APPROPRIATENESS OF INFLATION TARGETING AS MONETARY POLICY FRAMEWORK FOR ZAMBIA

by

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A dissertation submitted to the University of Zambia in partial fulfillment of the requirements of the degree of Master of Arts in Economics

THE UNIVERSITY OF ZAMBIA

LUSAKA

2010

DECLARATION

I, Hangoma Peter, declare that this dissertation:

a) Represents my own work;

b) Has not previously been submitted for a degree at this or any other University; and

c) Does not incorporate any published work or material from another dissertation.

Signed: ....

Date: ....

APPROVAL

This dissertation of Hangoma Peter has been approved as partial fulfillment of the requirements for the award of the Master of Arts degree in Economics by the University of Zambia.

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ABSTRACT

There is now consensus that inflation hampers economic and social development. It is therefore important to have a clearly defined and effective framework of inflation control. Since 1992, Zambia has been using monetary targeting as a framework of inflation control. However, the link between inflation and monetary aggregates is no longer stable and predictable. In this vein, the Bank of Zambia has been considering switching the monetary policy framework to inflation targeting. The objective of this research is to assess the applicability of this framework by investigating the factors that drive inflation. Inflation targeting works best if inflation is demand driven while the effects of supply side factors on inflation are temporary. Further, it must be possible to use a nominal interest rate as a monetary policy instrument. Using annual data from 1992 to 2008, we fit the standard model of inflation targeting by Svensson (1997) and then compare it to the Chand and Singh (2006) model. The Chand and Singh model reformulates the Svensson demand side to what is thought to better depict the economic structure of developing countries. The model recognizes that developing countries usually sustain large fiscal deficits which can be significant in driving inflation. To this end, the policy rule of interest rate should also respond to fiscal deficit ratio. Alternatively, fiscal deficit ratio itself can be used as a policy rule. Moreover, the Chand and Singh model also includes supply side factors with the reasoning that they might be significant in explaining inflation. Our results show that inflation in Zambia can be said to be demand driven and supply side factors are insignificant. However, the interpretation of aggregate demand in terms of output gap was found to be insignificant in driving inflation. Instead, the alternative interpretation, nominal excess demand growth was found to have more explanatory power. Fiscal deficit ratio was found to be insignificant. This precludes the possibility of it being employed as a policy rule. On the contrary, we found a significant, negative and stable relationship between inflation and the Treasury Bill (TB) rate. The main policy implication of the results is that inflation targeting can be adopted and serious attention has to be given to the interest rate that will be employed. The transmission mechanism is not smooth and Government should consider dealing with factors behind this problem. It would also be important to address the problem of information asymmetry in the banking system.

DEDICATION

To my son

Lubomba Sakhile Hangoma

ACKNOWLEDGEMENT

I wish to express my heartfelt appreciation to Prof V. Seshamani, my supervisor of this research. His guidance and thoughtful critique has given me a solid foundation for future report writing. I would like to thank Prof. D. Jonsson and Dr. C. N'gandwe for their insightful comments. My gratitude also goes to Dale Mudenda for the reading materials that he availed to me. To Mr. Mphuka, I shall always remain thankful for consolidating my skills in data analysis using STATA.

Perhaps my studies at UNZA would have been immaterial without Prof. Ndulo, the Head of Department of Economics. I would like to thank him for his tireless efforts in securing scholarships for many hardworking Zambians. I would also like to thank the Department of Economics secretary Sepo Kusiyo for allowing me to use facilities at the department.

My heartfelt appreciation also goes to the Bank of Zambia for providing me with a full scholarship. To Mr. Patson Banda and Sylvia in Training Division, Mr. Ilunga in Public Relations as well as the Economics Department members of staff at the Bank of Zambia, I say thank you. I also thank fellow members of the University of Zambia senate for serving as an inspiration in my academic pursuit. To Prof I. Nyambe and Prof R. Serpel, thank you for the confidence you had in me.

To my course mates, Bupe, Mutinta, Albert, Charles, Isaac, Kalombo and Kamwi, I say let us remain focused.

To my Sweetheart and mother to my son, Kapema, I thank you for being the best. My appreciation also goes to my mother and sisters who are the reason why I have reached this far.

Finally and most importantly, to the almighty God, I thank you for opening the windows of heaven and keeping me in shape.

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LIST OF ACRONYMS

ADF	Augmented Dickey Fuller test
AIC	Akaike Information Criterion
AR (P)	Autoregressive Model of order p
ARC	Autoregressive Conditional Heteroskedasticity
ARMA (p, q)	Autoregressive Moving Average of order p, q
BIC	Bayesian Information criterion
BoZ	Bank of Zambia
CPI	Consumer Price Index
CSO	Central Statistical Office
EMEs	Emerging Markets Economies
ERP	Economic Reform Program
GDP	Gross Domestic Product
HIPC	Highly Indebted Poor Countries Initiative
IMF	International Monetary Fund
ITF/ IT	Inflation Targeting Framework
MA (q)	Moving Average Model of order q
MAPE	Mean Absolute Percentage Forecast Error
MMD	Movement for Multiparty Democracy
NDA	Net Domestic Assets
NEER	Nominal Effective Exchange Rate
NERP	New Economic Recovery Programme
NFA	Net Foreign Assets
OLS	Ordinary Least Squares
OMO	Open Market Operations
REER	Real Effective Exchange Rate
RESET	Regression specification error test
TB	Treasury Bill
UAE	United Arab Emirates
UNIP	United National Independence Party
VAR	Vector Autoregressive Model

CHAPTER 1

1. INTRODUCTION

1.1. Background of the Study

In order to understand the inflation process in Zambia, it is important to review its economy from independence because the history of inflation and its management in Zambia is closely linked to its economic experience. In tracing the evolution of Zambia's economy, we can conceptualize three sub periods: the first one is between 1964 and 1982, then the 1983-1991 period and lastly the post 1991 period.

During the first period (1964-1982), policy making was essentially socialist oriented. The initial part of this period, running up to 1974, saw rising copper prices and low inflation; the maximum inflation rate was 10.8 percent in 1968. Macroeconomic performance was generally satisfactory. However, in 1974, higher oil prices and the world economic recession led to a fall in copper prices and as a result, export earnings fell sharply. Starting from early 1975, this predicament culminated into a current account deficit. With all these macroeconomic dynamics, the exchange rate would not adjust as it was fixed. The result was an overvalued exchange rate and this remained so throughout the period. Foreign exchange shortages, price controls and subsidies on most goods and services led to the emergence of black markets. To rid itself of these problems, the government borrowed heavily. The immediate cause of this propensity to borrow sprung from the need to finance current account deficits with expectation that copper prices would stabilize. But copper prices tumbled even lower. The result was contraction of debt of insurmountable magnitude.

In view of these problems, the second period (1983-1991) constituted a succession of structural and stabilization policies arrived at in collaboration with the International Monetary Fund (IMF) and World Bank (excluding the one worked out between 1987 and 1989). The first in the series of these policies was the Economic Reform Program (ERP), 1983-1986, which the government committed itself to in 1983. The IMF was interested to see a restoration of fiscal discipline.

Inflation, which was usually suppressed, was said to be a result of fiscal indiscipline. The ERP was worked out in the hope of generating revenue so that the government does not engage in deficit financing. In this vein, growth of nontraditional exports was to be promoted in order to reduce the reliance on copper. It was decided that in order to promote exports, the Kwacha was to be devalued progressively and the auctioning system was used as a way of allocating foreign exchange. Secondly, efficiency in the allocation and use of both foreign and domestic resources was to be promoted. Domestic savings were to be mobilized in order to curb overreliance on foreign investment. Interest rates were to be decontrolled in order to promote savings and efficiency in the allocation and use of scarce resources. Abolition of price controls was to give the manufacturers incentive and reverse the trend of food shortages. In the course of implementing these reforms, inflation was rising sharply; for example, it rose from 13.6 percent in 1982 to 51.8 percent in 1986 and then 127.9 percent in 1989. The rapid rise in inflation was directly blamed on the depreciation of the kwacha arising from introduction of the auctioning system. However, it has been argued that the actual rise in inflation was as a result of decontrol of prices. This means that with goods becoming available, there was a drop in the demand for real balances by the Zambian consumers (Bates and Collier-1995).

The removal of subsidies sparked riots in various parts of the country. In consequence, the government reintroduced various controls and subsidies in 1987. This was done under the New Economic Recovery Programme (NERP) whose theme was "Growth from own resources". Before long, faced with large fiscal deficits and shortages of foreign exchange, the government introduced a harsh structural adjustment programme in July of 1989. This was done without the blessings of the IMF. The programme involved both liberalization and stabilization measures. In June 1990, nevertheless, the IMF endorsed the programme. For purposes of controlling inflation, tight monetary and fiscal policies were to be instituted. In this quest, minimum reserve requirements of commercial banks were increased and nominal interest rates were raised. With the then approaching elections in 1991, the programme almost collapsed. This was because the United National Independence Party (UNIP) government began to reverse some reforms. This caused some donors to stop their support just before the elections.

