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Budget Deficit Financing and Exchange Rate Volatility in Kenya

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DECLARATION

This research project is my original work and has not been presented for award of a degree in any University.

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DEDICATION

To my beloved parents and family

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OPERATIONAL DEFINITION OF TERMS

Appreciation: A rise in the value of a country's currency in the foreign exchange market, relative to either a particular foreign currency or to a weighted average of other currencies.

Bandwagon effects: describes the interaction between the movements in exchange rate of one country and those of the major trading partners. The bandwagon effect arises when movements in exchange rate spread among countries with the probability of any country being affected increasing with the level of the trade relationship.

Depreciation: It is the changes in the exchange rate when it is allowed to float such that the value of local currency in terms of foreign currency falls. That is the weakening of local currency relative to foreign currency.

Devaluation: It is a deliberate reduction in the value of the local currency relative to the foreign currency in a fixed exchange rate regime.

Exchange rate regime: It is the way a country manages its currency with respect of the other major currencies of the world.

Exchange Rate Volatility: is the degree of upward and downward movements in exchange rate over a standard period, in this study - a month.

Exchange rate: It is the value of a foreign country's currency in terms of the home country's currency. It specifies how much one currency is worth in terms of the other.

Fiscal deficit: Also referred to as the *budget deficit,* represents the amount by which the total government revenues fall short of the total government expenditures.

Forward Exchange Rate : refers to an exchange rate that is quoted and traded today but for delivery and payment on a specific future date.

Future exchange rate: refers to an exchange rate that is quoted and traded today but for delivery and payment on a specific future date.

Interest rate parity: is a non-arbitrage condition which says that the returns from borrowing in one currency, exchanging that currency for another currency and investing in interest-bearing instruments of the second currency, and converting back the investment plus returns to the first currency at the end of the holding period, should be equal to the returns from purchasing and holding similar interest-bearing instruments of the first currency.

Law of one price: is an economic law stating that when the market is efficient, then all identical goods must have only one price.

Market exchange rate: Is the exchange rate as determined by the market forces of demand and supply.

Marshall-Lerner condition: States that a devaluation (currency become weaker) will improve the current account balance (exports minus imports) if the combined price elasticities of demand for exports and imports are greater than 1.

Official exchange rate: is the exchange rate fixed and announced by the monetary authority, and by which any international exchanges should take place.

Overshooting: An exchange rate overshoots when its short run response to a change in the market fundamental is greater than its long run response.

Real exchange rate: is obtained when the nominal exchange rate is adjusted with the relative price levels of the foreign country to that of the home country.

Self-fulfilling bubbles: an exchange rate exhibit a bubble if its current market value exceeds its fundamental value. If most market participants buy the asset in the hopes of selling it later at a higher price instead of buying it for the income it will generate, this could be evidence that speculative bubble is present.

Spot Exchange Rate : refers to the current exchange rate.

Trilema: a.k.a the Impossible Trinity refers to the tradeoffs among the following three goals: a fixed exchange rate, national independence in monetary policy, and capital mobility.

ACRONYMS AND ABBREVIATIONS

AIC	: - Akaike Information Criteria
BD	: - Budget Deficit
BOP	: - Balance of Payment
B-S	: - Balassa-Samuelson
CBK	: - Central Bank of Kenya
CIRP	: - Covered Interest Rate Parity
EAC	: - East Africa Community
ECM	: - Error Correction Model
GDP	: - Gross Domestic Product
IFS	: - International Financial Statistics
IMF	: - International Monetary Fund
IS-LM	: - Investment-Savings – Liquidity Multiplier
KSHS	: - Kenya Shillings
NDFBD	: - Net Domestic Financing of Budget Deficit
NER	: - Nominal Exchange Rate
NFFBD	: - Net Foreign Financing of Budget Deficit
PPP	: - Purchasing Power Parity
RER	: - Real Exchange Rate
SAP	: - Structural Adjustment Programmes
SDR	: - Special Drawing Rights
SIC	: - Schwarz Information Criteria
SSA	: - Sub-Saharan Africa
TOT	: - Terms of Trade
UIRP	: - Uncovered Interest Rate Parity
USA	: - United States of America
VAR	: - Vector Autoregressive model

ABSTRACT

This study was motivated by over a quarter of a century of exchange rate volatility, the persistent problem of budget deficit in Kenya, and the importance of the two in the economy, which explains their inclusions in the convergence criteria for the East Africa Community. Exchange rate volatility exposes the participants of international markets to the risk of loss and thus disturbs the optimal allocation of resources. Despite effort made by past studies to explain exchange rate volatility, there exists controversy in their findings, with a counter-argument being provided for each assertion. This study attempted to improve on the modelling of volatility in exchange rate in order to best explain its movement. This was done by analysing the effects of using the financing composition of budget deficit instead of budget deficit in modelling of exchange rate volatility. Thereafter, the model that provided the best fit and forecast were applied to determine the effects of budget deficit financing and macroeconomic fundamentals on exchange rate volatility under different exchange rate regimes. Monthly data spanning the period 1973:01 to 2005:12 for the following variables: exchange rate volatility, interest rate differential, inflation rate differential, domestic nominal interest rate, money supply differential, net foreign assets and productivity differential were used to achieve these objectives. The study tested for structural breaks and aggregation of variables problem then applied the VAR estimation technique to the model which offered the best fit. VAR results were used to explain the effects of macroeconomic fundamentals on exchange rate volatility. The results of impulse response functions and variance decomposition revealed that shocks to productivity differential, inflation rate differential, and to a lesser extent, the interest rate differential and the net foreign asset are the main drivers of exchange rate volatility in Kenya. The analysis of the results revealed a stronger medium- to long-term causality linkage from macroeconomic volatility to exchange rate volatility than the other way around. This was evidenced by bidirectional causalities between productivity differential, inflation rate differential, and to a lesser extent, the interest rate differential on one hand and exchange rate volatility on the other. The net domestic financing of budget deficit had positive effect, while the net foreign financing of budget deficit had negative effect. The study concluded that there is no aggregation problem in budget deficit. However, the model with the financing composition of budget deficit provided the best fit and the macroeconomic fundamentals successfully explained exchange rate volatility.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

1.1.1 Exchange Rate Volatility in the Post-Bretton Woods Period

Since the collapse of the Bretton Woods system, the volatility of exchange rates has increased with no comparable increase in the volatility of the underlying economic variables (Baxter and Stockman, 1989; Flood and Rose, 1995). In the medium and long term, theoretical literature attributes volatility of exchange rate to volatility in the underlying macroeconomic fundamentals such as money supply differential, GDP differential, interest rate differential, inflation rate differential and productivity differentials. Hence, exchange rate will only move significantly or erratically under floating exchange rate, if the underlying forces governing its demand and supply are themselves erratic (Friedman, 1953; Johnson, 1969). Researchers have dedicated a lot of time and energy testing this theoretical proposition since 1970s. Studies by Razzak and Grennes (1998) and Morana (2009) found evidence supporting this theory. Flood and Rose (1999), however, raised an important objection to these studies by arguing that volatility of exchange rate exceeds the volatility of macroeconomic fundamentals.

Concerns over exchange rate volatility began in 1970s in most part of the world and attracted a lot of interest, due to its effect on international flow of capital, goods and services. At both theoretical and empirical levels, the international trade and finance literature have underscored the effects of exchange rate volatility on international trade flows, pricing of exports and domestic goods, market structure (entry-exit decisions), and international asset portfolios. Moreover, although firms can protect themselves against short-term foreign exchange risk through hedging, they are exposed to medium- and long-term exchange rate volatility. Such exposure to foreign exchange risk could affect firms' investment decisions and therefore distorts the optimal allocation of resources. Therefore, predicting movements in exchange rate can have significant implication on these issues.

Studies that sought to explain and forecast movements in exchange rate in the post-Bretton Wood era in the 1970s, borrowed and applied to exchange rate the idea of monetary approach to Balance of Payment (BOP) due to its success. Regrettably, the monetary approach to exchange rate, unlike its BOP counterpart never turned out to be very successful. Various monetary models of exchange rate determination that emerged out of this approach, includes the flexible-price monetary model of Mussa (1976) and Frenkel (1976), and the sticky-price monetary model of Dornbusch (1976), which together with other structural models, were subjected to systematic review in a series of papers by Meese and Rogoff (1983) and Meese (1990). The random walk model Meese and Rogoff used as a benchmark against these structural models have not been convincingly explained and continues to exert a pessimistic effect on the field of empirical exchange rate modelling in particular and international finance in general (Frankel and Rose, 1995).

Consequently, some studies resorted to explaining the disconnect between exchange rate and macroeconomic fundamentals, a phenomena they termed as the exchange rate disconnect puzzle (see for example, Obstfeld and Rogoff, 2000). An interesting alternative to confront the failure of structural models is to consider the estimations and specifications problem in these models. The extensive use of monetary models, for example, has an important implication on the specification problems, as the fiscal aspects of the economy are left out. Chen and Rogoff (2002) noted that, while canonical exchange rate models such as Dornbusch's (1976) overshooting model seemed to broadly fit the inflationary periods of 1970s and the early 1980s, as inflation gradually stabilized in major countries over the ensuing period, it became clear that monetary instability alone could not possibly explain the persistent exchange rate volatility. Furthermore, Johnson (1969) had earlier indicated that underlying forces governing the demand and supply of foreign exchange included government policies, that is, the monetary and fiscal policies.

Although fiscal policy is a potential determinant of movements in the exchange rate, past studies have largely neglected it (see Razzak and Grennes, 1998; Flood and Rose, 1999). In fact, these studies have focused on the monetary model, which captures the monetary sector, leaving out the real or fiscal sector of the economy. Out of the few efforts made to capture the fiscal position, most of them have used budget deficit (see Canales-Kriljenko and Habermeir, 2004; Hsing, 2006). But in Kenya, the behaviour of the financing composition of the budget deficit has shown evidence of having changed with the changes in the exchange rate regime (structural breaks). Such changes in behaviour may be distorted by aggregation in the case of budget deficit, especially given that the underlying components of the aggregate tend to oppose each other (aggregation problem).

With the liberalization of the exchange rate, the movement of financing composition of the budget deficit over time have shown a tendency to oppose each other in Kenya. That is, while net domestic financing of budget deficit remained in net borrowing position, net foreign financing of budget deficit, for most of the time, has been switching from net borrowing position to net repayment position (Figure A5, Appendix 2). Therefore, aggregating the two in any model, especially as done by earlier studies, may have led to inappropriate modelling of expectation formation (Meese, 1990) and aggregation of variables problems, which in turn could have resulted in estimation problems such as poor fit, statistically insignificant parameters and sign-reversal. Consequently, these may be the reason behind the failure of budget deficit to explain movements in exchange rate in those studies that have considered it.

1.1.2 Historical Developments of Exchange Rate Regimes in Kenya

Following the suspension of US dollar convertibility to gold, the foreign exchange markets in Kenya, Uganda and Tanzania were suspended on August 1971 (Ryan, 2002). In late 1971, Kenya once more allowed its exchange rate to move with the US Dollar, after devaluation necessitated by the severe loss of reserves caused by expansionary fiscal policy, general international exchange rate instability, and trade restrictions on imports (Ndung'u, 1999). In February 1973, US dollar crisis led to the closure of most foreign exchange markets and the devaluation of the US dollar against gold by 10 percent. Kenya, Uganda and Tanzania shillings were effectively devalued to maintain the value of the East Africa Pound against the US dollar.

Kenya then shifted its exchange rate from a peg to the dollar to a peg to the Special Drawing Rights (SDR) in 1974. In 1978, crawling peg on the basket of main trading partners were introduced, and after 15 percent devaluation in September 1982, it was changed to a crawling peg in real terms (managed float). Under managed float, exchange rate adjustments were allowed to accommodate changes in inflations. Later in 1990, a market determined exchange rate was allowed to run concurrently with the managed float up to October 1993, when the two exchange rates were merged and the exchange rate was left to be determined by international market forces of demand and supply. Despite these changes, exchange rate control was not abolished. However, in 1996 it was relaxed and subsequently abolished in 1998 (Ryan, 2002).

In 1999, the East African Community was revived with the signing of Treaty between Kenya, Tanzania and Uganda, with an aim of attaining a Monetary Union by 2012. In 2007, two landmark events took place: membership expanded to include Burundi and Rwanda, and the Monetary Authorities of the member nations participated in the implementation of monetary co-operation, as stipulated in Article 5, 82 to 85 of EAC Treaty (Central Bank of Kenya, 2008). This Article outlines the undertaking by the partner states to co-operate in monetary and fiscal matters, and it sets out the convergence framework, which lays down both the primary and the secondary convergence criteria to be met by the partner states. Foremost of this undertaking is to bring the overall budget deficit/GDP ratio (excluding grants) to not more than 3 percent, and the achievement and maintenance of a stable real exchange rate. Convergence criteria are the preconditions for a monetary co-operation. Primary convergence criteria are the preconditions which need to be met while secondary convergence criteria reinforce primary convergence criteria.

Apart from changes in the exchange rate policy, there were also changes in policies affecting both domestic borrowings and foreign borrowings. Borrowing, either domestically or externally, were the two major sources of budget deficit financing in Kenya for the period under study. These changes in policies were instrumental in the development of the financial system in general and the domestic bond market in particular (Isaksson, 2001). Policies affecting borrowings were primarily geared towards stabilizing exchange rate, promoting import substitution strategy as well as addressing BOP problem.

1.1.3 Exchange Rate Volatility in Kenya

The issue of exchange rate volatility in Kenya dates back to early 1970s when there was instability in the foreign exchange markets in most part of the world caused by the collapse of the Bretton Woods System, leading to severe loss in foreign exchange reserves (Ndung'u, 1999). Generally, apart from various devaluations and revaluations, exchange rate remained relatively stable against the dollar up to 1982, when with the abolition of the fixed exchange rate, volatility in exchange rate began, but it was not as severe as that of 1990s.

In late 1971, Kenya Shillings was once again pegged to the dollar, and the exchange rate was fixed at Kenya Shillings 7.143 per unit of the dollar. In 1973, Kenya Shillings strengthened against the dollar due to the devaluation of the dollar following the instability in foreign exchange markets. But it was devalued and fixed at its initial values of Kenya Shillings 7.143 per dollar in 1974 (Ryan, 2002). This was maintained up to late 1975, when due to weak policy response to the loss of the EAC market and the coffee boom, movements in exchange rate began, though within very narrow range. Coffee boom was used to delay the necessary economic adjustments that were triggered by the second oil crisis, the severe drought of 1979 to 1980, the coup attempt of 1982 and the oil crisis caused by Iraq-Iran war in early 1980s. Eventually, the shift in exchange rate policy from fixed to managed float was introduced in September 1982 to deal with the appreciation of the real exchange rate (Legovini, 2002). Immediately before the switch to managed float exchange rate system, the exchange rate stood at Kenya Shillings 11.138 in August 1982, from its value of 7.143 per unit of a dollar in January 1973, which represents a depreciation of 56 percent for the period (IFS, 2008).

The managed float system allowed for adjustments in the nominal exchange rates to accommodate the changes in inflation. As a result, movements of Kenya Shillings against the US$ in the 1980s were gradual. The depreciation of the Kenya shillings were checked by the inflows of foreign resources for budgetary support and the impact of the shocks on exchange rate during the period was not profound. These include the severe drought and famine of 1984, and the struggle for multiparty system. During the period, the exchange rate opened at Kenya Shillings 11.217 per dollar in September 1982 and closed at Kenya Shillings 23.232 per dollar in September 1990. This translates to a depreciation of over 107 percent. But if the dual system is included, then the exchange rate depreciated by about 524 percent during the period, as it closed at Kenya Shillings 69.962 per dollar in October 1993 (IFS, 2008). Dual system existed between 1990 and 1993, with the market and the official exchange rate running concurrently.

In early 1990s, as part of the effort to bring the economy which was in recession under control before the first multiparty election, a series of economic adjustments were initiated. These included the relaxation of controls of foreign exchange transactions and the switch to floating exchange rate. The period began with the monetary shock that coincided with the liberalization of exchange rate. During the period, exchange rate volatility was high and it was difficult to control because of the monetary shocks emanating from the monetary base extended to the Treasury by the Central Bank. This led to adjustments in expectations, which in turn led to behaviour that influenced exchange rate volatility. Movements in exchange rate during this period were characterized by jumps, for instance between 1993 and 1999, monthly Kenya Shillings depreciated by more than 5 percent of its value ten times and appreciated by more than 5 percent five times (IFS, 2008) as shown in Figure 1.1.

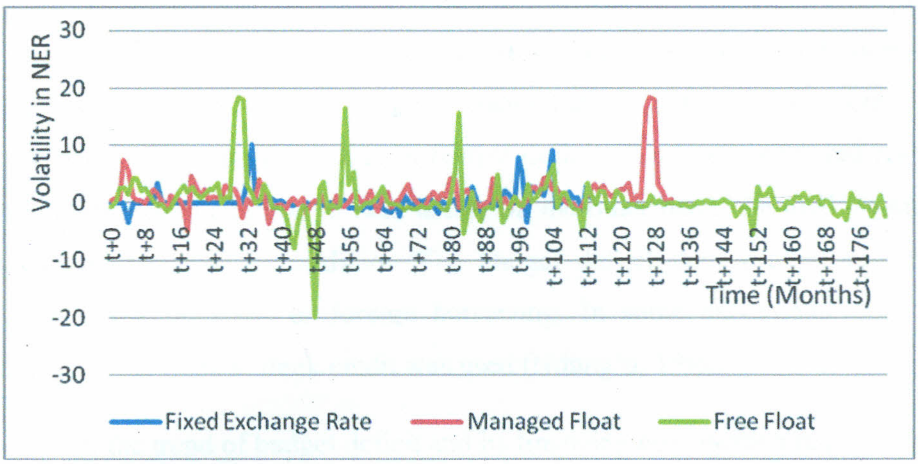

Figure 1.1: Comparative volatilities in exchange rate across regimes

Sources of data: IMF (2008) International Financial Statistics

Fig 1.1 compares exchange rate volatility across the three major exchange rate regimes in Kenya, namely: the crawling peg of the 1973 to 1982, the managed floats of the 1982 to 1990, and lastly the free float from 1993 to 2005. Between 1990 and 1993, there was the dual exchange rate system. $t+0$ represents the year when exchange rate regime became operational (so that t+1 is the next period and so on). Thus, $t+0$ is 1973:01 for fixed rate; 1982:09 for managed float and 1993:11 for free float. The dual exchange rate was included and is between t+97 and t+133 for the managed float and between t+0 and t+36 for the free float. Thus, overshooting in managed float between t+126 and t+132 occurred during dual exchange rate system. This figure portray free float as highly volatile immediately after its adoption, but volatility declined with time. The managed float is relatively less volatile compared to the free float, and the fixed exchange rate is less volatile of all the three.

The overshooting in managed float in t+126 (1993:03) coincides with that in t+29 (1993:03) in the free float, since both regimes included the dual exchange rate system. During this period, the government increased weekly Treasury bill auction from Kenya Shillings 1 billion to Kenya Shillings 5 billion. There was coffee boom in t+48 (1994:10) which improved cash inflows position leading to the appreciation of Kenya Shillings. In 1995:06, foreign exchange bearer certificates were introduced and de jure interest rate was freed. This period coincides with t+56. The government ceased to redeem foreign exchange at official rate in t+82 (1997:08), which became redeemable only at market rate (Ryan, 2002).

1.1.4 Budget Deficit and its Financing

For most of the period except 1995, 1999 and 2000, the revenues raised fell short of the government expenditures to meet the growing demands for infrastructure and social service as well as debt maintenance, thus resulting in budget deficit. Total non-borrowed resources include non-tax resources in addition to total taxes. On the other hand, the total expenditure includes capital and recurrent expenditure. The budget deficit that resulted was mostly financed through either domestic or foreign borrowing. In some exceptions, like in the general election of 1992, Central Bank credit was used (Ndung'u, 1999).

A proper analysis of the trend of budget deficit and its financing composition requires that the period be divided into three phases to correspond to the crawling peg, managed float and free float exchange rate regime. This is helpful in bringing out clearly the behaviour of the budget deficit and its financing composition during the different exchange rate regimes, and also any structural breaks. Table 1.1 shows the average government revenues, expenditures and budget deficits as a percentage of GDP for each of the three regimes.

Table 1.1: Revenues, Expenditures and Deficits as a percentage of GDP

	Phases/ Exchange rate regime		
	Fixed 1973 to 1982	Managed Float 1983 to 1990	Flexible 1991 to 2005
Total Non-Borrowed Resources (% GDP)	24.53	24.19	24.11
Total Expenditures (% of GDP)	30.26	28.49	25.93
Budget Deficit Excluding Grants (% of GDP)	-5.73	-4.30	-1.83

Sources of data: IMF (2008) International Financial Statistics

As presented in Table 1.1, between 1970s and early 1990s, the Kenyan government expenditure expanded quickly, with the total gross government expenditures averaging 30 percent of GDP per year during the period 1973 to 1982, then declining to an average of 29 percent of GDP per year during the period 1983 to 1990, and then to an average of 26 percent of GDP per year between 1991 and 2005.

Although there was growth in revenue collections, total non-borrowed resources as a percentage of GDP, on average, remained fairly stable across the three phases. It, however, lagged behind the growth in government expenditure for most of the years. The persistent problem of budget deficit remained high until after 1994, averaging 5.7 percent of GDP per year between 1973 and 1982, then declining to an average of 4.3 percent per year between 1983 and 1990, before falling to an average of 1.8 percent between 1991 and 2005.

The first phase experienced several shocks. It opened with the first oil crisis in 1973, then the loss of market due to the collapse of the EAC, the second oil crisis of 1977 to 1979, and the coffee boom of 1976 to 1979. Coffee boom led to expansion in government expenditure. Accompanying the policy switch of exchange rate in 1982 was the fiscal stabilization programme, which saw a reduction in the overall budget deficit by 3% of the GDP. These changes made Kenya the darling of the donor community, resulting in availability of foreign financing for budgetary support. Thus, the fiscal stability was short-lived as government expenditures began rising as a result and so did the budget deficit during the period 1982 to 1987.

On the contrary, for most of the 1990s, the strained relation between Kenya and the international lending institution meant that foreign budgetary support was limited and uncertain. This exacerbated the fiscal indiscipline and made the government to resort to the use of central bank credit and the expensive domestic short term borrowings to finance budget deficit. This led to high inflation as money supply grew by 47 percent in 1992 alone (Ndung'u, 1999), and high interest rates as domestic borrowing through weekly treasury bills auctions was adjusted upward by 400 percent in 1993 (Ryan, 2002).

Interest payments, for example, rose from 6 percent of expenditure in 1972 to 41 percent in the aftermath of the 1993 devaluation, to fall back to 22 percent by 1998 and 16 percent of total government expenditure in 1999 (IFS, 2008). Despite being at one of its lowest level in

1990s, interest payments on domestic debt for the fiscal year 1999 were more than double those allocated to financing external debt, even though the stock of external debt was about three times the stock of domestic debt (Rwegasira and Mwega, 2003). The high domestic interest rates in the 1990s meant that servicing of domestic debt consumed a significant proportion of government revenues, implying either less expenditure on other items or a wider budget deficit. In addition, high domestic interest rate together with the fiscal imbalances that accompanied the rising expenditure exerted pressure on domestic credit, hence crowding out private sector investments as well as causing inflationary pressures in the economy.

The fiscal adjustment programme that started in 1994 with severe cutting of expenditures and the government effort to reduce external debt, could be responsible for the low level of budget deficit after 1993. These successfully brought down the budget deficit to zero by 1995 and the external debt service payments from 34% of the cost of export of goods and services in 1990 to 14% in 2001. The strained relation between Kenya and the international donor community in the 1990s contributed, since the government could not access foreign resources for budgetary support in most of the years. Conversely, the relation improved with the election of a new government in 2002, which marked the beginning of an increase in aid flows as a result of increase in government borrowing to finance development projects on infrastructure as well as increase inflows of grants to support government efforts in social sectors and humanitarian responses to droughts, following successful Consultative Group (CG) meetings in 2003 and 2005 as cited in Mwega (2009).

Figure 1.2 shows the trend in the level of budget deficit and its financing composition as a percentage of GDP. Budget deficit values lies below zero while its financing composition lies above zero, indicating net borrowings for each of the component. The budget deficit values above zero indicate a budget surplus and the budget deficit values of zero indicates a balanced budget. On the other hand, budget deficit financing composition values less than zero indicates net repayments.

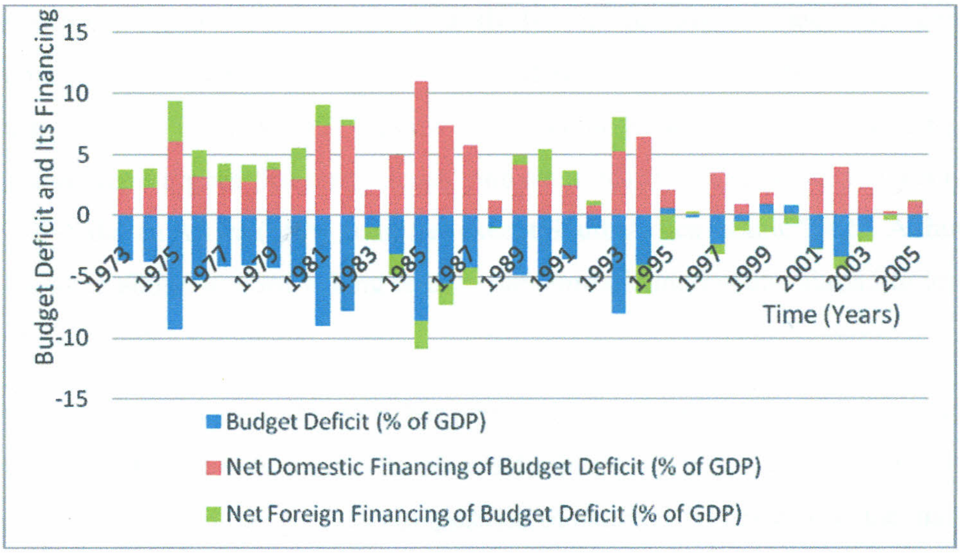

Figure 1.2: Budget deficit and its financing composition (% of GDP)

Sources: IMF (2008) International Financial Statistics.

Clearly from figure 1.2, both the net domestic and the net foreign financing of budget deficit indicated a net borrowing position during the fixed exchange rate regime up to 1982, when with the shift to the managed float exchange rate system, the net foreign financing of budget deficit initially shifted to a net repayment position. It then rose again to a net borrowing position after 1989, and then back to a net repayment position in 1995. This is the period immediately following the adoption of the free floating exchange rate. The net repayment position remained up to 2005. Unlike the net foreign financing, the net domestic financing of budget deficit remained in a net borrowing position for the entire period. During the period, budget deficit as a percentage of GDP was relatively high in the first two regimes but declined in the free float exchange rate regime.

1.1.5 The Link between Exchange Rate and the Budget Deficit Financing

The evolution and repayment of public debt consist of annual flows of domestic public debt and the annual flows of external public debt, which represents domestic financing and external financing of budget deficit, respectively. In addition, there is the monetary base created by augmenting the supply of money, reducing the reserves of the country as well as sale of government assets (a process known as privatisation of public enterprises). The interaction between the annual domestic and external inflows on one hand, and the annual domestic and external outflows on the other for budgetary support, gives the net domestic and the net foreign financing of budget deficit, respectively. The question is whether a country is able to choose whatever source to borrow from, whatever amount to borrow, on which currency the borrowings would be, and for how long it would borrow without any constraints. Some past studies have argued that many developing countries are constrained, and this is the case in the Sub-Saharan Africa (SSA) countries except South Africa (Kahn, 2005). Although, Kenya shows some ability to borrow long term in the domestic market and abroad in foreign currencies, these abilities are limited.

The inability of Kenya to borrow abroad in her own currency and to borrow in local currency at long maturities and fixed rates even at home, creates two problems: it exposes the country to currency mismatch due to the currency composition of external debt as well as the maturity mismatch caused by the short-term nature of the domestic currency debt (Hausmann *et al.*, 2003; Kahn, 2005). In Kenya, the problem of currency mismatch occurred due to continued incurrence of budget deficit financed partly by external borrowing, leading to rising level of foreign currencies denominated external debt. In this case, the rising level of public debt together with the depreciating local currency exerted upward pressures on expenditures as the resources to sustain and service public debt rose with the level of public debt, hence pushing the government deeper into further fiscal indiscipline by leading to an even wider budget deficit or reductions in the expenditures for other items.

The larger the budget deficit, the larger the financing requirements, which put continued pressure on inflation and exchange rates, and strained trade and financial liberalization policies as was the case in the 1990s, which in turn led to rising value of the dollar denominated external debt and so did interest payments on this debt as BOP seemed not to have improved with the depreciation of the Kenya Shillings. The reduction in expenditures, especially for capital items, could be responsible for the dismal performance of the economy in 1980s and 1990s. A reduction in expenditures in some way led to a reduction in the current output and also the future output. There is evidence of negative relationship between real output and exchange rate in Kenya (Ndung'u, 1999). A reduction in output leads to depreciation in Kenya Shillings.

The depreciating Kenya Shillings led to a vicious cycle, whereby the rising level of the dollar denominated external debt and its interest payment in turn led to increase in the budgetary resource requirements for the same stock of public external debt in dollar terms. This led to increase in borrowings or poor economic performance as resources were diverted to service public external debt. Due to lack of a well developed domestic bond market, increase in the domestic borrowings led to rising domestic interest rates and extensive foreign participations in domestic bond markets, making the Kenya Shillings vulnerable. When a country is exposed to currency mismatch, then in the event of a currency crisis, a depreciating domestic currency and the difficulty of rolling over short-term debt leads to balance sheet problems. This becomes a key source of financial instability and possibility of default (Kahn, 2005).

All the same, even in the case of maturity mismatch, the country is exposed to sudden movements in exchange rate in two ways. First, through accumulated past domestic financing of budget deficit, if the bulk of it is widely held by foreigners, due possibly to the narrow domestic financial market. Extensive foreign participation in the domestic bond markets occurs due to rising relative domestic to foreign real interest rate, resulting in exchange rate risk premium, enlarged by an expected depreciation of the local currency. This leads to capital inflows to take advantage of high yielding domestic currency. In this case, a change for example in the perceived risk could lead to mass capital outflows, leading to a depreciating local currency and rising domestic interest rate.

Secondly, since the government cannot borrow long-term in local currency and at a fixed rate, it has to regularly roll over the domestic-currency short term debt at maturity. Given the narrow domestic financial markets, it is likely that the domestic short term interest rate will rise whenever government tries to rollover domestic short term debt. If the government borrowing in the domestic market is rising, it will lead to higher domestic interest rates. This in turn can lead to crowding out of private investment, increase in capital inflows as well as increased foreign participation in the domestic bond market. In addition, the interest cost of domestic debts can rise quickly along with increases in domestic borrowings, especially in shallow financial markets.

