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The impact of real exchange rate volatility on economic growth: Kenyan evidence

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This paper examines the impact of real exchange rate volatility on economic growth in Kenyan. The study employed the Generalized Autoregressive Condition of Heteroscedasticity (GARCH) and computation of the unconditional standard deviation of the changes to measure volatility and Generalized Method Moments (GMM) to assess the impact of the real exchange rate volatility on economic growth for the period January 1993 to December 2009. Data for the study was collected from Kenya National Bureau of Statistics, Central Bank of Kenya and International Monetary Fund Data Base by taking monthly frequency. The study found that RER was very volatility for the entire study period. Kenya's RER generally exhibited a appreciating and volatility trend, implying that in general, the country's international competitiveness deteriorated over the study period. The RER Volatility reflected a negative impact on economic growth of Kenya.

JEL Classifications: C2, C3, C8, E1, E4, F1, F4

Keywords: Real exchange rate, nominal exchange rate, real effective exchange rate, nominal effective exchange rate, volatility, GARCH

Introduction

The real exchange rate (RER), is the rate at which goods, and services produced in one country can be exchanged for those produced in another country or group of countries abroad, has been recognized as an important aspects in international macroeconomics, and finance. Volatility in the RER has important implications on Kenya's economic growth. Increased RER volatility would, for instance, increase the uncertainty of profits on contracts denominated in a foreign currency, and would therefore reduce economic growth to levels lower than would otherwise exist if uncertainty were removed (Cote, 1994). There is, however, no available evidence that success has since been achieved in realizing the objective for which the foreign exchange market was liberalized. Large volatilities in nominal exchange rates have since characterized Kenya financial market (Kiptoo, 2007).

The problem of RER volatility has given rise to a broad debate in the economics, and finance professions in many parts of the world (Frenkel and Goldsstein, 1987; Cote, 1994). In Kenya, the subject has been at the center of current economic policy debate, involving policymakers, the business community, academic researchers, and the business press. All point out the potential deleterious effects of "excessive" volatility observed in the country's currency market since the adoption of a floating exchange rate in 1993 on the country's economic growth (CBK, 2002). There is, however, no consensus yet on whether such volatilities in the RER have influenced the Kenyan economic growth, or whether any such influences have been negative or positive. It is not known, also, whether such RER volatilities have translated into misalignment, and if so, the nature, extent, and impact of such misalignment on the Kenyan economic growth (Kiptoo, 2007).

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Various studies, particularly, in the developed and middle-income countries, have also explored the impact of exchange rate volatility and associated uncertainty on trade, investment, and economic growth. Majority of these studies have found that exchange rate volatility can affect trade directly, through uncertainty and adjustment costs, and indirectly through its effect on the structure of output and investment (Cote, 1994; Serven, 2002; Pickard, 2003; Cheong, 2004; Kikuchi 2004; Arize et. al., 2004).

In spite of the abundant literature on the effects of exchange rate volatility on macroeconomic variables such as economic growth, studies that specifically focus on Kenyan economy are scanty. The few studies that have been undertaken in Kenya on the subject of exchange rate behavior have mainly focused on explaining the determinants of exchange rate behavior, with emphasis on the role of macroeconomic variables such as monetary policy shocks. For instance, Were et. al., (2001), analyzed factors that have influenced the exchange rate movements since the foreign exchange market was liberalized in 1993. A related study by Ndung'u (1999) assessed whether the exchange rates in Kenya were affected by monetary policy, and whether these effects were permanent or transitory. The study by Kiptoo (2007) focused on the real exchange rate, volatility, and misalignment, and its impact on the Kenya's international trade, and investment. Sifunjo, (2011) focused on chaos and non-linear dynamical approaches to predicting exchange rates in Kenya. Even then, these studies including Ndung'u (1995), Ndung'u (2001), Kiptoo (2007), and Sifunjo, 2011 did not deal with the impact of exchange rate volatility on the Kenya's economic growth.

The Real Exchange Rate concept

An exchange rate as stated earlier is the rate at which one currency may be converted into another. Among other things, the exchange rate determines how much the residents of a country pay for imported goods, and services, and how much they receive as payment for exported goods, and services. RER can be expressed in nominal or real terms. It is referred to as the nominal exchange rate (NER) when inflation effects are embodied in the rate, and as the real exchange rate (RER) when inflation influences have been excluded (Copeland, 1989; Lothian and Taylor, 1997).