It was not until 1992 that real reforms under the Economic Recovery Programme were implemented. This was under the new government of the Movement for Multiparty Democracy (MMD). In September 1992, the interest rates were liberalized and immediately both the 91 day Treasury Bill (TB) rate and lending rate shot up. Inflation also rose sharply as a result of the decontrol of prices. However, it fell to 54 percent by the end of 1994 .On the foreign exchange market, the exchange rate system was unified in December 1992 and largely determined by market forces. Exchange controls were completely removed in February of 1994. Monetary policy was to be exercised by adjusting monetary aggregates; thus, the Bank of Zambia (BoZ) adopted what is called monetary targeting as a framework of monetary policy. In strengthening these reforms, TB auction was introduced and the Treasury Bill market liberalized in 1993. This meant that the system would help bring about a market determined interest rate in the economy. Monetary growth was to be restricted. The core liquid asset ratio for commercial banks was raised and a rediscounting charge on Treasury Bills was introduced. The BoZ rate was also raised. These were aimed at containing the problem of slippages in monetary growth targets. What compounded this problem, however, was the banking crisis of 1995 which led to the closure of three commercial banks. In an attempt to rescue them, government injected millions in the banking sector. The immediate outcome was excess liquidity in the economy leading to a buildup of inflationary pressure. In order to stabilize liquidity conditions in the economy, BoZ introduced Open Market Operations (OMO) in March 1995. In August of the same year, monthly auctions of bonds were introduced and government bonds were floated on the Lusaka Stock Exchange.

By the end of 1997, inflation had fallen to 20 percent. However, between 1998 and 2005, it stubbornly remained in the range of 15 to 30 percent; a seemingly steady state under monetary targeting. Meanwhile, due to its commitment in implementing various reforms, Zambia's budget position was strengthened when it attained the Highly Indebted Poor Countries (HIPC) Initiative completion point. At the same time, copper prices peaked, and the exchange rate posted strong gains against major currencies. For the first time in 30 years, inflation fell to a single digit; 9.4 percent in April of 2006.

It declined further to 8.6 percent at the end of the first half of 2006 and 8.2 percent three months later. However, the inflation rate started taking an upward trend in 2007 when it increased by 0.7 percent from the previous year's figure and closed at 8.9 percent. In 2008, it continued its upward trend to close at 16.6 percent in December 2008. The rising inflation coincided with the global economic crisis.

Needless to say, inflation causes various distortions in the economy and the need to manage it cannot be overemphasized. The relevant question therefore is; what are the drivers of inflation in Zambia? Even more, how can inflation be managed in Zambia and what monetary policy framework can be adopted to effectively manage it? This study seeks to answer these questions.

The Bank of Zambia Act No.43 of 1996 gives the authority to formulate and implement monetary policy to the Bank of Zambia. Hitherto, as indicated earlier, the Bank of Zambia has been using monetary targeting as its monetary policy framework. According to Muhanga and Dinde (2003), the price stability objective is pursued where growth in reserve money is controlled in line with a target set for each year. Staying within the targeted rate of reserve money requires maintaining certain levels of Net Domestic Assets (NDA) and the Net Foreign Assets (NFA) on the Bank of Zambia balance sheet. But the NFA is set exogenously of the price stability objective in accordance with the IMF backed monetary program. Hence, it is NDA which becomes the operational variable. Until recently, growth rate of the banking system's credit to the central government was the most emphasized NDA component. In order to attain the desired level of NDA, the Bank of Zambia intervenes in the interbank money market mainly through indirect instruments such as Open Market Operations (OMO) and auction of government securities. Occasionally, direct instruments such as reserve ratio are also applied as long as this is within monetary growth program.

Over the past 18 years however, most countries have abandoned monetary targeting citing its limitation in controlling inflation. Their alternative has been what has come to be called "New monetary policy".

The "New monetary policy" is understood to include: a numerical and official inflation target; monetary policy exercised through interest rates and an independent central bank. Further, price stability must be the only long run primary objective of monetary policy. This framework has been flagged "Inflation Targeting". The IMF (2005) indicates that Inflation Targeting (IT) has become an increasingly popular monetary policy strategy, with some 21 countries (8 industrial and 13 emerging markets) now inflation targeters and that many countries are considering following suit. It goes without saying that this framework can be implemented in various forms depending on the country's political, institutional and economic structure.

Before invoking the required question in the next paragraph, we need to mention that Zambia has been planning to adopt this framework for some time now. Bloomberg (2008) reports "Zambia is aiming to adopt an inflation-targeting framework in the next three years to better control price growth. The bank's Monetary Policy Committee will probably consider a ``position paper'' on the introduction of a benchmark interest rate and inflation-targeting next week, the bank's director of economics, said in an interview at the Global Interdependence Centre conference in Cape Town today".

Stated thus, the question is: Is Zambia's economic structure suitable for the adoption of this framework? If so, in what form should it be implemented? These questions characterise this study. All policies need to be optimally coordinated to achieve an inflation target. However, the level and need for coordination differs from country to country.

1.2. Statement of the Problem

As indicated earlier, the Bank of Zambia is still using monetary targeting as a framework of monetary policy. It is assumed, in this framework, that there is a positive relationship between monetary aggregates and inflation. It is also assumed that monetary aggregates can be controlled easily and the relationship between monetary aggregates and inflation is stable and predictable. In the case of Zambia however, it has been shown that this relationship is actually nonexistent. Using monthly data from 1994 to 2005, Pamu (2006) found that reserve money and all measure of broad money do not explain inflation dynamics in Zambia. Ng'andwe (1980) also investigated this relationship in the early part of Zambian history (1964-1976) and found that while monetary contraction backed by the IMF led to a drop in GDP during the study period, it had no significant impact on inflation. These results are also consistent with Mutoti (2006). The findings of Ng'andwe (1980) complemented by recent studies cast doubt on whether a relationship between money and inflation has ever existed in Zambia. The few studies that find a relationship have demonstrated that this relationship is weak. Among these is Simatele (2004). Moreover, Mishkin (2001) writes "If there is velocity instability, so that the relationship between the monetary aggregate and the goal variable is weak, then monetary aggregate targeting will not work. The weak relationship implies that hitting the target will not produce the desired outcome on the goal variable and thus the monetary aggregate will no longer provide an adequate signal about the stance of monetary policy" Broadly viewed, this has been the problem for Zambia.

The problem is that monetary aggregates have been difficult to control in Zambia and the link between monetary aggregates and inflation is weak. As evidence, the targets for monetary expansion have not been attained either due to uncontrollability or shifting targets midway. Shifting targets is usually done when the initial monetary growth target is seen to be inconsistent with the inflation outcome. For example, in 2006, broad money was targeted to grow by 14.6 percent yet it grew by 45.6 percent. Reserve money itself was targeted to grow by 10.5 percent yet it actually grew by 29.6 percent. In 2007, the same thing happened, targets for both reserve money and broad money was 6 percent while the actual outcome was 9.2 percent and 26.3 percent for reserve money and broad money respectively. The uncontrollability of monetary aggregates has also been attributed to globalization and financial innovation. The implication is that monetary targets are not credible in serving as nominal anchors in tying down inflation expectations because targets are both highly variable and unattainable even in the long run. Moreover, there is no predictable relationship between the monetary aggregates and inflation, so that even though the target is hit, the desired inflation is not attained making anchoring expectations based on monetary aggregates difficult. There is therefore, a lack of nominal anchor to tie down inflation expectation in Zambia.

Moreover, there is a lack of a monetary policy framework which is sufficiently forward looking (putting more emphasis on forecasting). Liquidity forecasting is poor. This may explain why it has been difficult to hit targets. A forward looking framework might enable the authorities to take corrective measures to reduce the effects of an adverse outcome or even prevent the outcome itself. Svensson (1997) observes 'Inflation reacts with "long and variable lags" and with variable magnitude to changes in the monetary policy instrument and is affected by factors other than monetary policy, sometimes with a shorter lag than monetary policy. The central bank necessarily must adopt a forward-looking perspective, attempting to control inflation one to two years ahead. Forecasts (projections) of crucial macro-variables become central'. This idea is not emphasized in monetary targeting.

1.3. Statement of objectives

1.3.1. General Objective

To investigate whether inflation targeting is applicable in Zambia by exploring the inflation generating process

1.3.2. Specific Objectives

In line with the general objective, the following specific objectives arise:

i.) To analyse if supply side factors are more significant than demand side factors in determining inflation in Zambia so as to make Inflation Targeting inapplicable.

ii.) To determine whether the fiscal deficit ratio in Zambia is significant to warrant a modification of the instrument rule of inflation targeting.

iii.) To provide policy options for an appropriate approach to inflation management in Zambia in as far as inflation targeting is concerned.

1.4. Statement of Hypotheses

i.) Supply side inflation drivers do not dominate demand side factors so that inflation targeting is applicable.

ii.) The fiscal deficit ratio is high requiring a modification of the inflation targeting policy rule.

1.5. Justification and Significance of the Study

In the initial analysis, it is necessary to attribute the significance of this study to the fact that no study on inflation targeting has been carried out for Zambia. Yet this framework has drawn so much attention and it is claimed to be the best option for countries desiring to lower inflation and sustain it at low levels. This framework can be justified on both theoretical and empirical grounds.