The foregoing analysis clearly shows that the external financing of the budget deficit, domestic financing of budget deficit, the exchange rate, the domestic public debt and the foreign currency denominated public external debt as well as the level of output, are all interrelated through currency and maturity mismatches. What is not clear is whether the behaviour of the financing composition of the budget deficit after liberalization is due to this interrelationship or due to government change in policy to reduce the rising cost of servicing dollar denominated external debt due to depreciating Kenya Shillings, and how this behaviour affects exchange rate. This interrelationship is the subject of investigation in this study. Figure 1.3 shows the trend of the budget deficit and its financing composition as a percentage of GDP; indexed with 1973 as the base. Indexed values have been preferred as they scale the series to a common base.

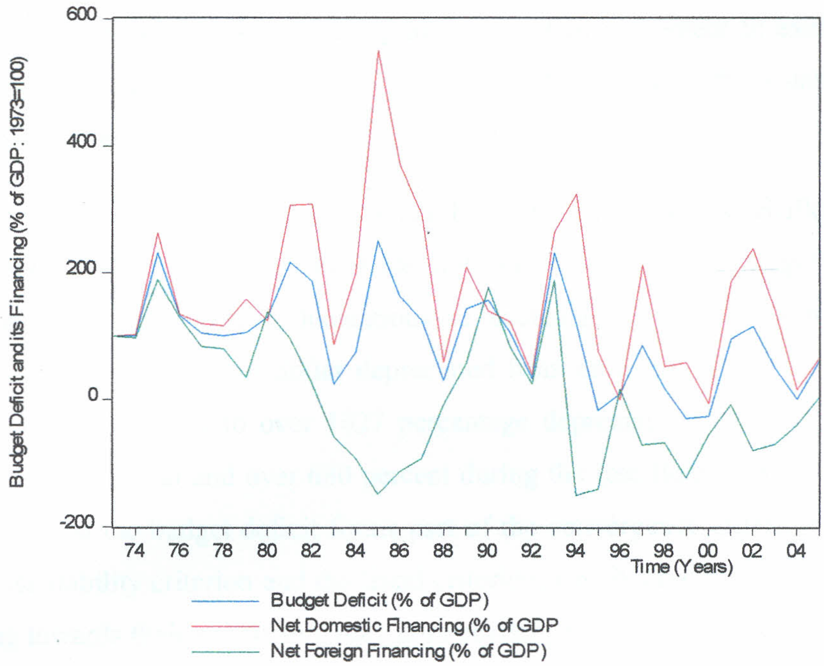

Figure 1.3: Trend of the Budget Deficit and its Financing as a percentage of GDP (Indexed values)

Sources: IMF (2008) International Finance Statistics.

From figure 1.3, the trend in the net domestic, the net foreign financing and the budget deficit jointly trailed each other during the fixed exchange rate regime, 1973 to 1980, and during the dual exchange rate system, 1990 to 1993. But this was not the case in the managed float, 1981 to 1990, and the free float, 1993 to 2005, whereby the trend of the net domestic and net external financing of the budget deficit tended to deviate from each other. This suggests a strong relationship between the exchange rate regime and the budget deficit, more specifically its financing composition. Furthermore, this observation together with those in Appendix 2 raises a critical question of whether it is appropriate to use aggregated budget deficit or its financing composition. Use of aggregated budget deficit may conceal the exact effects of the fiscal policy on the exchange rate, thus giving a false picture.

There are several reasons as to why budget deficit financing and exchange rate volatility were of research interest in this study. Firstly, although some past studies such as Canales-Kriljenko and Habermeier (2004) and Hsing (2006) had successfully linked exchange rate and budget deficit, there was need to consider whether budget deficit financing causes exchange rate volatility. The choice of the financing composition of budget deficit was heavily influenced by Flood and Rose (1999), who argued that if one introduces a variable that behaves completely differently across regimes to explain movement in exchange rate, alongside macroeconomic fundamentals, then it will significantly alter the volatility of the macroeconomic fundamentals.

Secondly, the management of budget deficit has been the single largest challenge in the Kenyan economy, one that the government has not been able to tackle (Legovini, 2002). Thirdly, Kenya has witnessed real fluctuations in exchange rate in the last 30 years. Quantitatively, Kenya Shillings per dollar depreciated from an average of 7.02 in 1973 to 79.17 in 2004, which translate to over 1027 percentage depreciation, averaging over 107 percent during managed float and over 680 percent during the free float (IFS, 2008). Lastly, the exchange rate and the budget deficit forms part of the convergence criteria of the EAC: the exchange rate stability criterion and the fiscal criterion, which although partner states are already working towards their attainment, may pose challenges for Kenya, since the exchange rate has not been stable and the budget deficit (excluding grants) to GDP ratio has most of the time not been within the acceptable range.

It is against this backdrop that this study identified the need to consider the impact of budget deficit financing on exchange rate volatility, and explore ways in which Kenya can bring these two variables within the convergence criteria by 2012. Thus, these two issues need critical empirical examination in Kenya, more so, since in policy literature, the conventional wisdom is that exchange rate-based stabilization programmes induce more fiscal discipline than do money-based programmes. Hence, exchange rate stability is most likely to result in the fiscal discipline and vice versa, if fiscal position affects exchange rate in the case of Kenya.

1.2 Statement of the Problem

Exchange rate is an important price for any open economy whether small or large. Thus, its stability is top on the agenda of any country's macroeconomic goals, since it determines the level of imports and exports, thereby the equilibrium in the balance of payment and ultimately the rate of economic growth. On the other hand, the level of budget deficit is associated with many ills in the economy, including instability in prices such as interest rates, general price levels and the exchange rate.

Instability in exchange rate imposes risks on the participants of the foreign exchange markets. Thus, predicting changes in exchange rates would allow businesses, investors and policymakers to make informed decisions when conducting international businesses and economic policies. Unfortunately, this has remained a daunting task for a long time and is one of the longstanding puzzles in international economics. It is so, probably due to problems associated with variables such as structural breaks in variables (Chinn, 1997), inappropriate modelling of expectation formation (Meese, 1990) and aggregation of variables problems.

In Kenya, in the 1990s, foreign financing of budget deficit was suspended several times. This period was associated with high exchange rate volatility as well. It could be the case whereby changes in the foreign financing of budget deficit could explain changes in exchange rate volatility. Therefore, taking the level of budget deficit rather than its financing composition may lead to specification and estimation problems such as poor fit, statistically insignificant parameters and sign-reversal, especially if the effects of financing composition of budget deficit are compensatory. Consequently, these may result in failure of budget deficit to explain movements in exchange rate. Thus, the need to investigate the effects of using the financing composition of budget deficit instead of the level of budget deficit in modelling of exchange rate volatility. In view of this, the following research questions were addressed.

1.3 Research Questions

This study sought to tackle the following questions:

i. What are the effects of using the financing composition of budget deficit instead of the level of budget deficit in modelling of exchange rate volatility?

ii. What are the effects of budget deficit (or its financing composition) and macroeconomic fundamentals on exchange rate volatility under different exchange rate regimes?

iii. What policy implications can be drawn from the findings?

1.4 Objectives of the Study

The overall goal of this study was to establish the relationship between budget deficit financing and nominal exchange rate volatility in Kenya.

Specific objectives included:

i. To analyse the effects of using the financing composition of budget deficit instead of budget deficit in modelling of exchange rate volatility.

ii. To determine the effects of budget deficit financing and macroeconomic fundamentals on exchange rate volatility under different exchange rate regimes.

iii. To draw policy implications based on the empirical findings.

1.5 Significance of the Study

This study provides a framework for identifying the underlying factors causing instability in exchange rate. It set a basis from which the monetary authority can identify and target the shock underlying the exchange rate volatility, unless it is simultaneous opposing shocks under which the monetary authority is tasked to determine the direction and the relative importance of each force and possibly the required intervention. In this way, it improves on the exchange rate targeting as it guides on the level of intervention required to keep the exchange rate at a certain level.

Secondly, this research contributes to the international finance literature by analysing the effects of aggregation in modelling of exchange rate volatility. Aggregation problem if it exists in estimation can dwarf the total effects of the underlying sub-variables/sub-units or even result in sign reversal. Lastly, it is one of the studies on the investigation of the long run relationship between nominal exchange rate volatility, the level of budget deficit and macroeconomic fundamentals in developing countries.

1.6 Scope and Organization of this Study

Monthly time series data for the period between 1973:01 and 2005:12 was used. The rationale for choosing this period was that switching to the floating exchange rate started in 1973 after the collapse of the Bretton Wood System, while 2005 gives the last year when domestic and external borrowing ceased to be the major source of budget deficit financing as the government started privatisation, whose proceeds went towards financing part of the budget deficit. Considering periods beyond 2005 could complicate structural breaks, as it is likely that structural breaks, other than those attributable to changes in exchange rate regime could occur.

The study is organized into five chapters. Chapter one introduces the study and its objectives. In chapter two, relevant theoretical and empirical literatures are reviewed and then the theoretical framework is presented. The research design and methodology is developed in chapter three. Empirical results are presented and discussed in chapter four, and finally summary, conclusion and policy implications are presented in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, theoretical and empirical literature on the determinants of nominal exchange rate volatility was reviewed.

2.2 Theoretical Literature

In this section, major theoretical arguments on determination of long-run equilibrium exchange rate are explained. The theoretical model in exchange rate volatility generally seeks to address the central problem of designing and fitting a robust model for accurate prediction of exchange rate and its volatility. The exchange rate theories explained in this section was classified into three kinds: partial equilibrium models, general equilibrium models and hybrid models. Partial equilibrium models included PPP and the interest rate parity models, which only consider the goods market and the assets market, respectively; and the external equilibrium model, which states that the exchange rate is determined by the balance of payments.

General exchange rate equilibrium models include the Mundell- Fleming model, which deals with the equilibrium of the goods market, money market and balance of payments and the Balassa-Samuelson model, which is built on the maximization of firm's profit. A simple monetary model with price flexibility and the Dornbusch Overshooting model are obtained by combining the monetary equilibrium with the adjustment of price and output toward their long run equilibrium.

2.2.1 Purchasing Power Parity

It is also called the inflation theory of exchange rates. Purchasing power parity (PPP) can be traced back to sixteen-century Spain and early seventeen century England, but Swedish economist Cassel was the first to name the theory PPP in 1918. Cassel believed that if an exchange rate was not at parity, it was in disequilibria and through arbitrage, either the exchange rate or the purchasing power would adjust until parity was achieved.

Purchasing power parity is a generalised form of the Law of One Price which states that identical goods should be sold at identical prices after adjusting for exchange rates. Profit opportunities should ensure that its prices are equal. Under the law of one price, exchange rate is the ratio of domestic price of a good to the ratio of the foreign price of an exactly identical good. That is $P_i = S \times P_i^*$. Where P_i and P_i^* is the domestic and foreign price of good i, respectively and S denote the nominal exchange rate, which expresses foreign currency in terms of the local currency. If the prices of each good are equalized between the two countries and if the goods baskets and their weights in the two countries are the same, then the absolute PPP holds:

$$S = \frac{P}{P^*} \quad \text{(2.1)}$$

Absolute PPP theory was first presented to deal with the price relationship of goods with their values in different currencies. The theory requires very strong preconditions. Generally, absolute PPP holds in an integrated, competitive product market with the implicit assumption of a risk-neutral world, in which the goods can be traded freely without transportation costs, tariffs, export quotas and other trade barriers. However, in real world, most of these assumptions are unrealistic. In the real world, for example, each economy produces and consumes tens of thousands of commodities and services, many of which have different prices from country to country because of transport costs, tariffs and other trade barriers.

Absolute PPP is generally viewed as a condition of goods market equilibrium. Under absolute PPP, both the home and foreign market are integrated into a single market. Since it does not deal with money markets and the balance of international payments, it is considered a partial equilibrium theory. Perhaps because absolute PPP requires many strong impractical preconditions, it fails in explaining practical phenomenon, and signs of large persistent deviations from absolute PPP have been documented.

Although absolute PPP may contradict practical data, this does not imply market failure (Sideris, 2006). It may simply reflect the inability, without expenses, to instantaneously move goods from one place to another. Thus, a more general version of PPP called the relative purchasing power parity was introduced to describe the relationship of prices with the exchange rate in different economies. Generally, relative PPP can be derived by assuming that transaction costs are proportionately related to price level. Assume that P_t and P_t^* is the domestic and foreign price of an identical good at time t, respectively. k represents the cost of transport and is constant percentage of the price, and such that transport cost becomes kP_t. Then the domestic price of a foreign good would be the price in foreign currency multiplied by the exchange rate in local currency, $S_tP_t^*$, that is

$$(1+k)P_t = S_tP_t^* \quad \text{(2.2)}$$

Taking the logarithm and differentiating each side of equation (2.2) with respect to time t, we get relative PPP expressed by

$$\frac{\Delta S_t}{S_t} = \frac{\Delta P_t}{P_t} - \frac{\Delta P_t^*}{P_t^*}, \quad \text{(2.3)}$$

Equation (2.3) states that the relative change of the exchange rate equals the difference of the inflation rate between the two economies.

If we let $\frac{\Delta S_t}{S_t} = s_t$, $\frac{\Delta P_t}{P_t} = p_t$ and $\frac{\Delta P_t^*}{P_t^*} = p_t^*$, then Equation (2.3) can be written as

$$s_t = p_t - p_t^* \quad \text{(2.4)}$$

This means that differences in the inflation rate in the two countries causes changes in nominal exchange rate between two countries. That is, whenever a country's price level is expected to fall relative to other country's price level, its currency should appreciate relative to other country's currency, and the reverse is true for an expected rise in relative price level. Equation (2.4) can also be arrived at directly by taking the logarithm and differentiating equation (2.1). If the real exchange rate is denoted by the ratio of national price levels,

$$q_t = \frac{S_tP_t^*}{P_t}, \quad \text{(2.5)}$$

The PPP theory is based on the assumption that real exchange rates are fixed. If absolute PPP holds, the real exchange rate equals one. If relative PPP holds, the real exchange rate should be a constant, but not necessarily equal to one. If an economy adopts a fixed exchange rate regime, the relative PPP model forecasts that the home prices change at the same speed as foreign prices. Conversely, if the inflation rates in the two economies are the same, according to relative PPP, the exchange rate should be constant.

Purchasing power parity does not hold in the short run even for goods and services that are traded internationally (Sideris, 2006). But purchasing power parity does tend to hold in the long run. In addition, PPP is not a very reliable determinant, since it does not take into considerations changes in technology, commercial policies, labour force, tastes and preferences and the national productivity, which in turn changes the real exchange rate. Despite its weaknesses, the Relative PPP approach continues to be applied to date. Relative PPP provides a connection between the home and foreign country in exchange rate models which is also applicable to exchange rate volatility in this study.

2.2.2 Interest Rate Parity

The interest rate parity condition was developed by Keynes in 1923 to link the exchange rate, interest rate and inflation. The theory contents that a rise in the interest rate of the home country is usually followed by the appreciation of the home currency, and a fall in the home interest rate is followed by a depreciation of the home currency (Frankel, 1979). This indicates that the price of assets plays a role in exchange rate variations. This theory has two forms: covered interest rate parity (CIRP) and uncovered interest rate parity (UIRP). CIRP describes the relationship of the spot market and forward market exchange rates with interest rates on bonds in two economies. UIRP describes the relationship of the spot and expected exchange rate with nominal interest rates on bonds in two economies.

The Covered Interest Rate Parity (CIRP) begins by assuming two countries; the home country and the foreign country. The nominal interest rate at time t in the home country is i_t and that of the foreign country is i_t^*, the spot exchange rate is S_t and the forward exchange rate at time t+1 is S_{t+1}. If a local investor invests one unit of the local currency for a single period, the return would be i_t at time t+1, and the sum of the principal and interest at time t+1 is $1+i_t$. Alternatively, this investor can convert that unit of local currency into foreign currency and invest it in foreign assets, which pay i_t^* as interest at time t. Thus, the sum of the principal and interest at time t+1 in foreign currency is $\frac{1+i_t^*}{S_t}$. However, since the forward exchange rate is S_{t+1}, this sum of the principal and interest in local currency is $\frac{S_{t+1} \times (1+i_t^*)}{S_t}$.

In a perfectly competitive market, the returns differential is less likely to persist for long. In other words, the return from investing in local currency must be the same as the return from investing in foreign currency. This relation can be expressed using the covered interest rate parity condition:

$$\frac{1+i_t}{1+i_t^*} = \frac{S_{t+1}}{S_t} \qquad (2.6)$$

Equation (2.6) is the precise form of the covered interest rate parity condition.

Let $\frac{S_{t+1}}{S_t} = 1 + f_{t+1}$, where f_{t+1} is the forward premium (discount), that is, the proportion by which the forward exchange rate exceeds (falls below) the spot exchange rate. Equation (2.6) becomes

$$1+i_t = (1+i_t^*)(1+f_{t+1}) = 1+i_t^* + f_{t+1} + i_t^* f_{t+1}$$

But since $i_t^* f_{t+1}$ is negligible it can be excluded. Thus, we have

$$i_t - i_t^* = f_{t+1} \qquad (2.7)$$

Equation (2.7) is the covered interest rate parity, which states that the domestic interest rate must be higher (lower) than the foreign interest rate by an amount equal to the forward premium (discount) on domestic currency. According to CIRP, if the exchange rate is fixed, the interest rate of the two countries should be equal. Thus, a small country with a pegged exchange rate regime cannot carry out monetary policy independently.

The Uncovered Interest Rate Parity (UIRP) considers uncertain environment without hedging where investors faces uncertainty over future outcomes. In a rational expectation framework, the forward exchange rate may be strongly influenced by the market expectations about the future exchange rate, if new information is taken into consideration. In this case the uncovered interest rate parity condition may hold. Given all variables, remain as earlier defined except the forward exchange rate S_{t+1} is substituted by the expected exchange rate $E(S_{t+1})$, the UIRP condition can be written as

$$\frac{1+i_t}{1+i_t^*} = \frac{E(S_{t+1})}{S_t} \qquad (2.8)$$

Equation (2.8) is the uncovered interest rate parity. Like PPP, the UIRP does not allow for investor's preferences. In other words, equation (2.8) is derived under the condition that investors are risk neutral. This means that agents are concerned only with average returns.

Similarly, the uncovered interest parity can be presented as:

$$i_t - i_t^* = \Delta s_t^e, \qquad (2.9)$$

where $1+\Delta s_t^e = \frac{E(S_{t+1})}{S_t}$ and Δs_t^e, is the expected rate of appreciation of foreign currency. Equation (2.9) states that the domestic interest rate must be higher than the foreign interest rate by an amount equal to the appreciation rate of foreign currency. As with PPP, uncovered and covered interest rate parity conditions are derived under the assumption of no transaction barriers, a perfectly competitive capital market and no arbitrage opportunities at equilibrium. Clearly, this is a partial equilibrium, as it only considers the assets market. The uncovered interest parity is one of the building blocks of the synthesized monetary model used in this study.

2.2.3 The Mundell-Fleming Model

The previous two models reviewed did not consider the role of money, thus the effect on the nominal exchange rate of monetary policy is not clear. The Mundell-Fleming model is an economic model that was developed by Robert Mundell and Marcus Fleming in 1960s (Dornbusch, 1986). The model is an extension of the IS-LM model. Whereas the traditional IS-LM Model deals with economy under autarky (or a closed economy), the Mundell-Fleming model tries to describe an open economy. By extending the IS-LM model to the case of an open economy, the model provides an understanding of how the exchange rate is determined. The IS-LM model considers three markets: goods, money and assets, and is mainly used to analyse the impacts of monetary policy and fiscal policy. When the goods market is not in full employment equilibrium level, it shows how to use fiscal policy and monetary policy to adjust the economy to full employment equilibrium. Since only two of the three markets are independent, the IS-LM model only establishes a linkage between the money market and goods market. In the Mundell-Fleming model, the balance of international payments is considered as another equilibrium condition in addition to the money market and goods market.

The first equilibrium is the goods market equilibrium, which is given by the IS equation

$$Y = C + I + G + (X - M) \quad (2.10)$$

where Y denotes domestic national income; C = C(Y) denotes consumption, which is a function of income; I = I (i) denotes investment, which is a decreasing function of nominal interest rate i; G denotes government spending; X = X(Y*,q) denotes exports, which is an increasing function of foreign national income and real exchange rate. M = M(Y,q) denotes imports, which is an increasing function of domestic income and decreasing function of the real exchange rate.

The real exchange rate (q) is defined by

$$q = \frac{SP^*}{P},$$

where S is the nominal exchange rate; P, P* denote domestic and foreign prices, respectively.

The second equilibrium is the money market equilibrium, which is defined by the LM equation. Let Md/P = L(Y,i) represent real money demand, which is an increasing function of domestic income and decreasing function of the interest rate, and Ms represent money supply. The money market equilibrium condition can be expressed as

$$\frac{M^s}{P} = L(Y, i), \quad (2.11)$$

The final market equilibrium is the external equilibrium denoted by the BP equation

$$BP = CA + KA = 0 \quad (2.12)$$

where current account $CA = PX - SP^{*}M$ and capital account $KA = K(i - i^{*} - \Delta s^{e})$

The three are determined simultaneously. One of the most important issues addressed by the model is the so-called trilemma, which states that perfect capital mobility, monetary policy independence and a fixed exchange rate regime cannot be achieved simultaneously. Specifically, it argues that a country cannot sustain monetary policy independence in a fixed exchange rate regime with perfect capital mobility. However, this argument is made in a small country setting, and it is not necessarily true in a bigger economy. The model also predicts a perfect correlation between the level of exchange rate and the level of money supply in the long run. Another important implication is that devaluation may lead to further devaluation if fiscal discipline, inflation and balance of payments are not well managed, or if the assets market produces a self-fulfilling bubble. Finally, the impact of devaluation on the improvement of the current account may be weakened if an economy is heavily reliant on the re-export processing industry. The model used in this study inherited much of the dominant Mundell-Fleming Model, with some modification to capture budget deficit.

2.2.4 The Balassa-Samuelson Model

Since, price levels are determined by the interaction between supply and demand, which in turn are associated with producer and consumer's behaviour, a starting point for studying the determinants of the real exchange rate is to investigate producer's behaviour and consumer's behaviour, which are associated with the microeconomic foundations of exchange rate theory. In this subsection, from the angle of producer behaviour, the Balassa- Samuelson (B-S) model due to Balassa and Samuelson (1964) is presented. It shows clearly the role of productivity in the real exchange rate determination.

The standard version of the B-S model is presented using a single-factor aggregate production function. The model assumes that the production functions of traded goods (T) and non-traded goods take the following form:

$$Y_T = A_T L_T$$
$$Y_N = A_N L_N$$
$$Y_T^{*} = A_T^{*} L_T^{*}$$
$$Y_N^{*} = A_N^{*} L_N^{*}$$

where Y is production, A is a constant describing technology, and L is labour force. Foreign economy employs the same kind of technology as the domestic economy, but the value of the technological parameter (A) may differ. The subscript T denotes the traded goods sector and the subscript N the non-traded goods sector. This model also assumes that the law of one price holds for traded commodities and that the world price of traded commodities is equal to one without a loss of generality. In addition, labour is perfectly mobile between sectors within an economy, but immobile between economies. The mobility of labour ensures that the wage rates w are equal in all sectors of an economy. Price index is the weighted geometric average of prices of traded and non-traded goods:

$$P = (p_T)^{\gamma}(p_N)^{1-\gamma} = (p_N)^{1-\gamma} = \left(\frac{A_T}{A_N}\right)^{1-\gamma} \quad \text{.......... (2.13)}$$

where γ is the share of traded goods in total outputs. If this share is the same at home and abroad, then the relative price vis-à-vis the outside world is

$$\frac{P}{P^*} = \left(\frac{A_T / A_N}{A_T^* / A_N^*}\right)^{1-\gamma} \quad \text{.......... (2.14)}$$

Let $A_T = GDP_{nom}$, where GDP_{nom} is the nominal GDP per employee. Therefore, equation (2.14) can be re-written as

$$\frac{P}{P^*} = \left(\frac{GDP_{nom}}{GDP_{nom}^*}\right)^{1-\gamma}\left(\frac{A_N^*}{A_N}\right)^{1-\gamma} \quad \text{.......... (2.15)}$$

Equation (2.15) states that the relative price is determined by relative GDP and the relative technological level or productivity in non-traded goods sector of the two economies. Other things remaining the same, a higher nominal GDP growth in the home country than abroad, leads to an appreciation of the real exchange rate. On the other side, given the economic growth rates, higher productivity of non-traded goods in the home country than the foreign country will lead to depreciation of the real exchange rate.

The B-S model is one of the cornerstones of the traditional theory of the real equilibrium exchange rate. The key empirical observation underlying the model is that countries with higher productivity in traded goods compared with non-traded goods tends to have high price levels. The B-S model hypothesis states that productivity gains in the traded goods sector allow real wages to increase commensurately, and since wages are assumed to link the traded to the non-traded goods sector, wages and prices also increase in the non-traded goods sector. This leads to an increase in the overall price level in the economy, which in turn results in an appreciation of the real exchange rate.

The shortcomings of this model are clear. First, it assumes that the traded goods price at home is the same as that abroad. This is clearly unrealistic. Secondly, since it says nothing about the demand side, it is criticized by the Keynesian school, which regards price to be rigid or sticky. Thirdly, without considering the behaviour of consumers, or the demand side, it is difficult to interpret how market prices are formed. Last and most importantly, this model does not deal with the role of money; it can at best explain partly how the real exchange rate is determined. This model captures effect of differences in sectoral productivity in exchange rate. Productivity as one of the main drivers of movement in exchange rate is very important to this study.

2.2.5 The Flexible Price Monetary Model

The simple monetary model was originally created in a frictionless world with only one good and one bond, separately by Mussa (1976) and Frenkel (1976). In this model, money market equilibrium, PPP and UIRP are assumed to hold. This model has three building blocks.

The first is the money market equilibrium equation given by

$$m_t - p_t = -\eta i_t + \phi y_t \qquad (2.16)$$

where p is the log price level, i is the nominal interest rate, y is the log of real output and m is the log of money supply. The second block is purchasing power parity. Let s be the log of the nominal exchange rate, defined as the price of foreign currency in terms of local currency; p^* and p denote the log of the foreign country price of the goods basket and the log of the home currency price level. The purchasing power parity in log terms is

$$s_t = p_t - p_t^* \qquad (2.17)$$

The third building block is uncovered interest parity, which can be expressed as:

$$i_t = i_t^* + \left(E_t(s_{t+1}) - s_t\right) \quad (2.18)$$

where $\left(E_t(s_{t+1}) - s_t\right) = \Delta s_t^e$. Substituting equation (2.17) and equation (2.18) into money market equilibrium equation (2.16), we obtain

$$s_t = \frac{1}{1+\eta}\sum_{j=t}^{\infty}\left(\frac{\eta}{1+\eta}\right)^{j-t} E_t\left\{m_j - \phi y_j + \eta i_t^* - p_j^*\right\} \quad (2.19)$$

Equation (2.19) demonstrates that the exchange rate depends on both current values as well as expected future values of related variables. That is, an increase in the domestic money supply and foreign interest rate raises both the domestic price level and nominal exchange rate level; and that changes in real domestic income and the foreign price level have a negative effect on the domestic level and nominal interest rate.

In the extreme case of a fixed exchange rate regime, the domestic interest rate and price level are equal to their foreign counterparts. Therefore, money supply is endogenously determined by domestic output, the foreign interest rate and foreign price level:

$$m_j = \phi y_j - \eta i_t^* + p_j^* \quad (2.20)$$

The model did not take into consideration the deviations in exchange rate due to sticky good prices which is considered in this study.

2.2.6 Dornbusch Overshooting Model

The evidence that the choice of exchange rate regime can have important effects on real variables motivated a sticky price extension of the flexible exchange rate monetary model. This yielded the elegant Dornbusch Overshooting model, which was presented in the influential masterpiece "Expectations and Exchange Rate Dynamics" by Rudiger Dornbusch in 1976. Under the Dornbusch (1976) model, uncovered interest rate parity and the money market equilibrium of the flexible monetary model are included. However, the assumption of flexible prices is replaced by sticky prices. Thus, the first condition in Dornbusch model is the monetary equilibrium:

$$m_t - p_t = -\eta i_t + \phi y_t \quad (2.21)$$

where m is the money supply, p is the domestic price level, and y is domestic output, all in logarithms; η and φ are positive parameters. Equation (2.21) implies that higher interest rates raise the opportunity cost of holding money and thereby lower the demand for money; on the other hand, a higher interest rate also means high costs of speculation, which lowers the demand of money as well. Conversely, an increase in output raises the transaction demand for money. Finally, the demand for money is positively related to the level of prices. The second condition is uncovered interest rate parity, which can be rewritten as

$$i_t = i_t^* + \left(E_t(s_{t+1}) - s_t\right) \qquad (2.22)$$

where s is the logarithm of the exchange rate (home currency price of foreign currency), and E_t denotes market expectations based on information at time t. $i_{t+1} = \log(1+i_{t+1})$ and $i^* = \log(1+i^*)$ are approximately correct. The foreign interest rate i^* is taken as a given exogenous variable. In accordance with uncovered interest rate parity, the home interest rate must be equal to the foreign interest rate i^* plus the expected depreciation rate of the home currency $E_t\left(s_{t+1} - s_t\right)$.

Unlike under the perfectly flexible price model, the prices of goods are sticky and cannot adjust immediately to clear the market in the Dornbusch model. With sticky prices, an adjustment mechanism is needed for an economy to converge to its equilibrium path in which full employment is realized. Given the magnitude of the departure of the real exchange rate from its long-term equilibrium, the force to pull it back to equilibrium will increase. Dornbusch assumes that if the real exchange rate rises over its long-term equilibrium level, or if the foreign currency is overvalued or the domestic currency is undervalued, the demand for domestic goods will increase. On the other hand, if the real exchange rate falls below its long-term equilibrium level, or the foreign currency is undervalued or domestic currency is overvalued, then the demand of domestic goods will fall. In this connection, the third condition is an adjustment mechanism of the demand for domestic goods, which can be expressed as

$$y_t^d = \bar{y} + \delta\left(s_t + p^* - p_t - \bar{q}\right) = \bar{y} + \delta\left(q_t - \bar{q}\right), \qquad (2.23)$$

Where p and p^* are the logarithms of the domestic price level P in domestic currency and foreign price levels, respectively, with p^* in foreign currency, δ is a constant greater than zero, $q_t = \log\left(S_t P^* / P\right) = s_t + p^* - p_t$ is the real exchange rate at time t, $\bar{q} = \log\left(SP^* / P\right) = s + p^* - p$, and y denote real exchange rate at which full employment is realized and the exogenous long-term equilibrium output, respectively.

The fourth condition is the price adjustment equation. Keynes assumed that the domestic price level p does not move instantaneously in response to unanticipated monetary disturbances, but adjusts only slowly over time. However, under Dornbusch's model the feature of sticky prices is different from that in the Mundell-Flemming model where the domestic price level is basically assumed to be fixed.