The NER can be expressed in bilateral or multilateral term. A bilateral exchange rate refers to the exchange rate of one currency, say the Kenya shilling, in terms of another, say, the US dollar (Copeland, 1989). On the other hand, a multilateral exchange rate, also referred to as the Nominal Effective Exchange Rate (NEER).It is the rate of one currency against a weighted composite basket of that country trading partner currencies. The movements in the multilateral exchanges rates represented by NEERs rather than those of the bilateral exchange rates are the focus of this study. This is because Kenya trades with more than one country, and hence, the need to focus on the composite basket of trading partner currencies. Subsequent use of Norminal Exchange Rate (NER) in this study therefore refers to NEER except where specific reference is made to NER.

The RER, on the other hand is expressed as the NER adjusted for inflation. This adjustment can be obtained through the multiplication of the NER with the ratio of the foreign price level to the domestic price level (Adler and Lehman, 1983). Alternatively, the inflation adjustment can be achieved by multiplying the NER with the domestic relative price of tradable to non-tradable goods (Edwards, 1989).

Real exchange rate volatility

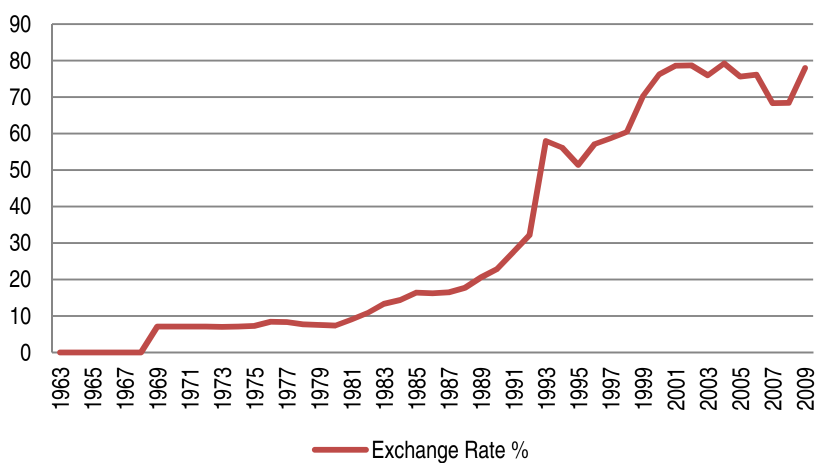
RER volatility refers to short-term fluctuations of the RER about their longer-term trends (Frenkel and Goldstein, 1987). It also entails short-term (monthly, weekly, or even hourly) fluctuations in the exchange rates as measured by, their absolute percentage changes during a particular period (Williamson, 1985). Excess RER volatility has been known to reduce the level of economic growth by creating uncertainty about the profits, unemployment, and poverty. It is also known to restrict the international flow of capital by reducing both direct investment in foreign operating facilities, and financial portfolio investment. Finally, increased RER volatility may lead to higher prices of internationally traded goods by causing traders to add a risk premium to cover unanticipated exchange rate fluctuations (McKinnon and Ohno, 1997).

There are two situations in which flexible exchange rates may be described as too volatile. First, exchange rates can be fully consistent with fundamental economic variables, such as relative prices, and macroeconomic policies, while still responding excessively to shocks to those variables before adjusting gradually to new long-term equilibrium levels. Such exchange rate 'overshooting' may occur because international capital markets adjust almost instantaneously to shocks, while goods and services markets adjust slowly (Dornbush, 1976). While predictable, this type of exchange rate volatility is costly since it amplifies the domestic impact of disturbances arising in foreign markets, exacerbating fluctuations in domestic growth, and unemployment. Second, flexible exchange rates may be too volatile if they are primarily influenced by factors unrelated to fundamental economic variables. In this case, exchange rate movements would be largely unpredictable, especially, in the short term. Furthermore, the short-term independence of exchange rates from fundamental variables can lead to long-term exchange rate misalignment volatility could also have an impact on growth. Theoretical and empirical work shows that a volatile economic environment (for example volatility of the terms of trade, exchange rates, money supply, productivity) has a harmful effect on economic performance (Frenkel and Goldsten, 1987).

The exchange rate of Kenya shilling to the US Dollar from 1967 to 2009 has been described by the fixed exchange rate error, the crawling peg error and the floating error.

