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DETERMINATION OF THE EQUILIBRIUM REAL EXCHANGE RATE AND ITS MISALIGNMENT IN KENYA

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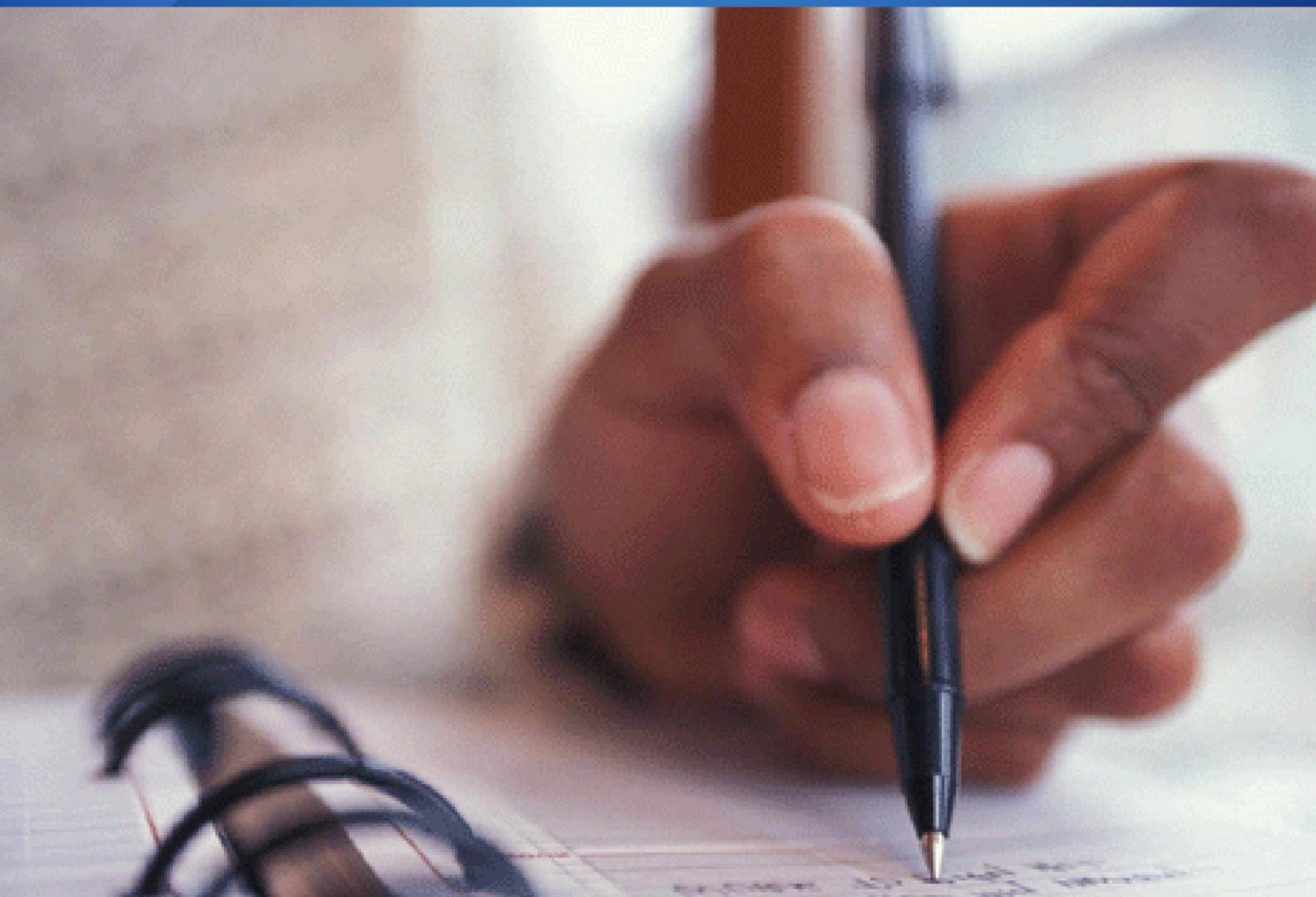

Determination of the Equilibrium Real Exchange Rate and its Misalignment in Kenya

Moses C. Kiptui*, Joseph Wambua† and Benjamin Maturu‡

Abstract

This paper studies the real exchange rate misalignment in Kenya using data over the period 1998 – 2012. The Behavioural Equilibrium Exchange Rate (BEER) approach to determine the extent of exchange rate misalignment is adopted. A vector error correction model (VECM) is estimated and results indicate that the real exchange rate is largely driven by real incomes, money supply and government expenditures. It is also shown that the equilibrium real exchange rate has been closely aligned to its long run equilibrium level save for instances when misalignment occurred due to major economic shocks such as the recent global financial crisis and the Euro zone economic crisis.

