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Abstract

With the liberalization of exchange rate in most countries, policy makers have to contend with erratic movements in exchange rates in the short-run, causing exchange rate misalignments in the long run. Exchange rate misalignments have several adverse implications including distorting resource allocation between production sectors, distorting patterns of trade, and distorting debt repayment schedules for indebted countries, among others. When exchange rate movements become erratic, monetary authorities intervene in the exchange rate markets to correct any misalignments. Interventions are supposed to be based on some indicator that the observed exchange rates are either over-appreciated or over-depreciated, hence the need for an intervention. Without this knowledge, it is possible that wrong interventions may be carried out, interventions may be carried out when they are not necessary, or interventions may not be done at all when they are necessary. This study estimates the equilibrium exchange rate in Kenya using the fundamental equilibrium approach. The results show that there were three main episodes of misalignment; in late 2002 to early 2003, mid 2004, and mid 2005. In general, the study finds that real exchange rate misalignments are mean-reverting in the long run, and therefore should not warrant policy intervention.

Abbreviations and Acronyms

BEER	Behavioural Equilibrium Exchange Rates
CBK	Central Bank of Kenya
CHEER	Capital Enhanced Measures of the Equilibrium Real Exchange Rates
ECM	Error Correction Model
FEER	Fundamental Equilibrium Real Exchange Rate
FEVD	Forecast Error Variance Decomposition
IMF	International Monetary Fund
LRER	Long Run Real Exhange Rate
NATREX	Natural Real Exchange Rates
PPP	Purchasing Power Parity
PRGF	Poverty Reduction and Growth Facility
SDR	Special Drawing Rights
VARMA	Vector Autoregression Moving Average
VECM	Vector Error Correction Model

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1. Introduction

In flexible exchange rate regimes, erratic exchange rates are a common phenomenon of the short-term economic activity. Most of these erratic movements are driven by temporary shocks, including speculative attacks that are only short-term. In the long run, exchange rate movements are driven by some basic fundamentals, which push the exchange rates towards a stable equilibrium. There are several definitions of equilibrium exchange rates. Edwards (1989) defines *equilibrium real exchange rates* as the relative price of non-tradable to the tradable goods which for given sustainable values of other relevant variables such as taxes, international terms of trade, commercial policy, capital and aid flows and technology, result in the simultaneous attainment of internal and external balance (equilibrium). Internal equilibrium in the market is achieved when the market for non-tradable goods clear both in the current and in the future. External equilibrium, on the other hand, is achieved when the current account balances are consistent with the long run sustainable capital flows, both in the present and in the future. The long run real exchange rate (LRER) is therefore achieved at the point of intersection of the internal equilibrium and the external equilibrium. Deviations of the actual rates from equilibrium rates lead to exchange rate misalignments. Exchange rate misalignment is expressed as the percentage deviation of the actual rate from its equilibrium value and is calculated as:

$$MIS = \left(\frac{ARER}{ERER} - 1 \right) .100 \qquad \text{(1.1)}$$

where MIS represents exchange rate misalignments, $ARER$ is the actual *RER* and $ERER$ is the equilibrium *RER*.

Exchange rate misalignments (either over-appreciations or over-depreciations) lead to misallocation of resources between the different sectors in the economy and between countries. There have been arguments for and against depreciation and appreciation of exchange rates in most developing economies. In most cases, due to diversity in the structures of these economies, there seems to be no consensus. Proponents of the export promotion theory argue that the government should strive to maintain a depreciating currency in order to make export prices relatively lower in the international markets, thus making exports more competitive. This should increase export volumes, thereby improving terms of trade, and the balance of payments, hence increasing national incomes. Proponents of appreciation in developing countries, on the other hand, argue that since imported raw materials form a substantial proportion of the developing countries cost of production, depreciation of the exchange rate is detrimental to the economy as it increases import prices, which leads to increased cost of production, making domestically produced goods less competitive in the international markets compared to foreign goods. They therefore argue that all government interventionist policies to stabilize or manage exchange rates must be geared towards maintaining an appreciating currency and avoiding over-depreciation. In most cases, monetary authorities in these countries find themselves in the centre of this debate without an idea on how to intervene.

The responsibility of price stability in most countries is bestowed upon the central banks. How they intervene to correct erratic movements of exchange rates depends on the intended direction of the correction. The direction depends on what levels of the exchange rates the central bank sees as the optimum (equilibrium). On one hand, if the perceived equilibrium is wrong, then there will be a wrong intervention. It is therefore important for the monetary authorities to know exactly what the equilibrium exchange rates are at any given time to avoid wrong interventions. The other major nightmare for policy makers in the absence of a calculated or perceived equilibrium rate is to determine whether the exchange rates observed at a given time are over-appreciated or over-depreciated, and therefore warrant a policy intervention. In order to intervene optimally, the policy makers must necessarily know where the long-run equilibrium should be and whether the observed exchange rates are either over-depreciated or over-appreciated.

With the liberalization of the exchange rates in Kenya, for instance, there has been (an ongoing) debate on the appropriate level of exchange rates in Kenya. Some of the loudest voices have been the exporters when the nominal exchange rates are rapidly appreciating, and the importers when the exchange rates are depreciating. The occasional interventions by the Central Bank of Kenya (CBK) to this date are not pegged on any optimum levels of exchange rates, but on intuition. It is therefore important to determine what the equilibrium exchange rate levels in Kenya are, and which ones can be used as a basis of informing policy incase of any interventions. It is also important to determine whether there have been any periods of significant misalignments in Kenya, which could be indicative of instances when monetary policy authorities did not recognize that the observed exchange rates were either over-appreciated or over-depreciated, and therefore interventions were necessary.

This paper uses a rigorous econometric approach to determine equilibrium exchange rates. The aim of the paper is to determine the equilibrium exchange rates and exchange rate misalignments in Kenya using the fundamental equilibrium approach under the internal-external equilibrium approach of the determination of equilibrium exchange rates.

Section one gives definitional issues and the evolution of exchange rate policy in Kenya. Section two gives the empirical literature review, and section three gives the theoretical foundations of the model used. Section four provides the empirical model, while section five gives the model results and section six summarizes and concludes the study.

1.1 Nominal Exchange Rates

Nominal exchange rate (NER) as used in this study is the units of domestic currency per unit of foreign currency, i.e:

$$NER = \frac{E^d}{E^f} \tag{1.2}$$

With this definition, a decrease in the index signifies an appreciation of the nominal exchange rates in domestic currency terms. A depreciation of the nominal exchange rate is the increase in the nominal exchange rate index.

1.2 Real Exchange Rates

The real exchange rate (RER) as used in this study is the nominal exchange rate multiplied by the foreign price index divided by the domestic price index, i.e:

$$RER = \frac{NER.P^f}{P^d} \tag{1.3}$$

This is the external real exchange rate.

1.3 Exchange Rate Policy in Kenya

Until 1975, Kenya operated under the fixed exchange regime where the exchange rate was fixed at given levels by the monetary authorities, like most economies in the world at the time. Kenya currency (the Kenyan Shilling) exchange rate remained fixed at 7.143 to the US dollar. Between October 1975 and December 1982, the Kenya shilling was pegged to the special drawing rights (SDR), calculated from a basket of currencies and considered to be more stable than the single currency peg. In the crawling peg regime, the exchange rate is adjusted on a daily basis against a composite basket of currencies of the country's major trading partners. However, the pegging of the exchange rate to the SDR was considered inadequate, since the weights used did not reflect the trade pattern. The 1990s began with a dual exchange rate system. There was, however, pressure from the donor community for the government to speed up the process of liberalization, as one of the loan conditionalities. Adopting a floating exchange rate regime was also among these conditions. A floating exchange rate, where the market forces are left to determine the rates, was finally adopted in October 1993. Since then, the shilling has remained largely market driven, with the Central Bank only intervening to correct erratic movements in the rate. With the liberalization of the exchange rates in Kenya, there is no overt monetary policy objective to manage the exchange rates, except mildly through such instruments as periodic increments in the Central Bank's foreign exchange holdings, to strengthen the weakening shilling in the case of a rapid weakening.

2. Empirical Literature Review

Several studies have attempted to estimate equilibrium real exchange rates in different countries and regions using different approaches. Edwards (1994) uses a single equation reduced form estimation method to estimate the long-run equilibrium real exchange rates (LRER) for 12 developing countries between 1962 and 1984. The fundamentals used in the study included the rates of growth of total factor productivity, terms of trade, the share of government consumption in GDP, a measure of the openness of the trade regime, and a measure of the severity of capital controls, and proxies for temporary demand shocks and changes in the nominal exchange rates, which the study took as affecting the short-term adjustment process of the RER to the long run RER. The results show that short-run real exchange rate movements have responded to both nominal and real disturbances. The study finds that expansive and inconsistent macroeconomic policies of the countries in the study generated forces towards real over-valuation.