FIGURE 1. PROFILE OF KENYA'S EXCHANGE RATE REGIMES, 1967-2009

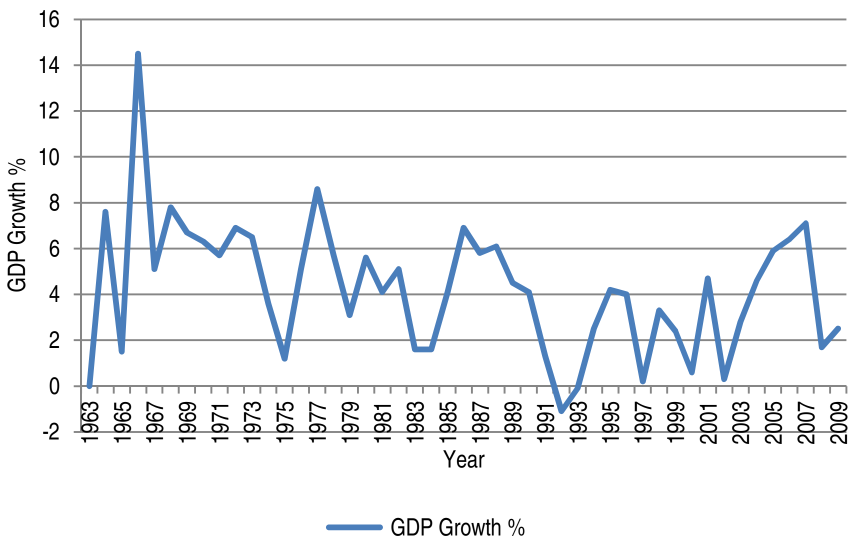
(Kenya Shilling per US dollar)



Source: Derivations from data from Kenya National Bureau of Statistics (KNBS)-2010.

The economic growth profile of Kenya can be divided into five decades as highlighted by Figure 2 below

FIGURE 1. KENYA'S GDP GROWTH RATES (1963-2009)
Real GDP growth rate (1964/1982 prices)



Source: Derivations from data from Kenya National Bureau of Statistics (KNBS)-2010.

Exchange rate determination

Economists and financial experts are yet to agree on a single theory that defines the exchange rate. Hitherto, there are at least five competing theories of the exchange rate concept, which may either be classified as traditional or modern. The traditional theories are based on trade and financial flows, and purchasing power parity, and are important in explaining exchange rate movements in the long run.

These theories are: the elasticity approach to exchange rate determination, the monetary approach to exchange rate determination, the portfolio balance approach to exchange rate determination, and the purchasing power theory of exchange rate determination. The modern theory, however, focuses on the importance of capital and international capital flows, and hence, explains the short run volatility of the exchange rates and their tendency to overshoot in the long run.

The model estimation methods

The real exchange rate *(rer)* is obtained by adjusting the nominal exchange rate (*ner*) with inflation differential between the domestic economy, and foreign trading partner economies. The derivation of the *rer* therefore, requires that the data of the *ner*, domestic inflation and foreign inflation be obtained. Since the Kenya shilling appreciated against some currencies and depreciated against others during the study period, the Nominal Effective Exchange Rate (*NEER*) is constructed. The *NEER* is derived by weighting the bilateral shilling exchange rate against its trading partner currencies using the value of Kenya's trade (imports plus exports) with its respective trading partners. The data required to derive the *NEER* is for Kenya's bilateral exchange rates with respective trading partners. Since some of the data on bilateral exchange rates are originally expressed in terms of (United States) US dollars, cross rates had to be obtained, so as to have all bilateral exchange rates expressed in terms of Kenya Shilling per foreign currency. The calculation of the *NEER* is achieved through the arithmetic mean approach that involves summing up the trade weighted bilateral exchange rates as shown in equation 1 below:

$$NEER_t = \sum_{it}^{n} ER_{it} * w_{it} \qquad (1)$$

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 1) is computed as follows:

$$ER_{it} = \left[\frac{NER_c}{NER_{t=0}}\right] * 100 \qquad (2),$$

where, the NER_c is the index of Kenya shilling exchange rate per unit of trading partner currency in the base period (2007) while $NER_{t=0}$ is the index or Kenya shilling exchange rate per unit of trading partner currency in the current period year.

The choice of 2007 as the base year is rationalized in terms of 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 1993-2009-study period. The year 2007 also enjoyed macroeconomic stability, with inflation rates that were not only low but also stable, while the current account balance as well as fiscal deficits was considered to have been at sustainable levels.

Each monthly bilateral trade weight in (equation 1) was computed as a ratio of total trade (exports plus imports) for each trading partner to the ratio of total trade (export plus imports) for all Kenya's trading partners. The formula used in deriving the trade weights is:

$$w_{it} = \left[\frac{\sum(x_{it} + m_{it})}{\sum(X_t + M_t)}\right] \qquad (3),$$

where, x_{it} is total value of Kenya'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 at 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 $i=1, 2 .....,n$ where, n is the total number of Kenya's trading partners which in this study was 140. The *NEER* is obtained by combining equations 2, and 3 using the following formula:

$$NEER_t = \sum_{it}^{n} ER_t * w_t \qquad (4),$$

where, ER_t is the bilateral exchange rate (equation *2*), and w_t, is the bilateral trade weight, n is the total number of countries, which is 140. Based on (equation 4), a decline in *NEER* represents an appreciation, while an increase represent 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* is 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:

$$REER_t = NEER_t \left[\frac{P_{wt}}{P_{dt}}\right] \qquad (5),$$

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:

$$P_{wt} = \sum_{it}^{n} P_{it} * w_t \qquad (6),$$

where, P_{it}, is the price level of Kenya's i^{th} trading partner countries proxied by CPT 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 used in the derivation of *REER*.

