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THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

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Abstract

With the liberalization of the exchange rate market in Kenya, it is expected that contractionary monetary policy meant to reduce inflation will lead to exchange rate overshooting. Exchange rate overshooting on the other hand, reduces aggregate output through the exchange rate channel of the monetary policy transmission mechanism. Contracting monetary policy with the objective of reducing inflation has the potential to restrict output growth, if exchange rates overshoot, putting the policy makers in a dilemma. This paper examines whether exchange rates overshoot in Kenya, and its impact on output when monetary policy contracts. Using Kenyan data and error correction modeling, the short-run results show that following a contractionary monetary policy, exchange rates undershoot in Kenya instead of overshooting. The undershooting is attributed to the intervention in the exchange rate market by the Central Bank of Kenya (CBK). It addition, undershooting of the exchange rate has positive impacts on output but the full impact is restricted again by the Bank's intervention. Therefore, for the full impacts to be realized, the CBK needs to leave the exchange rates fully to the market forces when the disturbances are identified to monetary policy shocks. The study also finds that the exchange rate channel of monetary policy transmission mechanism in Kenya is effective. The study recommends that the CBK recognizes this channel, and incorporates exchange rates in its monetary policy formulation by constructing and using the Monetary Policy Conditions Index (MCI).

Abbreviations and Acronyms

ADF	Augmented Dickey Fuller
CBK	Central bank of Kenya
CLMM	Classical Mundell – Fleming Model
EAC	East African Community
MCI	Monetary Policy Conditions Index
OMO	Open Market Operations
PPP	Purchasing Power Parity
UIP	Uncovered Interest Rate Parity

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1. Background

Exchange rate as a component of monetary policy is one of the key tools in economic management and in the stabilization and adjustment policies in developing countries where low inflation and international competitiveness have become major policy targets. With the adoption of a floating exchange regime in Kenya in the 1990s, it was expected that the country would benefit from several advantages of such a regime, including, first, a more continuous adjustment of the exchange rates to shifts in demand for and supply of foreign exchange. Secondly, it was expected that the demand and supply of foreign exchange would equilibrate by changing the nominal exchange rate rather than the level of reserves. Thirdly, it was hoped that the regime would allow Kenya the freedom to pursue its own monetary policy, without being concerned about balance of payment effects (Ndung'u, 1999). The exchange rate is also a very important policy variable for economic stability and management, since it is a relative price in making spending and investment decisions (Marrinan, 1989).

Changes in monetary policy are expected to lead to changes in the exchange rates through the monetary policy transmission mechanisms, and in particular through the exchange rate channel. The Central Bank of Kenya (CBK), which is the custodian of monetary policy in Kenya, has the authority to either contract or expand monetary policy in line with its targeted objectives of price stability and economic growth by fostering liquidity and solvency and the proper functioning of a stable market-based financial system. A contractionary monetary policy, for instance, is desirable for keeping inflation at the CBK's desired one-digit target limit of below five per cent. With this authority, several episodes of contractionary monetary policy have been witnessed in Kenya.

The massive contractionary policy adopted by the CBK after the 1992 general elections, for instance, maintaining inflation levels to a target of below five per cent, aimed at maintaining price stability and certainty of money value (Central Bank of Kenya, 2002). However, the Dornbusch overshooting model (Dornbusch, 1976) predicts that countries that tighten monetary policy should experience exchange rate overshooting (over-appreciation of the domestic currency). The basis of the Dornbusch overshooting model is that sticky output prices is the main cause of exchange rate overshooting. Through the exchange rate channel of the monetary policy transmission mechanisms, exchange rate overshooting (initial over-appreciation of the exchange rates resulting from a contractionary monetary policy) reduces competitiveness of the domestic exports through its workings in increasing domestic prices and interest rates, hence making domestic goods more expensive to foreigners. With reduced exports and increased interest rates, aggregate incomes and output decrease. A contractionary monetary policy, therefore, will most likely, lead to exchange rate overshooting, which on the other hand, has negative impacts on aggregate income and income growth (at least in the short-run).

The impact of exchange rate overshooting in the long-run depends on whether the effects are persistent or temporary. If the effects are permanent, then a contractionary monetary policy intended to reduce inflation leads to another undesirable outcome of restricting output growth; a policy paradox. This study aims at establishing whether exchange rates overshoot in Kenya after monetary policy shock and how it affects aggregate incomes, both in the short and long-run. The study is important for the monetary authority, CBK, in determining the effectiveness and the side-effects of the restrictive monetary policy stance in the presence of exchange rate overshooting in Kenya. This would be useful in designing monetary policies that are effective in a liberalized financial market with freely floating exchange rates and free capital mobility.

To achieve the objectives of the study, an error correction model is estimated. The results of the short run overshooting model show that the coefficient of money supply in the preferred model is positive and less than one, implying that the reaction of exchange rates, after a monetary policy change, is less than proportionate to the exchange rate depreciating in the short run. This means that the exchange rates in Kenya undershoot instead of overshooting following a monetary policy contraction because CBK intervenes in the exchange rate market so as to sterilize movements in the exchange rates, when it thinks the movements are too erratic. The coefficient of the error correction term in the cointegrating equation is negative in line with the theoretical expectations. This implies that exchange rates will not undershoot in the long run. The disequilibria in the short run exchange rate path are adjusted in the long run so that the initial equilibrium is restored. It is further found that exchange rate undershooting has positive impacts on output; but the extent of the impact is restricted by the CBK's intervention policies. For the full impact to be realized, CBK needs to leave the exchange rates fully to the market forces, if the disturbances are from monetary policy shocks. The study findings also imply that the exchange rate channel of monetary policy transmission mechanism in Kenya is effective, since exchange rate undershooting impacts significantly on output. The study recommends that the CBK recognize this channel by incorporating the exchange rates in the monetary policy formulation, by constructing and using the Monetary Policy Conditions Index (MCI) in their monetary policy decision making.

The remaining part of this paper is organized as follows; the rest of section one gives an overview of currency overshooting and monetary policy in Kenya. Section two gives both the theoretical and empirical literature review, and Section three gives the theoretical and empirical models that have been used. Section four gives the empirical results, while Section five concludes the study.

1.1 Currency Overshooting

Exchange rate overshooting refers to a temporary over-reaction of the nominal exchange rate due to a monetary shock, before returning to its equilibrium value in the long run. The major fundamental economic reason for currency overshooting is the sticky goods prices, combined with instantaneous adjustment in the asset market. The overall price level increases less than the money supply, leaving the demand for money lower than the supply. Sticky prices imply that the domestic price levels do not move instantaneously in response to unanticipated monetary policy shocks in the short run and adjust slowly over time. This is the price puzzle of monetary policy.

Assuming that money is neutral in the long run, a permanent fall in money supply leads to a proportionate fall in both the price level p, and the exchange rate e, in the long run. Unanticipated fall, for instance, in money supply m with the price levels temporarily fixed in the short run, will lead to a fall in the supply of real balances m-p. To equilibrate the money market, the demand for real balances must also fall. For the demand for real balances to go up, the domestic rates of interest r, will rise. The domestic rates of interest will only rise if and only if, over the future life of the bond contract, the home currency is expected to appreciate. The initial appreciation of the currency will, on impact, be larger than the long run appreciation, meaning that it overshoots its long run value. This initial excess appreciation of the currency leaves room for the ensuing depreciation needed to clear the bond and the money markets in the long run.

