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The Exchange Rate and the Interest Rate Differential in Kenya

A Monetary and Fiscal Policy Dilemma

Njuguna S. Ndung'u

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

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Njuguna S. Ndung'u

Macroeconomic and Econometric Modelling Division

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Bishops Garden Towers, Bishops Road
PO Box 56445, Nairobi, Kenya
tel: +254 2 719933/4
fax: +254 2 719951
email: admin@kippra.or.ke

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Abstract

The paper analyses the relationship between the real exchange rate and the real interest rate differential on one hand and the implications they have on portfolio capital flows on the other. It shows that the nominal exchange rate deviates from the perceived long-run equilibrium level determined by the purchasing power parity relationship, and these deviations are governed by the interest rate differential. The deviations from purchasing power parity are absorbed by the real interest rate differential in an error correction formulation. Since the high-frequency data used is likely to be noisy, the model is re-estimated in a technique that uses time-varying parameters (the Kalman filter) for comparison. The Kalman filter uses all the available information in a manner related to Bayesian learning and can be considered the empirical counterpart to rational expectations. The results are not radically different. This allows us to move further and interpret the results. It is argued that the interest rate differential will widen as the real exchange rate appreciates, and this triggers capital to flow in. Also, domestic inflation will rise as the real exchange rate depreciates, and the influence of foreign inflation will decrease as the exchange rate appreciates.

The policy lessons that emanate from these results relate to interest rate structure and exchange rate management. One of the aspects of policy dilemma argued in the paper is that the real interest rate differential and the exchange rate absorb shocks from each other. The paper shows that closing the gap in the real interest rate differential (that is, lowering the domestic interest rate) will be consistent with a depreciation of the exchange rate. The optimal approach is not to sterilize these capital flows but to allow exchange rate movements to stabilize them in the medium to long term. As a result, the effects on the interest rate structure will be transitory. Thus, doing nothing in the presence of short-term capital flows is optimal. This is because Kenya has a floating exchange rate and an open capital account. Doing nothing will allow the exchange rate to equilibrate reserves and determine the optimal flow of short-term capital. It should be clear at the outset that movement of short-term capital is a reflection of agents' perception of risk of domestic assets in the country or is a stock adjustment reacting to either changes in prices or shocks or both. As the latter is part of the arbitrage process and not a structural phenomenon, effective policy intervention is likely to increase distortion and compound the problem.

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From the desk of the Executive Director

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Executive Summary

The objective

The objective of the paper is to analyse the relationship between the real exchange rate and the real interest rate differential and the underlying implications on short-term (speculative) private capital flows. This ties together the conduct of monetary policy, the effects of fiscal policy on interest rates and exchange rate management. The outcome of these policies displays conflicts that indicate a policy dilemma.

Several benefits accrue to a country with a floating exchange rate:

- It allows a continuous adjustment of the exchange rate in line with the demand and supply conditions of foreign exchange in the economy.
- It equilibrates the demand and supply of foreign exchange by changing the exchange rate rather than the level of reserves.
- It allows the country to pursue its own monetary policy without having to be overly concerned about the balance of payments effects.
- External shocks and imbalances are reflected in exchange rate movements rather than in reserve movements or Central Bank intervention to control the adjustment process.

These benefits have not been fully realized in Kenya, and this paper shows why this has been the case.

Policy dilemma

The primary focus of monetary and exchange rate policies over the period has shifted due to conflicting objectives and

problems facing the authorities with the presence of heavy capital inflows. The policy focus has been to keep reserve money on the targeted path while at the same time intervening in the foreign exchange market to minimize exchange rate movements. Intervention is through open market operations, which mop up excess liquidity injection in the economy. To make the commercial paper attractive, the rate of interest has to be high relative to other financial assets. This cushions domestic prices but the Treasury bill rate rises.

These policy choices have several effects, reflecting the policy conflict:

- The high interest rate regime, although an instrument to meet the goals of the monetary authorities, jeopardizes chances for an early economic recovery and over the years have discouraged investment necessary for future economic growth.
- Fiscal pressure influences the interest rate structure and hence monetary and exchange rate policies. Thus, the current interest rate structure is a result of the domestic debt problem in the country.
- The high interest rates on Treasury bills ensure that the domestic and foreign interest rate differential remains positive and thus has perpetuated the problem of speculative private capital flows.
- The sale of Treasury bills has increased government domestic debt. These bills are mostly short term (91 days) and are mainly held by the financial sector. Turning the financial sector to being driven by short-term lending is hardly conducive for financial sector development. Their default would trigger a banking crisis. In addition, they introduce rollover risks, thus compounding the domestic debt problem.

- The Treasury bill rate is not a good instrument of monetary policy, due to this short-term nature of the commercial paper and government debt. It is not flexible downward unless the exchange rate is allowed to depreciate.

How can exchange rate stability be achieved in the presence of volatile capital flows? And can there be a meaningful target on reserves with a floating exchange rate and an open capital account?

Conclusion and policy implications

It is shown that the interest rate differential will widen with real exchange rate appreciation, and this will trigger capital inflows. Domestic inflation will rise with exchange rate depreciation, and the influence of foreign inflation will decrease with exchange rate appreciation.

The policy lessons that come out from the analysis relate to the interest rate structure and the real exchange rate. It is argued that closing the gap in the real interest rate differential (that is, lowering the domestic interest rate) is consistent with depreciation of the exchange rate. That is, to come to a low interest rate regime, the authorities must be prepared to live with a relatively depreciated currency. Perhaps the optimal approach would be to limit intervention in the foreign exchange market and thus allow capital flows to be stabilized by the exchange rate movements in the medium to long term.