Real Exchange Rate volatility (V). This study attempted to measure *RER* volatility in two ways. The first was through the computation of the (unconditional) standard deviations of *RER* changes within pre-determined periods while the second was through the Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) developed by Bollerslev in 1986. The standard deviation method is the most traditional way of measuring volatility (Kenen and Rodrik, 1986; Caballero and Corbo, 1989).Under this approach, the *RER* volatility is measured by computing the annual standard deviation of the *RER*. The monthly *RER* volatility also referred to as the growth rate of *RER* (V) is defined as the natural logarithm of the standard deviation of monthly *RERs* within a year, and is measured as follows:

$$V_i = ln\left[\sqrt{\frac{1}{n-1}\sum(RER_i - \overline{RER_\iota})}\right] \qquad (7),$$

where, V_i denotes the *RER* volatility, RER_i represents the monthly *RER*, and $\overline{RER_i}$ denotes the 12-month average of *RERs*. The use of the standard deviation approach, however, has two weaknesses. The first weakness is that it assumes that the empirical distribution of *RER* is normal. The second limitation is that it ignores the distinction between predictable and unpredictable elements in the exchange rate process.

Due to the tendency for *RER* data to be skewed in terms of distributions or volatility clusters, the use of simple descriptive statistics such as the standard deviation method has been discouraged as a measure of *RER* volatility. Consequently other alternative models have been developed to measure *RER* volatility. One such model is, the Auto-Regressive Conditional Heteroscedasticity (ARCH), developed by Engle (1982). The model considers the variance of the current error term to be a function of the variances of the previous time period's error terms. In the context of this study, the model assumed that the *rer* uncertainty (volatility) was generated by first order autoregressive process that is specified as:

$$rer_t = \beta_0 + \beta_1 rer_{t-1} + \varepsilon_t \qquad (8),$$

where rer_t is the natural logarithm of *rer*, β_0 and β_1 are the parameters to be estimated and ε_t is an error that is normally distributed with zero *(0)* mean, and constant variance (δ^2). The variance of the error term depends upon time *(t)*. The ARCH model characterizes the way this dependence can be captured by an autoregressive process of the form:

$$\delta_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \ .... + \alpha_m \varepsilon_{t-m}^2 \qquad (9),$$

where δ_t^2 is the conditional variance of the *rer*, ε_{t-1}^2 for *I = 1,2,3 .... m* denotes the squared residuals derived from equation 10, and α_1 for *I = 0, 1, ... m* are the parameters to be estimated.

The restriction $\alpha_1 \geq 0$ is meant to ensure that the predicted variance is always not a negative value. The term ε_{t-1}^2 represents the ARCH, and is therefore a measure of information about the *rer* volatility in the previous period. This study, however, employed the Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH). The GARCH model is an extension of the ARCH model in which the variance is given by:

$$\delta_t^2 = \alpha_0 + \beta_1 \delta_{t-1}^2 + \beta_2 \delta_{t-2}^2 + \cdots + \beta_k \varepsilon_{t-k}^2 + \alpha_1 \delta_{t-1}^2 + \alpha_2 \delta_{t-2}^2 + \cdots + \alpha_m \delta_{t-m}^2 \qquad (10),$$

where δ_{t-1}^2 for *j=1, 2... k* is the GARCH term representing the last period's forecast variance. GARCH *(1, 1)* is the simplest specification in this class, and is the most widely used specification. Thus, the GARCH (*1, 1*) model is given by:

$$\delta_t^2 = \alpha_0 + \beta_1 \delta_{t-1}^2 + \alpha_1 \varepsilon_{t-1}^2 \qquad (11).$$

This study employed equation 11 as the GARCH process to capture the *rer* volatility. This involves explaining the *rer* volatility by positing a structural relationship between volatility and its determinants.

Data source

The method of data collection was secondary research, which essentially involved reviewing data sources that have been collected for some other purpose than the study at hand. The main sources of the data was from local institutions were as follows: The Statistical Bulletins and the Monthly Economic Reviews of the Central Bank of Kenya (CBK): the Economic Surveys of the Kenya National Bureau of Statistics (KNBS), the Budget Outturns of the Ministry of Finance. For the study period of January 1993 to December 2009 with monthly frequency total of 204 in construction of RER while, yearly frequency total of 17 data values were used. In other instances, however, the data was extracted from the relevant publications or documents of the above institutions, and saved in Excel spreadsheet. The main sources of international data were the International Financial Statistics (IFS), and the Directorate of Trade Statistics (DTS). The Library Network that serves the World Bank Group, and the IMF, was the sole source of data from international sources. United Nations data base on social indicators was extensively reliable source of information.