JEL Classification: F0, F31, P33

Key Words: Real Exchange Rate, Misalignment

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1. Introduction

The real exchange rate is an important macroeconomic variable in an economy. A more critical concern is not just the level or trends in real exchange rate (RER) but the extent to which the RER is aligned to its equilibrium level. Any deviations of RER either above or below its equilibrium level are an issue of concern to policy makers and the general public. Ideally, there is a desire to have the RER aligned as much as possible to its equilibrium level since substantial deviations point to distortions in the economy, for instance, cases of over-valuation or under-valuation of the RER with attendant consequences on the economy. Since the equilibrium RER is unobserved, several measures have been devised by researchers for its measurement.

Several empirical studies have examined drivers of the real exchange rate and some have also attempted to test for misalignment. The approaches adopted by these studies are diverse in nature and so are the results arrived at. Each country study seems to reveal unique characteristics of the exchange rate determination process. We examine some of these studies and their findings.

Using a vector error correction modeling approach, De Jager (2012) estimates the equilibrium real effective exchange rate for South Africa. The results showed that a 1 percent increase in the real interest rate differential would induce a 0.8 percent appreciation of the real effective exchange rate (REER). A 1 percent increase in South Africa's real GDP per capita was found to induce a 1.3 percent appreciation of the REER in the long run. A 1 percent increase in commodity prices relative to oil prices induced a 0.1 percent appreciation of the REER in the long run while increased openness was associated with depreciation of REER. On the fiscal side, it was found that a 1 percent improvement in the government deficit or a decline in public sector borrowing requirement as a percentage of GDP led to depreciation of the REER by about 1.5 percent. The error correction term was found to be around 0.28 implying that on average 28 percent of the gap between the REER and the equilibrium real exchange rate (ERER) is eliminated in every quarter.

Grenade and Riley (2009) studies the factors that determine the REER and the extent of REER misalignment in the ECCU over the period 1990 – 2007. Results show that a 1 percent increase in the ratio of capital flows to GDP leads to a 0.008 percent appreciation while a 1 percent increase in the ratio of government consumption to GDP leads to a REER appreciation of 0.36 percent. Similarly, a 1 percent improvement in terms of trade appreciates the REER by 0.59 percent.

Minou and Imam (2011) assess the equilibrium value of the Mauritius rupee in 2006-07 and over the medium term using two methods: first, the macroeconomic balance approach in which the equilibrium RER is modeled as a function of the current account and secondly, through estimation of a reduced form model which included the RER and its determinants as suggested by economic theory. Results showed that positive terms of trade shock improves trade balance with the resulting increase in domestic demand causing higher prices of non-tradables and hence appreciation of the RER. Increased openness leads to lower domestic prices which depreciate the RER. An increase in government consumption appreciates the RER since much of government consumption is on non-tradables. Overall, the RER was found to be closer to its equilibrium level.

Atasoy and Sweta (2006) apply an error correction model (ECM) to estimate equilibrium real exchange rate for Turkey over the period 1980Q1 – 2003Q2. Results show that the Turkish Lira was over-valued in 1994 and 2001. Further, the study relates the equilibrium real exchange rate to exports performance and concludes that towards the end of the sample period, the actual exchange rate was close to its equilibrium level hence it was not detrimental to the export sector.