Elbadawi (1994), using annual data from 1967-1990 for Chile and Ghana and 1967-1988 for India, regressed the LRER on the fundamentals, including terms of trade, a measure of openness as a proxy for commercial policy, the level of net capital inflows relative to GDP, the share of government spending on GDP, and the rate of growth of exports. The estimated ERERs and the corresponding RER misalignments from the study confirm that the ERER is not a fixed number. The study infers from this finding that simple PPP modeling that gives the ERER as a fixed number could be a misleading simplification (Elbadawi, 1994).

Elbadawi and Soto (1994) used annual data from 1960 to 1990 on the Chilean economy and focused on the role of capital inflows, which in an earlier work by Elbadawi (1994) was assumed to be one of the fundamentals. The study distinguished between the short run and the long run inflows. After separating the ratio of net capital inflows to GDP into short term and long-term inflows, they found that the short term inflows variable was not stationary and, therefore, they omitted it from the cointegrating equation. The study found out that an increase in the long-run inflows led to the appreciation of the LRER, and that the magnitude of the effect was larger than that of government spending. Further, the results showed that episodes of the short term capital inflows led to the appreciation of the LRER.

Baffes, Elbadawi and O'Connell (1999) developed a single equation approach to estimating the equilibrium exchange rates using annual data from Cote d'Ivoire and Burkina Faso. They argue that the equilibrium exchange rate is determined by the intersection of the internal balance and the external balance curves. The macro fundamentals that determine the stability of this point of intersection include world real interest rates, the rate of inflation in the domestic price of traded goods, total net foreign aid received by the government, the sum of government and private spending on traded goods, the transaction costs associated with private spending, terms of trade and trade policy, rationing of foreign credit and changes in the relative domestic price of traded goods. Using the error correction modeling and counterfactual simulations, the paper finds that for Ivory Coast, freer trade, higher domestic investment, and smaller trade deficits all produced a depreciation of the equilibrium rate and therefore tended to increase the estimated degree of misalignment. The real exchange rate was over-valued by 34 per cent during 1987-93 in Ivory Coast, which is attributed to fiscal laxity and structural rigidities that characterized the Ivory Coast's economy around that time. The study, on the other hand, finds that Burkina Faso's currency was under-valued by one per cent, on average, between 1980 and 1986 by nearly 14 per cent between 1987 and 1993.

Byung-Yeon K. and Korhonen (2005) use a dynamic heterogeneous panel model to estimate real equilibrium exchange rates for advanced transition economies. The countries included: Czech Republic, Hungary, Poland, and Slovakia. Their findings show that exchange rates converge in five years in five transition economies. Also, at the outset of transition process, these currencies were clearly over-valued. Over time, however, a process of real exchange rate appreciated and allowed the currencies to converge to their equilibrium levels by 1999. The real effective exchange rates for Czech Republic, Hungary, Poland and Slovakia, appeared substantially over-valued by between 8 per cent and 40 per cent.

3. Theoretical Foundations

There are several different approaches used in literature to define the long run equilibrium real exchange rates (LRER). The most common of these approaches are the Purchasing Power Parity (PPP) approach, and its extensions including the Balassa-Samuelson approach and the Capital Enhanced Measures of the Equilibrium Real Exchange Rates (CHEERS) approach. The other is the Permanent and Transitory decomposition of the Equilibrium Real Exchange Rates (PEER) approach, which includes the Beveridge-Nelson Decompositions, the Structural Vector Autoregression Approach and the Cointegration Based PEERS. The other approaches are the Behavioural Equilibrium Exchange Rates (BEER) and the Internal-External Equilibrium (I-E), which includes the Fundamental Equilibrium Exchange Rate (FEER), and the Natural Real Exchange Rates (NATREX). In this study, the fundamental equilibrium approach is used.

The Fundamental Equilibrium Real Exchange Rate (FEER) approach is based on the internal-external equilibrium framework and has been advanced by, among others, Williamson (1983), Williamson (1994) and Edwards (1989). Edwards (1989), for instance, defines equilibrium real exchange rates as the relative price of non-tradable goods to the tradable goods, which for given sustainable values of other relevant variables such as taxes, international terms of trade, commercial policy, capital and aid flows and technology result in the simultaneous attainment of internal and external balance (equilibrium). Internal equilibrium is achieved when the market for non-tradable goods clear both in the current and in the future. External equilibrium, on the other hand, is achieved when the current account balances are consistent with the long run sustainable capital flows, both in the present and in the future; that is, when payments account is balanced. The long run real exchange rate (LRER) is therefore achieved at the point of intersection of the internal equilibrium and the external equilibrium. Empirical studies have used different choices of the underlying real exchange rate fundamentals. Sometimes because of data availability considerations, some variables that are considered as fundamentals in some studies are excluded from other studies. While a thorough discussion is beyond the scope of this paper, the rationale behind the variables used in this paper as the fundamentals are highlighted.

3.1 Changes in Technical Progress

According to the Balassa-Samuelson effect (Balassa, 1964 and Samuelson, 1964), if productivity in the tradables sector grows faster than in the non-tradables sector, the resulting higher wages in the tradables sector will increase the pressure on wages in the non-tradables sector, resulting in a higher relative price of non-tradables (i.e., a real appreciation of the exchange rate). Empirical estimations based on extensions to the original Balassa-Samuelson model (for instance Balassa, 1973 and Hseih, 1982) have confirmed that cross-country productivity differentials have significant effects on real exchange rates.

3.2 Government Deficit

An increase in government deficit means either that government expenditures have gone up relative to the increase in taxes, or that taxes have reduced while expenditures have not reduced proportionately. Increased government expenditures with reduced taxes implies that the government must seek extra financing from domestic borrowing using government securities such as treasury bills. Domestic borrowing puts pressure on the domestic interest rate, and because the foreign interest rate remains unchanged, interest rate differential narrows, attracting more capital inflows in the country. This leads to an upward shift in the internal equilibrium locus, with the external balance remaining unchanged. This depreciates the exchange rate.

3.3 Interest Rate Differentials

Any increases in the domestic rates of interest (a reduction in the foreign rates of interest) will reduce interest rate differentials, assuming that foreign interest rates (domestic rates of interest) remain unchanged. This will attract foreign investments and capital inflows into the country. Increased capital inflows are likely to depreciate the exchange rates as the supply of foreign currency outstrips the demand. Exchange rates are expected to appreciate when domestic interest rates reduce or foreign interest rates rise. Montiel (1999) shows that a change in the world interest rates leads to a change in the real exchange rates in the opposite direction. Therefore, an increase in the world interest rates is expected to lead to a reduction in the index of the real exchange rates, which signifies an appreciation of the real exchange rates. A decrease in the world interest rates will, on the other hand, depreciate the real exchange rates.

3.4 Terms of Trade

The impact of terms of trade worsening on the real exchange rate is theoretically undefined because two contrary effects play in opposite ways. In the first instance, a deterioration of terms of trade induces a negative income effect, leading to a decline in the domestic purchasing power. This results in a reduction in the private demand for non-traded goods and a real depreciation of the exchange rate. On the other hand, a substitution effect makes the consumption of imported goods relatively more expensive. As a result, there is a shift of demand in favour of the non-traded goods and an appreciation of the real exchange rates. The total effect of terms of trade deterioration on real exchange rate depends on the strength of the income and substitution effects. According to Edwards (1989), when the income effect dominates the substitution effects, then the RER is expected to appreciate as terms of trade improve. On the other hand, when the substitution effect dominates the income effect, then the real exchange rates are expected to depreciate.

3.5 Government Expenditures

The impact of increased government (public) demand on real exchange rate is traditionally linked to the hypothesis that government spending generally falls disproportionately higher on non-traded goods. Higher government expenditures on the non-tradables than tradables raises the relative price of the non-tradable goods, thereby appreciating the exchange rates.