Using the price adjustment mechanism proposed by Mussa (1982), which is better suited than Dornbusch's original formulation to dealing with more complex exogenous shocks, the sticky-price adjustment process can be described as

$$p_{t+1} = p_t + \psi\left(y_t^d - \bar{y}\right) + \left(s_{t+1} - s_t\right) \quad \text{......} \quad (2.24)$$

The Dornbusch model is well known for its overshooting phenomenon, which states that one permanent change in the money supply must lead to a proportionate change in the price level and the exchange rate in the long run. But in the short run, the price level is fixed and the nominal exchange rate must overshoot its long-run equilibrium. That is, any initial disturbance of money supply will cause a larger rise in exchange rate in the short-run than in the long-run. Another significant conclusion of the Dornbusch model is that the impact on the exchange rate of a monetary shock is greater when prices are sticky than when they are flexible. The third conclusion is that the exchange rate converges to its flexible-price equilibrium value following an initial overshooting after a shock and that the nominal exchange rate is more volatile than the real exchange rate when $\psi\delta < 1$.

A central conclusion of the model is that with sticky prices and flexible exchange rates, monetary shocks will impact on the real economy, leading to large changes in prices and output and prolonged adjustment. If the exchange rate is fixed, the real effects of money demand shocks can be eliminated by setting money supply to money demand. The model also states that the exchange rate policy is to some extent inconsistent with the independence of monetary policy. When a real shock occurs, say a long-run rise in the real exchange rate, the model forecasts that a new full employment equilibrium adjustment will occur immediately under a floating exchange rate regime, and need not change the price level. If the exchange rate were fixed, in order to recover the real economy to equilibrium, the entire burden would have to be borne by the prices of goods. But because these prices are sticky, it is a time-consuming process for the economy to reach equilibrium.

The deficiencies in this model include the inability to deal adequately with the current account and fiscal policy dynamics, or more fundamentally, with welfare issues, because it lacks a micro foundation. In addition, it is premised on the assumption that capital is perfectly mobile and the market is clear. In cases where capital mobility is imperfect, or where capital control is stringent, as in developing countries, there is a lot of room for the model to be improved. Finally, a fixed exchange rate regime may not be a viable option in the long run, given the limited ability of an economy to endure pervasive speculative attacks on a fixed exchange rate. Finally, the model in its original formulation was intended to represent equilibrium at a point in time. This model provided a basis of relaxing the price flexibility assumptions in the flexible price monetary model used in this study.

2.2.7 Balance of Payment Model

The Balance of Payment Approach is based on the assumptions that there exists an exchange rate and there exists internal and external equilibrium. The internal equilibrium is based on the assumption of the existence of full employment. The external equilibrium is the equilibrium in the balance of payments. Balance of payments equilibrium condition holds under floating exchange rates in the absence of intervention in the foreign exchange market:

$$ca_t + ka_t = 0 \quad \text{......} \quad (2.25)$$

where ca_t and ka_t denote the current account and capital accounts of the balance of payments, respectively. Ignoring some minor components, the current account is determined by:

$$ca_t = nx_t + i_t' nfa_t \quad \text{......} \quad (2.26)$$

where nx_t denotes net exports and $i_t' nfa_t$ represents net interest payments on net foreign assets.

This model does not assume PPP to be true in all cases, but assumes that the real exchange rate or term of trade as a measure of competitiveness have an impact on net exports and the current account. It also assumes that a rise in domestic income worsens net exports through its effect on imports, while a rise in foreign income improves the net export position through its influence on domestic exports. Thus, net exports are determined by a standard relationship:

$$nx_t = \alpha_1\left(s_t + p_t^* - p_t\right) - \alpha_2 y_t + \alpha_3 y_t^* \qquad (2.27)$$

where s_t is the log of the spot exchange rate, p_t is the log of the domestic price level, y_t is the log of domestic income, p_t^* is the log of the foreign price level and y_t^* is the foreign income. α_1, α_2 and α_3 are elasticities.

In practice, the international capital markets are not necessarily perfect, and thus the uncovered interest parity may not hold everywhere. However, when the capital markets are not in equilibrium, a mechanism for adjusting the flows of capital will take effect. In other words, if other things are equal, a rise in the domestic interest rate raises capital inflow, while a rise in the foreign interest rate lowers capital inflow, leading to a rise in the expected exchange rate (domestic currency depreciation), which will encourage capital outflow.

$$ka_t = \mu\left(i_t - i_t^* - \Delta s_{t+k}^e\right) \qquad (2.28)$$

where i_t denotes an interest rate yield of domestic deposits, and i_t^* an interest rate yield of foreign deposits, and Δs_{t+k}^e is the expected change in the exchange rate. Substituting equation (2.27) into equation (2.26) and the resulting expression, along with equation (2.28) into equation (2.25) we obtain the balance of payments exchange rate equation:

$$s_t = p_t - p_t^* + \left(\frac{\alpha_2}{\alpha_1}\right) y_t - \left(\frac{\alpha_3}{\alpha_1}\right) y_t^* - \frac{1}{\alpha_1}\left(i_t^* nfa_t\right) - \left(\frac{\mu}{\alpha_1}\right)\left(i_t - i_t^* - \Delta s_{t+k}^e\right) \qquad (2.29)$$

This formula is usually thought to be a general expression of an equilibrium exchange rate in that it satisfies the balance of payments equilibrium under floating exchange rates. It is clear that when $\mu \to \infty$ then the UIRP is satisfied and when $\alpha_1 \to \infty$ then the PPP condition is satisfied.

Combining Equation (2.29) and the definition of the real exchange rate

$$q_t = s_t + p_t^* - p_t, \qquad (2.30)$$

The real exchange rate at time t can be rewritten as:

$$q_t = \left(\frac{\alpha_2}{\alpha_1}\right) y_t - \left(\frac{\alpha_3}{\alpha_1}\right) y_t^* - \frac{1}{\alpha_1}\left(i_t nfa_t\right) - \left(\frac{\mu}{\alpha_1}\right)\left(i_t - i_t^* - \Delta s_{t+k}^e\right) \qquad (2.31)$$

This theory is more reliable as it can explain permanent deviations in PPP. This approach offers guidance on short term ups and downs. In spite of this, the model does not inform us about the exact rate of unemployment and secondly, the exchange rate does not maintain its consistency in accordance with the external accounts. This model was used to capture the external equilibrium in the Mundell-Fleming model integrated into the synthesized model in this study.

2.3 Empirical Literature Review

There are numerous empirical research studies that have attempted to find a model that best fit and forecast exchange rate movements. Unfortunately, literature on the role of budget deficit financing in exchange rate movement is very limited. Thus, literature provides little guidance on this part. This section summarises literature in this area that were found relevant to and supporting this study.

Baxter and Stockman (1989), using post-war time series of 49 countries, both developed and developing, examined the variability of output, trade variables, private and government consumption. They found no evidence that the cyclic behaviour of the real macroeconomic aggregates depends systematically on the exchange rate regime, except only for real exchange rate whose volatility increased since 1973 for most of the countries in their sample.

Razzak and Grennes (1998) estimated the reduced-form monetary model for trade-weighted dollar with the rest of the G7 countries. Their results showed that the estimated reduced form coefficients had the signs implied by the model, and the estimated elasticities had plausible magnitudes that concurred with the restrictions implied by the model. The study found that long-term interest rate and the real national output differential appreciated the exchange rate, while the 30 day interest rate differential depreciated the exchange rate. They also showed that the variance of fundamentals as defined in their model, were greater than that of the nominal exchange rate, which is consistent with Friedman (1953) and Johnson (1969).

Flood and Rose (1999), using VAR on cross rates between the dollar, Dutch Mark (euro) and yen, found that macroeconomic fundamentals appeared irrelevant in explaining high- and medium-frequency exchange rate dynamics for low inflation countries. According to the study, monetary models performed fairly well in a high inflation and low frequencies, since PPP works much better over very low frequency. The study also found that exchange rate volatility increased dramatically in the post-Bretton Woods era with no comparable behaviour in the macroeconomic fundamentals.

Ndung'u (1999), using time series quarterly data from Kenya for the period 1970 to 1995 assessed whether the exchange rate is affected by the monetary policy and nature of these effects. By using OLS the study found that real income significantly drove exchange rate appreciations, while money supply and the rate of inflation depreciated the nominal exchange rate.

Khan *et al* (2002) investigated the effect of budget deficit on real exchange rate in Pakistan for the period 1982 to 1998. By using ordinary least squares, the study found that the coefficients had approximately the expected signs, although some were not statistically significant. Interest rate differential and terms of trade were found to be statistically insignificant. The study also established that budget deficits had a negative effect on the real exchange rate, and that the overall budget deficit had no relation with the nominal exchange rate, but the budget deficit financed by banking system led to higher nominal interest rate.

Orlowski (2004) analysed the impact of interest rates and the inflations on the exchange rate movement for G7 countries using ARCH. The study measured exchange rate movement as the log of the differential of the spot rate, and found that they both (interest rates and inflation) caused movements in exchange rate, and their effect varied across countries sampled. Further, the study found evidence that exchange rate movements in some countries were driven mainly by persistency effects.

Canales-Kriljenko and Habermeir (2004), drawing on information from survey on foreign exchange market organization, examined factors affecting exchange rate volatility by focusing on the structures of the foreign exchange rate regime. Using cross sectional data for

85 developing and transition economies, they found that domestic macroeconomic variables related to Nominal Effective Exchange Rate (NEER) in the expected manner. External development as well as the nominal variables explained volatility as expected. The study also found that NEER volatility was higher in countries with higher inflation and higher fiscal deficit, and lower in countries with faster real GDP growth and more open economies. Other macroeconomic variables such as current account, private capital flows relative to GDP, and volatility of the terms of trade were not found to be significantly correlated with NEER volatility.

Hsing (2006), using ordinary least squares to estimate an extended open economy model, examined short-term exchange rate fluctuations for Poland for the period 1996Q1 to 2004Q1. The study found that real exchange rate was positively affected by the government deficit to GDP ratio and the expected exchange rate, and negatively influenced by real money supply (M2), foreign interest rate and the expected inflation rate. Performance in the stock market did not affect the real exchange rate. Further, the study found evidence that interest rate parity condition hold.

Kiptui and Kipyegon (2008), using Johansen and error correction technique, investigated the effects of external shocks on real exchange rate movements in Kenya for the period between 2000 and 2007. They found real GDP growth and changes in interest rate differentials to be highly significant at 1 percent. Real GDP growths, productivity, deteriorating terms of trade and government spending had a depreciating effect on real exchange rate. The study found that interest rate differential and openness tended to appreciate the real exchange rate. An important conclusion of their study is that in the short-run, real GDP depreciated the real exchange rate, while in the long-run it appreciated.

Beckmann, Belke and Kuhl (2009), using time-varying coefficient estimation approach on various monetary models across regimes for the period 1975:01 to 2007:12 for US$ and DM, found no stable single long-run equilibrium relationship among fundamentals and exchange rates. Nevertheless, they found that fundamentals included in their studies played an important role in determining the exchange rate, although their impact differed significantly across different sub-periods and finally that there were no recurring regimes.

Morana (2009) investigated for medium and long term relationship between macroeconomic volatility and exchange rate volatility in G7 countries using fractionally integrated factor vector autoregressive (FI-F-VAR) model and found evidence of significant long-term linkages and trade-offs between macroeconomic and exchange rate volatility, particularly involving output and inflation volatility, and money growth volatility to a lesser extent. Moreover, the study found bi-directional causality. The linkage was much stronger from macroeconomic volatility to exchange rate volatility than the other way around. The study also found that foreign country's macroeconomic volatility matter for long term exchange rate volatility.

2.4 Overview of Literature

There has been extensive theoretical literature and empirical literature on exchange rate in general and nominal exchange rate volatility in particular. Theoretical literature shows the exchange rate between two countries' currencies as a function of macroeconomic fundamentals such as the interest rates, prices, output, money, trade balance, government debt, consumption, investment and terms of trade, mostly expressed as differential. Hence in theoretical literature, volatility in exchange rate is due to volatility in the underlying fundamentals. However, empirical literature tying volatility of exchange rate to volatility of these macroeconomic fundamentals is at its best contradictory. Indeed empirical findings vary across studies, with a counter-argument being provided for each assertion.

Although most studies agree that exchange rate volatility increased in the post-Bretton Wood era with no corresponding increase in volatility in the macroeconomic fundamentals, little has been said about the aggregation problem due partly to the use of aggregated variables in estimation, and the widely used assumptions of symmetry in relative semi-elasticites in variables. In exchange rate modelling, majority of the studies use models in which variables enter in differential form. This is due to the assumption of symmetry in behavioural coefficients, where the difference between domestic and the corresponding foreign variable are used in estimation. For instance, suppose x_t is a domestic variable and the corresponding foreign variable is x_t^*, then $\left(x_t + \left(-x_t^*\right)\right)$ that becomes $\left(x_t - x_t^*\right)$ enters the estimation as one variable. Indeed, this is aggregation where foreign variables are treated as negative in the aggregation.

Nevertheless, aggregation problem may significantly impact on the ability of the model to fit the data, if one of the variables is unstable, hence causing inherent instability in the aggregate. Notwithstanding this, the studies did not posit that the inconsistencies across studies could be attributed to the use of aggregated variables and this simplifying assumption. The following offered an approach whereby the specified model was tested for the problem in the aggregation of the variable, and where there was evidence of this problem, the model was res-specified with the disaggregated components of the budget deficit and a Vector Autoregressive estimation technique will be used to generate the impulse response function and variance decomposition. Then, this was used to evaluate the performance of the selected model. To avoid misspecification of the model, macroeconomic fundamentals that have been identified in empirical literature to cause nominal exchange rate volatility were included. Although there are other aggregated variables in the model, the focus was on the budget deficit due to the possible instability in one of its financing component, that is, the net foreign financing. The instability in the net foreign financing of budget deficit increases the possibility of aggregation problem in the budget deficit.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The section develops the methodology for analysing the volatility of exchange rate between Kenya Shillings and the US dollar. The crux of this section was to develop a methodology that would identify and take into consideration estimation and specification problems. Aggregation of variables problems was tested and its effect on the performance of the model was investigated.

3.2 Research Design

The bottom line of this study lay in properly modelling volatility in exchange rate so as to ultimately obtain a model that best fits to explain the effect of macroeconomic fundamentals on exchange rate volatility. Quantitative time series data spanning the period 1973:01 to 2005:12 was utilized to answer research questions raised. The study period was divided into four; 1973:01 to 1982:08, 1982:09 to 1990:10, 1990:11 to 1993:10 and 1993:11 to 2005:12 to correspond to fixed, managed float, dual and free float exchange rate system, respectively. This division provided a priori information of exogenous structural breaks resulting from exchange rate policy changes. Where the structural breaks were present, dummy variables were introduced to capture their effects.

The test for aggregation problem was used to reveal the effects of aggregating the financing composition of budget deficit on modelling of volatility in exchange rate. Hence, the presence of aggregation problem effectively showed that there is much difference in using shocks to the financing composition of budget deficit to explain exchange rate volatility instead of using shocks to the budget deficit. To determine which of the two candidate models is superior to the other, an evaluation of their forecasting performances was conducted using forecasting error and the forecasting performance coefficients.

Vector Autoregressive estimation technique was then used to analyse the model that provided the best fit with the following variables: exchange rate volatility, interest rate differential, inflation rate differential, domestic nominal rate, money supply differential, net foreign assets, financing composition of budget deficit and productivity differential. This was done after the series had been subjected to time series property test. Impulse response functions and variance decomposition generated from VAR was used determine the forces behind volatility in exchange rate.

3.3 Theoretical Framework

The theoretical proposition developed starts with an assumption of a government with a budget deficit that has to be financed either domestically or externally. The decision on the optimal financing mix depends on, among other things, the domestic and foreign real interest rates, the expected exchange rate as well as the spot exchange rate. These variables affect foreign investors' and lenders' decisions as well.

If the government opts for domestic borrowings, then from a macroeconomic policy perspective, the lack of a well developed bond market places constraints. In such circumstances, it is likely that the domestic interest rates tend to rise faster with the increase in the level of domestic borrowing, such that when domestic real interest rate exceed foreign real interest rate, foreign investors will come in to absorb excess domestic borrowing, so long as they are properly compensated for the foreign exchange risk. If as a result, the domestic bonds become widely held by foreigners, then they expose the capital account to sudden capital reversals and consequently the exchange rate to sudden movements. Although there is no exchange rate risk to the government in terms of repayment and servicing, since the foreigners will bear the exchange rate risk to the extent that domestic firms or banks suffer from currency mismatch, they are exposed to potential instability (Kahn, 2005).

The foreign investors' investment behaviour is assumed to follow portfolio balance model, which assumes that domestic and foreign securities are imperfect substitutes due to foreign exchange risk. Thus, investors must be compensated by an exchange rate risk premium for holding domestic securities. This implies that interest rate parity condition does not necessarily hold. New borrowings lead to changes in the supply of domestic securities relative to foreign securities, which causes a fall in bond prices, translating to a rise in the domestic real interest rate. These changes disturb the equilibrium in the investors' portfolios. To restore the balance, a change in the exchange rate risk premium, measured as the deviation from the uncovered interest rate, is required. Given market expectations about the future exchange rate, the exchange rate risk premium can be calculated from uncovered interest rate parity.

$$\varphi = i_t^* - i_t + \frac{\Delta s_t}{s_t} \quad \text{......} (3.1)$$

where $\Delta s_t = E(s_{t+1}) - s_t$ is the expected depreciation in the domestic exchange rate, s_t is the spot exchange rate, and i_t and i_t^* are the domestic and foreign interest rate at time t, respectively. The exchange rate is the domestic price of a unit of foreign currency.

A rise in i_t causes a fall in $\left(i_t^* - i_t\right)$, and the risk premium declines, but whether the spot rate appreciates or depreciates, and whether the change in the expected exchange rate is positive or negative, depends on the expected relationship between the current spot rate and the future expected exchange rate. Economists like Meese and Rogoff (1983) viewed changes in exchange rates as following a random walk, which means that a future increase is as likely as a decrease, that is, $E\left(s_{t+1}\right) = f\left(s_t\right)$. Thus, from f' we have two possibilities. Firstly, if $f' > 0$ and other things remaining the same, then for a decline in $\left(i_t^* - i_t\right)$, s_t has to appreciate, while $E\left(s_{t+1}\right)$ has to depreciate or a combination of the two. Secondly, when expectations are regressive $f' < 0$, and holding other things constant, then for a decline in $\left(i_t^* - i_t\right)$, s_t has to depreciate, or $E\left(s_{t+1}\right)$ has to appreciate or a combination of the two.

On the other hand, if the government opts for external financing, then its decision is affected by, among other things, the spot exchange rate, the expected exchange rate and both the domestic and the foreign interest rate. This decision is assumed to follow the uncovered interest rate parity. From equation (3.1), interest rate parity only holds when $\varphi = 0$, thus the level of exchange rate risk premium determines whether uncovered interest rate parity holds or not, which in turn determines the extent to which a country can finance its budget deficit using external financing.

When uncovered interest rate parity condition holds, the country can finance unlimited budget deficits by borrowing abroad, so long as they are willing and able to pay the going foreign rate of interest. But, due to the existence of the exchange rate risk, $\varphi > 0$, the uncovered interest parity does not hold, and the country will find that the more it borrows, the higher the rate of interest it must pay. Furthermore, the latter case is also relevant for foreign lenders who want compensation in the form of exchange rate risk premium for the risk they take in lending in domestic currency. That is, foreign financing of budget deficit is absorbed by foreign investors only if the adjustment in their portfolio is rewarded by a higher yield. Given the rate of return, this is accomplished partly by a depreciation of the local currency, thus $\varphi > 0$.

Generally, the more the country borrows, the higher the rate of interest it must pay due to rising leverage, and the higher the exchange rate risk premium that must be supplied to foreign lenders to avail loans. Although the depreciation of the local currency strengthens the home country's competitiveness in the international market, the extent to which this boost exports and discourage imports (that is, improves balance of payment) depends on the Marshall Lerner index of the country. If the Marshall Lerner index is greater than one, then deprecation of local currency improves balance of payment, which avail resources that can be applied to service interest on accumulated external borrowings.

The foregoing analysis assumes that the home country's foreign borrowings are in local currency. However, many developing countries are not able to choose whatever source to borrow from, whatever amount to borrow, on which currency the borrowings would be, and for how long it would borrow without any constraints. In such a case, external financing of budget deficit has to be denominated in the foreign currency. This creates a problem as it exposes the country to currency mismatch due to the currency composition of external debt (Hausmann et al., 2003; Kahn, 2005). Suppose due to this problem the country follows a policy such that financing of the budget deficit leads to growth in both domestic and foreign public debt in one period. Thus, the proportion of net domestic financing, $ndfbd$, measured as the new domestic borrowings less repayments of existing domestic debt, and the net foreign financing, $nffbd$, defined as new foreign borrowings less repayments of existing foreign public debt, to total net budget deficit, bd, is greater than zero. That is $\frac{ndfbd}{bd}, \frac{nffbd}{bd} > 0$.

If in some other period, the country decides to borrow locally to repay foreign debts, then $\frac{ndfbd}{bd} > 0$ and $\frac{nffbd}{bd} \leq 0$, which implies that the domestic public debt is growing while foreign public debt is constant or declining. Suppose the domestic bond market is narrow and the market expectation is regressive and also that current domestic borrowing affects the spot exchange rate through the action of foreign investors in the domestic bond market, while repayment and servicing of foreign debts affects and is affected by the expected future exchange rate. Furthermore, assume that the market participants are fundamentalist. Essentially, foreign exchange markets have two kinds of traders; the fundamentalists and the chartists. The fundamentalists compare the market exchange rates with the fundamental rate and they forecast the future market rate to move towards the fundamental rate. In this sense they follow a negative feedback rule. As the country's domestic borrowing goes up, i_t rises, causing a fall in $\left(i_t^* - i_t\right)$. Since $f' < 0$, then for a decline in φ, s_t has to depreciate. But the market expectation will change as soon as the fundamentalist realises that the expected future exchange rate will be overvalued as the government acquires foreign exchange to repay external debt. Thus, the expectation changes so that $f' > 0$ and the expected exchange rate, $E\left(s_{t+1}\right)$, instead depreciates. This is contrary to the conventional wisdom that when the government borrows domestically to repay or service external debt, then the exchange rate will appreciate (depreciate) as the country experience capital inflows in response to the rising domestic interest rates, and depreciates (appreciates) due to outflows to repay the external debt. Other things remaining the same and assuming Marshall Lerner index of one, then the depreciation of the spot and expected exchange rate means that the domestic resources required to service foreign currency denominated external debt has to go up by the percentage of the depreciation. Thus, the question is whether under this controversy, it is appropriate to aggregate domestic and external financing of budget deficit, when investigating the impact of fiscal policy on nominal exchange rate volatility.

3.4 Model Specification

The synthesised model used in this study was borrowed from Frankel (1997) and was adjusted to capture the real (fiscal) sector of the economy as well as the Balassa-Samuelson effects. The former was achieved by relaxing one good and one bond assumptions of the monetary model. These two models are considered as follows:

I. Monetary and Portfolio Balance Model.

The starting point is the equilibrium in the money market in the home country. But in a small open economy, the money market fundamentals in the foreign country matters as well. Therefore, the money market equilibrium in the home and foreign country can be expressed as;

$$m_t - p_t = \kappa y_t - \lambda i_t + v_t \qquad (3.2)$$

$$m_t^* - p_t^* = \kappa^* y_t^* - \lambda^* i_t^* + v_t^* \qquad (3.3)$$

where m_t, p_t, y_t and v_t denote the first difference log-levels of the money supply, the price level, income and the shock to the money market, respectively at time t; i_t denote the level of the interest rate at time t; κ and λ are positive constants; and the starred variables denote foreign variables and parameters. Combining equation (3.2) and (3.3) gives,

$$\left(m_t - m_t^*\right) = \left(p_t - p_t^*\right) + \left(\kappa y_t - \kappa^* y_t^*\right) - \left(\lambda i_t - \lambda^* i_t^*\right) + \left(v_t - v_t^*\right) \qquad (3.4)$$

Although there is no a priori information to expect symmetry in the behavioural coefficients, it is usually assumed that the income elasticities and interest rate semi-elasticities of money demand are the same for the domestic and foreign country ($\kappa = \kappa^*$ and $\lambda = \lambda^*$) (Neely and Sarno, 2002). This specification saves considerable degrees of freedom in a dynamic model. Thus, equation (3.4) is re-expressed as:

$$\left(m - m^*\right)_t = \left(p - p^*\right)_t + \kappa\left(y - y^*\right)_t - \lambda\left(i - i^*\right)_t + \left(v - v^*\right)_t \qquad (3.5)$$

In its flexible price formulation monetary model, assume that only one bond is traded, which gives the uncovered interest rate parity condition as:

$$\left(i - i^*\right)_t = \Delta s_{t+k}^e \qquad (3.6)$$

where Δs_{t+k}^e is the expected depreciation of the domestic currency.

Combining equation (3.5) and (3.6) and solving for relative price levels:

$$\left(p - p^*\right)_t = \left(m - m^*\right)_t - \kappa\left(y - y^*\right)_t + \lambda \Delta s_{t+k}^e - \left(v - v^*\right)_t \qquad (3.7)$$

One good assumption gives us the PPP. Relative PPP with a stationary deviation can be expressed as:

$$s_t = p_t - p_t^* - \mu_t \quad (3.8)$$

where s_t denotes the first difference log-level of the nominal bilateral exchange rate (the domestic price of the foreign currency), μ_t is a stationary deviation from PPP. From equation (3.8),

$$\Delta s_{t+k}^e = \Delta p_{t+k} - \Delta p_{t+k}^* \quad (3.9)$$

Assuming that the system is stable, a rational expectation and an exogenous income growth, then the expected inflation rate is equal to the rationally expected monetary growth rate. That is:

$$\Delta p_{t+k} - \Delta p_{t+k}^* = \pi_t - \pi_t^* \quad (3.10)$$

Combining equations (3.7), (3.8), (3.9) and (3.10) yields the flexible price monetary model of exchange rate determination

$$s_t = \left(m - m^*\right)_t - \kappa\left(y - y^*\right)_t + \lambda\left(\pi - \pi^*\right)_t - \left(v - v^*\right)_t - \mu_t \quad (3.11)$$

According to equation (3.11), exchange rate (as the relative price of currency) is determined by the demand and supply for money. An increase in domestic money causes a proportionate depreciation. An increase in domestic income or a decrease in the expected inflation rate raises the demand for money and thus causes an appreciation.

Relaxing the price flexibility assumption

To achieve this, PPP is replaced with its long run version:

$$\bar{s} = \bar{p} - \overline{p^*} \quad (3.12)$$

Then equation (3.11) becomes:

$$\bar{s} = \left(m - m^*\right)_t - \kappa\left(y - y^*\right)_t + \lambda\left(\pi - \pi^*\right)_t - \left(v - v^*\right)_t \quad (3.13)$$

since agents expect that in the short run when the exchange rate deviates from its equilibrium path, it closes that gap with a speed of adjustment θ. Furthermore, they expect that in the long run when the exchange rate lies on its equilibrium path, it will increase at $\left(\pi - \pi^{*}\right)$

$$\Delta s_{t+k}^{e} = -\theta\left(s_{t} - \bar{s}\right) + \left(\pi - \pi^{*}\right)_{t} \quad (3.14)$$

Substituting equation (3.14) into interest rate parity equation (3.6) yields:

$$s_{t} - \bar{s} = -\left(\frac{1}{\theta}\right)\left[\left(i - \pi\right)_{t} - \left(i^{*} - \pi^{*}\right)_{t}\right] \quad (3.15)$$

The gap between the exchange rate and its equilibrium value is proportional to the real interest rate differential. That is, when a tight domestic monetary policy causes the nominal interest rate differential to rise above its equilibrium values, an incipient capital inflow cause the value of the currency to rise proportionately above its equilibrium level.

Solving equation (3.13), which represents the long run monetary equilibrium path with equation (3.15) representing the short run overshooting effect, the following general monetary equation of exchange rate determination is obtained.

$$s_{t} = \left(m - m^{*}\right)_{t} - \kappa\left(y - y^{*}\right)_{t} + \lambda\left(\pi - \pi^{*}\right)_{t} - \left(\frac{1}{\theta}\right)\left[\left(i - \pi\right)_{t} - \left(i^{*} - \pi^{*}\right)_{t}\right] - \left(v - v^{*}\right)_{t} \quad (3.16)$$

Relaxing the assumption of perfect substitutability of bonds

This is achieved by integrating the monetary model given by equation (3.16) with the portfolio-balance models given by equation (3.17):

$$\frac{B_{t}}{S_{t}F_{t}} = \beta\left(i_{t} - i_{t}^{*} - \Delta s_{t+k}^{e}\right) \quad (3.17)$$

Taking logs, equation (3.17) becomes:

$$b_{t} - s_{t} - f_{t} = \alpha + \beta\left(i_{t} - i_{t}^{*} - \Delta s_{t+k}^{e}\right) \quad (3.18)$$

Adding and subtracting the nominal interest rate differential into equation (3.15) to obtain equation (3.19):

$$s_t - \bar{s} = -\left(\frac{1}{\theta}\right)\left\{(i-\pi)_t - (i^* - \pi^*)_t + \left[i_t - i_t^* - \Delta s_{t+k}^e\right]\right\} \qquad (3.19)$$

Equation (3.19) implies that the exchange rate deviates from its long run value by an amount proportional to the real interest rate differential and the risk premium.