Bergvall (2004) studies the determinants of real exchange rates in the Nordic countries by developing an inter-temporal optimizing model which takes into account both supply and demand factors which are considered as central in the determination of whether or not exchange rates are over-valued in real terms. The paper argues that a country will experience a real appreciation if it experiences 'faster relative output growth per unit of labour input in the tradable sector' or an improvement in terms of trade. The study also found that in the case of Denmark and Norway the long rum movements in the real exchange rates were significantly influenced by exogenous terms of trade shocks. Demand shocks were found to be significant factors for the real exchange rate in Finland while for Sweden both supply and demand factors and exogenous terms of trade shocks were found to be significant factors for the long term movements of the real exchange rate.

Sossounov and Ushakov (2009) use cointegration techniques to study the long run real exchange rate of the Russian Ruble over the period 1995Q1 – 2008Q1. The most significant drivers of the long run real exchange rate of the Ruble were found to be oil prices (terms of trade) and labour productivity differential with respect to Germany.

The foregoing empirical literature emphasizes the need to carry out country specific studies on the equilibrium real exchange rate and subsequently, the extent of misalignment. This main objective of this study therefore is to compute Kenya's equilibrium real effective exchange rate on the basis of the Behavioral Equilibrium Exchange Rate (BEER) approach and subsequently identify key variables driving the real exchange rate. The study also seeks to study the extent of real exchange rate misalignment by computing the deviations of actual RER from BEER. Real exchange rate equilibrium and misalignment has received less attention in Kenya despite the policy significance of such analysis.

The rest of the paper is organized as follows: section 2 presents the methodology, section 3 presents the results while section 4 concludes.

2. Methodology

This study will adopt the approach introduced by MacDonald (1997) in which the real exchange rate misalignment is determined using the behavioral equilibrium exchange rate (BEER) approach. The starting point of the BEER approach is the uncovered interest parity in which the real exchange rate is driven by interest rate differentials.

$$E_t\left(\Delta S_{t+k}\right) = \left(i_t - i_t^*\right) \tag{1}$$

Where i_t is nominal interest rate, Δ is difference operator and E_t is the conditional expectations operator $t+k$ is the maturity horizon of financial assets/bonds.

When expected inflation is subtracted we derive an equation for the real exchange rate:

$$q_t = E_t\left(q_{t+k}\right) - \left(r_t - r_t^*\right) \tag{2}$$

Uncovered interest parity (UIP) is assumed to hold, as in equation (1) above.

Fisher decomposition of nominal interest rates into real and expected inflation components yields

$$i_t = r + E_t\left(\Delta P_{t+k}\right) \tag{3}$$

$$i_t^* = r^* + E_t\left(\Delta P_{t+k}^*\right) \tag{4}$$

Substituting (3) and (4) into (1) we obtain

$$E_t\left(\Delta S_{t+k}\right) = \left(r_t - r_t^*\right) + E_t\left(\Delta P_{t+k} - \Delta P_{t+k}^*\right) \tag{5}$$

After rearrangement we get

$$q_t = E_t\left(q_{t+k}\right) - \left(r_t - r_t^*\right) \tag{6}$$

where r is the real interest rate. Equation (6) states that the current equilibrium exchange rate is determined by two components, the expectation of the real exchange rate in period $t+k$ and the real interest rate differential.

Assuming that the expectation of the exchange rate is the equilibrium exchange rate, $\bar{q}$:

$$q_t = \bar{q}_t - \left(r_t - r_t^*\right) \tag{7}$$

Actual exchange rate therefore consists of two components, the equilibrium rate driven by fundamentals and the real interest rate differential. As the fundaments change, however, $\bar{q}_t$ adjusts to q_t due to recurring deviations from equilibrium. The deviation between actual exchange rate and the equilibrium exchange rate may occur due to changes in fundamentals which cause permanent changes in the real exchange rate or simply transitory changes which are reversed at a later date. MacDonald (1997) decomposed the real exchange rate to derive factors driving the real exchange rate.