3.6 Capital Flows

Montiel (1999) argues that an increase in receipts of transfer incomes from abroad (capital inflows), shifts the external balance to the right and this permits the expansion of consumption, leading to appreciation of the real exchange rates. Capital outflows, on the other hand, are expected to depreciate the real exchange rate through the same channel. According to Corden (1994), a foreign capital surge affects the economy by raising domestic absorption, which leads to an increase in consumption demand for both traded and non-traded goods. On non-traded goods market, this excess demand has to be matched to a proportional increase of the non-traded supply in order to ensure market equilibrium. This in turn leads to a rise of the price of non-traded goods. The traded consumption increase, on the other hand, will cause the trade balance to deteriorate without any effects on the price of the traded good, since it is entirely determined by the law of one price. The change in the price of the non-traded good following the foreign capital inflows entails an appreciation of the real exchange rate.

3.7 Private Consumption

Changes in private consumption expenditures are expected to have implications on the relative prices of the non-tradable goods and the tradable goods. A change in private consumption that increases the relative prices of the non-tradable goods appreciates the exchange rates. On the other hand, a change in private consumption which increases the relative price of the tradable goods depreciates the exchange rates.

4. Empirical Model

From literature review, we identify several fundamental determinants of the equilibrium real exchange rate including:

$$\overline{e}_t = f\left(CE_t^p, Def_t^p, Inf_t^p, ir_t^p, g\,exp_t^p, tot_t^p, tech_t^p\right) \tag{4.1}$$

where: $\overline{e}_t$ is the unobserved real exchange rate, CE_t^p is the permanent value of the unobserved consumption expenditure, Def_t^p is the unobserved government budget deficits, $g\,exp_t^p$ is the permanent value of the unobserved government expenditure, ir_t^p is the unobserved interest rate differentials and Inf_t^p is the unobserved net capital outflows. $tech_t^p$ is the unobserved value of the permanent technical progress while tot_t^p is the unobserved terms of trade.

Letting F_t^p denote the vector of the permanent value of the unobserved fundamentals, i.e. $F_t^p = \left[CE_t^p, Def_t^p, Inf_t^p, ir_t^p, g\,exp_t^p, tot_t^p, tech_t^p\right]$, our task then is to construct a time series for the unobserved equilibrium real exchange rate $\overline{e}_t$ using data on the observed real exchange rate RER_t and the observed values of the fundamentals F_t. As a first step, we assume that the long-run relationship is linear in log transformations of the variables. We can therefore transform the relationship as:

$$ln\,\overline{e}_t = \beta'\,ln\,F_t^p \tag{4.2}$$

The relationship given in equation (4.2) represents the unobserved equilibrium relationship rate and the fundamentals. According to Baffes *et al*. (1999), to obtain an empirical model that is consistent with equation (4.2) but which relates to the observable variables, we translate into stochastic terms two features of equation (4.2). First, we assume that equation (4.2) comes from a steady-state relationship between the actual real exchange rate and the fundamentals. This means that any deviations from the relationship (4.2) must be mean reverting. That is:

$$ln\,RER_t = \beta'\,ln\,F_t + \varepsilon_t \qquad \varepsilon_t \sim \mathrm{N}\left(0, \sigma^2\right) \tag{4.3}$$

where ε_t is a stationary random variable with mean of zero and F_t is a vector of the observed fundamentals.

Secondly, we assume that the steady state is dynamically stable; that is, the economy chooses a convergence path for given values of the fundamentals (Baffes *et al*., 1999). In this sense, any disturbances that cause the real exchange rates to deviate from its equilibrium path in the short run will eventually lead to convergence back to equation (4.2), in the absence of new shocks. This assumption implies that the long run relationship can be represented by an error correction model in a single-equation framework as:

$$\Delta ln\,RER_t = \alpha\left(ln\,RER_{t-1} - \beta' ln\,F_{t-1}\right) + \sum_{i-1}^{p} \delta_j\, ln\,RER_{t-j} + \sum_{i-0}^{p} \gamma'_j \Delta ln\,F_{t-j} + \upsilon_t \qquad (4.4)$$

where α represents the adjustment speed from the short run to the long run and β are the long run parameters. Our concern is to estimate the long run parameters β and use them to fit $\overline{e}_t$. Using actual observed data, existence of a long run relationship capable of generating stable β requires that either all the parameters are stationary or are integrated of the same order and at the same time cointegrated (unless there is multicointegration). The above single equation error correction model (ECM) is only appropriate when there is one cointegrating relationship among the variables. When there are more than one cointegrating relationships, then a single equation formulation is inappropriate. In addition, the single equation framework is only appropriate when all the variables are weakly exogenous. In case any of the variables is not weakly exogenous, then a system of equations is more appropriate. If this is the case, the model can be represented by a vector error correction model (VECM) of the form:

$$\Delta z_t = \Gamma z_{t-1} + \sum_{j=1}^{p} A_j \Delta z_{t-j} + \upsilon_t \text{ where } z_t = \left[ln\,RER_t, F_t\right] \qquad (4.5)$$

To obtain the long run parameters β from either the ECM or the VECM, we must first determine that there is a long-run relationship governing the variables in our model. As mentioned above, a long-run relationship among the variables exists only if all the variables are stationary or are integrated, of the same order and are cointegrated. The first step therefore is to determine the order of integration of the variables included in the model in order to determine whether the variables are all stationary or are integrated of orders higher than zero. If they are non-stationary, then we proceed to determine whether they are cointegrated. To proceed, the variables in equation (4.3) need to be constructed from the available data to be used in the estimation process.

4.1 Construction of Variables

The variables to be used in the estimations are constructed as follows: Real Exchange Rates (RER) variable is calculated as the ratio of domestic consumer price index (P^d) to the foreign price index—US wholesale price index (P^f) multiplied by the actual NER:

$$RER = NER\left(P^f / P^d\right)$$

Terms of Trade (tot) variable is calculated as the ratio of export price to the import price index (expressed in the national currency terms); government expenditure (gexp) variable is the total government expenditure as a ratio of GDP; and net capital flows (Inf) variable is the net capital outflows minus net capital inflows. Technical progress (tech) variable is calculated as GDP per worker, signifying labour productivity, while primary deficits (Def) variable is calculated as the total government revenue minus total government expenditure. Interest rate differential (ir) variable is calculated as the difference between the London interbank rates and the domestic rates of interest, and treasury bill rates (Tbill) variable is the 30-day treasury bill rates.

4.2 Data Sources

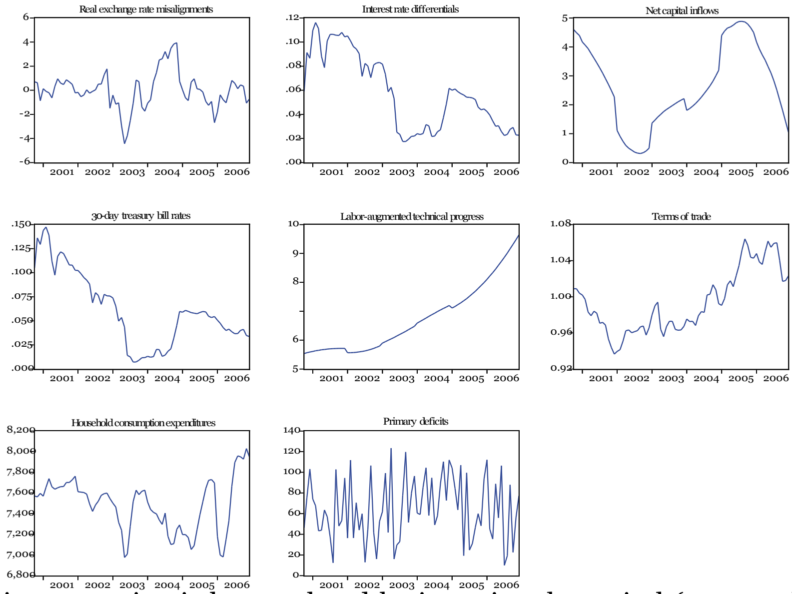
The data used in this study are all monthly data for the period between January 2000 – December 2006 and are obtained from the International Monetary Fund (IMF) website, International Labour Organization (ILO) website and country databases such as the CBK monthly bulletins. The data that are not available in monthly frequency were interpolated from annual to monthly frequency, using the data conversion options available in the Eviews econometric software.

4.3 Determining the order of integration of the variables

After specifying the empirical model as in equation (4.3), the task is to establish whether the variables are cointegrated. Existence of cointegration implies existence of long-run relationship among the variables. If the variables are not cointegrated, then long-run equilibrium real exchange rates cannot exist with these variables as the fundamentals. One of the requirements for existence of cointegration among variables is that the variables must be integrated and of the same order unless they are multicointegrated. The starting point therefore is to establish the order of integration of each of the variables. This is done using the unit root tests. All the variables in the model, except primary deficits are found to be integrated of order one. Primary deficits, which is found to be I(0), is therefore excluded from the estimations since it cannot be cointegrated with the other variables that are I(1).