Empirical results

This section measures and reports on the results of the *RER* volatility. In order to measure the *RER* volatility, the study generated GARCH specification as follows:

$$lnREER_t = \pi_t + \beta_t lnREER_{t-1} + \varepsilon_1 \qquad (12),$$

where, $\varepsilon_t(O, h_t)$

$$\varepsilon_t = \alpha_t + \beta\varepsilon_{t-1}^2 + \gamma h_{t-1} + u_1 \qquad (13).$$

The above conditional variance of *RER* is a function of three terms (i) the mean, α, (ii) news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, ε_{t-1}^2 (the ARCH term), and (iii) the last period's forecast error variance, γh_{t-1} (the GARCH term) as shown in equation 13. This study estimated a number of versions of ARCH models. The GARCH (*1, 1*) model generated the best result shown in Table 1 (Appendix).

Growth model

This section employed the GMM methodology: first, to empirically examine the impact of volatility on economic growth. The findings and results were presented, interpreted, and evaluated against theory, and results of other studies. Table 2 (Appendix) shows the descriptive statistics of economic growth model.

Time series properties

It is important to test whether there are any structural breaks, trends, or stationary in the data. The integration order of all the variables in the economic growth demand equation was determined by employing the ADF, and PP tests. The results are presented in Table 3 (Appendix). The movements of the variables suggest that they are all stationary (some variables suggest that they are all stationary, and others are first difference stationary). This was ascertained by carrying out formal unit root test.

Table 4 (Appendix) provides all the variables including the *rer* volatility, and the results are rather interesting. The *rer* volatility positively influence growth. A one percent increase in *rer* volatility decreases growth by 0.348. Government expenditure impact on growth as earlier observed in the two tables previously. Per capita, health, and secondary education positively influence growth as expected even though insignificant. Primary enrolment had a negative impact on growth. Terms of trade indicated a negative influence on growth. R-squared of 42 percent, and a Durbin Watson statistics of 2.1 higher than the desired of 2.

Table 5 (Appendix) provides all the variables but eliminating the *rer* volatility, from the model. This does not affect the negative impact of the government expenditure on economic growth. However, the influence is significant. This means that neither *rer* volatility nor misalignment affect how government expenditure influence growth. The same argument applies to primary enrolment, secondary enrolment, and terms of trade. However and notably is education (primary and secondary enrolment), have significant negative, and positive influence on economic growth respectively. Per capita insignificantly negatively influences economic growth. The R-squared value is 42 percent indicating the highest fit model, A Durbin-Watson statistics of 2.3 indicating a positive autocorrelation of the model.

Discussion

The results show that the economic growth is influenced largely by changes in all explanatory variables *rer* volatility showed a negative elasticity of 0.348 insignificant. This evidence confirms what is available in literature. Government expenditure, primary enrolment, and term of trade indicate negative elasticity's to economic growth. All the three variables are insignificant. Secondary enrolment had a positive significant elasticity to economic growth. Life expectancy showed a positive but insignificant elasticity to economic growth in the absence of *rer* misalignment in the model.

The above findings of the current study concur with the finds of Bini-Smaghi (1991) used Ordinary Least Square (OLS) technique to estimate the effect of *RER* volatility on trade in manufactured goods within the European Monetary System (EMS). The study found that *RER* volatility, measured by the standard deviation of weekly rates of changes of the intra-EMS effective rate for the quarter, had a negative, and significant effect on export volumes in all the three countries of (Germany, France, and Italy). Hondroyiannis *et al.,* (2005) undertook a study that examined the relationship between exchange-rate volatility, and aggregate export volumes for 12 industrial economies using a model that included real export earnings of oil-producing economies as a determinant of industrial-country export volumes. Five estimation techniques, including a generalized method of moments (GMM), and random coefficient (RC) estimation, were employed on panel data covering the estimation period 1977:1-2003:4 using three measures of volatility, namely, the absolute values of the quarterly percentage change in the exporting nation's effective exchange rate, log of the eight-quarter moving standard deviation of the *REER*, and a constructed GARCH measure of volatility. In contrast to current study, the study by Hondroyiannis *et al.,* (2005) did not find a single instance in which volatility had a negative, and significant impact on trade. In all cases, the coefficient on volatility was near zero.