It is generally agreed that in the short run, monetary policy can affect real variables such as unemployment and growth. In the long run however, it cannot affect real variables but only nominal variables such as inflation. It is thus a good idea for monetary policy to concentrate on what it can do; maintaining price stability in the long run. This is the premise of the Inflation targeting. It puts the objective of price stability as the only long run primary goal of monetary policy and makes the price level as the intermediate target of monetary policy.

Moreover, an explicit inflation target is necessary for tying down inflation expectation. Private agents tend to adjust their prices depending on the inflation expected in future. This tends to make price level unstable as a result of fluctuations in expectations. Expectations are formed either adaptively, based on the past behavior of inflation, or rationally based on all available information-especially monetary policy. In this vein, committing to a future value of inflation and working to achieve it, the inflation target feeds in the expectation formation function and stabilizes the expectations. In so doing, it acts as a constraint on the value of money (nominal anchor). It is said to be the best candidate for this purpose. A money growth target can also serve as a nominal anchor but as has been explained and seen in the case of Zambia and indeed many other countries, money growth has become uncontrollable and the relationship between inflation and money growth seems to have broken down. An Exchange rate target can also serve as a nominal anchor but this option has been seen to be unsatisfactory for many countries including Zambia. Thus the only candidate for nominal anchor becomes the inflation target.

The debate on whether monetary policy should be based on rules or on discretion is settled with ITF. Discretion would land the country in a problem of "dynamic (time) inconsistency". In respect of this, Barro et al (1983) held that discretion usually robs the monetary authorities of credibility due to time inconsistency. According to him, since the Phillips Curve trade-off does exist in the short run, it is obviously optimal for a discretionary authority to inflate the economy and trade it for lower unemployment and higher income. But when people adapt their beliefs, raising their inflation expectations, the real effect of the monetary expansion will vanish, leaving merely an inflation bias, which is unfortunately permanent. Rules on how monetary policy should be conducted, for example growing money supply by X% per year, might be a solution but unfortunately they are also rigid and do not grant the authorities leverage to respond to short run fluctuations in the economy. The inflation targeting framework combines the flexibility of discretion and the need for rules by committing that monetary policy will be conducted with a rule that no inflation bias shall ensue and yet pursuing a bit of discretion to smooth output fluctuations in real economic variables in the short run.

On empirical grounds, ITF has been shown to be successful in many countries including developing countries. With Zambia having a problem with monetary targeting, inflation running out of control, the option of inflation targeting might be attractive.

However, in standard inflation targeting theory, inflation is assumed to be a demand driven process where supply shocks are assumed to be white noises while monetary and fiscal policy shocks determine the inflation dynamics through the "aggregate demand channel". Indeed in developed countries, many of which have adopted this framework, the inflation generating process has been shown to be largely demand driven and their inflation performance has on average been better than for developing countries which have also adopted the ITF. Many studies suggest that for most of these countries, supply side factors are predominant. This study is an attempt to find out whether supply side factors are as important as demand side factors in Zambia's inflation generating process. In doing this, it will contribute in helping the Bank of Zambia decide on whether it should adopt this framework or not; a question it has been trying to resolve in the past few years.

Moreover, by explicitly bringing fiscal consideration, this study will assist in determining whether the appropriate policy rule to be used actively should be an interest rate rule (which the BOZ is considering) or the deficit ratio. If it is an interest rate rule, should it respond only to the variables postulated in standard inflation targeting based on stylized facts? Or should there be a modification of the interest rate rule to conform it to the prevailing conditions in Zambia? By answering these questions, this study shall contribute to a better understanding of inflation in Zambia.

Bernanke and Mishkin (1997) contend that inflation targeting as applied takes various forms. This paper shall contribute in determining what form, if appropriate, inflation targeting should take. In light of this, Svensson (1999) emphasizes that in an optimal IT regime, the policy instrument should respond to any variable that marginally helps predicting inflation.

We end by quoting Mishkin (2001) "Because the devil is in the details in achieving transparency and accountability, what strategy (monetary policy framework) will work best in a country depends on its political, cultural and economic institutions and its past history"

CHAPTER 2

2. LITERATURE REVIEW

Many studies have been conducted to assess the performance of inflation targeting in both developed and developing countries. This framework has generally been found to be successful in controlling and sustaining low levels of inflation. We did not, however, find any study that explicitly evaluates the efficacy of inflation targeting for Zambia.

In recommending monetary targeting for Zambia, Zgambo (2001) used the classical equation of exchange to determine if money was neutral. Using the Granger causality test, he concluded that money was neutral and hence, granger causes CPI inflation. However, it must be noteworthy that while establishing that money granger causes inflation may be necessary for monetary targeting to be successful, it is not sufficient; one needs to establish how easy it is to control and whether this relationship is stable. Cabos et al (2001) found that control problems involved in targeting broad money are larger than targeting inflation rate. In this study, they were investigating the scale and indicator problems surrounding alternative monetary policy regimes using a dynamic kalman filter for German data. They thus recommended an inflation targeting framework for the European Central Bank. Secondly, the relationship between money and inflation is determined by the stability of money demand and velocity of money. Many studies have, however, shown that money demand has been highly unstable. But even if money demand were to be stable, it can be shown that monetary targeting is not very potent on several grounds. After estimating various demand functions for Turkey, Levent Korap (2008:29) reports "We attribute such an estimation result to the fact that the main factors leading to domestic inflation are determined out of the money demand variable space. This weakens explicitly the discretionary policy role of monetary aggregates in applying to stabilization programs against domestic inflation.....even if stable money demand equations can be obtained by the monetary authorities, this should not mean any support to the efforts of monetary targeting"

Contrary to Zgambo's findings, Mutoti (2006) examined the transmission mechanism of monetary policy for post liberalized Zambia using a cointegrated Structural VAR.

He concluded that there is a weakened relationship between money and inflation. Further, that the movements in the CPI are largely due to supply and exchange rate shocks. He then recommended that structural policies of controlling inflation such as boosting food supply would be needed. Using monthly data from 1994 to 2005, Pamu (2006) applied the methods of Cointegration, variance decomposition and granger causality in order to answer the question; 'what is the appropriate nominal anchor for inflation in Zambia?' He found that reserve money and all measures of broad money do not explain inflation dynamics in Zambia. M3 did not affect inflation in the short run but .he found a weak long run relationship between M3 and inflation. Variance decomposition demonstrated the importance of factors outside the money space.

With monetary targeting showing a gloomy picture, research shows that inflation targeting can be a panacea to the inflation problem. Among the increasing number of studies conducted to test its effectiveness, most have arrived at a positive conclusion. (Mishkin & Schmidt-Hebbel (2002), Berg (2005), Petursson (2004)).

However, some authors recommend inflation targeting with precaution. Vega et al (2005) carried out a research with an objective of determining the effect of Inflation targeting adoption on inflation dynamics. They found that ITF reduced the persistence of inflation in developing countries. In their conclusion, they held that since IT is understood to be flexible, the reduction in persistence was most likely as a result of anchoring of expectations to a defined nominal level. The small magnitude of the reduction however, prevented them from categorically concluding in favour of ITF in this particular dimension of the inflation dynamics. In fact, Arestis and Angeriz (2006) adds 'Our own evidence of ITF on emerging countries, though, suggests that non-IT central banks have also been successful in achieving and maintaining consistently low inflation rates. This evidence clearly implies that an emerging country central bank does not need to pursue an IT strategy to achieve and maintain low inflation.........the environment of the 1990s was in general terms a stable economic environment, "a period friendly to price stability " so that it is not convincing to attribute reduction in inflation to ITF'.

In general thus, some authors doubt that ITF is effective in reducing inflation in developed countries. If so, it is even more doubtful that it can work well in developing countries. In line with this reasoning, Fraga et al (2003) in their research found that even though ITF has, on average, reduced inflation in both developed and Emerging Market Economies (EMEs), EMEs were found to have had a relatively worse performance. They go on to reveal that under inflation targeting, EMEs have the challenge of breaking the vicious circle between two sides.

On one side, they have to deal with low credibility and more fragile institutions. On the other side, they have to deal with higher macroeconomic instability and vulnerability to various shocks. This means that inflation targeting may fail in developing countries either due to institutional factors and/or due to the underlying macroeconomic structure. This study focuses on the latter issue; macroeconomic structure. This approach of abstracting from institutional factors is consolidated by various authors. The argument in this case is that provided the authorities in these economies are sufficiently motivated to want the benefits of inflation targeting, they may use the introduction of ITF as an instrument of promoting needed reforms in economic institutions. It is, presumably, in this spirit that the International Monetary Fund (IMF) and other agencies have been encouraging emerging economies to adopt the ITF.

