Determinants of Equilibrium Real Exchange Rate and its Misalignment in Kenya: A Behavioral Equilibrium Exchange Rate Approach

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Determinants of Equilibrium Real Exchange Rate and its Misalignment in Kenya: A Behavioral Equilibrium Exchange Rate Approach[1]

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Abstract

This paper examines the real exchange rate misalignment in Kenya using quarterly data over the period 2000 – 2014. The Behavioral Equilibrium Exchange Rate (BEER) approach to determine the extent of exchange rate misalignment is adopted. A vector error correction model (VECM) is estimated and the results show that the real exchange rate is largely driven by fundamentals. Thus, 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 shock such as the recent global financial crisis and the Euro zone economic crisis. Hence, given the managed float regime in Kenya, exchange rates keep adjusting to changing economic fundamentals.

JEL Classification: F31, C32

Keywords: exchange rate, equilibrium, misalignment, Kenya

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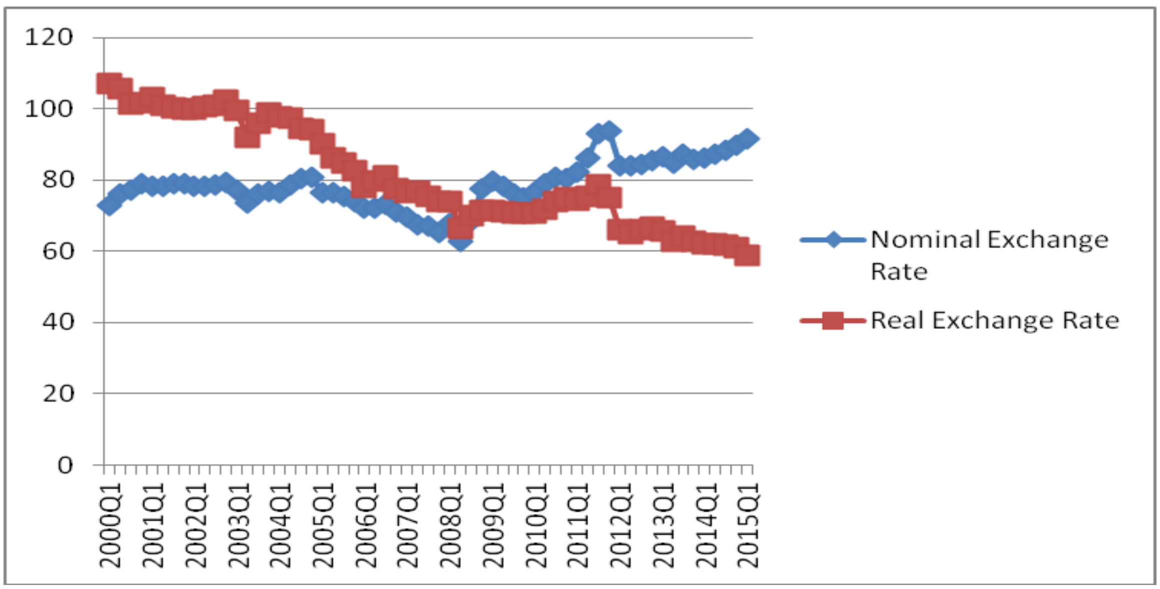
1. Introduction

Over the recent past, the Kenya Shilling depreciated against the US dollar an episode attributed to various macroeconomic factors and shocks. What is unclear among researchers and policymakers is whether the movement in the nominal exchange rate represents a shift in equilibrium real exchange rate. Therefore, an accurate analysis of the equilibrium exchange rate, and consequent misalignment would prove crucial. As indicated in figure 1, though the real exchange rate has moved closely with the nominal exchange rate, the two have moved in opposite directions since 2011, with the Kenya shilling depreciating in nominal terms but appreciating in real terms.