This is tantamount to arguing for a policy of doing nothing in the presence of short-term capital flows (that is, do not sterilize these flows), as this may be optimal. This is because Kenya has a floating exchange rate and an open capital account. Doing nothing will allow the exchange rate to determine the optimal flow of short-term capital and equilibrate the foreign exchange reserves.

Since the movement of short-term capital is either a reflection of agent perception of risk of domestic assets in the country or a stock adjustment reacting to changes in prices or shocks, or both, this is part of the arbitrage process and not a structural phenomenon—so effective policy intervention is likely to increase distortion.

These conclusions are supported by the recent decline in interest rate, especially in 1998 and 1999, when the Central Bank lowered the rate on Treasury bills without allowing the exchange rate to depreciate and when there was a recession in the economy. This situation was clearly unsustainable and the action inappropriate. The end result was a banking crisis and a depression in the capital market. If interest rates have to fall, the Central Bank has to be prepared to live with a relatively depreciated currency. For Kenya in its current economic environment, there are advantages of having a depreciated currency and a low interest rate. The economy could thus revive through private investment and exports.

1 Introduction

The liberalization experience in Kenya shows that domestic interest rates have remained high even when inflation has been low and declining. That is, the economy has been on a deflationary trend since 1994, save for a few blips in 1997, and the exchange rate has been volatile. The paper analyses the relationship between real exchange rate movements and the real interest rate differential and their implications for short-term (speculative) private capital flows. In view of the fact that foreign exchange and financial markets were liberalized in the 1990s, the paper assesses the liberalization experience and draws policy lessons from it.

In this liberalization period, Kenya has experienced short-run capital flows responding to an interest rate differential. These capital flows are essentially portfolio flows for speculation. In this period, conflicting goals and objectives in managing the exchange rate have brought the authorities a policy dilemma. It relates to targeting both a competitive exchange rate and low inflation in a floating exchange rate regime. To pursue these goals, the authorities have intervened occasionally in the foreign exchange market to stabilize (and sometimes defend) the nominal exchange rate in the face of volatile capital flows. Then they have to follow this action by sterilizing these capital flows in the money market, thereby raising the domestic interest rates. The result has been that the exchange rate has been stabilized in the short run but at the cost of high interest rates, which jeopardize the goal of increased domestic investment and economic recovery.

The liberalization experience with a floating exchange rate and liberalized interest rates has not so far been documented or assessed. The aim of this paper, therefore, is to shed light on the policy choice by analysing the link between the real exchange rate and the real interest rate differential. One of the

implications of this analysis is the effect that short-term private capital flows have on these variables. Since capital movements are a reflection of stock adjustment or an arbitrage process, we are not attempting a structural model here. On the other hand, domestic interest rates have been pushed by the presence of a large and growing domestic debt. Thus the targets are a competitive exchange rate and low inflation—and only one instrument, the rate of interest, that is affected by domestic debt. Current fiscal adjustment has failed.

The sample is drawn from monthly data from 1990 to 1997. This period has been characterized by economic reforms, which cover

- financial market liberalization
- external trade liberalization
- foreign exchange market liberalization
- domestic price decontrols
- capital account liberalization
- domestic marketing liberalization

Thus, economic reform policies bear on the foreign exchange market, the exchange rate, inflation and interest rates. However, because the sample span is small and available data in the required frequencies are scant, there are limitations in the assessment and the extent to which we can utilize empirical techniques. Analysis of the relationship between the real exchange rate and the real interest rate follows traditional models, in which deviations of purchasing power parity from its true long-run value are reflected by an interest rate differential. We ask several questions in this approach:

- Is there a systematic relationship between real exchange rate and real interest rate differential?
- What empirical lessons can be learned and what empirical representation does the data support?
- Do these results explain the instability of the exchange rate in this period?

First, we specify the theoretical relationship between the real exchange rate and the real interest rate differential. This relationship can be rationalized on the basis that unanticipated money disturbances are likely to affect both the real interest rate differential and the exchange rate, and there is likely to be a strong relationship between them (Obstfeld and Rogoff 1996).

The subsections immediately following provide background to the study and the liberalization and economic management issues. Section 2 provides the analytical methodology and section 3 provides the empirical results. The conclusion in section 4 summarizes the policy lessons and options.

1.1 Liberalization policies

Since 1990, several economic reform measures have been actively implemented. First, interest rates were liberalized in 1990. Then in mid-1992, foreign exchange bearer certificates were introduced,[1] which provided a significant relief to the foreign exchange market since possession of these entitled the bearer to some amount of foreign exchange without the long delay of going through the foreign exchange licensing process.[2] Thus the device effectively meant that Kenya had an official dual exchange rate. Furthermore, exporters were allowed to

[1] Foreign exchange bearer certificates (Forex-Cs) were purchased at the official exchange rate from the Central Bank of Kenya, in foreign exchange on a 'no questions asked' basis. The certificate, which bore an interest rate, was then as marketable as any other paper asset.

[2] The bearer of Forex-C applied for a licence under 'No Foreign Exchange Required' and was processed virtually immediately. The bearer then purchased foreign exchange from the Central Bank at the official exchange rate.

retain specified proportions of their foreign exchange earnings,[3] and all importers were required to purchase their foreign exchange requirements from the commercial banks following the suspension of trading in Forex-Cs in January 1993.

