz SC	3.791532	4.700219
Mean dependent	4.168966	-6.160126
S.D. dependent	2.814439	4.830829
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's Survey, 2018

Diagnostic Tests and Model Checking

There are normally a large number of parameters that are involved in the unrestricted VAR models which usually give rise to imprecise estimators (58). It is therefore more appropriate to limit the dimensionality of the parameter space by imposing some restrictions (58). The restrictions may be derived from non-sample information such as economic theory and from statistical procedures.

Therefore, it is vital to observe the stability of the model and confirm whether the residuals stand by the assumptions of the model. Post-estimations tests were conducted for the models so as to confirm the validity and stability of the estimates. The tests and their findings are discussed below.

Stability Test

In chapter three, it was stated that stability is an important feature of the $VAR(p)$ – process. Thus, VAR generates stationary time series with time-invariant means, variances and covariance structure. This study tried to analyze the reverse roots of characteristic polynomial by carrying out a VAR stability condition check test as indicated in equation 3.30 in chapter three. The results in Tables 9 and 10 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.

Inverse Roots of AR Characteristic Polynomial

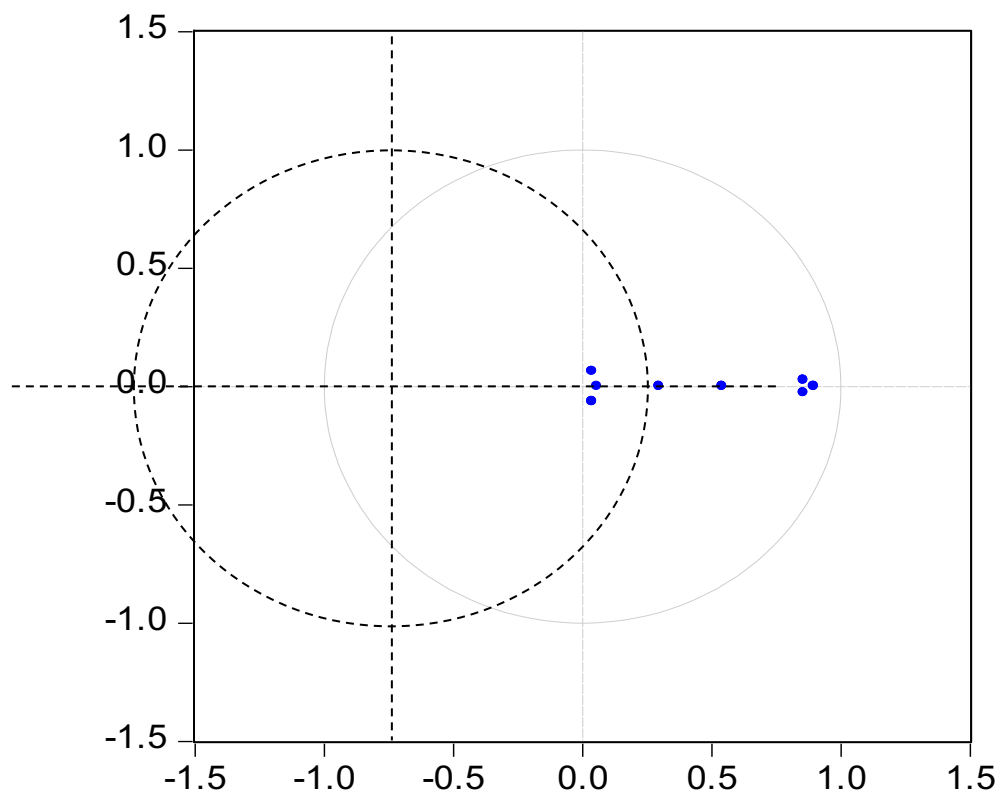


Figure 5: Roots of the Companion Matrix
Source: Author's Survey, 2018

Normality Test

Although the validity of many of the statistical procedures in view of VAR models is not strictly dependent on normality, departure from the normality assumption may give a hint to the improvement of the model. However, it should be noted that normal distribution of errors is vital especially when there is need to make interpretations depending on the estimated econometric equation. This study plotted the residuals for the two models in order to determine whether the residuals are stationary or not. Figure 6 indicates that the residuals are indeed stationary (white noise processes) implying that the estimated parameters are valid.