1.2 Monetary Policy in Kenya

Monetary policy in Kenya, like in other countries, ultimately seeks to promote economic well being of the country's citizens by striving to achieve high and sustainable non-inflationary rate of economic growth and employment, as well as a viable balance of payment position. Before 1966, matters relating to monetary management were handled by the East African Currency Board, which also served Uganda and Tanzania. The Central Bank of Kenya was established in 1966 under the Central Bank Act (CAP 481) after the collapse of the East Africa Community (EAC). The bank's primary objectives were to maintain a desirable level of foreign exchange reserves to cover at least four months of import cover, and maintain price stability and a stable currency.

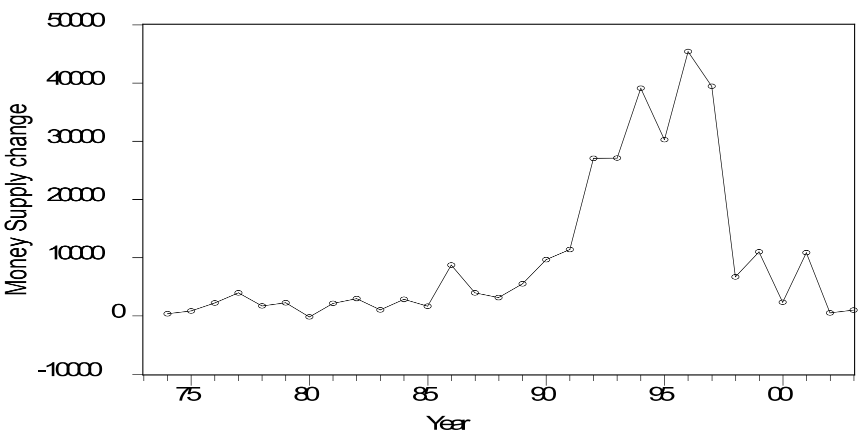
Since its establishment in 1966, the CBK has essentially used a monetary-targeting framework to pursue the inflation objective. The use of this monetary policy strategy has been and continues to be based on the presumption that on money matters, the behaviour of monetary aggregates has a major bearing on the performance of the economy, particularly on inflation. During 1966 to 1970, the CBK pursued a rather passive monetary policy, partly because the bank had not then acquired sufficient experience in the management of monetary policy. Apart from the year 1967 and 1969, the country's balance of payments and the budget recorded substantial surpluses. The pound sterling, to which the shilling was pegged, was devalued in 1967 by 14.3 per cent, occasioning the first balance of payments crisis since independence. The CBK did not consider this as an exchange rate problem, but as a temporary problem that did not require any devaluation. There was an improvement in the balance of payments in 1968, when it reverted to a surplus. As a result of this, there was improvement and the increase in domestic credit by 27 per cent in the year, and growth in money supply accelerated from 8 per cent in 1968 to about 19 per cent in 1969. The country had to confront severe constraints on the balance of payments following the collapse of the Bretton Woods system of fixed exchange rates in 1971 and the oil crises of 1973 when the balance of payments came under increasing pressure.

Prior to July 1991 when the open market operations (OMO) were introduced, the Central Bank of Kenya had been using four main instruments for implementing monetary policy. These were the minimum liquid asset ratio, the minimum cash balances, interest rate controls and credit controls. Currently, monetary policy management requires right reserve money forecasting. As indicated in CBK (2000), the Central Bank of Kenya currently uses M3X as the principal concept of money in conducting monetary policy. Until 1998, the conduct of monetary policy had focused on the behaviour of the broad monetary aggregate, M3.

The stability of the relationship between M3 and nominal GDP was compromised as the banks and non-banking institutions engaged in large-scale portfolio shifts between deposits, government paper, and foreign-currency denominated deposits. This shift appeared as a response to either actual or perceived changes in the relative rates of return of these financial assets, as well as to other factors related to the sophistication of the local market participants, the openness of the capital account, the perception of Kenya in the eyes of international financial investors and the perceived liquidity of government paper. In the process of these shifts, the velocity of M3 changed, thereby reducing the usefulness of this aggregate as a guide for monetary policy. CBK then changed and started to focus on the much broader monetary aggregate, M3X[1] and M3XT. Therefore, M3X remains the monetary aggregate programming target and indicates the stance of monetary policy followed under the Central Bank's monetary aggregate anchor.

There are three fundamental monetary regime options that a country can adopt: an exchange rate anchor, a monetary aggregate

Figure 1.1: Marginal change money supply in Kenya



Source: CBK Quarterly Bulletin (various)

[1] M3X is defined as M3 plus foreign currency deposits (FCDs) held by residents, whereas M3XT is M3X plus holdings of government paper by the non-bank public.

anchor, and an inflation target anchor. An exchange target anchor uses an exogenously determined trajectory of the exchange rate as a nominal anchor, a monetary anchor relies on a pre-committed path for the money supply to anchor inflation rate, and in inflation targeting, and the anchor for inflation is the publicly announced inflation target itself. Money supply as measured by M3 has been expansionary over the years to 1996 when it started declining (Figure 1.1).

The decline in money supply from the early 1990s as seen in Figure 1.1 is attributed to the mopping up of excess liquidity after the 1993 high inflation rates. The annual inflation rates in 1993 reached a high of 46 per cent after the massive monetary expansion in 1992 to finance the first multiparty elections. Hence, there was need to come up with measures to reduce money supply. The Central Bank in 1996 came up with the first monetary policy statement in pursuant of Section 4B of the Central Bank of Kenya (Amendment) Act of 1996, which conferred autonomy on the Central Bank. The autonomy mandated CBK to specify the monetary policy objectives, the means through which these polices would be achieved and the reason for undertaking them. In this statement, the Central Bank's major target was to reduce inflation to single digit levels. This necessitated a contractionary monetary policy by the CBK.

2. Literature Review

2.1 Overview of Theoretical Literature

This section reviews some of the developments in modeling of exchange rate overshooting. In the Classical Mundell-Fleming (CLMM) model, the goods market is assumed to be slowly clearing, while the asset market is in continuous equilibrium. This may give rise to exchange rate overshooting due to the differential adjustment speeds of the assets and the goods markets. However, one of the limitations of the CLMM is that it ignores international capital flows and future expectations of exchange rate movements, which are major determinants of exchange rates. The portfolio balance approach, which emphasizes the link between the balance of payments and the adjustments in the asset stocks, assumes that domestic and foreign assets are not perfect substitutes, and therefore the UIP does not hold (Insard, 1995). Empirical tests of the portfolio balance models based on earlier works of Meese and Rugoff (1983) incorporating cumulative trade and current account balances, have become widely adapted (Hooper and Morton, 1983 and Were *et al.*, 2001).