The estimation proceeds in a general to specific framework with a general unrestricted model estimated first. In the general model, it is assumed that all the model variables are endogenous. However,

Figure 4.1: Movements of model variables in Kenya



this assumption is latter relaxed by imposing theoretical (structural) restrictions on the general VECM model. The graph of all the variables, including primary deficits at levels, is given in Figure 4.1. The graphs confirm that except for primary deficits, the other variables seem to be non-stationary.

4.4 Lag Selection

To select the number of lags, we first estimate the general VECM model with eight lags and conduct lag selection test using the different information criterion. For instance, eight lags are chosen as a default with no particular reason behind the choice of eight and not seven, for instance. The results from the lag selection test are given in Table 4.1.

Table 4.1: Lag selection criteria for Kenya

VAR Lag Order Selection Criteria						
Endogenous variables: LOG(RER) LOG(INFLOWS) LOG(IR) LOG(TBILL) LOG(HHCONS) LOG(TOT) LOG(TECH)						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	446.3627	NA	6.95e-15	-12.73515	-12.50850	-12.64523
1	1089.204	1136.618	2.34e-22	-29.94794	-28.13475*	-29.22859
2	1164.830	118.3711*	1.13e-22*	-30.71971	-27.31998	-29.37092*
3	1195.804	42.19721	2.13e-22	-30.19723	-25.21096	-28.21901
4	1232.150	42.13946	3.86e-22	-29.83043	-23.25762	-27.22278
5	1295.063	60.17830	3.88e-22	-30.23372	-22.07438	-26.99664
6	1363.169	51.32598	4.49e-22	-30.78751*	-21.04162	-26.92099

where * indicates lag order selected by the criterion, LR is the sequential modified LR test statistic (each test at 5% level), FPE is the final prediction error, AIC is the Akaike information criterion, SC is the Schwarz information criterion, and HQ is the Hannan-Quinn information criterion.

LR, FPE, and HQ all suggest that we use two lags. After choosing the appropriate number of lags, the next step is to re-estimate the general model with two lags and test for the number of cointegrating relations. We do this with all the I(1) variables in their levels. The results of the cointegration test are given in Table 4.2.

Table 4.2: Trace cointegration test for Kenya

Series: LOG(RER) LOG(INFLOWS) LOG(IR) LOG(TBILL) LOG(HHCONS) LOG(TOT) LOG(TECH)				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.507767	164.8077	125.6154	0.0000
At most 1 *	0.421637	113.7738	95.75366	0.0016
At most 2 *	0.365915	74.34997	69.81889	0.0208
At most 3	0.265782	41.54877	47.85613	0.1718
At most 4	0.128318	19.30443	29.79707	0.4712
At most 5	0.095854	9.416630	15.49471	0.3282
At most 6	0.029576	2.161579	3.841466	0.1415

where * denotes rejection of the hypothesis at the 0.05 level

The trace test indicates that there are three cointegrating equations at the 0.05 level. Table 2 reports the trace test results, while Table 4.3 reports the maximum eigenvalue test results. For each table, the first column is the number of cointegrating relations, the second column is the ordered eigenvalues, the third column is the test statistic, and the last two columns are the 5 per cent and 1 per cent critical values. The trace test shows that there are three cointegrating equations.

Max-eigenvalue test indicates that there is only one cointegrating equation at the 0.05 level. This contradicts the trace test, which indicates that there are three cointegrating relations. Enders (2004) argues that when there are such contradictions, one must look at the theoretical rationality of the existence of either of the number proposed by the trace test and the maximum eigenvalue test. In this case, the possibility of existence of more than one cointegrating vector given the theoretical relationships in the model, is examined. In other

Table 4.3: Maximum eigenvalue cointegration test for Kenya

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.507767	51.03387	46.23142	0.0142
At most 1	0.421637	39.42387	40.07757	0.0591
At most 2	0.365915	32.80120	33.87687	0.0668
At most 3	0.265782	22.24434	27.58434	0.2081
At most 4	0.128318	9.887797	21.13162	0.7551
At most 5	0.095854	7.255051	14.26460	0.4594
At most 6	0.029576	2.161579	3.841466	0.1415

where * denotes rejection of the hypothesis at the 0.05 level

words, from the theoretical relationship of the model variables, is it logical to expect three cointegrating relationships instead of just one cointegrating relationship? The answer is yes. So we use three cointegrating relationships as proposed by the trace test, instead of one proposed by the maximum eigenvalue test. The results further show that the real exchange rate equation is in the cointegrating space, meaning that there is a long-run relationship among the variables in the real exchange rate equation for Kenya.

4.5 Restricting the General Model for Kenya

We have so far assumed that all the variables in the model are endogenous. In this case, we expect that there are feedback effects from one variable to the next. This necessitates the use of the VAR representation of the model. It may be the case, however, that the variables are not endogenous. In this case, a VAR is not the right representation of the relationship of the model variables. This could be the case when there is no feedback from one variable to the other. If so, then a single equation formulation will be the appropriate representation of the relationship. After establishing that there are three cointegrating relations from the general VECM, a test to determine whether there are feedback effects to justify the use of a VAR, instead of a single equation model, is done using the exogeneity tests.

4.6 Exogeneity Tests

If a variable does not respond to the deviations from the long-run path, it is said to be weakly exogenous. This means that if the speed

Table 4.4: Exogeneity tests

Tests of cointegration restrictions:				
Hypothesized No. of CE(s)	Restricted Log-likehood	LR Statistic	Degrees of Freedom	Probability
4	1141.381	20.73590	4	0.000357
5	1159.234	NA	NA	NA
6	1163.954	NA	NA	NA

NA indicates restriction not binding.

of adjustment is zero, then the variable *i* is weakly exogenous. The implication of weak exogeneity is that the weakly exogenous variable does not contribute to the feedback mechanism that necessitates the use of a system of equations instead of a single equation formulation of the model. In other words, if all the model variables are weakly exogenous, then there will be no feedback in the model and a single equation formulation of the model is appropriate (Enders, 2004). Table 4.4 presents the results of the tests for weak exogeneity of net capital inflows for Kenya.

Looking at the p-values from Table 4.4, the null hypothesis is rejected and the net capital inflows are exogenous at both 5 per cent and 10 per cent significance levels. Net capital inflows are therefore endogenous in the exchange rate model for Kenya, meaning that there are feedback effects from exchange rates to the net capital flows and vice versa.

Exogeneity tests results of the other model variables for Kenya show that the interest rate variable has a LR statistic of 21.5971, with four cointegrating relations and a probability value of 0.000241. This shows that the interest rate variable is also endogenous in the model. The exogeneity test for the treasury bill rates gives a LR statistic of 21.26 and a probability value of 0.00028. This leads to the rejection of the null hypothesis that the treasury bill rates are exogenous in the model. Household consumption is also endogenous, with LR statistic of 19.502 and a probability value of 0.000626. Terms of trade variable for Kenya return a LR statistic of 39.026 and a probability of 0.000, implying that the variable is also endogenous in the model. The exogeneity test on technical progress also indicates that the variable is endogenous in the model, with LR statistic of 20.1625 and a probability value of 0.000464.

The exogenity tests confirm that there are long-run feedback effects among all the model variables in Kenya, and therefore all the variables are endogenous in the real exchange rate model. The feedback effects can best be captured by a VAR representation of the model. This means that a single equation specification would lead to misspecification of the model.

4.7 The Long Run Theoretical Restrictions

As we know, there is no theoretical meaning in the general VECM representation of the model. The only consideration in the general VECM is that there are feedback effects among the model variables ,and therefore a single equation estimation of the model leads to misspecification. To get intuitive results out of it, we can restrict the model to reflect the theoretical structure of the economy. For instance, it is theoretically logical to assume that the real exchange rates have long run effects on the net capital inflows, and there are possibly feedback effects such that the net capital inflows in turn have long-run effects on the real exchange rates. However, it would be theoretically illogical to assume that treasury bill rates, for instance, will determine technical progress. There could be some short-run effects and feedback effects, but these could be too remote to conceive theoretically in the long-run. In this case, it would be important to restrict the coefficient of the variables that have no long-run theoretical relationship to zero. To do this, we impose restrictions on the parameters of the cointegrating vectors. To be able to identify the restrictions, we need to go back to economic theory.