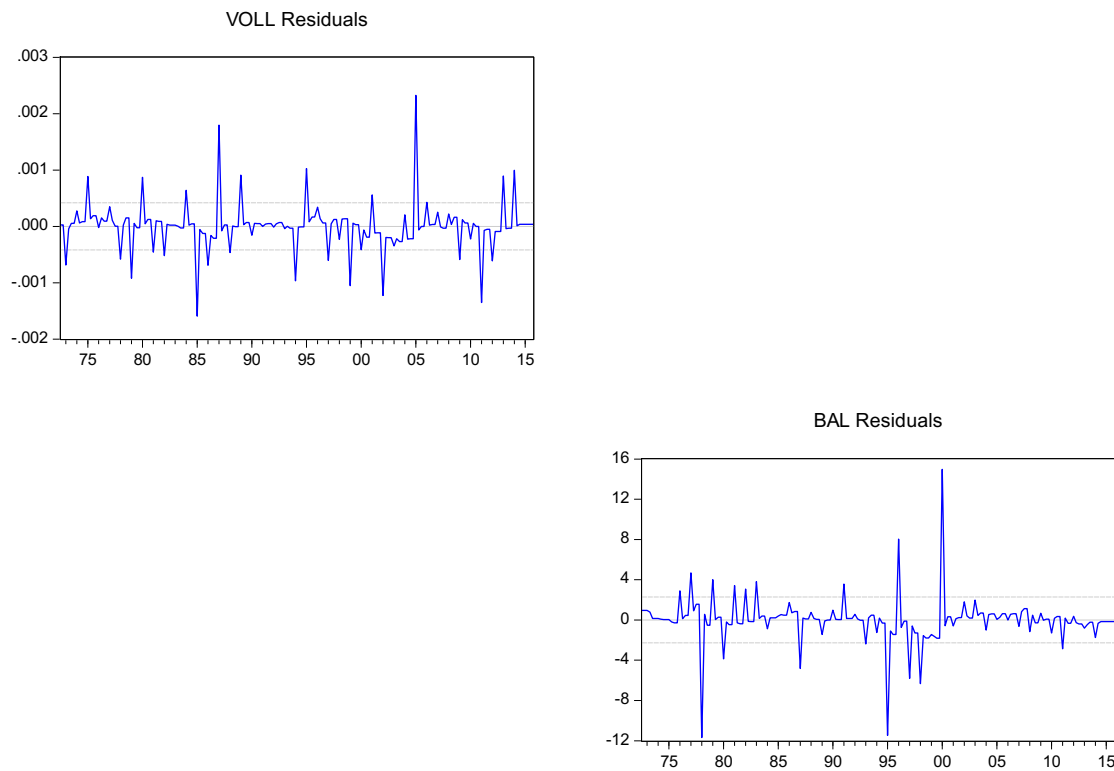


Figure 6: Plot of the Residuals of the VAR Model
Source: Author's Survey, 2018

Having determined that the residuals are indeed stationary from the plots in Figure 6, a Jarque-Bera test for normality was also carried out on the residuals of the VAR models. This was meant to confirm the above results. 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 centered residuals. The results of the Jarque-Bera test are presented in Table 16. The results confirmed that the errors in the models are normally distributed. The p-values were all $0.000 < 0.05$.

Table 16: VAR Residual Normality Tests

VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: residuals are multivariate normal

Sample: 1972Q1 2015Q4

Included observations: 174

Component	Skewness	Chi-sq	Df	Prob.
1	0.901049	23.54478	1	0.0000
2	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	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	2586.211	2	0.0000	
Joint	6525.486	8	0.0000	

Source: Author's Survey, 2018

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. Tables 17 and 18 show the results which confirmed that there was no autocorrelation in the models. The Breusch-Godfrey LM test and Portmanteau Test indicated that there was no residual serial correlation at the stated lag order Q-stat was 0.352242 and 3.9221945 at lag one and two respectively. For the Portmanteau Test the values were 0.862681 and 16.07181 respectively.