Studies reviewed in this paper that used Johansen cointegration technique and found a negative and significant relationship between the *RER* volatility, and investment in developed countries are Caves (1989), Eun (1997), Dominquez and Tesar (2001), Bergin and Tchakarov (2003), Doukas et al., (2003), Kiyota and Urata (2004) and Siregar and Rajan (2004). These studies findings agree with the findings of the current study. About the impacts of RER Volatility on economic growth and investment.

The study by Kiptoo (2007), focused on *RER* volatility and misalignment on international trade and investment. The study used Generalized Autoregressive Condition Heteroscedaticity (GARCH) and unconditional standard deviation. The study found out that RER volatility has a negative and significance impact on trade and investment during the study period 1993 to 2003. Finally, the study by Sifunjo (2011) examined chaos and non-linear dynamical approaches to predicting exchange rates in Kenya. The study used GARCH to measure foreign rate volatility. The results suggest presence of non-linearity in the returns, high volatility in the exchange market with a maximum duration of 6 months. Foreign exchange market was found not to be efficient in the weak form. The two study findings are similar o the current study findings indicate a large volatility of the real exchange rate in Kenya.

Conclusion

The study adduced evidence that the conditional volatility of the *RER* depended on both domestic and external shocks to *RER* fundamental and macroeconomic changes. Overall, however, Kenya's *RER* generally exhibited a appreciating and volatility trend, implying that in general, the country's international competitiveness deteriorated over the study period, hence, impacting negatively on the economic growth of Kenya.

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Appendix

TABLE 1. GARCH ESTIMATION OF RER VOLATILITY (DEPENDENT VARIABLE: LNRER)

Dependent Variable: RER				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 09/21/11 Time: 11:53				
Sample: 1993M01 2009M12				
Included observations: 204				
Convergence achieved after 33 iterations				
Presample variance: backcast (parameter = 0.7)				
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	39172.50	90547.53	0.432618	0.6653
	Variance Equation			
C	3.35E+11	1.98E+10	16.89336	0.0000
RESID(-1)^2	0.818655	0.363499	2.252151	0.0243
GARCH(-1)	-0.046961	0.039906	-1.176791	0.2393
R-squared	0.057691	Mean dependent variance		211632.3
Adjusted R-squared	0.057691	S.D. dependent variance		719782.2
S.E. of regression	740253.6	Akaike info criterion		29.21426
Sum squared residual	1.11E+14	Schwarz criterion		29.27933
Log likelihood	-2975.855	Hannan-Quinn criteria.		29.24058
Durbin-Watson stat	0.562470			

FIGURE 3. GARCH BASED RER VOLATILITY

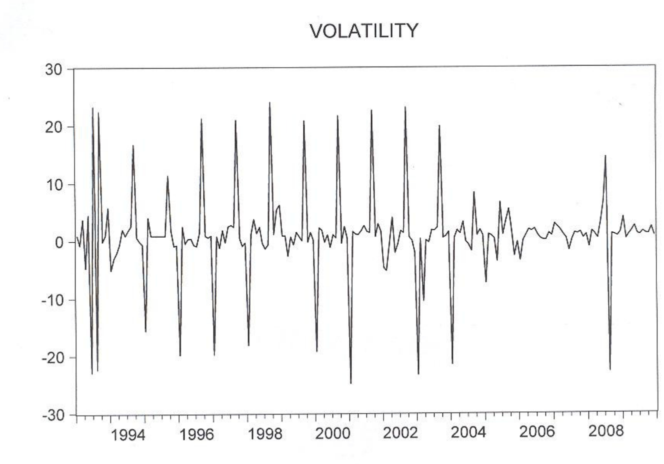

TABLE 2. DESCRIPTIVE STATISTICS OF ECONOMIC GROWTH MODEL

	GROWTH	GOVT	CAPITA	HEALTH	PRI	SEC	VOL
Mean	0.011765	20.44560	486.2941	50.70588	43.15262	27.95924	3.176710
Median	0.000000	18.05942	438.0000	51.00000	62.42384	39.25363	0.810246
Maximum	0.200000	79.57454	773.0000	82.00000	85.69088	59.46480	41.07310
Minimum	0.000000	1.484199	276.0000	28.00000	0.000000	0.000000	-0.482978
Std. Dev.	0.048507	15.80351	142.0426	17.50987	37.75703	24.74450	9.789075
Skewness	3.750000	3.253762	0.880362	0.315993	-0.273533	-0.202710	3.719558
Kurtosis	15.06250	13.15382	2.725836	1.938375	1.181744	1.245856	14.92090
Jarque-Bera	142.9090	103.0256	2.249180	1.081238	2.553780	2.295983	139.8592
Probability	0.000000	0.000000	0.324786	0.582388	0.278903	0.317273	0.000000
Sum	0.200000	347.5752	8267.000	862.0000	733.5946	475.3071	54.00406
Sum Sq. Dev.	0.037647	3996.017	322817.5	4905.529	22809.50	9796.642	1533.216
Observations	17	17	17	17	17	17	17