The economic structure, in particular, the inflation generating process is important. If it is other than the one that supports ITF, the implementation of this framework is less likely to be successful. Dossche and Everaert (2005) submit "It is generally accepted that over the medium to long run inflation is a monetary phenomenon, i.e. entirely determined by monetary policy. Over shorter horizons, though, various macroeconomic shocks, including variations in economic activity or production costs, will temporarily move inflation away from the central bank's inflation target" Thus, supply side factors are assumed to be white noise in that they have constant mean, variance and zero covariance. But they also doubt the authenticity of this claim by continuing; "A profound understanding of the process generating inflation, in particular the speed of inflation adjustment in response to such shocks is of crucial importance for an inflation targeting central bank"

Indeed many researches on developing countries show that supply side factors are likely to have as much an impact as demand factors in driving inflation. If this is true, then the key assumption of inflation targeting is falsified. Bailliu et al (2003) carried out a research in which they were investigating which models are most effective in forecasting inflation in emerging markets. They found that the best performing models are the mark-up models in which supply side factors play the most significant role. The Phillips curve did fairly well at explaining and forecasting inflation when using actual values for the explanatory variables.

It did not do well, however, in the forecasting exercises when using forecasted values for the explanatory variables. The money gap model did not appear very useful given that it was unable to beat even a simple Autoregressive Model, AR (1). This means that supply side factors are likely to be significant in determining inflation in developing countries and this might dampen the effectiveness of ITF.

Cost push factors if significant can generally dampen the effectiveness of IT. Cognisant of the likely dominance of supply side factors, Chand and Singh (2006) carried out a research to investigate the applicability of inflation targeting in India with an objective of finding out if supply side factors are significant to render inflation targeting inapplicable in India. They thus tested the "standard model" of inflation targeting as postulated by Svensson (1997) which specifies an interest rate channel of monetary policy transmission and assumes that it is demand factors that drive inflation and supply shocks are white noise. This model was found to be inadmissible for Indian data. They thus formulated an alternative model which considers the supply side factors but also reformulates the demand side of the standard model. They concluded that due to the dominance of supply side factors, inflation targeting is not applicable in India unless combined with both monetary and fiscal instruments and be closely coordinated with other instruments such as government buffer stock and other supply-side operations. In such circumstances Chand and Singh seem to hold the view that optimal rules have to be applied. However, Sutherland (2002) carried out a research where he demonstrated that optimal rules are difficult to implement in practice and are only of theoretical interest. Simple inflation targeting rules, which are relevant in practice, are not capable of handling inflation in an economy where the cost push shocks have a high variance. Only fully optimal targeting rules work in this vein.

On the Chand and Singh reformulation of the Svensson demand side, Mehra (2005) is skeptical. He indicates that the "excess demand" model based on nominal excess demand growth is a radical change of the Svensson formulation—a change from "levels" to "growth rates and he does not see any significant difference in the two. However, the findings of Orphanides et al (2004) might suggest that "excess demand" models have more predictive content than "output gap" models. The objective in their research was to assess the reliability of inflation forecasts based on output gap estimates in real time. They found that the relative usefulness of real-time output gap estimates diminishes when compared to simple bivariate forecasting models which use past inflation and output growth. They then concluded that the results call into question the practical usefulness of the output gap concept for forecasting inflation.

Mutoti (2006) seems to agree with the view that that supply side factors play a dominant role in determining inflation by delimitating the Zambian case. Under such circumstances, he recommended structural policies such as boosting food supply and stabilising exchange rate as a way of controlling inflation. In line with this view, Bailliu et al (2003) has shown that ITF as applied in Latin America has involved foreign exchange market intervention.

Contributing to the debate, Meng (2006) employed the Chand and Singh procedure for China and concluded that Chinese inflation was demand driven but that the Chand and Singh reformulation of the demand side of the Svensson model worked better than the standard formulation by Svensson. Moreover, The IMF (1996) and recent literature has found that the output gap, which is at the heart of the Svensson formulation, explained little of the movement in inflation for developing countries.

Chand and Singh (2006) in their research also found that fiscal deficits were very significant in India. The significance of fiscal deficit may lead to fiscal dominance[1]. But in ITF literature, fiscal dominance is said to be a condition that would crowd the

[1] Fiscal dominance is a situation where a central bank loses instrument independence as its monetary policy instruments are severely incapacitated or made ineffective as a result of high fiscal deficits.

effectiveness of inflation targeting. Chand and Singh however, postulate that even with fiscal dominance, ITF can work. This can be achieved by choosing an appropriate policy rule other than the standard interest rate rule; either using the deficit ratio or the interest rate rule that responds to variables including deficit ratio. On Zambia's part, some authors have suggested employing an interest rate rule. Muhanga and Dinde (2003) carried out a study to asses which policy instrument should be targeted by the Bank of Zambia. Specifically, they were comparing a monetary target and an interest rate target. Their conclusion was that an overnight interbank rate would be a good target for the Bank of Zambia. Later, we shall explore the practical challenges of deciding which interest rate to target.

As to whether fiscal deficit is significant in Zambia or not, various studies have been conducted to answer this question. Muchimba (2008) conducted a study to determine whether the budget deficit in Zambia has a direct impact on inflation. Using a vector error correction model, she found a relationship, though weak, between budget deficit and inflation. Mwansa (1998) used annual data for the period 1966 to 1995 to investigate the relationship between budget deficit and inflation in Zambia. He also established that the relationship between fiscal deficit and inflation was significant though weak. He attributed this weak relationship to price controls and subsidies and their subsequent removal. Agenor and Montiel (1996) contend that the relationship between inflation and fiscal deficit may be weak due to various reasons such as; an unstable money demand function, slow adjustment of expectations and if increase in budget deficit is financed by issuing bonds rather than money supply. Hence, the effect of fiscal deficit on inflation is dependent on how the deficit is financed. Ng'andwe (1980) carried out a study in order to identify the factors that contributed to inflation in Zambia between 1964 and 1976. He found that large budget deficits that were financed by monetary growth were a source of inflation. He further noted that between 1964 and 1970, monetary factors were not significant in explaining inflation. Only after 1970 did monetary factors start playing a role in inflation determination. He attributed this to budget deficits that were financed by monetary base. Additionally, Ng'andwe (1980) held that during the sample period, increases in marketed goods lagged behind the rising aggregate demand leading to the build up of inflationary pressure. The rising aggregate demand was due to large wage claims and a rapidly expanding public sector. In this dimension of his study thus, inflation was found to be demand driven in Zambia.

Simatele (2004) did a forecasting experiment for Zambia using monthly data for the period 1994 to 2001. Her objective was to compare the Mean Absolute Percentage Forecast Error (MAPE) of an AR (1) model of inflation with MAPEs of alternative models constructed by adding one variable to an AR (1) at a time. She found that the model with broad money, M2, had a lower MAPE than an AR (1) and concluded that it had more information content to explain inflation. However, models with deposit rate and foreign sector variables performed better than the one with M2. The significance of deposit rate is noteworthy for ITF. She also estimated an error correction model and found that Treasury bill rate was significant though with a positive sign. Anti-Ego (2000) carried out a research in order to compare alternative domestic monetary policy strategies in Uganda by estimating a VAR for the period 1982 to 1997. Granger causality tests showed Treasury bill rate to be significant in explaining inflation movement though the relationship was not very significant. Variance decomposition showed that inflation mainly explained itself five quarters after which base money explained an average of 30% while Treasury bill rate explained about 20% of the long run movements in inflation. Canetti and Greene (1991) carried out a research in order to investigate the effect of monetary growth and exchange rate movement in ten African countries including Zambia. Variance decomposition showed that neither exchange rate movement nor money supply growth had a dominant role in explaining innovations in CPI in most of these countries. Innovations in inflation were explained by inflation itself.

CHAPTER 3

3. METHODOLOGY

3.1 Theoretical Framework

A monetary policy framework comprises "the institutional arrangements under which monetary policy decisions are made and executed" (Fry 2000). Inflation targeting is not a rule but a monetary policy framework. Bernanke et al. (1997) describe inflation targeting as framework for monetary policy characterized by the public announcement of official quantitative targets (or target ranges) for the inflation rate over one or more time horizons, and by explicit acknowledgment that low, stable inflation is monetary policy's primary long-run goal. Among other important features of inflation targeting are; vigorous efforts to communicate with the public about the plans and objectives of the monetary authorities and to a large extent, mechanisms that strengthen the central bank's accountability for attaining those objectives. Lastly, and most importantly, using a nominal interest rate as a policy instrument.

In inflation targeting, the central bank necessarily adopts a forward-looking perspective; attempting to control inflation one to two years ahead. Forecasts (projections) of crucial macro-variables, and inflation itself, become cardinal. Inflation targeting, thus, becomes 'inflation-forecast targeting'. The central bank's inflation forecast is conditional on current information and a given path for the monetary policy. It is this forecast that the central bank targets to hit. If the forecast diverts from the desired inflation target, a nominal interest rate is adjusted to make the forecasted inflation in the future period hit the target. Below, we present a standard theory of inflation targeting based on the classical theory of utility maximization.

The standard theoretical formulation of inflation targeting, just like any other monetary policy framework, assumes that a central bank has a welfare function which it seeks to optimize. In this case, it has an objective function which it optimizes subject to a particular constraint. This is the central bank problem. The rationale behind this stabilization policy is that fluctuation can do damage to social welfare. A central bank generally cares about social benefit and wants to minimize social loss.

