The Impact of Central Bank's intervention in the foreign exchange market on the Exchange Rate: The case of Zambia (1995-2008)

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THE IMPACT OF CENTRAL BANK'S INTERVENTION IN THE FOREIGN EXCHANGE MARKET ON THE EXCHANGE RATE: THE CASE OF ZAMBIA (1995-2008)

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DEDICATION

TO MY WIFE AND CHILDREN

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ABSTRACT

The central bank of Zambia called Bank of Zambia (BOZ) has, like many other central banks in both developing and developed economies, been from time to time intervening in the foreign exchange market by either purchasing or selling foreign exchange (mainly United States of America Dollars) to the market. Central banks have given a myriad of reasons for this particular behaviour. Chief among these and which is the focus of this paper is to smooth volatility or reverse a trend of the domestic currency in this case the kwacha. Despite central banks' intervention activities in the foreign exchange markets, literature on the efficacy of these interventions in terms of impacting domestic currencies has remained controversial. While some strands of literature seem to suggest that such intervention has an impact on the currencies some literature disagrees.

Early studies done in the 1980s suggest that intervention operations do not affect the exchange rate and if they do this effect is very small and only in the short run. More recent studies however, have found evidence of the effect on both the level and volatility of exchange rates. Further, recent studies focused on emerging market and developing countries have found strong evidence of the effect of central banks' intervention operations in the foreign exchange market on exchange rates.

This paper therefore examines the effect of the BOZ's foreign currency market interventions on the level and volatility of the kwacha/ USD exchange rate between 1995 and 2008. In order to study the impact of interventions on the kwacha, the paper uses monthly data (both sales and purchases) on foreign exchange intervention and employs the GARCH (1, 1) and Exponential GARCH frameworks to model volatility. The results from GARCH model suggest that sales of foreign exchange in this case the $ causes the exchange rate to appreciate while purchases of the $ cause the exchange rate to depreciate. As for the impact on volatility, the GARCH (1, 1) model reveals that BOZ interventions increase volatility.

Empirical results from the EGARCH model on the other hand suggest that both sales and purchases of $ cause the exchange rate to appreciate. The results on the impact of intervention on volatility are mixed though generally intervention appears to be increasing volatility.

LIST OF ABBREVIATIONS

BOZ =Bank of Zambia (Zambia's central bank)

K = Kwacha (Official exchange rate in Zambia)

$ = United States of America dollar

Fed = Federal Reserve Bank

Y = Japanese Yen

M = Germany Deutschmark

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1 INTRODUCTION

Foreign exchange intervention is the process by which central banks and other monetary authorities either buy or sell foreign exchange in the foreign exchange market normally against their own currencies in line with some policy objective. Some of the objectives include among others to control inflation or maintain internal balance; to maintain external balance and prevent resource misallocation or preserve competitiveness and boost growth; and to prevent or deal with disorderly markets or crises. To achieve these objectives, central banks might seek to target the level of the exchange rate, dampen exchange rate volatility or influence the amount of foreign reserves.

There are a number of reasons why central banks intervene in the foreign exchange markets. There are however, four common reasons; to calm disorderly markets (smoothing volatility), cure exchange rate misalignment, signal future monetary policy and build international reserves.

Exchange rates like many other financial assets exhibit volatility trends which may result in loss of liquidity. This volatility may also have adverse effects on international trade, the external balance and threaten the orderly functioning of the market. Central banks may therefore intervene to calm this disorderly behaviour.

There are times that exchange rates drift away from fundamentals and what monetary authorities consider to be the equilibrium level. Therefore, central banks may be forced to try and reverse this misalignment and bring the exchange rate back to its normal path.

Moreno (2005) reporting on a survey of why central banks in emerging market economies intervened revealed that policymakers are typically concerned not just with how much the exchange rate might deviate from equilibrium but with how quickly it does so. Intervention will often attempt to slow the rate of change in the exchange rate without preventing trend

changes, a policy that is known as ‘leaning against the wind”. While intervention of this kind typically occurs when the exchange rate is moving away from equilibrium, it can sometimes occur if the exchange rate is moving back to equilibrium, but “too quickly”. Slowing the rate of change in the exchange rate can stop herding behaviour by acting as a circuit breaker. By reducing uncertainty, this type of intervention may facilitate foreign exchange market development. On the other hand, by acting as a provider of “insurance” against rapid exchange rate movements, official intervention could also undermine incentives for the development of hedging capability in the private sector. Chile, Israel and Mexico were given as examples.

Intervention may also be used to signal future changes to monetary policy and calm expectations if monetary policy is changed unexpectedly which might otherwise lead to a loss in confidence and thereby induce an unwarranted moves in the exchange rate.

Finally, central banks may want to build international reserves of foreign currencies and so they will enter the foreign exchange market to purchase a foreign currency. International reserves are sometimes used as collateral to attract foreign investors.

The practice of intervention has been around for a while though it really intensified after the collapse of the Bretton Woods System in 1972. Before then intervention was allowed for the sake of keeping exchanges rates within agreed parity bands. However, after the demise of the fixed exchange rate system, the discretion to intervene in the foreign exchange market became incumbent upon individual states and their monetary authorities. To this extent the International Monetary Fund (IMF) even issued guidelines on how member states should conduct their intervention activities. Historically, the G -5 countries who included Japan, Germany, the United States of America, and France signed the Plaza Agreement in 1995. The agreement was about coordinated intervention. Consequently, over the years all major developed countries have intervened in the foreign exchange market on a number of

occasions albeit the frequency now is very minimal. However, developing countries are now more active in this area.

Canales-Krijenko (2003) in a survey of central banks' foreign exchange market intervention revealed that central banks issuing major currencies were seldom active in the foreign exchange market because they had developed policy frameworks that target short-term interest rates and exchange rate policies that limited foreign exchange intervention to calm disorderly market conditions. On the other hand most central banks in developing and transitional economies were more active in the foreign exchange market across all exchange rate regimes.

However, the key question in academia, politics and government is whether this intervention is really effective. Unfortunately, this question and the debate around it has been raging from the time of the introduction of the floating exchange system in the early 1970s, and it does not seem to be receding. There are three different views points on this matter.

One strand of thought posits that intervention operations do not at all affect the level or volatility of the exchange. Another school of thought states that intervention while not being only ineffectual at influencing the level of the exchange rate also increases the volatility of the exchange. The last strand of thought states that intervention operations do influence the exchange rate and do also calm disorderly markets in the process arresting volatility (Dominguez 1998, Edison et al 2003)

Empirical studies conducted in the early 1980s have suggested that intervention whether sterilized or not was ineffective in as far as affecting the exchange rate was concerned. Of particular note was the Jurgensen Report of 1983 which categorically stated that intervention was in the main ineffective. However, studies into the phenomenon conducted after the 1990s using high –frequency central bank intervention data which was missing in the 1980s studies suggest that intervention does have an effect after all. It should also be noted that despite the scepticism about the efficacy of intervention both in academia and public

policy sectors, it is ironical that most central banks both in developing and developed countries continue to intervene in their foreign exchange markets. This should therefore point to the fact that central banks believe intervention does work and is effective in achieving their policy objectives.

Broadly speaking an exchange rate is the price of one currency in relation to another. This price is either expressed in domestic currency units per unit of foreign currency or as foreign currency units per unit of the domestic currency (Pilbeam 2006). In this paper the former definition is adopted such that we express the exchange rate as kwacha units per United States of America dollar unit. When we talk about exchange rates we are invariably talking referring to the nominal exchange rate. The definition of nominal exchange rate is alluded to earlier. In contrast, a real exchange rate is the price of domestic goods to relative to foreign goods or the number of foreign goods one gets in exchange for domestic goods.

The foreign exchange market is where currency trading takes place. It is where institutions facilitate the buying and selling of foreign currencies. It involves a process where one party purchases a quantity of one currency in exchange for paying a quantity of another. Currently, foreign exchange markets are the most liquid financial markets in the world.
The BIS (2007) reported that turnover in the traditional foreign exchange markets had grown unprecedented by 69 per cent since April 200 4 to $3.2 trillion (See graph below).

The U.S. dollar which is the international reserve currency continues, as Table 1 depicts, to be the most traded currency world over.

Figure 1: Foreign exchange Turnover (USD millions)

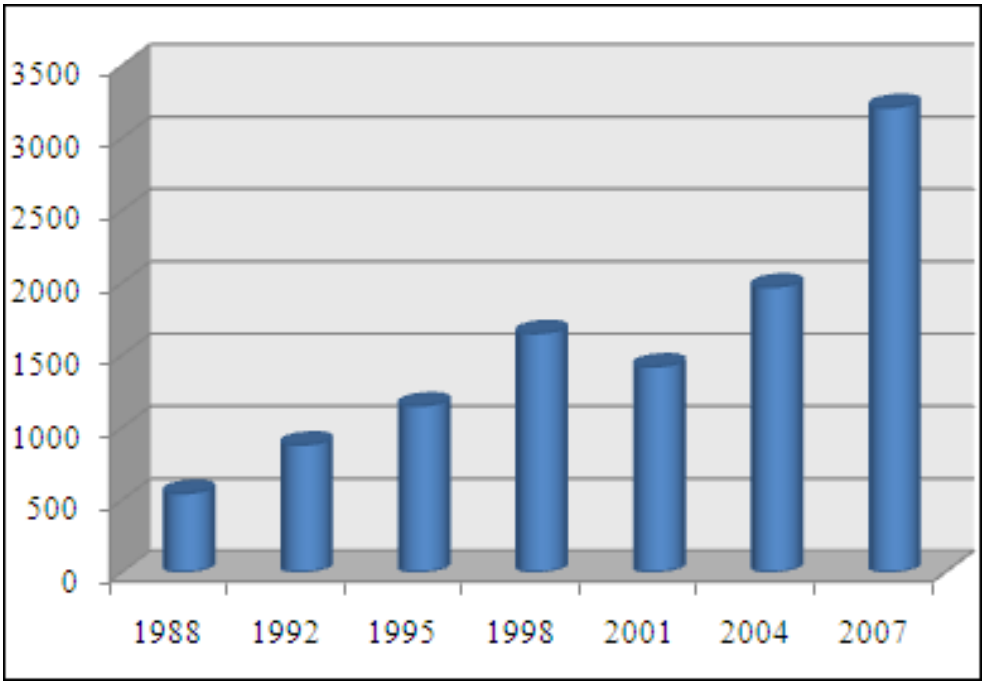


TABLE 1: MOST TRADED CURRENCIES (2007)

Rank	Currency	ISO 4217 code (Symbol)	% daily share (April 2007)
1	United States dollar	USD ($)	86.3%
2	Euro	EUR (€)	37.0%
3	Japanese yen	JPY (¥)	17.0%
4	Pound sterling	GBP (£)	15.0%
5	Swiss franc	CHF (Fr)	6.8%
6	Australian dollar	AUD ($)	6.7%
7	Canadian dollar	CAD ($)	4.2%
8-9	Swedish krona	SEK (kr)	2.8%
8-9	Hong Kong dollar	HKD ($)	2.8%
10	Norwegian krone	NOK (kr)	2.2%
11	New Zealand dollar	NZD ($)	1.9%
12	Mexican peso	MXN ($)	1.3%
13	Singapore dollar	SGD ($)	1.2%
14	South Korean won	KRW (₩)	1.1%
		Other	14.5%
		Total	**200%**

Source: BIS

There are a number of participants in the foreign exchange market who include the following:

The central banks or monetary authorities. These play an important role in the foreign exchange market. They attempt to control the money supply, inflation and or interest rates and often have official or unofficial target rates for their currencies. They frequently intervene to buy and sell their currencies in a bid to influence the rate at which their currency is traded.

Commercial banks. The interbank market caters for both the majority of commercial turnover and large amounts of speculative trading. Some trading is undertaken on behalf of customers but much is conducted by proprietary desks trading for the bank's own account.

Commercial companies. They include international investors, multinational corporations who need foreign exchange for the purposes of running their businesses. Normally, they do not directly purchase or sell foreign exchange themselves but they place buy/sell orders with commercial banks. Though their impact on exchange rates is minimal, commercial companies' trade flows are an important factor in the long term direction of a currency's exchange rate. Some firms can have an unpredictable impact when very large positions are covered due to exposures that are not widely known by other market participants.

Foreign exchange brokers. Often banks do not trade directly with one another, but they transact through foreign exchange brokers.

Money transfer/ Remittance companies. These perform high volume low value transfers generally by economic migrants to their home country. One example of such institutions is Western Union.

Hedge funds act as speculators. A majority of foreign exchange transactions are speculative. Economic agents that buy and sell foreign exchange have no plan to actually

take delivery of the currency in the end rather they were solely speculating on the movement of that particular currency. They may control billions of equity and may borrow billions more and thus overwhelm intervention by central banks to support almost any currency if the economic fundamentals are in the hedge funds favour.

Foreign exchange markets in emerging markets and developing economies like Zambia are fundamentally different from those of developed countries. They are small in size, undercapitalized and underdeveloped, sometimes highly regulated by the central banks and other monetary authorities.

Disyatatat and Galati (2005) describe the situation in emerging market economies as follows: (i) the size of intervention relative to market turnover tends to be larger, (ii) the existence of some form of capital controls limiting access to international capital markets gives central banks in these countries greater leverage in the market, and (iii) the lower level of sophistication of the domestic market along with stringent reporting requirements may endow central banks with a greater informational advantage not only with respect to fundamentals but also aggregate order flows and net open positions of major traders.

The size of foreign exchange intervention relative to the turnover in the foreign exchange market has a telling effect on the impact of intervention on the exchange rate. Foreign exchange intervention in developing countries accounts for a much larger proportion of total foreign exchange market turnover than in developed countries.
Through the existence of foreign exchange controls, like surrender requirements to the central banks, some developing countries increase the size of intervention in comparison to the size of the foreign exchange market.

Central banks in developing countries also possess an information advantage over economic agents which their counterpart institutions in developed economies do not possess. For example some of them might have a better grasp of aggregate foreign exchange order flow including future monetary and exchange rate policy than economic agents.

When examining the efficacy of intervention therefore this clear distinction on the environments in emerging market economies as opposed to developed ones is very essential. The factors highlighted above seem to make central bank intervention in developing and transitional economies more effective than in developed ones.
This is supported by a number of studies (Edison et al 2003) (Disyatat and Galati 2005) (Simatele 2004) (Domac and Mendoza 2004) (Kim et al 2000).

This paper studies the impact of the central of Bank, the Bank of Zambia's (BOZ) intervention in the foreign exchange market in Zambia on the domestic currency, the kwacha (K). It does not distinguish between sterilized or unsterilised intervention due to the limited time span of the research. Therefore, it focuses on the fact the BoZ intervened in the foreign exchange market. The BOZ has been intervening in the foreign exchange market ever since the start of the flexible exchange rate system in 1992. However, due to data unavailability the period 1992 -1994 has been excluded from the sample period.

