

Liberalization of the foreign exchange market in Kenya and the short-term capital flows problem

By

Njuguna S. Ndung'u
Economics Department
University of Nairobi, Kenya

AERC Research Paper 109
African Economic Research Consortium, Nairobi
July 2001

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Published by: The African Economic Research Consortium
P.O. Box 62882
Nairobi, Kenya

Printed by: The Regal Press Kenya, Ltd.
P.O. Box 46116
Nairobi, Kenya

ISBN 9966-944-48-6

Table of contents

List of tables

List of figures

Abstract

1.	Introduction	1
2.	The analytical framework	8
3.	Empirical results	15
4.	Conclusion	20
	Notes	22
	References	24
	Appendices	25
A.	The preferred model results	25
B.	Variance decomposition of key endogenous variables	26

List of tables

1.	Unit root tests	15
2.	The real exchange rate movements (ΔS): Regression results	16
3.	Dynamic analysis results	18

List of figures

1.	History of inflation rate, money supply growth, real exchange rate movements and nominal interest rate growth in Kenya (1992–2000)	7
2.	History of exchange rates, capital movements and real interest rate differentials in Kenya (1992–2000)	7
3.	Dynamic analysis results	19

Abstract

The paper analyses the relationship between real exchange rate movements and real interest rate differential on the one hand, and the impact of short-term (speculative) private capital flows and domestic and external shocks on the real exchange rate on the other. This has been analysed in two stages. First, it is expected that a purchasing power parity cannot hold and so the nominal exchange rate is shown to deviate from the perceived long-run equilibrium level determined by the purchasing power parity relationship and these deviations are governed by interest rate differential. It is shown that domestic inflation will rise with a real exchange rate depreciation and that the influence of foreign inflation will decrease with exchange rate appreciation.

In the second stage of the analysis, a vector autoregressive (VAR) model is estimated with private short-term capital flows entering the model in levels and in their volatility form. The results confirm that domestic as well external shocks influence the movements of real exchange rate and real interest rate differential, thereby directly affecting or triggering capital flows.

The policy lessons relate to the interest rate structure and the effects on the real exchange rate. Interventions to stem adverse movements in the nominal exchange rate seem to lead to high interest rates. This is one of the aspects of policy dilemma argued in the paper. 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. Perhaps the optimal approach is 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 will remove the effects on the interest rate structure.

Acknowledgements

I wish to thank, with the usual disclaimer, the participants and resource persons of AERC biannual workshops and one anonymous referee for comments on the drafts of this paper. They have helped a great deal to shape the paper.

1. Introduction

The liberalization experience in Kenya during the 1990s shows that domestic interest rates have remained high even when inflation has been low and stable and the exchange rate has been volatile. This paper analyses the relationship between real exchange rate movements and the real interest rate differential on the one hand and the impact of short-term (speculative) private capital inflows, money supply and fiscal deficit on the real exchange rate, on the other.

One phenomenon that has arisen in this liberalization period is that of short-run speculative capital flows responding to interest rate differentials. These capital flows are essentially portfolio flows for speculative purposes. They have presented the authorities with a policy dilemma rooted in conflicting goals and objectives for exchange rate management and accompanying policies. The policy dilemma relates to the targeting of a competitive exchange rate and low inflation in a floating exchange rate regime. To pursue these goals, the authorities have at times intervened in the foreign exchange market to stabilize (and sometimes defend) the nominal exchange rate in the face of volatile capital flows and then have had to follow this action with sterilization of these capital flows in the money market, thereby raising the domestic interest rates. These measures have stabilized the exchange rate in the short run, but at high interest rates, thus jeopardizing the goal of increased domestic investments and economic recovery.

The liberalization experience with a floating exchange rate and liberalized interest rates has not so far been documented or assessed. The paper therefore attempts to shed light on the policy choice by analysing the link between the real exchange rate and the real interest rate differential. This is the focus of the first part of the paper. The second part of the paper analyses a broad spectrum of variables in an attempt to show their relative contribution to real exchange rate movements in this period and thus assess the experience of liberalization of the foreign exchange market in Kenya. One of the variables is private capital flows. Since capital movements are a reflection of stock adjustment or an arbitrage process, a structural model is not attempted here. Rather, the analysis is conducted using conditional volatility of private short-term capital flows. We test whether the stochastic volatility of capital flows drives the real exchange rate and how long these effects may last, besides documenting the effects of other variables on the real effective exchange rate.

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

- Financial market liberalization
- External trade liberalization

- Foreign exchange market liberalization
- Domestic price decontrols
- Capital account liberalization
- Domestic marketing liberalization

Thus, economic reform policies in this period exhibit some bearing in the foreign exchange market, the exchange rate, inflation and interest rates. However, due to the sample span and data availability (in the required frequencies), there are limitations in the assessment and the extent to which empirical techniques can be used. The paper proposes to first analyse the relationship between the real exchange rate and the real interest rate following the traditional models and where the deviation of the purchasing power parity relationship from its true long-run value is reflected by interest rate differential. Several questions are asked 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 do the data support?
- Have volatilities in private capital flows influenced the movements in the real exchange rate? Do they have a permanent effect on the real exchange rate or are they transitory?
- Do these results explain the instability of the exchange rate in this period?

We start with the 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 real interest rate differential and the exchange rate and there is likely to be a strong relationship between them (Meese and Rogoff, 1988). We then proceed to incorporate the effects of private capital flows and other variables in a vector autoregressive model (VAR).

The paper is organized as follows: the following subsections provide the background to the study in liberalization and economic management issues. Section 2 provides the analytical methodology and Section 3 provides the empirical results. The paper ends with a conclusion that summarizes the policy lessons and options.

The liberalization policies

Beginning in 1990, Kenya actively implemented several economic reform measures. First, interest rates were liberalized in 1990. Second, in mid 1992, foreign exchange bearer certificates¹ were introduced; these provided a significant relief to the foreign exchange market since possession 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 retain specified proportions of their foreign exchange earnings³

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 the liberalization process of the foreign exchange market continued, there were a few handicaps. By March of 1993, for example, speculation in foreign exchange was rife. Kenya was in serious danger of a flight from the shilling and prices were increasingly 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. There were also increased amounts of domestic currency circulating in the economy, partly because Treasury financed its deficit domestically since foreign funds were not available. Seasonal increases in cash, which coincided with the 1992 elections, put yet more pressure on the domestic prices. In addition, the drought of 1990/91 continued into 1993, which meant that food prices⁵ continued to rise while large amounts of foreign exchange were required for food imports. Furthermore, there were financial scams (involving a few banks) that contributed to increased money supply in the economy and led to the collapse of these banks.