In line with this reasoning, standard inflation targeting assumes that the central bank problem is a dynamic one. It seeks to minimize the inter-temporal loss function subject to a given or forecasted inflation level at some future time period. It minimizes this loss by choosing an optimal path of its policy interest rate.

The standard theory of inflation targeting, formally derived by Svensson (2007), is presented hereunder:

The instantaneous loss function is defined as:

$$L(\pi_t) = \frac{1}{2}(\pi_t - \pi^*)^2 \qquad (1)$$

Where π^* is the inflation target and π_t is inflation at time t.Thus the loss function for each period is specified as the deviation of inflation at that time period from the target. Inflation targeting is seeking to equate π_t to π^* in order to minimise loss .This however is a more strict version of inflation targeting. In a more flexible version, some weight is placed on output stabilisation. Thus, the loss function in this case is defined as:

$$L(\pi_t, y_t) = 1/2[(\pi_t - \pi^*)^2 + \alpha y_t^2] \qquad (2)$$

Equation (2) means that the objective function also has a consideration for output stabilization where α is the weight attached to output stabilization. If α=0, then it is strict inflation targeting as specified by equation (1). We are going to use the strict version for expository simplicity, yet the results can be generalized to a flexible version with considerable validity.

Now, given that there is an infinite discrete time horizon from t to ∞, in which policy decisions are made, the objective function can be formulated to capture loss functions from time t to time ∞. Thus the inter-temporal loss function is the sum of expected discounted loss functions from time t to ∞. This is specified as:

$$E_t \sum_{i=t}^{\infty} \emptyset^{i-t}\, L(\pi_t) = 1/2\ E_t \sum_{i=t}^{\infty} \emptyset^{i-t}\, L\big(\pi_t - \pi^*\big)^2, 0 < \emptyset < 1, \emptyset\ is\ the\ discount\ factor \qquad (3)$$

Equation (3) is the loss function that the central bank seeks to minimize. In doing so, the central bank must be able to forecast future inflation rate π_{t+i} and seek to equate this to the target π^*.

The constraint of the minimization problem is derived from the transmission mechanism of monetary policy which embodies the structure of the economy.

This is specified as:

$$\pi_{t+1} = \pi_1 + \propto_1 x_t + \varepsilon_{t+1} \qquad (4)$$

$$x_{t+1} = \beta_1 x_t - \beta_2 r_t + \eta_{t+1} \qquad (5)$$

$$r_t = (1 + i_t)/(1 + E_t\pi_{t+1}) - 1 = i_t - E_t\pi_{t+1} \qquad (6)$$

, and ($\propto_1$, β_1, $\beta_2 > 0$, $\beta_1 < 1$) .

ε_{t+1} and $\eta_{t+1}$are independently and identically distributed, i.i.d, shocks to aggregate supply and aggregate demand respectively and they cannot, therefore, be known before time t+1. π_t is the inflation rate at time t while x_t is the output gap at time t, i_t is the nominal interest rate and r_t is the real interest rate both for time t. $E_t\pi_{t+1}$ is the expected rate of inflation of period t+1 (or inflation forecast) based on information available in period t.

In equation (4) inflation rate is a function of previous inflation, previous output gap and current supply shocks while equation (5) shows that output gap is determined by previous output gap, previous real interest rate and current demand shocks. The coefficient of lagged inflation rate is one; meaning that the effect on inflation will be permanent and hence monetary expansion will lead to an inflation bias. According to this model thus, there is a one-year lag between inflation and aggregate demand, and a one-year lag for interest rate to affect aggregate demand.

By substituting we get the following reduced form; which is the constraint in the minimization problem:

$$\pi_{t+2} = (1 + \beta_1)\pi_{t+1} + (\propto_1 \beta_2 - \beta_1)\pi_t \text{-} \propto_1 \beta_2 i_t + (\varepsilon_{t+2} - \beta_1\varepsilon_{t+1} + \propto_1 \eta_{t+1}) \qquad (7)$$

Equation (7) shows that a change in interest rate can only affect inflation after 2 years, thus control lag or policy horizon is 2 years in this model.

Combining the inter-temporal loss function (objective function) and the reduced form (constraint), the central bank problem can be stated as:

$$minimise E_t \sum_{i=t}^{\infty} \emptyset^{i-t} L(\pi_t) \tag{8}$$

$$\text{s.t } \pi_{t+2} = (1+\beta_1)\pi_{t+1} + (\propto_1 \beta_2 - \beta_1)\pi_t \text{-} \propto_1 \beta_2 i_t + (\varepsilon_{t+2} - \beta_1 \varepsilon_{t+1} + \propto_1 \eta_{t+1}), \forall t \tag{9}$$

Where $L(\pi_t) = \frac{1}{2}(\pi_t - \pi^*)^2$

In equation (8) and (9), the central bank is trying to minimize the expected future welfare loss by an appropriate time path for the interest rate. As indicated, assessing this problem shows that the control lag is about two time periods. Setting of the key rate in the current period can only affect inflation two time periods ahead. Hence we can separate the above infinite horizon problem into a repetition of the following:

$$minimise\ E_t\, \emptyset^2\, L(\pi_{t+2}) + E_t \sum_{i=t,t\neq 2}^{\infty} \emptyset^{i-t} L(\pi_t) \tag{10}$$

$$\text{s.t. } \pi_{t+2} = (1+\beta_1)\pi_{t+1} + (\propto_1 \beta_2 - \beta_1)\pi_t \text{-} \propto_1 \beta_2 i_t + (\varepsilon_{t+2} - \beta_1 \varepsilon_{t+1} + \propto_1 \eta_{t+1}) \tag{11}$$

It should be noted that the second part of the objective function in equation (10) is irrelevant to choice in the current period and thus it can be regarded as a constant when differentiating as follows:

$$\partial E_t \emptyset^2 \frac{L(\pi_{t+2})}{\partial i_1} = \emptyset^2 \propto_1 \beta_2 (E_t \pi_{t+2} - \pi^*) = 0 \rightarrow E_t \pi_{t+2} = \pi^* \tag{12}$$

$$\rightarrow (1+\beta_2) E_t \pi_{t+1} + \alpha_1 \beta_1 x_t - \alpha_1 \beta_2 i_t = \pi^* \tag{13}$$

$$given\ \ E_t \pi_{t+2} = E_t \pi_{t+1} + \propto_1 E_t x_{t+1} = (1 + \propto_1 \beta_2) E_t\, \pi_{t+1} + \propto_1 \beta_1 x_t \text{-} \propto_1 \beta_2 i_t \tag{14}$$

The central bank's optimal choice of period t interest rate is the one that would make the expected inflation rate in period t+2 hit the target, the expected inflation rate is the inflation forecast and in this case an intermediate target for monetary policy. That is, the key interest rate in year t should be set so that the forecast of the one-year 'forward' inflation rate from period t + 1 to period t + 2, conditional upon information available in time t, equals the inflation target.

Rearranging (13) leads us to the following interest rate rule:

$$i_t = E_t\pi_{t+1} + a_1(E_t\pi_{t+1} - \pi^*) + a_2x_t, a_1 = 1/(\propto_1 \beta_2), a_2 = \beta_1/\beta_2 \qquad (15)$$

Equation (15) is the optimal reaction function for the central bank which will make the expected or inflation forecast equal the target. It says that the optimal setting of interest rate in year t must respond to this period's output gap, next period's inflation rate forecast and its deviation from the long run inflation target. Thus in a steady state, interest rate is such that potential output is equal to actual output so that $x_t = 0$ and inflation forecast hits its target. The social welfare loss from inflation fluctuation is minimized. Moreover this instrument rule looks like the Taylor rule but they differ in that the coefficients of the Taylor rule are obtained from historical practice while in this Svensson rule , the coefficients are obtained optimally by deriving them from the structure of the economy.

3.2 Empirical Model

We have two models to specify. One regarded as the standard model of inflation targeting originally postulated by Svensson (presented above) and the other, an alternative, by Chand and Singh.

3.2.1 Svensson (1997) Model Specification

As presented above the structural representation of the Svensson model is:

$$\pi_{t+1} = \pi_1 + \propto_1 x_t + \varepsilon_{t+1} \qquad (16)$$

$$x_{t+1} = \beta_1 x_t - \beta_2 r_t + \eta_{t+1} \qquad (17)$$

$$r_t = (1 + i_t)/(1 + E_t\pi_{t+1}) - 1 = i_t - E_t\pi_{t+1} \qquad (18)$$

, and $\propto_1$, β_1, $\beta_2 > 0$, $\beta_1 < 1$

From this structural form of the model, we can obtain the following reduced form:

$$\pi_{t+2} = (1 + \beta_1)\pi_{t+1} + (\propto_1 \beta_2 - \beta_1)\pi_t - \propto_1 \beta_2 i_t + (\varepsilon_{t+2} - \beta_1\varepsilon_{t+1} + \propto_1 \eta_{t+1}) \qquad (19)$$

$$= (1 + \propto_1 \beta_2)\pi_t + \propto_1 (1 + \beta_1)x_t - \propto_1 \beta_2 i_t + (\varepsilon_{t+2} - \beta_1\varepsilon_{t+1} + \propto_1 \eta_{t+1}) \qquad (20)$$

Equation (20) expresses the endogenous variable as function of the predetermined variables (lagged endogenous and exogenous variables).