2) Aims and Objectives

This paper intends to establish whether the Bank of Zambia's intervention in the foreign exchange market from 1998 to 2008 has had an impact on the level and volatility of the kwacha.

3) Outline of the Study

The study is divided into a further five chapters. Chapter two provides the review of both theoretical and empirical literature. It outlines the assumptions, predictions, and weaknesses

of various exchange rate determination models and channels through which central bank intervention in the foreign exchange market affects exchange rates. Chapter three provides a brief overview of Zambia and the exchange rate policy history in the country from independence to date. Chapter four describes the data used in the study namely sales and purchases of the United States Dollars (USD). It also highlights the EGARCH and GARCH models used to model the impact of Bank of Zambia's intervention impact on the kwacha. Chapter five provides the empirical results while chapter six is the conclusion.

CHAPTER 2 REVIEW OF LITERATURE

2. 1. THEORETICAL LITERATURE.

Exchange rate determination is often interpreted to arise from three basic models. These are the purchasing power parity, monetary and portfolio balance models. Additionally in the recent past the signalling/expectations and microstructure/order flow have been identified as channels through which foreign exchange market intervention may affect the exchange rate. These five theories are discussed below:

2.1.1. PURCHASING POWER PARITY (PPP) MODEL

This is the oldest and widely used model for assessing long run exchange rate movements. It states that changes in exchange rates between currencies will tend to reflect changes in relative countries' price levels.

Its basic tenet according to Pilbeam (2006) is the law of one price which posits that once prices are converted into one currency, the same good should sell for the same price in a another country.

ASSUMPTIONS

The model assumes the following:

- The goods are tradable.
- The goods are homogenous.
- There are no impediments to trade such as tariffs, transport and transaction costs.
- The price systems works.
- The economies are operating at full employment.
- There is full information across economies.

There are two versions of the model. The absolute PPP is based on the strict interpretation of the law of one price while the relative one is a more relaxed and weaker version.

The absolute version postulates that the equilibrium exchange rate between two countries' currencies is determined entirely by the ratio of the two countries' national price levels as follows:

$$S = \frac{P}{P^*} \quad \text{..... 2.0}$$

Where S is the domestic exchange rate, P and P* represent domestic and foreign consumer price indices respectively.

Equation 2 states that if the foreign prices go up relative to domestic ones, then the domestic currency will appreciate in value. Conversely, if the prices of domestic goods increase relative to the foreign ones, then the domestic currency will depreciate.

The relative version overcomes some hurdles of its predecessor by recognizing the presence of transport costs and tariffs in international trade. It posits that the exchange rate will be determined by inflation differential between two countries.

$$\%\Delta S = \%\Delta P - \%\Delta P^* \text{..... 2.1.}$$

Where %ΔS is the percentage change in the exchange rate,

%ΔP in the domestic inflation and

%ΔP* change in the foreign inflation.

The relative PPP version predicts that if relative prices double in the home country between a base period and some subsequent date, the exchange rate will depreciate by an equal proportion.

WEAKNESSES

The model has performed badly in determining exchange rates especially after the introduction of flexible exchange rate regimes due to a number of flaws. Firstly, it is difficult to tell whether or not the model applies to both tradable and non-tradable sectors. If there is a difference between price inflation in the traded and non-traded sectors across countries then the model will not capture these effects. Secondly, countries have different weights attached to a similar set of goods and services. This will therefore lead to greater disparity from aggregate PPP. Further, assumptions related to international movement of goods are not realist because in reality transaction and transport costs will always exist when goods move from one country to the other. Finally empirically the model has performed very badly.

2.1 2.MONETARY MODELS

The monetary models posit that the exchange rate should be viewed as an asset price which depends on the current and expected future values of relative supply of domestic and foreign financial assets. They seek to explain how changes in the domestic and foreign supply and demand for money both directly and indirectly influence the exchange rate.

The paper examines the Flexible –Price and Sticky- Price monetary models.

FLEXIBLE –PRICE MODEL

The Flexible-price Monetary Model is attributed to Frenkel (1976) Mussa (1976) and Bilson (1978). Though being a monetary (asset) model it is an extension of the PPP model.

Hallwood and MacDonald (2008) state that the model depends on PPP equation in order to explain the exchange rate.

ASSUMPTIONS

- Domestic and foreign bonds are perfect substitutes and therefore the Uncovered Interest Parity (UIP) condition holds continuously(S=P-P*)
- Prices and wages are all flexible both downwards and upwards.
- There is perfect capital mobility.
- Absolute PPP holds continuously.
- Demand to hold real money balances is positively related to real income and negatively related to the domestic interest rate.
- Money supply and real income are exogenously determined.
- The money market is the only important asset market.

From the above assumptions, we can derive the main equation (reduced form) of the model which is:

$$S= (M- M^*) - k(y- y^*) +\theta(r- r^*) \quad (2.2)$$

s = nominal spot exchange rate (domestic currency price of foreign currency)

m = domestic money supply

y = domestic scale variable (usually income level)

r = opportunity cost of holding money usually interest rate,

θ = constant

(Corresponding foreign magnitudes are denoted by an asterisk)

PREDICTIONS

The predictions of the flexible-price monetary model are as follows:-

Firstly there is proportionality between relative monies and the exchange rate so that the coefficient on the money supply m is expected to be 1. In other words, an increase in domestic money supply relative to foreign stock would lead to a rise in the exchange rate i.e. depreciation of the domestic currency in terms of the foreign currency.

A rise in domestic real income, *ceteris paribus*, creates an excess demand for domestic money stock. In an attempt to increase their real money balance, domestic residents reduce expenditure and prices fall until money market equilibrium is achieved. Through PPP, falling domestic prices (with foreign prices constant) imply an appreciation of the domestic currency in terms of the foreign currency. (Sarno and Taylor 2008)

Finally, an increase in domestic interest rates leads to a depreciation of domestic currency.

WEAKNESSES

The major weakness of the model is its reliance on the PPP model and its assumptions are also oversimplified.

THE STICKY-PRICE MODEL

The Dornbusch Sticky-Price Model has the same features as the Flexible –Price model in the long run but differs in the short run. In this horizon it is assumed that prices and wages are not adjustable downwards because they are 'sticky'. This means that the goods market does not continuously clear in the short-run and that the PPP condition does not hold but it does so in the long-run.

ASSUMPTIONS

- Goods prices and wages tend to change slowly downward in the short run.
- Uncovered interest parity (UIP) holds continuously.
- There are jump variables in exchange rates which compensate for stickiness of goods prices.
- There is money-neutrality.

SHORT RUN OVERSHOOTING

Due to price stickiness goods prices do not continuously clear. So there is an asymmetry of adjustment between goods and assets markets. The Sticky –Price Pilbeam (2006)
model is given below

$$Es^{\bullet} = \Theta\,(\hat{S} - S) \qquad \Theta > 0. \qquad (2.3)$$

Where $\hat{S}$ is the exchange rate's long run value while S is the spot rate and Θ is the adjustment parameter and the gap between the current exchange rate S and its long-run equilibrium value $\hat{S}$.

There is "overshooting" of the exchange in the short –run when there is an unexpected increase in domestic money supply, the exchange rate and prices level are expected to change appropriately. However, due to price stickiness this does not happen. This does not hence clear the money market but instead it is cleared by a fall in interest rate.

As a result international investors anticipate a depreciation of the currency to compensate for the lower interest rates. The domestic currency then appreciates to a level which exceeds (overshoots) its long-run value. This follows from the UIP which implies that the domestic interest rate can only be below the foreign rate if economic agents expect the exchange rate to appreciate which can only happen if the current spot rate moves more than the long run value.
In essence the extent of the overshooting incidences hinges on the interest rate semi-elasticity of the demand for money.

LONG RUN EQUILIBRIUM

In the long run the PPP equation ($S= P-P^*$) holds. After the currency overshoots its long run value in the short run, it will eventually start depreciating as prices adjust until its long run PPP is satisfied.

PREDICTIONS

According to equation 2.3 the expected rate of depreciation of a currency is determined by the speed of the adjustment parameter and the gap between the current exchange rate and its long run value. If S is above $\hat{S}$ then it is anticipated that the local currency will appreciate. Conversely if the spot rate is below its long run value, the currency will be expected to depreciate.

In the long run the exchange rate will be determined by relative prices of goods between countries.

WEAKNESSES

The major weakness of this model like other asset theories is that there is no role for the current account in determining the exchange rate when in real life since exchange rates have an impact on the current account.
The other problem is that this model omits a range of assets and only considers money.

THE PORTFOLIO BALANCE MODEL (PBM)

The PBM is a dynamic exchange rate determination model which is hinged upon the interplay of asset markets, current account balance, prices and the rate of asset accumulation. It introduces the current account aspect which monetary models did not capture. The current account plays a prominent role in the exchange rate determination while the exchange rate affects the trade balance and current account and hence the net foreign assets.

Here the central role of wealth variables is recognized; economic agents allocate their wealth among different assets, and the proportion of each asset held depends on the risk and return assessments economic agents make.

ASSUMPTIONS

- Three assets are held by economic agents and authorities. These are domestic monetary base (M), domestic bonds denominated in the domestic currency (B) and foreign bonds denominated in foreign currency (F).
- Domestic and foreign assets are imperfect substitutes. Therefore uncovered interest parity does not hold.
- Domestic prices and output are fixed following a policy disturbance.
- The country concerned is too small to influence world exchange rates.
- Money demand depends not only on income but also on wealth and interest rates.
- Net exports are a positive function of the real exchange rate.

SHORT RUN EQUILIBRIUM

The total wealth (W) of economic agents consists of the domestic monetary base (M), domestic bonds (B) and foreign bonds as follows (F);

$$W = M + B + F \quad \text{..... (2.4)}$$

The short run equilibrium is given by:

$$B^* = T(S/P) + i^* B^* \qquad T > 0 \qquad \text{.....(2.5)}$$

Where B^* capital account

$i^* B^*$ is the net debt service receipts.

The short run equation (2.5) shows the rate of change of the capital account as equal to the current account which is also in turn equal to the sum of the trade balance and net debt service receipts. This means that the trade balance depends positively on the level of the real exchange rate.

When domestic interest rates rise, economic agents adjust their portfolio by substituting domestic for foreign bonds. This causes the demand for foreign assets to decline and the money realised from selling foreign assets is converted into the domestic currency which results into the fall of the spot rate.

LONG RUN EQUILIBRIUM

In the long run, it is the interplay between the real sector and the financial markets that lead the economy to its long run status. Equilibrium in the long run takes place when the domestic price level and the quantity of foreign bonds are such that there is a zero balance on the current account. At this point there is no accumulation or de-cummulation of wealth. When the current account is in balance the rate of change in the exchange rate will be zero.

$$CA = T(S/P) + i^* B^*$$

Where T (.) is a function of competitiveness..... (2.6)

A current account surplus (deficit) is associated with a domestic currency appreciation (depreciation) which tends to eliminate the surplus (deficit). This means that in the long run exchange rate determination is a macroeconomic problem involving the interaction of goods and asset markets.

PREDICTIONS

The model predicts that certain monetary authority policy actions have short-run effects on the exchange rate.

Firstly, when monetary authorities embark on expansionary foreign exchange operations by buying foreign bonds from the private sector, this will increase the sector's holdings of money but a downfall of foreign bonds. This will lead Copeland (2008) to a downward adjustment of interest rates and a rise in the price of foreign currency and therefore currency depreciation.

Expansionary open market operations which increase the private sectors holdings of money and reduction of domestic bonds will lead to domestic currency depreciation and a fall in domestic interest rates.

The difference between this and the first is qualitative rather than quantitative Copeland (2008)) Monetary authorities can also embark an expansionary foreign exchange activity but accompany this with contractionary open market operations by first purchasing foreign assets with domestic money base and the offset the increase in the money supply by selling domestic bonds (sterilized foreign exchange intervention). The short run effect of this policy measure is that it will increase the supply of domestic bonds but decrease the private sector's levels of foreign assets. The result is a depreciation of the exchange rate and a rise in interest rates.

CHANNELS OF INTERVENTION.

2.1.4 PORTFOLIO BALANCE CHANNEL

In line with the portfolio balance model discussed, this channel postulates that investors hold three types of assets in different proportions and because foreign and domestic assets are imperfect substitutes, central bank intervention which alters the asset supplies relative outstanding supply of domestic assets will require a change in the expected relative returns. This will culminate in a change of the exchange rate.

2.1.5 THE SIGNALLING CHANNEL

This channel was developed by Mussa (1981). He started from the general monetarist view of exchange rates being assets. This asset market view of exchange rates postulated that exchange rates as relative assets prices like other assets were impacted upon by current events as well as the market's expectation of future events. Therefore, they changed from time to time due to the receipt of new information that changed the market's view of the economically appropriate exchange rate.

FIVE FEATURES OF EXCHANGE RATES

Mussa identified five key features of the asset market view of exchange rates:

The exchange rate being a relative price of two highly durable currencies means that the prevailing exchange rate is conceived by the market to be linked to future exchanges rates. The market knows that the fundamentals determining the prevailing exchange rate will also to a greater extent affect the future rates.

The central bank can control the supply of currencies in an economy, therefore the central bank's monetary policy is of first order of importance for the behaviour of exchange rates.

Market participants hold different types of currencies depending on the expected returns. These participants change their currency portfolios according to differences in returns and this currency substitution has an impact on the exchange rate.

There is inefficiency in the foreign exchange market. This entails that the prevailing exchange rates are not a result of full available information and there are opportunities for some participants to make extraordinary profits.

Exchange rates play a vital role in responding to changes in real economic conditions. Changes in exchange rates indicate innovations in the trade balance which convey new information that changes the market's beliefs concerning the present and future behaviour of the real economic factors that ultimately determine the behaviour of the trade balance and the equilibrium relative price of one country are output in terms of the outputs of other countries.

Mussa argued that exchange rates could provide a very useful indicator of monetary policy in the place of market interest rates in that a policy that links positive changes in the domestic money supply to positive changes in the foreign exchange value of domestic money ought to offset fluctuations in the demand to hold domestic money.

One principal channel that pure central bank foreign exchange market intervention can impact on the exchange rate is influencing the expectations of non-official economic agents over the likely future behaviour of exchange rates. The effect of expectation may stem from intervention itself or from information that such intervention provides concerning the likely future behaviour of monetary and exchange rate policies.

However, this effect on exchange rates is only in the short run and not in the long –run.