4.8 Theoretical Relationships among the Model Variables

From economic theory, we can deduce the following structural relationships among the variables:

Real exchange rates are determined by net capital inflows, interest rate differentials, treasury bill rates, terms of trade and technical progress. Interest differentials are influenced by exchange rates, net capital inflows and treasury bill rates, while net capital inflows are determined by the exchange rates, treasury bill rates, interest rate differentials (higher real interest rate in the home country promotes capital inflows and reduces capital outflows, thus net capital inflows increase). Treasury bill rates are determined by net capital inflows, interest rate differentials and the exchange rates through capital inflows. Terms of trade depend only on the real exchange rates, while household consumption is determined by the exchange rates, net capital inflows, interest rate differentials and terms of trade. Lastly, technological progress is exogenous in the model. These theoretical relations can be summarized as:

$$
\begin{aligned}
&rer_t = \lambda_{12} Inflows_t + \lambda_{13} ir_t + \lambda_{14} Tbills_t + \lambda_{15} hhcons_t + \lambda_{16} tot_t + \lambda_{17} tech_t + \mu_{1t} \\
&Inflows_t = \lambda_{21} rer_t + \lambda_{23} ir_t + \lambda_{24} Tbills_t + \lambda_{25} hhcons_t + \mu_{2t} \\
&ir_t = \lambda_{31} rer_t + \lambda_{32} Inflows_t + \lambda_{34} Tbills_t + \mu_{3t} \\
&Tbills_t = \lambda_{42} Inflows_t + \lambda_{43} ir_t + \mu_{4t} \\
&hhcons_t = \lambda_{51} rer_t + \lambda_{52} Inflows_t + \lambda_{53} ir_t + \lambda_{56} tot_t + \mu_{5t} \\
&tot_t = \lambda_{61} rer_t + \lambda_{67} tech_t + \mu_{6t} \\
&tech_t
\end{aligned}
$$

Imposing theoretical restrictions on the β matrix and considering that we have only three cointegrating relations, the β matrix will change to portray these restrictions. The β matrix will therefore be of the form:

$$
\begin{bmatrix}
1 & -\lambda_{12} & -\lambda_{13} & -\lambda_{14} & -\lambda_{15} & -\lambda_{16} & -\lambda_{17} \\
-\lambda_{21} & 1 & -\lambda_{23} & -\lambda_{24} & -\lambda_{25} & 0 & 0 \\
-\lambda_{31} & -\lambda_{32} & 1 & -\lambda_{34} & 0 & 0 & 0 \\
0 & -\lambda_{42} & -\lambda_{43} & 1 & 0 & 0 & 0 \\
-\lambda_{51} & -\lambda_{52} & -\lambda_{53} & 0 & 1 & -\lambda_{56} & 0 \\
-\lambda_{61} & 0 & 0 & 0 & 0 & 1 & -\lambda_{67} \\
0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
rer_t \\ Inflows_t \\ ir_t \\ Tbills_t \\ hhcons_t \\ tot_t \\ tech_t
\end{bmatrix}
\qquad (4.6)
$$

where the zeros in the matrix represent the imposed restrictions.

5. Model Results

This section gives the results from the restricted model and the long run parameter, the impulse responses and the variance decompositions.

5. 1 Restricted Cointegration Results

With these restrictions in place, the general VECM model can be re-estimated and tested if restrictions imposed are binding. Table 5.1 shows that conditional on three cointegrating equations, all the restrictions that we imposed are binding.

Table 5.1: Tests of cointegration restrictions for Kenya

Tests of cointegration restrictions:				
Hypothesised No. of CE(s)	Restricted Log-likelihood	LR Statistic	Degrees of Freedom	Probability
3	1224.486	4.013051	2	0.134455
4	1232.725	NA	NA	NA
5	1242.559	NA	NA	NA
6	1246.186	NA	NA	NA
NA indicates restriction not binding.				

After establishing that the restrictions are binding, we report the results of the restricted cointegrating coefficients in Table 5.2, while Table 5.3 gives the adjustment coefficients of the restricted model.

Table 5.2: Restricted cointegrating coefficients for Kenya

Restricted cointegrating coefficients (not all coefficients are identified)						
LOG(RER)	LOG(INFLOWS)	LOG(IR)	LOG(TBILL)	LOG(HHCONS)	LOG(TOT)	LOG(TECH)
1.000000	0.028912	-0.420577	0.250419	-0.187295	-0.341192	0.259274
30.10560	1.000000	-19.75514	11.27549	0.000000	0.000000	-1.277036
-1.606973	-0.051542	1.000000	-0.571163	0.000000	0.000000	0.000000

A calculation of the t-statistics, which is the ratio of the coefficient estimates to the standard errors (in parenthesis), reveals that the net capital inflows, household consumption and terms of trade are all insignificant at the 10 per cent level. The other remaining variables are found to be significant in the adjustment of the short-run disturbances to the long-run. The significant coefficients are given in bold.

Table 5.3: Adjustment coefficients for Kenya

Adjustment coefficients (standard error in parentheses)			
	CointEq1	**CointEq2**	**CointEq3**
D(LOG(RER))	**1.329619**	0.458178	9.535386
	(0.43212)	(0.09320)	(1.96634)
D(LOG(INFLOWS))	-3.271354	-0.150260	-4.231952
	(3.98539)	(0.85957)	(18.1352)
D(LOG(IR))	**-4.925566**	-1.616890	-34.40414
	(3.44820)	(0.74371)	(15.6908)
D(LOG(TBILL))	**-10.41337**	-2.929874	-62.38889
	(4.66322)	(1.00576)	(21.2196)
D(LOG(HHCONS))	0.152823	0.180278	3.601671
	(0.33624)	(0.07252)	(1.53004)
D(LOG(TOT))	0.072104	0.024254	0.522349
	(0.20619)	(0.04447)	(0.93827)
D(LOG(TECH))	**-0.577653**	-0.064073	-1.508189
	(0.11249)	(0.02426)	(0.51189)

From the restricted cointegration results and the adjustment coefficients given in Tables 5.2 and 5.3, respectively, the matrix of the error correction terms $\pi x_{t-1} = \alpha\beta' x_{t-1}$ can be given as:

$$\begin{bmatrix} 1.32 & 0.45 & 9.53 \\ -3.27 & -0.15 & -4.23 \\ -4.92 & -1.61 & -34.40 \\ -10.41 & -2.92 & -62.38 \\ 0.15 & 0.18 & 3.60 \\ 0.07 & 0.02 & 0.52 \\ -0.57 & -0.06 & -1.51 \end{bmatrix} \begin{bmatrix} 1.00 & 0.02 & -0.42 & 0.25 & -0.18 & -0.34 & 0.25 \\ 30.10 & 1.00 & -19.75 & 11.27 & 0.00 & 0.00 & -1.27 \\ -1.60 & -0.05 & 1.00 & -0.57 & 0.00 & 0.00 & 0.00 \end{bmatrix} \begin{bmatrix} \ln rer_{t-1} \\ Inflows_{t-1} \\ \ln ir_{t-1} \\ \ln Tbills_{t-1} \\ \ln hhcons_{t-1} \\ \ln tot_{t-1} \\ \ln tech_{t-1} \end{bmatrix} \qquad (5.1)$$

5.2 Discussion of Long-Run Results

A positive shock to the terms of trade (TOT) leads to an appreciation of the real exchange rates. The TOT coefficient in the β matrix is -0.34. This implies that a one-per cent improvement in the terms of trade appreciates the real exchange rates by 34 per cent. As discussed in Baffes, Elbadawi and O'Collel (1989), the effects of the terms of trade shocks on the real exchange rates could be either to appreciate the real exchange rates, if the spending effects dominate the substitution effects, or to depreciate the real exchange rates if substitution effects dominate the spending effects. Following this argument, we can say that in Kenya, the spending effect of the terms of trade dominates the substitution effects.

Shocks on the net capital inflow leads to a depreciation of the real exchange rates. This shows that Kenya is a net creditor in the international financial market, with the amount of net capital outflows dominating net capital inflows. Likewise, changes in productivity lead to depreciation of the real exchange rates in Kenya. According to Baffes, Elbadawi and O'Collel (1989), the effect of productivity shocks on the real exchange rates could also be two way. If there is technical progress in the traded goods sector that dominates technical progress in the non-traded goods sector, the real exchange rate will appreciate. The reason is that the effect of a positive shock on productivity in the traded goods sector is to increase the demand for labour in the traded goods sector. This will attract labour from the non-traded goods sector (since factors are mobile between the two sectors). At a given exchange rate, the traded goods expand, while creating excess demand in the non-traded goods sector requiring a real appreciation to restore equilibrium. In the case where technical progress in the non-traded goods sector dominates the one in the traded goods sector, the effect of the shock is a depreciation of the real exchange rate. This seems to be the case from our results for Kenya. This means that the productivity shock is experienced more on the non-traded goods sector than on the traded goods sector in Kenya.