TABLE 3. UNIT ROOT TEST FOR STATIONARITY - GMM

Results of Unit Root Tests of variables employed in growth model

Variable	Type of Test/Level of Test	Lag Length*	Calculated Value	Test Critical Value	Level Significance **	Order Integration
CAPITA	ADF Test Statistic at Levels, without trend	1	-1.149831	-3.081002	5% critical value	1(0)
	ADF Test statistic at 1st difference without trend	3	-2.883398	-2.713751	10% Critical Value	1(1)
	ADF Test Statistic at levels with trend.	3	-3.960369	-4.886426	1% Critical Value	1(0)
	ADF Test Statistic at 1st difference with trend	3	-1.982425	-4.992279	1% Critical Value	1(1)
	PP Test statistic at levels without trend	2	-0.540206	-3.065585	5% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	0	-1.986004	-3.959148	1% Critical Value	1(1)
	PP Test Statistics at levels with trend	2	1.370587	-3.733200	5% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend	1	-1.913664	-4.728363	1% Critical Value	1(1)
GOVT	ADF Test Statistic at Levels, without trend	0	-3.812873	-3.920350	1% Critical Value	1(0)
	ADF Test statistic at 1st difference without trend	0	-6.232786	-3.081002	5% Critical Value	1(1)
	ADF Test Statistic at levels with trend.	0	-3.699668	-4.667883	1% Critical Value	1(0)
	ADF Test Statistic at 1st difference with trend	0	-6.021141	-3.324976	10% Critical Value	1(1)
	PP Test statistic at levels without trend	0	-3.812123	-3.920350	1% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	14	-13.46300	-3.959148	10% Critical Value	1(1)
	PP Test Statistics at levels with trend	1	-3.699034	-3.73320	5% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend	14	-15.12411	-4.728363	1% Critical Value	1(1)

TABLE 3. UNIT ROOT TEST FOR STATIONARITY - GMM

Results of Unit Root Tests of variables employed in growth model

Variable	Type of Test/Level of Test	Lag Length*	Calculated Value	Test Critical Value	Level Significance **	Order Integration
HEALTH	ADF Test Statistic at Levels, without trend	2	-0.976350	-4.004425	1% Critical Value	1(0)
	ADF Test statistic at 1st difference without trend	2	-3.225762	-3.119910	5% Critical Value	1(1)
	ADF Test Statistic at levels with trend.	1	-3.643737	-4.728363	1% Critical Value	1(0)
	ADF Test Statistic at 1st difference with trend	2	-3.259164	-3.362984	10% Critical Value	1(1)
	PP Test statistic at levels without trend	5	-1.895714	-3.920350	1% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	5	-2.358690	-2.681330	10% Critical Value	1(1)
	PP Test Statistics at levels with trend	4	-1.343061	-3.733200	5% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend	7	-2.682282	-3.324976	10% Critical Value	1(1)
PRI	ADF Test Statistic at Levels, without trend	2	0.727087	-2.690439	10% Critical Value	1(0)
	ADF Test statistic at 1st difference without trend	1	5.513368	-4.004425	1% Critical Value	1(1)
	ADF Test Statistic at levels with trend.	1	-4.263334	-4.728363	1% Critical Value	1(0)
	ADF Test Statistic at 1st difference with trend	1	-5.266088	-3.791172	5% Critical Value	1(1)
	PP Test statistic at levels without trend	15	-1.74208	-3.920350	1% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	8	-8.535038	-3.959148	1% Critical Value	1(1)
	PP Test Statistics at levels with trend	15	-5.910484	-4.667883	1% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend					
SEC	ADF Test Statistic at Levels, without trend	2	-0.505939	-2.690439	10% Critical Value	1(0)
	ADF Test statistic at 1st difference without trend	1	-5.351138	-4.004425	1% Critical Value	1(1)
	ADF Test Statistic at levels with trend.	1	-4.443426	-4.728363	1% Critical Value	1(0)
	ADF Test Statistic at 1st difference with trend	1	-5.096970	-3.342253	10% Critical Value	1(1)
	PP Test statistic at levels without trend	15	-0.911743	-3.065585	5% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	8	-10.44534	-3.081002	5% Critical Value	1(1)
	PP Test Statistics at levels with trend	14	-7.875888	-4.667883	1% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend	8	-9.769806	-4.728363	1% Critical Value	1(1)
TOT	ADF Test Statistic at Levels, without trend	0	-2.38862	-2.673459	10% Critical Value	1(0)
	ADF Test statistic at 1st difference without trend	1	-4.784952	-3.081002	5% Critical Value	1(1)
	ADF Test Statistic at levels with trend.	1	-1.981264	-4.667883	1% Critical Value	1(0)
	ADF Test Statistic at 1st difference with trend	3	-3.168480	-3.388330	10% Critical Value	1(1)
	PP Test statistic at levels without trend	0	0.238862	-3.920350	1% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	1	-4.734753	-2.681330	10% Critical Value	1(1)