Figure 1: Trends in nominal and Real Exchange Rates



Empirical studies on the drivers of the RER and its misalignment exist. Results vary from one country to the other and also vary over the periods of study. In terms of studies from other parts of Africa, Imam and Minoiu (2011) employ two structural models, notably, the Macroeconomic Balance (MB) approach and the Fundamental Equilibrium Exchange Rate (FEER) method for Namibia. They find that in 2006-07, the real exchange rate was aligned with the equilibrium RER. As a robustness check, similar results were obtained when the External Sustainability (ES) approach was used. De Jager (2012) estimated an equilibrium path for South African RER using a Vector Autoregressive Model (VECM) with the view to quantify the extent of misalignment of the REER from its long run value. The findings identify the real interest rate differential, commodity prices and size of fiscal balance, openness measure and capital flows to South Africa as the main drivers of the equilibrium REER. It was also reported that the Rand/dollar rate was approximately 1 per cent over-valued during the last quarter of 2011.

In Kenya, there are a few studies that attempt to estimate the RER equilibrium path, and analyze the extent and implications of exchange rate misalignment. A study by Maturu (2002) looked at the RER behavior in Kenya by using quarterly data covering the period 1980-98. It was found that a linear relationship binding together the RER and fundamentals existed, and that the RER was overvalued. Kiptoo (2007) on the other hand focused on the effect of RER volatility and misalignment on international trade and investment by using data spanning 1993-2003. The main result was that the RER was undervalued, and that RER volatility and misalignment did impact negatively and significantly on Kenya's trade and investment over that period.

Musyoki et al., (2012) examine the RER misalignment in Kenya by using the Johansen cointegration and error correction approach based on single equation and vector autoregressive (VAR) specification. They found that over the period covering 1993-2009, the RER was often above its equilibrium, and the country's international competitiveness weakened over this period.

Kiptui and Kipyegon (2008) studied the exchange rate trends in 1996-2007 and found that external shocks to a large extent influence RER as demonstrated by the significance of the terms of trade and openness in the long-run and short-run estimations. The study found minimal misalignment and actually noted that the appreciation as predicted by the fundamentals was in fact steeper than the realized appreciation. The shilling therefore, was not overvalued going by the misalignment of the real exchange rate from equilibrium. There were times when the shilling was overvalued particularly noticeable in the period just after liberalization. Afterwards, the shilling became more depreciated. Further, Kiptui (2015) in a more recent study finds the predominant role played by demand shocks in the determination of the real exchange rate. Thus the exchange rate was found to play a shock absorber role.

This study thus examines movements in the real exchnage rate to examine if the real exchange rate is aligned to its fundamental determinants. This is important considering that the real exchnage rate is often taken to be a measure of competitiveness, implying that an overvalued currency would hurt the export sector and adversely affect economic growth. Moerover, persistent misalignment could easily trigger balance of payments and currency crises. Therefore there is need to examine the extent of misalignment so as to take appropriate policy measures. This paper is organized as follows: section 2 discusses various approaches applied in the assessment of misalignment, section 3 outlines the empirical model while section 4 presents the results. Section 5 concludes the study.

2. Review of approaches to the study of misalignment

Various approaches to the measurement of exchange rate misalignment have been advanced: behavioral equilibrium exchange rate (BEER) developed by Clark and McDonald (1998), Permanent equilibrium exchange rate (PEER) proposed by Clark and Mc Donald (2000), fundamental equilibrium exchange rate (FEER), macroeconomic balance approach, natural rate exchange rate approach (NATREX)and external sustainability approach. We discuss each of these briefly below.

i. Behavioral Equilibrium Exchange Rate (BEER)