As liberalization of the foreign exchange market continued, there were few barriers. For example, by March 1993, speculation in foreign exchange was rife. Kenya was in serious danger of flight from the shilling, and increasingly prices were being quoted in dollars. Those who were importing on trade credit were uncertain as to what price they would have to pay for foreign exchange when their letters of credit were called;[4] hence they were writing the expected foreign exchange redemption into their price structure. Increased domestic currency was circulating in the economy, partly due to Treasury financing its deficit domestically since foreign funds were not available, while seasonal increases in cash, which coincided with the 1992 elections, put yet more pressure on domestic prices. In addition, the drought of 1990/91 continued into 1993, which meant that food prices[5] continued to rise while large amounts of foreign exchange were required for food imports. Furthermore, there were financial scams (involving a few

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[3] Initially, in June 1992, non-traditional exporters could retain 100%; from February 1993 all importers could retain 50% of export proceeds in foreign exchange.

[4] The official exchange rate was devalued by 25% on 9 March 1993, 31% on 20 April and 6% on 6 May 1993.

[5] Food prices account for almost 40% of the weighted Nairobi consumer price index, which is conventionally used to measure inflation. They had more than doubled in 1992/93. The price of maize, the main foodstuff, was controlled until the end of 1993. Its price was subject to periodic revision, the largest of which was a 93% rise in June 1992 to remove the subsidy that farmers had been compelled to give to urban dwellers.

banks) that contributed to increased money supply in the economy and that led to the collapse of these banks.

Towards the end of March 1993 price instability had got to such state that all financial liberalization measures were supposed to stop to allow time for a more orderly process to be worked out. The new process included stepping up weekly Treasury bill auctions from Ksh 1 billion to Ksh 5 billion. This was associated with a rapid rise in the Treasury bill discount rate which is viewed as a benchmark for all interest rates. A consequence of this was that the difference between Kenyan and foreign interest rates widened—a sure recipe for speculative capital to flow in.

In April 1993, both import and foreign exchange licensing was eliminated and 100% retention accounts were established. Thus both the supply and the demand for foreign exchange in the trade account should have become market driven. Initially, in part due to the backlog of demand and expectations that there would be backtracking on the policy, the exchange rate depreciated far faster than the gradual devaluation on the official rate.[6] Data suggest that the interest rate differential, the exchange rate expectations, forecasts on inflation and the general stability were such that holders of foreign exchange abroad took advantage of the liberalized regime to profit by bringing funds back[7], converting them to shillings and benefiting from the high Treasury bill rate. The market exchange rate overshot as was often predicted in theory since

[6] After a delay, the rate was incrementally devalued until 19 October 1993 when the official rate was abolished and merged with the market rate.

[7] This capital inflow, which in many ways appears similar to that which created problems through currency appreciation in South America, was not as destabilizing as it was there, probably because it was not free 'hot money' since it had not left the country following the narrowing of the interest rate differential.

first, inflation responded to the drying up of liquidity then, as real returns on Treasury bills grew excessive, the interest rate started to track inflation down. But interest rates still remained high enough to encourage and ensure an inflow of speculative short-term capital.

The whole period is characterized by a shift in attention away from the real economy to one in which trade in financial assets predominates. With rates on secure government paper earning excess premium per annum, lending for investment or the purchase of inputs from abroad must have been seen as unattractive. Exporters were benefiting from devaluation while the depressed demand for imports, which are fundamental for a resource-poor country like Kenya, was dampening growth in other sectors.[8] Furthermore, the government budget was being tightly controlled. The environment was made all the more difficult because of the massive burden, both from the Treasury bill rate and from the large stock of domestic debt together with the more expensive service costs on foreign debt. This combination of factors strengthened fears of policy reversal and exacerbated coordination problems in the economy. The situation has compounded the problem of fiscal management and militated against fiscal adjustment.

The Treasury's concern to help the Central Bank control the supply of money made it imperative that it should re-establish the credibility of its macroeconomic program to be able to replace high-cost domestic borrowing with concessionary program funds from abroad. These funds would, of course, dampen the pressure on the exchange rate. As a sign of

[8] GDP grew by 0.2% in 1993; the monetary economy registered no growth. Formation of private gross fixed capital was static during the same period. It was only in 1995 that positive and significant growth of 4.8% was recorded. The decline in growth has been quite significant: in 1996 it stood at 4.6%, came down to 2.4% in 1997, further down to 1.8% in 1998.

commitment to this most difficult program,[9] government spending was severely curtailed as a matter of policy target (although the curtailment has been difficult to maintain).

By November 1993, not only had the government abolished the official exchange rate but in further liberalization that allowed citizens to hold foreign exchange, it had gone so far as to reassure traders of commitment to a more market-driven policy. Other measures included

- Capital controls: offshore borrowing by residents was allowed in February 1994 but was still subject to quantitative limits. Complete liberalization of offshore borrowing was implemented in May 1994. The remaining restrictions on inward portfolio investment were lifted in January 1995.
- Foreign investors were allowed to participate in the stock market under guided policy in January 1995.
- Non-bank financial institutions were required to transform themselves to banks, and by 1995 they were also subject to the statutory cash ratio.

All these measures ensured that a liberalized environment ensued. We can thus look at the indicators and ask whether they conform to the expectations.

1.2 The liberalization process in Kenya: a period of policy dilemma

As the process of liberalization continued, the financial market showed short-run fluctuations, due largely to the volatility of the foreign exchange flows. The primary focus of the monetary and exchange rate policies shifted because the presence of

[9] The difficulties are political as much as economic since the program means continuing deflationary policies in the face of falling real incomes and unemployment, including retrenchment of civil servants.

heavy capital inflows faced the authorities with conflicting objectives and problems. By 1994, the policy focus was to keep reserve money on the targeted path while at the same time intervening in the foreign exchange market to minimize the appreciation of the exchange rate. However, interventions in the foreign exchange market led to an increased money supply. This in return needed to be sterilized through the sale of Treasury bills, through open market operations. To make the commercial paper attractive, the rate of interest had to be high relative to other financial assets. This would cushion domestic prices but also meant that the Treasury bill rate had to rise. Several effects emanated from these policy actions:

- The high interest rates, although an instrument to meet the goals of the monetary authorities, jeopardized chances of economic recovery and discouraged investment necessary for future economic growth.
- The high interest rate on Treasury bills ensured that the domestic and foreign interest rate differential would remain positive, and thus it has perpetuated the problem of speculative private capital flows.
- The sale of Treasury bills in the sterilization process has increased government domestic debt. These short-term (91-day) bills have been held mainly by the financial sector. Driving the financial sector by short-term lending is hardly conducive for developing it.