The real exchange rate is defined as

$$q_t = S_t - P_t + P_t^* \tag{8}$$

Where S_t is nominal spot exchange rate, defined as local currency price of a unit of home currency. P_t denotes price level and an asterisk denotes a foreign variable, lower case letters denotes logarithms of the variables. General prices may be decomposed into traded and non-traded components:

$$P_t = (1-\alpha_t)P_t^T + \alpha_t P_t^{NT} \tag{9a}$$

$$P_t^* = (1-\alpha_t^*)P_t^{T*} + \alpha_t^* P_t^{NT*} \tag{9b}$$

where the $\alpha's$ denote the shares of non tradable goods sectors in the economy, superscript T indicates that the variable is defined for traded goods, while NT denotes non-traded good. In this context, arise in q_t^T denotes depreciation for traded goods:

$$q_t^T \equiv S_t + P_t^{T*} - P_t^T \tag{10}$$

Substituting (9a), (9b) and (10) into (8) we obtain:

$$\bar{q}_t = q_t^T + \alpha_t^*\left(P_t^{NT*} - P_t^{T*}\right) - \alpha\left(P_t^{NT} - P_t^T\right) \tag{11}$$

Equation (11) highlights potential sources of long run real exchange rate variability: q_t^T, the real exchange rate for traded goods which may change with respect to trade in imperfect substitutes and other factors, also changes in the relative prices of non traded to traded goods between the country and foreign country.

Sources of long-run real exchange rate variability will therefore consist of among others, the following.

1. Balassa –Samuelson effect:- productivity differentials may exist due to differences in the productivity in traded and non-traded sectors. Traded sector tends to experience productivity

increases compared to non-traded sector. This results in expansion in the traded goods as well as increase in wages. The increase in income has ripple effects on the non-traded sector. The non-traded sector prices rise due to higher demand thus causing an appreciation of the real exchange rate since $\overline{q}_t$ fall as $\left(P_t^{NT} - P_t^{T}\right)$ rise.

2. Aggregate demand changes: - the effect of government investment and consumption on the real exchange rate depends on the proportion of expenditure falling on non-traded goods in contrast to traded goods. If a large share of government expenditure falls on non-traded goods it causes an appreciation of the real exchange rate. In case a large proportion of government expenditure falls on traded goods a current account deficit will ensue causing a depreciation of the real exchange rate.
3. Saving- investment balance and current account deficits and the real exchange rate:- The relative price of traded goods depends on the current account which in turn is influenced by fiscal policy and the balance between investment and savings. Increased government fiscal deficits will reduce savings and cause current account deficits and hence a depreciation. Fiscal consolidation increases savings and net foreign assets which results in appreciation of the real exchange rate.
4. Real price of oil and terms of trade ratio:- terms of trade being the price of exports over the price of imports could have effects on the real exchange rate. The price of oil is known to affect the relative price of traded goods thus causing terms of trade effects on the real exchange rate.

The following factors are known to influence the real exchange rate and signs of the effects indicated against each variable:

$$RER = f(\overset{(-)}{y}, \overset{(+)}{M}3, \overset{(-)}{G}\exp, \overset{(-)}{CABr}, \overset{(-)}{NFA}, \overset{(-)}{OPEN}, \overset{(-)}{capf}, \overset{(+/-)}{TOT}) \tag{12}$$

Estimation is done using the Johansen cointegration approach. Application of the Johansen approach starts with unrestricted vector autoregressive (VAR) model:

$$Z_t = \delta + \theta_1 Z_{t-1} + \theta_2 Z_{t-2} + \ldots + \theta_k Z_{t-k} + \varepsilon_t \tag{13}$$

for $t = 1, 2, \ldots, T$. Z_t is a vector of N variables, θ_i are $N \times N$ coefficient matrices, and ε_t is IID N -dimensional vector with zero mean and covariance Ω.

The vector autoregressive model can be re-parameterized in the following Error Correction Model (ECM) form:

$$\Delta Z_t = \delta + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-1} + \varepsilon_t \tag{14}$$

The Π matrix contains information on the long-run relationship among the given variables. The Johansen approach applies Maximum Likelihood technique to estimate the system by imposing the restriction

$$\Pi = \alpha\beta' \tag{15}$$

Given the value of r, α is $n \times r$ and β' is $r \times n$, where r represents the rank of Π. α measures speed of adjustment to equilibrium of the dependent variable while βZ_{t-1} represent the r cointegrating relationships.

The Johansen procedure tests hypotheses regarding the rank of long-run matrix Π. If rank of Π equals zero it will imply lack of cointegrating relationship. If rank of Π is n (full rank) then the variables must be stationary in levels. If however it is found that Π is of rank r where $0 < r < k$ then ΠZ_{t-1} are linear combinations that are stationary. r Cointegrating vectors therefore exists if the variables in Z_t are $\mathrm{I}(1)$ and the rank of the matrix Π is r. Although the variables in Z_t are non-stationary, the r linear combinations are stationary thus suggesting r cointegrating vectors.