Table 17: VAR Residual Serial Correlation LM Test

VAR Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: no residual autocorrelations up to lag h

Sample: 1972Q1 2015Q4

Included observations: 174

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	Df
1	0.352242	NA*	0.354278	NA*	NA*
2	3.921945	NA*	3.965489	NA*	NA*
3	8.541855	0.9311	8.666451	0.9265	16
4	71.00581	0.0001	72.60014	0.0001	32
5	73.24583	0.0109	74.90644	0.0078	48
6	74.64509	0.1707	76.35568	0.1385	64
7	75.49870	0.6216	77.24506	0.5665	80
8	140.1378	0.0022	144.9993	0.0009	96

*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's, 2018**Table 18: VAR Residual Portmanteau Tests for Autocorrelations**

VAR Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: no residual autocorrelations up to lag h

Sample: 1972Q1 2015Q4

Included observations: 174

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	Df
1	0.862681	NA*	0.867667	NA*	NA*
2	16.07181	NA*	16.25364	NA*	NA*
3	30.37709	0.9831	30.80989	0.9804	49
4	308.5471	0.0000	315.5251	0.0000	98
5	317.5812	0.0000	324.8265	0.0000	147
6	332.5945	0.0000	340.3759	0.0000	196
7	340.2910	0.0001	348.3950	0.0000	245
8	614.2207	0.0000	635.5261	0.0000	294

*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's Survey, 2018

Heteroskedasticity Test

Table 19 presents the results for the Lagrange-Multiplier (LM) test for heteroskedasticity which also supports the null hypothesis of no heteroskedasticity in the four Models. The p-value was $0.0147 < 0.05$ and $0.0238 < 0.05$.

Table 19: VAR Residual Heteroskedasticity Tests

Joint test:					
<hr/> <hr/>					
Chi-sq	Df	Prob.			
<hr/> <hr/>					
611.6017	784	1.0000			
Individual components:					
Dependent	R-squared	F(28,145)	Prob.	Chi-sq(28)	Prob.
<hr/> <hr/>					
res1*res1	0.256709	1.788515	0.0147	44.66740	0.0238
res2*res2	0.156674	0.962081	0.5260	27.26130	0.5041
res3*res3	0.164333	1.018363	0.4490	28.59401	0.4333
res4*res4	0.055982	0.307097	0.9997	9.740801	0.9995
res5*res5	0.109849	0.639062	0.9171	19.11376	0.8946
res6*res6	0.076681	0.430074	0.9946	13.34241	0.9912
res7*res7	0.206792	1.350071	0.1304	35.98180	0.1431
res2*res1	0.132862	0.793455	0.7590	23.11798	0.7271
res3*res1	0.221527	1.473646	0.0740	38.54571	0.0885
res3*res2	0.189198	1.208406	0.2340	32.92051	0.2387
res4*res1	0.118364	0.695246	0.8695	20.59526	0.8418
res4*res2	0.080123	0.451062	0.9921	13.94137	0.9876
res4*res3	0.139008	0.836084	0.7028	24.18736	0.6716
res5*res1	0.154702	0.947753	0.5462	26.91810	0.5227
res5*res2	0.122455	0.722633	0.8419	21.30720	0.8123
res5*res3	0.172432	1.079010	0.3716	30.00324	0.3631
res5*res4	0.102230	0.589687	0.9485	17.78795	0.9314
res6*res1	0.144615	0.875508	0.6484	25.16293	0.6190
res6*res2	0.085146	0.481971	0.9869	14.81536	0.9803
res6*res3	0.187112	1.192011	0.2492	32.55744	0.2524
res6*res4	0.049757	0.271160	0.9999	8.657648	0.9998
res6*res5	0.112510	0.656506	0.9036	19.57678	0.8794
res7*res1	0.177304	1.116062	0.3281	30.85085	0.3237
res7*res2	0.143018	0.864230	0.6641	24.88514	0.6341
res7*res3	0.191372	1.225572	0.2189	33.29868	0.2249
res7*res4	0.156920	0.963875	0.5235	27.30414	0.5017
res7*res5	0.088171	0.500751	0.9828	15.34175	0.9746
res7*res6	0.125592	0.743802	0.8187	21.85298	0.7881

Source: Author's Survey, 2018

Lag Exclusion Wald Test

At this point, a null hypothesis about the non-significance of a given lag in the model was tested. The Wald statistic and the p-values for the joint significance is reported – separately for each equation and jointly for the entire model for every lag. Table 20 presents the results which indicate that all lags are significant p – values were all $0.000 < 0.05$.