Treasury bill rate is not a good instrument of monetary policy. It cannot be very flexible downward because of the short-term nature of the commercial paper and government debt.

The authorities realized that high interest rates were counterproductive, and thus from 1994 they adopted a policy aimed at bringing the interest rates down. This was difficult, because lowering the interest rate (with short-term bills) led to massive redemption of the Treasury bills and substantial outflows of capital. This showed that short-term capital inflows

were 'hot money', taking advantage of the high domestic interest rate and subject to abrupt reversal. These outflows of capital put the exchange rate under pressure to depreciate. In response, the authorities decided to defend the shilling by drawing down the stock of international reserves. Such a step led to the reserves being depleted to critically low levels, and the policy was not sustainable. Thus at this stage, the unfolding policy dilemma acquired a third dimension— low levels of international reserves in addition to a volatile exchange rate and high interest rates.

To reverse the trend, protect the level of international reserves and stabilize the exchange rate, the authorities resorted to monetary measures including subjecting the non-bank financial institutions to a cash ratio just like the banks, discouraging the discount window at the Central Bank through high and punitive interest rates, and raising the rate of the short-term Treasury bills. These measures stabilized the exchange rate and helped build foreign exchange reserves. But the interest rates were much higher, and so the old problem reappeared. That is, how can economic recovery take place in an environment of high interest rates? Thus a policy dilemma has emerged:

- How can exchange rate stability be achieved in the presence of volatile capital flows?
- Is it possible to maintain a competitive exchange rate, a stable nominal exchange rate and low inflation in a floating exchange rate policy?

Effecting economic recovery through lower interest rates and at the same time maintaining macroeconomic stability through high interest rates and keeping a competitive exchange rate as a target would require accepting relatively large exchange rate fluctuations. This has been considered less feasible as it would introduce wide instability in the economy.

Given these policy dilemmas, it becomes crucial to understand the link between exchange rate and interest rates. We ask

whether changes in the real interest rates, domestic and foreign, are important in explaining real exchange rate movements. In this paper, we empirically test this relationship on Kenyan data to uncover the relationship between real exchange rate and real interest rate differential.

The authorities have been overly concerned with movements of the nominal exchange rate in the face of volatile capital flows. Capital flows are a reflection of stock adjustment, reacting either to changes in asset prices or to shocks or to both, which is essentially part of the arbitrage process (see Goldstein et al. 1991). Furthermore, capital flows to or from a particular country represent the market-based response of the private sectors to improvements or worsening in the risk profiles of domestic assets (Asea and Reinhart 1996).

But the reaction in Kenya has been to intervene in the foreign exchange market and thus defend the shilling from this pressure. Viewed in the wider goal of maintaining a competitive exchange rate and low inflation, this shows a cycle of intervention and sterilization. In the process, interest rates have increased and remain at high levels. But the overriding objective in economic management has been to stimulate economic recovery and increase the investment response—difficult to manage with high interest rates. Thus the intermediate targets have been adversely affected, as has attainment of the long-term objectives of stimulating growth, creating employment and reducing poverty.

The experience of the macro variables is summarized in figures 1 and 2. They show the movements of inflation, money supply, real exchange rate, capital flows and interest rates. They collectively show a period of turbulence consistent with the policy dilemma argued earlier. First, the nominal exchange rate depreciates with a lower interest rate. It stood at Ksh 44.47 to the dollar with the interest rate around 11.8% in 1995 but

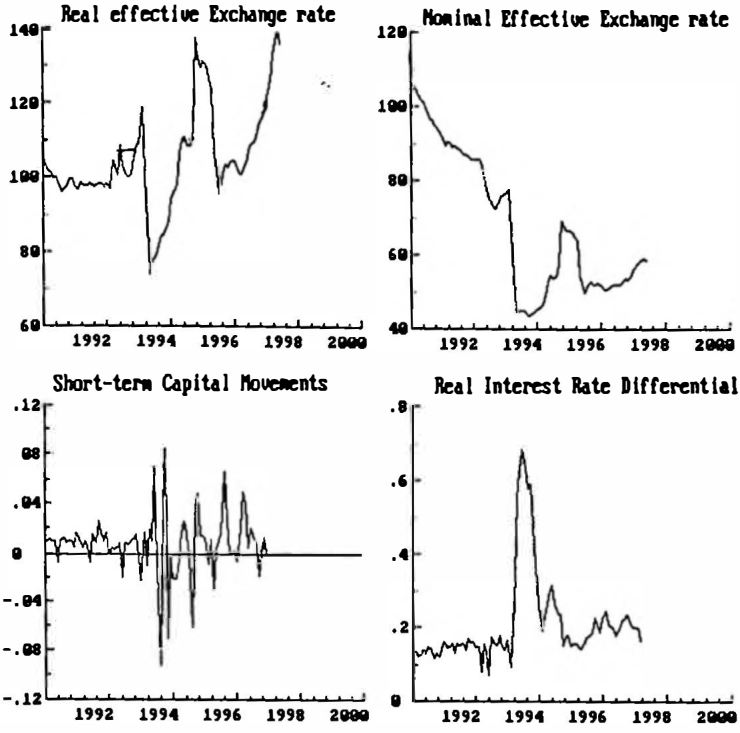

Figure 1. Real and nominal effective exchange rates, short-term capital flows and real interest rate differential.

depreciated to over Ksh 70.00 when the interest rate declined to below 10% in 1999.