5.3 Impulse Responses for Kenya

The vector autoregression moving average (VARMA), which is a moving average representation of the VAR in that the system variables are expressed in terms of the present and the past values of all the shocks in the system, allows one to describe how a shock to a particular variable at one moment in time shifts the expected time path of each of the variables in the model compared with its expected evolution had the shock not occurred. A general VARMA can be represented as:

$$\Delta x_i = \sum_{j=0}^{\infty} \varphi_i \varepsilon_{t-i} \quad i = 0, \ldots, n \tag{5.2}$$

where $\varphi_i(0)$ are impact multipliers and denotes the response of each variable to innovations in each of the corresponding error terms on impact, ε_{t-i} are the innovations and *n* is the number of variables in the system. The sets of coefficients $\varphi_i(0), \varphi_i(1), \ldots, \varphi_i(n)$ are the impulse response functions. Plotting the impulse response functions is a practical way to trace the time path of the system variables as they respond to various shocks over time. Figure 5.1 traces the response of the real exchange rates to shocks from the other variables in the system.

Figure 5.1: Impulse responses of the real exchange rates in Kenya

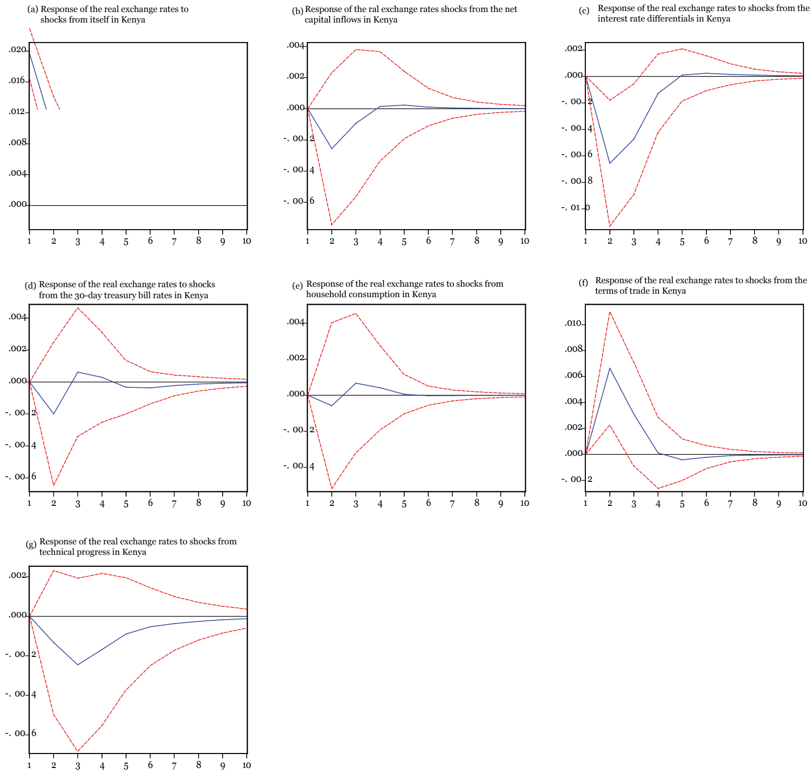


Figure 5.1 shows how the real exchange rates in Kenya respond to one unit shock in the fundamentals. Panel (a) shows the response of the real exchange rates to shocks from itself. Panel (b) shows the response of the real exchange rates to shocks from the net capital inflows. The question of concern in panel (b) is whether the real exchange rates appreciate or depreciate, and if there are shocks to the net capital inflows in Kenya. The impulse response function shows that for a one unit shock in the net capital inflows, the real exchange rates in Kenya appreciates by about 0.0025 units within the first two months, reaches the peak at the end of the second month, and starts depreciating back towards its initial (long-run) path. Therefore, the effect of a change in the net capital inflows in Kenya is to appreciate the real exchange rates. However, the effect seems not significantly different from zero throughout the forecast horizon. A look at the dotted confidence intervals shows that the chance that the actual value lies within two-standard deviation interval is not significantly different from zero at the 5 per cent significance level. Panel (c) shows the response of the real

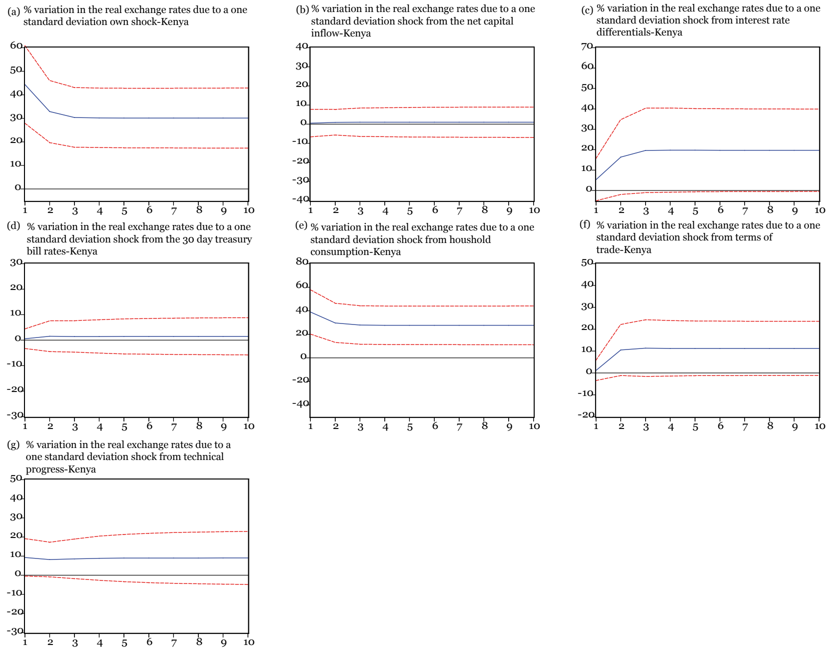
exchange rates to the changes in interest rate differentials. The panel shows that the real exchange rate appreciates on impact, reaches a peak at the end of the third month and starts to depreciate back towards its initial path. We see that the two-standard deviation interval lies outside the zero line in the first three months, implying that the effect of the interest rate differential on the real exchange rate in Kenya is significant in the first three months. The effects of the interest rate differential shocks on the real exchange rate disappears between the fifth and the seventh month as the real exchange rate returns fully to its initial path before the shock. Panel (d) shows that till the end of the second month, real exchange rates in Kenya have been appreciating due to shocks from the 30-day treasury bill rates, but the effects are not significant. Changes in household consumption in panel (e) lead to a slight appreciation of the real exchange rates, but the effects again are not significant. In panel (f), exchange rates depreciate in the first two months following a shock in the terms of trade in Kenya. The effects are significant for almost three months. At the third month, the real exchange rate starts to appreciate as it traces back its initial path. It comes back to its initial path after about 7 months. Panel (g) shows that the real exchange rate appreciates following a shock in technical progress. The real exchange rate returns to its initial path after the tenth month. However, the two-standard deviation interval shows that there is a 95 per cent chance that the actual effects are not significantly different from zero.

5.4 Variance Decomposition

The forecast error variance decomposition (FEVD) technique, introduced by Sims (1980), helps to determine what proportion of the variance in a series, for instance, is due to its own shock and other identified shocks. It allocates weights to each identified shock in the system, at every forecast horizon for a particular variable. Over a short horizon, the "own shock" often dominates the variance forecast. However, shocks to other variables in the system may gain in importance relative to own shock as the horizon lengthens.