The test for cointegration is carried out using two tests: Trace test and Maximum eigenvalue test;

$$\lambda_{trace}(r_0) = -T \sum_{j=r_0+1}^{k} \log(1-\hat{\lambda}) \tag{16}$$

$$\lambda_{\max}(r_0) = -T \log(1-\hat{\lambda}_{r_0+1}) \tag{17}$$

Where $\hat{\lambda}$ are canonical correlations between z_{t-k} and Δz_t.

Consistent with the BEER approach applied by McDonald (1997) among others, estimation is carried out in a VAR framework and the Johansen approach is used to derive the long-run cointegrating vector.

3. Analysis and discussion of results

Quarterly data is obtained from the Central Bank of Kenya. The real exchange rate series is computed based on currency weights relating to exports and imports with particular trading partners: US dollar

0.53, UK£ 0.08, Japanese Yen 0.03, Uganda shilling 0.03, Tanzania shilling 0.02, South African rand 0.03, Euro 0.18, Indian Rupee 0.06, and Chinese Yuan 0.04.

Table 1: Unit root tests

Variables	ADF statistics	PP statistics
Ln RER	-0.748 (0.826)	-0.875 (0.780)
Ln m 3	4.749 (1.00)	4.61 (1.00)
In y	0.647 (0.99)	1.44 (0.999)
CABr	0.518 (0.986)	-2.599 (0.098)
Ln NFA	-1.350 (0.601)	-1.315 (0.617)
Ln oil p	-1.717 (0.418)	-1.787 (0.383)
Ln open	-2.117 (0.239)	-1.933 (0.315)
Ln cons	0.013 (0.956)	1.817 (0.999)
Ln Cap fr	-2.464 (0.13)	-2.490 (0.145)

The analysis started with examining properties of the data particularly examining stationarity of the variables. All the variables were formed to have unit root and became stationary on first differencing. This paved way for estimation of a vector auto-regression model. Preliminary estimation and imposing zero restrictions on the Beta coefficients of the co-integrating relation, a number of variables were dropped as the zero-restriction test on the coefficients could not be rejected. For a start a VAR with five endogenous variables was adopted.

$$Z = Z(\ln y, \ln m3, \ln G\exp, CABr) \tag{18}$$

where $\ln y$ is the log of real output, $\ln m3$ is log of money $m3$, $\ln G\exp$ is log of total government expenditure and $CABr$ is current account balance as a percent of nominal GDP.

The VAR estimation indicates that 5 lags are optimal as selected by the Akaike information criteria while cointegration test indicated five co-integrating equations (Table 2). Though there was no unique co-integrating vector, the vector which included all the variables and a trend term was consistent with theoretical expectations. The cointegrating vector and equation for the real exchange rate are as given in Table 3.

Table 2: Cointegration test results

Hypothesized number of co-integrates equations	Eigen value	Trace statistics	Max-Eigen value statistics
$r=0$	0.720	180.84* (88.80)	68.65* (38.33)
$r=1$	0.505	112.19* (63.88)	37.99* (32.12)
$r=2$	0.497	74.196* (42.92)	37.09* (25.82)
$r=3$	0.357	37.11** (25.87)	23.82** (19.39)
$r=4$	0.218	13.29 ** (12.52)	13.29** (12.52)

Note: ** implies significance at 5% level, while * implies significance at 1 % level.