Table 20: VAR Lag Exclusion Wald Tests

	REER	CAB	Joint
Lag 1	146.5695 [0.000000]	141.9561 [0.000000]	536.3433 [0.000000]
Lag 2	0.773256 [0.941997]	1.027104 [0.905659]	6.738993 [0.977970]
Df	4	4	16

Source: Author's Survey, 2018

VAR Granger Causality/Block Exogeneity Tests

Granger causality is basically meant to test the relationship between past values of the macroeconomic variables and their current values. The VAR (1,1) model was estimated since it satisfies the stability condition and has the optimal lag length as indicated in section 4.7.1.1. The causality tests results are reported in Table 21.

Results showed that the null hypothesis that REER volatility does not Granger cause real CAB is rejected at 5% significance level, thereby implying that REER volatility Granger caused CAB but in an insignificant manner ($p - \text{value} = 0.9314 > 0.05$). The block Exogeneity test indicated that REER volatility Granger caused CAB.

Theoretical analyses of the relationship between higher exchange-rate volatility and international trade transactions have been conducted by (59) and some other economists who hold the view that exchange rate volatility is the source of exchange rate risks and has certain implications on the volume of international competitiveness, consequently on the current account balances.

Table 21: VAR Granger Causality/Block Exogeneity Tests

VAR Granger Causality/Block Exogeneity Wald Tests

Sample: 1972Q1 2015Q4

Included observations: 174

Dependent variable: REER

Excluded	Chi-sq	df	Prob.
CAB	2.516539	2	0.2841
All	3.692410	6	0.7182

Dependent variable: CAB

Excluded	Chi-sq	df	Prob.
REER	0.142213	2	0.9314
All	3.273623	6	0.7738

Source: Author's Survey, 2018

Interpretation and Discussion of VAR estimates and Test of Hypotheses

Volatility of Real Effective Exchange Rate

The study sought to determine the volatility of real effective exchange rate in Kenya. To achieve this objective, the first hypothesis stated that real effective exchange rate in Kenya has not been volatile. The GARCH model was estimated since it was feasible and has remained the workhorse for estimation of real effective exchange rate volatility.

VOL

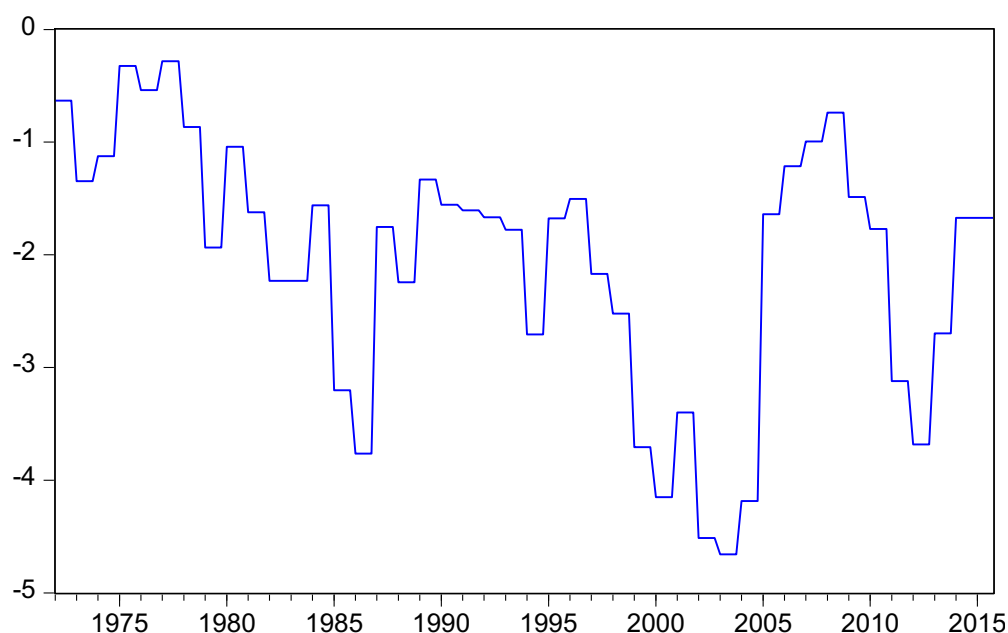


Figure 7: Plot of REER Volatility in Kenya

Source: Author's Survey, 2018

The generalized ARCH (p,q) model – called GARCH(p,q) – allows for both autoregressive and moving average components in the heteroskedastic variance. If we set $p=0$ and $q=1$, it is clear that the first-order ARCH model given by (3.31) is simply a GARCH (1,1) model. Similarly, if all values of β_1 equal zero, the GARCH (p,q) model is equivalent to an ARCH(q) model. The benefits of the GARCH model should be clear; a high-order ARCH model may have a more parsimonious GARCH representation that is much easier to identify and estimate (47). This is particularly true since all coefficients in (3.31) must be positive. Clearly, the more parsimonious model will entail fewer coefficient restrictions. Moreover, to ensure that the variance is finite, all characteristic roots of (3.10) must lie inside a unit cycle and imply that the process is stable (47).