Second, the value of the Treasury bills rose from Ksh 85.89 billion in January 1995 to Ksh 115.90 billion in May 1999. Third, domestic debt rose from Ksh 115.14 billion in the 1995/96 fiscal year to Ksh 156.37 billion in the September 1999/2000 fiscal year. Treasury bills represent the bulk of domestic debt, which directly affects the domestic interest rate structure and thus militates against effective monetary policy. The interest structure is thus a reflection of fiscal management and in the pressure from short-term capital movements. The profile of these variables between 1995 and 1999 is shown in

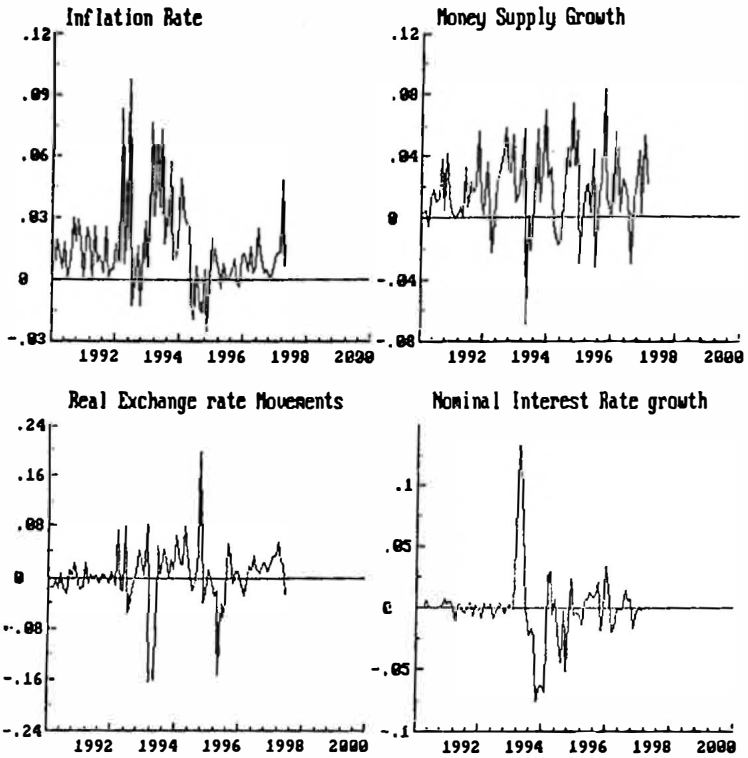

Figure 2. Inflation, real exchange rate, money and nominal interest rate movements.

figure 3. In addition, gross reserves held at the Central Bank rose from Ksh 26.13 billion in January 1995 to Ksh 42.06 billion in May 1999.

2 The analytical framework

2.1 Real exchange rate and real interest rate differential

The liberalization process in the 1990s implies that, to formulate effective policies, we need to understand what explains the exchange rate movements in Kenya in this period. A crucial issue for policy-makers is how to manage the

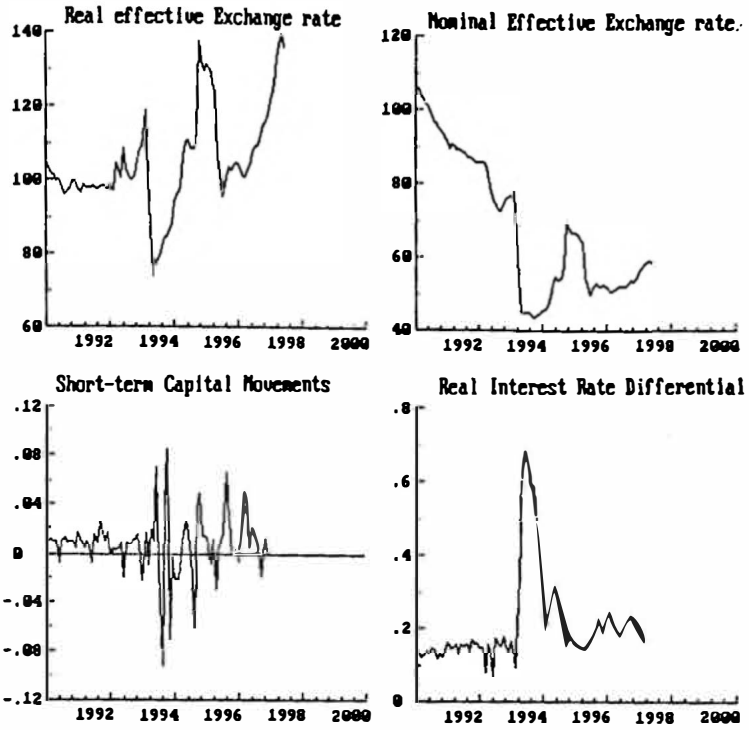

Figure 3. Real and nominal effective exchange rates, short-term capital flows and real interest rate differential.

exchange rate and conduct monetary policy in an environment in which capital (portfolio) flows are volatile.