In the Dornbusch overshooting model (1976), the price level is sticky in the short run but flexible in response to excess demand in the goods market in the long run. In what has become a classical paper, Dornbusch (1976) proposed that rather than output adjusting to equate demand and supply in the goods market, the supply of output could be assumed fixed, just like in the classical approach. The general level of prices could rise (fall) in response to excess demand (supply). With asset market clearing instantaneously and the goods market adjusting only slowly (sticky prices), the expectation of a future appreciation of exchange rates (e) allows interest rates (r) to fall below its initial value, hence overshooting the exchange rate. As goods market prices rise, the exchange rate appreciates back towards its long run equilibrium value. The extent of this short run exchange rate overshooting is given by totally differentiating the price level equation, noting that $\partial e=\partial m=\partial p$ gives $\partial e/\partial m=(1+1/\mu\beta)$, where $0<\mu\beta<1$. A one per cent rise in the money supply has a larger than one per cent effect on the exchange rate. Moreover, the extent of exchange rate overshooting depends on the interest elasticity for the demand for money, β, and the regressive expectation coefficient, μ. Thus, if the interest elasticity of the money demand is low, any change in the money supply will result in a relatively large change in the interest rate and will be mirrored by a large overshoot of the exchange rate. Dornbusch (1976) model also had methodological limitations when examined from a micro-foundations point of view (Were *et al.*, 2001). The model lacks choice theoretical foundations, particularly the micro-foundations of aggregate supply. Its specification of the price determination is *ad hoc*. The model is also ill-equipped to capture current account dynamics (Obstfelt and Rugoff, 1996). In addition, it does not explicitly model the implicit bond market. Considering the limitations of each of these theoretical foundations, it is important when establishing for the evidence of exchange rate overshooting, to incorporate the different aspects of these models to capture all their salient futures.

2.2 Overview of Empirical Literature

Driskill (1981) using the Swiss-US Dollar exchange rate and monthly data used the single equation procedure to estimate the quasi-reduced form for the Swiss-Franc-US Dollar exchange rate for the period 1973-1977. His approach was to convert the continuous time, two-country theoretical model into a discrete time, and two-country empirical model. The model is reduced to two dynamic equations, one for the price level and the other for the exchange rate. To convert the Dornbusch model into a two-country model for the prices and the exchange rate, Driskill defines all variables in relative terms. The empirical model for exchange rate is attained by using the uncovered interest parity equation combined with regressive expectations, where the long-run equilibrium exchange rate is replaced by the relative money supply $\bar{e}$. Driskill used the relationship below to establish exchange rate overshooting:

$$e_t = b_0 + b_1 e_{t-1} + b_2 \hat{m} + b_3 \hat{m}_{t-1} + b_4 \hat{p}_{t-1} + b_5 \hat{y}_t + b_6 \hat{y}_{t-1} + b_7 \hat{g}_{t-1} + v_t \quad \text{.....................} (2.1)$$

The Dornbusch model implies that the following four restrictions are valid: $b_1<0$, $b_2<0$, $b_4<0$, and $b_1 + b_2 + b_3 + b_4 = 1$ The sign and size of b_2 indicates the short-run overshooting and constraint that the sum of the first four b s to unity is equivalent to long-run PPP. Furthermore, since the price level rises only after the exchange rate has overshot its long run equilibrium level, prices rise as the exchange rate appreciates back towards equilibrium and therefore $b4$ must be negative. The terms in government expenditure are not strictly part of the Dornbusch model and are excluded in the estimated version of the model. The income terms also had to be omitted because the proxies used for the Swiss income data were insignificant. Driskill's results offer strong evidence for exchange rate overshooting with $b_2<0$ and strongly significant.

Demey (1984) re-estimated the model using the same data set by maximum likelihood method to obtain efficient estimates of the parameters and to test the implied cross-equation restrictions, not tested by Driskill. Demey's estimates are rather different from Driskill for two reasons. First, Demey uses a moving average error process as implied by the theoretical model, and not an autoregressive error process as used by Driskill. Secondly, the oil dummy included in Driskill is not in Demey's test for technical reasons. Demey's coefficients differ considerably in magnitude and sign from those of Driskill; in particular, in the unrestricted form, the coefficient of b_2 is less than unity, suggesting exchange rate overshooting. Demey explicitly tests two restrictions using the likelihood ratio procedure. He tests for the validity of other restrictions, which includes the test for PPP which, however, again exceeds its critical value leading to the rejection of the restrictions. Therefore, contrary to Driskill's results, it seemed that overshooting is not an important feature in the case of Swiss-US Dollar exchange rate.

Papell (1984) tests the Dornbusch model using constrained maximum likelihood techniques, which incorporate cross-equation restrictions, and the assumption of rational expectations for the effective exchange rates indices of Germany, Japan, the UK and USA using quarterly data from 1973 quarter two (Q2) to 1984 quarter four (Q4). In their model, most of the structural parameters have plausible values, but the critical parameter for the overshooting was the coefficient of the price level in the exchange rate equation (δ_2). If δ_2 is positive, then there is exchange rate overshooting, but if it is negative, undershooting prevails. The results obtained show that half of the coefficients are positive and half are negative. The only country where overshooting seems a credible hypothesis is West Germany, while Japan displays the characteristics of undershooting. For UK, the results are weak, and insignificantly different from zero.

Papell (1984) estimates a two-country version of the Dornbusch overshooting model, assuming rational expectations and postulates endogenous money supply. Monetary policy in both countries is assumed to be responsive to exchange rate and price level changes. The estimated model consists of six equations, which are estimated structurally using constrained maximum likelihood techniques and quarterly data for the USA, and West Germany for the period 1973 quarter three (Q3) to 1981 quarter four (Q4). The strongest result is that while the US monetary policy is strongly accommodating of prices, Germany's monetary policy is sufficiently offsetting for the combined monetary policies, not to induce exchange rate undershooting.

Faust and Rogers (2000), in an attempt to assess the instantaneous overshooting hypothesis by Dornbusch and testing for the validity of PPP and UIP, used the US monthly data for the period 1974:1 to 1997:12. They used an extension of the Bayesian simulation method to produce the error bands on the impulse response and values drawn from the reduced standard form parameters. They found that the delayed overshooting result is sensitive to dubious identifying assumptions. They found little evidence that the large UIP deviations are the main source of the forward premium anomaly. Also, monetary policy shocks might explain less exchange rate variance than previously believed. Their results allow for an early peak in the exchange rate, which might give a role for the conventional overshooting model. However, the bulk of the variance of the exchange rate after policy shocks is due to large deviations from UIP. This, they concluded, is inconsistent with Dornbusch overshooting model.

Bahmani (2000), testing for overshooting of the Turkish Lira, used the error correction model to test for the short and long run overshooting using Turkish monthly data, covering January 1987 to December 1998. By combining the concepts of PPP theory and the Quantity Theory of Money, he developed a log linear model of exchange rate determination given by:

$$Logs = \left(LogM_T - LogM_{US}\right) - \left(LogY_T - LogY_{US}\right) + \left(LogV_T - LogV_{US}\right) \ldots\ldots\ldots\ldots\ldots\ldots.(2.2)$$

Where variables with the T subscript are domestic (Turkish) variables, while those in US subscript denote foreign variables, and V velocity of money from the quantity theory of money. The study proxied the velocity of money using inflationary differentials and the interest rates (since they argued that velocity of money is determined by the two factors) to come up with the error correction model given by:

$$\Delta s_t = a_0 + \sum_{j=1}^{n} b_j \Delta s_{t-1} + \sum_{j=1}^{n} c_j \Delta m_{t-1} + \sum_{j=1}^{n} d_j \Delta y_{t-j} + \sum_{j=1}^{n} f \Delta i_{t-1} + EC_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(2.3)$$

The study found that the values for the coefficients of Δm variable were positive up to the second lag order, but negative from the third lag order onwards, implying that the Lira depreciates first due to a monetary policy shock, and then appreciates in the long run. This showed overshooting in the short run, with most coefficients being insignificant. The error correction term EC_{t-1} in this study was positive, implying that there was overshooting in the long run.