The key feature of GARCH models is that the conditional variance of the disturbance of the (y_t) sequence acts like an ARMA process. Hence, it is to be expected that the residuals from a fitted ARMA model should display this characteristic pattern (60).

Results of real effective exchange rate are presented in Table 22. Results indicated that the GARCH (1,1,1) selected by AIC and BIC model fitted the data very well. R-Square was 0.8642756 indicating that the model explained 86.43 percent of the variations in REER volatility, log likelihood was also a large number $92.34 > 30$. The coefficient of the GARCH model was 0.9255271 meaning that for one unit change in the lagged REER volatility the current level of REER volatility was expected to change by 0.9255271. The results reported a p – value of $0.0000 < 0.05$ and t – statistic of $32.90 > 1.96$. Based on these results, the first null hypothesis that real effective exchange rate in Kenya has not been volatile is rejected. It is concluded that real effective exchange rate in Kenya was volatile (p – value $0.000 < 0.05$) within the period under consideration (1972q1 – 2015q4).

Table 22: GARCH Results on Real Effective Exchange Rate

Sample Period	1973q1 - 2015q4			
Number of observations	172			
Log likelihood	-92.341568			
R-squared	.8642756			
Adjusted R-squared	.86347722			
Root MSE	41635337			
Variable	Coef.	Std. Error	t – Value	P> t
REER L1	0.9255271	0.0281299	32.90	0.000*
Constant	-0.1612711	0.0666751	-2.42	0.017*
AIC	188.6831			
BIC	194.9781			

Source; Author's Survey, 2018

Real Effective Exchange Rate Volatility and Current Account Balances

The results also showed that REER volatility explained 78% of the variations in CAB (Table 23). Results of VAR for REER and CAB are presented in Table 23. Results of Model 1 that has CAB as a dependent variable showed that coefficient of lagged value of CAB was positive (0.9387) and was significant with a t – statistic of $11.9912 > 1.96$. Also in model 2 with REER as a dependent variable, the results showed that REER (-1) volatility had positive and insignificant effect on CAB. It indicated that when REER (-1) volatility changes by one unit then CAB was expected to increase by 0.056066 units. In the case of REER (-2), results were negative and insignificant. It

also showed that if REER (-2) volatility increases by one unit CAB was expected to deteriorate by -0.181993 units. These results conform to the conclusions of multivariate VAR model regression analysis. Based on these results, the fourth null hypothesis that REER volatility had no impact on CAB in Kenya was rejected. These results support prior results by (21).

Table 23: VAR Results of CAB and REER

Vector Autoregressive Estimates

Sample (adjusted): 1972Q3 2015Q4

Included observations: 174 after adjustments

Standard errors in () & t-statistics in []

	1 CAB	2 REER
CAB(-1)	0.938726 (0.07828) [11.9912]	0.002223 (0.01429) [0.15550]
CAB(-2)	-0.064091 (0.07882) [-0.81312]	0.008361 (0.01439) [0.58103]
REER(-1)	0.056066 (0.42902) [0.13068]	0.948668 (0.07833) [12.1116]
REER(-2)	-0.181993 (0.42664) [-0.42657]	-0.018990 (0.07789) [-0.24380]
Constant	-0.001049 (0.00045) [-2.32621]	-8.65E-05 (8.2E-05) [-1.05012]
R-squared	0.784221	0.868805
Adj. R-squared	0.779114	0.865700
Sum sq. residuals	0.000871	2.90E-05
S.E. equation	0.002270	0.000415
F-statistic	153.5524	279.7901
Log likelihood	814.9170	1110.824
Akaike AIC	-9.309391	-12.71062
Schwarz SC	-9.218614	-12.61984
Mean dependent	-0.006160	-0.002074
S.D. dependent	0.004831	0.001131
Determinant resid covariance (dof adj.)		8.52E-13
Determinant resid covariance		8.04E-13
Log likelihood		1929.109
Akaike information criterion		-22.05872
Schwarz criterion		-21.87717

Source; Author's Survey, 2018

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 24.