Substituting equation (3.13) into equation (3.19) yields:

$$s_t = \left\{\begin{array}{l} (m-m^*)_t - \kappa(y-y^*)_t + \lambda(\pi-\pi^*)_t - \left(\frac{1}{\theta}\right)\left[(i-\pi)_t - (i^*-\pi^*)_t\right] + \\ \left(\frac{1}{\theta}\right)\left[i_t - i_t^* - \Delta s_{t+k}^e\right] - (v-v^*)_t \end{array}\right\} \qquad (3.20)$$

The synthesized equation of monetary and portfolio-balance models is obtained by relaxing the assumption that domestic and foreign assets are perfect substitutes. This is accomplished by replacing the uncovered interest rate parity with the imperfect substitutability condition in equation (3.18). In this case exchange rate deviates from its equilibrium values not only because sticky good prices create real interest rate differential, but also because imperfect bond substitutability creates a risk premium. Substituting equation (3.18) into equation (3.20) gives:

$$s_t = \left\{\begin{array}{l} (m-m^*)_t - \kappa(y-y^*)_t + \lambda(\pi-\pi^*)_t - \left(\frac{1}{\theta}\right)\left[(i-\pi)_t - (i^*-\pi^*)_t\right] + \\ \left(\frac{1}{\theta}\right)\left[b_t - s_t - f_t - \alpha\right] - (v-v^*)_t \end{array}\right\} \qquad (3.21)$$

Solving for s_t in equation (3.21) yields the synthesised equation of the monetary and portfolio-balance model:

$$s_t = \left\{\begin{array}{l} \frac{\alpha}{1+\theta\beta} + \frac{\theta\beta}{1+\theta\beta}(m-m^*)_t - \frac{\theta\beta\kappa}{1+\theta\beta}(y-y^*)_t + \frac{\beta(\theta\lambda+1)}{1+\theta\beta}(\pi-\pi^*)_t - \frac{\beta}{1+\theta\beta}(i-i^*)_t + \\ \frac{1}{1+\theta\beta}(b-f)_t \end{array}\right\} . \qquad (3.22)$$

II. The Real Sector and Balassa-Samuelson Model.

The real/fiscal sector is captured using the equation for the goods market represented by equation (3.23):

$$Y_t = C_t + I_t + G_t + (X_t - M_t) \text{ ....} \quad (3.23)$$

where Y_t denotes domestic national income at time t; $C_t = C(Y_t)$ denotes consumption at time t, which is a function of income; $I_t = I(i_t)$ denotes investment at time t, which is a decreasing function of nominal interest rate i_t; G_t denotes government spending at time t; $X_t = X(Y_t^*, Q_t)$ denotes exports at time t, which is an increasing function of foreign national income and real exchange rate; $M_t = M(Y_t, Q_t)$ denotes imports at time t, an increasing function of domestic income and decreasing function of the real exchange rate. The real exchange rate at time t is defined by $Q_t = \dfrac{S_t P_t^*}{P_t}$

Due to narrow financial market in Kenya, an increase in government spending is most likely to be followed by higher and distorting taxes, or even higher government borrowings, both of which adversely hurt the economy. But evidence from this study showed that in Kenya, total non-borrowed resources as a percentage of GDP remained fairly constant, leaving government borrowing as the only sources of financing increase in government spending. Defining $G_t = \overline{T}_t + BD_t$ implies that government spending is equal to total non-borrowed resources plus borrowed resources (budget deficit). Assuming $\overline{T}_t$ is relatively constant, then any changes in the fiscal policy will change BD_t. Equation (3.23) can be rewritten as:

$$Y_t = C_0 + C_1(Y_t - tY_t) + I_0 - I_1 i_t + \overline{T}_t + BD_t + X_0 + K^* Y_t^* + X_1 Q_t - M_0 - M_1 Y_t + M_2 Q_t \text{ ....} \quad (3.24)$$

where the part of the variable with the subscript 0, represents autonomous part of that variable.

Taking logs and differentiating with respect to time t, equation (3.24) yields:

$$(1 - C_1 + C_1 t + M_1) y_t - \kappa^* y_t^* = -I i_t + bd_t + (X_1 + M_2) q_t \text{ ....} \quad (3.25)$$

where $t = t$, $y_t = \ln(Y_t)$, $y_t^* = \ln(Y_t^*)$, $bd_t = \ln(BD_t)$, and $q_t = \ln(Q_t)$.

Defining $\kappa = (1 - C_1 + C_1 t + M_1)$ and assuming symmetry in relative semi-elasticities of income then equation (3.25) simplifies to:

$$bd_t = \kappa\left(y - y^*\right)_t + Ii_t - \left(X_1 + M_2\right) q_t \text{ ..... } (3.26)$$

Replacing real exchange rate with the definition of nominal exchange rate yields;

$$bd_t = \kappa\left(y - y^*\right)_t + Ii_t - \left(X_1 + M_2\right)\left(s_t - \left(p_t - p_t^*\right)\right) \text{ ..... } (3.27)$$

Equation (3.27) implies that budget deficit is positively affected by national output differential and domestic interest rates, but negatively affected by the real exchange rate.

It has been shown that different sectoral productivity trends at home and abroad can have an impact on the real exchange rate based on broad prices and cost indices. This aspect is captured using Balassa-Samuelson model. This model was developed from weighted average of the prices of traded goods (T) and non-traded goods (N), where $\hbar$ is the share of the traded goods in the domestic basket of goods and $\lambda\!\!\!^{-}$ is the share of traded goods in the foreign basket of goods.

$$p_t = \hbar p_t^T + \left(1 - \hbar\right) p_t^N, \text{ ..... } (3.28)$$

$$p_t^* = \lambda\!\!\!^{-} p_t^{T*} + \left(1 - \lambda\!\!\!^{-}\right) p_t^{N*}, \text{ ..... } (3.29)$$

If the traded goods were freely tradable such that arbitraging was possible, then

$$q_t^T = s_t + p_t^{T*} - p_t^T \text{ ..... } (3.30)$$

If we define $q_t = s_t + p_t^* - p_t$ and substitute equation (3.30) into this definition, it yields

$$q_t = q_t^T - p_t^{T*} + p_t^T + p_t^* - p_t \text{ ..... } (3.31)$$

Substituting equation (3.28) and (3.29) into equation (3.31) and rearranging, it becomes

$$q_t = q_t^T + \left(1 - \lambda\!\!\!^{-}\right)\left(p_t^{N*} - p_t^{T*}\right) - \left(1 - \hbar\right)\left(p_t^N - p_t^T\right) \text{ ..... } (3.32)$$

Assuming productivity-base wages and the share of traded goods in both the home and foreign country to be equal, that is $(\hbar = \lambda = \varpi)$, then the relative prices of traded goods and non-traded goods can be expressed as

$$p_t - p_t^* = (1-\varpi)\left(\frac{\mu_{LN}}{\mu_{LT}}\left(A_T - A_T^*\right) - \left(A_N - A_N^*\right)\right) \quad (3.33)$$

where $\mu_{LT} = \frac{wL_T}{Y_T}$ and $\mu_{LN} = \frac{wL_N}{pY_N}$ are the labour shares of the income generated in the traded and non-traded sectors, respectively; p_t and p_t^* are the domestic and foreign price level, respectively. A_N and A_T are the constants describing technology for non-traded and traded goods sectors, respectively, and ϖ is the share of traded goods in total outputs.

If the non-traded relative to traded goods were labour intensive, then the model forecasts that the domestic economy will experience real appreciation if its productivity-growth advantage in traded goods exceeds its productivity growth advantage in non-traded goods. An increase in productivity in the traded sector leads to an increase in real wages, which is then transmitted to the non-traded sector. These combined to increase the overall price level in the economy, which in turn results in an appreciation of the real exchange rate.

Combining equation (3.27) and (3.33) and rearranging:

$$s_t = \frac{1}{\left(X_1 + M_2\right)}\left\{\kappa\left(y - y^*\right)_t + Ii_t - bd_t\right\} + (1-\varpi)\left(\frac{\mu_{LN}}{\mu_{LT}}\left(A_T - A_T^*\right) - \left(A_N - A_N^*\right)\right) \quad (3.34)$$

Making $\kappa\left(y - y^*\right)_t$ the subject in equation (3.34) yields

$$\kappa\left(y - y^*\right)_t = \left(X_1 + M_2\right)\left\{s_t - (1-\varpi)\left(\frac{\mu_{LN}}{\mu_{LT}}\left(A_T - A_T^*\right) - \left(A_N - A_N^*\right)\right)\right\} + Ii_t + bd_t \quad (3.35)$$

Substituting equation (3.35) into equation (3.22) and solving for s_t gives equation (3.36)

$$s_t = \left(\frac{1}{\left(1+\theta\beta+\theta\beta\left(X_1+M_2\right)\right)} \right) \left\{ \begin{array}{l} \alpha+\theta\beta\left(m-m^*\right)_t+\theta\beta\left(X_1+M_2\right)(1-\varpi) \\ \left(\frac{\mu_{LN}}{\mu_{LT}}\left(A_T-A_T^*\right)-\left(A_N-A_N^*\right) \right)-\theta\beta I i_t-\theta\beta b d_t + \\ \beta(\theta\lambda+1)\left(\pi-\pi^*\right)_t-\beta\left(i-i^*\right)_t+(b-f)_t \end{array} \right\} \text{............ (3.36)}$$

Equation (3.36) expressed exchange rate as positively related to the money supply differential, the inflation rate differential, productivity differential and the relative bond holdings. On the other hand, exchange rate is negatively related to the domestic nominal interest rate, the interest rate differential and the budget deficit. The signs obtained in equation (3.36) are in line with those predicted by the individual models.

Equation (3.36) implies volatility trade-off. That is, volatility in the left hand side of this equation is due to the volatility from the right hand side. If the exchange rate is fixed, then (ν) shocks causes volatility in money, output or interest rates. If the exchange rate floats cleanly, then the same shock creates exchange rate movements (Flood and Rose, 1999).

Following equation (3.36), the estimated model with the expected signs in brackets is expressed as:

$$VolNER = f\left(\overset{+}{M2D}, \overset{+}{INF}, \overset{-}{IRD}, \overset{-}{DNI}, \overset{-}{BD}, \overset{+}{PD}, \overset{+}{NFA}, D_i \right) \text{.. (3.37)}$$

where:

$VolNER$: is the standard deviation of the exchange rate, Kenya Shillings per unit of US dollar;

$M2$: is the percentage change in the money supply differential;

INF : is the inflation rate differential;

IRD : is the interest rate differential;

DNI : is the domestic nominal interest rate;

BD : is the percentage change in the budget deficit; since the forecasting performance of the model with the financing composition of budget deficit was superior, then the percentage change in the net domestic financing and net foreign financing composition of budget deficit, $ndfbd$ and $nffbd$, respectively were used instead;

PD : is the percentage change in the productivity differential;

NFA : is the percentage change in the relative bond holding; and

D_i : are the dummy variables for structural breaks. Since there are four exchange rate regimes, then the dummy variables are D_1, D_2 and D_3 defined as:

$$D_1 = \begin{cases} 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{if it is fixed exchange rate regime} \\ 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{otherwise} \end{cases}$$

$$D_2 = \begin{cases} 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{if it is managed float exchange rate regime} \\ 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{otherwise} \end{cases}$$

$$D_3 = \begin{cases} 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{if it is dual exchange rate regime} \\ 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{otherwise} \end{cases}$$

The final exchange rate is the flexible exchange rate regime, which is taken care of by the constant term.

3.5 Definition and Measurement of Variables

The following variables that were used in this study are defined.

Exchange rate volatility ($VolNER$) is the standard deviation of the percentage change in the average monthly official exchange rate of Kenya Shillings against the US dollar. Exchange rate is the price of US dollar in terms of Kenya Shillings.

Productivity is the value of industrial production index for both the home and foreign country, converted into indices (1995=100). It was used as a proxy for the relative differences in sectoral productivity.

Inflation rate is the change in the log of the consumer price indices. Consumer price indices (CPI) a measure of the price level in the economy were taken for both Kenya and US.

Interest rate is the coupon rate of interest on short term government securities (91 Days Treasury bills). This was the monthly average measured as a percentage per annum.

Money supply (M2) comprised of currency plus demand deposits. It was expressed in millions of Kenya Shillings. The values for US were converted into Kenya Shillings equivalent.

Budget Deficit (BD) is the total resources (including grants) less government spending measured in millions of Kenya Shillings. It was used as a measure of budget deficit less grants. Net incurrence of domestic and foreign liabilities expressed in millions of Kenya Shillings is used as a measure of net domestic financing of budget deficit ($NDFBD$) and net foreign financing of budget deficit ($NFFBD$), respectively. Net incurrence in this context means new borrowings less repayments.

Net Foreign asset (NFA) is the value of total foreign assets less the value of foreign total liabilities. It is measured in millions of Kenya Shillings.

Domestic Nominal Interest Rate (DNI) is the rate of interest on 91 days Treasury bill. This was monthly average and was measured as a percentage per annum.

D_1 is a dummy variable capturing the effect of fixed exchange rate regime.

D_2 is a dummy variable capturing the effect of managed float exchange rate regime.

D_3 is a dummy variable capturing the effect of dual exchange rate regime.

3.6 Time Series Properties and Series Stability Test

Prior to time series econometric analysis of equation (3.37), it is necessary to investigate the time series properties of the variables. This has significant implication on the estimation techniques and transformation that can be used to achieve accurate analyses and modelling of the underlying relationship. Therefore, in the next sub-section the unit root and cointegration test conducted are highlighted.

3.6.1 Stationarity of the Data

Augmented Dicker-Fuller (ADF) test was applied to test for Unit root. This test reveals two critical properties of the time series variables: First, it is particularly important to test for unit root in time series variables because in case it contains unit root, it may be stationary at first difference, that is, difference stationary and it can only be analysed at that level where it is stationary. If the unit root is absent, then the variables are trend stationary and will be described using time series model without any transformation. Secondly, in the case of difference stationary, the shock is permanent while for trend stationary it is transitory.

3.6.2 Cointegration Analysis

If the stationarity test shows the presence of unit root in the series, that is the series are I(1), then data will be analysed for possible cointegration. The Johansen method was used. Johansen method involves a maximum-likelihood estimation procedure that provides estimates of cointegrating vectors for a given number of variables. Johansen approach tests whether the equilibrium error is 1(0), that is, the null hypothesis of no cointegration or 1(1). If the equilibrium error is found to be I(0), then the null hypothesis is rejected. Cointegration thus requires that the equilibrium error $z_t = \left(f_{1t}, f_{2t}, \ldots., f_{kt}\right)$ is mean reverting, even though the underlying variables f_i wander widely. The mean reversion behaviour of the equilibrium error is of key interest if economic theory suggests a long run equilibrium relationship between the underlying variables. Any shock to the system will die out, which means that the shock is transitory.

It is based on the following error correction representation:

$$\Delta f_t = \sum_{j=1}^{k} \alpha_j \Delta f_{t-j} + \theta(r) f_{t-1} + \varepsilon_t, \quad \ldots\ldots (3.38)$$

where f_t, is a k x 1 vector of 1(1) processes. The rank of $\theta(r)$ equals the number of cointegrating vectors, which is tested by maximum eigenvalue and trace statistic (Norden and Godbout, 1997).

The main advantage of this approach over ADF tests is that it addresses the simultaneity biases and corrects for autocorrelation and endogeneity caused by the use of more than one endogenous variable at the same time. In addition, Engle and Granger's technique is limited to bivariate cointegrating, whereas Johansen's maximum-likelihood approach can be extended to multiple variables.

3.6.3 Structural Break Tests

To test for structural breaks, Chow break point test was used. To carry out the test, the data was divided into four sub-samples. This test involves testing the null hypothesis of no structural change against an alternative of three structural breaks. This test requires the estimation of a single equation using least squares, and is based on a comparison of the sum of squared residuals obtained by fitting a single equation to the entire sample, with the sum of squared residuals obtained when separate equations are fitted to each sub-sample of the data. To carry out this test linear regression model is specified in a dynamic framework and estimated for the entire sample and for each sub-sample of the data in each exchange rate regime (Greene, 2008).

$$q_t = f_{t-i}\beta + \varepsilon_t \text{..............} i = 0,1,2,\text{.....}, p \text{ ....} (3.39)$$

where q is an $n \times 1$ matrix of the dependent variable, f is an $n \times (k+1)$ matrix (where the first column is a place holder column of ones for the constant) containing independent variables, their lagged values and those of the dependent variable, β is a $(k+1) \times 1$ column matrix containing the regression constant and coefficients, and ε is an $n \times 1$ column matrix of the disturbance vector with multivariate normal distribution. The test was carried out on the two possible equations that is, for both the equation with the aggregated budget deficit and the other with disaggregated budget deficit. If the test result shows structural breaks, then it implies that there are significant differences in the estimated equations. Dummy variables were introduced in this case to capture the effect of structural breaks. Presence of structural indicate significant changes in the relationships as well as changes in volatility of the exchange rate, macroeconomic fundamentals and the financing composition of budget deficit (or budget deficit) across the different exchange rate regimes.

3.6.4 Test for Aggregation of Variables Problem and Model Selection

To analyse the effects of using the financing composition of budget deficit instead of budget deficit on modelling of exchange rate volatility, two dynamic regression equations were estimated using OLS. The lags included for the dependent and each of the independent variables in the estimated equation were those suggested by VAR pre-estimation lag selection process. After estimation, residuals were generated and the ratio of the sum of squared residuals was obtained and compared with the F-test. The two regression equations estimated for this test were:

$$VolNER_t = f_{t-i}\beta + \alpha_0 D_1 + \alpha_1 D_2 + \alpha_2 D_3 + \alpha_3 BD_{t-i} + \xi_{agg} \text{ ....} (3.40)$$

$$VolNER_t = f_{t-i}\beta + \alpha_4 D_1 + \alpha_5 D_2 + \alpha_6 D_3 + \alpha_7 NDFBD_{t-i} + \alpha_8 NFFBD_{t-i} + \xi_{disagg} \text{ ....} (3.41)$$

where q is an $n\times1$matrix of the dependent variable, f is an $n\times(k+1)$ matrix (where the first column is a place holder column of ones for the constant) containing IRD, INF, DNI, PD, M2D NFA, their lagged values and those of the VolNER, $\beta$is a $(k+1)\times1$ column matrix containing the regression constant and coefficients, ξ_{agg} and ξ_{disagg} are $n\times1$column matrix of the disturbance vectors with multivariate normal distribution. α_3, α_7 and α_8 is $\kappa\times1$column matrix containing regression constant for BD, NDFBD and NFFBD, respectively.

Equation (3.40) and (3.41) represents the model with aggregated and disaggregated budget deficit, respectively. The test statistics used is given below.

$$\gamma=\frac{\left(\sum_{t-1}^{n}\varepsilon_{t,agg}^{2}-\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}\right)\Big/ j}{\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}\Big/(n-k)}$$

where $\sum_{t=1}^{n}\varepsilon_{t,agg}^{2}$ and $\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}$ are the sum of squared errors when the model is estimated with aggregated and disaggregated variables, respectively. j is the number of hypothesis; k is the number of estimated parameters in the model with disaggregated variables and n is the number of observations. The test hypothesis is against$H_1:\gamma\neq0$. It tests whether the model can be improved by disaggregating the variables in the estimation. It also determines which model to use when analysing the impact of macroeconomic fundamentals and the level of budget deficit or the financing composition of budget deficit.

The null hypothesis assumes that the difference between sums of squared error obtained when the model is estimated with aggregated series are not significantly different from the sums of squared residuals obtained by using disaggregated series. If the sums of squared errors are substantially different, then the assumption that the null hypothesis is true significantly reduces the ability of the model to fit the data, and thus data do not support the null hypothesis. If the null hypothesis is true, then aggregation of sub-variables has no significant impact on the estimated parameters. If the null hypothesis is true, then γhas an F-distribution with j numerator degrees of freedom and $n-k$ denominator degrees of freedom. If γ is too large, then the null hypothesis is rejected. That is, where the F-statistics (γ) were greater than the critical F-values, then the null hypothesis of no aggregation problem was rejected. The decision criterion will be to compare the values of γ with the critical values F_c, which leaves a probability α in the upper tail of the F-distribution with j and $n-k$ degrees of freedom. Appendix I develops this test.

The performance of the models used to test for aggregation problem were subjected to further evaluation so as to select the model that offers the best fit. The performances of these models were compared and the model that had the lowest forecast error was selected. The Root Mean Squared Error and Mean Absolute Error were used for this purpose. The forecast error statistics for Root Mean Squared Error and Mean Absolute Error depend on the scale of the dependent variable. As relative measures, they are therefore suitable for comparing forecasts for the same series across different models as is the case in this study. The criterion is the smaller the error, the better the forecasting ability of that model. The Random Walk model was used as a bench mark for the overall performance of the candidate models.

3.7 Estimation Technique

Since exchange rate volatility was not functionally explained by macroeconomic fundamentals and budget deficit or its financing composition, Vector Autoregressive (VAR) estimation technique was preferred. The test for the aggregation problem determined whether there are significant differences between the models with the aggregated or disaggregated budget deficit, while the performance evaluations determined which of these two models provided the best fit. With the help of VAR estimation technique, the model selected was used to determine the impact of macroeconomic fundamentals and budget deficit or its financing composition on exchange rate volatility.

A VAR model is widely used to describe the evolution of a set of k endogenous variables over the same sample period as a linear function of their past evolution. A VAR with lag order of p, denoted as VAR (p), can be expressed as:

$$f_t = \alpha + \beta_1 f_{t-1} + \beta_2 f_{t-2} + \dots\dots\dots + \beta_p f_{t-p} + \xi \quad \dots\dots (3.42)$$

where the vector f_t is a $k \times 1$ vector containing κ variables, which has f_{it} as the i^{th} element at time t, such that, if the i^{th} variable is nominal exchange rate volatility, then f_{it} is the value of nominal exchange rate volatility at time t, α is a $k \times 1$ vector of constant terms (intercept), β_i is a $k \times k$ matrix of coefficients (for $i = 1,2,.......,p$) and ξ_t is a $k \times 1$ zero mean stochastic disturbance term capturing non fundamental determinants, for instance related to speculative behaviour in the exchange rate market. VAR model has three types: the reduced form VAR, the recursive VAR and the Structural VAR. The latter was used with no identifying restrictions. However, dummy variables which were treated as exogenous were included to capture the effects of changes in exchange rate regime. The search for p was based on Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC). The criterion was to choose p so as to maximize AIC. In an attempt to reduce the size of the model, zero coefficients were imposed on variables and lags with low t-statistics. A reduction in SIC in this case implies an improvement in the model. Therefore a model with a lower SIC was preferred. Before choosing the lag order, the residual was analysed for serial correlation problem.

The use of VAR requires that all the variables used be of same order of integration. Where variables are stationary at level, then VAR can be used at level. Variables can be integrated of order zero; I(0) and it can also be integrated of order d; I(d), where $d > 0$. If variables are I(1), then it is important to determine whether it is co-integrated or not. If it is I(1) and co-integrated, then the error correction term has to be included in the VAR. The model then becomes a vector error correction model (VECM), which is a restricted VAR. On the other hand, if the variables are I(1) and not co-integrated, then a VAR can be used at first difference. That is, estimation will be done at first difference where the variables are stationary.

3.8 Diagnostic Tests

3.8.1 Stability Test

Stability test for a VAR (p) process involves checking that the eigenvalues of the following matrix are less than one. If they are then the VAR is stable.

$$\beta = \begin{pmatrix} \beta_1 & \beta_2 & \cdots & \beta_{p-1} & \beta_p \\ I & 0 & \cdots & 0 & 0 \\ 0 & I & \cdots & 0 & 0 \\ \vdots & \vdots & \cdots & \vdots & \vdots \\ 0 & 0 & \cdots & I & 0 \end{pmatrix}$$

VAR is stable where the eigenvalues for the stability matrix above lies inside the unit circle.

3.8.2 Residual Diagnostic Tests

Residual diagnostic tests on the model results will include tests for normality and serial correlation. The test statistics are Normality (Jarque-Bera statistic) and Serial Correlation (Breusch-Godfrey Serial Correlation LM test). Each test procedure produces either or both of finite F-distribution or Chi-square asymptotic statistic output and their associated probability numbers (p-values). The p-value indicate the probability of obtaining a test statistic whose absolute value is greater than or equal to that of the sample statistic if the null hypothesis is true. Thus, low p-values lead to the rejection of the null hypothesis (existence of the anomaly). For example, if a p-value lies between 0.05 and 0.01, the null hypothesis is rejected at the 5 percent but not at the 1 percent level.

3.9 Data Type, Refinement and Sources

The primary source of data used was from the International Financial Statistics of the International Monetary Fund database for Kenya, and EconStats and Organisation for Economic Co-operation and Development (OECD) for the United States of America. The frequency of the data was monthly and the type of data was secondary. Where data was available at low frequency, it was interpolated to monthly frequency.

The model required data on exchange rate for Kenya Shillings against the US dollar, interest rates for both Kenya and the United States of America, inflation rate for both Kenya and the United States of America, money supply (M2) for both Kenya and the United States of America, productivity indices for both Kenya and the United States of America, net foreign assets, treasury bill rate, and the level of budget deficit and its financing components. Money supply, net foreign assets, budget deficit and its financing composition were as expressed as a percentage of GDP. The data on interest rate, inflation rate, money supply and productivity differential was expressed in differential form, that is domestic values of these variables were expressed relative to values of their foreign counterparts.

Variables except interest rates and inflation rate were expressed as percentage changes. Percentage changes were computed by transforming the variables using logs, such that X_t became x_t after transformation, obtained as $x_t = 100\ln\left(\frac{X_t}{X_{t-1}}\right)$. To allow for this transformation where a series has both positive and negative values, a hundred was added to the net foreign assets as a percentage of GDP, budget deficit as a percentage of GDP, the net domestic financing of budget deficit as a percentage of GDP and the net foreign financing of budget deficit as a percentage of GDP. This was appropriate as none of the values in these variables exceeded 100% when expressed as a percentage of GDP.

Volatility of the exchange rate was the standard deviation whose variance σ_t^2 at time $t-1$ for k observations was obtained as:

$$\sigma_t^2 = \frac{1}{\kappa - 1}\sum_{i=1}^{\kappa}\left(q_{t-i} - \bar{q}\right)^2 \qquad (3.43)$$

where $\bar{q} = \sum_{i=1}^{k} q_{t-i}/k$, q_t is the percentage changes in exchange rate. This approach assigns equal weights to each observation in the moving window of exchange rate. The window size was 12 observations.

3.10 Data Analysis and Techniques

This study tackled two objectives. The first was to analyse the effects of using financing composition of budget deficit or the level of budget deficit on modelling of volatility in exchange rate. This was achieved by testing for aggregation problem in the budget deficit using F-test. Where there was evidence of aggregation problem, the performance of the two candidate models, the model with the aggregated budget deficit and the other with the disaggregated budget deficit, were evaluated using their forecasting errors. The Root Mean Squared Error and Mean Absolute Error were used to evaluate performance of the candidate models for within the sample forecast for the period 2005:01 to 2005:12. These two forecast error statistics depend on the scale of the dependent variable. As relative measures it is therefore suitable for comparing forecasts for the same series across different models as it was the case in this study. The criterion is the smaller the error, the better the forecasting ability of that model. Theil inequality coefficient was used for comparison to ensure consistency in results. The model with the best fit was then selected to address the second objective.

The second objective of this study was to determine the effects of budget deficit (or its financing composition) and macroeconomic fundamentals on exchange rate volatility under different exchange rate regimes. This was accomplished by Vector Autoregressive estimation of the model selected in the first objective. After VAR estimation, impulse response and variance decomposition was generated and used to analyse the effects of shocks to budget deficit (or its financing composition) and macroeconomic fundamentals on exchange rate volatility. This analysis was conducted while taking into consideration the structural breaks in variables which were tested using Chow break point test, and where present, dummy variables were introduced to capture their effects.

CHAPTER FOUR

EMPIRICAL RESULTS

4.1 Introduction

This chapter presents empirical findings of this study. First an overview of the properties of the data is presented. Secondly, the effects of using the financing composition of budget deficit instead of budget deficit in modelling of exchange rate volatility is presented and explained. Finally, the effects of budget deficit financing and macroeconomic fundamentals on exchange rate volatility under different exchange rate regimes is analysed and explained.

4.2 Unit Root, Cointegration and Structural Break Test Results

4.2.1 Unit Root Tests

The null hypothesis that the series are I (1) against an alternative hypothesis that the series are I (0) was tested using ADF unit root tests. Variables were taken to be stationary where p-values were less than 0.05. Table 4.1 shows the unit root tests results of the variables.

Table 4.1: Unit Root Test Results

	Levels		**First Difference**		Level of integration at 5% level of significance
	ADF (no trend)		ADF (no trend)		
Variables	Z-Values	P-Values	Z-Values	P-Values	
Exchange Rate Volatility (VolNER)	-3.86	0.0023	-9.64	0.0000	I(0)
Interest Rate Differential (IRD)	-3.22	0.0189	-8.53	0.0000	I(0)
Inflation Rate Differential (INF)	-3.42	0.0103	-7.44	0.0000	I(0)
Domestic Nominal Interest Rate (DNI)	-3.42	0.0104	-8.67	0.0000	I(0)
Productivity Differential (PD)	-8.09	0.0000	-13.23	0.0000	I(0)
Money Supply Differential (M2D)	-8.34	0.0000	-14.19	0.0000	I(0)
Net Foreign Asset (NFA)	-2.09	0.2507	-5.92	0.0000	I(1)
Budget Deficit (BD)	-8.627	0.0000	-17.40	0.0000	I(0)
Net Domestic Financing of Budget Deficit (NDFBD)	-12.06	0.0000	-19.07	0.0000	I(0)
Net Foreign Financing of Budget Deficit (NFFBD)	-7.91	0.0000	-15.25	0.0000	I(0)

Sources: Derived from data.

The tests were carried out with an intercept and no trend whose critical values were as follows:

1) 1% Critical Value -3.45

2) 5% Critical Value -2.87

3) 10% Critical Value -2.57

As shown in Table 4.1 exchange rate volatility, interest rate differential, inflation rate differential, domestic nominal interest rate, money supply, net domestic financing of budget deficit, net foreign financing of budget deficit and the productivity differential were integrated of order zero, which implies that they were stationary at level. Net foreign assets (NFA) was the only variable that was integrated of order one, however, it become stationary when differenced once. This decision is the same at 1%, 5% and 10% significance level.

4.2.2 Cointegration Analysis Results

Since only one variable had unit root, cointegration analysis could not be conducted. Cointegration is considered only when two or more variables have unit root.

4.2.3 Structural Break Tests

This entailed testing the null hypothesis of no structural breaks against an alternative of three structural breaks occurring in 1982:09, 1990:10 and 1993:10 for the two candidate equations. Table 4.2 present Chow Break Point test results for structural breaks. Structural break were taken to exist where the probability values of the test statistics were less than 0.05.

Table 4.2: Chow Break Point Test Results

Model		Statistics	Probability
Model with aggregated budget deficit	F-statistic	2.5561	0.0001
	Log likelihood ratio	69.4678	0.00001
Model with disaggregated budget deficit	F-statistic	2.2696	0.0002
	Log likelihood ratio	69.3342	0.0001

Sources: Derived from data.

The test results for equation with the aggregated and disaggregated budget deficit rejected the null hypothesis of no structural breaks in favour of three structural breaks in the underlying relationship. The implication of this is that there is no single relationship explaining movement in exchange rate but four separate relationships for each of the four exchange rate regimes.

4.3 Effects of Aggregation of Budget Deficit on Modelling of Exchange Rate Volatility

The first objective of this study was to analyse the effects of using financing composition of budget deficit instead of the budget deficit on modelling of exchange rate volatility. The selection of the model to be used to analyse the impact of macroeconomic fundamentals and the level of budget deficit or the financing composition of budget deficit on exchange rate volatility was done using the test for aggregation problem, then followed by an evaluation of the performance of the two candidate models using within the sample forecast performance for one year (2005:01 to 2005:12).

The models with aggregated and disaggregated budget deficit were estimated with eight lags of the dependent variable, each of the independent variables and the dummy variables for structural breaks, then residuals were generated and the sum of the squared residuals were captured. These results are presented in Table 4.3.