Market participants are influenced by bandwagon effects that may culminate into volatility of the exchange rate

The central bank has control over money supply and has knowledge about its future monetary policy which market participants do not have. The central bank therefore may intervene in the foreign exchange market to guide the behaviour of exchange rates in line with its long-run monetary policy. There is a moral hazard in intervention in that market participants will not always believe that central bank pronouncements about future policy and will undertake measures that minimize their risk. Through sterilized intervention, the central bank signals future monetary policy, the market by observing this intervention expands its information set and changes its expectations of the existing and future exchange rates. When the participants revise their expectations of future fundamentals, they also revise their expectations of future spot exchange rates which in turn changes the existing exchange rate. If the central bank intervenes by buying the domestic currency, market participants will change their perceptions about future monetary policy and anticipate a tighter monetary policy in the future. This will translate consequently in the appreciation of the local currency.

2.1.6 THE ORDER FLOW (MICROSTRUCTURE) CHANNEL

The contradiction between the traditional macroeconomic approach to exchange rate determination and reality obtaining in foreign exchange markets led to a growing interest in the market microstructure.

According to this model, a more realistic description of the foreign exchange market microstructure is obtained by relaxing the assumption of identical agents, perfect information or costless trading and identifying the economic effects of the organisation of foreign exchange market. The market microstructure might help sort out some of the empirical problems of conventional models discussed earlier.

In a ground breaking work on this model, Bacchetta and Van Wincoop (2006) were worried about the poor explanatory power of exchange rate determination theories. They therefore set about to provide an alternative model which could help resolve the exchange rate puzzle.

ASSUMPTIONS

- Market participants are heterogeneous. This comes about in that there are different investors who differ in terms of information about future macroeconomic fundamentals and have different exchange rate risk exposure associated with non-asset income.
- Some information relevant to exchange rates is not publicly available.
- There are differences in the trade mechanisms affected prices.
- A small amount of hedge trades can become the dominant source of exchange volatility when information is heterogeneous while there is no impact when investors have common information.

SHORT RUN

This heterogeneity disconnects the exchange rate from observed fundamentals in the short run. Secondly, there is a close relationship between the exchange rate and order flow over all time horizons. Rational confusion plays a vital role in the disconnection process. Investors are not sure whether the increase in the exchange rate is brought about by an improvement in average private signals about future fundamentals or an increase in unobserved hedge trades have an amplified effect on the exchange rate given that they are confused with changes in average private signals about future fundamentals.

LONG RUN

In the long run rational confusion disappears and investors learn about future fundamentals and so there is a close link between the exchange rate and the observed fundamentals. The impact of unobserved hedge trades on the equilibrium price will therefore gradually weaken culminating to a closer long –run relationship between the exchange rate and observed fundamentals.

$\Delta P = g(X, I, Z)$.....2.7

Where ΔP is the change in the nominal exchange rate between two transactions.

X is the order flow

I is the inventory cost

Z is the other micro determinants.

According to the above equation (2.7) customers learn about fundamentals from direct sources, which they use to impact on order flow and then dealers learn about fundamentals from the behaviour of order flows. Eventually, this affects the trading process and finally the price.

2.2 EMPIRICAL REVIEW

Central banks have been intervening in the foreign exchange market ever since the early 1970s. The practice that initially started with the G-5 countries has now spread all over the world and while developed countries rarely intervene in their foreign exchange markets, developing and emerging market economies have pushed up their levers in as far as the practice of intervention is concerned. The key question that has always been asked is whether this intervention does intend achieve its objectives of reversing trends or reducing currency volatility. This question has been empirically tested over the years and therefore there exists a large body of knowledge on the topic.

The empirical results produced my concerned studies have been mixed. Some studies have produced evidence that intervention has an impact on both the level and volatility of the exchange rate while others have found that intervention is actually ineffective.

This chapter provides a critical review of these studies.

One of the very first studies on the effectiveness of central bank intervention on exchange rates came through a report of a study commissioned by the G7 economic summit at Versailles in 1982. The Jurgensen Report (1983) concluded that intervention effects were very small and only occurred in the short-run.

Another study by Bordo and Schwartz (1991) agreed with the Jurgensen Report. They tested the portfolio balance channel by calculating standard deviations of the daily United States dollar ($) / Germany mark (M) as well as the $/ Japanese yen (Y) exchange rates. They found that there was no evidence that intervention worked and the study concluded that intervention only increased foreign exchange market uncertainty.

Therefore, the consensus among policy makers and academics during that time was that intervention was ineffective and if at all it was its effects were only in the short-run.

The major problem with these early studies was that the researchers did not use real high frequency intervention data provided by central banks. During this period central banks were very secretive in their intervention operations and so they did not release their intervention data to researchers or indeed the market. So most researchers instead, used proxies of various kinds as intervention variables. Expectedly therefore their results were not really reliable. Bordo and Schwart's methodology of standard deviation is not a very good econometric model and as such its estimates are likely to be biased and inefficient.

Sarno and Taylor (2001) reviewed the various channels of intervention and the empirical studies that had been done in the area of central bank intervention. They opined that due to poor quality of data in the early studies conducted in the 1980s; most empirical studies indicated that intervention was ineffective.

On the other hand in the 1990s the veil of secrecy was removed and central banks became more open and transparent: they released intervention data to the market on a regular and timely basis. Studies done in this dispensation seem to suggest that central bank intervention is effective.

A number of studies were undertaken to test the signalling channel hypothesis and most of them concluded that there was evidence that intervention affected the exchange rate through this channel.

In this regard, Dominguez (1990) examined 3G central banks' foreign exchange interventions operations. She studied intervention activities of the 3G countries namely the United States of America (U.S.A), Germany and Japan for the period from 1985 to 1987. Her aim was to establish whether or not unilateral and coordinated intervention operations influenced market operations. She used newspaper accounts of intervention to develop an ex-post excess returns model under the framework of the signalling channel hypothesis. She defined ex-post excess returns as the realised return that market participants made by borrowing from one institution and lending to

another. Intervention was construed to signify conveyance of central bank credible inside information to the market about future monetary policy. The study found that coordinated intervention operations consistently impacted on the longer term market expectations. However, the results were mixed in as far as unilateral interventions by the Federal Reserve and the Bundesbank on influencing ex post excess returns was concerned. The evidence presented indicated that market participants were overall able to observe the source and size of intervention and this had a significant economic and statistical effect on market expectations.

The above findings are supported by another study conducted by Dominguez (1998) herself. She again used the signalling channel to examine the impact of central bank's intervention on daily and short –term behaviour of exchange rate volatility. Her sample period ranged from 1977 to 1994 and included the U.S.A, Germany and Japan. Using data from the three central banks in relation to $/Y and $/M markets, she constructed a GARCH conditional variance model to measure ex-post daily and weekly volatility. Her results were quite robust and fundamentally her GARCH parameters were highly significant. The study revealed that for the mid 1980 sub period, for example, for both the dollar –mark and dollar –yen, central banks' interventions reduced volatility and the Bundesbank interventions overall reduced dollar-mark and dollar –yen volatility during the sample period. The study also brought out a very important fact that intervention need not be publicly announced for it to be effective. Secret intervention was also effective in calming volatility.

Another set of researchers namely Kaminsky and Lewis (1996) also lent support to the efficacy of the intervention through the signalling channel. They examined the signalling channel hypothesis to test whether or not the Federal Reserve's intervention activities implied changes in future monetary policy. They also examined the effect of intervention on the exchange rate. Using data on market observations from the financial press of foreign exchange rate intervention by the Fed for the period September 1985 to February 1990 and testing whether or not intervention provided no information about future policy, the duo found that intervention provided significant information about future changes in monetary policy.

However, the results conflicted with the traditional signalling hypothesis in that despite intervention providing significant information about future policy, most of the information came from interventions to sell the $ that were followed by tight monetary policy. Further, evidence showed that major movements in the exchange rates occurred after interventions depended on whether the interventions were consistent with future monetary policy. This sample dependent evidence emanated from the sample dependent nature of monetary and intervention policy. Therefore during periods when intervention was perceived to be consistent with the direction of future monetary policy, the results of intervention were effective while in other periods it was not. All in all intervention did signal future monetary policy though on a number of occasions this signal was in the opposite direction

Fatum and Hutchison (1999B) slightly differed with the work of Dominguez, Kaminsky and Lewis. They used an event study methodology to assess the Germany's Bundesbank and Federal Reserve bank's intervention operations in the foreign exchange market on the M/$. They covered the period from 1st September 1985 to 31st December 1995. They contended that intervention affected the exchange rate only in the short run. They however, did agree that there was evidence that intervention signalled future monetary policy.

The major weakness in the methodology employed by Fatum and Hutchison is that it did not allow for a specific channel of intervention and they interpreted their results to mean there was a signalling of future monetary policy. The other weakness of the event study methodology is that the problem of endogeneity. This arises since central banks take the decision to intervene on the basis of observed exchange rate trends.

Neely (2005) raised very important concerns over the event study methodology that most researchers including Fatum and Hutchison, Domingeuz and Frankel (1993) had employed in examining the impact of intervention on exchange rates. He stated that to establish the effect

of intervention on the exchange rate, researchers ought to consider how all variables that affect exchange rates and intervention interact. Most of these studies employing the event study were plagued with simultaneity bias. Estimates of β were inconsistent because intervention was related with the error term.

He concluded by saying that even nonparametric event studies were still subject to all the econometric problems that beset more conventional econometric procedures. To improve the event study methodology where inferring of structural effects is concerned, researchers were supposed to lay fairly strong conditions.

Fatum and Hutchison (1999A) contradicted the studies that had supported the signalling channel hypothesis. This particular study investigated the linkages between U.S. daily intervention operations and the expected changes in future monetary policy. To do this they used the time varying GARCH methodology and the sample period was 27th March 1989 to 31st December 1993. They used daily Federal Reserve data on sales and purchases of currencies and investigated whether this affected the Federal Funds Futures Rate. They found that intervention did not convey a clear signal about future monetary policy. Therefore the signalling story was not very clear and further that intervention led to greater monetary uncertainty.

Kim et al (2000) used the Exponential GARCH methodology to study the effectiveness of the Reserve Bank of Australia's intervention of the United States Dollar/ Australian Dollar exchange rate. Studying intervention activities for the period 1983- 1997, they found that RBA intervention had some success as there was evidence of a stabilising influence on the exchange rate. In particular, purchases of the Australian dollar tended to strengthen the currency and reduced its volatility.

Aguilar and Nydahl (2000) the Swedish's Riksbank's foreign exchange market interventions for the period between January 1993 – 1996. They used actual daily data from the central bank to

estimate a GARCH model and implied volatilities from currency options. They were examining the krona/mark and krona/USD exchange rates. The results were mixed. They found that the interventions depreciated the krona though the magnitude was small. Secondly, the effects of interventions on volatility were not significant and the estimated coefficients of the intervention variable were negative. However, for the 1995 and 1996 intervention had significant effects on the krona/mark and krona/usd exchange rates. For the whole period no significant effect of intervention was found.

A number of studies were also conducted to test the microstructure channel of intervention.

Dominguez (2003A) examined the effectiveness of central bank intervention in relation to the state of the market under the auspices of the market microstructure channel at the time of intervention. To do this she used Reuters intra-daily data in the $-Mark and $-Yen markets of the 3G's intervention activities (U.S., Germany and Japan). The study covered the 1987-1995 time period.

Using the event study approach her empirical results indicated that Federal Reserve (Fed) intervention activities significantly affected both the $-Mark and $-Yen intra-day returns and volatility and these effects persisted at least to the end of the day. There was also evidence that Fed interventions that occurred when the US and European markets were open had larger effects than those that took place at other times. In terms of the state of the market at the time of intervention, the study supported the hypothesis that the effectiveness of central bank intervention depended on the state of the market. All in all there was evidence that central bank interventions influenced intra daily foreign exchange volatility.

Again as pointed out by Neely (2005) Dominguez's event study methodology employed in this study is also subject to the same criticism of simultaneity bias and therefore the conclusions drawn are not as robust as they are suggested.

Another of her studies Dominguez (2003B) of the foreign exchange intervention activities of the 3G central banks from 1990 to 2002 supported her earlier contention that intervention is effective. This time her focus was both on the very short term and long term impacts of intervention episodes. She found that the Fed's dollar purchases during 1992 to 1995 resulted in the M/$ rate coming down while the $ did rise. She also found evidence which was suggesting that oordinated interventions proved to be very successful as the Euro appreciated by 2 percentage points and the intervention effects lasted longer than forty eight hours.

Further, Dominguez (2006) analysed the influence of interventions on exchange rate volatility. She studied the United States of America's (Federal Reserve Bank) activities in the deusmark-dollar and Japanese yen/ dollar foreign market from August August 1989 to August 1995. Her study used the microstructure approach developed by Bacchetta and Van Wincoop (2006). Her main focus was to try to explain short term currency movements which conventiononal exchange rate models had failed to explain.

She used intra day FX FX Reuters data to construct an event study methodology to study the impact of central bank interventions. Her results pointed to the fact that intervention by the three banks influenced volatility up to 1 hour before the Reuters announcement. The results also showed that public announcements by the Federal Reserve Bank that it was going to intervene also significantly impacted on volatility. Her coefficients on intervention were positive which demonstrated that in the short –run central bank interventions were linked to increases in volatility. These short run effects were as a result of the heterogeneity of market participants in terms of accessing information which is in line with the postulates of the microstructure theory. She found that in the long run however, central bank interventions had no effect because in that time horizon information had been acquired by all market participants and consequently volatility returned to its pre –intervention level.

Beine, Benassy- Quere and Lecourt (2002) assessed the effects of the U.S, Germany and Japanese central banks' intervention on the evolution and volatility of the daily M/$ and Y/$ exchange rates. They covered the 1985 to1995 time period and used the FIGARCH methodology as a measure of volatility. They found that central bank interventions had a significant impact on the conditional mean of the exchange rate variations though net purchases of currencies were associated with subsequent depreciation of the currencies. This finding was in line with findings of previous studies by Almekinders and Eijffiner (1993) and others. This meant that what actually happened was leaning –against –the wind. Evidence showed that intervention increased volatility across all the three banks over some sub –periods which supported the microstructure channel where market participants test the central bank's determination after an intervention activity.

The study also lent support to the effectiveness of secret interventions in effecting exchange rate variations. In contrast reported interventions increased volatility of the exchange rates. Coordinated interventions, like purchase of the $, was significantly associated with the following $ depreciation and was more powerful in influencing the exchange rates than individualised interventions. Overall, the study concluded that publicly reported interventions moved the market in albeit in the wrong direction and like many other studies discovered, intervention was found to increase volatility in the short –run.

The portfolio balance channel was put to a number of empirical tests and the results were also quite encouraging.

Dominguez and Frankel (1993B) investigated the impact of central bank intervention using the portfolio balance channel. They covered a period of 6 years (1982-1988) and studied the intervention activities of the fed, Bundesbank and Switzerland National Bank. They abandoned the conventional portfolio balance specification and instead used an alternative method that used 4 –week ahead survey forecasts from Money Market Services. Their model was based on instrumental variables so as to avoid the simultaneity bias and other econometric estimation

difficulties. The coefficients on intervention were overall statistically significant. Therefore the effects of central bank intervention on the exchange rate the portfolio channel were effective.