3.2.2 Chand and Singh (2006) Model Specification

3.2.2.1 Demand Side.[2]

The structural form of the model is:

$$\pi_{t+1} = \pi_t + \alpha ed_{t+1} + \varepsilon_{t+1} \quad (21)$$

$$ed_{t+1} \equiv y_{t+1} - [(1 + \pi_t)(1 + q_{t+1})\text{-}1] = y_{t+1} - (\pi_t + q_{t+1}) \quad (22)$$

$$y_{t+1} = c + \beta_1 Dd_t - \beta_2 D(i_t - \pi_t) + \eta_{t+1} \quad (23)$$

$(\alpha, \beta_1, \beta_2 > 0, \alpha \leq 1)$

π_t is the inflation rate in period t while y_t is the growth rate of nominal income (current sales income) at time t; ed_t is nominal excess demand growth at time t; q_t is the real potential output growth rate at time t assumed to be a function of technology, labor and capital inputs and exogenous in the current short-term context; d_t denotes the fiscal deficit ratio at time t, the ratio of government budget deficit to GDP; and i_t still denotes the nominal interest rate at time t. D is the difference operator meaning first difference. In each period, ε, η are supply and demand shocks respectively which are assumed to be i.i.d.

The constant, c, corresponds to the nominal growth rate in steady state; when inflation hits the target and real output grows at its potential. If the nominal income growth rate equals the nominal potential output growth rate, excess demand growth would be zero. There would then be no additional pressure on the inflation rate, which would maintain its initial rate, assumed to be the previous period's rate. Since q_t denotes the potential growth rate of real output, producers are assumed to have lagged expectations; expecting production costs to grow at previous period's inflation rate.

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[2] Note that the major difference between the Chand & Singh model demand side and the Svensson model comes from replacing x_t with ed_t. These are alternative interpretations of the inflation generating process.

Therefore,$[(1+\pi_t)(1+q_{t+1})$-1] is the expected growth of nominal sales income when the economy expands at its potential level.

This model gives the following reduced form:

$$\pi_{t+1} = \pi_t - \alpha(\pi_t + \widehat{q_{t+1}} - c) + \propto \beta_1 Dd_t - \alpha\beta_2 D(i_t - \pi_t) + \alpha\varepsilon_{t+1} + \varepsilon_{t+1} \qquad (24)$$

Using the same procedure as we did in the Svensson model, it can be shown that optimality is reached when the inflation forecast is equal to the target rate. That is;

$$E_t\pi_{t+1} = \pi_t - \alpha(\pi_t + \widehat{q_{t+1}} - c) + \propto \beta_1 Dd_t - \alpha\beta_2 D(i_t - \pi_t) = \pi^* \qquad (25)$$

However, unlike in the Svensson model where the control lag is two years, it is one year in this model. Solving yields two policy rules, one for the interest rate and the other one for the fiscal deficit ratio;

$$Di_t = D\pi_t + \frac{\pi_t - \pi^*}{\alpha\beta_2} + \frac{\beta_1}{\beta_2}Dd_t - \frac{1}{\beta_2}(\pi_t + \widehat{q_{t+1}} - c) \qquad (26)$$

$$Dd_t = \frac{\pi_t - \pi^*}{\alpha\beta_1} + \frac{\beta_2}{\beta_1}D(i_t - \pi_t) + \frac{1}{\beta_1}(\pi_t + \widehat{q_{t+1}} - c) \qquad (27)$$

Unlike in the Svensson model, setting of interest rate rule in equation (26) also responds to fiscal deficit ratio and the nominal value of potential output. Now since there are two instruments, the Tinbergen instrument-policy rule requires only one instrument to be chosen. If both instruments are found to be significant, the one with a relatively higher impact can be identified by comparing β_1 and β_2 in Equation (24).

3.2.2.2 Supply Side

As mentioned earlier, the Chand and Singh model also incorporates supply side factors as drivers of inflation. This may be the case for Zambia considering that it is a developing country and most studies for developing countries show that cost push inflation may be important in inflation formation. It is assumed that the general price level in the economy is set as a mark-up on average marginal cost, which is the weighted average of marginal costs of all input factors.

To present it mathematically, we have:

$$P_t = A_t \prod_{t=1}^{n} x_{it}^{\alpha i}, where \sum_{i=1}^{n} \alpha_i = 1 \quad (28)$$

Here, X_i is the cost of the i[th] factor; α_i is the share of the i[th] factor in total cost and A_t is a constant capturing the mark up. Mark up is considered to be fairly constant over a long period of time. Taking logs and then differentiating yields an input-based inflation equation. This can be shown as follows:

Taking logs we find; $\ln P_t = \ln A_t + \sum_{i=1}^{n} a_i \ln x_{it}$ (29)

then differencing once to get: $\dot{P_i} = a + \sum_{i=1}^{n} a_i x_i$ (30)

In equation (30), the rate of inflation can be interpreted as a weighted average of the cost inflation of different input factors, and is also influenced by the growth rate of profit margin, a.

3.3 Data and Variable Description

We shall use annual data for the period 1992 to 2008 corresponding to the period after liberalization and the period of monetary targeting.

a) Inflation.

Our measure for inflation denoted 'π' is Consumer Price Index (CPI) Inflation; it is calculated by logging CPI then differencing it and multiplying by 100. This is exactly how inflation is calculated by Bank of Zambia for purposes of policy. Since our data is annual, we get the average of the monthly inflation rates for each year to get the annual inflation rate. It is the dependant variable in our study. But lagged inflation also appears as our lagged endogenous or predetermined variable. According to the adaptive expectations hypothesis, if inflation expectations are formed adaptively, then inflation in the next period is formed on the basis of past inflation values so that economic agents factor it in their transactions and contracts[3].

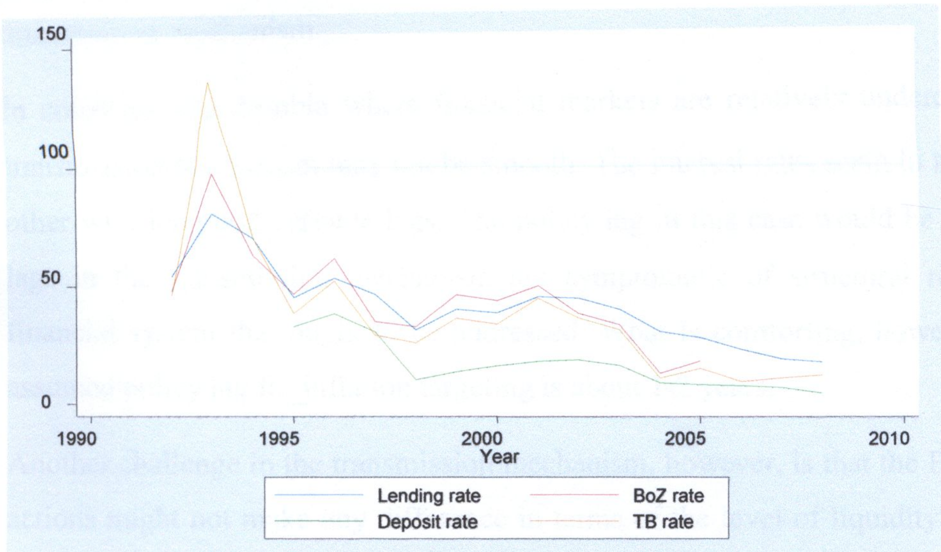
[3] Specifically, an adaptive expectation theory of inflation holds that expected inflation is the weighted average of past inflation, It is given as;
$\pi^e = (1-\Theta)\sum_{i=0}^{x}(\Theta\pi)i$, where π^e is expected inflation, Θ is the weight and (Θπ)i is the weighted inflation of the i[th] period.

The implication is that the expected inflation will become realised, of course with some deviation[4]. In our study, expectations are captured by lagged inflation rate and we expect a positive sign for this variable. We obtained the data on inflation from the Central statistical office (CSO) and Bank of Zambia.

b) Interest Rate

We use the 91day Treasury Bill rate as nominal interest rate denoted 'i'. For inflation targeting, the Bank of Zambia has to chose a policy rate, either TB rate itself or any other interest rate such as the BoZ rate, the overnight rate or the repurchase agreement (repo) rate. Figure 1 below shows the relationship between TB rate, BoZ rate, lending rate and deposit rate. All interest rates appear to be positively related.

Figure 1: Annual Interest rates between 1992 and 2008



Source: Authors own computations.

There might be deviations from the observed relationship in the short run. In the long run, however, there seems to be an error correction mechanism that eventually restores this relationship. This relationship can be traced by analysing the transmission mechanism.

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4 On the basis of the correlogram and indeed inflation targeting theory itself, We adopted a simple adaptive expectation hypothesis where inflation today is determined by inflation in the last period represented;

$\pi_{t-1} = \pi_t + \mu$, where μ is the residual term.