Here, we propose to add to this understanding by first formulating and estimating an error correction of the relationship between real exchange rate and real interest rate differential in both a static model and a model with time-varying parameters. In the analysis, exchange rate movements are explained by the real interest rate differential. A variant of this study is by Asea and Reinhart (1996), who use trend-cycle decomposition and impulse response functions to investigate the relationship between interest rates and the real exchange rate for a number of African countries. Here we differ by recovering and

estimating a structural relationship between the real exchange rate and the real interest rate differential. By analysing this relationship only, however, we do not exclude the effects of other macroeconomic variables, because we believe that other indirect effects enter the relationship:

- Capital flows have put pressure on the real exchange rate and thus give reason for the authorities to intervene. Thus, the observed real exchange rate has accumulated policy actions from intervention as well as pressure from capital flows.
- Capital flows have been shown to respond to the interest rate differential. The policy response of intervening and sterilizing the effects on the exchange rate and domestic money supply amounts to treating the symptoms rather than curing the disease. It thus perpetuated the inflows during the period of study, as is shown by the instability of the exchange rate.
- The domestic money supply reflects both fiscal policy action aimed at low inflation and sterilization in the foreign exchange market. Thus, the observed rate of domestic interest reflects an accumulation of short-term domestic debt (fiscal pressure) and monetary (and fiscal) policy action.

The observed relationship between exchange rate movements and the real interest rate differential indirectly captures the policy action and thus the policy dilemma, as argued in the preceding section. Deviating from Asea and Reinhart (1996), we shall estimate an error-correction formulation of this relationship. In this way we can disentangle the long-run relationship and account for the short-run responses. The main question is: What aspects does this analytical formulation deal with? In reflecting on this, the model uses the real interest rate differential to explain the deviation from the approximation of the purchasing power parity. we feel that this is plausible in view of the implicit influences taken into account, like short-

term capital movements, policy response and monetary policy. This assumption helps in drawing out policy implications and lessons that can be learned.

2.2 The empirical model

In the simplest version of the Dornbusch model (1988), where there are only permanent unanticipated changes in the level of money supply, lower nominal interest rates are associated with depreciation. In flexible-price models, shocks to the growth rate of the money supply will lead to the opposite correlation, and increases in the nominal interest rate are associated with currency depreciation. Thus, money supply shocks are differentiated from money supply growth shocks. Unlike the money supply-level shocks, money growth rate shocks lead to a positive correlation between nominal interest rates and exchange rates in the Dornbusch model. Although the correlation between nominal exchange rates and interest rates is ambiguous when money shocks are dominant, the Dornbusch model does offer a strong, clear prediction about the correlation between real exchange rates and real interest rates when the long-run real exchange rate is constant.[10]

In the formulation proposed in this paper, we do not need to have either money or domestic output because these correlations are embodied in the price-level adjustment mechanism (see Obstfeld and Rogoff 1996, pp. 612).

$$P_{t+1} - P_t = \psi(Y_t^d - \overline{\overline{Y}}) + S_{t+1} - S_t \qquad (1)$$

where P is the price level
Y^d is the output level, which is demand determined

[10] In the short sample we are dealing with, we make the assumption that there is a long-run real exchange rate that the authorities target implicitly. This assumption is because the policy focus has been to maintain a competitive exchange rate that supports the export sector.

Y-bar is the level of output equivalent to its natural rate
S_t is the nominal exchange rate.

Thus the term in the brackets reflects the effect of Keynesian excess demand on domestic prices. Equation (1) shows that prices adjust slowly in response to excess demand. Consequently, monetary disturbances that have been less than perfectly anticipated can cause temporary deviations in the real exchange rate from its long-run equilibrium. We assume that the long-run exchange rate is governed by a purchasing power parity condition but that it does not hold continuously—and that these deviations can be captured by the real interest rate differential[11] (see Macdonald and Nagayasu 1997). These deviations also reflect the underlying real variables that keep the real exchange rate from the level determined by purchasing power parity. The long-run exchange rate is expressed as:

$$\overline{\overline{S_t}} = P_t - P_t^f \qquad (2)$$

where S_t-bar is the long-run real exchange rate
P is the domestic price level and P^f is the foreign price level.

We assume that the expected change in the nominal exchange rate is governed by:

$$E_t (S_{t+k} - S_t) = -\Phi(S_t - \overline{\overline{S_t}}) + E_t\Delta P_t - E_t\Delta P_t^f \qquad (3)$$

where E_t is the expectations operator conditional on the information available at period t.

The uncovered interest parity condition is assumed to hold:

$$E_t S_{t+k} - S_t = i_t - i_t^f \qquad (4)$$

[11] The original formulation of the real interest rate differential model required that the long-run exchange rate be determined by the purchasing power parity relation. We follow Macdonald and Nagayasu (1997) in assuming that deviation from the preferred equilibrium relationship for a short sample is governed by interest rate differential.

where i_t is the domestic interest rate and i_t^f the foreign interest rates. Equations (2) to (4) can be solved to obtain:

$$S_t = P_t - P_t^f - \Phi^{-1}[(i - E_t\Delta P_{t+k}) - (i_t^f - E_t\Delta P_{t+k}^f)] \quad (5)$$

which summarizes the fact that an exchange rate will be above or below its long-run level by a proportion due to the real interest rate differential (see Macdonald and Nagayasu 1997). This equation forms the basis of investigation in this paper.

The empirical implementation follows two stages. First, an error correction form is postulated and then the model is reformulated in a form with parameters modified for the error correction term and in an autoregressive form of order k. This large statistical model with too many parameters is estimated and reduced until a preferred parsimonious model is obtained. Second, we re-estimate the model in a state-space form, using a method that estimates time-varying parameters. This requires formulating a measurement equation and a transition equation. Here we use the Kalman filter, which uses all the available information in a manner related to Bayesian learning and can be considered the empirical counterpart to rational expectations (see Cuthbertson et al. 1992). From equation (5), we assume that we have a measurement equation that we can now summarize as:

$$S_t = \beta_t X_t + \epsilon_t \quad (5')$$

where $X_t = \{ P, P^f, RID \}$ and that $\epsilon_t \sim (0, \nu_t)$.