Table 3: Normalized co-integrating coefficients

$\ln RER$	$\ln y$	$\ln m3$	$\ln G\exp$	$CABr$	$constant$	$Trend$
1.00	3.685	-0.766	0.914	0.363	-16.118	-0.016
	(0.358)	(0.227)	(0.196)	(0.307)		(0.002)
	[10.285]	[-3.375]	[4.670]	[1.184]		[-7.714]
Adjustment Coefficients						
$\Delta\ln RER$	$\Delta\ln y$	$\Delta\ln m3$	$\Delta\ln G\exp$	$\Delta CABr$		
-1.131	-0.099	0.293	-0.097	-0.273		
(0.332)	(0.044)	(0.166)	(0.134)	(0.269)		
[-3.408]	[-2.278]	[1.768]	[-0.718]	[-1.012]		

Real GDP which captures effects of productivity has a negative effect on the real exchange rate as expected implying that economic growth appreciates the real exchange rate. Money supply, M3, has positive effects since an expansionary monetary policy will be expected to depreciate the domestic currency. Government expenditure which is most recurrent in nature is shown to have negative effects implying that an increase in government expenditure appreciates the real exchange rate as expected. These three variables have highly significant effects on the real exchange rate. The current account balance has negative effects as expected since an improvement of the current account is expected to cause an appreciation of the currency. A trend term is found to be highly significant signaling structural changes of the economy over the period. The results indicate that the current account is not significant and by imposing zero-restrictions, the null hypotheses could not be rejected. By imposing the zero restriction we derived a co-integrating vector which included four endogenous variables and a trend term. The results are given in Table 4. $\ln y$, $\ln m3$ and $\ln G\exp$ remain highly significant and with the expected coefficient signs as before.

Table 4: Estimation of co-integrating and adjustment coefficients: Normalized co-integrating coefficients

$\ln RER$	$\ln y$	$\ln m3$	$\ln G\exp$	$constant$	$Trend$
1.00	4.828	-1.653	1.625	-16.471	-0.005
	(0.713)	(0.391)	(0.337)		(0.003)
	[6.767]	[-4.226]	[4.313]		[-1.483]
Adjustment coefficients					
$\Delta\ln RER$	$\Delta\ln y$	$\Delta\ln m3$	$\Delta\ln G\exp$		
-0.812	-0.019	0.190	-0.063		
(0.154)	(0.026)	(0.098)	(0.080)		
[-5.288]	[-0.767]	[1.935]	[-0.785]		

The exchange rate misalignment is derived by first smoothing the estimated long run real exchange rate series using the Hodrick-Prescott filter with a smoothing parameter of $\lambda = 200$. The smoothed long run series and the actual real exchange rate are shown in the Figure 1 and Figure 3 for the two co-integrating vectors. The percentage misalignment is given in Figures 2 and 4.

Real exchange rate misalignment is, therefore, determined by computing the percentage deviation of the actual exchange rate from the estimated equilibrium exchange rate. Figure 2 shows the extent of exchange rate misalignment for the model that includes current account balance while the extent of misalignment in the model that excludes current account balance is shown in Figure 4.