Towards the end of March 1993 price instability had reached such a state that all financial liberalization measures were supposed to stop in order to allow time for a more orderly process to be worked out. The new process included stepping up weekly treasury bill auctions from Ksh1 billion to Ksh5 billion. This was associated with a rapid rise in the treasury bill discount rate, which is viewed as a bench mark 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 licences were eliminated and 100% retention accounts were established, thus both the supply and 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 market exchange rate depreciated far faster than the gradual devaluation of the official rate.⁶ Data suggest that the interest rate differential, exchange rate expectations and forecasts on inflation, and the general instability were such that holders of foreign exchange abroad⁷ took advantage of the liberalized regime to profit by bringing funds back, converting them to shillings and benefiting from the high treasury bill rate. The market exchange rate overshot, as has often been predicted in theory, since first, inflation responded to the drying up of liquidity and then, as real returns on treasury bills grew to be excessive, the interest rate started to track inflation down. But still interest rates remained high enough to encourage and ensure an inflow of speculative short-term capital.

The whole period was 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 came to be seen as unattractive. Exporters were benefiting from devaluations while the depressed demand for imports, which are fundamental to a resource-poor country like Kenya, was dampening growth in other sectors.⁸ Furthermore, the government budget was being tightly controlled. This was made all the more difficult because of the massive burden of both the treasury bill rate and the larger domestic debt

stock, together with the more expensive foreign debt service costs. This combination of factors strengthened fears of policy reversal and exacerbated coordination problems in the economy, which compounded the problem of fiscal management and militated against fiscal adjustment.

The Treasury's concern to assist the Central Bank of Kenya (CBK) to control the supply of money made it imperative to re-establish the credibility of its macroeconomic programme in order to be able to replace high-cost domestic borrowing with concessionary programme funds from abroad. These funds would, of course, dampen the pressure on the exchange rate. As a sign of commitment to this most difficult programme⁹ government spending was severely curtailed as a matter of policy target (though it has been difficult to fulfil).

By November 1993, not only had the official exchange rate been abolished but further liberalization allowing citizens to hold foreign exchange had gone so far as to reassure traders of commitments to a more market driven policy. Other measures included:

- Offshore borrowing by residents was allowed in February 1994, but still subject to quantitative limits. Complete liberalization of offshore borrowing was implemented in May 1994 and 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 (NBFIs) 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 the result conforms to the expectations.

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 foreign exchange flows. The primary focus of the monetary and exchange rate policies shifted because of conflicting objectives and problems facing the authorities with the presence of heavy capital inflows. 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 increased money supply. This in return had to be sterilized through the sale of treasury bills through open market operations (OMO). In order 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. There are several effects emanating from these policy actions:

- The high interest rates, though an instrument to meet the monetary authorities' goals, were jeopardizing chances of economic recovery and discouraging investments necessary for future economic growth.
- The high interest rate on treasury bills implied that domestic and foreign interest rate differentials remained positive and thus perpetuated the speculative private capital flows problem.
- The treasury bills sold in the sterilization process were building government domestic debt. These bills were short term (91 days) and were mainly being held by the financial sector, thus causing the sector to be driven by short-term lending, which is hardly conducive to financial sector development.
- Because of the short-term nature of the commercial paper and government debt, the treasury bill rate would not be very flexible downward, thus this is not a good instrument of monetary policy.
- Looked at in the long run, the policy process does not appear to be coordinated. The exposition above and what has happened in the process may look like monetary policy response to capital inflows (which is reflected by sterilization) while at the same time there is capital flow that must have been attracted by high interest rate differential. Both the outcomes lead to high interest rate differentials, one coming from sterilization, an undesirable outcome on interest rate, and the other coming from exchange rate depreciation in the face of capital outflow and requiring interest rates to rise to stabilize the exchange rate. This is a reflection of a policy dilemma and does not show a clear optimal path for the policy.

The authorities realized that high interest rates were counterproductive, and from 1994 adopted a policy goal aimed at bringing them down. This was a tricky policy because lowering interest rates (with short-term bills and a high government domestic debt) led to massive redemption of treasury bills and substantial outflows of capital. This demonstrated again that short-term capital inflows came in to take advantage of high domestic interest rates and were thus "hot money" (and they were being held in treasury bills) and subject to abrupt reversal. The outflows of capital put the exchange rate under pressure to depreciate. In response, the authorities decided to defend the shilling from sliding. The only mechanism for doing this was to draw down the stock of international reserves. This led to a depletion of reserves to critically low levels making this policy unsustainable. Thus at this stage, the unfolding policy dilemma acquired a third dimension, volatility in the exchange rate, high interest rates and low levels of international reserves.

To reverse the trend and protect the level of international reserves and stabilize the exchange rate, the authorities resorted to monetary measures. This required subjecting the NBFIs to cash ratio just like the banks, discouraging the discount window at the central bank through high and punitive interest rates, and raising the short-term treasury bill rate. These measures stabilized the exchange rate and helped build up 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 the policy dilemma that emerged related to achieving exchange rate stability in the presence of volatile capital flows. The overriding objective was to maintain a competitive

exchange rate, a stable nominal exchange rate and low inflation in a floating exchange rate policy. The exchange rate was not allowed to float freely. Effecting economic recovery through lower interest rates and at the same time maintaining macroeconomic stability through high interest rates and having a target on a competitive exchange rate would require accepting relatively large exchange rate fluctuations. This has been considered less feasible and thus compounded the interest rate problem and monetary response to short-term capital flows.

Given this policy dilemma, it becomes crucial to understand the link between exchange rates 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 study, we empirically test this relationship on the Kenyan data to uncover the relationship between the real exchange rate and the real interest rate differential.

From this background it has been shown that the authorities have been overly concerned with the movements of the nominal exchange rate in the face of volatile capital flows. Capital flows are a reflection of stock adjustment, reacting to changes in asset prices or shocks or both, which is essentially part of the arbitrage process (see Goldstein et al., 1991). Furthermore, capital flows to a particular country represent the private sector's market-based response 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 increased and a high interest rate regime was maintained. But the overriding objective in economic management has been to stimulate economic recovery and increase the investment response—difficult to maintain with high interest rates. Thus the intermediate targets have been affected adversely, which thus affects the attainment of the long-term objectives of growth, employment creation and poverty reduction.

The experience of the macro variables so far described in this period is summarized by the graphs in Figures 1 and 2. They show the movements of the inflation rate, money supply, real exchange rate, capital flows and the interest rates. They collectively show a period of turbulence consistent with the policy dilemma argued earlier.