Supporting the above study ,Eijffringer (1998) studied the $ in relation to exchange rates of the Working Group countries (Germany, Japan, Canada, France and Italy) from 2nd January 1978 to 30th July 1982. Using the additive decomposition of time-series methodology, his main interest was to establish whether intervention by a single central bank in the Group had the same impact relative to joint intervention. Though his results were mixed, there was evidence that sterilized intervention did affect the exchange rate through the portfolio balance channel. He also found evidence that joint/coordinated intervention was more effective than a single country's intervention.

Frenkel and Pierdzioch (2005) examined the effects of the Bank of Japan (BOJ) intervention of the Y/$ volatility for the 1993-2000 period. One remarkable difference between this study and others was that the data used was official data obtained from the BOJ while the previous studies had used inaccurate reports contained in the financial press. They used volatilities implicit in foreign currency options as a measure of volatility and used a model similar to Dominguez (1998) and Tanner (1996). They found that there was a statistically significant positive link between the interventions and the yen/$ volatility. The study also revealed that the mere presence of the BOJ in the foreign exchange market contributed to the exchange rate volatility. Concerning empirical tests on the effect of expected exchange rate volatility and press reports of BOJ intervention, their results demonstrated that interventions that were done secretly and therefore not reported in the press were positively correlated with exchange rate volatility.

A number of studies have revealed that central bank intervention does not actually calm volatility but instead it increases the volatility behaviour of exchange rates.

A study conducted by Bonser-Neal (1996) like many others testify to this fact. Bonser-Neal used options data from the Philadelphia Stock Exchange for the period 1985 to 1991 to study volatility of the M/$ and Y/$ in response to central bank intervention and other economic variables. Her study measured exchange volatility using implied volatility derived from foreign currency options. Her model was built around two equations which she estimated using data from the Bundesbank and Federal Reserve. During the sample period there was no evidence that central bank intervention reduced exchange rate volatility rather that volatility actually increased. However, during the post-Louvre period intervention decreased volatility to some degree though generally the result was that it had no effect. Her results pointed to the different effects of intervention during different sub –periods. The M/$ and Y/$ volatility increased during the Louvre period but decreased in the subsequent period.

Humpage (1999) used the logit model to study the Federal Reserve Bank of New York's intervention operations against the mark and yen from 18th February 1987 to 23rd February 1990. His empirical results suggested that the U.S. intervention successfully leaned against the wind in that the depreciation of the $ was reversed. His results also suggested that coordinated intervention was more successful at affecting the exchange rate than uncoordinated intervention.

Another study that supported the portfolio balance channel was done by Ghosh (1992). He used monthly data from 1980 -1988 to examine the effectiveness of the Federal Reserve intervention activities on the $ -M exchange rate. He controlled for signalling and discovered that the coefficients for the portfolio balance variables were significant. He therefore concluded that there was some evidence that the portfolio balance channel was an effective channel for intervention. However, he put a proviso that for intervention to be effective the magnitude of

intervention needed to be high. His example was that about $13 billion of intervention was required to move the $/M exchange rate by 0.15 t 0.35 per cent.

Despite the encouraging results obtained by the above –mentioned studies Sarno and Taylor (2001) revealed that these studies that tested the portfolio balance channel faced number insurmountable problems. They pointed out that translating the theoretical framework of the channel in real financial terms was very difficult. This made the portfolio balance channel less attractive to the signalling channels and consequently PBC was going to be abandoned to the backyard while the signalling channel would become more prominent. However, they did point out that on a general level evidence on intervention was mixed though in the recent past most researches were beginning to suggest that intervention had some effect on both the level and volatility of the exchange rates establish

Literature on the impact of central bank intervention on the exchange rate has recently recognized that emerging market economies are intervening more in foreign exchange rate markets than developed countries. There is also some evidence which seems to suggest that intervention is more effective in former countries than former ones. This is mainly due to the structural differences that exist between these economies. Financial sectors in emerging economies are underdeveloped and thin therefore central bank intervention is bound to have a significant impact on the overall foreign exchange market.

It should also be pointed out that because of the nature of foreign exchange markets in these emerging markets it is very difficult to identify a single channel that could be used to study central bank intervention and let alone explicitly identify as a channel through which intervention affected the exchange rate. Therefore, most studies are of a general nature.

One emerging market economies study was done by Edison, Cashin and Liang (2003). They examined intervention activities of the Reserve Bank of Australia (RBA) from January 1984 – December 2001 to try to see the effect of intervention on the level and volatility of the exchange rate. They used the event study methodology and the GARCH to study the impact on the level and volatility respectively. They found that intervention did not consistently influence the level of the exchange rate but it was successful in reversing a trend. Concerning volatility, the evidence suggested that the RBA was successful in smoothing the exchange rate.

This evidence contradicts the majority of studies conducted in developed countries and highlighted above which seem to suggest that central bank intervention actually increases exchange rate volatility. This result from Edison et al is very pertinent to the subject of this paper in that Zambia is also a developing country. Therefore, we expect to find evidence that intervention will reduce volatility.

Another developing country study was by Disyatat and Galati (2005). The duo studied the impact of the Czech National Bank (CNB)'s intervention operations on level, volatility and rock reversal of the koruna/euro exchange rate from 2001-2002. Their results indicated that intervention had some effects albeit weakly statistically significant impact on the exchange rate but there was no evidence that intervention had influence on short –term exchange volatility. These results supported assertions that the portfolio balance and microstructure channels were more potent in emerging market economies than industrial ones.

Again, Domac and Mendoza(2004) used the Exponential GARCH to study the efficacy of the Turkish and Mexican central bank interventions on the $/peso and $/Lira exchange rates for the periods 1st August 1996- 29th June 2001 (Mexico) and 22nd February 2001 and 30th May 2002 respectively. The evidence from the study suggested that overall intervention had a highly

significant impact on the exchange rates. The mere presence of central bank in the foreign exchange market also had an impact on the exchange rate.

This evidence tarries with evidence adduced in studies done in developed countries it appears to suggest that perhaps signalling and the microstructure channels are also relevant for developing countries.

There is very little that has been done in terms of empirical studies in Zambia. The only study was done by Simatele (2004). She used GARCH (1, 1) to investigate whether or not the Bank of Zambia's intervention activities from 1997-2003 had any influence on the k/$ exchange rate. Her evidence showed that cumulative intervention led to a depreciation of the exchange rate but it reduced volatility of the exchange rate. In this regard, the BOZ was successful its objective of smoothing kwacha volatilities.

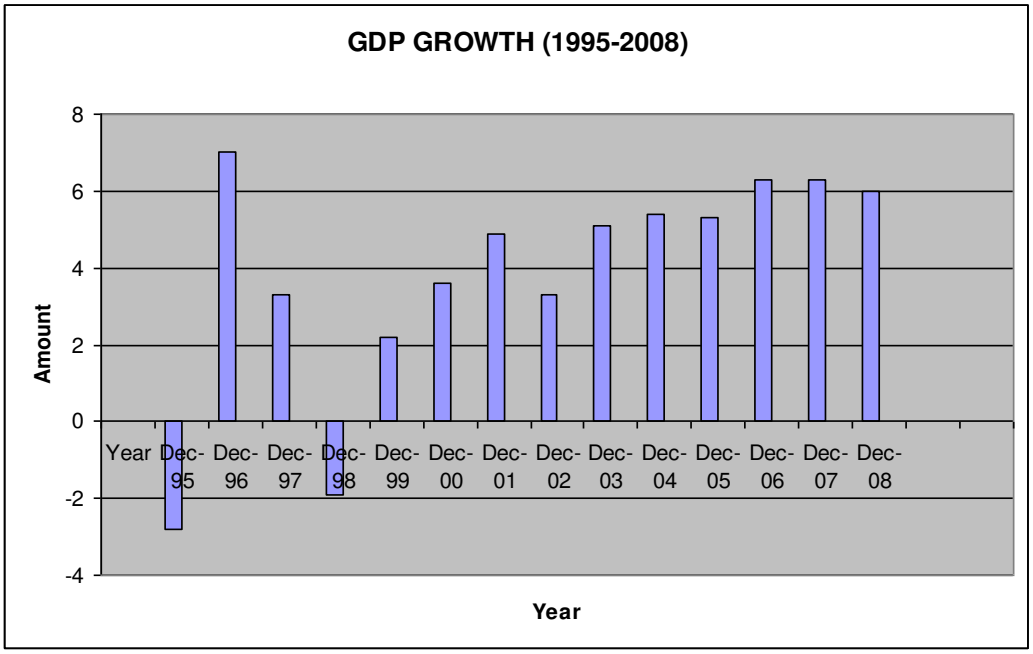
CHAPTER 3: EXCHANGE RATE POLICY IN ZAMBIA

3.1 BACKGROUND

Zambia is a landlocked country located in Sub –Saharan Africa and with an area of around 752,618 kms. The country's main economic mainstay since gaining independence from Great Britain on 24th October 1964 has been export of copper and other minerals. This is also the main source of foreign exchange for the country. The population has been growing at around 2.1 % annually and at the end of 2008 it was estimated to be around 12.450 million.

As figure 3.1 shows the economy has been recovering from negative growth of -2.82 in 1995 to 6.02% in 2008. The main drivers for this relatively high growth rate are partially attributed to the high production and export of minerals as a result of the general high metal prices during the boom period.

Figure 2: GDP GROWTH RATE IN ZAMBIA 1995- 2008

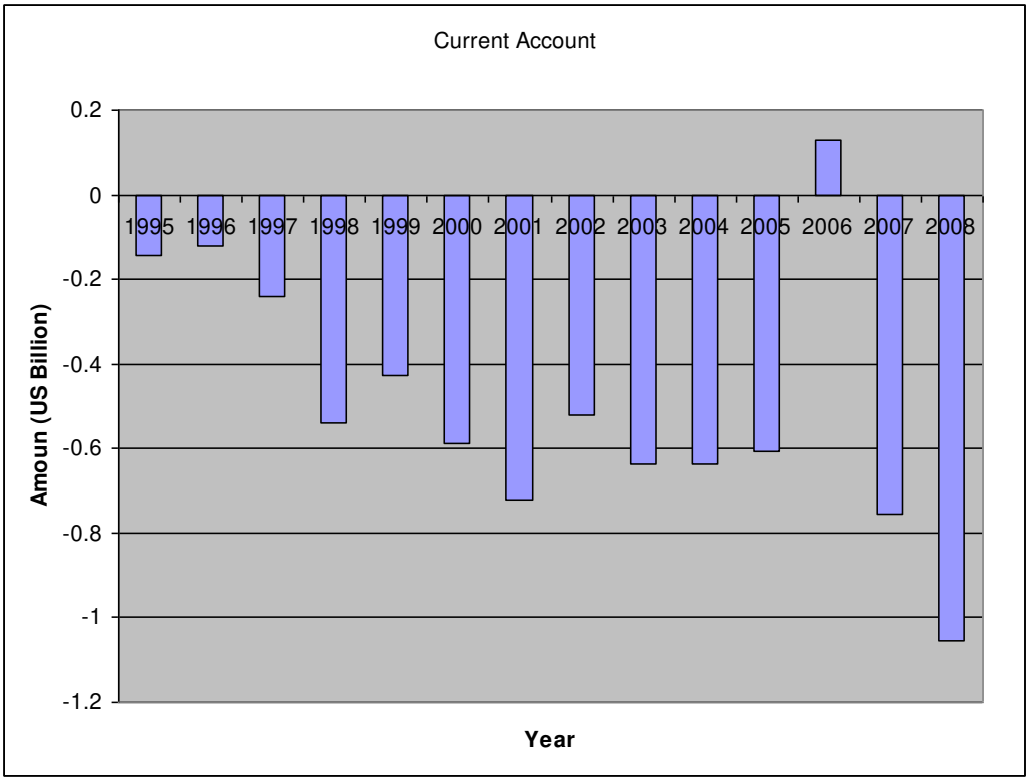


Despite this impressive Gross Domestic Product (G.D.P) growth rates, the country's current account has remained in deficit. As can be seen from Figure 3.2 from 1995 to 2008 the country has recorded negative figures. In 1995 the current account deficit was $ 0.145 billion. In 2008 it

was $1.054 billion. Purchasing Power Parity (PPP) GDP has however, being increasing over the years. In 1995 it was £7.59 billion while it rose to $10.68billion in 2002 and in 2008 it was around $17.423 billion.

Consumer Price Index (CPI) inflation too has been relatively high. In 1995 it was 45.98%, though it started declining after that. It dropped by almost 10% the following year. In 2007 it reduced to a record low of 8.9% but it went up the following year to 16.6%.

Figure 3: ZAMBIA CURRENT ACCOUNT POSITION (1995-2008)



3.2. AN ACCOUNT OF FOREIGN EXCHANGE REGIMES IN ZAMBIA

1964 -1985: Fixed Exchange System

From independence the official currency in Zambia was the Zambian pound which was administratively pegged to the British pound and was fully convertible. On 16th January 1968, the official currency was changed to the kwacha and was pegged to the British pound sterling until 3rd December 1971 when it linked to the US dollar at the rate of K0.714/USD. This represented a devaluation given the kwacha's appreciation against the dollar following a de factor devaluation of the $ unit on 15th August 1971.

On 8th July 1976, ties with the $ were severed and the kwacha was linked to the special drawing rights (SDR) at SDR1.08479. However, this peg lasted only up To 6th July 1983. After that a crawling peg based on a basket of currencies of five major trading partners of Zambia was introduced. Under that arrangement, the kwacha was allowed to adjust but within a narrow range.

1985 -1987: Auctioning System

In October 1985, an auctioning system based on marginal bid was introduced as a way of determining the exchange rate and allocating foreign exchange due to declining copper revenues and a mounting external debt. The spot exchange rate was K2.2/$ reaching K5.01 in the first weekly auction and 11th October 1986 it was at K8.30. During this system the kwacha depreciated by 86%. On 2nd August 1986 a 'Dutch Auction' replaced the auction system and BOZ increased the amount of foreign exchange. However, this system was short-lived and it was suspended in January 1987 when the spot rate increased (depreciated) to a K15/$ level, after which the exchange rate system reverted to the fixed regime of the past.