We assume that we cannot observe values of β_t but that they can be generated by a transition equation of the form

$$\beta_t = T_t\beta_{t-1} + R_t\eta_t \quad (6)$$

where $\eta \sim (0, \Omega_t)$ and T_t and R_t are known matrices. Equations (5') and (6) comprise a state-space representation, which we will compare with the results of the static parameter estimates.

3 Empirical results

3.1 The data

We start the empirical results by providing unit root tests of the variables in the analysis, shown in table 1. Several unit root tests are used because we are dealing with high-frequency data that are extremely noisy due to shocks and regime shifts, and some tests like those in the Dickey-Fuller (DF) class have low power. Tests used are the Dickey-Fuller, the Phillips-Perron and the weighted symmetric. We see that all the variables are non-stationary and thus require differencing to make them stationary. But before this is done, we test for cointegration to incorporate long-run information from the variables in the model.

Table 1. Unit root tests

Test / variable	RER	S	TDR	RID	I	P	P^f
WS	–2.83	–1.90	–2.3	–2.00	–1.10	–0.50	0.94
P-values	0.134	0.714	0.44	0.68	0.97	0.99	0.98
DF	–2.74	–1.72	–2.1	–2.20	–1.80	–0.80	–0.80
P-values	0.222	0.74	0.56	0.48	0.71	0.97	0.96
PP	–13.00	–6.17	–9.5	–8.30	–2.30	–1.30	–16.00
P-values	0.264	0.732	0.45	0.40	0.96	0.99	0.15

RER – real exchange rate; S – nominal exchange rate; TDR – Treasury discount rate; RID – real interest rate differential; I – foreign interest rate, P – domestic price level; P^f – foreign price level; WS – weighted symmetric test; DF – Dickey-Fuller test; PP – Phillips-Perron test

3.2 The exchange rate and real interest rate differential

Once the characteristics of the data are established, the next step is to analyse cointegration relationships between the

nominal exchange rate, domestic and foreign prices, and the real interest rate differential. The results show a cointegrating vector (the error correction mechanism term, ECM_t) of the form

$$ECM_t = S_t + 0.495\ P_t + 0.241\ P_t^f - 0.8395\ RJD_t\ -6.12$$

which was found to be stationary and shows that these variables cointegrate. This is consistent with the arguments presented above that the purchasing power parity may not hold at all times and may thus require the real interest rate differential to stabilize the vector; that is, deviations from the purchasing power parity are absorbed by real interest rate differentials. Thus in equation (5) the parameters were reset with this cointegrating vector and the variables in first difference; then it was estimated with six lags of each variable and the ECM lagged one step. In addition, dummies were set to reflect interventions or shocks in the foreign exchange market. These were identified as influential points (outliers) after recursive estimation showed instabilities in the regression coefficients. These are shown as dummies (D) in table 2 and are motivated along the lines of events in 1993, 1994, 1995 and 1996. The preferred model is shown in the appendix together with the state-space estimation results. The two sets of results do not significantly deviate from each other, which shows that we have been successful in estimating a model that tentatively reflects the data used. The preferred model is solved and is shown in table 2.

The results in table 2 show that we have managed to estimate and solve for the relationship between the real exchange rate and the real interest rate differential. The results show that, first, the interest rate differential increases as the real exchange rate appreciates. This is consistent with the arguments above that when the local currency starts sliding, capital flows in to take advantage of the weak shilling. Because interest rates are high, any further intervention to cushion domestic prices from

Table 2. The exchange rate–real interest rate differential: solved regression results

Variable	Coefficient	Standard error	*t*–ratio
Constant	0.001	0.006	0.158
ΔRID_t	–0.592	0.1356	–4.37
ΔP_t	–0.6101	0.2779	–2.20
ΔP_t^f	1.308	1.033	1.27
ECM_{t-1}	–0.1836	0.1006	–1.83
D933	–0.1485	0.04901	–3.03
D9410	0.1368	0.03374	4.05
D955	–0.1896	0.04672	–4.06
D9612	0.06962	0.03293	2.11

RID_t – real interest rate differential (t is time); P_t – price level; P_t^f – foreign price level; ECM_{t-1} – a lagged error correction term as defined by the cointegrating vector; D_i – a dummy showing the year and month of the shock it represents; Δ indicates the first-difference operator.

Wald test χ^2 (8) 75.675 [.0000]**

this liquidity injection must raise the domestic interest rate to make the government commercial paper more attractive to hold. This is consistent with the argument above that stabilization of the exchange rate will require high interest rates. But this perpetuates the problem of capital flows.

Second, inflation will increase with depreciation of the real exchange rate, and this is consistent with the theoretical prediction. Third, the impact of foreign inflation on domestic prices decreases with real exchange rate appreciation, which again is consistent with expectations. Fourth, long-run movements of the real exchange rate, if out of line with the postulated variables, will contribute to an appreciated real exchange rate. This is the cointegrating vector, which shows that the purchasing power parity relationship will hold only when the real interest rate differential is taken into account. The

speed of the adjustment process is low; 18.4% of the disequilibrium from the previous period will be transmitted to appreciate the real exchange rate in the current period. Finally, interventions in the market have served to stimulate further depreciation or appreciation of the real exchange rate movements. This is consistent with the dummies in the model.

What, then, do we learn from these results?

- Interest rate as an instrument of achieving both stability of the exchange rate and low inflation is clearly inadequate.
- Changes in the real interest rate differential and inflation drives real exchange rate movements.
- A highly positive real interest rate differential will trigger capital inflow, which will affect the exchange rate and the money market both directly and indirectly through dynamic interactions. In a floating exchange rate regime, the nominal exchange rate is an indirect tool of monetary policy.