Figure 1: History of inflation rate, money supply growth, real exchange rate movements and nominal interest rate growth in Kenya (1992-2000)

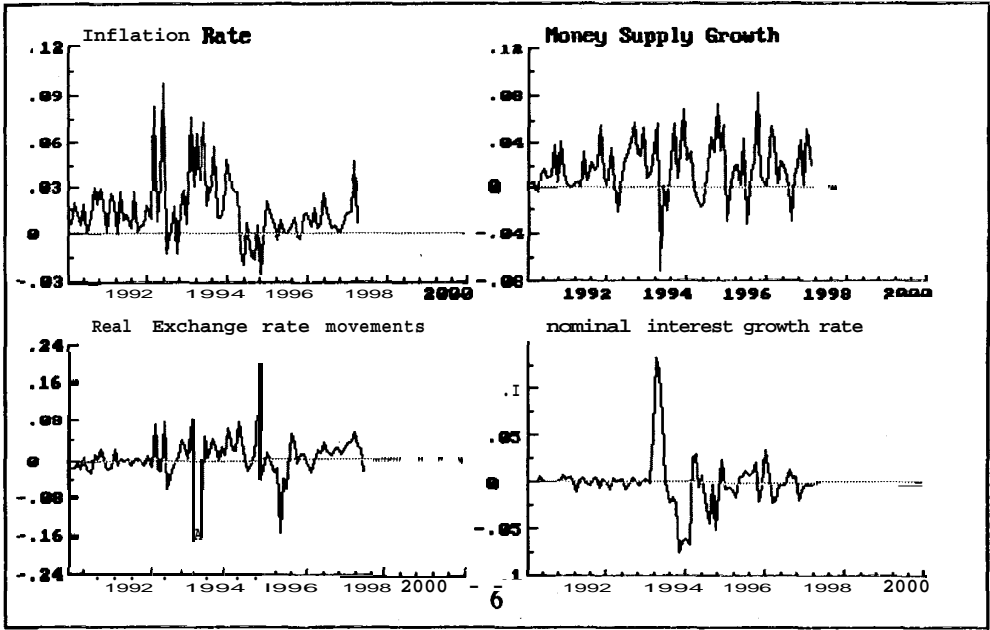
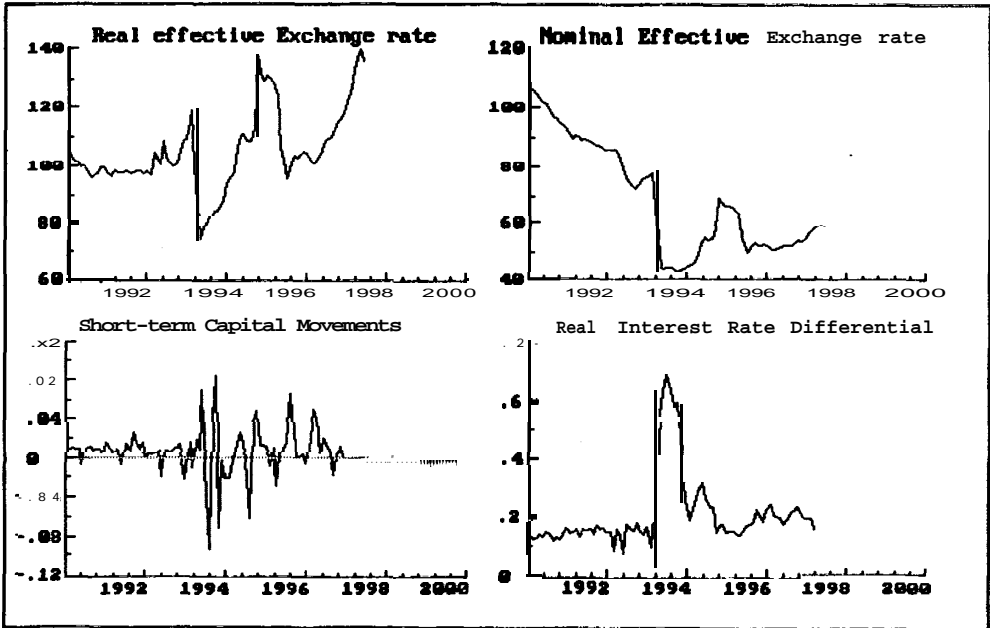


Figure 2: History of exchange rates, capital movements and real interest rate differentials in Kenya (1992-2000)



2. The analytical framework

Real exchange rate and real interest rate differential

The foregoing synopsis of the liberalization process in the 1990s implies the need to understand what accounted for exchange rate movements in Kenya in this period if at all appropriate and effective policies are to be formulated. A crucial issue for policy makers is how to manage the exchange rate and conduct monetary policy in an environment with volatile capital (portfolio) flows. The paper proposes to add to this understanding by first formulating and estimating an error correction formulation of the relationship between the real exchange rate and real interest rate differential in both static and time-varying parameters model. In the first part of the analysis, the 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 real exchange rates for a number of African countries. We differ in this paper by attempting to recover and estimate a structural relationship between the real exchange rate and the real interest rate differential. By limiting the analysis to this relationship, however, we do not exclude the effects of other macroeconomic variables. This is because we believe that other effects enter indirectly into 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 flow has been shown to respond to interest rate differential. The policy response of intervention and sterilizing the effects on the exchange rate and domestic money supply amounts to curing the symptoms rather than the disease and thus has perpetuated the inflows in the period of study. This shows up in the instability of the exchange rate, as both actions lead via different transmission channels to a high interest rate regime.
- Domestic money supply reflects both a target on low inflation and fiscal policy action, as well as sterilization in the foreign exchange market. Thus the observed rate of domestic interest rate partly reflects an accumulation of high short-term domestic debt (fiscal pressure) and monetary policy (fiscal policy) action.

Thus the observed relationship between exchange rate movements and real interest

rate differential indirectly captures the policy action and hence the policy dilemma detailed in the preceding section. It was argued that the link between the real exchange rate and the real interest rate differential is important in Kenya in this period. By estimating an error correction formulation of this relationship we can disentangle the long-run relationship and also account for the short-run responses. The main question asked is, what aspects are taken up by this analytical formulation. To partly reflect on this, the model used takes the deviation from the purchasing power parity approximation to be explained by the real interest rate differential. 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 will help in drawing policy implications and lessons that can be learned.

The empirical model

In the simplest version of the Dornbusch (1988) model, where there are only permanent unanticipated changes in the level of money supply, lower nominal interest rates on a currency are associated with a depreciation. In flexible-price models, shocks to the growth rate of money supply will lead to the opposite correlation, and increases in the nominal interest are associated with currency depreciation. Thus distinction is made between money supply shocks and 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 and clear prediction about the correlation between the 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: 612):

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

where P is the price level, Y^d is the output level, which is demand determined, \bar{Y} is the level of output equivalent to its natural rate and S_t is the nominal exchange rate. Thus the term in the brackets reflects the Keynesian excess demand on domestic prices. Equation 1 shows that prices adjust slowly in response to excess demand. Consequently, less than perfectly anticipated monetary disturbances 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 (PPP) condition but does not hold continuously and these deviations can be captured by the real interest rate differential¹¹ (see McDonald and Nagayasu, 1997). These deviations also reflect the underlying real variables that keep the real exchange rate from its PPP-determined level. The long-run exchange rate is expressed as:

$$\bar{S}_t = P_t - P_t^f \quad (2)$$

where \bar{S}_t 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:

$$E_t(S_{t+k} - S_t) = -\Phi(S_t - \bar{S}_t) + E_t\Delta P_t - E_t\Delta P_t^f \quad (3)$$

where E_t is the expectations operator conditional on the information available at period t . The uncovered interest parity condition is modified to include a risk premium. Unlike McDonald and Nagayasu (1997), we do not anticipate the uncovered interest parity to hold in Kenya.