1987- 1991: Two-Tier System (Fixed and flexible Systems)

In April 1987, the monetary authorities introduced a two-tier system. The first tier which was an administratively determined rate was used for official transactions and while a flexible exchange rate system (auction system) was used for the remainder of transactions. Due to a drastic depreciation of the second tier kwacha exchange rate(K40/$), the auctioning system was abandoned in May 1987 and replaced by a fixed exchange rate system administered by the Foreign Exchange Management Committee (FEMAC). The exchange rate was then set to K9/$. In 1990 the FEMAC was restructured and an Open General License (OGL) system introduced. A dual exchange rate system comprising the official and unofficial (retail and OGL) windows was adopted and managed by FEMAC. The exchange rate on the official window was lower than the black market one.

In October 1991, a new party the Movement for Multiparty Democracy (MMD) won presidential elections on the platform of a shift from socialism orientation that the previous government had been leaning towards to a capitalist and neo liberal pragmatic orientation. This new government therefore embarked on a number of economic and financial reforms which included the management of the exchange rate system. As a result, due to the economic liberalisation agenda, the OGL, retail and the official windows were unified as a precursor to full liberalisation the foreign exchange market and exchange rate regime.

1992 – 2008: Flexible Exchange Rate

In 1992, the OGL list was expanded but was later abolished in December 1994 when the Exchange Control Act was repealed. In January 1994 kwacha became fully convertible. Other notable changes were the introduction of bureaux de change system and elimination of capital controls. In 1995 commercial banks were also allowed to maintain foreign exchange accounts.
As a way of determining the exchange rate, a dealing system was put into place. This is a broad

based market determined foreign exchange interbank market and has been operational since mid-July 2003. The official rate is now the average of the rates of the major players in the interbank market who include commercial banks and bureau de changes. The system allows commercial banks to buy and sell foreign exchange from the central bank. The Bank of Zambia determines the official exchange rates through an auction held at the Bank whereas commercial banks determine their inter-bank and customer (retail and corporate) rates prevailing in the market based on the cost of acquisition of their foreign exchange. Though individual financial institutions decide on the appropriate exchange rates to use for particular transactions, it is the Bank of Zambia's responsibility to ensure the publication and dissemination of average exchange rates of financial institutions and those prevailing at the Bank of Zambia.

The official exchange rate is determined by the dealing's weighted average exchange rate. The BOZ buying rate is the simple average of the primary dealers low bid rates while the selling rate is the simple average of the primary dealers high offer rates. The International Monetary Fund (IMF) Zambian Country Report (2008) described the Zambia's exchange regime has been a managed float which was broadly in line with the macroeconomic fundamentals.
The BOZ was said to be committed to a flexible exchange system though it would intervene from time to time to smooth fluctuations in the kwacha.

The current (May 2009) k/$ exchange has increased to around K5, 300.

3.4 PARALLEL FOREIGN EXCHANGE BLACK MARKET.

Zambia has over the years experienced a thriving a parallel black foreign exchange market. This market has existed side by side with the official foreign exchange rate market.

The main reason for the emergence and blossoming of the parallel market was the macroeconomic regimes of the post –independence era and the many policy reversals that were undertaken by the former government. Price controls had been undertaken from independence to agricultural goods and other essential commodities. Interest rates were also controlled for a considerable period of time until they became negative. The collapse of the copper prices and the early 1970s oil crises also fuelled a deterioration of Zambia's terms of trade. As a result of the restrictions on trade and foreign exchange, the sad phenomenon of misinvoicing ensued.

These restrictions culminated into excess demand for foreign exchange leading to significant profit opportunities and growth of the black market. Some importers over-invoiced their imports in order to obtain extra currency which they sold at the black market for a profit.

From the early 1980s, the country witnessed unprecedented illegal mining and export of emeralds. The foreign exchange earned through these illegal exports found its way into the black market.

According to Aron and Elbadawi (1992) the overvalued exchange rate and foreign exchange controls created excess demand for the parallel foreign exchange market to flourish. The black market premium which is the ratio of the black market rate to the official rate was around 100% in the 1970 and by the early 1990s it was around 400%. The premium declined quickly and remarkably when the auction system was introduced from 68% in 1985 to 31% in 1986. However, in 1988 when the auction was suspended the premium soared to 418%.

The constant devaluation of the kwacha fuelled the growth of the black market in that economic agents always expected that the kwacha would further be devalued and government would abandon its monetary and fiscal policies.

As a matter of fact Aron and Elbadawi point out 'the perceived incredibility or unsustainability of the auction program especially during 1985 and the following two years had a hand in the failures of the crawling peg and the auction regimes and the ultimate collapse of the economic program in 1987'

Currently, because of the removal of controls, the liberalisation of trade and the introduction of a flexible exchange rate regime, the premium has tumbled down quite markedly though the black market is still an active part of the foreign exchange market in Zambia.

CHAPTER 4 DATA AND METHODOLOGY

4.1 DATA DESCRIPTION

The exchange rate data used in this study are monthly average mid quotes expressed as Zambian kwacha (K)/United States Dollar ($), so that a rise in the exchange rate is a depreciation of the K. Official intervention is defined as a sale (positive) or purchase (negative) of foreign assets in the foreign exchange market measured in $ in logs. Monthly exchange rate returns are calculated by taking the log difference of the K/$.

Both intervention and exchange rate data were sourced from the Bank of Zambia. The exchange rate and intervention data are monthly in frequency and cover the period from January 1995 to December 2008. These data are published on the bank's official website with a month's lag.

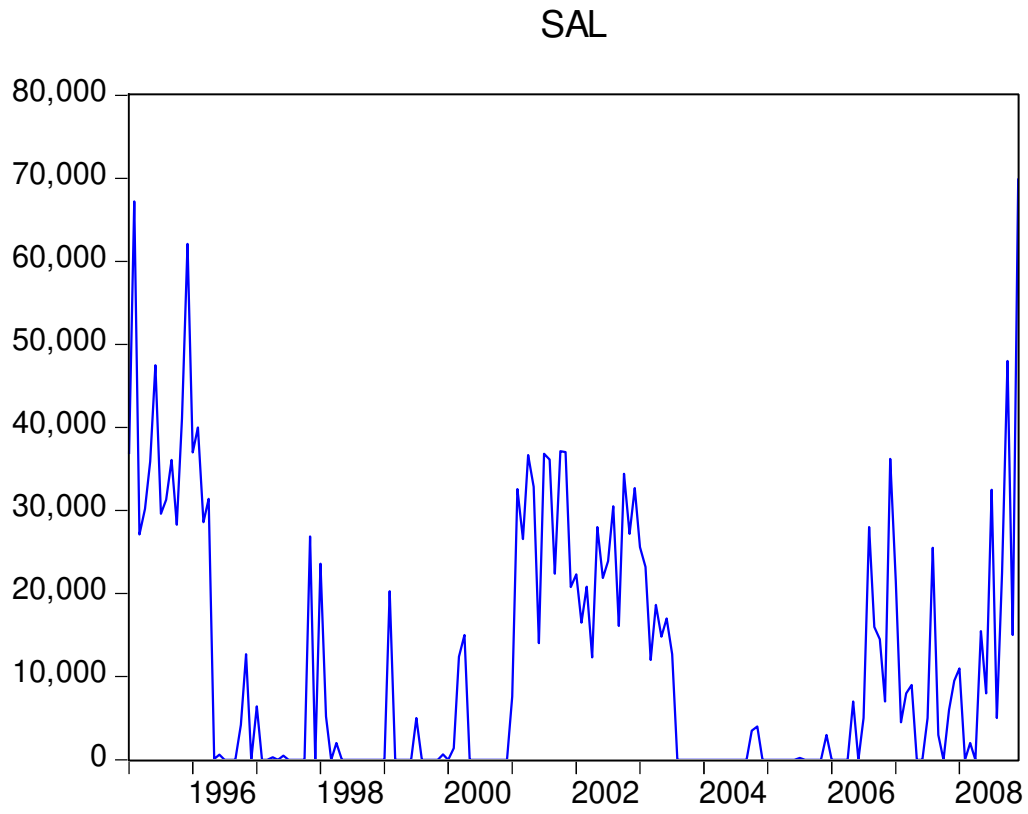
The data suggest an asymmetry in the nature of the BOZ's intervention operations specifically net purchases of $ are more frequent than sales though on average sales transactions tend to be larger. The frequency of intervention is discernibly much lower in the initial period of the sample period.

To test for the unit root in the data we use the Augmented Dickey Fuller (ADF) Test and the results are shown in Tables 1 and 2 in the next chapter. We could not reject the null hypothesis that exchange rate was non stationary at level. However, exchange rate series became stationary at first difference meaning it was integrated to order 1. The purchases data series were stationary but the sales data series were non stationary and integrated to order 1.

From 1995 to 2008 the BOZ entered the foreign exchange market on 196 occasions. The maximum amount of intervention was $90,800,000 while the minimum was $100,000. Of the 196 occasions, BOZ entered the foreign exchange market 102 (52%) times to purchase the $ and only 94 (48%) times to sell. The total volume of these interventions amounted to $3,021,139,000.40 out of which $1,944,655,000 was sold to and $ 1,076,484.40 was purchased from the foreign exchange market. In 1995 and from 2001 to 2003 the BOZ intervened every month.

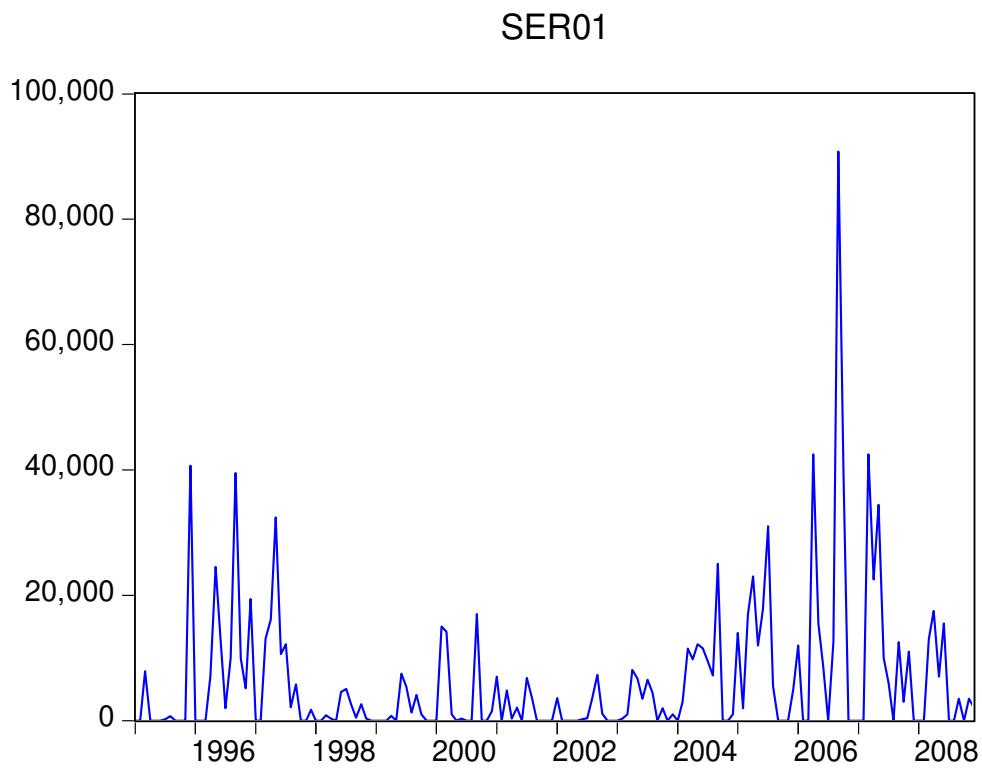
In terms of $ sales the highest volume sold was $70,000,000 in December 2008. The highest annual $ sold was in 1995 when BOZ sold a total of $ 473,200,000.00. The least annual sales occurred in 2005 when BOZ sold a paltry $5000. In terms of monthly sales the lowest was again in2005 where $200 was sold.

Figure 4: BOZ SALES OF USD IN 000 (1995-2008)



In terms of purchases, the BOZ was more active in 2004, 2005, 2006 and 2007. It purchased $90,750,000.40, $ 127,100,000, $220,800,000=00 and $141,908,000=00 from the foreign exchange market respectively. The lowest amount purchased was in 1998 when BOZ purchased $16,365. It is worth noting that in the years when purchases were high, the trend was such that BOZ sold less $ and purchased more $.

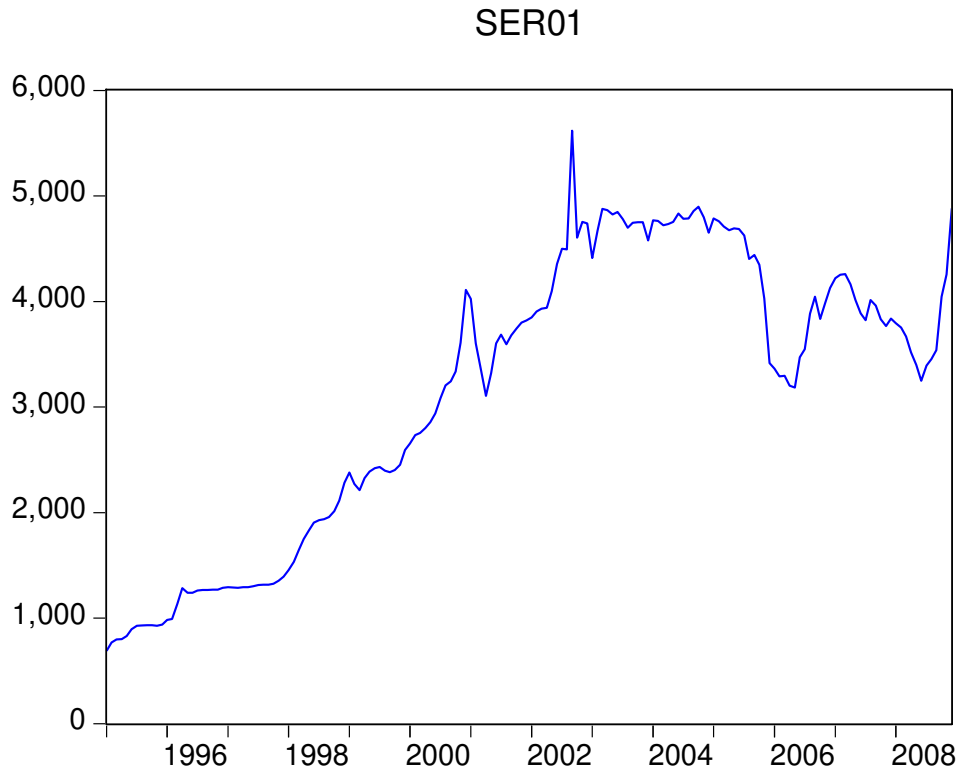
FIGURE 5: BOZ PURCHASES OF USD IN 000 (1995-2008)



The exchange rate trend is depicted by Figure 3. In January 1995, the exchange rate was K688.65/$. This is the lowest in the sample period. Since then the exchange rate has been increasing and by December 1996 it had increased to K1, 287 (86%). At the end of December 2000 it had peaked to K4, 108.75. Thereafter it started to decrease until March 2002 when it started increasing once again. It averaged around K4000 up to September 2002 when it peaked to K5, 619.21.