Figure 5.2 shows the decomposition of the changes in the real exchange rates in Kenya for ten months. Panel (a) shows the contribution of own shocks to the variance of the real exchange rates. Panel (a) shows that in the first month, around 44 per cent of the changes in the real exchange rates in Kenya are attributed to own shocks. From panel (c), we see that in the first month, changes in interest rate differentials account for

Figure 5.2: Variance decomposition of real exchange rate changes in Kenya



around 5.26 per cent of the variation in the real exchange rates. Panel (g) shows that shocks from household consumption account for 38.89 per cent of the changes in the real exchange rates in the first period. Shocks from technical progress and terms of trade account for 9.29 per cent and 1.14 per cent of the changes in the real exchange rates in the first period, respectively. The variance decomposition table, which is not reproduced here, shows that apart from the contribution of net capital inflows and terms of trade, the contribution of the other variables to the changes in the real exchange rates in the first month are all significant at the 5 per cent significance level. The contribution of own shocks reduces to 32.84 per cent in the second month and thereafter steadies at around 30 per cent for every subsequent month till the tenth month. Whereas the contribution of own shocks and household consumption shocks explain less and less of the variations in the real exchange rates after the first month, the contribution of the other variables increases after the first month. In fact, in the second month, net capital inflows account for 0.97 per cent of the real exchange rate changes, and this increases to 0.992 per cent in the tenth month. The interpretation of this result is that net capital inflows is not an instantaneous determinant of the real exchange rates; that is, the changes from the net capital inflows will not

affect the real exchange rates instantaneously but with a lag, probably signifying the existence of feedback effects. It could be the case that the changes in the net capital inflows affect the real exchange rates through other model variables such as interest rate differentials and treasury bill rates. The contribution of interest rate differentials increases from 5.26 per cent in the first month to stabilize at 19 per cent in the third month. The contribution of interest rate differentials remains significant throughout the forecast horizon. The contribution of terms of trade, which is not significant at 5 per cent significance level in the first month, becomes very significant in the second month, signifying the importance of terms of trade shocks in explaining the variations in the real exchange rates from the second month onwards.

From the above analysis, we can conclude that in the first month, household consumption accounts for the highest percentage of the variations in the real exchange rates followed by technical progress, interest rate differentials and terms of trade in that order. On average, other than own shocks, with a contribution of around 30.1 per cent, household consumption accounts for the highest variation in the real exchange rates in Kenya at 27 per cent, followed by interest rate differentials at around 19 per cent, terms of trade at 11 per cent, technical progress at 9 per cent, treasury bill rates at an average of 1.46 per cent and the lowest contribution coming from net capital inflows at around 0.99 per cent.

5.5 Model Stability

Since we are using two lags, our model is an AR(2) model is given as:

$$x_t = A_1 x_{t-1} + A_1 x_{t-2} + \varepsilon_t \tag{5.3}$$

where x_t is a $(n.1)$ vector of $(x_{1t}x_{2t},\dots,x_{nt})'$ endogenous variables, ε_t is a $(n.1)$vector of $(\varepsilon_{1t}\varepsilon_{2t},\dots,\varepsilon_{nt})'$and A_1 is a matrix of parameters.

To determine the stability of equation 5.3, there is need to examine the homogenous part given as:

$$x_t = A_1 x_{t-1} + A_1 x_{t-2} \tag{5.4}$$

We can use the method of undetermined coefficients and argue that each x_{it} has a solution of the form:

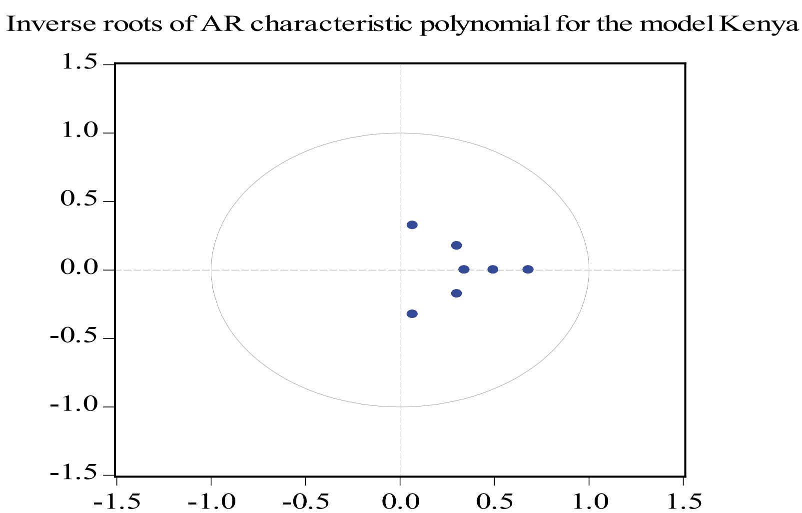
$$x_{it} = \pi_i \lambda^t \tag{5.5}$$

where π_i is an arbitrary constant and $\lambda_1, \lambda_2, \dots\lambda_n$ denote the characteristic roots if the system has n variables. The necessary and sufficient condition for stability is that all the characteristic roots lie within the unit root circle (Enders, 2004). Figure 5.3 plots the characteristic roots from the solution of the restricted VECM model into the unit root circle. It shows that all the characteristic roots of the restricted VECM model for Kenya lie within the unit root circle, meaning that the restricted VECM for Kenya that was estimated is stable. The stability of the VAR is important for sustainability of a long-run relationship. Given these results, a forecast for the equilibrium real exchange rates from the long-run model can be forecasted.

5.6 Equilibrium Exchange Rates and Exchange Rate Misalignments in Kenya

The equilibrium real exchange rate can be identified econometrically as that unobserved function of the fundamentals towards which the actual real exchange rate gravitates over time (Kamisky, 1993; and Baffes *et al.*, in Hikle and Montiel, 1999). The equilibrium real exchange rate is calculated as the fitted real exchange rate from the long run parameters of the fundamentals (Baffes *et al.*, in Hikle and Montiel, 1999). Since the variables are cointegrated, an OLS regression of the long run equation yield "super consistent" estimator of the cointegrating parameters (Enders, 2004; and Stock, 1987). We estimate the long run real

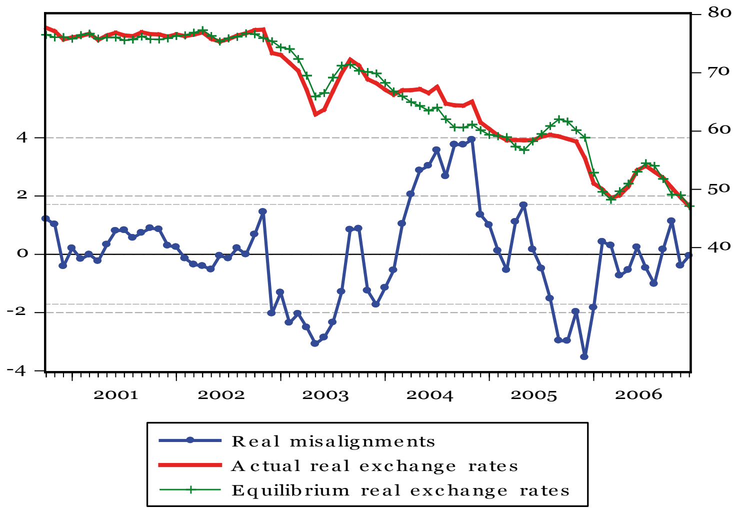
Figure 5.3: Stability test for the first-order VAR Kenya



exchange rate equation by OLS and solve for the long run static model to obtain the fitted values of the real exchange rates. Figure 5.4 shows the calculated equilibrium long-run real exchange rates for Kenya, which are fitted from the actual real exchange rates and plots them together with the deviations of the actual from the equilibrium rates.

Figure 5.4 shows the trends in the actual real exchange rates and the calculated equilibrium real exchange rates. It also shows the deviations of the actual from the equilibrium. Given that our model is stable, any deviations from the long run path tend to converge back to the initial path over time, such that the deviations as can be seen from the figure, are mean reverting. Figure 5.4 captures some very salient events that have impacted on the real exchange rate in Kenya since the year 2000. The actual real exchange rates and the equilibrium real rates have been appreciating over the sample period. The first major misalignment was an over-appreciation of the real exchange rates (actual rate appreciated more than equilibrium rates) from mid 2002, reaching a peak of around Ksh 62 per US dollar in real terms in the early 2003. The Central Bank of Kenya's monthly economic review of December 2003 attributes the over-appreciation of the real exchange rate in this period to positive sentiments following the election of a new government in December 2002, which raised expectations about increased inflows particularly from the donor community (Central Bank of Kenya, 2003b). These expectations were apparently built from mid 2002 when it became

Figure 5.4: Actual vs equilibrium real exchange rates in Kenya



apparent that there would be a change of government in December. From early 2003, an episode of recovery of the actual real exchange rates was seen as the actual rates moved back towards their initial path as it was before mid 2002 (this was some kind of a depreciation of the actual rates). While this could be taken as the real exchange rates correcting itself from the previous over-appreciation, the actual rates stood above the equilibrium rates between late 2003 and mid 2004. In other words, the equilibrium rates were more appreciated than the actual rates (the actual rates were under-appreciated). Central Bank of Kenya (2003) attributes the depreciation (under-appreciation) during this period to increased demand for foreign exchange from the energy sector, the manufacturing sector and other corporate bodies. Central Bank of Kenya (2004) also attributes the depreciation (under-appreciation) of the Kenya shilling against the US dollar in the same period to international developments at the time.