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

where i_t and i_t^f are domestic and foreign interest rates, respectively, and RM_t is the risk premium. The risk premium is a function of real exchange rate volatility and we also postulate that the real exchange rate volatility is a function of the volatility of the capital flows. This is consistent with the argument by Asea and Reinhart (1996) that short-term capital movements reflect the risk profile in a country. However, the relationship in Equations 4 and 5 reflect the long-run solution and the risk premium is a short-run phenomenon (arbitrage process) so that it is picked up implicitly by exchange rate movements in the short-run equation. We therefore suppress this variable in solving for Equation 5. Volatility is extracted via a state-space representation of the form in Equations 7 and 7'. Equations 2 to 4 can be solved to obtain:

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

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 differential¹² (see McDonald and Nagayasu, 1997). This equation will form the basis of investigation in the first part of the analysis. It implicitly incorporates various influences that affect economic management. First, the exchange rate is affected by capital flows that respond to the interest rate differential. Expectations of inflation emanating from expectations of monetary finance on fiscal deficits are transmitted to the interest rate via domestic debt. So even though the real interest rate differential is modelled, the implicit pressure seems to come from the fiscal side via domestic debt and also via the interventions. These combined effects hinder the flexibility of the interest rate to reflect the money market condition. In addition, inflationary expectations seem to sustain a high interest rate regime.

The empirical implementation follows two stages; first, an error correction form is postulated and then the model is reformulated in a re-parameterized form with the error correction term and in an autoregressive form of order k . This large over-parameterized

statistical model is estimated and reduced until a preferred parsimonious model is obtained. Second, we re-estimate the model in a state–space form, a time-varying parameter estimation method. This requires formulating a measurement equation and a transition equation. Here we use the Kalman filter, which utilizes 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 we have a measurement equation, which we now summarize as:

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

where $X_t = \{ P, P^f, RID \}$, $\varepsilon_t \sim (0, \nu_t)$ and β_t is the vector of states at time t . In the measurement equation in (5') the variance of ε_t is ν_t . We assume that we cannot observe values of β_t but that they can be generated by a transition equation of the form:

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

where $\eta_t \sim (0, \Omega_t)$ and T_t is a matrix of coefficients in the transition equation, which is known, and the variance of η_t is m_t . Both ν_t and m_t are assumed known. If m_t is equal to zero, then there is no time variation. Equations 5' and 6 comprise a state–space representation that we will compare with the results of static parameter estimates.

Real exchange rate movements and short-term capital flows

The exchange rate is affected by various variables and policy actions. Among these variables is short-term capital movement. However, it is shown by, for example, Goldstein et al. (1991) that it is difficult to come up with a structural model to explain short-term capital flows because short-term capital movements reflect stock adjustment in the arbitrage process. Furthermore, Asea and Reinhart (1996) argue that capital flows reflect a risk perception by the economic agents. Our interest, however, is to show how the real exchange rate is affected by the movements in the short-term capital flows as well as to account for the effects of other macro variables on the exchange rate in the liberalization period and thus reveal areas of interdependence and policy weakness.

To accomplish this, we estimate a model with the macro variables and conditional volatility of capital flows (conditional on the information available in period t) as one of the variables. We attempt to show whether volatilities in capital flows drive the real exchange rate and whether this has effects on other variables. This analysis is repeated with private capital flows as a ratio to GDP instead of the volatility measure. The analysis is carried out in VAR. The variables that enter the system are the conditional volatility of the private capital flows, the real effective exchange rate movements, changes in the real interest rate differential, money supply growth, changes in foreign interest rate and government deficit to GDP ratio. This formulation follows Agenor et al. (1997).¹³

The volatility of short-term capital flows is conditional on information period t ($E_t(Z_{t+k})$). This is consistent with the fact that the variable with a changing variance is usually modelled by a stochastic process. In the general case we would assume that the variables have a unit root in this sample period and are thus log-difference stationary, but short-term capital flow is shown from the graphs and unit root tests to be stationary in level. Nevertheless, such a series even though stationary may not be independent because of the serial dependence in the variance (see Harvey and Shephard, 1993, and Harvey et al., 1995, and the procedure in STAMP 5.0). The conditional volatility of this variable can be extracted and modelled by:

$$Z_t = \sigma \varepsilon_t e^{\frac{1}{2}h_t}; \quad \varepsilon_t - iid(0,1) \quad (7)$$

where

$$h_{t+1} = \pi h_t + \mu_t - NID(0, \sigma_\mu^2) \mid \pi \leq 1 \quad (7')$$

The term σ^2 is a scale factor and subsumes the effect of a constant in the regression of h_t , π is a parameter, μ_t is a disturbance term that is uncorrelated with ε_t , ε_t is an iid (0,1) are random disturbances symmetrically distributed about zero. The h_t equation is a transition equation in autoregressive form where the absolute value of π is less than unity to ensure that the process in Equation 7' is stationary. Thus, Equations 7 and 7' represent the stochastic volatility model and are consistent with the state-space model shown in Equations 5' and 6. These equations generate the conditional volatility of capital flows to be used in the VAR.

The capital flow is essentially composed of portfolio flows; Agenor et al. (1997) argue that these flows are associated with an increase in consumption rather than domestic investment. The empirical specification formulated is argued to capture key features of the theoretical framework, that is that capital flows respond to macroeconomic conditions. In this formulation Agenor et al. (1997) consider an open economy with four types of agents (households, firms, governments and the central bank). The optimality conditions of the model yield three pillars of the analytical framework: a money demand function, a demand function for foreign loans and a dynamic equation for consumption.

The empirical exercise is now to model and estimate the dynamic interactions among the variables in a VAR and decompose the forecast error variance to analyse how a unit shock is transmitted to the variables in the system.