From then it trended around K4, 600 through to November 2005. In December 2005, it decreased quite significantly to around K3, 400 though this was short lived as it increased in September 2006. It closed at K4, 882.97 in December 2008.

Figure 6: MONTHLY KWACHA AND USD EXCHANGE RATE (1998 -2008)



4.2. METHODOLOGY

The main purpose of this study is to investigate the impact on intervention on both the level and volatility of the K/$ exchange rate.

Volatility can be estimated using time series econometric techniques or market determined option prices. Previous studies have demonstrated that there exists temporal clustering in the variances of the exchange rate changes meaning that large changes are followed by equally large changes while small changes are followed by small changes.

The study will first test for ARCH effects to establish whether or not indeed a GARCH family model is appropriate for these types of data. A test for ARCH effects reveals that we cannot reject the presence of ARCH effects in our data is therefore, the use of GARCH is justified[1]. The results are shown in Table 3.

These have the advantage of estimating the conditional variance in that they give an ex post measure of weekly or daily volatility while the exchange rate options provide ex ante measure of volatility.

This methodology enables us to test the impact of intervention on both the mean and conditional volatility of the exchange rate at the same time by modelling the heteroscedastic errors in our exchange rate equation.

Further, there being no exchange rate options in existence in Zambia, the market determined option prices methodology cannot be used.

However, the study will also use the GARCH (1,1) methodology to so that the estimates obtained can be compared to those obtained from the main methodology of the study namely EGARCH.

[1] Using Eviews we obtained a probability value of 0.000 and use the rule of thumb at 5%level of significance to test the null hypothesis that there were ARCH effects

THE EFFECTS OF BOZ'S INTERVENTION ON THE VOLATILITY OF THE KWACHA

Most central bank's rationale for intervention is the 'calming of disorderly' exchange rate markets. In essence this entails arresting exchange rate volatility.
This study will adopt the Exponential GARCH (EGARCH) methodology proposed by Nelson (1991) and used by Domac and Mendoza (2004) and Kim et al (2000) to model the overall effects of intervention and the individual sales and purchases.

We propose the following process to model exchange rate returns and conditional volatility assuming that the error terms are drawn from a double exponential (DE) distribution:

GARCH models are outperformed by fractionally integrated or long-memory processes and they tend to underestimate the intervention effects in terms of volatility (Beine et al 2002 and Domac and Mendoza 2004).

Further, EGARCH has a number of advantages over the ordinary GARCH models which include the fact that the latter do not account for leverage effects and they imply that the impact of a volatility shock disappears over time at an exponential rate (Beine et al (2002).

Enders (2004) revealed that EGARCH allows for asymmetric effects of shocks. In this case purchases and sales of foreign exchange are supposed to have asymmetric effects on the exchange rate. Unfortunately, GARCH being a symmetric model does not take that into account. Another weakness of GARCH is that it is necessary to ensure that all of the estimated coefficients are positive but EGARCH does not require non negativity constraints.

The E-GARCH allows for the inclusion of negative variables affecting volatility, which, in turn, makes it possible to analyze, the sales and purchases, components of the intervention activities.

$r_t = ø_0 + ø_{sale}\,\text{sale} + ø_{pur}\,\text{purch} + \epsilon_t$

$\epsilon_t \sim DE(0,\sigma^2)$ $\quad \epsilon_t = \epsilon_t \sigma_t \quad \epsilon_t \sim$ iid (0,1)

$\ln(\sigma^2_t) = \omega + \alpha(|\epsilon_{t-1}|) + \gamma(\epsilon_{t-1}) + \beta(\ln(\sigma^2_{t-1}) + \delta\,\text{sale} + \delta_{purch}\,\text{purch}$ 4.1

Where

r_t is equal to $\Delta \ln S_t$ (is the log change in the K/$ exchange rate between period t and t-1)

SALE is BOZ sales of $

PURCH is BOZ purchase of $

γ is a leverage parameter

PURCH will take a value of one when there is a purchase of dollars and zero otherwise, while SALES takes a value of minus one for every sale of dollars.
This will ascertain the effects of BOZ intervention in frequency terms, by studying the response of the variance to the number of times BOZ sells or buys at the same time.

The parameter α in the variance equation resembles the clustering effect showed by GARCH models.

γ allows the variance to respond differently following equal magnitude negative or positive shocks.

Volatility persistence is measured by β under the restriction that the estimate is smaller than one to avoid an explosive behaviour of the variance.

To examine the asymmetric response of the variance to positive and negative innovations, we employ the News Impact Curve (NIC) by Engle and Ng (1993), which is as follows:

$$NIC(\varepsilon_t \mid \sigma_t^2 = \sigma^2) = \begin{cases} A\exp\left(\frac{\alpha\gamma + \alpha}{\sigma}\right) \text{ for } \varepsilon_t > 0 \\ A\exp\left(\frac{\alpha\gamma - \alpha}{\sigma}\right) \text{ for } \varepsilon_t < 0 \end{cases}$$

$$A = \sigma^{2\beta} \exp(w - \alpha\sqrt{2/\pi}) \quad \text{... 4.2}$$

As stated above our GARCH (1, 1) which will be compared with the above EGARCH model is as follows:

$$\Delta \ln S_t = \alpha + \beta \text{Int}_t + \varepsilon_t \quad \text{.....4.3}$$

$$\varepsilon_t \mid \Omega_{t-1} \sim \text{iid}(0, h_t) \quad \text{.....4.4}$$

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 \varepsilon^2_{t-1} + \gamma_2 \mid \text{Int}_t \mid \quad \text{.....4.5}$$

Where $\Delta \ln S_t$ is the log change in the K/$ exchange rate between period t and t-1. (A positive value is an appreciation of the K)

Int_t is the variable that captures BOZ intervention activities.

$\mid \mid$ is the absolute value operator

ε_t is the disturbance term.

Equation 4.3 measures the direct effect of official intervention on the kwacha while equation 4.4 states that the regression residuals will be modelled as a GARCH process. Equation 4.5 describes the conditional variance.

The model parameters will be estimated using the quasi-maximum likelihood approach developed by Bollerslev and Wooldridge (1992) which yields standard errors that are robust to nonnormality in the density function underlying residuals.

According to Brooks (2002) to determine which model is appropriate we will use the Engle and Ng (1993) sign bias test. This test will tell us whether an asymmetric (EGARCH) or symmetric

(GARCH) model is appropriate for our data series. This test is applied to the residuals of a GARCH returns data. It is based on the significance of Φ_1 in the following equation:

$$\mu_t = \Phi_0 + \Phi_1 S^-_{t-1} + \upsilon_t$$

where υ_t is an iid error term. If positive and negative shocks to μ_{t-1} impact differently upon the conditional variance, then Φ_1 will be statistically significant.

Our prior expectation on this score is that sales and purchases will affect the condition variance differently and therefore a model that care of this type of asymmetry, which in our case is EGARCH should be more appropriate.

PRIOR EXPECTATIONS

Our expectation from this study is that BOZ's interventions are effective in reversing the depreciating trend of the kwacha. Further we expect that volatility of the kwacha will increase due to this intervention. As pointed out by Disyatat and Galati(2005) one would expect a priori that foreign exchange intervention in emerging market countries may be more effective because (i) the size of intervention relative to market turnover tends to be larger, (ii) the existence of some form of capital controls limiting access to international capital markets gives central banks in these countries greater leverage in the market, and (iii) the lower level of sophistication of the domestic market along with stringent reporting requirements may endow central banks with a greater informational advantage not only with respect to fundamentals but also aggregate order flows and net open positions of major traders.

CHAPTER 5: RESULTS

This section aims to assess whether Bank of Zambia interventions have any impact on the evolution of the exchange rate and its volatility.

To this end, Tables 5 and 6 report the empirical results obtained from GARCH and EGARCH models respectively. They report central bank intervention effects on the conditional mean and variance.

We however first present the results of our tests for unit root and ARCH effects in our data in Tables 2 reveals that ADF tests for the unit root shows that the exchange rate is nonstationary. After first difference, the exchange rate series does become stationary meaning that the series are integrated to the order 1(See Table 3)

Table 2: ADF TESTS FOR THE EXCHANG RATE (AT LEVEL)

Null Hypothesis: LER has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.838361	0.6816
Test critical values:	1% level	-4.013946	
	5% level	-3.436957	
	10% level	-3.142642	

Table 3: ADF TESTS FOR THE EXCHANGE RATE (FIRST DIFFERENCE)

Null Hypothesis: D(LER) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.89099	0.0000
Test critical values:	1% level	-4.014288	
	5% level	-3.437122	
	10% level	-3.142739	

ARCH tests are reported in Table 4 and stated earlier we could not reject the hypothesis that the series have ARCH effects. This lends support to the use of GARCH and EGARCH models.

Table 4: ARCH TEST

Heteroskedasticity Test: ARCH

F-statistic	56.80550	Prob. F(1,21)	0.0000
Obs*R-squared	16.79221	Prob. Chi-Square(1)	0.0000

Table 5. GARCH ESTIMATION OF THE EXCHANGE RATE.

CONDITION MEAN

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.554223	0.094200	5.883495	0.0000
LS(-1)	0.039685	0.004702	8.439495	0.0000
LSALE	-0.070994	0.010750	-6.603786	0.0000
LPURCH	0.009320	0.004084	2.282072	0.0225
CONDITION VARIANCE				
C	-0.006426	0.003082	-2.085182	0.0371
RESID(-1)^2	1.063364	0.275898	3.854193	0.0001
GARCH(-1)	0.346587	0.093795	3.695174	0.0002
LSALE	0.000636	0.000294	2.166234	0.0303
LPURCH	-0.000165	8.30E-05	-1.985239	0.0471

Table 6. EGARCH ESTIMATION OF THE EXCHANGE RATE

	Coefficient	Std. Error	z-Statistic	Prob.
CONDITIONAL MEAN				
C	0.280694	0.028485	9.854042	0.0000
LS(-1)	0.012793	0.002611	4.899596	0.0000
LSALE	-0.026207	0.001299	-20.18152	0.0000
LPURCH	-0.000938	0.002635	-0.356169	0.7217
CONDITIONAL VARIANCE				
C(5)	-7.916350	3.552413	-2.228443	0.0259
C(6)	0.805065	0.129104	6.235775	0.0000
C(7)	0.135139	0.094117	1.435861	0.1510
C(8)	0.761937	0.077636	9.814174	0.0000
C(9)	0.689722	0.375028	1.839121	0.0659
C(10)	-0.292876	0.164917	-1.775899	0.0757

Figure 7: GARCH CONDITION VARIANCE

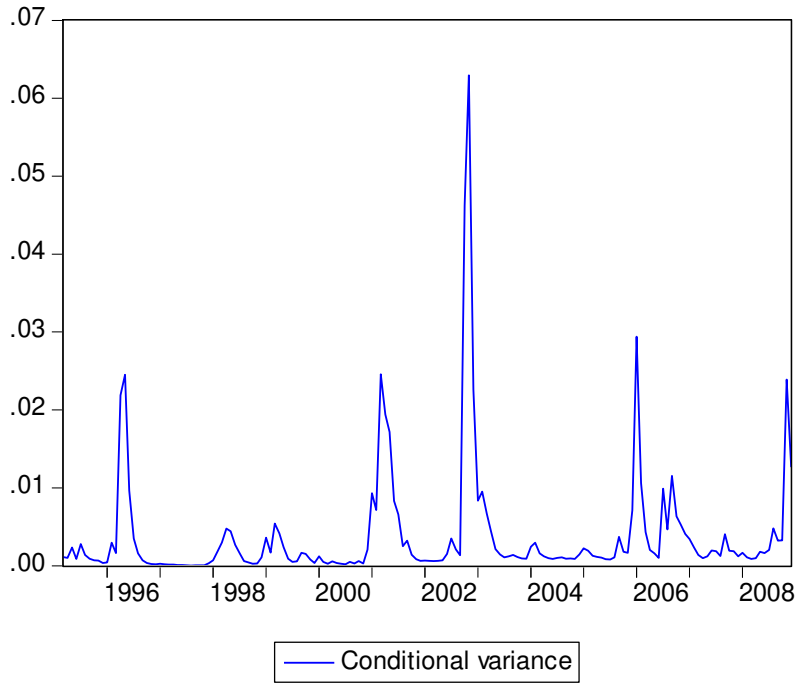


Figure 8: EGARCH CONDITION VARIANCE

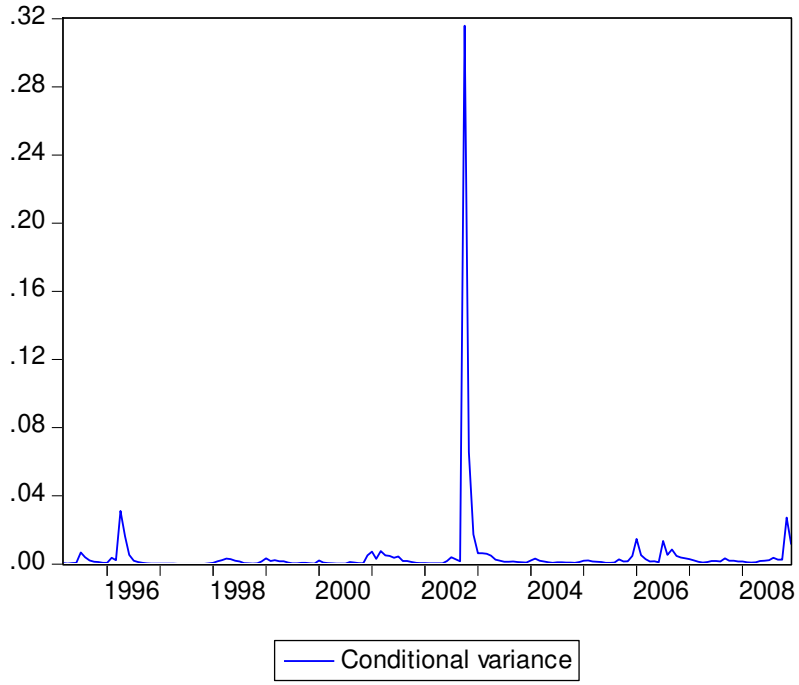
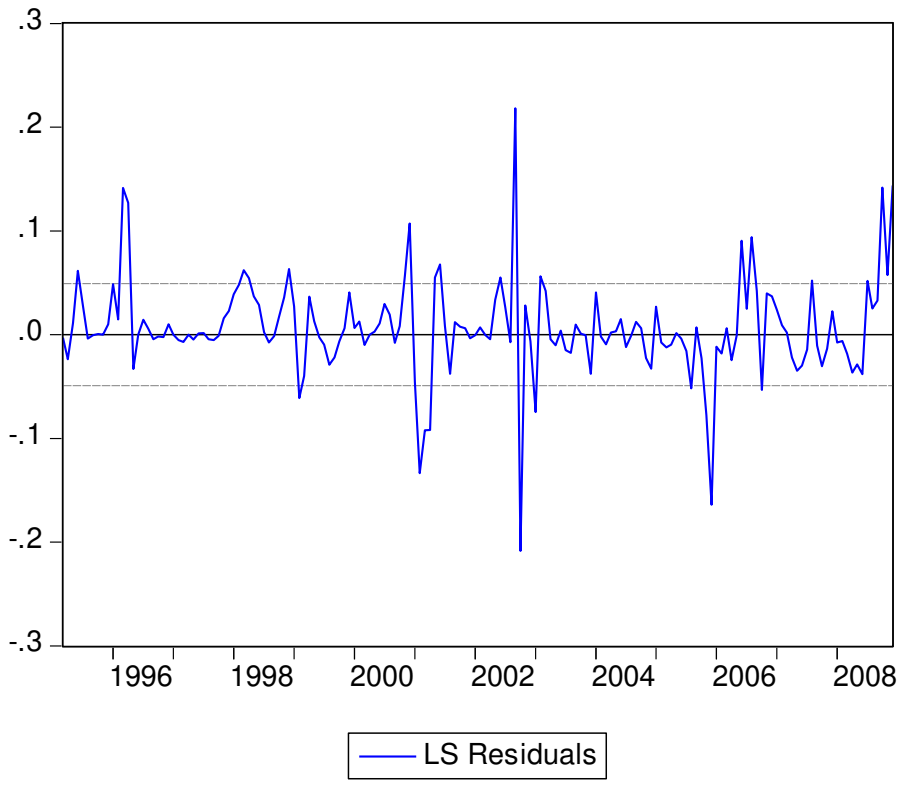