The behavioral equilibrium exchange rate (BEER) approach was introduced by Clark and MacDonald (1999, 2000). In this approach, fundamental determinants of the real exchange rate are quantified through econometric estimation with an extended version of the uncovered interest parity as the theoretical background (Ègert and Lahrèche-Rèvil, 2003). This consists of estimating the relationship between the real exchange rate and a number of fundamentals and transitory factors (Rubaszek, 2004; Dufrenot and Ègert, 2005). Deviation from equilibrium represents misalignment. The basis is the risk-adjusted uncovered interest parity condition:

$$E_t[\Delta_k s_{t+k}] = (i_t - i_t*) - c \,,$$

Where s is the log of the price of a unit of foreign currency, $E_t[.]$ is the rational expectations operator conditional on the information set at time t, Δ_k is the k-period difference operator so that $E_t[\Delta_k s_{t+k}] = E_t(s_{t+k} - s_t)$, i_t is the compounded nominal interest rate for k periods on a bond with the maturity horizon k, c is a (constant) risk premium and * is an indicator for foreign variables.

By subtracting the expected inflation differential from both sides of the equation, it is converted into a real relationship as follows:

$$E_t[\Delta_k s_{t+k}] - \{E_t[\Delta_k p_{t+k} - \Delta_k p*_{t+k}]\} = (i_t - i_t*) - \{E_t[\Delta_k p_{t+k} - \Delta_k p*_{t+k}]\} - c$$

This can be rewritten;

$$q_t = E_t[q_{t+k}] - (r_t - r_t^*) + c$$

Where $r_t = i_t - E_t[\Delta_k p_{t+k}]$ is the compounded real interest rate for k periods and q_t is the real exchange rate. This is therefore the condition for risk-adjusted real uncovered interest rate parity.

The real exchange rate is explained by the expected future real exchange rate, the real interest rate differential and the risk premium. The real interest rate differential enters with a negative sign indicating that an increase in the differential will cause an appreciation of the real exchange rate. Likewise, a decrease in the risk premium will cause the real exchange rate to appreciate.

The unobservable expected future real exchange rate, $E_t[q_{t+k}]$ is assumed to be determined by a set of long-run determinats, the so-called fundamentals. Faruqee (1995) argues that the most relevant fundamentals are net foreign debt as a share of GDP, the terms of trade, and the relative price of tradables to non-tradables (i.e the ratio of the home country's tradables to non-tradetables to the equivalent foreign price ratio). This acts as a proxy for productivity differentials.

ii. Permanent Equilibrium exchange Rate (PEER)

The long-run equilibrium exchange rate is computed using long-term value of the fundamentals found by decomposing the series into permanent and transitory components. The deviation can be obtained by decomposing the cointegration vector itself into permanent and transitory components via Gonzalo and Granger method. Other authors have added variables capturing exogenous demand factors

iii. Fundamental Equilibrium Exchange Rate (FEER)

FEER was developed by Williamson (1983). This approach assesses the equilibrium exchange rate directly as a function of macroeconomic fundamentals (Church, 1999; Ègert and Lahrèche-Rèvil, 2003; Church, 1992). Fundamental equilibrium exchange rate requires estimating a reduced form relationship between the REER and a vector of macroeconomic fundamentals including government consumption, trade openness, terms of trade, technological progress / productivity (Balassa-Samuelson effect), NFA (to GDP) position, investment (supply-side effects) and a capital controls dummy for post- 1994 liberalization. A cointegration analysis is carried out and insignificant variables removed.

iv. Natural Real Exchange Rate approach (NATREX) developed by Stein (1994) and extended by Stein and Allen (1997)

This approach distinguishes between medium term equilibrium in which external and internal balance prevails and a long term equilibrium in which net foreign debt is constant and the capital stock has reached its steady state level (Frankel and Koske, 2012). Frankel and Koske (2012) combine the behavioral equilibrium exchange rate approach and NATREX concept thus applying a two-step methodology. In step one the long-run relationship between the real exchange rate and economic fundamentals is estimated for a group of countries which do not include the countries being studied. The estimates constitute a benchmark for other countries. In step two the equilibrium exchange rates of the countries being studied are derived by applying the estimated coefficients to data from these countries. Long term NATREX depends on a set of variables which include the productivity of the tradable goods sector (u_T), the productivity of non-tradable goods(u_{NT}), the time preference(p), the world interest rate (r*)and the terms of trade (t).