Table 4.3: Squared Residuals for the Aggregated and Disaggregated Model

Models	Sample Size	Sum of Squared Residuals
Model with Aggregated Variables	390	62.7397
Model with Disaggregated Variables	390	62.2186
Difference		0.5212

Sources: Derived from data

Applying the test statistics yields

$$\gamma = \left(\frac{(62.7397\text{-}62.2186)/1}{62.2186/390\text{-}76} \right) = \left(\frac{0.5212}{0.1981} \right) = 2.631$$

The critical values of $F_{1,\infty}$ distribution from Stock and Watson (2007) are 2.71, 3.84 and 6.63 for 10%, 5% and 1% level of significances, respectively. Since F-statistics (γ) does not exceeds the critical values at 10%, 5% and 1% significance level, then the null hypothesis could not be rejected. The implication of these results is that, although there are signs of aggregation problem in budget deficit, it was not significant at the conventional significance level. Therefore, there is no much difference in using volatility in the level of budget deficit or volatility in the financing composition of budget deficit to explain exchange rate volatility. Therefore, using the financing composition of budget deficit or the level of budget deficit in explaining nominal exchange rate volatility makes little or no difference. To obtain the best model from these two models, their performances were evaluated using their forecasting errors and benchmarked against the performance of the random walk model. The results of the Root Mean Squared Error, Mean Absolute Error and Theil Inequality Coefficient are summarised in Table 4.4

Table 4.4: Forecast Errors and Performance Coefficients.

Model Test	Model with aggregated budget deficit	Model with disaggregated budget deficit	Random Walk
Root Mean Squared Error	0.3410	0.2921	0.2950
Mean Absolute Error	0.2757	0.2287	0.2465
Theil Inequality Coefficient	0.1144	0.1000	0.1000

Sources: Derived from data

The forecast sample for the results in Table 4.4 is: 2005:01 to 2005:12. The model with the lowest Root Mean Squared Error and the Mean Absolute Error is the one with the disaggregated budget deficit. Thus, this model offers the best fit for explaining exchange rate volatility. This model also outperformed the Random Walk model. This is inconsistent with the findings of Meese and Rogoff (1983). Therefore, the model with the financing composition of budget deficit was selected and used to analyse the impact of macroeconomic fundamentals and the financing composition of budget deficit on exchange rate volatility.

4.4 Estimation Results

Prior to estimating VAR, it is important to highlight what is expected regarding aggregation problem, structural breaks in some variables, and non-stationarity in some series. The test results for aggregation problem indicated that there is no aggregation problem in the budget deficit. Since these results could not conclusively determine which model to adopt, it was necessary to evaluate the models using forecast errors. The model with disaggregated budget deficit had the lowest forecast errors and hence this model provided the best fit. The evidence of structural breaks implied that there were significant changes in variables across exchange rate regimes. Therefore, in the presence of these two problems, it is statistically inappropriate to use the level of budget deficit and one equation for the entire period, either for forecasting or for policy analysis. The non-stationarity in net foreign asset was addressed by including the variable at the level where it was stationary.

It is expected that after taking into consideration the foregoing estimation and specification issues, then movements in macroeconomics fundamentals are expected to explain exchange rate volatility. If this is true, then this implies an improvement in modelling of volatility in exchange rate. VAR was estimated with the following variables: exchange rate volatility, interest rate differential, inflation rate differential, domestic nominal interest rate, net foreign assets, the productivity differential together with the financing composition of budget deficit and the exogenous dummy variables to take care of the identified structural breaks. VAR was estimated using eight months lag of each the endogenous variables. Due to the high frequency of the series, p-lag of eight was considered appropriate than the more restrictive lag of one. Once the model was estimated and diagnosed for various issues, impulse response functions and variance decomposition were generated.

4.4.1 VAR Diagnostic Tests

Various diagnostic tests were conducted to test the appropriateness of the estimated VAR. The test for VAR stability, serial autocorrelation, normality test and the lag exclusion test are summarised in Table 4.5. The details of this test are in appendix 3.

Table 4.5: Summary of Diagnostic Tests

VAR Condition Test	Test Statistics	Conclusion
Test for VAR stability	Roots of polynomial within unit cycle	VAR satisfies stability condition.
Test for autocorrelation	P-values for LM test for autocorrelation was 0.3161	No autocorrelation at lag order of 8.
Test for Residual multivariate normality	P-values for Jarque-Bera was 0.0000	Residuals are multivariate normal.
Wald exclusion lags test	P-values for Wald exclusion lags test was 0.014	Lag exclusion is not rational.

Sources: Derived from data

4.4.2 Effects of Budget Deficit Financing and Macroeconomic Fundamentals on Exchange Rate Volatility.

The second objective of this study was to determine the effects of budget deficit (or its financing composition) and macroeconomic fundamentals on exchange rate volatility under different exchange rate regimes. From the forecast error evaluation results, the model with the financing composition of budget deficit provided the best fit. Therefore, to achieve this objective, the effects of the financing composition of budget deficit were analysed together with those of other macroeconomic fundamentals.

This objective was achieved by using impulse response functions and variance decomposition. An impulse response function traces the effect of a one standard deviation shock to one of the innovations on current and future values of the endogenous variables. A shock to the j^{th} variable directly affects the j^{th} variable, and is also transmitted to all of the endogenous variables through the dynamic structure of the VAR.

The following graphs shows the effect of one standard deviation positive shock to each of the macroeconomic fundamentals on exchange rate volatility over 120 months horizon. The variables were ordered as follows: exchange rate volatility, interest rate differential, inflation rate differential, domestic nominal interest rate, money supply, net foreign asset, net domestic financing of budget deficit, net foreign financing of budget deficit and the productivity differential. In each graph, the solid line represents the estimated response while the dashed lines represent two standard errors band. Each relationship is considered significant where zero lies outside the confidence band for at least two month.

Figure 4.1 presents the impact of own shock on exchange rate volatility.

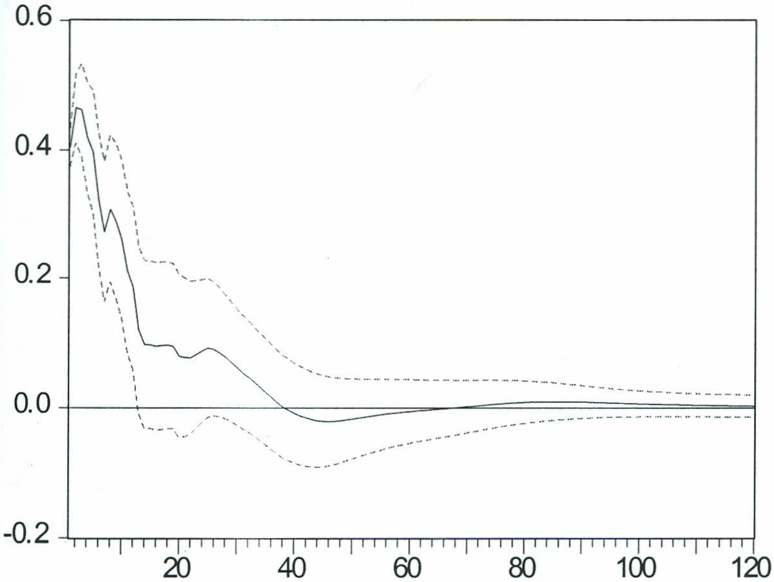

Figure 4.1: The impact of own shock on exchange rate volatility.

Source: Derived from data.

A one standard deviation own shock to exchange rate volatility resulted in a stable time path, which was initially positive then crossed over to negative after close to three years, then back to positive territory before it fizzles out. The results in figure 4.1 are significant and shows that a one standard deviation own shock to exchange rate volatility has effects that last for 108 months. This suggests that unexpected shock to exchange rate volatility has positive effects on itself.

Figure 4.2 presents the impact of interest rate differential on exchange rate volatility.

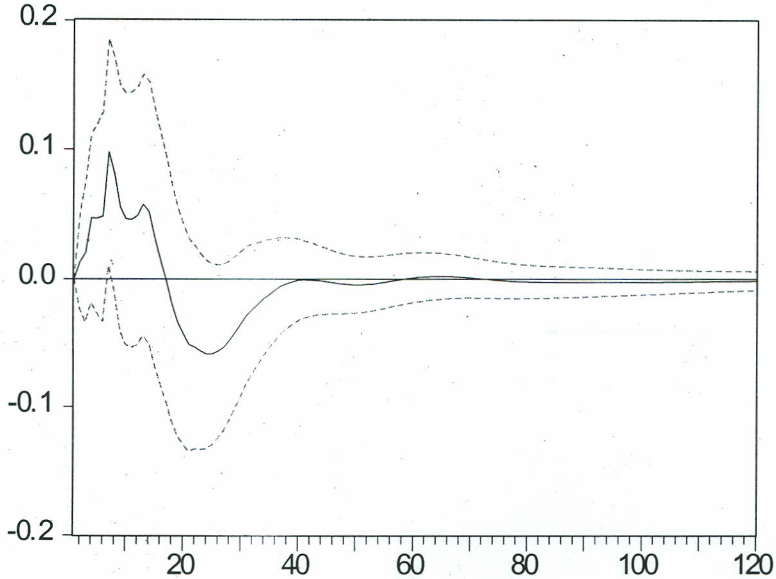

Figure 4.2: The impact of interest rate differential on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to interest rate differential resulted in a stable time path, which declined to zero with respect to exchange rate volatility as shown in figure 4.2. The reaction of exchange rate volatility to changes in interest rate differential, though not significant, was initially positive then turned negative after about 18 months before dying out after about 60 months. The implication of this is that interest rate differential has mixed effects on exchange rate volatility. The large confidence interval which includes zero indicates that after a one standard deviation positive shock to interest rate differential, an increase in exchange rate volatility may or may not materialize.

Figure 4.3 presents the impact of inflation rate differential on exchange rate volatility.

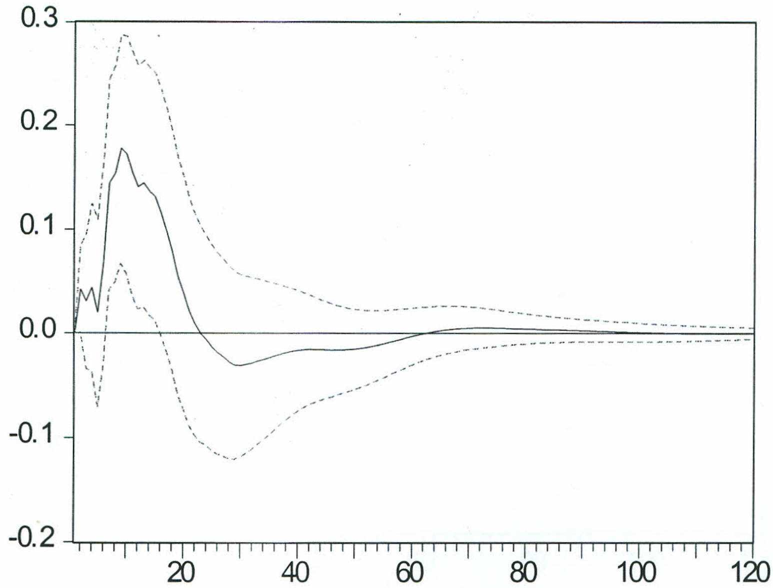

Figure 4.3: The impact of inflation rate differential on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to inflation rate differential resulted in a stable time path, which declined to zero with respect to exchange rate volatility as shown in figure 4.3. The effect of a one standard deviation shock on inflation rate differential on exchange rate volatility were significant and would last for close to 60 months, after which it fizzles out. The effect was initially positive for a period of about 24 months, before turning to the negative territory. This suggests that inflation rate differential have positive effect on exchange rate volatility, since the effect takes longer in the positive territory.

Figure 4.4 presents the impact of domestic nominal interest rate on exchange rate volatility.

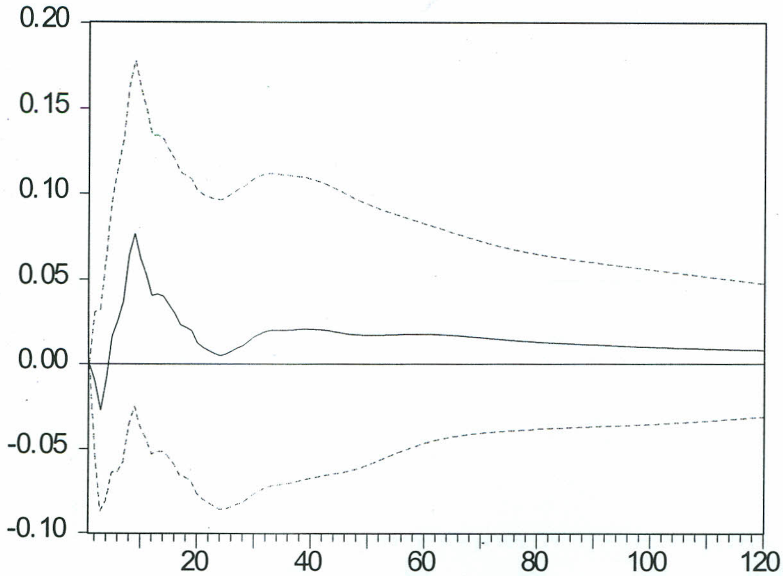

Figure 4.4: The impact of domestic nominal interest rate on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to domestic nominal interest rate resulted in a stable time path, which persisted beyond 120 months with respect to exchange rate volatility as shown in figure 4.4. The effects of a one standard deviation shock on domestic nominal interest rate on exchange rate volatility were insignificant and persisted beyond 120 months. The large confidence interval which includes zero indicates that after a one standard deviation positive shock to domestic nominal interest rate, an increase in exchange rate volatility may or may not occur. The effect was initially negative for about four months then moved to positive territory where it persisted. This suggests that domestic nominal interest rate have persistent effect on exchange rate volatility.

Figure 4.5 presents the impact of money supply differential on exchange rate volatility.

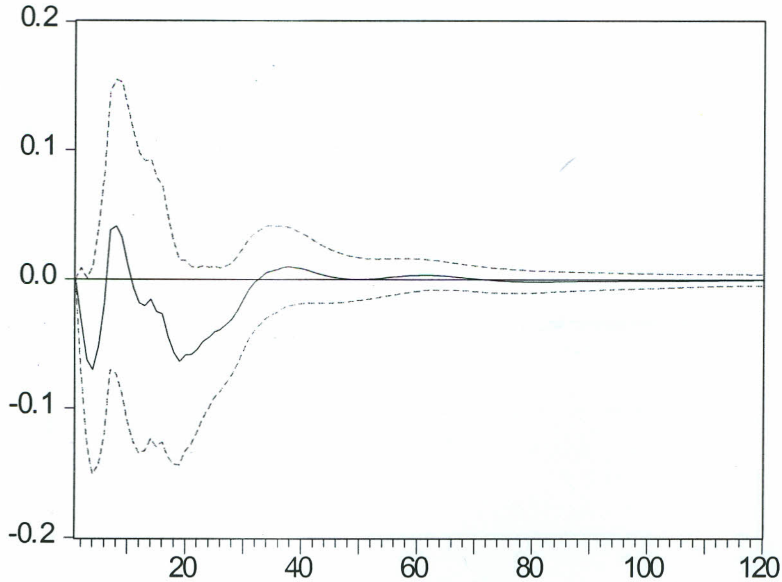

Figure 4.5: The impact of money supply differential on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to money supply differential resulted in a stable time path which declined to zero with respect to exchange rate volatility as shown in figure 4.5. The effect of a one standard deviation shock on money supply differential on exchange rate volatility was insignificant and would last for about 45 months, after which it fizzles out. The effects were initially negative for a period of about 7 months then moved to positive territory and back to negative territory. This suggests that money supply differential affect exchange rate volatility negatively since the magnitude of the effect lasted for 29 months in the negative territory. The large confidence interval which includes zero indicates that after a one standard deviation positive shock to money supply differential, a decline in exchange rate volatility may or may not materialize.

Figure 4.6 presents the impact of net foreign asset on exchange rate volatility.

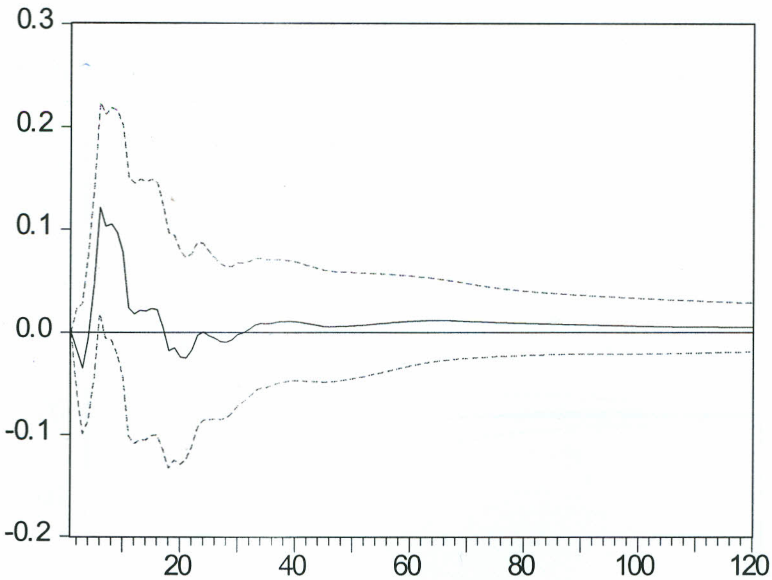

Figure 4.6: The impact of net foreign asset on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to net foreign asset resulted in a stable time path which declined to zero with respect to exchange rate volatility as shown in figure 4.6. The effect of a one standard deviation shock on net foreign asset on exchange rate volatility was insignificant and would last for about 120 months, after which it dies out. The effects was initially negative for a period of about 4 months then moved to positive territory and back to negative territory. This suggests that net foreign asset affect exchange rate volatility positively, since the magnitude of the effect lasted for close to 102 months in the positive territory. The large confidence interval which includes zero indicates that after a one standard deviation positive shock to net foreign asset, an increase in exchange rate volatility may or may not occur.

Figure 4.7 presents the impact of net domestic financing of budget deficit on exchange rate volatility.

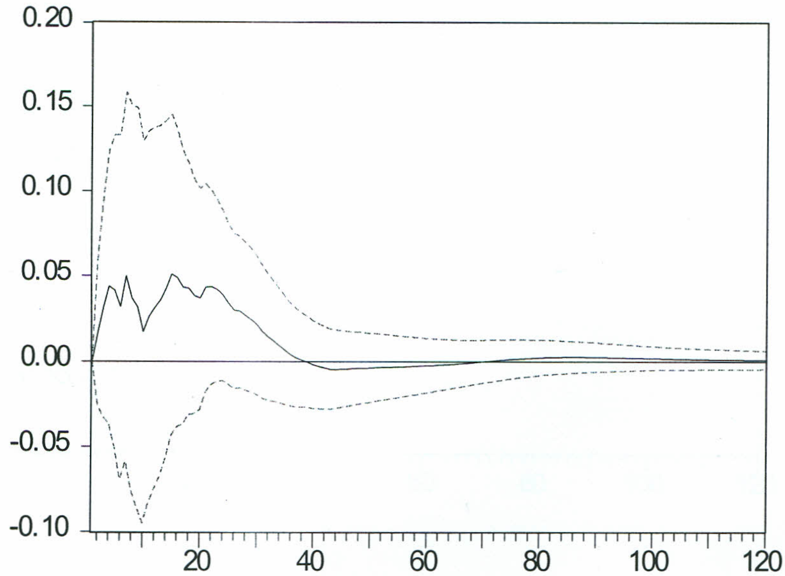

Figure 4.7: The impact of net domestic financing of budget deficit on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to net domestic financing of budget deficit resulted in a stable time path, which declined to zero with respect to exchange rate volatility as shown in figure 4.7. The effect of a one standard deviation shock on net domestic financing of budget deficit on exchange rate volatility was insignificant and would last for close to 108 months, after which it fizzles out. The effect was initially positive for a period of about 36 months before turning to the negative territory. This suggests that net domestic financing of budget deficit have positive effect on exchange rate volatility since the effect takes longer in the positive territory and also its magnitude is bigger on the positive territory. The large confidence interval which includes zero indicates that after a one standard deviation positive shock to net domestic financing of budget deficit, an increase in exchange rate volatility may or may not materialize.

Figure 4.8 presents the impact of net foreign financing of budget deficit on exchange rate volatility.

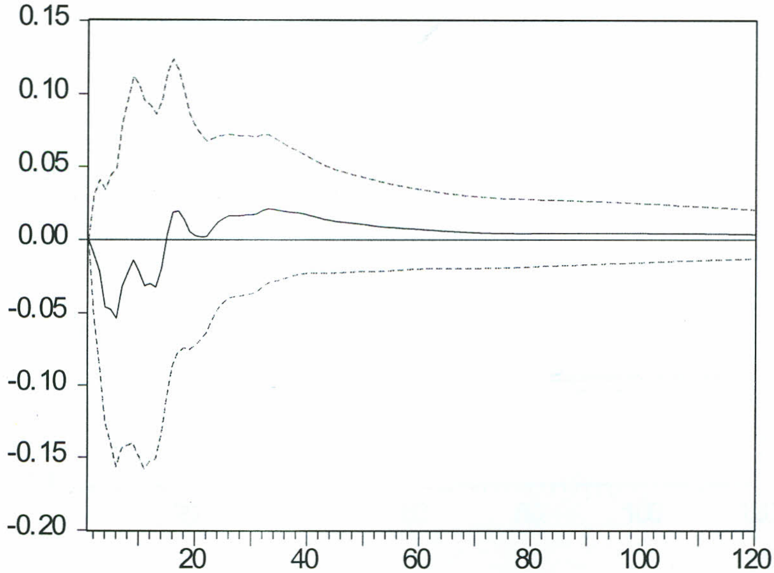

Figure 4.8: The impact of net foreign financing of budget deficit on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to net foreign financing composition of budget deficit resulted in a stable time path which persisted beyond 120 months with respect to exchange rate volatility as shown in figure 4.8. The effects of a one standard deviation shock on net foreign financing composition of budget deficit on exchange rate volatility were insignificant and persisted beyond 120 months. The effect was initially negative for about sixteen months, then moved to positive territory where it persisted. This suggests that net foreign financing composition of budget deficit rate have persistent effect on exchange rate volatility. The large confidence interval which includes zero indicates that after a one standard deviation positive shock to net foreign financing composition of budget, a decline in exchange rate volatility may or may not occur.

Figure 4.9 presents the impact of productivity differential on exchange rate volatility.

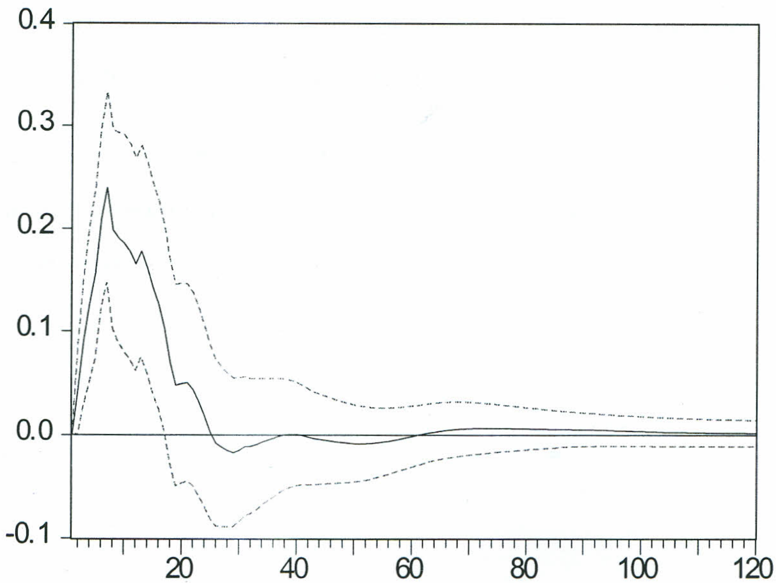

Figure 4.9: The impact of productivity differential on exchange rate volatility

Sources: Derived from data.

The response to one standard deviation innovation to productivity differential resulted in a stable time path, which declined to zero with respect to exchange rate volatility as shown in figure 4.9. The effect of a one standard deviation shock on productivity differential on exchange rate volatility was significant and would last for close to 102 months, after which it fizzles out. The effect was initially positive for a period of about 24 months before turning to the negative territory then back to positive territory. This suggests that productivity differential have positive effect on exchange rate volatility, since the magnitude of the effect is bigger and takes longer in the positive territory than in the negative territory.

Variance decomposition is an alternative method to the impulse response functions for examining the effects of shocks to the dependent variables. It determines how much of the forecast error variance for any variable in a system is explained by innovations to each explanatory variable over a series of time horizons. It was also important to consider the ordering of the variables when conducting these tests, as in practise the error terms of the equations in the VAR will be correlated, so the result will be dependent on the order in which the equations are estimated in the model. Therefore, the variables were ordered as follows: exchange rate volatility, interest rate differential, inflation rate differential, domestic nominal interest rate, money supply, net foreign asset, net domestic financing of budget deficit, net foreign financing of budget deficit and the productivity differential.

The results of the forecast error variance decomposition for exchange rate volatility and the macroeconomic fundamentals are presented in the next page. Results are reported for every interval of 24 months.

Table 4.6: Variance Decomposition of exchange rate volatility and macroeconomic fundamentals.

Variance Decomposition of:	Period	Interest Rate Differential	Inflation Rate Differential	Domestic Nominal Interest rate	Money Supply Differential	Net Foreign Asset	Net Domestic Financing of Budget Deficit	Net Foreign Financing of Budget Deficit	Productivity Differential	**Sum of the Macroeconomic Fundamentals**	**Exchange Rate Volatility**
Exchange Rate Volatility	24	2.25	10.17	1.17	1.78	2.48	1.39	0.59	17.95	**37.78**	**62.22**
	48	2.83	10.18	1.41	1.97	2.43	1.54	0.83	17.25	**38.44**	**61.56**
	72	2.82	10.18	1.67	1.96	2.51	1.54	0.88	17.18	**38.74**	**61.26**
	96	2.82	10.16	1.80	1.96	2.56	1.54	0.89	17.15	**38.88**	**61.12**
	120	2.82	10.14	1.88	1.96	2.59	1.54	0.90	17.13	**38.95**	**61.05**
Interest Rate Differential	24	32.15	20.39	0.74	3.66	2.44	1.74	2.92	27.85	**91.89**	**8.11**
	48	29.62	19.29	1.17	3.54	2.45	2.07	2.73	25.90	**86.78**	**13.22**
	72	29.21	19.29	1.34	3.52	2.56	2.08	2.70	25.77	**86.46**	**13.54**
	96	29.16	19.25	1.41	3.51	2.57	2.08	2.72	25.72	**86.43**	**13.57**
	120	29.13	19.24	1.46	3.51	2.59	2.08	2.73	25.70	**86.44**	**13.56**
Inflation Rate Differential	24	4.25	57.20	2.17	2.14	0.96	1.70	2.88	10.15	**81.46**	**18.54**
	48	4.32	50.55	4.38	2.19	2.27	2.01	2.57	9.37	**77.67**	**22.33**
	72	4.23	48.61	5.02	2.17	2.62	2.05	2.57	9.57	**76.84**	**23.16**
	96	4.23	48.19	5.45	2.15	2.75	2.04	2.67	9.49	**76.97**	**23.03**
	120	4.21	47.95	5.71	2.14	2.85	2.03	2.71	9.47	**77.06**	**22.94**
Domestic Nominal Interest Rate	24	28.92	18.85	4.10	3.63	3.14	1.73	0.99	29.25	**90.60**	**9.40**
	48	26.14	17.45	3.94	3.45	3.04	2.12	1.01	26.91	**84.06**	**15.94**
	72	25.97	17.53	4.13	3.43	3.06	2.11	1.11	26.74	**84.09**	**15.91**
	96	25.89	17.49	4.28	3.42	3.13	2.11	1.12	26.68	**84.11**	**15.89**
	120	25.85	17.46	4.34	3.42	3.15	2.11	1.13	26.64	**84.10**	**15.90**
Money Supply Differential	24	4.95	3.71	3.10	74.88	4.05	1.61	1.33	3.78	**97.41**	**2.59**
	48	4.98	3.84	3.12	74.47	4.07	1.63	1.33	3.81	**97.26**	**2.74**
	72	4.98	3.84	3.13	74.44	4.08	1.63	1.33	3.81	**97.25**	**2.75**
	96	4.98	3.84	3.14	74.43	4.08	1.63	1.34	3.81	**97.25**	**2.75**
	120	4.98	3.84	3.14	74.42	4.08	1.63	1.34	3.81	**97.25**	**2.75**
Net Foreign Asset	24	0.43	3.12	2.31	1.62	85.47	1.26	0.86	2.99	**98.06**	**1.94**
	48	0.47	3.13	2.35	1.65	85.31	1.26	0.86	3.03	**98.04**	**1.96**
	72	0.47	3.13	2.36	1.64	85.28	1.26	0.87	3.03	**98.04**	**1.96**
	96	0.47	3.13	2.37	1.64	85.27	1.26	0.87	3.03	**98.04**	**1.96**
	120	0.47	3.13	2.37	1.64	85.27	1.26	0.87	3.03	**98.04**	**1.96**
Net Domestic Financing of Budget Deficit	24	4.11	1.20	1.97	8.29	3.28	70.01	5.15	4.05	**98.07**	**1.93**
	48	4.13	1.22	1.97	8.30	3.28	69.94	5.16	4.07	**98.06**	**1.94**
	72	4.13	1.22	1.97	8.30	3.28	69.94	5.16	4.07	**98.06**	**1.94**
	96	4.13	1.22	1.97	8.30	3.28	69.94	5.16	4.07	**98.06**	**1.94**
	120	4.13	1.22	1.97	8.30	3.28	69.94	5.16	4.07	**98.06**	**1.94**
Net Foreign Financing of Budget Deficit	24	2.50	1.62	2.63	2.21	2.37	4.86	77.88	3.00	**97.08**	**2.92**
	48	2.50	1.63	2.70	2.22	2.43	4.86	77.67	3.01	**97.02**	**2.98**
	72	2.50	1.63	2.74	2.22	2.44	4.85	77.58	3.02	**96.99**	**3.01**
	96	2.50	1.63	2.76	2.22	2.45	4.85	77.56	3.02	**96.99**	**3.01**
	120	2.50	1.63	2.77	2.22	2.46	4.85	77.54	3.02	**96.99**	**3.01**
Productivity Differential	24	1.30	4.76	0.60	3.51	28.64	1.94	0.68	55.52	**96.96**	**3.04**
	48	1.32	4.82	0.63	3.52	28.54	1.96	0.68	55.41	**96.87**	**3.13**
	72	1.32	4.82	0.64	3.52	28.52	1.96	0.68	55.37	**96.83**	**3.17**
	96	1.32	4.82	0.64	3.52	28.51	1.96	0.68	55.36	**96.83**	**3.17**
	120	1.32	4.82	0.64	3.52	28.51	1.96	0.68	55.36	**96.83**	**3.17**

Sources: Derived from data.

As shown in table 4.6, the results of the forecast error variance decomposition are clear cut, pointing to evidence of medium- to long-term linkages between macroeconomic fundamentals and exchange rate volatility, and to mostly idiosyncratic long memory dynamics for most of the variables except domestic nominal interest rate. For most of the variables, own shock explained the bulk of volatility fluctuations at all the horizons, with the contribution of other shocks increasing as the forecast horizon increases.