Figure 1: Equilibrium real exchange rate versus actual rate

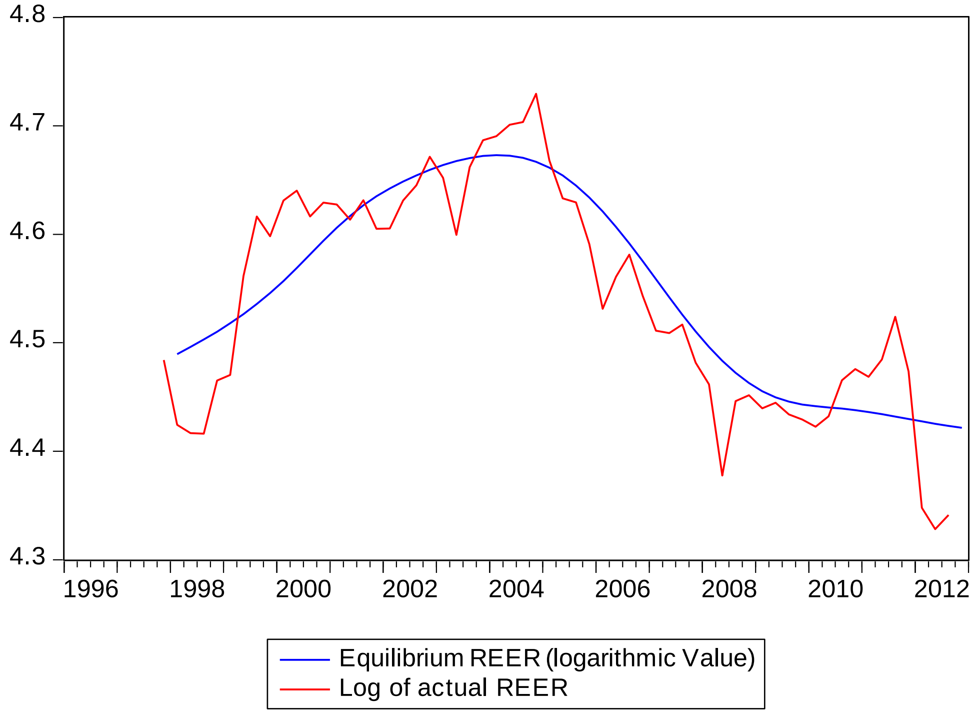


Figure 2: Misalignment

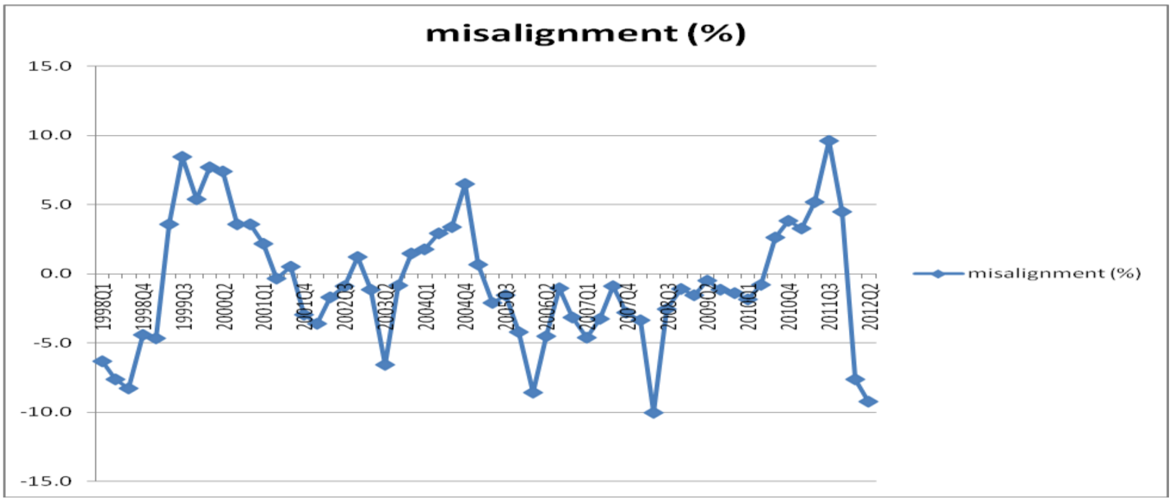


Figure 3: Equilibrium real exchange rate versus actual exchange rate (model excluding current account balance)