At the time, the US dollar had been reversing its previous losses against the Euro and the pound following increased optimism about the performance of the US economy. Central Bank of Kenya (2004) attributes the depreciation of the exchange rates to the slow pace of resumption of donor funding and increased import demand, noting that the rising depreciation in much of early 2004 was attributed to increased demand for hard currencies in the domestic market to meet import requirements. There was particular increased demand for the dollar as importers covered their positions in the wake of rising oil prices and uncertainties surrounding the international oil markets, with the standoff between the US and the United Nations Security Council, and on Iranian nuclear power ambitions. The under-appreciation was mitigated by the sharp appreciation of the shilling from early 2004, attributed to increased inflows mainly from resumption of donor funding under the Poverty Reduction and Growth Facility (PRGF). This followed loan approval by the International Monetary Fund (IMF) amounting to about US$ 252.75 million on 21 November 2003 (Central Bank of Kenya, 2003b). The results show that, on average, the real exchange rates in Kenya were over-appreciated by about 0.0735 per cent between October 2000 and December 2006. The per year averages reveal that the real exchange rates were over-depreciated in 2001 by 0.08 per cent; it was over-depreciated by 0.36 per cent in 2002 and by 0.85 per cent in 2004. The real exchange rates were, however, over-appreciated in 2003 by 0.65 per cent, by 0.031 per cent in 2005, and by 0.322 per cent in 2006.

6. Summary and Conclusions

Exchange rate misalignments are a phenomenon of flexible exchange rate regimes. It refers to the deviation of the actual real exchange rates from equilibrium rates. Exchange rate misalignments may have adverse effects on allocation of resources in the economy, as it distorts export and import prices, among other adverse effects. Over-depreciations, for instance, are likely to create domestic inflationary pressures and increase debt payment obligations of indebted countries, while over-appreciation is likely to reduce export demand and restrict domestic production. To avoid the adverse effects brought about by exchange rate misalignments, monetary authorities in most developing countries usually intervene in the exchange rates market when they feel that the exchange rate movements are erratic. This intervention requires that monetary authorities know the equilibrium levels of exchange rates, so that the intervention achieves its objective. It is possible that in the absence of an indicator of where the optimal levels of the exchange rates are at a given time, the monetary authorities may over-intervene, under-intervene or may not even intervene at all when the exchange rates are already too misaligned. It is therefore important for the monetary authorities to know the optimal levels of exchange rates and the degree of misalignments from this equilibrium level, in order to determine whether any misalignments at a given time are significant enough for them to intervene and the extent of the intervention.

In Kenya, for instance, the CBK intervenes without an indication as to whether the rates are already too high above or too low below the equilibrium. In this case, it is possible that the CBK sometimes intervenes when it is not necessary and at times it waits for too long to intervene. The study estimated the equilibrium real exchange rates and the degree of exchange rate misalignments in Kenya. This should form a basis for policy intervention in the exchange rate market as an indicator of the optimum levels of exchange rates when the movement of the rates are very erratic. Secondly, the econometric procedure that is proposed for determining equilibrium exchange rates in this study is argued to be stronger and can be adopted by other researchers in determining equilibrium exchange rates. We use the structural vector autoregressions (SVAR) in determining the equilibrium exchange rates in Kenya.

The results show that the fundamental determinants of the real exchange rate movements, including capital inflows and import demand expectations, play a very significant role in determining the movements of the real exchange rates in developing countries such as Kenya. Other than the role of expectations and the fundamentals, it is clear that the actions of the international financial institutions, including the IMF and the World Bank through donor funding agreements and disagreements with the developing countries have very significant implications on the real exchange rates of these countries. In addition, the international economic environment, including the economic and institutional expectations in the other trading partner countries as well as expectations in the global markets, like the expectations in the oil supply and demand in the global markets, has similar significant effects on the real exchange rates of these countries. One major observation from the results is the surprising way in which the methodology we chose to calculate the equilibrium real exchange rate seems to capture the issues that defined the real exchange rate trends in Kenya. This is an indication of the robustness of the results that we get.

The variance decomposition results show that in the long-run, household expenditures account for the highest variation in the real exchange rates in Kenya. As the results from the long-run estimation show, an increase in household consumption leads to an appreciation of the real exchange rates in the long-run. This suggests that, in order to reduce sustained exchange rate misalignments, the government must put in place policies aimed at stabilizing consumption expenditures, including stabilizing inflationary pressures. Erratic movements in prices will likely lead to erratic movements in consumption expenditures and real exchange rates. The second most important source of variation in the real exchange rates is the interest rate differentials. To reduce erratic movements in the real exchange rates and real exchange rate misalignments, the government should ensure that changes in interest rate differentials are not erratic. The other major contributors to the variations in the real exchange rates are the terms of trade and technical progress. It is also important that changes in these two variables be kept as stable as possible. This will ensure that movements in the real exchange rates are also stable, and real exchange rate misalignments will thus be avoided.

References

Balassa, B. (1964), "The Purchasing Power Parity Doctrine: A Reappraisal", *Journal of Political Economy*, Vol. 72.

Balassa, B. (1973), "Just How Misleading are Official Exchange Rate Conversions? A Comment", *The Economic Journal*, 83:332.

Baffes J., I. Elbadawi and S. A. O'Connell (1999), "Single Equation Estimation of the Long-Run Real Exchange Rate", in Lawrence E. Hinkle and Peter J. Montiel (eds), *Exchange Rate Misalignments: Concepts and Measurements for Developing Countries,* New York: Oxford University Press.

Byung-Yeon Kim and Korhonen, Iikka (2005), "Equilibrium Exchange Rates in Transition Countries: Evidence from Dynamic Heterogeneous Panel Models," *Economic Systems*, Vol. 29 (2): 144-162.

CBK (2003a), *Monthly Economic Review June 2003*, Nairobi: Government Printers.

CBK (2003b), *Monthly Economic Review December 2003*, Nairobi: Government Printers.

CBK (2004), *Monthly Economic Review January 2004*, Nairobi: Government Printers.

Corden, W. M. (1994), *Economic Policy, Exchange Rates and the International Systems*, Oxford: Clarendon Press.

Edwards S. (1989), *Real Exchange Rates, Devaluations and Adjustments*, Cambridge, Mass: MIT Press.

Edwards S. (1994), "Real and Monetary Determinants of Real Exchange Rates Behaviour: Theory and Evidence from Developing Countries", in John Williamson (ed), *Estimating Equilibrium Exchange Rates,* Washington DC: Institute for International Economics.

Elbadawi I. (1994), "Estimating Equilibrium Long-Run Real Exchange Rates", in John Williamson (ed), *Estimating Equilibrium Exchange Rates*, Washington DC: Institute for International Economics.

Elbadawi, I. and Soto (1994), "Capital Flows and Equilibrium Real Exchange Rates in Chile", Policy Research Working Paper

1306, Washington DC: World Bank.

Enders, W. (2004), Applied Econometric Time Series, 2nd ed, John Wiley and Sons.

Hsieh, D. A. (1982). "The Determination of the Real Exchange Rate, The Productivity Approach", *Journal of International Economics,* 12.

Hyder Z. and A. Mahboob (2006), "Equilibrium Effective Real Exchange Rate and Exchange Rate Misalignments in Pakistan", SBP-Research Bulletin, Vol. 2, No. 1.

Kaminsky G. (1993), "Is There a Peso Problem? Evidence from the Dollar/Pound Exchange Rate, 1976-1987", *The American Economic Review*, Vol. 83, No. 3.

Montiel, P. (1999), *Determinants of the Long-Run Real Exchange Rate*, in Lawrence E. Hinkle and Peter J. Montiel (eds), "Exchange Rate Misalignments: Concepts and Measurements for Developing countries", New York: Oxford University Press.

Samuelson, P. A. (1964). "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, 46:2: 145-54.

Sims. C. A. (1980) "Macroeconomics and Reality", *Econometrica* 48.

Stock J. (1987), "Asymptotic Properties of Least Square Estimators of Cointegrating Vectors", *Econometrica* 55.

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

Williamson J. (1994), "Estimates of FEERs", in J. Williamson (ed.), *Estimating Equilibrium Exchange Rates*, Washington: Institute for International Economics.

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