The normal transmission mechanism is that when one interest rate (policy rate) is affected, the other interest rates follow. Changes in these interest rates affect economic activity and eventually inflation. For example, assume BoZ chooses the overnight rate as its target and decides to raise it. In order to do this, it will directly sell securities in the banking sector. This will lead to a reduction in the amount of excess reserves. Less liquidity in the banking sector will raise the overnight rate and then the lending rate so that the amount of money being extended for investment and/or consumption reduces. Moreover, we also expect a rise in the deposit rate so that liquidity is attracted in the banking system. The result is a drop in consumption and investment spending and thus aggregate demand. With a drop in aggregate spending, the rate of increase in prices (inflation) slows. This is called the interest rate channel of the monetary policy transmission mechanism.

In countries like Zambia where financial markets are relatively underdeveloped, this transmission mechanism may not be smooth. The interest rates seem to respond to each other with long and variable lags. The policy lag in this case would be very long. The lags in the transmission mechanism are symptomatic of structural rigidities in the financial system that ought to be addressed. What is comforting, however, is that the assumed policy lag for inflation targeting is about 1-2 years.

Another challenge in the transmission mechanism, however, is that the Bank of Zambia actions might not make any difference in terms of the level of liquidity in the banking system. This is because commercial banks that house government accounts usually have huge sums of money. The implication is that a tightening of monetary conditions would still leave banks with excess reserves. This may have the tendency to cause some interest rates to be unresponsive. The government is in the process of dealing with this problem.

We expect interest rate to be negatively related to inflation rate. We obtained the data on 91 day TB rate from the Bank of Zambia (BoZ).

c) Output Gap

The Output gap denoted 'x' is calculated by taking the natural logarithm of real GDP and subtracting it from its smoothed trend. The smoothed trend is obtained by the Hodrick-Prescott filter and taken to be the potential level of real output. Output measures are GDP at current prices and GDP at constant 1994 prices. We expect a positive coefficient of output gap. This is in line with the convention thinking in the Philips curve hypothesis; Positive output gap indicates an excess aggregate demand and this has a propensity to put upward pressure on prices that can potentially give rise to higher rates of inflation.

On the other hand, negative output gaps indicate excess capacity and exert an importunate downward pressure on prices and as a result, inflation is expected to decline. This means a positive relationship between output gap and inflation. So, we expect the coefficient of output gap to be positive. We obtained the data on GDP from the Central statistical office (CSO).

d) Fiscal Deficit Ratio

The budget deficit ratio is defined as the ratio of government budget deficit to nominal GDP. Government budget deficit is defined as tax revenue plus grants minus expenditure. According to theory, depending on how fiscal deficit is financed, it might lead to inflation. Generally however, high fiscal deficits are inflationary. We expect a positive relationship between budget deficit ratio and inflation so that when the ratio of government deficit to GDP increases, inflation also increases. We obtained the data on deficit ratio from the IMF publications and the Ministry of Finance and National planning.

e) Money Supply

For our measure of money supply we use broad money, M2. This is defined as currency with non banks, demand deposits, bills payable, time deposits, savings deposits and foreign demand deposits. Milton Friedman's common saying is "inflation is everywhere a monetary phenomenon". The monetarist approach to the analysis of the economy is based on this reasoning; that it is the level of money supply in the economy that leads to inflation. According to this theory thus, an increase in money supply is what brings about inflation. So we expect a positive coefficient for money supply. We obtained the data on money supply from the Bank of Zambia (BoZ).

f) Oil Price

We use the average of petrol and diesel pump price as oil price. We then get its natural logarithm and then difference it to get change in oil prices or oil price inflation. Oil is a very important input in the production process. An increase in oil price tends to cause increases in food prices and transportation cost. This has the effect of increasing production cost and producers might, depending on the elasticity of demand, pass on the increases in production costs to the consumers through price increases.

We thus expect a positive relationship between change in oil prices and inflation rate. We obtained the data on oil prices from the Ministry of Energy and Water Development, Department of Energy.

g) Earnings

Wages are commonly used in studies in order to capture the increasing cost of labour. However we did not manage to get data on wages so we used earnings of public sector, parastatal and private sector employees. Earning are in fact said to be better than wages because not only do they capture salaries, but also allowances accruing to workers. The data was gotten from the CSO from their labour market survey publications. Earnings of public sector, parastatal and private sector employees are reported. We calculated the average of all three sectors to get our measure of earnings. Like oil price, we log it and then difference it to get change in earning. Like the oil price, we expect change in earnings to be positively related to inflation so that that if earnings increase, inflation also increases.

h) Fertilizer price

This is employed to represent increasing cost in the agriculture sector. We use the market price of the average of compound D and top dressing fertilizer. The increase in the cost of fertilizer contributes to the increase in the prices of foods such as maize. An increase in the prices of fertilizer causes farmers, including those that don't use fertilizer, to increase the prices of their products. Thus, regardless of the number of farmers that are using it, increases in the fertilizer price is likely to be inflationary. Oil price also complements in capturing the increase in the cost of inputs in the agriculture sector. Like other supply side variables, we log fertilizer price and then difference it to get change in fertilizer prices. We expect change in fertilizer price to be positively related to inflation so that when fertilizer price increases, inflation also increases. We obtained the data on fertilizer prices from the Ministry of Agriculture and Cooperatives.

i) Nominal Excess Demand Growth

Nominal excess demand growth denoted 'ed' is defined as the difference between nominal GDP growth rate y and the growth rate of potential output q valued at the preceding year's rate of inflation[5].When nominal GDP growth rate is greater than nominal potential GDP, then the economy is overheating and there will be a buildup of inflationary pressure. The converse is also true. We thus expect ed to be positively related to inflation; thus, a positive coefficient of ed.

j) Nominal Aggregate Supply Growth

Nominal aggregate supply growth denoted 'nas' is defined as growth rate of potential GDP, q, valued at the preceding year's rate of inflation[6]. The potential output growth rate is a function of technology, labor, and capital inputs, and is taken as exogenously given in the current short-run context. So the fluctuation in nas is as a result of the fluctuation in producer's inflation expectations when valuing q. We expect nominal aggregate supply growth to be negatively related to inflation. This means that when it increases, inflation slows and vice versa.

k) Real effective exchange rate

The theory of exchange rate pass through hold that changes in exchange rate have an effect on inflation. We use the real effective exchange rate (REER) as our measure of exchange rate.

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[5] It is given by $ed_{t+1} = y_{t+1} - (\pi_t + q_{t+1})$, where y_{t+1} is nominal GDP at time t+1, q_{t+1} is growth in potential real output at time t+1 and π_t is inflation at time t.

[6] It is given by $nas_{t+1} = \pi_t + q_{t+1}$, where q_{t+1} is growth in potential real output at time t+1 and π_t is inflation at time t.

The REER is obtained from the nominal effective exchange rate (NEER). The *NEER* is the weighted average of major bilateral nominal exchange rates, with weights determined by trade shares reflecting different level of importance of each currency in a country's international trade. It is a widely used index to assess competitiveness, reflecting the changes in trade flow caused by exchange rate. Real effective exchange rate (*REER*) is obtained by adjusting *NEER* for inflation differentials with those countries. Changes in exchange rate may affect the price level in two ways; (1) directly and (2) indirectly through the trade balance. The direct effect is when depreciation leads to an increase in prices of imported goods while an appreciation leads to a lowering of these prices. The indirect effect is ambiguous and depends heavily on the Marshall-Lerner condition as well as domestic absorption. According to the Marshall-Lerner condition, depreciation can either cause an improvement or deterioration in the trade balance. Depending on domestic absorption, improvement or deterioration in trade balance tends to lead to a rise or drop in aggregate demand and then inflation. Zambia relies heavily on imported goods. This means that a depreciation that improves trade balance is less likely to be inflationary since much of the increase in income is spent on imported commodities. Therefore, exchange rate is more likely to affect inflation through the direct channel. Since we are using quantity quotation, we expect a positive relationship between inflation and exchange rate. We obtained the data on REER from the Bank of Zambia (BoZ).

3.4 Estimation Procedure

On account of its versatility, we used Stata version 10 for data analysis. The method used is Ordinary Least Squares (OLS). Two models were estimated, the Svensson model and the Chand and Singh model. Each model is estimated according to the lag structure given. Where the results are found to be unsatisfactory, the model with the lag structure that best fits the data is fitted. The lag structure for inflation is determined by using a correlogram. For the other variables, we selected the appropriate lag length on the basis of the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC). The selected model has to satisfy all required diagnostic tests. To save on degrees of freedom, since we only have 17 data points, we started with a lag structure of two for each variable and selected the models that satisfied all diagnostic tests and with lowest possible AIC and BIC.

The first step was to estimate the Svensson model. In doing this, we applied Ordinary Least Square (OLS) method to the reduced form of the model in order to test the coefficient of the interest rate and output gap. With the Svensson specified lag structure not satisfactory, we explored models with alternative lag structures and the difference form model with a lag structure of one for all the variables was finally determined.