$$R = f(p, u_T, u_{NT}, r^*, t)$$

With internal and external balance satisfied, there is no pressure on the real exchange rate to move in either direction. Deviations are due to cyclical and speculative factors. The NATREX level is not constant but changes as the fundamentals change.

v. Macroeconomic Balance Approach

This is a forward looking approach and involves a number of steps: estimating the long-run relationship between the current account balance and its determinants using dataset of several countries over some period; based on the estimated relationship, to project the behavior of the current account over the medium term for the country under study; discrepancies between the two paths provide an estimate of the extent of misalignment and the adjustment needed to bring the exchange rate in line with its equilibrium (Imam and Minoiu, 2012; Dunaway et al, 2006). The equilibrium real exchange rate is typically derived based on the historical relationship between the current account balance and a set of macroeconomic fundamentals. The key assumption is that the econometric estimates reflect the equilibrium relationship between the dependent variable and the fundamentals.

The idea is to find the equilibrium exchange rate implied by sustainable current account balance (current account norm) which is determined by external and domestic macroeconomic fundamentals. The current account position is deemed to be sustainable if current policies can maintain external and internal balance with no need for major policy shift. The approach is to estimate a model of the determinants of the current account balance using panel data for several countries. The estimation gives important information about the equilibrium long-run relationship between the current account and its determinants. The next step is to determine the exchange rate adjustment needed to close the gap between current account norm and the underlying current account based on estimated trade elasticities. The underlying current account is that which would prevail given existing policies.

vi. External sustainability approach

This is a variant of the forward looking macroeconomic balance approach (Imam and Minoiu, 2012). It retains the main idea of assessing real exchange rate misalignment by comparing the underlying current account with the norm. It derives current account norm based on stock equilibrium concept. Current account norm is the NFA-stabilizing balance and is given by:

$$ca^{ES} = \frac{g+\pi}{(1+g)(1+\pi)} b^{ES}$$

Where g represents growth rate of real GDP, π is inflation level, b^{ES} is benchmark NFA level (% of GDP).

3. Methodology

The analysis adopted in this paper is based on 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 nominal exchange rate is driven by nominal interest rate differentials.

$$E_t(\Delta S_{t+k}) = (i_t - i_t^*) - C \qquad (1)$$

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. C is the risk premium.

When expected inflation is subtracted from both sides of the equation, an equation for the real exchange rate is derived:

$$q_t = E_t(q_{t+k}) - (r_t - r_t^*)$$

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

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

Actual exchange rate therefore consists of two components, the equilibrium rate driven by fundamentals and the real interest rate differential.

Sources of long-run real exchange rate variability consist of among others, the following (Atasoy and Saxena, 2006):

- 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
- Fiscal policy and aggregate demand: - 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.
- Saving- investment balance and current account deficits:- The relative price of traded goods depends on the current account which in turn is influenced by the balance between investment and savings.
- terms of trade ratio:- 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.
- Openness is expected to cause depreciation.
- Capital inflows appreciate the exchange rate

Signs of the effects are indicated against each variable:

$$REER = f(\overset{(-)}{\ln y}, \ln \overset{(+)}{M}3, \ln \overset{(-)}{G}\exp, \ln \overset{(-)}{NFA}, \overset{(-)}{OPEN}, \ln \overset{(+/-)}{TOT})$$

where $\ln y$ is the log of real output, $\ln m3$ is log of money $m3$ deflated by cpi, $\ln G\exp$ is log of government recurrent expenditure also deflated by cpi, LnNFA is log of net foreign assets, OPEN is openness index and TOT represents terms of trade.

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.

Levin (1997) argued that money supply growth causes the exchange rate to either overshoot or undershoot. In addition, the study found that the real interest rate depends inversely on the real interest rate in contrast to the real interest differential. Money supply, m3 is therefore used instead of the interest rate differential.