3. Theoretical Model

The theories discussed in Section 2, portfolio balance approach (Keynesian approach), Mundell-Fleming model (Fixed price models) and the Dornbusch flexible price model, each has its assumptions, which in most cases, limit their applicability in the developing countries. To develop an encompassing exchange rate overshooting model, it is possible in principle to integrate these approaches into a unified model. Thus, these different models can be viewed as complementary and not necessarily competing (Rugoff, 2002).

In this study, the classical exchange rate overshooting theory is used as a baseline for empirical model development. In the classical exchange rate overshooting model, changes in the money stock are assumed to be proportionate to the price level changes and the change in exchange rate in the long run. A monetary policy change will change the exchange rates and prices in the same direction and magnitude (Pentecost, 1993). An over-reaction of the exchange rates due to a monetary policy change is interpreted as either an exchange rate overshooting or undershooting depending on the direction of change. On the other hand, a disproportionate change in prices as monetary policy changes implies that prices are sticky, and that prices will not move instantaneously with movements in the exchange rates. This is the money neutrality hypothesis. The classical model has the following assumptions:

It is firmly based on the quantity theory of money. The quantity theory of money is given by:

$$M = \frac{PY}{V} \quad \text{...(3.1)}$$

Equation (3.1) is the money demand equation, where *M* is the money stock (assuming total money supply equals total money demand), *P* is the general price level, *Y* is income level and *V* is money velocity (It is assumed that total money supply equals total money demand). Since V, the velocity of money is not observable, Bahmani (2000) argues that it can be substituted by its major determinants, the interest rates (R) and the inflationary expectations (Π). Equation (3.1) then becomes:

$$M = \frac{PY}{R\Pi} \quad \text{...(3.2)}$$

Equation (3.2) may be linearized by taking its logarithms, which gives:

$$m = p + y - r - \pi \quad \text{...(3.3)}$$

where: $m = \log(M)$; $p = \log(P)$; $y = \log(Y)$; $r = \log(R)$; *and* $\pi = \log(\Pi)$

This representation means that all prices, including the wage rates, are perfectly flexible, thereby establishing full automatic employment of resources. One major assumption of the classical model is that the velocity of money is constant so that money is neutral in its effects to the real economy in the long run. That is:

$$\Delta m = \Delta p = \Delta e \quad \text{...(3.4)}$$

where (Δm) is the monetary policy change, Δp is the change in the price level and Δe is the appreciation or depreciation of the exchange rates. This means that a monetary policy change Δm would lead to a proportionate change in the price levels and the exchange rates in the long run. In the short run however, the classical theory assumes that prices are sticky. This is in line with the Dornbusch model.

The second proposition of the classical theory is that domestic and foreign prices are linked through the nominal exchange rates. According to the classical theorists, the exchange rate is the purchasing power of the domestic currency in terms of foreign currency. This relationship can be expressed as:

$$E = \frac{P^d}{P^f} \quad \text{...(3.5)}$$

where E is the nominal exchange rate, P^d is the nominal domestic price level and P^f are the nominal foreign prices. Taking the logarithms of equation (3.5) gives:

$$e = p^d - p^f \quad \text{...(3.6)}$$

where $e=log(E)$, $p^d=log(p^d)$ and $p^f=log(p^f)$. This relationship is what Keynes called the Purchasing Power Parity (PPP). The proponents of the classical theory also argue that the change in the expected depreciation of the home currency will be equal to the excess of the domestic nominal interest rates over the foreign nominal rates. That is:

$$r^d - r^f = \theta(\overline{e} - e) \quad \text{...(3.7)}$$

where θ is the expectations operator, $\overline{e}$ is the equilibrium nominal exchange rates in logs, e is the current nominal exchange rates in logs, r^d is the domestic nominal interest rates in logs and r^f are the foreign nominal interest rates in logarithms. This relationship represents the uncovered interest rate parity (UIP) condition. The UIP represents a situation of perfect capital mobility, meaning that the bonds, apart from their currency denominations, are perfect substitutes and that international portfolios such as foreign securities are adjusted instantaneously.

Equation (3.3) gives the classical exchange rate determination model, which is basically a monetary model because it does not include the supply side of the economy. This becomes the major criticism of the classical model; that is, the supply side is not incorporated in the model (Mundell, 1961). To include the supply side, the Keynesian economists came up with the portfolio balance monetary model (Rugoff, 2002). In this model, they suggested that including current account flows and net capital inflows in the classical model would capture the supply side. Empirical application of the portfolio balance model is based on the assumption that currency composition of financial portfolios could be measured by incorporating the current account balance (Were *et al.*, 2001). Based on the interpretations of Meese and Rugoff (1983) that current account balances are terms that allow for changes in the long run exchange rate, the relationship can be represented by an equation as:

$$e = \alpha + \beta\, Cab + \eta \inf + u \quad \text{...}(3.8)$$

where βCab is the component part of the current account balance that affects the exchange rates, ηinf is the influence of the net capital inflows on the exchange rates and u is the disturbance term. Incorporating these two supply side variables into the classical model gives:

$$e = (m\ ) + (y\ ) + (r) + (\pi^{d}) + Cab + \inf \quad \text{...}(3.9)$$

To capture the sticky price aspect of the exchange rate overshooting theory, price levels are used to proxy inflationary expectations in the model. The rationale for using price levels is that inflation is the percentage change in the price levels two periods apart (Bahmani, 2000). That is:

$$\theta(p_{t-1} - p_t) = \pi \quad \text{..}(3.10)$$

where θ is the expectations operator, p_t and p_{t-1} are the domestic prices in time *t-1*, respectively. Ndung'u (1999) argues that in the short run prices are sticky and therefore the purchasing power parity (PPP) does not hold continuously. Further, deviations from the PPP will be absorbed by the interest rate differentials. Therefore, inclusion of the interest rate differential *(rr)* in the model will ensure the maintenance of the PPP assumption. Taking GDP for *y* and including the *rr* variable into equation (3.9), a theoretical model may be derived as:

$$e_t = \alpha_0 + \alpha_1 m_t + \alpha_2 rr_t + \alpha_3 p_t + \alpha_4 GDP + \alpha_5 Cab + \alpha_6 \inf + u_t \quad \text{(3.11)}$$

where *Cab* is the current account balance, *inf* is the net external capital inflows, *rr* is the interest rate differential and *ut* is the error term. The expression in equation (3.11) is a hybrid of the classical and the portfolio balance models, since it incorporates the characteristics of both models.

When there is a contractionary monetary policy, *m* in the equation (3.11) falls. Following the money neutrality theory, the expectation is that exchange rate (e_t) will change in the theoretical direction, with the same magnitude as the monetary policy (money supply). The theoretical direction of exchange rates due to a monetary policy contraction is an appreciation. If α_1 is negative with a coefficient greater than one, this implies that a monetary policy change leads to an over-appreciation (overshooting) of the exchange rates. On the other hand, a positive which is greater than one, implies an over-depreciation (overshooting), while a negative, which is less than one is undershooting (under-appreciation). If the coefficient is positive but less than one, then there is an under-depreciation (undershooting) of the exchange rates.