To sketch the analysis, let X_t denote a vector of endogenous variables:

$$X_t = \{M2, RID, S, PVTK\}$$

where M2 is nominal money supply, RID is real interest rate differential, S is real effective exchange rate and PVTK is private capital flows (enters both in volatility form and in levels as a ratio to GDP). In addition we have:

$$Y_t = \{LIBOR, DEFGDP\}$$

where LIBOR is the foreign interest rate and DEFGDP is fiscal deficit to GDP ratio. These two variables are considered exogenous and enter into the VAR modelled to depend on their history. We have exogenized DEFGDP because it is a target/policy variable controlled by the government; similarly, foreign interest rates are unaffected by domestic policies (see Agenor et al., 1997).

For the time being we proceed with the endogenous variables $n=4$, and we assume that the structure of the model is consistent with the class of dynamic linear stochastic models, which can be represented as:

$$D(L)\Delta X_t = \mu_t \quad (8)$$

where L is the shift operator, μ_t is a vector of white noise errors and D_i are (4×4) matrixes of finite coefficients that summarize the dynamics of the model. ΔX_t is a vector of the variables in the system. We make the assumption that the variables have a unit root and thus are first-difference stationary. Each of the μ_{jt} is to be interpreted as an exogenous structural shock to the j^{th} equation. For example, $j=4$ represents the private capital flows equation and thus μ_{4t} is a random variable depicting the innovation to the capital flows process.

The sample second moments of the joint probability distribution generating the data are fully summarized by the following Wold moving average representation:

$$\Delta X_t = (I + D_1(L) + D_2(L^2) + \dots)\mu_t = D(L)\mu_t \quad (9)$$

$$\text{where } E(\mu_t \mu_t') = \Sigma$$

If the data generating process for ΔX_t is covariance stationary, then $\lim_{s \rightarrow \infty} D_s = 0$. Furthermore, if $D(L)$ is invertible, then the coefficient in $D(L)$ and Σ are directly obtainable from the following VAR representation of ΔX_t :

$$A(L)\Delta X_t = C(L)^{-1}\Delta X_t = v_t \quad (10)$$

where $A(L)$ is a k^{th} matrix of polynomials in the lag operator L with all roots inside the unit circle and v_t is a vector of zero-mean, independently and identically distributed innovations with a covariance matrix Σ .

But one problem that arises is that Equation 8 is consistent with any linear theoretical model and thus has little empirical content. We thus require further restrictions so that $D(L)$ can be uniquely identified. In the VAR literature, the choice of identifying restrictions is based on a priori economic reasoning regarding the structure of the system. The most commonly used restriction is the recursive system (triangularization) where the

innovations of the first variable in the system affect all variables and the innovations of the last variable contemporaneously affect only that variable.

This method has basic weaknesses by imposing a recursive structure in the dynamic analysis and may not be adequate for evaluating the effects of structural economic disturbances as our paper intends to do. The method has been convenient and easy to apply but is inconsistent with any plausible model. To resolve these empirical weaknesses and identify the desired dynamic multipliers we use restrictions from the economic model itself.¹⁴ The most important aspect of this analysis is to analyse the causal structure of the variables in the system. The causal structure will show which variables affect all the other variables and thus determine their position in the matrix.

3. Empirical results

The data

We begin by providing unit root tests of the variables in the analysis. These are shown in Table 1. Several unit root tests have been used because we are dealing with high frequency data that are extremely noisy due to shocks and regime shifts and some tests like the Dickey–Fuller (DF) class of tests have low power. We see that private capital flows and the deficit to GDP ratio are stationary; all the other variables are non-stationary.

Table 1: Unit root tests

Test Var	S	NER	M2	TDR	RID	I	P	DEFGDP	P ^f	PVTK
WS	-2.83	-1.9	-2.77	-2.3	-2	-1.1	-0.5	-3.6	0.94	-2.95
P-values	0.134	0.714	0.155	0.44	0.68	0.97	0.99	0	0.98	0.068
DF	-2.74	-1.72	-4.28	-2.1	-2.2	-1.8	-0.8	-3.4	-0.8	-5.865
P-values	0.222	0.74	0	0.56	0.48	0.71	0.97	0.1	0.96	0
PP	-13	-6.17	-22.4	-9.5	-8.3	-2.3	-1.3	89.1	-16	-83
P-values	0.264	0.732	0.04	0.45	0.4	0.96	0.99	0	0.15	0

The tests are conclusive for all the variables except money supply, where the Dickey–Fuller and Phillips–Perron tests indicate that it might be a stationary process. But the weighted symmetric test, the graphs and the autoregression of money supply do not corroborate these results. It is seen that the variable is clearly non-stationary. We proceed under the assumption that the variables are all I(1), and private capital flows and deficit to GDP ratio are I(0).

The exchange rate and real interest rate differential

Having established the characteristics of the data, we next analyse the cointegration relationships among the nominal exchange rate, domestic and foreign prices, and the real interest rate differential. The results show a cointegrating vector of the form:

$$ECM_t = NER_t - 0.495 P_t + 0.241 P_t^f - 0.8395 RID_t - 6.12$$

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 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. This implies that we cannot map PPP relation coefficients in the vector. Here, the results show a coefficient of -0.495 and 0.241 for domestic prices and foreign prices, respectively. This should be contrasted with -1 and 1 for domestic and foreign prices if the strict PPP relationship were to hold, showing that the *ECM* computed here corroborates arguments in the paper. Thus Equation 5 was re-parameterized with this cointegrating vector and the variables in first difference and estimated with six lags of each variable and the *ECM* lagged one step. In addition, there were dummies that reflected interventions or shocks in the foreign exchange market. These were identified as influential points (outliers) after recursive estimation showed instabilities in the regression coefficients. The preferred model is shown in Appendix 4, while the solved model is shown in Table 2.

Table 2: The real exchange rate movements (ΔS): 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^f	-0.6101	0.2779	-2.2
ΔP_t^d	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

Wald Test χ^2 (8) 75.675 [.0000]**

The results in Table 2 show that we have managed to estimate and solve for the relationship between the movements of the real exchange rate and real interest rate differential. The results show that, first, interest rate differential increases with real exchange rate appreciation. 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 this liquidity injection must raise the domestic interest rate to make the commercial paper more attractive to hold. Again this is consistent with our argument that stabilization of the exchange rate will require high interest rates. But this perpetuates the capital flows problem. Second, inflation will increase with real exchange rate depreciation, which is also consistent with the theoretical prediction. Third, the influence of foreign inflation decreases with real exchange rate appreciation, again consistent with expectations. Fourth, long-run movements of the real exchange rate, out of line with the postulated variables, will contribute to an appreciated real exchange rate. This is the cointegrating vector, which showed that the purchasing power parity relationship will not hold. The vector

becomes stationary when the real interest rate differential (RID) 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 we learn from these results then is that:

- Interest rate as an instrument of achieving both stability of the exchange rate and low inflation as argued earlier is clearly inadequate.
- Changes in the real interest rate differential and inflation drive real exchange rate movements and this is corroborated by the dynamic analysis shown below.