Figure 9: EGARCH LS RESIDUALS



EFFECTS OF INTERVENTION

5.2.1 MEAN EQUATION

We first examine the exchange rate mean level. In the GARCH model (Table 5) lsale (log of sale) coefficient has a negative sign while the lpurch (purchase) coefficient has a positive sign. A negative coefficient indicates that the exchange rate moves in the desired direction for intervention, that is, a sale of $ depresses the value of the kwacha/$ exchange rate. It shows that sales of $ reduce the mean of the exchange rate while a positive sign on purchases indicates that purchasing $ increases the value of the exchange rate entailing a depreciation of the kwacha. Both sales and purchases are also statistically significant.

It is difficult to understand the rationale behind BOZ's purchases of $ from the market if in this case they lead to the depreciation of the kwacha. One would however, assume that the objective is to build international reserves rather than to influence the exchange rate.

A similar study by Domac and Mendoza (2004) which was examining the intervention operations of the Turkish and Mexican central banks makes the same observation that a net sale of $100 million appreciates the exchange rate by 0.08% and 0.20% in Mexico and Turkey respectively. The study also observes that purchase of foreign exchange did not influence the exchange rate at all.

In contrast to GARCH model, the EGARCH model's estimation results presented in Table 6 show that the coefficients of both sales and purchases of $ are negatively signed. The results show that BOZ sales and purchases activities both lead to an appreciation of the exchange rate. Similar results in studies such as Kim et al (2000) make the same observation that the Reserve Bank of Australia's intervention had moved the exchange rate in the desired direction of the intervention. Fatum and Hutchison (1999) also find evidence that intervention does affect the exchange rate. Our finding is also consistent with the related work of Catte et al (1999), Humpage (1999) and Dominguez and Frankel (1993).

The interpretation of the negatively signed sales coefficient also means that when the BOZ is selling $ it is getting kwacha from the market. This will therefore cause the exchange rate to appreciate (decline). This is similar to the finding of Edison et al (2003) that when on those days when official net sales of $ occurred in Australia, the USD/ Australian dollar tends to be rising. In other words, the Reserve Bank of Australia sales the domestic currency this results in its appreciation.

5.2.2. VARIANCE EQUATION

The pattern of effects of intervention on the conditional volatility is different from that on the conditional mean. The sales coefficient in the GARCH model is positively signed and it is statistically significant while the purchases coefficient is negatively signed and is statistically insignificant. This shows that sales of dollars increase the variance of the exchange rate while purchases of dollars reduce it. The ϕ_1 in this model is positively signed and is statistically significant. This is in line with our expectation and therefore the GARCH model is not the best for our study and instead the EGARCH model is best suited for this kind of study.

The ARCH and GARCH coefficients are typically close to unity indicating that volatility shocks in the exchange rate are rather persistent.

Purchases of $ reduces the variance of the exchange rate. This shows that the central bank actually achieves its objective of smoothing out exchange rate fluctuations. The study by Dominguez (1998) of the Federal Reserve intervention activities makes a similar observation that on general level central bank intervention increased exchange rate volatility. Similarly a study on the effect of sales of foreign exchange on volatility by Kim et al (2000) using Australian data too found that the conditional volatility of the exchange rate return was significantly raised. Beine et al (2002) find strong evidence that central bank interventions tend to increase,

rather than to reduce, the volatility of exchange rates. This result is also consistent with the major stream of the literature and specifically with Bonser-Neal and Tanner (1996) and Baillie and Osterberg (1997a, b). It is consistent with the microstructure, according to which the market tests the determination of the central banks just after the intervention occurs, especially since volatility is usually found in the literature to be positively correlated with turnover (see for instance Hartmann, 1998).

It appears the mere presence of the central bank in the foreign exchange market sends ambiguous signals to market participants about both the intentions of the central bank and its future monetary policy. This ambiguity can be interpreted to mean that the signalling channel is the channel through which BOZ interventions in the foreign exchange market affects the exchange.

CHAPTER 6. CONCLUSION

In this paper we investigate the impact of the Bank of Zambia's foreign exchange market intervention on the level and volatility of the exchange rate namely the kwacha/ USD exchange rate.

To measure this impact we use GARCH (1, 1) as well as EGARCH. To determine the appropriateness of GARCH models we first test for ARCH effects in the data. Our ARCH presence is subsequently confirmed and therefore we proceed to use GARCH (1, 1). GARCH (I, I) is estimated using quasi maximum likelihood.

We also use Exponential GARCH which enables us to investigate both the overall effect of the intervention and the individual effect of sales and purchases.

We use the sign bias test to test the best model between EGARCH and GARCH. We find that the former model is better than the GARCH because of the asymmetrical impact of sales and purchases of dollars on the exchange rate.

Empirical results from the GARCH model suggest that sales of foreign exchange lead to an appreciation of the kwacha which is basically 'leaning against the wind'. In this regard, the BOZ's goal of reversing a depreciation of the currency is achieved. In terms of volatility, the GARCH results suggest that purchasing foreign exchange reduces volatility while selling it increases volatility.

Our EGARCH results suggest that both sales and purchases of cause an appreciation of the exchange rate while the impacts of such interventions on volatility are mixed. Purchases of $ appear to reduce the volatility of the kwacha while sales of $ increase it.

There are a few possible directions for future research. First it would be important to know exactly which channel/s the BOZ intervention activities affect the kwacha. Second it would be important to distinguish between secret and publicly announced interventions so that their

different effects on the kwacha can be compared. Thirdly, it would be interesting to extend the data set to include interventions on more than one exchange rate. This could include a Sub-Saharan currency like the South African Rand which is pervasively used in the Zambian domestic economy. This would increase the number of observed public interventions and would allow for a more specific testing of hypotheses.

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APPENDIX 1

GARCH OUTPUT

Dependent Variable: D(LS)
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/11/09 Time: 17:49
Sample (adjusted): 1995M03 2008M12
Included observations: 166 after adjustments
Convergence achieved after 40 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1) + C(8)*LSALE + C(9)*LPURCH

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.554223	0.094200	5.883495	0.0000
LS(-1)	0.039685	0.004702	8.439495	0.0000
LSALE	-0.070994	0.010750	-6.603786	0.0000
LPURCH	0.009320	0.004084	2.282072	0.0225
Variance Equation				
C	-0.006426	0.003082	-2.085182	0.0371
RESID(-1)^2	1.063364	0.275898	3.854193	0.0001
GARCH(-1)	0.346587	0.093795	3.695174	0.0002
LSALE	0.000636	0.000294	2.166234	0.0303
LPURCH	-0.000165	8.30E-05	-1.985239	0.0471

R-squared	-0.081655	Mean dependent var	0.011131
Adjusted R-squared	-0.136771	S.D. dependent var	0.047009
S.E. of regression	0.050121	Akaike info criterion	-3.569802
Sum squared resid	0.394405	Schwarz criterion	-3.401080
Log likelihood	305.2936	Hannan-Quinn criter.	-3.501317
Durbin-Watson stat	1.579765		

EGARCH OUPTUT

Dependent Variable: D(LS)
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/11/09 Time: 17:51
Sample (adjusted): 1995M03 2008M12
Included observations: 166 after adjustments
Failure to improve Likelihood after 26 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1)) + C(9)
*LSALE + C(10)*LPURCH

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.280694	0.028485	9.854042	0.0000
LS(-1)	0.012793	0.002611	4.899596	0.0000
LSALE	-0.026207	0.001299	-20.18152	0.0000
LPURCH	-0.000938	0.002635	-0.356169	0.7217
Variance Equation				
C(5)	-7.916350	3.552413	-2.228443	0.0259
C(6)	0.805065	0.129104	6.235775	0.0000
C(7)	0.135139	0.094117	1.435861	0.1510
C(8)	0.761937	0.077636	9.814174	0.0000
C(9)	0.689722	0.375028	1.839121	0.0659
C(10)	-0.292876	0.164917	-1.775899	0.0757

R-squared	0.004204	Mean dependent var	0.011131
Adjusted R-squared	-0.053245	S.D. dependent var	0.047009
S.E. of regression	0.048245	Akaike info criterion	-3.582352
Sum squared resid	0.363098	Schwarz criterion	-3.394883
Log likelihood	307.3352	Hannan-Quinn criter.	-3.506257
F-statistic	0.073182	Durbin-Watson stat	1.665371
Prob(F-statistic)	0.999893		

Dependent Variable: D(LS)
Method: ML - ARCH (Marquardt) - Generalized error distribution (GED)
Date: 05/11/09 Time: 17:52
Sample (adjusted): 1995M03 2008M12
Included observations: 166 after adjustments
Failure to improve Likelihood after 5 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1)) + C(9)
*LSALE + C(10)*LPURCH

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.465797	0.072748	6.402926	0.0000
LS(-1)	0.025160	0.008930	2.817417	0.0048
LSALE	-0.055084	0.000818	-67.36994	0.0000
LPURCH	0.007982	0.000625	12.78027	0.0000
Variance Equation				
C(5)	-4.264120	5.442462	-0.783491	0.4333
C(6)	0.675041	0.254116	2.656427	0.0079
C(7)	-0.036944	0.174159	-0.212126	0.8320
C(8)	0.544335	0.149915	3.630964	0.0003
C(9)	0.214197	0.574438	0.372880	0.7092
C(10)	-0.166998	0.254078	-0.657270	0.5110
GED PARAMETER	1.147957	0.135305	8.484190	0.0000

R-squared	-0.035808	Mean dependent var	0.011131
Adjusted R-squared	-0.102634	S.D. dependent var	0.047009
S.E. of regression	0.049363	Akaike info criterion	-3.749506
Sum squared resid	0.377688	Schwarz criterion	-3.543290
Log likelihood	322.2090	Hannan-Quinn criter.	-3.665802
Durbin-Watson stat	1.624748		

DATE	EXCHANGE RATE	SALE	PURCH	CMSALE	CMPURCH
Jan-95	688.65	36,800.00	0.00	36,800.00	-
Feb-95	769.57	67,200.00	0.00	104,000.00	-
Mar-95	797.08	27,100.00	7,900.00	131,100.00	7,900.00
Apr-95	802.06	30,200.00	0.00	161,300.00	7,900.00
May-95	829	35,900.00	0.00	197,200.00	7,900.00
Jun-95	893.51	47,500.00	0.00	244,700.00	7,900.00
Jul-95	927.71	29,600.00	200.00	274,300.00	8,100.00
Aug-95	930.78	31,300.00	700.00	305,600.00	8,800.00
Sep-95	932.68	36,100.00	0.00	341,700.00	8,800.00
Oct-95	932.68	28,300.00	0.00	370,000.00	8,800.00
Nov-95	927.92	41,100.00	0.00	411,100.00	8,800.00
Dec-95	937.79	62,100.00	40,700.00	473,200.00	49,500.00
Jan-96	982.19	37,000.00	0.00	510,200.00	49,500.00
Feb-96	992.2	40,000.00	0.00	550,200.00	49,500.00
Mar-96	1135.47	28,600.00	0.00	578,800.00	49,500.00
Apr-96	1282.9	31,400.00	7,100.00	610,200.00	56,600.00
May-96	1240.9	100.00	24,500.00	610,300.00	81,100.00
Jun-96	1241.03	600.00	13,010.00	610,900.00	94,110.00
Jul-96	1259.12	0.00	2,000.00	610,900.00	96,110.00
Aug-96	1267.86	0.00	9,990.00	610,900.00	106,100.00
Sep-96	1266.72	0.00	39,485.00	610,900.00	145,585.00
Oct-96	1269.15	4,200.00	9,900.00	615,100.00	155,485.00
Nov-96	1269.83	12,700.00	5,135.00	627,800.00	160,620.00

Dec-96	1287.43	0.00	19,402.00	627,800.00	180,022.00
Jan-97	1292.1	6,410.00	0.00	634,210.00	180,022.00
Feb-97	1290.14	0.00	0.00	634,210.00	180,022.00
Mar-97	1286.48	0.00	13,090.00	634,210.00	193,112.00
Apr-97	1292.42	300.00	16,115.00	634,510.00	209,227.00
May-97	1293.72	0.00	32,450.00	634,510.00	241,677.00
Jun-97	1302.74	500.00	10,600.00	635,010.00	252,277.00
Jul-97	1312.87	0.00	12,175.00	635,010.00	264,452.00
Aug-97	1315.62	0.00	2,100.00	635,010.00	266,552.00
Sep-97	1317.52	0.00	5,800.00	635,010.00	272,352.00
Oct-97	1325.08	0.00	0.00	635,010.00	272,352.00
Nov-97	1353.14	26,900.00	0.00	661,910.00	272,352.00
Dec-97	1392.14	0.00	1,749.00	661,910.00	274,101.00
Jan-98	1454.54	23,600.00	0.00	685,510.00	274,101.00
Feb-98	1534.14	5,200.00	0.00	690,710.00	274,101.00
Mar-98	1642.93	0.00	875.00	690,710.00	274,976.00
Apr-98	1748.7	2,000.00	300.00	692,710.00	275,276.00
May-98	1830.75	0.00	0.00	692,710.00	275,276.00
Jun-98	1903.38	0.00	4,545.00	692,710.00	279,821.00
Jul-98	1929.24	0.00	5,050.00	692,710.00	284,871.00
Aug-98	1936.85	0.00	2,545.00	692,710.00	287,416.00
Sep-98	1956.39	0.00	440.00	692,710.00	287,856.00
Oct-98	2013.23	0.00	2,610.00	692,710.00	290,466.00
Nov-98	2113.23	0.00	300.00	692,710.00	290,766.00
Dec-98	2281.45	0.00	0.00	692,710.00	290,766.00
Jan-99	2379.88	0.00	0.00	692,710.00	290,766.00
Feb-99	2271.6	20,300.00	0.00	713,010.00	290,766.00
Mar-99	2212.78	0.00	0.00		