The unrestricted vector autoregressive (VAR) model can be written as:

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

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

4. Analysis

Quarterly data is obtained from the Central Bank of Kenya and IFS of the IMF. The analysis covers the period 2000-2014. First we confirm the stationarity of the variable series using Augmented Dickey Fuller and Phillips-perron tests.

Table 1: Unit root tests

Variables	ADF statistics	PP statistics
Ln REER	-0.954 (0.764)	-0.893 (0.784)

Ln m 3	3.263 (1.00)	2.673 (1.00)
In y	1.542 (0.999)	1.826 (0.999)
Ln NFA	-1.66 (0.446)	-1.315 (0.617)
open	-2.117 (0.239)	-1.933 (0.315)
Lntot	-0.47(0.889)	-0.604(0.86)
Ln Gexp	-0.082 (0.946)	-2.535 (0.113)

All the variables were found 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, led to a number of variables being dropped as the zero-restriction test on the coefficients could not be rejected. The analysis thus proceeded with a VAR of four variables which were found to be significant. Two lags were found to be more appropriate for the study. A cointegration test was thus carried out.

Table 2: Cointegration test results

Hypothesized number of co-integrates equations	Eigen value	Trace statistics	Max-Eigen value statistics
$r = 0$	0.482	62.036* (47.856)	36.793* (27.584)
$r = 1$	0.505	25.243 (29.797)	17.799 (21.132)
$r = 2$	0.497	7.443 (15.495)	7.288 (14.265)

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

Table 3: Normalized co-integrating coefficients

$\ln REER$	$\ln y$	$\ln m3$	$\ln G\exp$	$cons\tan t$
1.000	1.748	-0.865	0.328	-20.996
	(0.149)	(0.109)	(0.086)	
	[11.695]	[-7.933]	[3.802]	

The cointegration test established one cointegrating vector. The long run coefficients and their significance are reported in table 3. 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 is shown to have negative effects implying that an increase in government expenditure appreciates the real exchange rate as expected. The speed of adjustment is -0.26 implying that it takes time for the system to return to equilibrium, on average about 4 quarters.

Next, the difference between the observed and the estimated equilibrium real exchange rate was computed to assess the level of misalignment or the extent of possible over- or undervaluation. This is shown in figure 2 below.