To investigate these conclusions further and formulate the policy lessons, we turn to the dynamic analysis.

The real exchange rate movements and stochastic volatility analysis of private capital flows

The dynamic analysis results are shown in Table 3 and Figure 3 for the forecast error variance and the respective impulse responses for a unit shock in the variable. We start with the volatility of capital flows. Two shocks from the two exogenous variables in the system are examined in terms of their effects on the real exchange rate movements, real interest rate differential and private capital flows.

The tables and graphs in Appendix B show the variance decomposition of the key endogenous variables in the system: the real effective exchange rate movements (ΔS), the changes in real interest rate differential (DRID) and private capital flows (VPVTK, volatility and PVTKY as a ratio to GDP). The historical innovation of ΔS is accounted for by its own history (23%), the volatility of capital flows (25%) and the changes in the foreign interest rate, DLIBOR (at 24.7%). Money supply growth and fiscal deficit have weaker effects, while changes in the real interest rate have the weakest effect at the end of the forecast period. As the forecasting horizon increases, volatility of capital flows becomes important in explaining the historical innovation of the real exchange rate movements.

The variance decomposition of DRID, on the other hand, is mostly associated with ΔS , while the rest of the variables have similar effects except a slightly weaker effect from deficit to GDP ratio, DEFGDP (at 10.5%), at the end of the forecasting horizon. The historical innovation of the volatility of capital flows at the end of the forecasting horizon mostly accounts for their own innovations (44%) followed by money supply growth (18%), ΔS (17%) and some weak effects from the other variables. These results thus show that volatility of capital flows has strong effects on the real exchange rate movements and the real interest rate differential. The results are somewhat different

Table 3: Dynamic analysis results

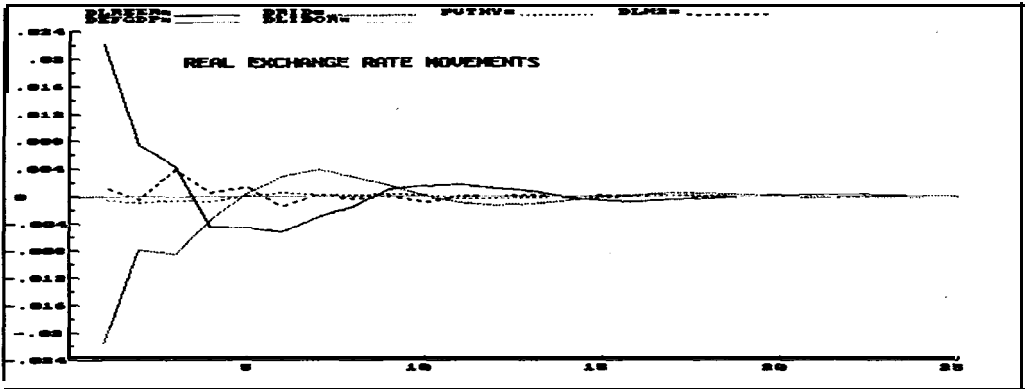
Months	ΔS	DRID	PVTKY	DM2	DEFGDP	DLIBOR
<i>Shocks from real exchange rate movements</i>						
1	88.3	0	0	0	5.6	6.1
5	54.4	4.5	7.1	9.8	13.5	10.8
10	52.4	5.1	7.7	11.3	13.2	10.3
15	51.9	5.3	7.8	11.4	13.4	10.2
20	51.9	5.3	7.9	11.4	13.4	10.2
24	51.9	5.3	7.9	11.4	13.4	10.2
<i>Shocks from real interest rate differential</i>						
1	49.8	41.7	0	0	1.5	7
5	38.7	27.2	9.2	8.7	9.7	6.5
10	37.4	25.5	9.1	8.3	12.4	7.3
15	37.4	25.3	9.1	8.3	12.4	7.5
20	37.3	25.3	9.1	8.3	12.4	7.5
24	37.3	25.3	9.1	8.3	12.4	7.5
<i>Shocks from private capital flows</i>						
1	0.49	0.05	98.3	0	0.5	0.6
5	2.7	9.7	71.2	12.3	1.7	1.7
10	2.8	13.3	62.3	14	3.9	3.8
15	2.9	13.4	61.4	14.5	4	3.8
20	2.8	13.6	61.2	14.7	3.9	3.8
24	2.8	13.6	61.1	14.7	3.9	3.8

when we use the capital flows to GDP ratio, which confirms that it is the volatility of capital flows that drives the real exchange rate and the real interest rate differential. The effects are persistent.

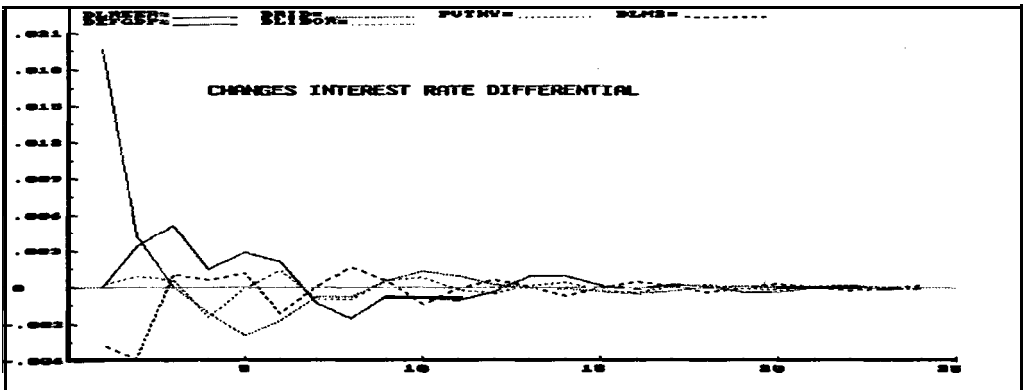
The impulse responses of one unit shock on the variables are shown in Appendix B. In all cases, the effect of the deficit is persistent, even though declining as the forecast period increases, but does not peter out even at the end of the forecast period. The real exchange rate movements seem to have some cyclical movements in the early months (for DRID and a VPVTK figures) but seem to die out fast as the horizon increases. When instead VPTKY is used, all the variables have cyclical fluctuations in the short run, up to the fifteenth month, but begin to peter out as the horizon increases and die out towards the end of the horizon.