On average, exchange rate volatility shocks explained between 61% and 62% of exchange rate volatility variance at the selected horizons. Similarly, interest rate differential shocks explained between 29% and 32% of interest rate differential variance. On the other hand, figures for the inflation rate differential are in the range of 47% to 57%. Money supply differential and the net foreign asset figures are in the average of 74% and 85%, respectively. Moreover, for the net domestic financing of budget deficit, the net foreign financing of budget deficit and the productivity differential figures are in the average of 70%, 77% and 55%, respectively. In most of the cases, with the exception of the domestic nominal interest rate, it is always the own volatility shock that explains the bulk of variability for each of the variables. On average, own shocks explained 3.94% to 4.34% of the variability in domestic nominal interest rate. The bulk of variability in domestic nominal interest rate was explained by productivity differential, interest rate differential and inflation rate differential in their order of significance.

Last but not least, while some contribution to the explanation of macroeconomic volatility is provided by the exchange rate shocks, a much stronger role seems to be played by the macroeconomic shocks. On average the exchange rate volatility shocks explained an average of about 8% of macroeconomic volatility variance at all the forecasting horizons considered, with the effects being more pronounced on inflation rate differential, domestic nominal interest rate, interest rate differential, productivity differential and net foreign financing of budget deficit, in that order of magnitude. The average contribution of macroeconomic volatility shocks to exchange rate volatility variance is about 38%. The main drivers of movements in exchange rate volatility were productivity differential and inflation rate differential and, to a lesser extent, interest rate differential and net foreign asset. The feedback effect in inflation rate differential and productivity differential provide evidence of linkages and trade-offs between macroeconomic and exchange rate volatility. While these linkages show bidirectional causality in the medium- to long-term, macroeconomic volatility does seem to be a stronger driving force for exchange rate volatility than the other way around. This finding supports Friedman (1953) assertion on the case for flexible exchange rates and is consistent with the findings of Morana (2009), at least in the medium term.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction

In this chapter, a brief summary of the important results from the study is given, followed by a conclusion highlighting important findings of the study, then policy recommendations and the suggested areas for further research.

5.2 Summary

This study sought to improve on the modelling of volatility in exchange rate in order to best explain its movement. This was achieved through a two step process each step representing an objective. The first step was to determine the model that best explains movement in exchange rate and then, in the second step, applying this model to determine the effects of budget deficit (or its financing compositions) and macroeconomic fundamentals on exchange rate volatility. Monthly data spanning the period 1973:01 to 2005:12 for the following variables: exchange rate volatility, interest rate differential, inflation rate differential, domestic nominal interest rate, money supply differential, net foreign assets and productivity differential were used to achieve these objectives.

The first step was to establish the effects of using the financing composition of budget deficit instead of budget deficit in modelling of exchange rate volatility. For this purpose two models were specified, one with the aggregated budget deficit and the other with the disaggregated budget deficit. The test for aggregation problem was conducted followed by the evaluation of the forecasting performance of the two candidate models with the ultimate goal of selecting the best model to address the second objective. The model selected in step one was applied to achieve the second objective which was to determine the effects of budget deficit financing and macroeconomic fundamentals on exchange rate volatility under different exchange rate regimes. VAR estimation technique was used for this purpose and the impulse response functions and variance decomposition were generated for the analysis of these effects.

As pointed out by the empirical analysis, aggregation problem can significantly affect the modelling of volatility in exchange rate. The test for aggregation problem results revealed the existence of aggregation problem although it was insignificant. Whereas aggregation problem seemed not to be significant at the conventional significance level, it had drastic effect on the performance of the model with the aggregated budget deficit. From the forecasting performance results, the model performed badly relative to the model with disaggregated budget deficit, which was the best, and the naïve random walk model which was the second best. Owing to its superb performance, the model with the disaggregated budget deficit was selected and used to analyse the effects of macroeconomic fundamentals on exchange rate volatility.

As per the results from the impulse response functions and the forecast error variance decomposition, macroeconomic fundamentals successfully explained exchange rate volatility, with the productivity differential and the inflation rate differential as the main drivers of exchange rate volatility. The two had positive effect and were statistically significant, since zero lied outside the confidence band for at least two months. Moreover, their effects were hypothetically satisfactory. The other variables that had positive impact on exchange rate volatility were domestic nominal interest rate, net domestic financing of budget deficit and the net foreign assets. The domestic nominal interest rate and the net domestic financing of budget deficit were not statistically significant and hypothetically satisfactory. The net foreign asset was statistically insignificant although it was hypothetically satisfactory. However, their effects may or may not occur due to large confidence interval which includes zero in their impulse response functions.

On the contrary, money supply differential and the net foreign financing of budget deficit had negative effect on exchange rate volatility. Although the two were statistically insignificant, money supply differential was not hypothetically satisfactory, while the net foreign financing of budget deficit was hypothetically satisfactory. Interest rate differential had mixed effect and was statistically insignificant. This results in not surprising as higher domestic interest rates relative to other countries attract foreign capital and cause the exchange rate to rise. On the other hand, it may happen that foreigners rather buy shares instead of Treasury bonds. In this case, a rise in interest rate may provoke the opposite results, since a rise in interest rate quite often depresses the stock market, favouring a tide of share sales by foreigners. The effect of money supply differential, the net foreign financing of budget deficit and interest rate differential on exchange rate volatility may or may not materialize due to large confidence interval which includes zero in their impulse response functions.

It is important to highlight, the impact of the net domestic financing of budget deficit and the net foreign financing composition of budget deficit on exchange rate volatility. The impact of the net domestic financing of budget deficit was positive and bigger in magnitude compared to that of the net foreign financing composition of budget deficit which was negative. Moreover, financing of budget deficit through domestic borrowing, had indirect effects on exchange rate volatility through its effect on money supply, the net foreign financing of budget deficit, interest rate differential and productivity differential, besides its direct effect. While financing of budget deficit through external borrowing tended to cause feedback effect on the net domestic financing of budget deficit besides its effect on exchange rate volatility.

On the other hand, exchange rate impacted significantly on inflation rate differential, domestic nominal interest rate, interest rate differential, productivity differential and net foreign financing of budget deficit, in that order of importance. The analysis of the results revealed that in the medium- to long-term, causality is stronger from macroeconomic volatility to exchange rate volatility than vice versa, with bidirectional causality between productivity differential, inflation rate differential and, to a lesser extent, the interest rate differential on one hand and exchange rate volatility on the other.

5.3 Conclusions

The results of this study point to new directions for the construction of improved models in exchange rate. Aggregation problem were shown to have potentially unfavourable effect in modelling of volatility in exchange rate. From the forecasting performance of the three models considered, the model with disaggregated budget deficit emerged the best. Owing to this, the model was adopted for analysing the effects of macroeconomic fundamentals on exchange rate volatility. As a result macroeconomic fundamentals successfully explained exchange rate volatility with the productivity differential and inflation rate differential as the main drivers of exchange rate volatility. The other variables with positive impact on exchange rate volatility were domestic nominal interest rate, net domestic financing of budget deficit and the net foreign assets. On the contrary, money supply differential and the net foreign financing of budget deficit had negative effect on exchange rate volatility. Finally, the analysis of the results revealed a stronger medium- to long-term causality linkage from macroeconomic volatility to exchange rate volatility than the other way around, with bidirectional causality in some variables. The impact of the net domestic financing of budget deficit was positive and bigger in magnitude compared to that of the net foreign financing composition of budget deficit which was negative. Owing to this negative relationship it is possible to attain an optimal financing mix that will stabilize exchange rate without necessarily having a balanced budget.

5.4 Policy Implications

i. Researchers should incorporate test for aggregation variables problem whenever they are dealing with models where some variables are aggregated before inclusion in the model. A proper modelling of aggregated variables may lead to a more accurate forecast and generally to a superior model. The implication of this to exchange rate modelling where several variables are modelled as aggregate in differential form may call for a reconsideration in modelling of such variables. Even where there is weak evidence of aggregation problem, aggregation problem can drastically affect the ability of the model to fit into the data, forecast and therefore can be outperformed by other models such as the Random Walk model.

ii. The government should strive to restore fiscal balance as this directly raises business and consumer confidence. The increase in confidence can encourage investment. On the other hand, the loss of investor and creditor confidence at home may cause investors and creditors to reallocate funds away from Kenya shilling based investments, causing a depreciation of the exchange rate, and to demand higher interest rates on Kenyan government debt. The reduction in domestic investment lowers domestic productivity growth relative to its foreign counterpart. The larger the gap, the higher the exchange rate volatility.

iii. The Central Bank of Kenya should formulate policies targeting to narrow the gap between the domestic inflation rate and the foreign levels. As the larger the gap, the higher the exchange rate volatility. As a general rule, a country with a consistently lower inflation rate exhibits a rising currency value, as its purchasing power increases relative to other currencies. Those countries with higher inflation like Kenya typically see depreciation in their currency in relation to the currencies of their trading partners. This is more pronounced if the major trading partners enjoy lower inflation rates, since it is the difference between domestic and foreign inflation rates that determine the direction and the scale of exchange rate movements.

iv. If the country is to achieve a stable exchange rate, it is critical to bring domestic interest rates closer to the foreign level of interest rates. By manipulating interest rates, central banks exert influence over both inflation and exchange rates, and changing interest rates impact inflation and currency values. Higher interest rates offer lenders in an economy a higher return relative to other countries. Therefore, higher interest rates attract foreign capital and cause the exchange rate to rise. The impact of higher interest rates is mitigated, however, if inflation in the country is much higher than in others, or if additional factors serve to drive the currency down. In some cases, it may happen that foreigners rather buy shares instead of Treasury bonds. If this were the strongest component of currency demand, then a rise in interest rate may provoke the opposite results, since a rise in interest rate quite often depresses the stock market, favouring a tide of share sales by foreigners. Therefore, there is need for policies to stabilize interest rate, so as to stabilize foreign investors' portfolio. Care should be taken to capture the effects causing changes in interest rate before intervening in the foreign exchange market.

v. The Government through the Central Bank should institute policies that support the growth of the domestic money and capital markets, so as to increase resilience to external shocks caused by factors such as change in investor risk preferences. There is also need for policies to stabilize these markets so as to maintain or increase investor confidence. This include policies that targets to reduce fiscal imbalance.

vi. It is critical for Central Bank to determine whether interest rate parity holds or not, before designing any monetary intervention in the foreign exchange market. Interest parity condition determines the direction of the effects of monetary intervention in the foreign exchange market. An expansionary monetary shock, for instance, would generate a persistent fall in the nominal interest rate. If the uncovered interest rate parity holds, this persistent decline in the spread between domestic and foreign interest rates results in the nominal exchange rate overshooting. If the uncovered interest rate parity does not holds, for instance, when there is positive spread, this persistent decline in the spread between domestic and foreign interest rates results in a decline in exchange rate volatility.

vii. To achieve a stable exchange rate, the government through Treasury needs to take into consideration the sources of financing any incidental budget deficit, although the aim is to reduce budget deficit as a percentage of GDP, with the ultimate target of a balanced budget. Fiscal discipline has become one of the macroeconomic targets due to its effects on the country's macroeconomic environment. Of much concern on the topic of fiscal discipline is the budget deficit. It is very clear from the results of this study that it is the financing composition budget deficit that matters and not the level of budget deficit. In order to mitigate the undesirable effect of the financing composition of budget deficit on exchange rate, the policy makers should take into consideration the fact that net domestic financing of budget deficit have positive effect while the net foreign financing of budget deficit have negative effect. Owing to this opposite effects, it is possible for policy makers to work out an optimal financing mix that will ultimately stabilize volatility in exchange rate without necessarily attaining a balanced budget. The implication of this to policy issues such as the convergence criteria of the East Africa Community is that it is possible for Kenya to bring the overall budget deficit/GDP ratio (excluding grants) to less than 3 percent and at the same time achieve and maintain a stable exchange rate. However, how the budget deficit is financed may hasten or delay the achievement of a stable exchange rate. One way of reducing budget deficit is rationalising government operations and maintaining a lean, efficient and motivated workforce.

Generally, to achieve a stable long-run exchange rate, substantial changes in fiscal policy are needed to deal pre-emptively with the risks stemming from large budget deficits and the economic imbalances they entail. The political system, however, should not only address the threat posed by future deficits but also the uncertainty posed by short term borrowing through treasury bills and make the necessary choices to put the nation on a sustainable fiscal course. A sustainable fiscal course will augur well with the Central Bank's policies of reducing interest rates, for instance, through reduction in domestic borrowing, in reserve requirements ratios and bank rates.

The government should, however, note that maintaining a sustainable fiscal course will not be possible in an environment where exchange rate is volatile and the country has a substantial amount of foreign currency denominated external public debt. It is important to note that temporary budget deficits intended to spur/stimulate an economy in the short run is only beneficial when the economy is weak and has a considerable size of unused resources. When necessary to spur a weak economy, it should be only in the short-run but the overall objective should be a sustainable budget over the fiscal cycle.

5.5 Limitations and Suggestions for Further Research

This study assumed bilateral exchange rate, yet movements in exchange rate of the major trading partners could have bandwagon effects in the domestic exchange rate. It also assumed that US dollar is the only base lending currency for all budgetary supports to Kenya, although a good number of bilateral lenders have their currencies as the base lending currencies. To take care of the possible differences in the nominal exchange rate volatility due to differences in the base lending currency, a study using panel data and targeting at different bilateral and multilateral lenders is therefore suggested.

A useful extension of the present study will be to consider possible differences in the exchange rate volatility due to differences in the base lending currency, by using panel data and targeting at different bilateral and multilateral lenders. Another researchable area emerging from this study is to consider aggregation problems in other variables included in exchange rate models.

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APPENDIX 1

Procedure for testing aggregation problem in variables.

A single equation-one explanatory variable regression is used. This keeps the analysis simple.

$$s_t = c + \beta f_t + \varepsilon_t \text{ .... (A1)}$$

where s is the exchange rate, f is an explanatory variable representing macroeconomic fundamentals, ε is the error term. c, and β are constants to be estimated. The use of equation (A1) requires a very strong precondition that semi-elasticities for f_1 and f_2 must be equal. This precondition is necessary as it saves considerable degrees of freedom in a dynamic model. Taking f_1 and f_2 as the underlying sub-variables making up f then equation (A1) can be rewritten as:

$$s_t = c + \beta_1 f_{1t} + \beta_2 f_{2t} + \varepsilon_t \text{ .... (A2)}$$

The ordinary least squares estimates for parameters in equation (A1) in deviation form are:

$$c = \bar{s} - \beta \bar{f}; \quad \beta = \frac{\sum_{t=1}^{n} f_t s_t}{\sum_{t=1}^{n} f_t^2}$$

And those of equation (A2) are:

$$c = \bar{s} - \beta_1 \bar{f_1} - \beta_1 \bar{f_2},$$

$$\beta_1 = \frac{\left(\sum_{t=1}^{n} f_{1t}s_t\right)\left(\sum_{t=1}^{n} f_{2t}^2\right) - \left(\sum_{t=1}^{n} f_{2t}s_t\right)\left(\sum_{t=1}^{n} f_{1t}f_{2t}\right)}{\left(\sum_{t=1}^{n} f_{1t}^2\right)\left(\sum_{t=1}^{n} f_{2t}^2\right) - \left(\sum_{t=1}^{n} f_{1t}f_{2t}\right)^2},$$

$$\beta_2 = \frac{\left(\left(\sum_{t=1}^{n} f_{2t}s_t\right)\left(\sum_{t=1}^{n} f_{1t}^2\right) - \left(\sum_{t=1}^{n} f_{1t}s_t\right)\left(\sum_{t=1}^{n} f_{1t}f_{2t}\right)\right)}{\left(\sum_{t=1}^{n} f_{1t}^2\right)\left(\sum_{t=1}^{n} f_{2t}^2\right) - \left(\sum_{t=1}^{n} f_{1t}f_{2t}\right)^2}$$

Suppose model (A1) is a restricted form of the (unrestricted) model (A2).

If the estimated parameters for f in equation (A1) and f_1 and f_2 in equation (A2), are approximately equal then estimating the model with aggregated values is as good as estimating it with disaggregated values of the variable. Under such situation there is no aggregated variables problem, but if there is, then there will be significant difference in the two models.

Since $\sum_{t=1}^{n}$ rema in the same in the two models, then the differences will be due to differences in $\beta\sum_{t=1}^{n} f_t$ and $\beta_1 \sum_{t=1}^{n} f_{1t}, \beta_2 \sum_{t=1}^{n} f_{2t}$, which is captured by the residuals. That is

$\sum_{t=1}^{n} \varepsilon_{t,agg} = \sum_{t=1}^{n} s_t - nc - \beta \sum_{t=1}^{n} f_t$ for equation (A1) and

$\sum_{t=1}^{n} \varepsilon_{t,disagg} = \sum_{t=1}^{n} s_t - nc - \beta_1 \sum_{t=1}^{n} f_{1t} - \beta_2 \sum_{t=1}^{n} f_{2t}$ for equation (A2)

Taking this as a special case of parameter restrictions, then $\sum_{i=1}^{h} \beta_i \sum_{t=1}^{n} f_{it} \approx \beta \sum_{t=1}^{n} f_t$ and thus the test becomes:

$$\gamma = \frac{\Delta \sum_{t=1}^{n} \varepsilon_t^2}{\sum_{t=1}^{n} \varepsilon_{t,disagg}^2} = 0; \; \gamma = \frac{\sum_{t=1}^{n} \varepsilon_{t,agg}^2 - \sum_{t=1}^{n} \varepsilon_{t,disagg}^2}{\sum_{t=1}^{n} \varepsilon_{t,disagg}^2} = 0$$. This can also be expressed as $\gamma = 0$

where $\sum_{t=1}^{n} \varepsilon_{disagg}^2$ and $\sum_{t=1}^{n} \varepsilon_{agg}^2$ are the sum of squared errors when the model is estimated with disaggregated and aggregated variable, respectively. This is a test for no aggregation problem, it tests $H_0 : \gamma = 0$ against $H_1 : \gamma \neq 0$. It tests whether the model can be improved by disaggregating the variables in the estimation. The test statistics is

$$\gamma = \frac{\left(\sum_{t-1}^{n} \varepsilon_{t,agg}^2 - \sum_{t=1}^{n} \varepsilon_{t,disagg}^2 \right) \Big/ j}{\sum_{t=1}^{n} \varepsilon_{t,disagg}^2 \Big/ (n-k)}$$

where j is the number of hypothesis, k is the number of estimated parameters in the model with disaggregated variables and n is the number of observations. ~

Since $\frac{\left(\sum_{t=1}^{n}\varepsilon_{t,agg}^{2}-\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}\right)}{\sigma^{2}} \sim \chi^{2}_{(j)}$ and $\frac{\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}}{\sigma^{2}} \sim \chi^{2}_{(n-k)}$ then an F random variable can be formed by the ratio of the two, that is

$$\frac{\left(\sum_{t=1}^{n}\varepsilon_{t,agg}^{2}-\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}\right)\Big/ j}{\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}\Big/ (n-k)} \sim F_{j,(n-k)}$$

If $\Delta\sum_{t=1}^{n}\varepsilon_{t}^{2}\to\infty$ then the assumption that the null hypothesis is true significantly reduces the ability of the model to fit the data, and thus data do not support the null hypothesis. If the null hypothesis is true, then aggregations of variables have no significant impact on the estimated parameters. Thus, there should be little change in the sum of squared errors when the null hypothesis is true, that is $\Delta\sum_{t=1}^{n}\varepsilon_{t}^{2}\to 0$. $\sum_{t=1}^{n}\varepsilon_{t,agg}^{2}$ assumes that the null hypothesis is true and therefore there is no need to disaggregate the variable into its underlying sub-variables.

If the null hypothesis is true, then γ has an F-distribution with j numerator degrees of freedom and $n-k$ denominator degrees of freedom. If the null hypothesis is not true, then $\left(\sum_{t=1}^{n}\varepsilon_{t,agg}^{2}-\sum_{t=1}^{n}\varepsilon_{t,disagg}^{2}\right)$ becomes large, implying that aggregation have large effects on the ability of the model to fit the data. In this case γ tend to be too large and the null hypothesis is rejected. The decision criterion will be to compare the values of γ with the critical values F_{c}, which leaves a probability α in the upper tail of the F-distribution with j and $n-k$ degrees of freedom.

APPENDIX 2

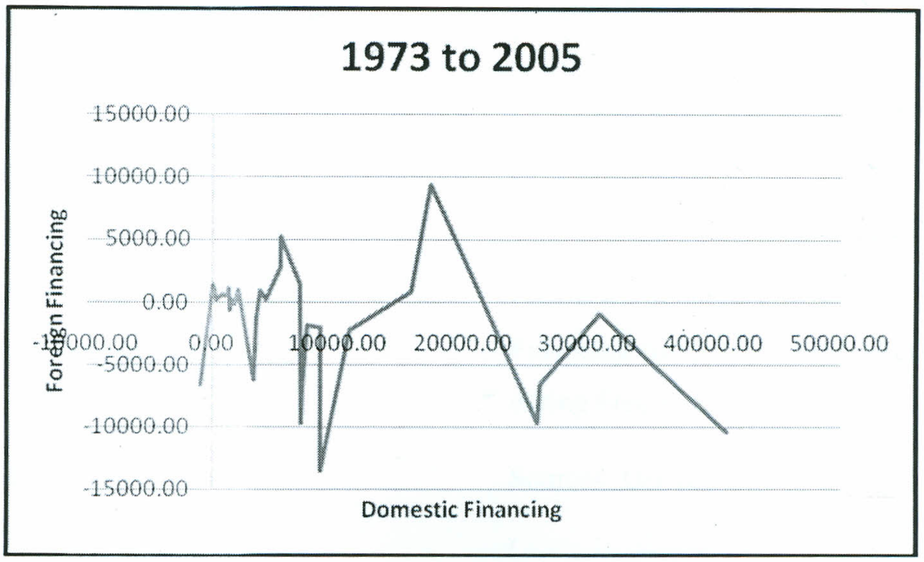


Figure A1: Relationship between Financing composition of Budget deficit for the entire period

Sources: Derived from data.

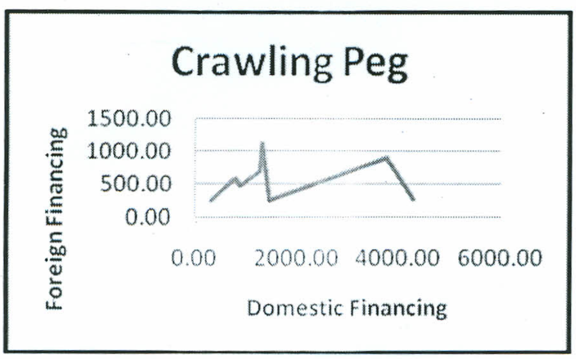


Figure A2: Relationship between Financing composition of Budget deficit during Crawling Peg

Sources: Derived from data.

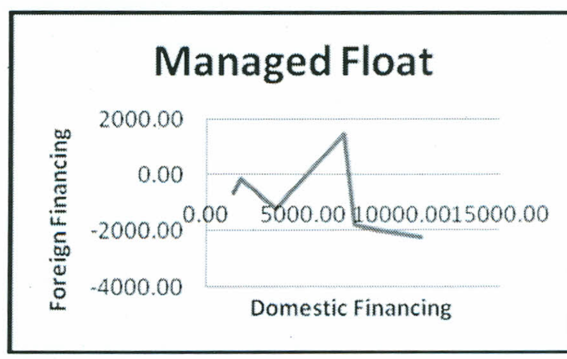
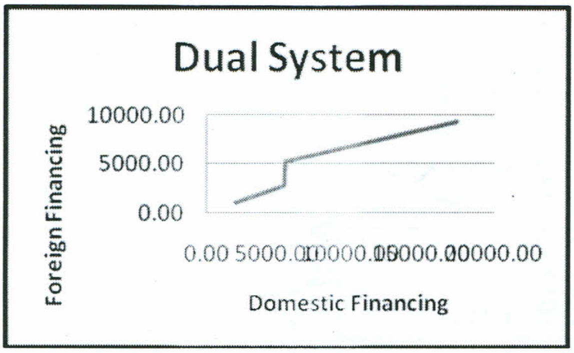


Figure A3: Relationship between Financing composition of Budget deficit during Managed Float

Sources: Derived from data.



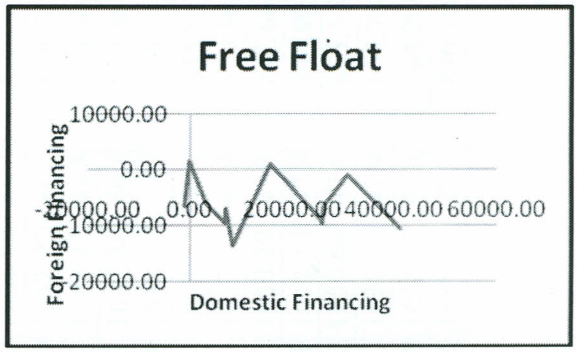


Figure A4: Relationship between Financing composition of Budget deficit during Dual System

Sources: Derived from data.

Figure A5: Relationship between Financing composition of Budget deficit during Free Float

Sources: Derived from data.

APPENDIX 3

A1 Raw Data

Table A1: Raw Data used in this Study

	Kenya										USA				
Time	Nominal Exchange	T-bill Rate	Inflation Rate	GDP	Productivity Index	Money Supply	Net Foreign Assets	Budget Deficit	Domestic Financing of budget deficit	Foreign Financing of budget deficit	T-bill Rate	Inflation Rate	GDP	Productivity Index	Money Supply
Jan-73	7.14	3.45	2.87	1225.50	6.42	4256.00	155.83	-16	-2	18	5.38	3.81	1615.10	45.8	810.30
Feb-73	7.14	3.44	3.26	1240.05	6.47	4412.00	150.32	-126	129	-3	5.59	4.27	1626.21	46.5	814.10
Mar-73	7.14	3.29	3.15	1255.16	6.53	4601.19	144.92	-96	82	14	6.08	4.72	1634.89	46.5	815.30
Apr-73	7.14	2.69	3.74	1270.84	6.59	4663.00	139.63	-31	-24	55	6.27	4.69	1642.02	46.5	819.70
May-73	7.14	2.64	5.65	1287.07	6.64	4896.00	134.45	-57	-3	60	6.32	5.63	1645.22	46.8	826.80
Jun-73	6.90	2.12	6.44	1303.87	6.70	4912.24	129.38	-21	9	12	7.17	5.61	1645.36	46.8	833.30
Jul-73	6.90	1.71	12.70	1321.23	6.75	4877.00	124.42	-141	92	49	7.99	5.58	1634.75	47	836.50
Aug-73	6.90	1.03	13.40	1339.16	6.81	4953.00	119.57	-13	6	7	8.69	7.44	1634.53	46.9	838.80
Sep-73	6.90	1.1	13.93	1357.64	6.87	5069.48	114.83	17	-18	1	8.40	6.94	1637.02	47.4	839.30
Oct-73	6.90	0.6	14.27	1376.69	6.92	5138.00	110.20	-48	20	28	7.21	7.37	1650.29	47.7	842.60
Nov-73	6.90	0.47	15.38	1396.30	6.98	5144.00	105.68	-5	5	1	7.86	8.29	1652.15	47.9	848.90
Dec-73	6.90	0.46	15.98	1416.48	7.03	5356.05	101.27	-49	38	11	7.44	8.72	1650.66	47.8	855.50
Jan-74	7.14	0.46	16.15	1459.20	7.12	5362.92	96.97	-118	95	23	7.78	9.63	1638.60	47.4	859.70
Feb-74	7.14	2.44	18.79	1479.57	7.20	5581.80	92.79	-146	141	5	7.12	10.00	1635.84	47.3	864.20
Mar-74	7.14	2.73	22.19	1499.59	7.29	5664.87	88.71	67	-103	36	7.93	10.36	1635.16	47.3	870.10

Apr-74	7.14	3.01	22.48	1519.25	7.37	5823.10	84.74	23	-65	42	8.30	10.31	1642.36	47.2	872.90
May-74	7.14	5.08	19.68	1538.54	7.46	5785.97	80.88	-89	84	5	8.27	10.67	1641.49	47.5	874.60
Jun-74	7.14	6	20.31	1557.48	7.54	5708.16	77.13	-56	13	43	7.95	11.06	1638.35	47.5	877.80
Jul-74	7.14	5.44	15.06	1576.05	7.63	5661.86	73.50	61	-90	29	7.53	11.45	1628.45	47.5	881.40
Aug-74	7.14	5.77	15.62	1594.27	7.71	5620.23	69.97	-101	69	32	8.91	10.82	1624.14	47	884.10
Sep-74	7.14	5.88	16.82	1612.13	7.80	5655.80	66.55	-47	36	11	8.23	12.12	1620.91	47.1	887.90
Oct-74	7.14	6.28	17.16	1629.62	7.88	5610.93	63.25	-49	26	23	7.43	12.45	1622.20	46.9	893.30
Nov-74	7.14	6.24	15.63	1646.76	7.97	5658.41	60.05	-186	137	49	7.49	12.34	1618.59	45.3	898.60
Dec-74	7.14	6.23	15.11	1663.54	8.06	5819.28	56.96	-75	73	2	7.15	12.24	1613.51	43.7	902.10
Jan-75	7.14	6.42	15.98	1642.99	8.11	5768.94	38.37	-198	128	70	6.32	11.72	1600.27	43.1	906.30
Feb-75	7.14	6.47	21.91	1660.60	8.17	5931.84	36.16	-404	338	66	5.51	11.16	1597.25	42.1	914.10
Mar-75	7.14	6.44	19.12	1679.40	8.23	5934.94	34.72	98	-116	18	5.50	10.20	1597.78	41.7	925.00
Apr-75	7.14	6.22	19.81	1699.39	8.29	5770.72	34.04	106	-125	19	5.62	10.16	1604.35	41.7	935.10
May-75	7.14	6.04	20.75	1720.57	8.34	5858.39	34.12	-279	263	16	5.24	9.24	1610.08	41.6	947.90
Jun-75	7.14	5.7	19.81	1742.94	8.40	6145.94	34.97	-185	140	45	5.30	9.16	1617.47	41.9	963.00
Jul-75	7.14	6	19.24	1766.50	8.46	6170.72	36.59	-240	230	10	6.12	9.88	1629.57	42.3	975.10
Aug-75	7.14	5.99	18.12	1791.25	8.52	6239.78	38.97	-268	199	69	6.44	8.59	1637.98	42.7	983.10
Sep-75	7.14	5.86	17.67	1817.20	8.58	6237.75	42.11	169	-222	53	6.41	8.11	1645.75	43.3	991.50
Oct-75	7.40	5.89	17.30	1844.33	8.63	6491.37	46.02	-299	170	129	6.00	7.25	1649.61	43.5	997.80
Nov-75	8.19	5.91	19.51	1872.66	8.69	6633.12	50.70	-201	56	145	5.47	7.20	1658.56	43.6	1006.90
Dec-75	8.25	5.99	20.28	1902.18	8.75	6830.97	56.14	-271	216	55	5.47	6.77	1669.32	44.1	1016.20
Jan-76	8.24	6.32	19.31	1923.82	8.87	6890.71	63.07	-104	80	24	4.89	6.74	1688.03	44.8	1026.60
Feb-76	8.26	6.39	11.95	1956.10	8.98	7097.41	70.01	-234	145	89	4.88	6.32	1697.83	45.1	1040.30
Mar-76	8.34	6.35	12.46	1989.95	9.10	7414.25	77.69	-87	23	64	5.01	5.93	1704.85	45.2	1050.00
Apr-76	8.39	6.24	12.50	2025.38	9.22	7449.79	86.10	40	-108	68	4.85	5.90	1706.03	45.5	1060.80
May-76	8.41	6.26	12.04	2062.37	9.33	7417.47	95.25	-113	66	47	5.19	6.25	1709.79	45.7	1072.10
Jun-76	8.45	6.23	12.48	2100.93	9.45	7597.67	105.13	50	-64	14	5.42	6.20	1713.08	45.7	1077.60
Jul-76	8.43	6.16	12.20	2141.07	9.56	7670.61	115.75	-332	274	58	5.24	5.04	1714.63	45.9	1086.30
Aug-76	8.41	5.78	10.89	2182.78	9.68	7710.01	127.11	-137	87	50	5.14	5.76	1717.88	46.2	1098.70