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 CAB in the proportion of approximate mean of 1.70%, that is, current account balances have a significantly weak influence over the ten period time horizon.

Table 24: Variance Decomposition of REER

Period	S.E.	REER	CAB
1	0.000418	100.0000	0.000000
2	0.000574	99.94756	0.014736
3	0.000678	99.54139	0.209242
4	0.000756	98.80389	0.593099
5	0.000817	97.89138	1.121766
6	0.000866	96.91193	1.753131
7	0.000907	95.92543	2.451736
8	0.000940	94.96360	3.188456
9	0.000968	94.04353	3.939628
10	0.000991	93.17470	4.686305

Source: Author's Survey, 2018

The results of variance decomposition for current account balance as a percentage of GDP are reported in Table 25. The results indicate that CAB is 94.61 per cent explained by its own innovations in the first period and this explanatory power declines to 91.67 per cent during the 10-th period. The CAB is approximately 4% explained by REER over the 10-period time horizon.

Table 25: Variance Decomposition of Current Account Balance (% of GDP)

Period	S.E.	REER	CAB
1	2.280289	3.476403	94.60641
2	3.105457	3.179473	95.22439
3	3.606576	3.271382	95.39295
4	3.948105	3.471639	95.16173
5	4.193380	3.705961	94.68086
6	4.374212	3.947921	94.07736
7	4.509374	4.185185	93.43475
8	4.611121	4.411003	92.80291
9	4.687972	4.621488	92.20989
10	4.746090	4.814509	91.67017

Source: Author's Survey, 2018

Impulse Response Functions

These impulses are derived using a recursive VAR model, in which Cholesky one-standard deviation shocks are applied and the response is estimated over a period of ten years following the initial occurrence of the shocks. The impulse response function of VAR is to analyze dynamic effects of the system when the model received the impulse. In our four dimensional VAR (2) model, the study worked out the response between these variables. Results of the impulse response analysis are presented in Tables 22 – 26 and Figure 8 which illustrates the response of real effective exchange rate volatility to one standard deviation innovation in each of the current account balances and also the response current account balances to one standard deviation innovation in real effective exchange rate volatility.

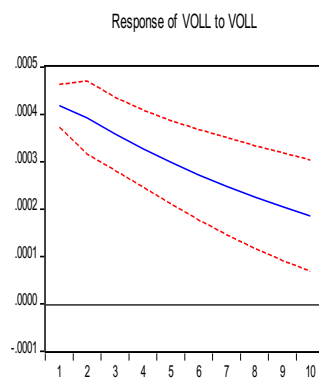
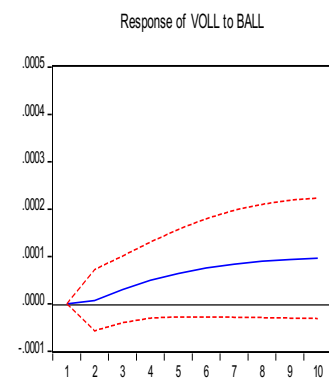
Table 26: Results of Impulse Response of CAB

Period	CAB	REER
1	0.002363	0.000000
2	0.004720	2.09E-05
3	0.007070	5.84E-05
4	0.009391	0.000120
5	0.011689	0.000197
6	0.013970	0.000284
7	0.016242	0.000375
8	0.018510	0.000466
9	0.020778	0.000557
10	0.023048	0.000646

Source: Author's Survey, 2018

Table 27: Results of Impulse Response of REER

Period	CAB	REER
1	-9.33E-05	0.000418
2	-0.000185	0.000830
3	-0.000276	0.001238
4	-0.000360	0.001641
5	-0.000438	0.002041
6	-0.000512	0.002437
7	-0.000584	0.002834
8	-0.000656	0.003229
9	-0.000727	0.003626
10	-0.000799	0.004022

Response to Cholesky One S.D. Innovations ± 2 S.E.**Figure 8: Impulse Response Functions**
Source: Author's Survey, 2018**Interpretation and Discussion of Impulse Response Results**

Response of REER Volatility to REER Volatility: Panel 1 of Figure 4.12 indicates the reaction of REER volatility due to one standard deviation of unanticipated positive shock to itself – a steady decline in Kenya's REER volatility. The dashed line shows that the positive shock to REER volatility is transmitted almost completely to REER itself. There is a revelation of a persistently sharp decline in REER volatility. Asymptotically, it will converge to the equilibrium in the long run.