Figure 3: Dynamic analysis results

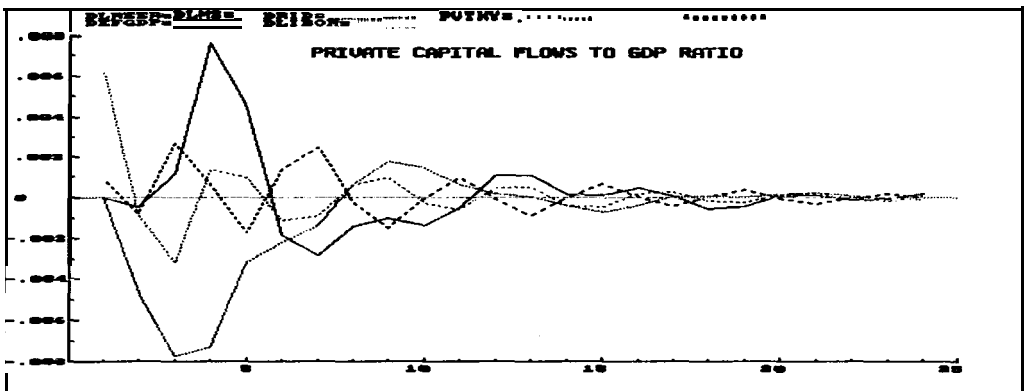
Real exchange rate movements



Changes in interest rate differential



Private capital flows to GDP ratio



4. Conclusion

The main objective of this paper was to analyse the relationship between real exchange rate movements and the real interest rate differential, on the one hand, and the impact of short-term (speculative) private capital flows, money supply and fiscal deficit on the real exchange rate, on the other. This proceeded in two stages. First, the nominal exchange rate was analysed as deviating from the perceived long-run equilibrium level determined by the purchasing power parity relationship, with these deviations governed by the interest rate differential. The results showed that an error correction formulation was an adequate representation of this relationship while adverse shocks and administrative events are modelled as well (using dummies). The model was then re-estimated in a time-varying parameters technique (the Kalman filter) and without dummies. The results mimicked those arrived at earlier, except that some variables were no longer significant, but the direction of causation was not affected. This allowed us to move further and interpret the results. It was argued that the interest rate differential will widen with real exchange rate appreciation and this triggers capital to flow in. Second, domestic inflation will rise with a real exchange rate depreciation and the influence of foreign inflation will decrease with exchange rate appreciation.

These results were able to mimic the postulated long-run relationships, and the modelled short-run single shocks were found to have an influence on the real exchange rate movements depending on the type of shock. Thus, the 1993 liberalization of the foreign exchange transactions and the adoption of the inter-bank 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 appreciated the exchange rate and were perhaps consistent with interventions in the market.

In the second stage of the analysis, a vector autoregressive model was estimated with private short-term capital flows entering the model in their volatility form (a reflection of the risk premium since the interest rate parity is not expected to hold and implicitly the risk premium is a function of the volatility of capital flows) and as a ratio to GDP. The volatility was analysed by first postulating measurement and transition equations (following Harvey et al., 1995). In terms of accounting for the relative contribution of the variable shocks in their innovations using the forecast error variance, the real exchange rate movements seemed to absorb the shocks from the real interest rate differential, and the volatility of the capital flows and government deficit had long-lasting effects on the variables in the system. The results from the dynamic analysis thus showed that:

- Volatility of capital flows and changes in the foreign interest rate account for almost half of the historical innovations of the real exchange rate movements. The other half was shared by own innovations (23%), money supply growth (13%), fiscal deficit (10%) and minimal effects from the real interest rate differential (4%). When the capital flows to GDP ratio is used the results are not as strong, implying the strong links of volatility to the real exchange rate and other variables. We conclude that it is the volatility of private capital flows that drives the exchange rate movements via the risk premium.
- The real interest rate differential accounts for about 18% of its own historical innovations at the end of the horizon. These strong effects come from real exchange rate movements and changes in the foreign interest rate.

The results confirm that domestic shocks as well as external factors contributed to the movements of the real exchange rate and the real interest rate differential, thereby perpetuating capital flow problems, but this has been compounded by inappropriate domestic policy response to short-term capital flows problems.

The policy lessons that come from the analysis relate to the interest rate structure and effects and the real exchange rate. The analysis shows that the two variables absorb the effects of shocks from each other as well as the shocks from capital flows, fiscal deficit and money supply. It was argued earlier that intervention to stem adverse movements in the nominal exchange rate leads to high interest rates. The results corroborate this view and show 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. So having a handle on the exchange rate movements prevents flexibility of the domestic interest rate downwards. This has been the experience in the study period. Perhaps the optimal approach is 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 and this will remove the effects of intervention on the interest rate structure. In line with Asea and Reinhart (1996), doing nothing in face of the short-term private capital flows may be considered optimal.

Notes

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 certificates bore an interest rate and were marketable like any other paper asset.
2. The bearer of a Forex-C applied for a licence under No Foreign Exchange Required (NFE) and was processed virtually immediately. The bearer then purchased foreign exchange from the central bank at the official exchange rate.
3. Initially (June 1992) non-traditional exporters could retain 100%; in February 1993 all importers were allowed to 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% by the end of May 1993.
5. Food prices account for almost 40% of the weighted Nairobi consumer price index that 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 were compelled to give to urban dwellers.
6. After 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 flows that created problems through currency appreciation in South America, was not so destabilizing since it would appear that it was not free “hot money” because it has not left the country following the narrowing of the interest rate differential.
8. GDP grew by 0.1% in 1993, while the monetary economy registered no growth. Private gross fixed capital formation was static during the period.
9. The difficulties were and still are political as much as economic since the solution requires a continuation of deflationary policies in the face of falling real incomes and unemployment, including laying off civil servants (retrenchment).
10. We believe that in the short sample we are dealing with there is a long-run real exchange rate that the authorities target implicitly. This is because the policy focus has been to maintain a competitive exchange rate that supports the export sector.
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 McDonald and Nagasyau (1997) in assuming that the deviations from

the preferred equilibrium relationship for a short sample are governed by the interest rate differential.

12. The real interest rate is computed empirically using $ri_t = \frac{i_t - inf_t}{1 + inf_t} \times 100$ where ri is the real interest rate, i is the interest rate and inf is the inflation rate.
13. We differ in the variables used in this study. For example, we use government budget deficit instead of expenditure due to lack of data in the required frequency, and then we start with the volatility of capital flows and we use money supply instead of velocity.
14. We adopt a method of structural decomposition based on Bernanke in the RATS programme. This procedure returns a factorization of the sample covariance matrix of residuals based on the input model. In addition, each variable is modelled to depend on lags of the endogenous and exogenous variables, while the exogenous variables are modelled to depend on their history.