Sep-76	8.37	5.25	9.51	2226.05	9.80	7872.90	139.19	31	-131	100	5.08	5.36	1721.59	46.4	1110.80
Oct-76	8.36	3.83	9.18	2270.90	9.91	8102.56	152.02	-254	216	38	4.93	5.34	1725.21	46.4	1125.00
Nov-76	8.37	3.76	8.76	2317.32	10.03	8281.60	165.58	-211	206	5	4.78	4.95	1730.22	47.1	1138.20
Dec-76	8.36	3.93	7.57	2365.31	10.14	8522.78	179.87	-24	2	22	4.35	4.93	1736.07	47.6	1152.00
Jan-77	8.34	4.87	7.55	2510.73	10.35	8825.96	265.31	-114	94	20	4.60	5.26	1741.73	47.3	1165.20
Feb-77	8.36	4.83	7.26	2557.85	10.56	9374.26	278.12	-162	155	7	4.67	5.94	1750.06	48	1177.60
Mar-77	8.35	3.52	12.32	2602.51	10.77	10163.30	288.71	48	-105	57	4.61	6.64	1760.02	48.6	1188.50
Apr-77	8.32	3.44	12.60	2644.72	10.97	10448.54	297.09	767	-836	69	4.53	6.97	1774.20	49.1	1199.60
May-77	8.32	2.48	13.26	2684.48	11.18	10654.72	303.24	-714	692	22	4.95	6.92	1785.47	49.5	1209.00
Jun-77	8.31	1.4	14.27	2721.78	11.39	11124.53	307.18	82	-153	71	5.02	6.87	1796.43	49.8	1217.80
Jul-77	8.24	0.59	14.55	2756.64	11.59	11450.64	308.90	-449	467	-18	5.17	6.85	1811.44	49.9	1226.70
Aug-77	8.28	0.11	15.46	2789.05	11.80	11696.34	308.39	-67	-39	106	5.49	6.46	1818.50	50	1237.00
Sep-77	8.32	0.24	18.82	2819.00	12.01	12072.12	305.67	-208	156	52	5.80	6.44	1821.96	50.2	1246.20
Oct-77	8.25	1.24	19.63	2846.51	12.22	12430.39	300.74	-66	67	-1	6.17	6.42	1816.08	50.4	1254.00
Nov-77	8.17	1.41	20.02	2871.56	12.42	12180.61	293.58	-369	292	77	6.11	6.73	1816.69	50.4	1262.40
Dec-77	8.06	1.41	21.02	2894.17	12.63	12437.13	284.20	-135	119	16	6.06	6.71	1818.03	50.5	1270.30
Jan-78	7.96	2.03	22.40	2841.57	12.70	12466.39	178.47	42	-57	15	6.45	6.67	1811.36	49.8	1279.70
Feb-78	7.93	2.29	24.50	2862.32	12.77	12956.62	168.61	-150	117	33	6.45	6.27	1820.71	50	1285.50
Mar-78	7.86	2.23	18.55	2883.68	12.84	13207.49	160.48	-143	75	68	6.29	6.56	1837.34	50.9	1292.20
Apr-78	7.83	2.29	18.96	2905.64	12.91	12999.36	154.07	533	-548	15	6.29	6.51	1878.83	52	1300.40
May-78	7.94	2.72	17.21	2928.20	12.99	12991.54	149.40	107	-179	72	6.39	6.80	1896.84	52.2	1310.50
Jun-78	7.86	2.5	17.01	2951.36	13.06	13245.72	146.46	34	-204	170	6.72	7.40	1908.93	52.5	1318.50
Jul-78	7.74	5.01	16.82	2975.12	13.13	13423.56	145.25	-1049	1063	-14	7.03	7.69	1906.25	52.5	1324.10
Aug-78	7.60	5.46	15.98	2999.49	13.20	13177.91	145.77	-114	68	46	7.05	7.99	1913.18	52.7	1333.50
Sep-78	7.59	6.5	14.34	3024.45	13.27	13374.82	148.03	-507	452	55	7.81	8.60	1920.87	52.8	1345.00
Oct-78	7.41	6.88	13.35	3050.02	13.34	13336.37	152.01	127	-163	36	7.96	9.21	1933.57	53.3	1352.30
Nov-78	7.50	6.85	12.79	3076.20	13.41	13619.52	157.72	-172	182	-10	8.63	8.83	1939.55	53.7	1359.10
Dec-78	7.53	6.67	13.66	3102.97	13.49	14277.88	165.17	-188	169	19	9.06	9.12	1943.08	54	1366.00
Jan-79	7.47	8.54	12.02	3128.65	13.59	13509.83	254.48	225	-187	-38	9.35	9.38	1941.10	53.6	1371.60

Feb-79	7.50	6.89	8.93	3156.69	13.70	13712.95	262.02	-332	254	78	9.31	9.94	1942.02	53.9	1377.80
Mar-79	7.51	6.7	8.26	3185.42	13.80	14197.37	267.93	-847	842	5	9.48	9.85	1942.79	54.1	1387.80
Apr-79	7.54	6.54	6.86	3214.81	13.91	14001.97	272.22	824	-820	-4	9.45	10.70	1941.39	53.6	1402.10
May-79	7.60	6.84	7.64	3244.88	14.02	14404.08	274.87	-192	176	16	9.61	10.91	1943.35	53.9	1410.20
Jun-79	7.57	6.82	7.46	3275.62	14.12	14988.35	275.89	-186	158	28	9.06	10.78	1946.66	53.9	1423.00
Jul-79	7.42	6.63	6.91	3307.03	14.23	14661.25	275.28	-781	672	109	9.23	11.31	1954.38	53.9	1434.80
Aug-79	7.43	5.34	6.76	3339.12	14.33	15045.02	273.03	316	-343	27	9.49	11.83	1958.08	53.5	1446.60
Sep-79	7.41	4.44	6.65	3371.88	14.44	15140.45	269.16	-941	904	37	10.28	12.02	1960.84	53.5	1454.10
Oct-79	7.43	4.43	7.21	3405.31	14.55	15582.86	263.65	-150	159	-9	11.69	11.92	1961.23	53.8	1460.40
Nov-79	7.47	4.47	8.27	3439.41	14.65	16100.37	256.52	448	-454	6	11.84	12.75	1963.13	53.8	1465.90
Dec-79	7.37	4.45	9.12	3474.19	14.76	16689.47	247.75	-103	108	-5	12.03	13.26	1965.14	53.8	1473.70
Jan-80	7.32	4.5	9.44	3499.64	14.88	16357.16	201.49	196	-166	-30	11.98	13.71	1974.31	54.1	1482.70
Feb-80	7.35	4.47	11.53	3536.19	15.00	16069.97	190.97	77	-167	90	12.77	14.12	1971.23	54.1	1494.50
Mar-80	7.55	4.49	15.07	3573.82	15.12	16439.69	180.31	-773	761	12	15.26	14.85	1962.96	53.9	1499.80
Apr-80	7.62	4.46	14.73	3612.55	15.24	16520.61	169.53	672	-654	-18	13.45	14.64	1937.14	52.8	1502.20
May-80	7.40	4.49	14.67	3652.38	15.36	16594.83	158.63	-160	154	6	8.67	14.48	1927.77	51.5	1512.30
Jun-80	7.32	6.05	13.76	3693.29	15.48	16368.96	147.60	77	20	-97	7.05	14.32	1922.49	50.8	1529.20
Jul-80	7.27	5.75	14.13	3735.30	15.60	16811.17	136.44	-1190	1071	119	8.02	13.10	1920.92	50.5	1545.50
Aug-80	7.36	5.8	14.21	3778.40	15.72	16717.92	125.15	-518	585	-67	9.07	12.96	1924.08	50.7	1561.50
Sep-80	7.33	5.78	14.17	3822.59	15.84	16732.46	113.74	129	-129	1	10.20	12.57	1931.60	51.5	1574.00
Oct-80	7.38	5.72	16.08	3867.87	15.96	16473.52	102.20	138	-925	787	11.56	12.73	1948.53	52.1	1584.80
Nov-80	7.53	5.82	15.21	3914.25	16.08	16690.36	90.53	-487	453	34	13.67	12.60	1960.98	53	1595.80
Dec-80	7.62	5.77	13.10	3961.72	16.20	16796.88	78.74	-612	328	284	15.58	12.47	1973.99	53.3	1599.80
Jan-81	7.61	5.77	12.67	4042.12	16.35	16567.72	71.66	-949	886	63	14.98	11.81	1996.72	53	1606.90
Feb-81	8.22	5.83	11.62	4090.44	16.49	16999.10	59.41	-635	586	49	14.83	11.39	2004.00	52.8	1618.70
Mar-81	8.66	5.83	9.72	4138.51	16.64	17291.65	46.83	-484	428	56	13.44	10.49	2004.98	53.1	1636.60
Apr-81	8.37	5.81	9.38	4186.34	16.78	17153.89	33.92	269	-272	3	13.61	9.88	1985.31	52.8	1659.20
May-81	8.61	5.81	9.68	4233.94	16.93	17264.74	20.68	38	-71	33	16.36	9.79	1984.45	53.2	1664.20
Jun-81	8.77	7.59	11.52	4281.28	17.08	17172.04	7.11	404	-259	-145	14.75	9.69	1988.04	53.4	1670.30

Jul-81	8.93	7.98	11.79	4328.39	17.22	18289.96	-6.79	-867	1038	-171	14.95	10.87	2009.31	53.8	1681.90
Aug-81	9.05	8.05	11.57	4375.25	17.37	18310.95	-21.02	-1091	1060	31	15.52	10.77	2011.89	53.8	1694.30
Sep-81	9.47	8.63	11.07	4421.87	17.51	17953.44	-35.58	-739	646	93	14.75	10.93	2009.01	53.5	1706.00
Oct-81	10.36	9.99	9.62	4468.24	17.66	18590.46	-50.47	-493	464	29	13.59	10.14	1994.50	53.1	1721.80
Nov-81	10.26	9.99	11.00	4514.37	17.81	18586.72	-65.69	853	-810	-43	10.94	9.59	1985.31	52.5	1736.10
Dec-81	10.26	9.99	19.32	4560.26	17.95	18952.71	-81.24	-972	73	899	10.86	8.82	1975.29	51.9	1755.50
Jan-82	10.35	12.6	20.10	4580.38	18.07	18028.95	-152.29	850	-642	-208	12.20	8.54	1956.90	50.9	1770.40
Feb-82	10.54	13.5	20.20	4626.85	18.19	18591.72	-166.19	-1965	1935	30	13.60	7.56	1950.83	51.9	1774.50
Mar-82	10.63	12.09	20.74	4674.15	18.31	19054.95	-178.10	-703	591	112	12.62	6.84	1949.57	51.5	1786.50
Apr-82	10.72	11.96	22.55	4722.28	18.44	18890.96	-188.02	1200	-1269	69	12.75	6.58	1962.19	51.1	1803.90
May-82	10.53	13.5	21.90	4771.24	18.56	18903.07	-195.96	-1381	1435	-54	12.12	6.74	1963.71	50.8	1815.40
Jun-82	10.84	13.5	21.01	4821.03	18.68	18752.73	-201.91	846	-874	28	12.42	7.11	1963.20	50.6	1826.00
Jul-82	10.95	13.46	20.46	4871.64	18.80	19191.86	-205.88	-162	392	-230	11.48	6.40	1956.64	50.4	1833.70
Aug-82	11.01	13.51	23.02	4923.09	18.92	19202.29	-207.87	-1402	1421	-19	8.71	5.71	1955.13	50	1848.50
Sep-82	11.06	13.5	23.00	4975.36	19.04	19872.66	-207.87	-136	84	52	7.94	5.03	1954.63	49.7	1862.40
Oct-82	11.15	9.99	21.91	5028.46	19.16	20679.39	-205.88	1051	-890	-161	7.71	5.23	1953.11	49.3	1873.70
Nov-82	11.21	10	20.24	5082.38	19.28	20569.75	-201.91	-1414	875	539	8.06	4.58	1956.16	49.1	1887.30
Dec-82	12.07	13.35	13.73	5137.14	19.40	21442.22	-195.95	-1339	1228	111	7.94	3.95	1961.73	48.7	1909.30
Jan-83	12.77	13.4	13.40	5235.52	19.56	21525.27	-134.19	58	260	-318	7.85	3.73	1970.23	49.6	1962.40
Feb-83	12.90	13.66	13.72	5290.14	19.72	21019.33	-126.52	-298	-29	327	8.14	3.51	1980.59	49.3	1999.60
Mar-83	12.95	14.9	12.51	5343.78	19.88	21416.39	-119.13	1040	-1171	131	8.32	3.51	1993.19	49.8	2017.80
Apr-83	12.99	13.62	11.45	5396.46	20.03	20324.13	-112.01	-131	175	-44	8.24	3.91	2011.70	50.4	2031.10
May-83	12.98	13.93	10.92	5448.18	20.19	20719.18	-105.16	481	-338	-143	8.17	3.46	2026.04	50.7	2045.50
Jun-83	13.18	15	10.94	5498.92	20.35	20769.58	-98.58	655	-533	-122	8.79	2.41	2039.87	51	2055.80
Jul-83	13.48	13.81	11.99	5548.70	20.50	21045.66	-92.27	-1368	1636	-268	9.08	2.61	2052.11	51.8	2067.10
Aug-83	13.70	13.71	10.14	5597.51	20.66	21035.37	-86.24	-1415	1257	158	9.35	2.60	2065.73	52.4	2076.20
Sep-83	13.72	14.86	10.78	5645.35	20.82	21639.00	-80.48	1775	-1707	-68	9.01	2.99	2079.66	53.2	2085.30
Oct-83	13.54	13.64	10.81	5692.23	20.97	21414.31	-75.00	-1637	1800	-163	8.64	2.78	2094.57	53.7	2101.50
Nov-83	13.70	14.27	10.99	5738.14	21.13	22086.80	-69.78	-439	518	-79	8.75	3.19	2108.60	53.8	2114.60

Dec-83	13.83	15	9.60	5783.07	21.29	22837.63	-64.84	593	-488	-105	8.99	3.80	2122.43	54.1	2125.70
Jan-84	13.92	13.57	10.51	5501.26	21.41	22738.00	-34.07	-1515	1179	336	8.91	4.19	2136.36	55.2	2140.40
Feb-84	13.79	13.85	9.13	5557.93	21.54	22689.96	-30.77	-590	664	-74	9.08	4.59	2149.57	55.4	2160.50
Mar-84	13.13	14.52	10.72	5627.31	21.67	22847.47	-28.84	820	-700	-120	9.50	4.79	2162.36	55.7	2177.50
Apr-84	13.76	14.58	10.59	5709.38	21.80	22582.41	-28.28	-706	796	-90	9.69	4.55	2176.52	56.1	2193.90
May-84	14.14	14.16	10.77	5804.16	21.92	22662.09	-29.08	863	-643	-220	9.84	4.13	2187.12	56.3	2206.40
Jun-84	14.28	13.4	10.37	5911.65	22.05	23138.64	-31.26	909	-623	-286	9.87	4.32	2195.96	56.5	2217.40
Jul-84	14.62	12.47	9.60	6031.83	22.18	23151.42	-34.80	-1023	1316	-293	10.10	4.10	2201.17	56.7	2225.80
Aug-84	14.72	12.5	9.49	6164.72	22.30	23981.52	-39.71	-1191	1281	-90	10.46	4.29	2207.89	56.8	2232.50
Sep-84	14.87	12.5	10.12	6310.30	22.43	24566.39	-45.99	-324	457	-133	10.38	4.26	2214.25	56.7	2246.50
Oct-84	15.01	12.49	10.43	6468.59	22.56	23960.04	-53.63	704	-318	-386	9.79	4.26	2219.32	56.6	2261.10
Nov-84	15.13	12.45	10.74	6639.59	22.68	25355.02	-62.65	-1430	1335	95	8.63	4.05	2225.66	56.8	2283.60
Dec-84	15.58	12.43	10.92	6823.28	22.81	25774.98	-73.03	1147	-1182	35	8.08	3.85	2232.32	56.9	2308.80
Jan-85	15.96	12.5	11.95	7482.95	23.30	25844.16	-162.37	-943	1240	-297	7.74	3.45	2240.06	56.7	2334.90
Feb-85	16.34	12.48	12.29	7672.61	23.79	25954.99	-172.23	1182	-1090	-92	8.23	3.63	2246.84	57	2356.40
Mar-85	16.48	13.79	14.99	7855.53	24.29	26287.04	-180.21	1004	-862	-142	8.54	3.81	2253.40	57.1	2368.50
Apr-85	16.07	14.68	14.65	8031.72	24.78	25690.15	-186.30	-1775	2214	-439	7.96	3.60	2257.00	57	2377.80
May-85	16.17	14.31	14.42	8201.17	25.27	25607.11	-190.50	60	94	-154	7.51	3.78	2265.16	57	2392.10
Jun-85	16.14	14.81	13.85	8363.89	25.76	25838.42	-192.82	-1186	901	285	6.96	3.77	2275.14	57	2415.20
Jul-85	16.31	14.31	13.27	8519.87	26.25	26385.06	-193.25	-1786	2236	-450	7.07	3.56	2292.02	56.7	2432.00
Aug-85	16.98	13.98	14.73	8669.11	26.74	26406.12	-191.79	-988	991	-3	7.14	3.36	2301.83	56.9	2446.50
Sep-85	17.26	13.22	12.17	8811.62	27.23	26209.78	-188.44	-1217	1410	-193	7.09	3.16	2309.65	57.2	2458.80
Oct-85	16.66	14.18	12.25	8947.39	27.73	26918.36	-183.21	-1135	1504	-369	7.16	3.34	2312.10	57	2470.60
Nov-85	16.44	14.41	11.52	9076.42	28.22	26918.36	-176.09	-519	799	-280	7.24	3.53	2318.45	57.2	2480.20
Dec-85	16.37	14.14	10.23	9198.72	28.71	28404.06	-167.08	-1430	1530	-100	7.11	3.90	2325.35	57.7	2494.60
Jan-86	16.33	14.89	4.91	9194.34	29.00	29235.10	-63.67	-349	213	136	7.08	3.89	2335.41	58.1	2504.80
Feb-86	16.14	14.85	5.97	9308.20	29.29	30299.43	-54.77	36	-1	-36	7.07	3.13	2341.41	57.7	2515.30
Mar-86	16.18	14.48	1.27	9420.36	29.58	31003.32	-47.86	40	161	-201	6.58	2.20	2345.98	57.3	2535.40
Apr-86	16.32	14.93	1.35	9530.81	29.87	30899.37	-42.95	506	-245	-261	6.06	1.65	2345.23	57.3	2560.20

May-86	16.29	13.24	1.70	9639.56	30.16	30791.84	-40.04	744	-656	-88	6.14	1.64	2349.84	57.4	2587.50
Jun-86	16.44	14.18	1.63	9746.60	30.45	31476.93	-39.12	512	-91	-421	6.23	1.81	2355.92	57.2	2607.70
Jul-86	16.13	13.25	2.09	9851.94	30.73	33400.84	-40.19	-3727	3681	46	5.84	1.63	2367.10	57.6	2629.60
Aug-86	16.05	12.44	0.85	9955.58	31.02	33524.70	-43.26	-331	473	-142	5.56	1.63	2373.41	57.5	2649.50
Sep-86	16.12	11.85	1.21	10057.51	31.31	34950.68	-48.32	-27	242	-215	5.21	1.62	2378.48	57.6	2671.10
Oct-86	16.15	11.23	2.23	10157.74	31.60	35309.31	-55.37	-334	586	-252	5.18	1.44	2380.39	57.9	2691.00
Nov-86	16.35	11.21	3.27	10256.27	31.89	35442.10	-64.42	-2474	2725	-251	5.34	1.25	2384.40	58.1	2704.70
Dec-86	16.22	12.15	4.26	10353.09	32.18	36230.35	-75.47	-1245	1535	-290	5.52	1.07	2388.61	58.7	2731.40
Jan-87	16.03	12.54	7.91	10320.32	32.39	39687.24	-141.96	-489	811	-322	5.43	1.43	2391.44	58.5	2747.10
Feb-87	16.25	12.66	7.48	10419.10	32.60	39910.26	-154.75	374	-300	-74	5.61	1.96	2397.21	59.2	2750.80
Mar-87	16.17	12.63	8.23	10521.54	32.81	40710.08	-167.30	-1202	1356	-154	5.59	3.05	2404.34	59.3	2756.80
Apr-87	16.08	12.83	8.25	10627.65	33.02	40382.40	-179.59	2025	-1617	-408	5.63	3.78	2415.33	59.7	2771.00
May-87	16.11	12.85	8.32	10737.41	33.23	40625.91	-191.64	-1864	1904	-40	5.66	3.76	2423.33	60.1	2776.40
Jun-87	16.34	12.99	8.77	10850.84	33.43	40630.02	-203.44	-547	598	-51	5.67	3.57	2430.84	60.3	2777.90
Jul-87	16.56	12.93	8.78	10967.93	33.64	40562.24	-214.99	-1245	1424	-179	5.67	3.92	2434.11	60.7	2782.50
Aug-87	16.60	12.96	8.71	11088.69	33.85	40779.29	-226.30	-785	931	-146	6.02	4.27	2443.43	61.2	2791.60
Sep-87	16.63	12.99	9.65	11213.10	34.06	39738.08	-237.35	810	-703	-107	6.38	4.43	2455.06	61.4	2803.00
Oct-87	16.97	12.98	9.00	11341.18	34.27	41230.28	-248.16	-1849	2158	-309	6.19	4.42	2476.35	62.3	2818.60
Nov-87	16.98	12.98	8.88	11472.91	34.48	42338.61	-258.72	-217	-63	280	5.72	4.60	2487.07	62.6	2823.30
Dec-87	16.73	13	9.56	11608.32	34.68	41994.30	-269.03	-752	1055	-303	5.77	4.42	2494.58	62.9	2830.80
Jan-88	16.91	12.99	9.76	11829.55	35.01	38249.89	-308.09	-787	974	-187	5.82	4.04	2491.73	62.9	2851.80
Feb-88	17.22	13.45	9.33	11968.83	35.33	38263.62	-316.68	-476	693	-217	5.66	4.03	2498.15	63.2	2874.80
Mar-88	17.08	13.48	9.58	12108.32	35.65	38228.51	-323.82	826	-650	-176	5.70	4.01	2506.72	63.3	2895.10
Apr-88	17.09	13.44	10.64	12248.03	35.98	36698.58	-329.48	-1928	2273	-345	5.89	3.99	2523.09	63.7	2915.20
May-88	17.20	13.49	11.07	12387.94	36.30	37356.62	-333.69	-873	491	382	6.24	3.97	2531.67	63.6	2930.60
Jun-88	17.58	13.99	12.33	12528.08	36.62	37404.95	-336.42	1750	-2069	319	6.45	3.96	2538.14	63.8	2942.70
Jul-88	18.15	13.49	12.67	12668.42	36.95	37777.37	-337.70	-1694	1666	28	6.71	4.12	2536.58	63.9	2952.60
Aug-88	18.39	13.49	14.27	12808.99	37.27	39158.46	-337.51	6	357	-363	7.04	3.92	2543.26	64.2	2957.70
Sep-88	18.44	13.5	14.71	12949.76	37.59	40360.97	-335.85	2286	-2737	451	7.24	4.07	2552.26	64	2962.50

Oct-88	18.34	13.5	14.41	13090.75	37.92	40011.34	-332.73	-974	937	37	7.35	4.24	2568.12	64.3	2971.00
Nov-88	18.21	13.38	14.33	13231.95	38.24	41553.68	-328.14	-562	531	31	7.74	4.23	2578.36	64.4	2985.90
Dec-88	18.37	13.52	13.58	13373.37	38.56	42834.72	-322.09	833	-712	-121	8.06	4.40	2587.51	64.7	2993.90
Jan-89	18.74	13.73	13.59	13471.12	38.88	43061.03	-223.37	-834	1212	-378	8.26	4.73	2594.83	64.9	2997.20
Feb-89	18.87	13.71	13.53	13614.80	39.19	45410.64	-218.22	-1229	323	906	8.51	4.88	2602.38	64.6	2997.60
Mar-89	19.20	13.69	14.28	13760.55	39.50	45778.23	-215.43	667	-852	185	8.81	4.86	2609.39	64.8	3005.30
Apr-89	19.39	13.78	14.15	13908.35	39.82	46732.30	-214.99	-3982	4271	-289	8.66	5.00	2614.98	64.8	3011.50
May-89	20.24	13.95	14.77	14058.20	40.13	46961.27	-216.92	-236	94	142	8.43	5.32	2621.62	64.3	3017.10
Jun-89	21.06	13.98	13.61	14210.11	40.44	46875.21	-221.22	-855	83	772	8.17	5.13	2628.40	64.3	3033.40
Jul-89	20.89	13.98	13.77	14364.08	40.76	47941.17	-227.87	-1586	1970	-384	7.89	4.94	2637.76	63.7	3058.10
Aug-89	21.23	13.99	12.26	14520.10	41.07	49241.44	-236.89	-1235	1065	170	7.90	4.76	2643.02	64.3	3080.10
Sep-89	21.73	13.99	12.30	14678.17	41.39	49890.39	-248.26	2331	-2114	-217	7.75	4.40	2646.62	64.2	3098.50
Oct-89	21.89	13.49	17.06	14838.30	41.70	51036.60	-262.00	-1251	1770	-519	7.63	4.55	2643.07	64.1	3120.40
Nov-89	21.87	14	12.65	15000.49	42.01	52600.14	-278.10	-1014	488	526	7.69	4.71	2647.42	64.3	3139.30
Dec-89	21.75	14	13.55	15164.73	42.33	53264.00	-296.56	747	-1275	528	7.64	4.70	2654.21	64.7	3158.40
Jan-90	21.72	14	14.17	15314.52	42.67	52499.84	-378.65	-1395	38	1357	7.64	5.16	2669.20	64.4	3172.40
Feb-90	21.81	14	14.35	15483.57	43.01	52712.75	-399.26	-931	873	58	7.74	5.14	2676.53	64.9	3184.80
Mar-90	22.75	14	17.30	15655.37	43.35	52953.38	-419.67	-5067	5143	-76	7.90	5.27	2681.97	65.3	3195.70
Apr-90	23.06	14	17.47	15829.91	43.69	52692.41	-439.87	2448	-3031	583	7.78	4.76	2684.57	65.2	3207.20
May-90	23.01	14.94	16.60	16007.20	44.02	53359.39	-459.85	214	-1229	1015	7.75	4.42	2686.93	65.3	3206.00
Jun-90	23.20	14.95	17.53	16187.24	44.36	54365.76	-479.63	-1635	126	1509	7.73	4.72	2688.10	65.5	3218.70
Jul-90	23.02	14.81	16.79	16370.03	44.70	54945.50	-499.20	-1872	2093	-221	7.63	4.87	2689.99	65.4	3229.10
Aug-90	23.15	14.97	17.42	16555.57	45.04	55632.04	-518.57	-2272	2278	-6	7.46	5.64	2687.37	65.5	3246.60
Sep-90	23.22	14.97	19.13	16743.85	45.38	57803.40	-537.72	-194	-735	929	7.37	6.09	2682.14	65.7	3259.30
Oct-90	23.09	15	15.71	16934.88	45.72	58094.21	-556.67	-1247	1342	-95	7.17	6.38	2669.24	65.2	3264.00
Nov-90	23.17	15.83	22.93	17128.66	46.06	60565.96	-575.40	-972	2245	-1273	7.07	6.20	2662.57	64.4	3267.70
Dec-90	23.79	15.93	23.13	17325.19	46.40	61493.66	-593.93	2209	-3652	1443	6.76	6.04	2657.09	63.9	3276.80
Jan-91	24.43	16.65	21.78	17430.71	46.87	61728.72	-670.64	-306	539	-233	6.23	5.67	2649.81	63.6	3292.70
Feb-91	24.79	17.33	24.11	17636.67	47.34	61769.98	-686.30	-929	1047	-118	5.95	5.34	2648.93	63.2	3309.50