TABLE 3. UNIT ROOT TEST FOR STATIONARITY - GMM

Results of Unit Root Tests of variables employed in growth model

Variable	Type of Test/Level of Test	Lag Length*	Calculated Value	Test Critical Value	Level Significance **	Order Integration
	PP Test Statistics at levels with trend	0	-1.981264	-3.733200	5% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend	2	-4.797961	-4.728363	1% Critical Value	1(1)
VOL	ADF Test Statistic at Levels, without trend	3	-3.2245152	-4.057910	1% Critical Value	1(0)
	ADF Test statistic at 1st difference without trend	3	-2.222445	-2.713751	10% Critical Value	1(1)
	ADF Test Statistic at levels with trend.	3	-3.113537	-3.362984	10% Critical Value	1(0)
	ADF Test Statistic at 1st difference with trend					
	PP Test statistic at levels without trend	1	-4.040725	-3.920350	1% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	14	-14.72717	-3.959148	1% Critical Value	1(1)
	PP Test Statistics at levels with trend	6	-5.064456	-4.667883	1% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend	14	-13.90660	-3.759743	5% Critical Value	1(1)
MISA	ADF Test Statistic at Levels, without trend	3	-1406928	-2.701103	10% Critical Value	1(0)
	ADF Test statistic at 1st difference without trend					
	ADF Test Statistic at levels with trend.					
	ADF Test Statistic at 1st difference with trend					
	PP Test statistic at levels without trend	5	-2.311852	-3.065585	5% Critical Value	1(0)
	PP Test statistic at 1st difference without trend	14	-7.452703	-2.681350	10% Critical Value	1(1)
	PP Test Statistics at levels with trend	14	-5.239709	-4.667883	1% Critical Value	1(0)
	PP Test Statistic at 1st difference, with trend					

*General automatically through use of Schwarz Info Criterion (SIC) based on a maximum lag length of 14

** based on MacKinnon (1996) one-sided p-values.

TABLE 4. ESTIMATION OF ECONOMIC GROWTH MODEL

Dependent Variable: GROWTH
Method: Generalized Method of Moments
Date: 10/04/11 Time: 12:51
Sample: 1993 2009
Included observations: 17
Linear estimation with 3 weight updates
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: GOVT CAPITA HEALTH PRI SEC TOT VOL
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	-0. 483	0.000314	-1.536240	0.1555
CAPITA	8.41E-03	8.69E-05	0.096813	0.9248
HEALTH	0. 618	0.000815	0.758922	0.4654
PRI	-0. 5710	0.003621	-1.576635	0.1460
SEC	9.039	0.005732	1.577033	0.1459
TOT	-11.437	0.022997	-0.497324	0.6297
VOL	-0.348	0.000412	0.845140	0.4178
R-squared	0.420154	Mean dependent var		0.011765
Adjusted R-squared	0.072247	S.D. dependent var		0.048507
S.E. of regression	0.046722	Sum squared resid		0.021829
Durbin-Watson stat	2.144265	J-statistic		0.766837
Instrument rank	8	Prob(J-statistic)		0.381197

TABLE 5. ESTIMATION OF ECONOMIC GROWTH MODEL

Dependent Variable: GROWTH
Method: Generalized Method of Moments
Date: 10/16/11 Time: 22:48
Sample: 1993 2009
Included observations: 17
Linear estimation with 3 weight updates
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: GOVT CAPITA HEALTH PRI SEC TOT
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	0.539	0.000298	-1.806386	0.0983
CAPITA	-4.20E-04	0.000123	-0.340737	0.7397
HEALTH	0.867	0.000901	0.962582	0.3564
PRI	-6.116	0.003321	-1.841724	0.0926
SEC	9.681	0.005307	1.824333	0.0954
TOT	-3.723	0.020686	-0.179965	0.8605
R-squared	0.421403	Mean dependent var		0.011765
Adjusted R-squared	0.158405	S.D. dependent var		0.048507
S.E. of regression	0.044500	Sum squared resid		0.021782
Durbin-Watson stat	2.340381	J-statistic		0.163588
Instrument rank	7	Prob(J-statistic)		0.685874