3.1 Empirical Model

Meaningful econometric estimation of a model using time series data requires that the data is stationary. According to Granger and Newbold (1974), econometric estimation using non-stationary time series data often leads to spurious results. Spurious results arise when the regression of non-stationary series, which are known to be unrelated, indicates that the series are correlated (Adams, 1992). Since the overshooting hypothesis is a short-run phenomenon, an appropriate method to test it would be to employ the error correction modelling and cointegration techniques. Engle and Granger (1987) argue that if two non-stationary variables are cointegrated, that is if there is a long term relationship between them, then the short run dynamics of the model can be described by an error correction model. This study adopts an approach similar to that of Bahmani (2000). It explores the existence of a cointegration relationship among the variables in the regression equation. If the variables are cointegrated, then a long run relationship among them can be established. The information in the error term of the long run relationship is then used to develop an error correction model, which is capable of describing the short term dynamics of the model.

The first step in applying the techniques is to determine the order of integration of each variable. The variables in the model are subjected to unit root tests using Augmented Dickey Fuller tests (ADF) and Phillip-Perron tests. The long run equation specified in equation (3.11) is a static model by its nature. Due to the dynamic relationships of the variables in the model, it is reasonable to assume an autoregressive distributed lag (ARDL) model with *n* lags as:

$$e_t = \alpha_0 + \sum_{j=0}^{n} \alpha_{1j} e_{t-j} + \sum_{i=0}^{n} \alpha_{2j} m_{t-j} + \sum_{i=0}^{n} \alpha_{3j} rr_{t-j} + \sum_{i=0}^{n} \alpha_{4j} p_{t-j} + \sum_{i=0}^{n} \alpha_{5j} GDP_{t-j} + \sum_{i=0}^{n} \alpha_{6j} Cab_{t-j} + \sum_{i=0}^{n} \alpha_{7j} \inf_{t-j} + \quad \text{.......................................(3.12)}$$

where *n* is the number of lags.

As discussed earlier, if a set of variables are cointegrated, then the short run dynamics of the long run equilibrium given in equation (3.11), can be described by an error correction model as:

$$\Delta e_t = \alpha_0 + \sum_{j=0}^{n} \alpha_{1j} e_{t-j} + \sum_{j=0}^{n} \alpha_{2j} m_{t-j} + \sum_{j=0}^{n} \alpha_{3j} rr_{t-j} + \sum_{j=0}^{n} \alpha_{4j} p_{t-j} + \sum_{j=0}^{n} \alpha_{5j} GDP_{t-j} + \sum_{j=0}^{n} \alpha_{6j} Cab_{t-j} + \sum_{j=0}^{n} \alpha_{7j} \inf_{t-j} + \alpha_8 ECT_{t-1} \quad \text{....................................(3.13)}$$

where $ECT_{t-1} = e_{t-1} - \beta_0 + \beta_1 m_{t-1} - \beta_2\, rr_{t-1} - \beta_3\, p_{t-1} - \beta_4 GDP_{t-1} - \beta_5 Cab - \alpha_6 \inf_{t-1}$ ....(3.14)

ECT_{t-1} is a linear combination of the variables denoting the error correction term in the ARDL model (3.13), with the assumption that all the variables are integrated of the same order and v_t is a disturbance term. The error correction term ($\alpha_8 ECT_{T-1}$) represents the short-term response necessary to move the system back long run equilibrium.

Before interpreting the results of the error correction model, a series of diagnostic tests on the variable and the equation itself are performed. If cointegration is established, the model is then re-estimated using appropriate lag selection criteria. Cointegration is then established using the residual based test introduced by Engel and Granger or the Johansen cointegration test. Concentrating on the sign of the lagged variable, it would be possible to establish overshooting of the exchange rate. If the coefficient of the Δm is negative and greater than one, this implies that the exchange rate first of all over-appreciates above its long run path. This would support the overshooting hypothesis in the short run. If the lagged error term (ECT_{t-1}) that is supposed to have a negative coefficient carries a positive coefficient, then this is interpreted as exchange rate overstaying above its long run equilibrium value; in other words it overshoots itself in the long run (Bahmani, 2000).

4. Model Estimation and Analysis of Results

4.1 Introduction

Data transformation was done before estimation and time series properties of the data determined using Augmented Dickey Fuller (ADF) test and the Phillip Perron tests. Non-stationary series in the data were made stationary by differencing. Cointegration was established using the Engel-Granger two-stage method and the Johansen test. The cointegrated variables were then used to form an error correction model, which was used to reconcile the short run and the long run dynamics of the model.

4.2 Data Type and Sources

To achieve the objective of this study, quarterly time series data for the period 1990:1 to 2007:4 was collected for the purpose of the study. The different data sources are Central Bank of Kenya Monthly Economic Reviews (1996-2008), World Bank Africa database 2008 CD ROM, US Federal Reserve Bank at http://www/stls.frb.org and the IFS CD ROM–December 2008. The series that were not available in quarterly series, including GDP were interpolated into quarterly series from annual series. All the variables are in their logs, and those with negative observations were transformed into logs by cumulating them using a constant.

4.3 Time Series Data Properties

An appropriate method of testing the order of integration (testing for stationarity) is the Augmented Dickey Fuller (ADF) test. It tests the null hypothesis $|\rho|=0$ against the alternative that $|\rho|<0$ in the autoregressive equations:

$$\Delta y_t = \alpha + \beta t + \rho y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-1} + u_t \qquad (4.1)$$

Figure 4.1 suggests that the variables in equation (3.11) seem to exhibit non-constant means and variance, which is evidence for either deterministic or stochastic trends in the data.