The study also sought to investigate the response of the current account balances to a shock on REER. The results are reported in Figure 4.12 showing a great impact on the series. The time paths of the response coefficients do not generally converge to zero. This implies that a positive shock from the REER volatility generates an immediate significant impact on the current account balances for the period under study. This reveals that REER volatility showed a negligible transitory shock to the current account balances in Kenya.

Response of REER Volatility to CAB: Initially, REER volatility was at equilibrium, and then started rising gently in response to the exogenous shock of CAB. It continues rising gently into the long run as revealed by Panel 4 of Figure 4.12. The shock dies after four quarters. `

CONCLUSION, POLICY IMPLICATIONS AND RECOMMENDATIONS

Conclusion

The test for volatility conducted using the GARCH model showed that there is persistent volatility in the Kenyan shilling's real effective exchange rate with that of the trading partners' currencies for the period under consideration. This result is in consonance with the findings of (61), (33), and (62). Therefore, the real effective exchange rate in Kenya was volatile during the study period.

It emerged that real effective exchange rate volatility has a positive and insignificant impact on current account balances for the period under consideration. These results disagree with (20); (25); (26); and (27) who found a negative relationship between exchange rate volatility and trade in Asia and Kenya respectively.

Results indicate that, real exchange rate volatility insignificantly affected CAB at 5 percent level of significance. Results further showed that increased exchange rate volatility (uncertainty) has adverse effects in the long-run on current account balances. The results further show that, long-run parameter estimates of the models are consistent with economic theory.

The conclusion drawn from the results of this study is that despite the adoption and implementation of a liberalized exchange rate regime in Kenya, success has not been achieved as expected in restoring equilibrium in the REER, CAB, and moderate and maintains a steady GDP growth rate. The results indicated that Kenya has experienced more pronounced episodes of REER volatility, implying deterioration in the country's international competitiveness. This is in line with the findings of (63) for the case of most COMESA countries. A priori relationship between the REER and current account balances is considered to be strong for a small open economy such as Kenya.

Policy Implications

The findings of this study exhibit some important implications for policymakers in Kenya and other developing countries of similar characteristics and stage of development.

There is need to apply the appropriate macroeconomic policy mix in the short run to mitigate the cyclical and short-term shocks that arise from REER volatility. However, to ensure that there is external stability in the long run, policies regarding structural improvement, such as export competitiveness enhancement, second stage import substitution and research and development, should be undertaken.

The key policy implication of the findings about the REER volatility is that prudent management of the exchange rate policy must be pursued. This will help reduce the exchange rate volatility associated with major trading partners. There is need to focus on the terms of trade in order to have a more significant positive impact on the current account balances. On the other hand,

inflation should be contained to levels that are productive without adversely affecting current account balances.

Based on the findings above, 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 balances 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. In addition, diversification of the economy should be considered as a top priority within the development agenda. Moreover, trade cooperation with neighboring countries in the region like the East African Community (EAC) would be helpful in increasing foreign earnings, particularly in the short run.

Recommendations

In light of these results, it is recommended that Kenya should maintain its market determined exchange rate and implement a monetary policy aimed at confining inflation to levels that are at par or lower than those of her trading partners. It should also undertake further macroeconomic, institutional and structural reforms as well as export promotion and diversification in order to reduce the adverse effect of REER volatility and thus improve its international competitiveness hence improving on the current account balances. In particular, the following recommendations are made based on the results obtained in this study:

Enhance and entrench macroeconomic stability in the country through the pursuit of appropriate monetary and fiscal policies. The government and monetary authorities should design policies and programs that will enhance the stability of a shilling in relation to other currencies especially that of the US Dollar, the Euro and the Sterling Pound. The Kenya government in general and the Central Bank of Kenya in particular should therefore endeavor to pursue relevant monetary and fiscal policies to attain and maintain low and stable single-digit inflation rate, which promotes export competitiveness.

Public expenditure should be reduced so as to mitigate domestic borrowing which has tended to put an upward pressure on the level of interest rates and caused REER volatility. Other measures include addressing structural factors within the banking system, such as reducing their operational costs, which caused an upsurge in interest rates.

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.

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