Figure 1: Equilibrium real exchange rate versus actual rate

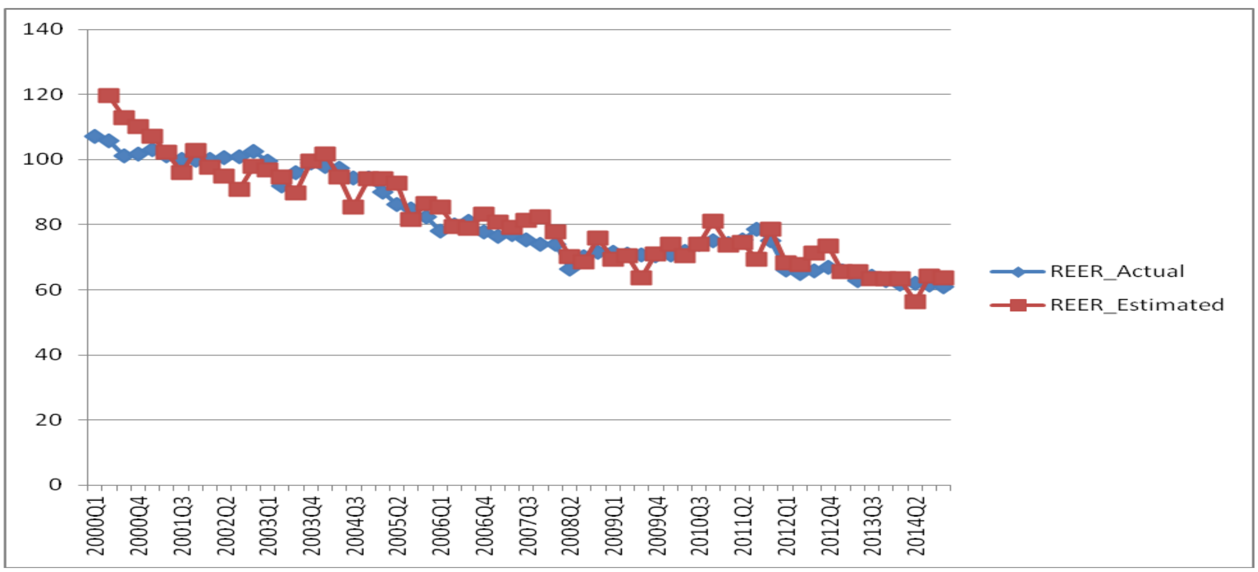
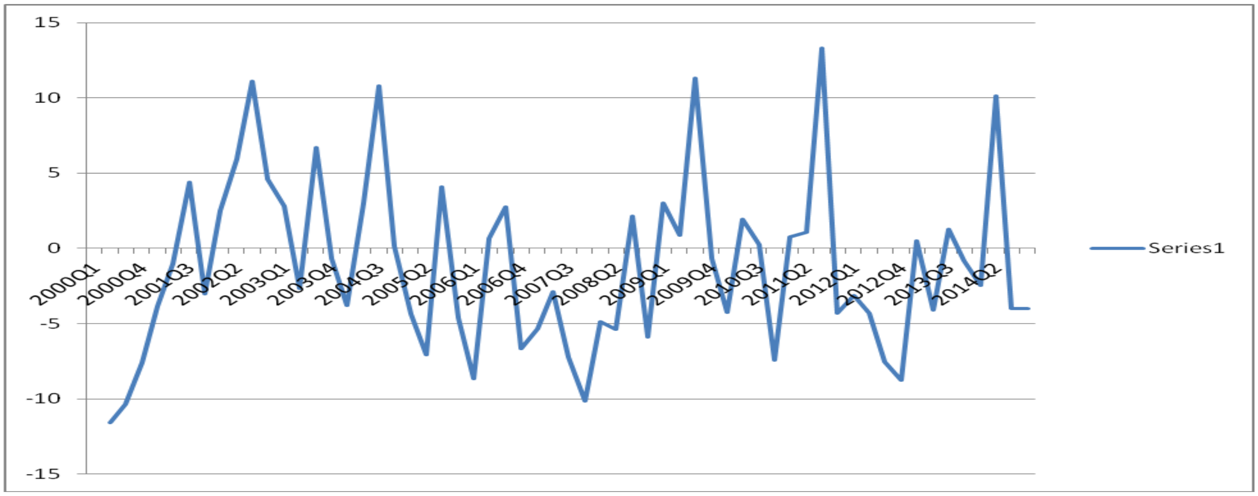


Figure 2: Misalignment (%)



The following observations are made:

- Misalignment has for most of the period been within 10% deviation from equilibrium
- Misalignment can be traced to a number of events which have had major influence on the exchange rate: the global financial crisis and the euro zone economic crisis.
- However, exchange rate was overvalued in 2006-2008 period and also in 2011-2013
- Minor overvaluation in 2014q4 of 4%

5. Conclusion

In conclusion, exchange rates are largely driven by real incomes, money supply and government expenditures. 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. Overvaluation does occur but is transient.

References

Atasoy, D. and Saxena, S.C. (2006). Misaligned? Overvalued? The untold story of the Turkish Lira. *Emerging Markets Finance & Trade*, 42(3), 29-45.

Church, K. B. (1999). Properties of the fundamental equilibrium exchange rate in the Treasury model. *National Institute Economic Review*, 169, 96-104.

Church, K.B. (1992). Properties of the fundamental equilibrium exchange rate in models of the UK economy. *National Institute Economic Review*, 141, 62-70.

Clark, P.B., and Macdonald, R. (1998). Exchange rates and economic fundamentals: A methodological comparison of BEERs and FEERs. IMF Working Paper 98/67, International Monetary Fund, Washington.