				713,010.00	290,766.00
Apr-99	2325.62	0.00	750.00	713,010.00	291,516.00
May-99	2389.16	0.00	0.00	713,010.00	291,516.00
Jun-99	2418.8	0.00	7,500.00	713,010.00	299,016.00
Jul-99	2431.55	5,000.00	5,400.00	718,010.00	304,416.00
Aug-99	2397.97	0.00	1,300.00	718,010.00	305,716.00
Sep-99	2381.41	0.00	4,070.00	718,010.00	309,786.00
Oct-99	2401.45	0.00	1,000.00	718,010.00	310,786.00
Nov-99	2452.42	0.00	0.00	718,010.00	310,786.00
Dec-99	2593.59	626.00	0.00	718,636.00	310,786.00
Jan-00	2653.88	0.00	0.00	718,636.00	310,786.00
Feb-00	2734.46	1,400.00	15,000.00	720,036.00	325,786.00
Mar-00	2754.84	12,400.00	14,200.00	732,436.00	339,986.00
Apr-00	2801.39	15,000.00	1,000.00	747,436.00	340,986.00
May-00	2857.76	0.00	0.00	747,436.00	340,986.00
Jun-00	2939.94	0.00	300.00	747,436.00	341,286.00
Jul-00	3083.9	0.00	0.00	747,436.00	341,286.00
Aug-00	3204.67	0.00	0.00	747,436.00	341,286.00
Sep-00	3244.11	0.00	17,000.00	747,436.00	358,286.00
Oct-00	3338.01	0.00	0.00	747,436.00	358,286.00
Nov-00	3608.42	0.00	0.00	747,436.00	358,286.00
Dec-00	4108.75	0.00	1,500.00	747,436.00	359,786.00
Jan-01	4024.53	7,600.00	7,000.00	755,036.00	366,786.00
Feb-01	3602.66	32,600.00	0.00	787,636.00	366,786.00
Mar-01	3349.59	26,550.00	4,790.00	814,186.00	371,576.00
Apr-01	3104.48	36,700.00	300.00	850,886.00	371,876.00
May-01	3323.04	32,850.00	2,090.00	883,736.00	373,966.00
Jun-01	3604.46	14,050.00	0.00	897,786.00	373,966.00

Jul-01	3685.3	36,850.00	6,800.00	934,636.00	380,766.00
Aug-01	3594.3	36,150.00	3,600.00	970,786.00	384,366.00
Sep-01	3678.19	22,400.00	0.00	993,186.00	384,366.00
Oct-01	3743.49	37,150.00	0.00	1,030,336.00	384,366.00
Nov-01	3800.85	37,050.00	0.00	1,067,386.00	384,366.00
Dec-01	3820.33	20,800.00	0.00	1,088,186.00	384,366.00
Jan-02	3848.65	22,300.00	3,600.00	1,110,486.00	387,966.00
Feb-02	3904.25	16,500.00	0.00	1,126,986.00	387,966.00
Mar-02	3930.72	20,830.00	0.00	1,147,816.00	387,966.00
Apr-02	3939.03	12,300.00	0.00	1,160,116.00	387,966.00
May-02	4097.61	28,000.00	0.00	1,188,116.00	387,966.00
Jun-02	4354.66	21,900.00	200.00	1,210,016.00	388,166.00
Jul-02	4499.23	23,900.00	350.00	1,233,916.00	388,516.00
Aug-02	4492.73	30,500.00	3,500.00	1,264,416.00	392,016.00
Sep-02	5619.21	16,100.00	7,300.00	1,280,516.00	399,316.00
Oct-02	4603.27	34,400.00	1,100.00	1,314,916.00	400,416.00
Nov-02	4753.73	27,199.00	0.00	1,342,115.00	400,416.00
Dec-02	4740.05	32,700.00	0.00	1,374,815.00	400,416.00
Jan-03	4410.96	25,600.00	0.00	1,400,415.00	400,416.00
Feb-03	4668.71	23,200.00	300.00	1,423,615.00	400,716.00
Mar-03	4877.52	11,990.00	1,000.00	1,435,605.00	401,716.00
Apr-03	4866.4	18,650.00	8,100.00	1,454,255.00	409,816.00
May-03	4824.04	14,800.00	6,700.00	1,469,055.00	416,516.00
Jun-03	4847.04	17,000.00	3,500.00	1,486,055.00	420,016.00
Jul-03	4779.32	12,700.00	6,500.00	1,498,755.00	426,516.00
Aug-03	4698.57	0.00	4,410.00	1,498,755.00	430,926.00
Sep-03	4745.65	0.00	0.00	1,498,755.00	430,926.00
Oct-03	4752.02	0.00	2,000.00		

				1,498,755.00	432,926.00
Nov-03	4751.27	0.00	0.00	1,498,755.00	432,926.00
Dec-03	4577.75	0.00	1,000.00	1,498,755.00	433,926.00
Jan-04	4767.64	0.00	0.00	1,498,755.00	433,926.00
Feb-04	4762.51	0.00	3,000.00	1,498,755.00	436,926.00
Mar-04	4722.06	0.00	11,500.00	1,498,755.00	448,426.00
Apr-04	4734.95	0.00	9,800.00	1,498,755.00	458,226.00
May-04	4754.58	0.00	12,198.50	1,498,755.00	470,424.50
Jun-04	4832.62	0.00	11,551.90	1,498,755.00	481,976.40
Jul-04	4783.13	0.00	9,500.00	1,498,755.00	491,476.40
Aug-04	4787.26	0.00	7,200.00	1,498,755.00	498,676.40
Sep-04	4856.29	0.00	25,000.00	1,498,755.00	523,676.40
Oct-04	4896.31	3,500.00	0.00	1,502,255.00	523,676.40
Nov-04	4797.64	4,000.00	0.00	1,506,255.00	523,676.40
Dec-04	4651.51	0.00	1,000.00	1,506,255.00	524,676.40
Jan-05	4,785.12	0.00	14,000.00	1,506,255.00	538,676.40
Feb-05	4,758.50	0.00	2,000.00	1,506,255.00	540,676.40
Mar-05	4,710.58	0.00	16,900.00	1,506,255.00	557,576.40
Apr-05	4,675.15	0.00	23,000.00	1,506,255.00	580,576.40
May-05	4,691.79	0.00	12,000.00	1,506,255.00	592,576.40
Jun-05	4,685.77	0.00	17,700.00	1,506,255.00	610,276.40
Jul-05	4,624.46	200.00	31,000.00	1,506,455.00	641,276.40
Aug-05	4,401.88	0.00	5,500.00	1,506,455.00	646,776.40
Sep-05	4,439.67	0.00	0.00	1,506,455.00	646,776.40
Oct-05	4,346.08	0.00	0.00	1,506,455.00	646,776.40
Nov-05	4,026.68	0.00	0.00	1,506,455.00	646,776.40
Dec-05	3,416.34	3,000.00	5,000.00	1,509,455.00	651,776.40
Jan-06	3,363.72	0.00	12,000.00	1,509,455.00	663,776.40

Feb-06	3,289.61	0.00	0.00	1,509,455.00	663,776.40
Mar-06	3,294.74	0.00	0.00	1,509,455.00	663,776.40
Apr-06	3,201.50	0.00	42,500.00	1,509,455.00	706,276.40
May-06	3,184.97	7,000.00	15,500.00	1,516,455.00	721,776.40
Jun-06	3,470.61	0.00	8,500.00	1,516,455.00	730,276.40
Jul-06	3,546.72	5,000.00	0.00	1,521,455.00	730,276.40
Aug-06	3,883.95	28,000.00	12,500.00	1,549,455.00	742,776.40
Sep-06	4,046.46	16,000.00	90,800.00	1,565,455.00	833,576.40
Oct-06	3,835.17	14,500.00	39,000.00	1,579,955.00	872,576.40
Nov-06	3,984.97	7,000.00	0.00	1,586,955.00	872,576.40
Dec-06	4,127.83	36,200.00	0.00	1,623,155.00	872,576.40
Jan-07	4,221.06	21,500.00	0.00	1,644,655.00	872,576.40
Feb-07	4,254.02	4,500.00	0.00	1,649,155.00	872,576.40
Mar-07	4,258.53	8,000.00	42,500.00	1,657,155.00	915,076.40
Apr-07	4,161.47	9,000.00	22,500.00	1,666,155.00	937,576.40
May-07	4,013.82	0.00	34,408.00	1,666,155.00	971,984.40
Jun-07	3,888.11	0.00	10,000.00	1,666,155.00	981,984.40
Jul-07	3,823.05	5,000.00	6,000.00	1,671,155.00	987,984.40
Aug-07	4,013.08	25,500.00	0.00	1,696,655.00	987,984.40
Sep-07	3,960.70	3,000.00	12,500.00	1,699,655.00	1,000,484.40
Oct-07	3,831.36	0.00	3,000.00	1,699,655.00	1,003,484.40
Nov-07	3,766.67	6,000.00	11,000.00	1,705,655.00	1,014,484.40
Dec-07	3,836.88	9,500.00	0.00	1,715,155.00	1,014,484.40
Jan-08	3,792.78	11,000.00	0.00	1,726,155.00	1,014,484.40
Feb-08	3,753.59	0.00	0.00	1,726,155.00	1,014,484.40
Mar-08	3,668.91	2,000.00	13,000.00	1,728,155.00	1,027,484.40
Apr-08	3,519.41	0.00	17,500.00	1,728,155.00	1,044,984.40
May-08	3,399.20	15,500.00	7,000.00		

				1,743,655.00	1,051,984.40
Jun-08	3,249.70	8,000.00	15,500.00	1,751,655.00	1,067,484.40
Jul-08	3,393.37	32,500.00	0.00	1,784,155.00	1,067,484.40
Aug-08	3,452.79	5,000.00	0.00	1,789,155.00	1,067,484.40
Sep-08	3,539.85	22,500.00	3,500.00	1,811,655.00	1,070,984.40
Oct-08	4,044.33	48,000.00	0.00	1,859,655.00	1,070,984.40
Nov-08	4,256.98	15,000.00	3,500.00	1,874,655.00	1,074,484.40
Dec-08	4,882.97	70,000.00	2,000.00	1,944,655.00	1,076,484.40

APPENDIX 3.

DATE	K/$	DATE	k/$
Jan-98	1454.54	Aug-03	4698.57
Feb-98	1534.14	Sep-03	4745.65
Mar-98	1642.93	Oct-03	4752.02
Apr-98	1748.7	Nov-03	4751.27
May-98	1830.75	Dec-03	4577.75
Jun-98	1903.38	Jan-04	4767.64
Jul-98	1929.24	Feb-04	4762.51
Aug-98	1936.85	Mar-04	4722.06
Sep-98	1956.39	Apr-04	4734.95
Oct-98	2013.23	May-04	4754.58
Nov-98	2113.23	Jun-04	4832.62
Dec-98	2281.45	Jul-04	4783.13
Jan-99	2379.88	Aug-04	4787.26
Feb-99	2271.6	Sep-04	4856.29
Mar-99	2212.78	Oct-04	4896.31
Apr-99	2325.62	Nov-04	4797.64
May-99	2389.16	Dec-04	4651.51
Jun-99	2418.8	Jan-05	4,785.12
Jul-99	2431.55	Feb-05	4,758.50
Aug-99	2397.97	Mar-05	4,710.58
Sep-99	2381.41	Apr-05	4,675.15
Oct-99	2401.45	May-05	4,691.79
Nov-99	2452.42	Jun-05	4,685.77
Dec-99	2593.59	Jul-05	4,624.46
Jan-00	2653.88	Aug-05	4,401.88
Feb-00	2734.46	Sep-05	4,439.67
Mar-00	2754.84	Oct-05	4,346.08
Apr-00	2801.39	Nov-05	4,026.68
May-00	2857.76	Dec-05	3,416.34

Jun-00	2939.94
Jul-00	3083.9
Aug-00	3204.67
Sep-00	3244.11
Oct-00	3338.01
Nov-00	3608.42
Dec-00	4108.75
Jan-01	4024.53
Feb-01	3602.66
Mar-01	3349.59
Apr-01	3104.48
May-01	3323.04
Jun-01	3604.46
Jul-01	3685.3
Aug-01	3594.3
Sep-01	3678.19
Oct-01	3743.49
Nov-01	3800.85
Dec-01	3820.33
Jan-02	3848.65
Feb-02	3904.25
Mar-02	3930.72
Apr-02	3939.03
May-02	4097.61
Jun-02	4354.66
Jul-02	4499.23
Aug-02	4492.73
Sep-02	5619.21
Oct-02	4603.27
Nov-02	4753.73
Dec-02	4740.05
Jan-03	4410.96
Feb-03	4668.71
Mar-03	4877.52
Apr-03	4866.4
May-03	4824.04
Jun-03	4847.04
Jul-03	4779.32
Jan-06	3,363.72
Feb-06	3,289.61
Mar-06	3,294.74
Apr-06	3,201.50
May-06	3,184.97
Jun-06	3,470.61
Jul-06	3,546.72
Aug-06	3,883.95
Sep-06	4,046.46
Oct-06	3,835.17
Nov-06	3,984.97
Dec-06	4,127.83
Jan-07	4,221.06
Feb-07	4,254.02
Mar-07	4,258.53
Apr-07	4,161.47
May-07	4,013.82
Jun-07	3,888.11
Jul-07	3,823.05
Aug-07	4,013.08
Sep-07	3,960.70
Oct-07	3,831.36
Nov-07	3,766.67
Dec-07	3,836.88
Jan-08	3,792.78
Feb-08	3,753.59
Mar-08	3,668.91
Apr-08	3,519.41
May-08	3,399.20
Jun-08	3,249.70
Jul-08	3,393.37
Aug-08	3,452.79
Sep-08	3,539.85
Oct-08	4,044.33
Nov-08	4,256.98
Dec-08	4,882.97