4 Conclusion and policy implications

This paper analyses the relationship between real exchange rate movements and the real interest rate differential. Its main objective in doing this is to argue the case for non-intervention in the foreign exchange market to sterilize short-term capital flows. Non-intervention would minimize the effects on the domestic interest rate and hence the exchange rate. we have analysed the relationship in two stages. First, the nominal exchange rate is analysed as deviating from the perceived long-run equilibrium level, determined by the purchasing power parity relationship. These deviations are governed by the interest rate differential. The results show that an error-correction formulation is an adequate representation of this relationship. Adverse shocks and administrative events are

modelled as well, using dummies. Next, the model is re-estimated in a technique using time-varying parameters (the Kalman filter) and without dummies. The results mimic those arrived at earlier. Some variables are no longer significant, but the direction of causation is not affected. This confirmation of my hypothesis allows us to move further and interpret the results. We argue that the interest rate differential will widen with appreciation in the real exchange rate and this will trigger capital inflow. Next, domestic inflation will rise as the real exchange rate depreciates, and the influence of foreign inflation will decrease as the exchange rate appreciates.

These results mimic the postulated long-run relationships, and the modelled short-run single shocks, depending on the type of shock, are found to influence real exchange rate movements. Thus, liberalizing foreign exchange transactions in 1993 and adopting the interbank market exchange rate with a parallel official exchange rate had the effect of depreciating the exchange rate substantially. Similarly, the 1995 expectations of the aid freeze led to a depreciated real exchange rate. The other outliers (dummies) for 1994 and 1996 appreciate the exchange rate and are perhaps consistent with interventions in the market.

These conclusions support the recent declines in interest rate, so that if interest rates are to fall, the Central Bank must be prepared to live with a relatively depreciated currency. To advise policy in Kenya's current economic environment, we should investigate and document the advantages of having a depreciated currency and low interest rate. Two important derivatives for such a policy are to stimulate export growth and stimulate private investments. These are necessary to revive and sustain growth in the economy.

The policy lessons that emerge from the analysis relate to the interest rate structure and the real exchange rate. The results of the analysis show that the two variables absorb the effects of

shocks from each. Interventions to stem adverse movements in the nominal exchange rate will lead to high interest rates. Closing the gap in the real interest rate differential (that is lowering the domestic interest rate) will be consistent with depreciating the exchange rate.

Perhaps the optimal approach is to limit intervention in the foreign exchange market and thus allow exchange rate movements to stabilize capital flows in the medium to long term. This will remove the effects of intervention on the interest rate structure. This is tantamount to arguing that the optimal policy in the presence of short-term capital flows is to do nothing. As Kenya has a floating exchange rate and an open capital account, doing nothing will allow the exchange rate to equilibrate reserves and determine the optimal flow of short-term capital.

Movements of short-term capital may reflect agent risk perception of domestic assets in the country or stock adjustment reacting to changes in prices or shocks, or both. As such adjustment is part of the arbitrage process and not a structural phenomenon, policy intervention is likely to increase distortion rather than lead to an improved outcome.

Appendix

Preferred model results

	Preferred model with dummies		State-space estimation results	
Variable	Coefficient	*t*–value	Coefficient	*t*–value
Constant	0.0006	0.157	0.0073	1.21
ΔS_{t-1}	0.471	6.13	0.527	4.44
ΔS_{t-3}	–0.182	–2.30	–0.105	–0.827
ΔS_{t-4}	0.140	1.74	0.229	1.86
ΔS_{t-5}	–0.142	–2.15	–0.054	0.536
Δ RID	–0.761	–7.58	–0.935	–6.02
ΔRID_{t-1}	0.654	5.19	0.855	9.37
ΔRID_{t-2}	–0.232	–1.85	–0.342	–1.85
ΔRID_{t-3}	0.200	1.55	0.408	1.97
ΔRID_{t-4}	–0.283	–3.18	–0.170	–1.24
ΔP^f_{t-2}	0.895	2.01	0.673	0.95
ΔP^f_{t-3}	–0.975	–2.19	–0.653	–0.94
ΔP^f_{t-5}	1.013	2.31	0.224	1.15
ΔP_t	–0.632	–4.16	–0.914	–3.75
ΔP_{t-1}	1.04	4.34	1.18	3.11
ΔP_{t-2}	–0.904	–3.78	–1.16	–3.047
ΔP_{t-3}	0.464	1.82	0.708	1.74
ΔP_{t-4}	–0.403	–1.72	–0.592	–1.58
ECM_{t-1}	–0.131	–2.61	0.291	–3.68
D933	–0.106	–4.58	—	—
D9410	0.098	5.93	—	—
D955	–0.135	–6.36	—	—
D9612	0.050	2.40	—	—

R^2 = 0.883978 F(22, 56) = 19.394 [0.00] σ = 0.01997 DW = 1.94
RSS = 0.022338 for 23 variables and 79 observations
Diagnostic tests:
AR 1- 6F(6, 50) = 1.2768 [0.2849] ARCH 6 F(6, 44) = 1.0053 [0.4342]
Normality $chi^2(2)$= 5.7861 [0.0554] Xi^2 F(40, 15) = 0.35182 [0.9957]
RESET F(1, 55) = 5.3402 [0.0246]*, where St – nominal exchange rate; RIDt – real interest rate differential (t is time); Pt – price level; Ptf – foreign price level; ECMt–1 – a lagged error correction term as defined by the cointegrating vector; Di – a dummy showing the year and month of the shock it represents; Δ indicates the first-difference operator

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