Mar-91	25.87	16.97	20.90	17849.31	47.80	61935.95	-699.30	-2625	1984	641	5.91	4.86	2651.46	62.9	3326.90
Apr-91	27.03	15.58	19.50	18068.64	48.27	62400.24	-709.64	580	-717	137	5.66	4.85	2662.96	63	3337.80
May-91	27.66	17.04	21.99	18294.64	48.74	62524.66	-717.33	-1740	-291	2031	5.46	4.83	2668.18	63.7	3348.40
Jun-91	28.42	16.47	20.78	18527.33	49.20	64642.91	-722.35	-1803	529	1274	5.58	4.66	2672.66	64.3	3357.30
Jul-91	28.79	15.92	22.16	18766.71	49.67	65146.40	-724.71	-719	761	-42	5.58	4.34	2675.53	64.3	3360.80
Aug-91	28.89	16.24	21.36	19012.76	50.14	66732.07	-724.42	-1132	1320	-188	5.33	3.71	2679.19	64.4	3359.60
Sep-91	28.80	16.51	20.80	19265.50	50.60	67854.16	-721.47	-608	1000	-392	5.23	3.53	2682.78	64.9	3359.50
Oct-91	28.79	17.35	18.76	19524.91	51.07	69372.13	-715.86	-342	112	230	5.01	2.92	2683.35	64.8	3364.80
Nov-91	28.41	16.29	15.97	19791.01	51.54	73356.58	-707.59	-1491	1985	-494	4.58	3.07	2688.96	64.7	3370.20
Dec-91	28.22	16.77	14.47	20063.80	52.00	74326.28	-696.66	2850	-2801	-49	4.10	3.07	2696.69	64.5	3377.00
Jan-92	28.47	16.31	16.46	20103.95	52.71	74532.50	-1087.95	-1874	1973	-99	3.80	2.61	2709.45	64.1	3385.50
Feb-92	29.06	15.54	14.55	20400.14	53.41	77299.01	-1054.72	-685	1377	-692	3.84	2.90	2719.22	64.6	3404.60
Mar-92	29.97	16.83	22.25	20713.05	54.12	77647.49	-1001.84	-58	186	-128	4.03	3.18	2728.93	65.1	3408.40
Apr-92	30.58	16.27	23.19	21042.69	54.82	75999.12	-929.31	375	-717	342	3.76	3.18	2738.55	65.6	3403.80
May-92	31.48	16.84	23.95	21389.05	55.53	75967.19	-837.14	-972	1069	-97	3.63	3.03	2748.12	65.8	3402.70
Jun-92	32.07	16.88	35.48	21752.13	56.23	77709.30	-725.32	1213	-1307	94	3.66	3.16	2757.63	65.8	3398.40
Jul-92	32.38	15.48	32.25	22131.93	56.94	80047.74	-593.85	-1526	879	647	3.22	3.16	2766.89	66.4	3398.60
Aug-92	32.90	17.03	32.33	22528.46	57.64	83450.47	-442.73	-1174	625	549	3.13	3.15	2776.44	66	3403.60
Sep-92	33.69	16.87	31.11	22941.71	58.35	88472.31	-271.97	-560	371	189	2.93	2.99	2786.08	66.2	3415.30
Oct-92	34.51	16.85	29.35	23371.69	59.05	91337.58	-81.56	364	-170	-194	2.86	3.12	2799.49	66.7	3428.90
Nov-92	35.73	16.46	30.64	23818.39	59.76	94038.13	128.49	3295	-3487	192	3.12	2.97	2806.56	66.9	3431.50
Dec-92	35.78	16.96	33.67	24281.81	60.46	99291.86	358.20	-1482	1284	198	3.23	2.97	2810.95	67	3430.30
Jan-93	36.23	17.17	32.10	25188.90	61.73	100360.53	1763.86	-786	164	622	3.02	3.25	2807.21	67.3	3424.60
Feb-93	36.56	17.1	41.37	25667.86	62.99	102043.69	1984.34	-169	-235	404	2.93	3.24	2810.36	67.5	3420.30
Mar-93	43.12	34.81	34.14	26145.62	64.25	105837.32	2175.95	-3136	2910	226	2.95	3.09	2814.93	67.5	3417.70
Apr-93	51.88	48.94	42.11	26622.20	65.52	112027.08	2338.69	334	-360	26	2.87	3.22	2823.27	67.7	3416.90
May-93	62.16	64.88	42.60	27097.58	66.78	104504.41	2472.56	2334	-1851	-483	2.95	3.22	2828.91	67.5	3442.30
Jun-93	64.15	70.64	39.12	27571.78	68.04	104648.10	2577.56	-12425	8441	3984	3.07	2.92	2834.22	67.6	3448.20
Jul-93	65.33	67.97	43.33	28044.78	69.31	102575.57	2653.69	-1028	1307	-279	3.04	2.78	2835.38	67.9	3447.70

Aug-93	65.42	65.59	47.67	28516.59	70.57	105290.62	2700.95	-1492	1736	-244	3.02	2.77	2842.86	67.9	3451.60
Sep-93	65.80	61.91	53.92	28987.21	71.84	111492.85	2719.34	-4172	5344	-1172	2.95	2.62	2852.86	68.2	3458.50
Oct-93	67.97	60.51	57.40	29456.65	73.10	112704.06	2708.86	-6697	7886	-1189	3.02	2.75	2870.16	68.7	3462.70
Nov-93	68.98	48.71	56.64	29924.89	74.36	116409.24	2669.51	-3686	-511	4197	3.10	2.75	2881.62	68.9	3476.30
Dec-93	68.41	39.34	54.70	30391.94	75.63	124828.50	2601.29	4112	-7405	3293	3.06	2.75	2892.02	69.3	3480.90
Jan-94	67.93	23.09	61.54	30858.81	76.74	128077.10	1517.67	-8085	10015	-1930	2.98	2.60	2898.21	69.6	3481.90
Feb-94	67.41	23.32	54.34	31323.44	77.86	132310.48	1433.10	-4698	3589	1109	3.24	2.46	2908.86	69.6	3482.70
Mar-94	66.05	28.44	53.69	31786.83	78.97	131771.60	1361.06	47	2987	-3034	3.50	2.59	2920.82	70.3	3488.50
Apr-94	62.78	27.56	47.75	32249.00	80.08	130172.63	1301.54	72	818	-890	3.66	2.44	2938.91	70.7	3492.30
May-94	58.05	29.08	41.12	32709.93	81.20	127963.89	1254.55	-3259	2227	1032	4.14	2.30	2949.87	71.1	3501.90
Jun-94	56.17	30.37	28.74	33169.62	82.31	126355.61	1220.08	5471	-6031	560	4.14	2.57	2958.51	71.6	3490.20
Jul-94	55.97	26.28	27.35	33628.09	83.43	127692.73	1198.13	-1692	1362	330	4.33	2.84	2959.70	71.7	3498.70
Aug-94	55.53	20.86	21.48	34085.32	84.54	133550.26	1188.71	-3758	6668	-2910	4.47	2.97	2967.58	72	3495.90
Sep-94	51.66	22.6	12.85	34541.32	85.65	138000.77	1191.81	-955	1856	-901	4.62	2.96	2977.02	72.2	3496.10
Oct-94	42.38	13.69	12.28	34996.09	86.77	148605.83	1207.43	-3124	3845	-721	4.94	2.68	2993.87	72.8	3494.50
Nov-94	43.50	16.59	8.40	35449.62	87.88	153782.55	1235.58	-284	1076	-792	5.27	2.68	3002.01	73.3	3497.60
Dec-94	45.18	17.9	6.61	35901.93	88.99	162721.63	1276.24	3512	-2662	-850	5.60	2.68	3007.31	74.1	3496.70
Jan-95	44.48	16.92	3.56	34152.83	89.91	157996.82	1402.53	-5358	5718	-360	5.70	2.80	3006.11	74.3	3502.10
Feb-95	44.47	16.95	1.41	34694.98	90.83	158934.55	1465.18	-298	-1570	1868	5.77	2.93	3008.47	74.3	3499.50
Mar-95	44.14	15.44	-0.70	35328.21	91.75	162185.73	1537.29	4415	4420	-8835	5.73	2.79	3010.72	74.4	3500.60
Apr-95	43.99	14.18	-3.66	36052.53	92.66	165796.49	1618.85	-2774	3643	-869	5.65	3.05	3009.95	74.4	3508.60
May-95	51.89	15.25	-1.85	36867.93	93.58	166258.29	1709.87	-536	556	-20	5.67	3.18	3014.20	74.5	3533.70
Jun-95	53.62	16.1	0.15	37774.41	94.50	173771.48	1810.35	4680	-7935	3255	5.48	3.03	3020.55	74.7	3559.20
Jul-95	56.59	17.94	-0.54	38771.97	95.41	168380.26	1920.28	-3380	5029	-1649	5.42	2.76	3032.40	74.5	3578.00
Aug-95	55.70	18.78	1.34	39860.61	96.33	170869.83	2039.67	-403	-624	1027	5.41	2.62	3040.39	75.5	3600.20
Sep-95	55.43	20.85	4.01	41040.34	97.25	175243.52	2168.51	5590	-3794	-1796	5.28	2.48	3047.91	75.8	3612.80
Oct-95	55.51	23.5	3.30	42311.15	98.17	173053.47	2306.81	-750	2432	-1682	5.28	2.74	3054.40	75.6	3624.00
Nov-95	55.54	22.65	5.56	43673.04	99.08	185030.93	2454.57	-3914	4638	-724	5.36	2.61	3061.44	75.8	3631.10
Dec-95	55.80	20.9	6.89	45126.01	100.00	176885.01	2611.79	5421	-5467	46	5.16	2.48	3068.46	76.2	3640.70

Jan-96	56.71	21.94	5.93	50772.22	103.60	176998.33	3232.22	646	-1133	487	5.00	2.73	3070.62	75.6	3658.90
Feb-96	58.29	25.89	5.32	52235.24	107.19	176225.70	3389.31	2828	-3323	495	4.83	2.59	3081.20	76.9	3673.00
Mar-96	58.41	24.05	6.39	53617.22	110.79	188094.66	3536.82	800	-397	-403	4.96	2.84	3095.38	76.8	3698.80
Apr-96	58.37	21.15	7.17	54918.17	114.39	196064.81	3674.74	-9531	10696	-1165	4.95	2.83	3121.79	77.4	3709.50
May-96	58.24	20.84	7.00	56138.08	117.99	197874.21	3803.08	1641	-2055	414	5.02	2.95	3136.66	77.9	3720.60
Jun-96	57.99	20.86	9.59	57276.96	121.58	202649.86	3921.84	7280	-11439	4159	5.10	2.69	3148.65	78.5	3734.30
Jul-96	57.31	20.53	11.06	58334.80	125.18	207884.56	4031.01	-6263	9332	-1609	5.15	2.94	3152.80	78.5	3749.00
Aug-96	56.99	20.65	10.85	59311.60	128.78	210286.52	4130.60	-1818	514	34	5.05	2.81	3162.70	79	3756.30
Sep-96	56.43	24.27	10.24	60207.37	132.38	204980.38	4220.61	1934	2067	-1302	5.11	3.06	3173.40	79.4	3765.00
Oct-96	55.86	23.42	10.67	61022.10	135.97	208400.25	4301.04	-906	-2120	259	4.99	3.05	3187.47	79.4	3781.20
Nov-96	55.62	21.8	11.21	61755.80	139.57	212648.79	4371.88	1083	1377	306	5.03	3.18	3197.87	80.1	3798.70
Dec-96	55.15	21.61	10.66	62408.46	143.17	227917.45	4433.15	598	-3496	-325	4.90	3.31	3207.17	80.6	3820.10
Jan-97	54.74	21.63	10.46	61073.80	144.27	222135.11	4369.00	-3568	4039	-526	5.04	3.03	3210.44	80.7	3833.50
Feb-97	54.93	21.55	11.51	61644.38	145.37	235485.94	4415.96	-625	1378	263	5.00	3.03	3221.21	81.7	3844.80
Mar-97	54.89	21.36	15.25	62213.90	146.46	240209.26	4458.19	-267	2335	-2349	5.14	2.76	3234.56	82.3	3858.10
Apr-97	54.38	20.79	15.70	62782.37	147.56	235859.79	4495.70	714	2945	-281	5.16	2.50	3254.94	82.4	3876.80
May-97	53.75	20.15	16.81	63349.78	148.66	240941.31	4528.49	-2534	-729	72	5.06	2.24	3270.12	82.9	3887.60
Jun-97	54.24	18.96	12.39	63916.15	149.76	240252.43	4556.55	-1953	3645	-1176	4.92	2.37	3284.55	83.3	3903.00
Jul-97	57.36	19.25	8.49	64481.46	150.86	238795.06	4579.90	-644	3488	-1342	5.05	2.24	3299.54	83.7	3924.90
Aug-97	67.12	23.58	7.35	65045.72	151.96	244452.24	4598.52	-4294	653	556	5.14	2.24	3311.48	84.9	3953.40
Sep-97	63.77	27.16	8.46	65608.93	153.05	234327.09	4612.41	-37	-400	-1378	4.96	2.10	3321.68	85.7	3973.00
Oct-97	62.64	27.2	8.36	66171.09	154.15	232001.09	4621.58	-3656	5387	54	4.97	1.97	3326.93	86.2	3989.00
Nov-97	63.93	26.51	10.73	66732.19	155.25	235577.07	4626.04	1526	-3500	-215	5.15	1.85	3336.07	87	4011.40
Dec-97	63.05	26.27	11.46	67292.24	156.35	261601.09	4625.76	-3157	6961	-287	5.16	1.72	3345.90	87.4	4033.30
Jan-98	61.16	26.28	13.25	68162.37	157.56	266708.65	4480.45	2647	3516	-979	5.04	1.47	3357.48	87.8	4056.30
Feb-98	60.52	26.41	12.81	68707.26	158.77	276176.58	4476.62	-1698	970	-200	5.08	1.47	3367.84	87.8	4088.30
Mar-98	60.13	26.9	7.53	69238.05	159.98	271207.88	4473.96	-7634	8704	-1531	5.03	1.47	3378.08	87.9	4114.60
Apr-98	59.61	26.96	6.63	69754.73	161.19	270058.20	4472.45	-242	-3661	247	4.96	1.46	3385.85	88.3	4136.70
May-98	62.60	26	4.32	70257.31	162.40	279133.56	4472.12	1089	-920	-1577	5.00	1.71	3397.56	88.9	4160.10

Jun-98	60.52	25.12	6.39	70745.77	163.61	274103.13	4472.94	10796	-8757	-549	4.98	1.71	3410.89	88.4	4186.10
Jul-98	59.34	24.45	8.82	71220.14	164.82	280513.76	4474.94	-4864	5147	62	4.96	1.70	3425.80	88	4202.50
Aug-98	59.37	23.2	8.78	71680.39	166.03	279610.82	4478.09	2555	1599	589	4.92	1.70	3442.39	89.8	4225.80
Sep-98	60.01	22	5.84	72126.54	167.24	278666.68	4482.41	-1896	633	-1380	4.63	1.58	3460.61	89.6	4269.70
Oct-98	59.87	19.82	4.90	72558.58	168.45	283141.50	4487.90	-1343	198	-1137	3.98	1.57	3486.87	90.2	4307.20
Nov-98	59.63	15.79	1.86	72976.51	169.66	283450.19	4494.55	-21	904	-1825	4.41	1.57	3503.59	90.1	4344.60
Dec-98	61.64	11.07	0.67	73380.34	170.87	284510.15	4502.36	-3644	-1160	1317	4.39	1.57	3517.14	90.4	4377.30
Jan-99	61.80	10.59	-0.47	73367.80	171.74	288227.14	4117.40	962	-386	875	4.34	1.69	3523.87	90.9	4398.90
Feb-99	62.53	10.97	1.49	73760.29	172.60	291537.35	4144.07	208	1189	-489	4.43	1.57	3533.87	91.3	4424.30
Mar-99	64.01	9.24	2.97	74155.56	173.46	294418.73	4188.44	-705	2803	-1290	4.45	1.68	3543.47	91.5	4435.50
Apr-99	65.65	9.27	3.72	74553.59	174.33	291155.62	4250.50	5923	-4162	-76	4.28	2.28	3549.51	91.7	4462.80
May-99	68.82	9.59	5.79	74954.40	175.19	290624.09	4330.25	-2508	1498	-2230	4.50	2.04	3560.68	92.3	4481.50
Jun-99	73.60	13.4	5.01	75357.99	176.05	292164.83	4427.70	3062	2931	-3161	4.56	1.92	3573.81	92.2	4506.50
Jul-99	73.10	14.81	5.29	75764.34	176.92	295699.39	4542.84	-1473	2464	-1653	4.55	2.15	3588.64	92.8	4530.40
Aug-99	74.41	14.94	6.64	76173.47	177.78	287548.13	4675.68	-2156	2392	-1173	4.72	2.27	3605.91	93.3	4551.20
Sep-99	75.68	16.74	8.33	76585.36	178.65	285553.17	4826.20	2063	-4284	-1060	4.68	2.63	3625.34	92.9	4564.50
Oct-99	75.57	17.79	9.44	77000.03	179.51	285706.81	4994.42	2634	2071	-841	4.85	2.50	3658.02	94.2	4584.80
Nov-99	74.79	18.69	10.64	77417.48	180.37	286215.45	5180.34	-817	858	-1218	5.06	2.62	3673.48	94.7	4610.80
Dec-99	73.94	20.46	10.43	77837.69	181.24	295513.44	5383.95	488	1249	-1195	5.20	2.74	3682.80	95.5	4635.00
Jan-00	70.68	18.92	9.72	78447.12	182.21	310630.00	6369.32	1561	-344	794	5.31	2.73	3668.59	95.5	4661.60
Feb-00	73.22	12.27	7.60	78865.06	183.19	308033.00	6576.26	1598	-624	-1197	5.54	3.21	3678.69	95.9	4679.00
Mar-00	74.43	11.9	5.95	79277.94	184.16	309403.00	6768.83	-12433	6969	-3235	5.69	3.79	3695.72	96.3	4706.20
Apr-00	74.36	12.09	7.26	79685.78	185.13	315792.00	6947.03	11961	-58	-1653	5.66	3.06	3739.07	96.9	4757.50
May-00	75.97	11.16	8.57	80088.56	186.11	309497.00	7110.88	2011	31	-575	5.81	3.17	3755.38	97.1	4752.10
Jun-00	77.55	10.01	11.23	80486.29	187.08	310355.00	7260.35	2024	1152	-6332	5.68	3.76	3764.06	97.2	4765.80
Jul-00	76.41	9.52	11.45	80878.97	188.06	313562.00	7395.46	-4588	7047	-268	5.95	3.63	3752.10	97	4779.40
Aug-00	76.45	9.7	11.31	81266.60	189.03	312424.00	7516.21	1317	-3208	-183	6.09	3.39	3755.26	96.8	4813.20
Sep-00	78.20	10.59	11.62	81649.18	190.00	308604.00	7622.59	5425	-9311	4007	6.00	3.37	3760.54	97.2	4845.00
Oct-00	79.26	10.81	11.32	82026.71	190.98	305717.00	7714.60	-3478	2076	-1492	6.10	3.48	3775.90	96.9	4863.80

Nov-00	78.86	14.16	11.61	82399.18	191.95	308608.00	7792.25	-472	6	764	6.18	3.36	3779.45	96.9	4872.80
Dec-00	78.73	13.47	11.78	82766.61	192.93	314686.00	7855.53	2415	-4656	2783	5.79	3.36	3779.15	96.5	4917.20
Jan-01	78.61	15.12	11.95	83516.61	191.69	310520.00	7483.95	-621	1957	960	5.18	3.82	3764.38	95.8	4972.70
Feb-01	78.25	15.4	10.13	83857.67	190.46	307017.00	7536.15	-1301	2238	-645	4.90	3.57	3764.36	95.2	5009.00
Mar-01	77.75	14.42	9.45	84177.41	189.23	308898.00	7591.62	-3803	2428	999	4.44	2.85	3768.47	94.9	5066.80
Apr-01	77.50	11.8	9.02	84475.84	188.00	312488.00	7650.37	-3800	6883	-1045	3.89	3.31	3787.40	94.7	5128.60
May-01	78.54	10.34	6.92	84752.96	186.77	307141.00	7712.40	-1756	-6157	6003	3.63	3.64	3791.73	94	5132.30
Jun-01	78.62	12.43	4.61	85008.76	185.54	305590.00	7777.71	-2443	1313	606	3.49	3.17	3792.17	93.4	5171.50
Jul-01	79.02	12.94	4.19	85243.25	184.31	306683.00	7846.30	-4527	5792	-288	3.52	2.71	3779.98	93	5205.10
Aug-01	78.91	12.78	4.02	85456.42	183.08	304343.00	7918.16	-7214	3849	-983	3.37	2.71	3779.15	92.6	5235.80
Sep-01	78.95	12.14	3.05	85648.27	181.84	310649.00	7993.30	2414	419	-277	2.68	2.70	3780.96	92.3	5345.60
Oct-01	78.97	11.5	3.21	85818.82	180.61	315485.00	8071.72	-3416	6438	-2610	2.17	2.13	3786.07	91.8	5338.10
Nov-01	78.96	11.45	2.17	85968.04	179.38	317955.00	8153.42	-2831	2328	-1737	1.88	1.91	3792.65	91.3	5380.50
Dec-01	78.69	10.84	1.64	86095.95	178.15	322329.00	8238.39	1538	3416	-1950	1.69	1.57	3801.38	91.3	5431.20
Jan-02	78.60	10.81	0.45	84489.92	177.96	316575.00	8310.55	-4613	877	-1622	1.65	1.11	3816.92	91.8	5462.60
Feb-02	78.25	10.47	1.20	84647.06	177.77	320222.00	8402.76	3361	207	-739	1.73	1.11	3826.42	91.8	5489.70
Mar-02	78.06	10.05	2.00	84854.74	177.58	320948.00	8498.92	-4615	5125	-1176	1.79	1.55	3834.56	92.5	5498.90
Apr-02	78.27	9.82	0.89	85112.97	177.39	325451.00	8599.03	-1002	10645	-1801	1.71	1.66	3839.66	92.8	5505.90
May-02	78.31	9.5	1.71	85421.75	177.19	325741.00	8703.10	-3883	-969	-23	1.73	1.21	3846.31	93.2	5528.30
Jun-02	78.66	7.5	2.83	85781.06	177.00	331633.00	8811.12	-2202	1639	-105	1.71	1.10	3852.83	94.1	5550.90
Jul-02	78.80	8.61	2.15	86190.92	176.81	333268.00	8923.09	-7296	6901	-823	1.69	1.43	3861.79	93.8	5600.40
Aug-02	78.81	8.29	1.81	86651.33	176.62	338704.00	9039.02	-3797	4403	289	1.62	1.76	3866.15	93.9	5636.30
Sep-02	78.81	7.26	1.78	87162.28	176.43	335873.00	9158.90	2867	2029	-1455	1.64	1.53	3868.46	93.9	5659.90
Oct-02	79.32	8.41	1.87	87723.77	176.24	338115.00	9282.73	-4199	706	-1607	1.59	1.98	3863.80	93.7	5712.10
Nov-02	79.57	8.28	2.58	88335.81	176.05	344536.00	9410.52	-6966	8389	-782	1.24	2.20	3865.72	94.1	5757.10
Dec-02	79.53	8.37	4.25	88998.39	175.86	350733.00	9542.26	-3041	1089	-570	1.19	2.32	3869.29	93.6	5784.70
Jan-03	77.72	8.29	6.37	90285.69	176.90	350831.00	9793.71	-2030	2041	-492	1.17	2.54	3874.44	94.3	5811.60
Feb-03	76.84	7.4	7.45	91025.27	177.95	351051.00	9928.50	2183	3329	-1467	1.16	3.08	3881.37	94.6	5847.50
Mar-03	76.58	5.8	10.12	91791.30	179.00	352748.00	10062.39	-4462	4294	-2230	1.13	2.95	3889.99	94.5	5860.50

Apr-03	75.66	6.34	11.64	92583.78	180.04	350497.00	10195.37	5152	451.92	-1047	1.14	2.17	3897.45	93.7	5906.70
May-03	71.61	5.4	14.91	93402.72	181.09	353507.00	10327.45	-7930	6165	-905	1.07	2.06	3911.62	93.7	5960.60
Jun-03	73.72	1.76	13.74	94248.11	182.14	362596.00	10458.63	-6250	7125	-1054	0.93	2.17	3929.64	93.8	5999.30
Jul-03	74.75	1.52	10.91	95119.95	183.18	370056.00	10588.91	-5670	5682.02	-1097	0.90	2.17	3961.05	94.2	6053.00
Aug-03	75.96	0.84	8.27	96018.24	184.23	370235.00	10718.28	-248	-779.197	-434	0.95	2.16	3979.60	94.1	6098.60
Sep-03	77.90	0.85	7.89	96942.99	185.28	370335.00	10846.75	4630	391.005	-1221	0.94	2.27	3994.84	94.7	6079.30
Oct-03	77.73	1.07	9.08	97894.18	186.32	379216.00	10974.31	-3373	1868.58	-1787	0.92	2.05	4003.46	94.8	6064.30
Nov-03	76.74	1.38	8.97	98871.83	187.37	385539.00	11100.97	-35	1051.99	-2079	0.93	1.83	4014.54	95.6	6064.50
Dec-03	76.02	1.41	8.35	99875.94	188.42	395116.00	11226.73	1959	-5659.73	4105	0.90	1.94	4024.80	95.5	6071.60
Jan-04	76.29	1.61	9.14	101390.47	189.99	394327.00	11360.46	-2389	2399.98	-1068	0.88	1.94	4033.04	95.8	6075.60
Feb-04	76.39	1.53	9.85	102427.17	191.56	391076.00	11484.04	-2600	984.322	-1691	0.93	1.60	4042.52	96.3	6113.30
Mar-04	77.26	1.62	8.32	103470.02	193.14	394788.00	11606.34	702	1757.22	-826	0.94	1.80	4052.04	95.7	6150.90
Apr-04	77.91	2.61	7.58	104519.01	194.71	399225.00	11727.37	3111	563.415	-1960	0.94	2.34	4061.52	96.2	6192.60
May-04	79.24	2.6	4.66	105574.15	196.28	402313.00	11847.12	-2844	-203.916	-1116	1.02	2.98	4071.22	96.9	6259.90
Jun-04	79.27	1.72	5.94	106635.43	197.85	407302.00	11965.59	1927	752.95	314	1.27	3.19	4081.06	96	6273.30
Jul-04	79.99	1.88	8.54	107702.86	199.43	411439.00	12082.79	-4049	4108.77	663	1.33	2.97	4090.36	96.7	6278.40
Aug-04	80.83	2.49	15.80	108776.44	201.00	417476.00	12198.71	-3001	3517.72	-683	1.48	2.65	4100.96	96.9	6301.90
Sep-04	80.72	2.91	18.96	109856.16	202.57	416955.00	12313.36	1258	-6939.64	426	1.65	2.53	4112.19	96.9	6335.90
Oct-04	81.20	4.5	18.29	110942.03	204.15	423131.00	12426.73	4250	2006.47	-383	1.75	3.27	4124.06	97.8	6360.70
Nov-04	81.20	6.26	16.65	112034.05	205.72	423509.00	12538.82	-1014	-787.976	308	2.06	3.49	4136.56	98	6397.40
Dec-04	79.77	8.29	16.25	113132.20	207.29	432567.00	12649.64	4438	-4812.34	-153	2.19	3.18	4149.68	98.7	6412.20
Jan-05	77.99	8.3	14.87	113860.25	208.94	428710.00	12248.26	3410	-4652.25	567	2.33	2.95	4167.75	99.1	6416.30
Feb-05	76.94	8.65	13.94	114986.49	210.59	428812.00	12377.96	642	-646.846	-504	2.53	3.04	4178.90	99.8	6429.10
Mar-05	74.80	8.62	14.15	116134.66	212.24	434914.00	12527.82	-2366	4970.51	343	2.74	3.13	4187.44	99.7	6444.00
Apr-05	76.15	8.66	16.02	117304.77	213.89	435336.00	12697.85	3992	-5985.37	-832	2.78	3.43	4187.81	99.6	6451.60
May-05	76.40	8.64	14.78	118496.80	215.54	437547.00	12888.04	-9040	4493.52	-410	2.84	2.79	4195.31	99.9	6467.80
Jun-05	76.68	8.46	11.91	119710.77	217.19	442402.00	13098.39	2867	-1944.65	33	2.97	2.57	4204.38	100.3	6499.80
Jul-05	76.23	8.59	11.77	120946.68	218.84	445204.00	13328.90	-8092	5418.13	1889	3.21	3.20	4218.59	100.2	6526.60
Aug-05	75.81	8.69	6.87	122204.51	220.49	452969.00	13579.57	-7122	5515.8	-358	3.44	3.71	4228.11	100.4	6556.30

Sep-05	74.10	8.5773	4.27	123484.28	222.14	453770.00	13850.40	-4809	2982.78	97	3.42	4.73	4236.50	98.7	6592.10
Oct-05	73.71	7.94	3.72	124785.98	223.79	463920.00	14141.40	-2907	3226.08	-253	3.69	4.29	4237.27	99.8	6620.90
Nov-05	74.74	7.85	6.04	126109.62	225.44	470309.00	14452.55	-4665	3335.24	-183	3.88	3.48	4248.31	100.9	6648.50
Dec-05	73.11	8.14	7.56	127455.18	227.09	474490.00	14783.87	2023	-831.727	425	3.88	3.49	4263.12	101.6	6674.10

GDP, Money supply, net foreign assets, budget deficit, domestic and foreign financing of budget deficits figures are in billions of the local currencies.

A2 The Lag Selections

The lag order for VAR estimation was determined using AIC and SIC. SIC recommended p=1 while AIC recommended p=8.

Table A2: P-Lag to be included in the VAR

Lag	FPE	AIC	SBIC
0	350.6060	31.40	31.77
1	0.0180	21.52	**22.74***
2	0.0090	20.83	22.88
3	0.0083	20.74	23.64
4	0.0078	20.69	24.42
5	0.0082	20.72	25.30
6	0.0079	20.68	26.09
7	0.0068	20.52	26.77
8	0.0060*	**20.38***	27.47
9	0.0063	20.40	28.34

Sources: Derived from data.

Endogenous: Exchange rate volatility, interest rate differential, inflation rate differential, domestic interest rate, money supply differential, net foreign asset, net domestic financing of budget deficit, net foreign financing of budget deficit and productivity differential.

Exogenous: Dummy variables for fixed, managed float and dual exchange rate regimes.

Effects of changes in exchange rate regime, as captured by the dummy variables, was taken as exogenous. All the variables were considered at the level where they are stationary that is, net foreign assets was differenced before estimation while the other variables were included at level.

A3 Diagnostic Test

The Lagrange-multiplier test for autocorrelation results are shown in Table A3.

Table A3: LM Test for Autocorrelation

Lag Order	Chi-Squared	Probability > Chi-Squared
1	144.20	0.0000
2	118.07	0.0045
3	126.43	0.0009
4	153.95	0.0000
5	161.59	0.0000
6	151.89	0.0000
7	197.91	0.0000
8	86.55	0.3161

Sources: Derived from data.

The tests of no autocorrelation at lag order of 8 could not be rejected at 5 and 1 percent level of significance, implying no autocorrelation at this lag order.

Jarque-Bera test for multivariate normality results are presented in Table A4.

Table A4: Jarque-Bera test results

Equation	Chi-Squared	Probability > Chi-Squared
Exchange Rate Volatility	2759.54	0.0000
Interest Rate Differential	284.90	0.0000
Inflation Rate Differential	66.42	0.0000
Domestic Nominal Interest Rate	155.11	0.0000
Money Supply Differential	296.30	0.0000
Net Foreign Asset	26000	0.0000
Net Domestic Financing of Budget Deficit	132.83	0.0000
Net Foreign Financing of Budget Deficit	380000	0.0000
Productivity Differential	19000	0.0000
ALL	430000	0.0000

Sources: Derived from data.

This test results indicated that the variables are normally distributed.

The Wald exclusion lags test results for exchange rate volatility equation are reported in Table A5.

Table A5: Test for exclusion of Lags

Lag	Chi-Squared	Probability > Chi-Squared
1	543.98	0.000
2	15.51	0.078
3	7.90	0.544
4	6.46	0.694
5	15.83	0.071
6	16.47	0.058
7	18.70	0.028
8	20.80	0.014

Sources: Derived from data.

Lag of 8 is important to this model at 5% level of significance.