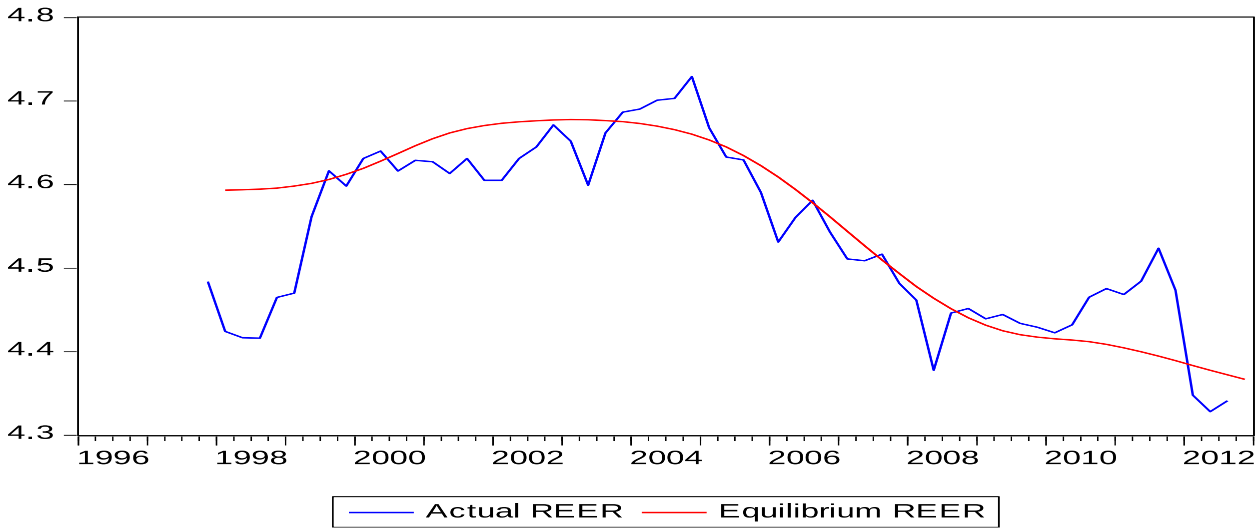
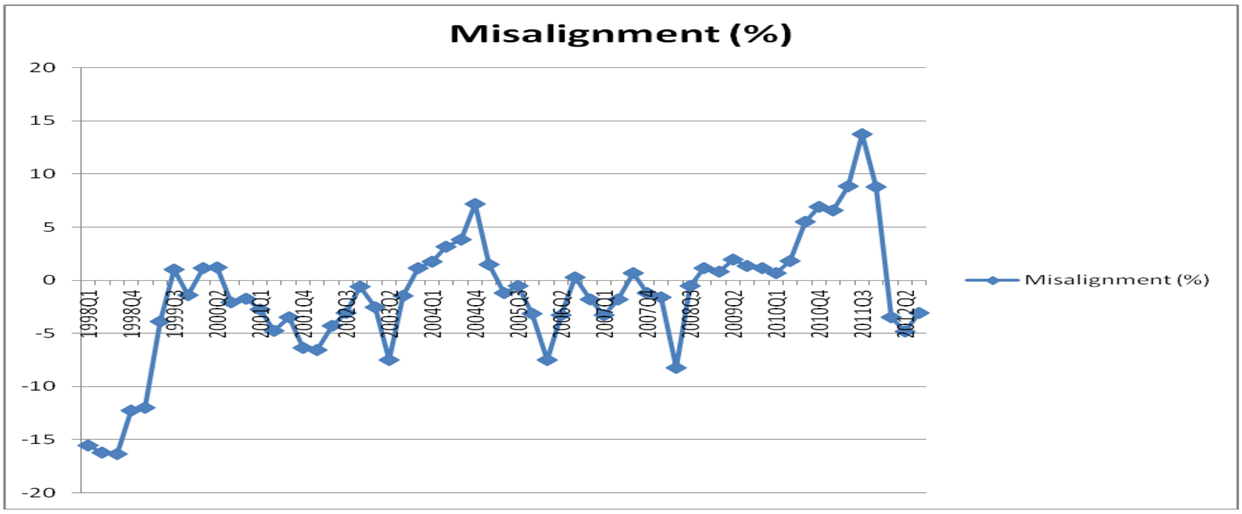


Figure 4: Exchange rate misalignment (model excluding current account balance)



If one considers misalignment of real exchange rate above 10% as that which should concern policy makers, then from the results in this study, misalignment has not been large. Misalignment has for most of the period been within 10% deviation from equilibrium. Figure 4 shows some misalignment in the period before 1998-99 period and also in 2011. The recent misalignment could be traced to the number of events which have had major influence on the exchange rate: the post-election violence, the global financial crisis and the euro zone economic crisis.

4. Conclusion

This study sought to determine the extent of misalignment of the real exchange rate in Kenya over the period 1998-2012. The Behavioral Equilibrium Exchange Rate (BEER) approach was adopted and applied in the analysis of the real exchange rate. Estimation was carried out in a VAR framework in which Johansen cointegration test and estimation were carried out. The resulting cointegrating vector demonstrated the significant role played by real incomes, money supply and government expenditures in influencing the magnitude of real exchange rate changes. Regarding the level of misalignment, it is clear that the real exchange rate has not been seriously misaligned during the period. Occasionally of course the real exchange could be pushed away from equilibrium by major economic shocks such as the recent global and euro zone economic crises.

It can be concluded that leaving the exchange rate to be driven by market forces while at the same time ensuring appropriate fiscal and monetary policies will steer the exchange rate along its equilibrium path.

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