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Appendix A: The preferred model 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
DRID	-0.761	-7.58	-0.935	-6.02
DRID _{t-1}	0.654	5.19	0.855	9.37
DRID _{t-2}	-0.232	-1.85	-0.342	-1.85
DRID _{t-3}	0.200	1.55	0.408	1.97
DRID _{t-4}	-0.283	-3.18	-0.170	-1.24
DP _t ⁱ	0.895	2.01	0.673	0.95
DP _{t-2} ⁱ	-0.975	-2.19	-0.653	-0.94
DP _{t-3} ⁱ	1.013	2.31	0.224	1.15
DP _{t-5} ⁱ	-0.632	-4.16	-0.914	-3.75
DP _t	1.04	4.34	1.18	3.11
DP _{t-2}	-0.904	-3.78	-1.16	-3.047
DP _{t-3}	0.464	1.82	0.708	1.74
DP _{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] $\sigma = 0.01997$ $DW = 1.94$

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] χ^2

F(40, 15) = 0.35182 [0.9957]

RESET F(1, 55) = 5.3402 [0.0246] *

Appendix B: Variance decomposition of key endogenous variables

Table B1: Shocks from real exchange rate movements (forecast error variance)

Months	ΔS	DRID	VPVTK	DM2	DEFGDP	DLIBOR
1	70	0	0	0	8.3	21.6
5	29	3	9.1	5.8	14.3	38.8
10	24.6	3.7	19.2	9.2	11.9	31.5
15	23.8	4.1	23.3	11.7	10.4	26.8
20	23.3	4.1	24.7	12.7	10	25.2
24	23.1	4.1	25	12.9	10	24.7

Table B2: Shocks from real interest rate differential

Months	ΔS	DRID	VPVTK	DM2	DEFGDP	DLIBOR
1	41.6	37.9	0	0	4.5	15.7
5	27.4	21.3	7.4	13.6	11.5	18.7
10	24.5	19.1	12	13.5	10.9	20.1
15	24.4	18.4	12.9	14.9	10.2	19.1
20	24.1	18.1	13.4	15.1	10.5	18.9
24	24.1	18	13.5	15.1	10.5	18.8

Table B3: Shocks from volatility of private capital flows

Months	ΔS	DRID	VPVTK	DM2	DEFGDP	DLIBOR
1	0.8	1.5	79	0	2.5	17
5	12.4	6.9	54	2.5	6	18.2
10	16.9	6.9	42.7	13.9	8.5	11.2
15	16.8	6.6	44.8	16.3	6.7	8.8
20	16.9	6.6	44.6	17.6	6.4	7.9
24	16.8	6.5	44.4	17.8	6.7	7.8

Figure B1: Real exchange rate movements

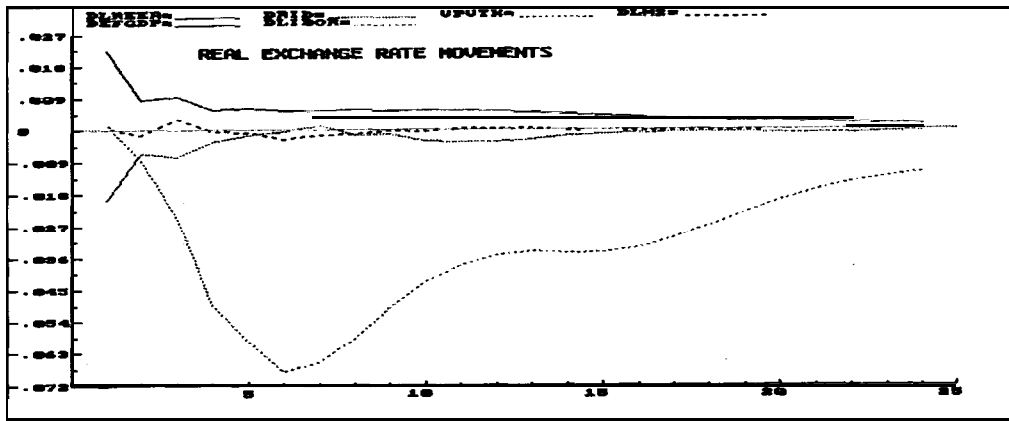


Figure B2: Real interest rate differential

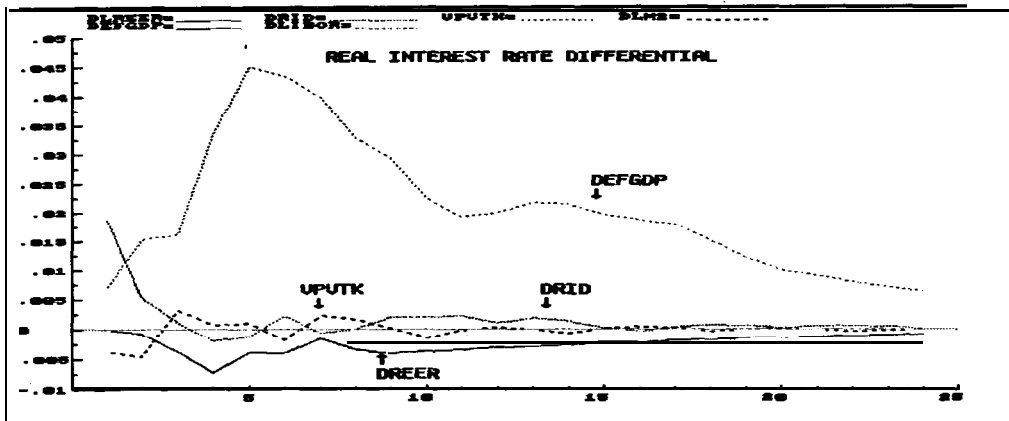
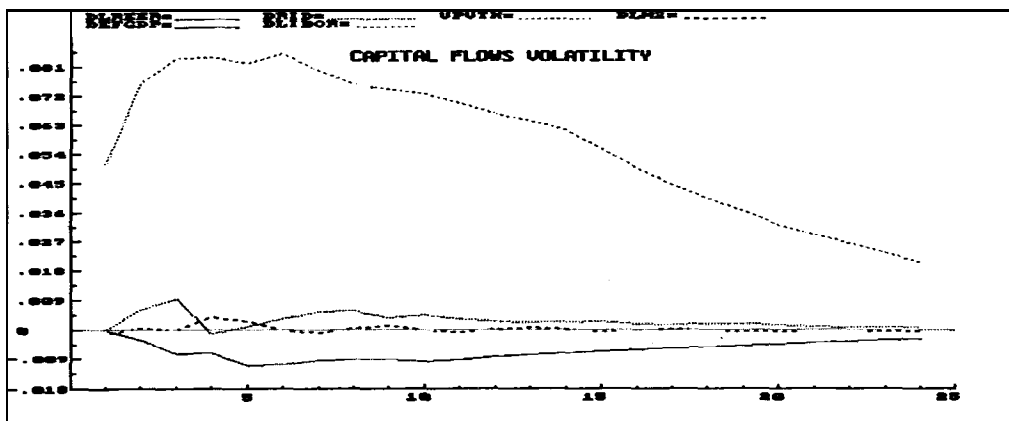


Figure B3: Capital flows volatility



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