Figure 4.1: Movements in model variables

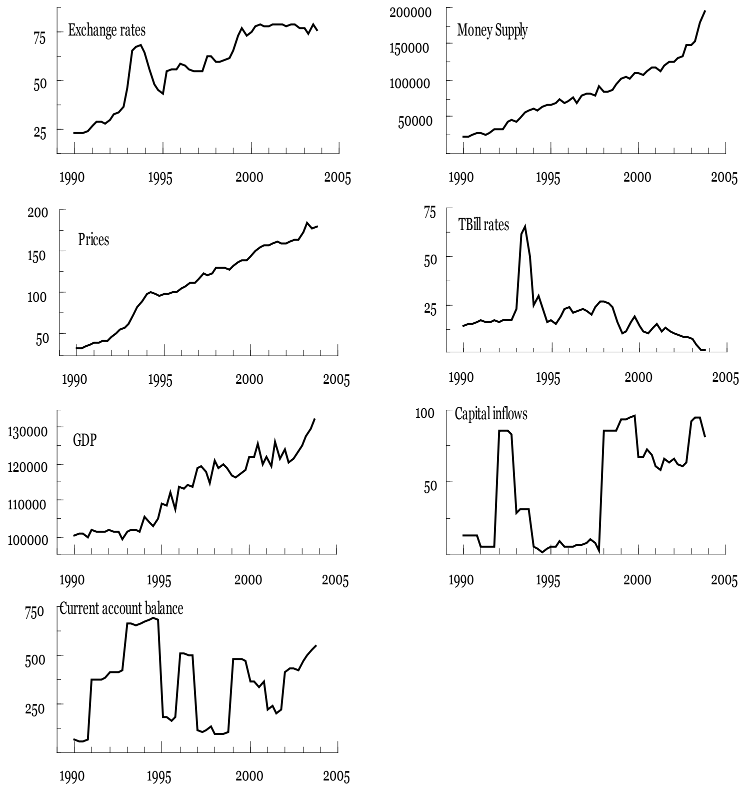


Table 4.1: ADF unit root tests

Variable	At levels	At first difference	Order of integration
Exchange rates (E)	-1.6361	-4.5144	I(1)
Prices (P)	-1.6128	-3.9365	I(1)
Money supply (M)	-2.3069	-7.7605	I(1)
Interest rate differentials (rr)	-2.2679	-9.5690	I(1)
Income (GDP)	-2.2679	-9.5690	I(1)
Capital inflows (inf)	-1.9195	-8.2538	I(1)
Current account balance (Cab)	-2.6930	-7.0763	I(1)

Note: The ADF test critical value used is 3.45 at 5% level of significance for 107 observations (constant plus time trend) and are obtained from Wayne (1976), which was constructed by David A. Dickey using Monte Carlo methods.

However, basing a decision on whether or not a series is non-stationary by casual inspection may be misleading. The decision is made on the basis of unit root tests. The unit root tests of the variables in the relationship (3.11) are reported in the Table 4.1.

The results of the unit root show that nominal exchange rates, domestic prices, money supply, interest differentials, income levels, capital inflows and current account balance are all non-stationary at levels. The tests show that all the variables are stationary after differencing once, which implies that they are I(1) variables.

4.4 Cointegration Test

The procedure for testing for cointegration is similar to that for testing the order of integration. The residual based cointegration test u_t introduced by Engel and Granger by analogy of equation (4.1) involves testing the significant of the coefficient $|\rho|$ in the OLS regression of:

$$\Delta u = \rho u_t + \varepsilon_t \quad \text{...}(4.2)$$

where u_t is the residual.

The test postulates that if the residuals from the OLS estimation of the non-stationary variables are stationary, then the series are cointegrated. Charemza and Deadman (1992) argue that there are two ways of establishing the long run relationship among variables that are integrated of the same order. One is to estimate the autoregressive distributed lag (ADL) model of the variables and solve the preferred model, and the other is by directly estimating a static model. The unit root tests on the residuals of both the ADL and the static model were found to be stationary, indicating that the variables are cointegrated. Johansen cointegration test results give further evidence of cointegration of the variables. The Johansen cointegration test results are reported in the Table 4.2.

Table 4.2: Johansen cointegration test results

Selected (0.05 level*) Number of cointegrating relations by model					
Data trend	**None**	**None**	**Linear**	**Linear**	**Quadratic**
Test type	**No intercept No trend**	**Intercept No trend**	**Intercept No trend**	**Intercept trend**	**Intercept trend**
Trace	2	2	1	1	1
Max-Eig	2	2	1	1	2

The results indicate that there are at least one cointegrating equation for all of the assumptions about the intercept and trend both in the cointegrating equation and the VAR. The cointegrating vector of the static model is therefore given as:

$$ECT_1 = e - 31.38 + 0.000024M3 - 0.47p + 0.00028GDP - 0.024\inf - 0.005cab - 0.35rr$$

However, given that all the variables in the model were I(1), it was possible to come up with another cointegrating vector that seemed to give better results. We therefore normalized the vector with the interest rate variable (treasury bill rates). The reason for this normalization was that the Central Bank of Kenya uses the treasury bill rates to influence monetary policy more than it uses the exchange rates (and exchange rate reserves). Therefore, the treasury bill rates drive monetary policy in Kenya more than the exchange rates. The cointegrating vector of the I(1) variables after normalization with the interest rates then becomes:

$$ECT_2 = Tbill - 13.87 - 0.96e + 0.00024M3 + 0.22p + 0.000053GDP + 0.0408\inf - 0.003cab$$

The ECT is then included in the general estimation of the short run model before reducing the general model to come up with the preferred model.

4.5 Preferred Model Results

The initial regression involves estimating an over-parametized (general) model to choose the appropriate number of lags to use in the final estimation (specific model). Initially, unrestricted model of the equation (3.13) with three lags of each variable of the model was estimated. The choice of the preferred model to be estimated proceeded with the elimination of the lags of each variable that seemed to be least significant. The over-parametized model was reduced to a specific model by comparing the critical t-ratios with the computed t-ratios. We fail to reject the null hypothesis in the cases where the computed t-ratio was smaller than the critical t-ratio, hence dropping the variable from the succeeding estimations. Elimination of variables that were least significant continued until the preferred model was reached. We estimated two models: one with with structural breaks, while the other did not consider the breaks. This was done because it was suspected that modelling the structural breaks using dummies would mask the shock periods. Results from the two estimations are then compared to see if they are different. The preferred model results are reported in Table 4.3 (a&b).

Table4.3(a): Short-run model results with no structural breaks

Variable	Coefficient	Std.Error	t-value	t-prob	Part. R^2
DLE_1	0.510902	0.1348	3.79	0.001	0.2697
DLM3_1	0.307046	0.1798	1.71	0.096	0.0696
DLM3_2	0.658511	0.1598	4.12	0.000	0.3033
DLM3_3	0.460839	0.1916	2.41	0.021	0.1292
DLPr_2	-0.920926	0.2644	-3.48	0.001	0.2373
DLGDP	-0.533411	0.3848	-1.39	0.174	0.0470
DLrr_1	0.0181535	0.01697	1.07	0.291	0.0285
DLinf_1	-0.0135447	0.01417	-0.956	0.345	0.0229
ECT_1	-0.00597819	0.002375	-2.52	0.016	0.1398
DLCab_1	-0.0122649	0.02256	-0.544	0.590	0.0075
Constant	-0.00657246	0.01494	-0.440	0.662	0.0049

Table 4.3(b): Short-run model results with structural breaks

Variable	Coefficient	Std.Error	t-value	t-prob	Part. R^2
DLE_1	0.129146	0.07912	1.63	0.111	0.0689
Constant	-0.00245755	0.008209	-0.299	0.766	0.0025
DLM3_1	0.271063	0.09023	3.00	0.005	0.2004
DLPr_3	-0.494191	0.1627	-3.04	0.004	0.2040
DLGDP_1	-0.424613	0.2278	-1.86	0.071	0.0880
DLCab_2	0.0149166	0.01174	1.27	0.212	0.0429
DLinf_1	0.0272211	0.008372	3.25	0.002	0.2270
DLinf_2	0.0189406	0.007123	2.66	0.012	0.1642
DLrr	-0.0293066	0.01058	-2.77	0.009	0.1757
D93.2	0.443068	0.04556	9.72	0.000	0.7243
D95.2	0.223923	0.03803	5.89	0.000	0.4905
D93.1	0.259796	0.03909	6.65	0.000	0.5510
D97.3	0.173419	0.04120	4.21	0.000	0.3299
ECT_1	-0.00222429	0.001535	-1.45	0.156	0.0551