De Jager, S. (2013). Modelling South Africa's equilibrium real exchange rate: A VECM approach. SA Reserve Bank Working Paper W/12/02. South Africa Reserve Bank.

Dufrenot, G. and Egèrt, B. (2005). Real exchange rates in Eastern Europe: what scope for the underlying fundamentals? *Emerging Markets Finance & Trade*, 41(2), 41-59.

Dunaway, S., Leigh, L. and Li, X. (2006). How robust are estimates of equilibrium real exchange rates: the case of china. IMF Working Paper, WP/06/220, International Monetary Fund, Washington.

Edwards, S. (1989), Exchange rate misalignment in developing countries. NBER Working Paper 2950, National Bureau of Economic Research.

Ègert, B. and Lahrèche-Rèvil (2003). Estimating the Equilibrium exchange rate of the Central and Eastern European Acceding Countries: the Challenge of the Euro Adoption. *Review of World Economics/ Weltwirtschaftliches Archiv*, 139(4), 683-708.

Frenkel, M. and Koske, I (2012). Are the real exchange rates of the EU member countries in line with fundamentals? Implications for the NATREX approach. *Journal of Economics and Statistics*, 232 (2), 129-145.

Gonzalo, J. and Granger, C. (1995). Estimation of common long-memory components in cointegrated systems. *Journal of Business and Economic Statistics*, Vol. 13, No.1, 27-35.

Gylfason,T. (2002). The Real Exchange Rate Always Floats. Center for Economic Policy Research (CEPR) Discussion Paper 3376, London**.**

Imam, P. and Minoiu (2011). The equilibrium exchange rate of Mauritius: evidence from two structural models. *Emerging Markets Finance & Trade*, 47(6), 134-147.

Kiptoo, C (2007), *Real Exchange Rate Volatility, and misalignment in Kenya, 1993-2003 , Assessment of its impact on International Trade, and investments*. Unpublished Ph.D Thesis, University of Nairobi .

Kiptui, M. and Kipyegon, L. (2008). External shocks and real exchange rate movements in Kenya. Paper presented at the African Econometric Society (AES) Conference, Pretoria, South Africa.

Kiptui, M.C (2015). Sources of exchange rate fluctuations in Kenya: The relative importance of real and nominal shocks. *Munich Personal Repec Archive (MPRA) Paper 61515.*

Levin, J.H. (1997). Money supply and exchange rate dynamics. *Journal of Economic Integration*, 12 (3), 344-358.

Maturu, B.O. 2002. *Modeling the Real Exchange Rate for Kenya, 1980-1998*. Unpublished Ph.d Thesis, Jomo Kenyatta University of Agriculture and Technology.

Musyoki, D., Pokhariyal, P.G., and Pundo, M. (2012). Real exchange rate equilibrium and misalignment in Kenya, *Journal of Business Studies Quarterly* 3(4), 24-42

Nilsson, K. (2004). Do fundamentals explain the behavior of the Swedish real effective exchange rate? *The Scandinavian Journal of Economics*, 106 (4), 603-622.

Rahman, A.K.M.A. and Basher, S.A. (2001). Real exchange rate behavior and exchange rate misalignments in Bangladesh. *The Bangladesh Development Studies*, 27(2), 69-93.

Rubaszek, M. (2004). A model of payments equilibrium exchange rate: Application to the Zloty. *Eastern European Economics*, 42(3), 5-22.

Stein, J. L. (1994). The natural real exchange rate of the US dollar and determinants of capital flows. In "*Estimating Equilibrium Exchange Rates*", ed. by J. Williamson, Institute for International Economics, Washington D.C.

Stein, J.L. (1997). *Fundamental Determinants of Exchange Rates*. Clarendon Press.

Vieira, F.V. and MacDonald, R. (2012). A panel data investigation of real exchange rate misalignment and growth. *Est. Econ., São Paulo*, 42(3), 433-456.

Williamson, J. (1983). *The Exchange Rate System*. Institute for International Economics, Washington.