The results in Table 4.3 (a&b) represent the short run dynamics of the model. Four dummies are included in the second model. Two of them represent the first and second quarter of 1993, another represents the second quarter of 1995, and the last represents the third quarter of 1997. The 1993 dummy represents a period when Kenya experienced the month-to-month overall inflation rates close to 70 per cent and growth hit a low of 0.2 per cent greatly weakening the shilling. Bad weather conditions, excessive growth in money supply from 1992 and continued price decontrols also depreciated the exchange rates further in 1993. The 1995 dummy represents the period when the Exchange Control Act was repealed, thereby completing the liberalization of the foreign exchange market. In 1997, exchange rates sharply depreciated as the real annual GDP grew by 2.3 per cent compared to 4.6 per cent in 1996, coupled with pre-election uncertainties in the third quarter of the year. The decline was attributed to adverse weather conditions, rising input costs, power interruptions, dilapidated infrastructure, pre-election violence, depressed investments, competition from imports arising from a liberalized trade regime, and lack of investor confidence mainly due to the withholding of donor funds, especially withholding Enhanced Structural Adjustment Facility (ESAF) fund from the IMF. Inflation increased due to shortfall in agricultural output caused by widespread drought in the late 1996 and early 1997; frequent increase in prices of petrol and petroleum related products, increase in VAT from 15 per cent to 16 per cent; and increase in duty on motor vehicles, tobacco, beer and other household goods in August 1997, which led to sharp depreciation of the shilling

The theoretical expectation was that the coefficient of money supply would be negative. Thus, monetary policy contraction would lead to exchange rate appreciation. In addition, the coefficient of the short run money supply DM3 was expected to be greater than 1 (one). Theoretically, monetarists would expect this coefficient to be exactly equal to one (the neutrality of money theory). The findings from both models indicate that the coefficient of money supply is positive and less than one. The coefficients in both models are significant. This means that due to a monetary policy change, the exchange rates depreciate by a less than proportionate percentage, implying that exchange rates undershoot in the short run. The less than full adjustment of the exchange rate can be attributed to the fact that when monetary policy changes, the ensuing change in the exchange rates is sterilized by the CBK. Therefore, the impacts of monetary policy on exchange rates are not fully endogenously felt.

The price coefficient is negative and less than one contrary to expectations. This implies that when domestic prices increase, nominal exchange rates appreciate. The expectation is that when domestic prices increase, exchange rates depreciate because exports become more expensive relative to the imports, worsening the trade balance, hence depreciating the exchange rates. The price coefficient that is less than one is in line with the theoretical expectations. It indicates that domestic prices will not change in the same proportion as money supply and exchange rates in the short run, going against the neutrality of money hypothesis. This supports the Dornbusch hypothesis that prices are sticky in the short run.

The lagged error correction term that was supposed to be negative carries the correct sign. The coefficient is negative, implying that after a monetary policy disturbance, the system adjusts towards the long run path in a convergent path. This shows that exchange rates do not overshoot in Kenya in the long run. The magnitude of the coefficient gives the speed of adjustment of the short run dynamics of the system, from short run disequilibria towards the long run path. This coefficient is, however, very small indicating a very slow speed of adjustment. The coefficient ranges between 0.0022 and 0.0059, meaning that between 0.22 per cent and 0.59 per cent of the present disturbances are passed on to the next quarter to adjust the system towards the long run equilibrium. When monetary policy is changed (contracted in this case), exchange rates depreciate but are not allowed by the CBK to depreciate to the full extent.

4.6 Solved Static Long Run Equation

The preferred model results were solved and the results of the solved static long run model are reported in Table 4.4.

The solved static model results closely corroborate the theoretical model. The price coefficient is positive, implying that an increase in the price levels leads to a one per cent depreciation in the nominal

Table 4.4: Long-run impacts of the fundamentals on exchange rates

	Coefficient	Std. Error	t-value	t-prob
Constant	0.0131472	0.01163	1.13	0.265
Lrr	-0.0342074	0.01110	-3.08	0.004
LP	0.241683	0.2696	1.896	0.037
LM3	-0.921511	0.2960	-3.11	0.003
LGDP	-1.81278	0.8001	-2.27	0.029
Linf	0.0892013	0.02049	4.35	0.000
LCab	0.0879536	0.02517	3.50	0.001
D93.2	0.630122	0.09115	6.91	0.000
D95.2	0.506292	0.09254	5.47	0.000
D93.1	0.282723	0.06275	4.51	0.000
D97.3	0.309276	0.07463	4.14	0.000

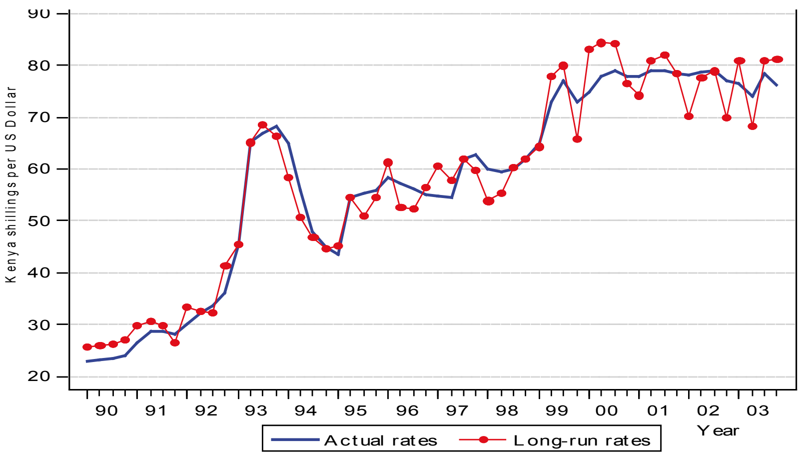
exchange rates by 24 per cent. As expected, an increase in the domestic interest rates over the foreign interest rates will appreciate the nominal exchange rate. A one percent increase in the interest rate differential will appreciate the nominal exchange rates by 3.4 per cent. Increased money supply contraction by one percent will increase domestic interest rates, encouraging capital inflows, hence appreciating the exchange rates by 92 per cent. Forecasting of the deviations of the nominal exchange rates from the equilibrium (short run equilibrium) from the cointegrating vector gives a series that shows the extent of exchange rate undershooting in Kenya. Figure 4.2 plots the deviations against the observed rates.

The chart indicates that exchange rate undershooting has not been seriously pronounced in Kenya, as the deviations from the short run equilibrium closely trace the observed nominal rates.

4.7 Impact of Exchange Rate Undershooting on Aggregate Output

To analyse the impact of exchange rate undershooting on aggregate outputs in Kenya, we motivate the exchange rate channel of monetary policy transmission mechanism. In this channel, monetary policy effects are transmitted into output through its impacts on domestic interest rates, capital inflows, exchange rates, domestic prices and net exports. Therefore, in the exchange rate channel, changes in output depend on the changes on these channel variables. Under flexible exchange rate regime, a tight monetary policy (M), for instance, leads to a rise in domestic interest rates vis-à-vis foreign interest rates. When

Figure 4.2: Actual vs long-run exchange rate



domestic real interest rates rise, domestic currency deposits become more attractive relative to foreign currency deposits, leading to a rise in the value of domestic deposits relative to other currencies. This implies an appreciation of the domestic currency (e). The higher value of the domestic currency makes domestic goods more expensive than foreign goods, causing a fall in net exports (NX), hence aggregate output (Y). This can be represented schematically as:

$$\downarrow M \Rightarrow \uparrow r_t \Rightarrow \uparrow rr_t \Rightarrow \downarrow e \Rightarrow \uparrow p \Rightarrow \downarrow NX \Rightarrow \downarrow Y$$

where rr_t is the interest rate differential and $\downarrow e$ signifies an appreciation.

To analyse the impacts of exchange rate undershooting on aggregate output through this channel, this study uses an error correction framework. The variables in the schematic relationship are all found to be I(1) series from unit root tests. They are further found to be cointegrated, hence the use of the error correction model to recover the long run characteristics of the data lost in the process of correcting for non-stationary. In this model, output is considered as dependent on the

Table 4.5: The over-parametized results on the impacts of exchange rate undershooting on aggregate output

	Coefficient	**Std.Error**	**t-value**	**t-prob**
Constant	0.00620126	0.01227	0.506	0.617
DLImp_1	- 0.385662	0.1025	-3.76	0.001
DLImp_2	- 0.169360	0.08985	-1.88	0.070
DLExp	0.173424	0.06335	2.74	0.010
DLExp_1	0.185520	0.07863	2.36	0.025
DLExp_3	0.151938	0.06485	2.34	0.026
Dldev_1	-0.405701	0.1193	-3.40	0.002
Dldev_2	-0.476683	0.1374	-3.47	0.002
Dldev_3	-0.180415	0.08952	-2.02	0.053
DLE	1.37234	0.1217	11.3	0.000
DLE_2	0.361504	0.2079	1.74	0.093
DLP_1	0.725282	0.2905	2.50	0.018
DLP_2	0.493677	0.3576	1.38	0.178
DLP_3	0.372266	0.2999	1.24	0.224
DLTbill	-0.0612459	0.02615	-2.34	0.026
D02.1	-0.159712	0.05610	-2.85	0.008
D01.1	-0.106727	0.05724	-1.86	0.072
D97.2	0.148789	0.05939	2.51	0.018
ECT3_1	-0.411819	0.1992	-2.07	0.048

deviations of the exchange rates from the equilibrium. The regression results are reported in Table 4.5.

Three dummies are included in the estimation. The first dummy captures the second quarter of 1997. During this period, GDP declined from 4.6 per cent in 1996 to 2.3 per cent, majorly due to adverse weather conditions, power interruptions and lack of investor confidence due to withholding of donor funds and pre election fever. The D01.1 dummy captures the period in 2001 when GDP growth rate slowed to -2.1. The results indicate that exchange rate undershooting expands output. All the lags of the Dldev variable, which represents the series for the exchange rate undershooting, are positive and significant, implying that output growth is expanded by the extent of exchange rate undershooting. This expansion, however, is restricted by the CBK's interventionary measures. The solved static model closely corroborates the short run model results s well as theoretical expectations.

Table 4.6: The long-run impacts of exchange rate undershooting on aggregate output

	Coefficient	Std.Error	t-value	t-prob
Constant	0.00300624	0.005980	0.503	0.618
LImp	-0.269063	0.07014	3.84	0.000
LExp	0.0677920	0.06693	1.01	0.317
Ldev	-0.0890531	0.5014	-1.78	0.083
LE	0.840529	0.1006	8.36	0.000
LP	0.292744	0.1594	-1.84	0.074
LTbill	0.0296907	0.01345	-2.21	0.033
D02.1	-0.0774247	0.02941	-2.63	0.012
D01.1	-0.0517391	0.02768	-1.87	0.069
D97.2	0.0721296	0.02858	2.52	0.016
ECT3	-0.199641	0.1124	-1.78	0.083

The static long run model results show that an increase in export volume by one per cent leads to an increase in GDP by 6.7 per cent. An increase in the deviation of the nominal exchange rates from its short run equilibrium values as monetary policy changes leads to an increase in GDP by 8.9 per cent in one quarter. Depreciation in the nominal exchange rates by one per cent (given by the positive coefficient), leads to an increase in GDP by 84 per cent. Domestic prices increases and domestic interest rates rise leads to an expansion in GDP. These results are consistent with the theoretical expectations.

5. Conclusion and Policy Recommendations

This study was motivated by the fact that there exists a relationship between exchange rate overshooting and output through the exchange rate channel of the monetary policy transmission mechanism. A prediction of the Dornbusch overshooting model is that exchange rate overshooting will be transmitted into the real economy through the exchange rate channel of the monetary policy transmission mechanisms, impacting negatively on aggregate output.

This study therefore aims at establishing evidence of exchange rate overshooting in Kenya, under the floating exchange rate regime using quarterly reports from 1990:1 to 2007:4. To establish the evidence of exchange rate overshooting, a short run equation was estimated using an error correction model, after making variables that were non-stationary to be stationary. The results of the short run overshooting equation show that exchange rates undershoot in Kenya in the short run.

The coefficient of money supply in the preferred model was positive and less than one meaning that when monetary policy is changed, exchange rates under-depreciates (undershoot) on impact. The expectation is that the change in exchange rates will be proportionate to the change in money supply. The coefficient that is less than one indicates that the change is not complete. The results further show that the short run path and the long run path converge over time. This is seen from the sign of the coefficient of the error correction term, which gives the direction and speed of adjustment from the short run to the long run. The coefficient was negative, implying an adjustment of the short-run disequilibria to the long run path per quarter.

5.1 Policy Recommendations

This study found that exchange rates undershoot in Kenya in the short run, but not in the long run. Exchange rates under-depreciate when monetary policy is changed. The under-depreciation could be attributed to the interventionary measures that the CBK institutes when it thinks that exchange rate movements are too erratic. The findings show that exchange rate undershooting impact positively on aggregate output. But since the extent of exchange rate change is restricted, its impact on output is also restricted by that intervention. It would be important, therefore, that CBK leaves the exchange rates totally to the market forces.

Another major finding of this study is that exchange rate impacts on output are significant in the model. This finding is important since it gives support to the effectiveness of the exchange rates in the transmission of monetary policy effects in Kenya. The CBK does not recognize the effectiveness of the exchange rate channel in the transmission of monetary policy effects. In CBK (2000), when the bank explains how its policies are transmitted in the economy and what magnitude of importance should be given to the monetary policy variables when formulating monetary policy, no mention is made of the exchange rate channel. A lot of emphasis is given to the interest rates in the credit channel. Other studies on monetary policy transmission mechanisms in Kenya have doubted the effectiveness of the credit channel in Kenya, arguing that private investments are not driven by interest rates. Therefore, manipulating interest rates may not have significant effects on aggregate output.

This may call for the inclusion of exchange rates in the CBK's monetary policy formulation, and formulating a reaction function that is consistent with the relative importance of macroeconomic variables. This may be done by constructing a monetary policy conditions index (MCI). The MCI can be constructed by looking at the relative importance of the monetary variables such as the term structure of the interest rates, the domestic debt and the exchange rates in influencing aggregate incomes. This will be in recognition of the fact that, having taken the step to float exchange rates, endogenous exchange rate impacts on output cannot be avoided and the only way to absorb its effects is by including it in the monetary policy formulation framework.

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