Failure to establish that output gap is significant in the Svensson model was not taken to mean that demand factors do not play a role in driving inflation in Zambia. Instead, we tested the reformulation of the demand side by Chand and Singh which is thought to be a better structural specification of developing countries' economies. In finding out which interpretation of inflation generating process explains inflation better, we regressed inflation on output gap and then inflation is regressed on nominal excess demand growth. We then compared the explanatory power of the two alternative interpretation of aggregate demand.

In view of the significance of the Chand and Singh interpretation of aggregate demand, we proceeded to estimate the reduced form of the Chand and Singh model with exactly the lag structure specified. The insignificance of the key variables in the model led us to explore other demand side variables that determine ed. Meanwhile, the inflation equation is estimated using only supply side variables. We then combined significant supply side variables with demand side variables as a fully specified inflation model and it is called the Triangle model of inflation[7]. Finally, a parsimonious model is estimated.

3.4.1 Diagnostic Testing

Various diagnostic tests are performed to make sure that our results are valid. Firstly we test all our variables for stationarity to ascertain their order of integration using the

[7] The Triangle model is specified as;
$\pi_t = \delta(L)\pi_{t-i} + \beta(L)d_t + \theta(L)s_t + \varepsilon_t$, where π_{t-i} captures inflation inertia, d_t captures demand factors and $s_t$represents supply factors. $\delta(L), \beta(L), \theta(L)$ are polynomials of the lag operator L with $Lx_t = x_{t-1}$ and ε_t is a white noise error term. See Lown and Rich (1997) for more on the triangle model.

Augmented Dickey Fuller Test (ADF) test. After running each regression, we tested our errors for unit root using the Dickey Fuller Test. We do this because if errors in a regression model are not stationary, then the results are likely to be spurious. However, if errors are stationary, even though the variables being regressed are non-stationary, there would not be any likelihood of spurious regression. Stationarity of errors of a regression model means that the variables in such a regression are cointegrated. We also used the Shapiro-Wilk test for normality (Swilk test) to ensure that the regression residuals are normally distributed. The advantage of this test over the Jarque-Bera test is that it can be used for a sample of between 4 and 2,000 observation while the Jarque-bera test can only be used for large samples. With only 17 sample points, the Swilk test is ideal. Normality tests are required because inferences from regression are valid only if errors are normally distributed. In testing for serial regression, we used both the Durbin Watson d and Breusch-Godfrey test of serial correlation. The Durbin Watson d test for first-order serial correlation in the disturbances assumes that all the regressors are strictly exogenous.

On the other hand, the Breusch-Godfrey test for higher-order serial correlation in the disturbance does not require that all regressors be strictly exogenous. We also performed the ARCH LM test to make sure that there is no autoregressive conditional heteroskedasticity (ARCH) effect in the error terms. An IM test which performs an information matrix test for the regression model and an orthogonal decomposition into tests for heteroskedasticity, skewness, and kurtosis is also conducted. This ensures that there is not only homoskadasticity in our errors but also ascertain the skewness and kurtosis of the distribution. The Ramsey regression specification-error test (RESET) is performed to ensure that the regression models are well specified. Lastly we calculate the variance inflation factor for each regression model to ascertain the level of multicollinearity in our independent variables.

The null hypothesis for the ADF/DF is that there is no stationarity. We reject the null hypothesis and conclude a particular series is stationary and the results significant if the p-value is less than 0.05 and highly significant if less than 0.01.

For all the other tests, the null hypothesis is that there is no problem(for example, no heteroskedasticity), if the p-value is greater than 0.05 we fail to reject this hypothesis and conclude that the results are insignificant to suggesting that a problem exists.

CHAPTER 4

4. EMPIRICAL ANALYSIS

4.1 Introduction

This chapter presents and discusses the empirical findings of this study. Section 4.2 gives an overview of the time series characteristics of the data; we shall focus a little more on inflation since it's our subject. Section 4.3 shall present the results and interpretation of the Svensson model. Section 4.4 Introduces the Chand and Singh model and assesses the effectiveness of the alternative interpretation of the inflation generating process and whether the Chand and Singh Model's reformulation of the demand side explains inflation better in Zambia. It also introduces the supply side variables in the inflation model and the effectiveness of introducing them is evaluated by estimating a triangle model of inflation where supply and demand side variables are combined. A parsimonious model is then estimated.

4.2 Time Series Properties of the Data

4.2.1. Descriptive Statistics

Below is the table of descriptive statistics which reports the Minimum, Maximum, Median and standard deviation of selected variables.

Table 1: Descriptive Statistics of Variables

Variable Name	symbol	Mean	Median	Maximum	Minimum	Standard Deviation
Inflation	π	36.733	24.000	186.000	9.000	43.317
Output gap	x	-0.002	-0.017	0.096	-0.078	0.046
Deficit Ratio	D	-0.019	-0.030	0.200	-0.100	0.069
Change in earnings	**ern**	0.278	0.246	0.768	-0.083	0.216
Change in oil prices	**oil**	0.295	0.255	1.211	-0.041	0.298
Change in fertilizer prices	**fer**	0.185	0.134	0.543	0.034	0.150
Treasury Bill rate	i	38.947	34.300	135.200	9.500	31.423
Nominal aggregate supply	**nas**	22	1	160	-11.71415	50.92971
Nominal excess demand growth	**ED**	-12	-2	7	-135	33.99412

4.2.2. Test for Stationarity

In this section, the variables we are using are tested for stationarity[8]. The need to test for stationarity stems from the fact that economic time series are often non-stationary and regression results with such variables, if they do not co-integrate, are often spurious. Table 2 below presents results for stationarity tests.

Table 2: Unit Root Tests

Variable	ADF	Breusch-Godfrey LM test for Serial Correlation	No. of lags in ADF	Order of integration
π	-4.031(-3.750)***	1.717[0.1900] ^	2	I(0)
x	-3.053(-3.000)**	0.509 [0.4757]^	2	I(0)
De	-3.444(-3.000)**	0.761[0.3829] ^	0	I(0)
Log(earn)	-1.408(-3.750)^	0.001[0.9697] ^	0	I(1)
d.Log(earn)	-4.461(-3.750)***	0.003[0.9529] ^	0	I(0)
Log(poil)	-5.468 (3.750)***	0.004 [0.9494] ^	0	I(0)
Log(pfer)	1.790 (-3.750)^	1.294 [0.2553] ^	0	I(1)
d.Log(pfer)	-3.213(-3.000)**	0.6745[0.2987] ^	0	I(0)
Ms2	4.664(-3.750)	1.287 [0.2565] ^	0	I(1)
d2.Ms2	-8.963(-3.750)	0.883 [0.3475] ^	0	I(0)
reer	-1.712(-3.750)	2.592 [0.1074] ^	0	I(0)
d.reer	-3.251(-3.000)**	0.248[0.6184] ^	0	I(0)
i	-2.101(-3.750)^	0.445[0.5045] ^	0	I(1)
di	-8.963(-3.750)***	1.282 [0.2575] ^	0	I(0)
nas	-2.022(-3.750)^	3.960 [0.0466] **	0	I(1)
d.nas	-5.025(3.750)***	0.292[0.5887] ^	0	I(0)
ED	-3.277(-3.000)**	0.029 [0.8658] ^	0	I(0)

***Significant at 1%, **Significant at 5%, ^ fail to reject the hypothesis. [ ] are p-values while ( ) are critical values

We test using the Augmented Dickey Fuller (ADF) test. When the lag in the ADF is zero, it diminishes to a Dickey Fuller test (DF).

[8] A time series variable is said to be strictly stationary if all moments are independents of time. However, here we are concerned only with weak stationarity were only the first moment about zero 0 (mean) and the second moment about the mean (variance) are constant or independent of time.

These tests assume that there is no serial correlation. We use the Breusch-Godfrey LM test for Serial Correlation to ensure that there is no serial correlation in the ADF model. While the LM test is a test for higher order serial correlation, it is also effective in first order tests like the Durbin Watson d is. The strategy adopted here follows Mwansa (1998) were we test for unit root in the variable with zero lag. If the test shows stationarity without serial correlation we say it integrated of order zero, I (0). Otherwise, we add lags. The lag length is determined by selecting the highest lag length with a significant last lag and with no serial correlation. If not stationary after augmenting, we difference the variable r times. If a variable has to be differenced r times before it becomes stationary, we say it is integrated of order r, I(r). The results are presented in the table 2 below. As can be seen,the variables, Inflation and output gap, are I (0) with two lags in the ADF. All the other variables are either I (0) or I (1).

4.2.3. Inflation and its lag structure

A correlogram can help us with the problem of identifying the process that generates inflation. Broadly viewed, we can use a correlogram to see if inflation is generated by an Autoregressive process of order p[9], AR(P) [10]or Moving Average process of order q, MA (q)[11] or by both processes which become an autoregressive moving average process of order p and q, ARMA(p,q)[12]. Figure 1 presents the correlogram of inflation. The shaded area is the 95% confidence interval for the various lags of inflation. An examination of the correlogram below indicates that only the first lag is significant for the autocorrelation function as well as the partial autocorrelation function. This means that the process that generates inflation can be identified as being an ARMA (1, 1).

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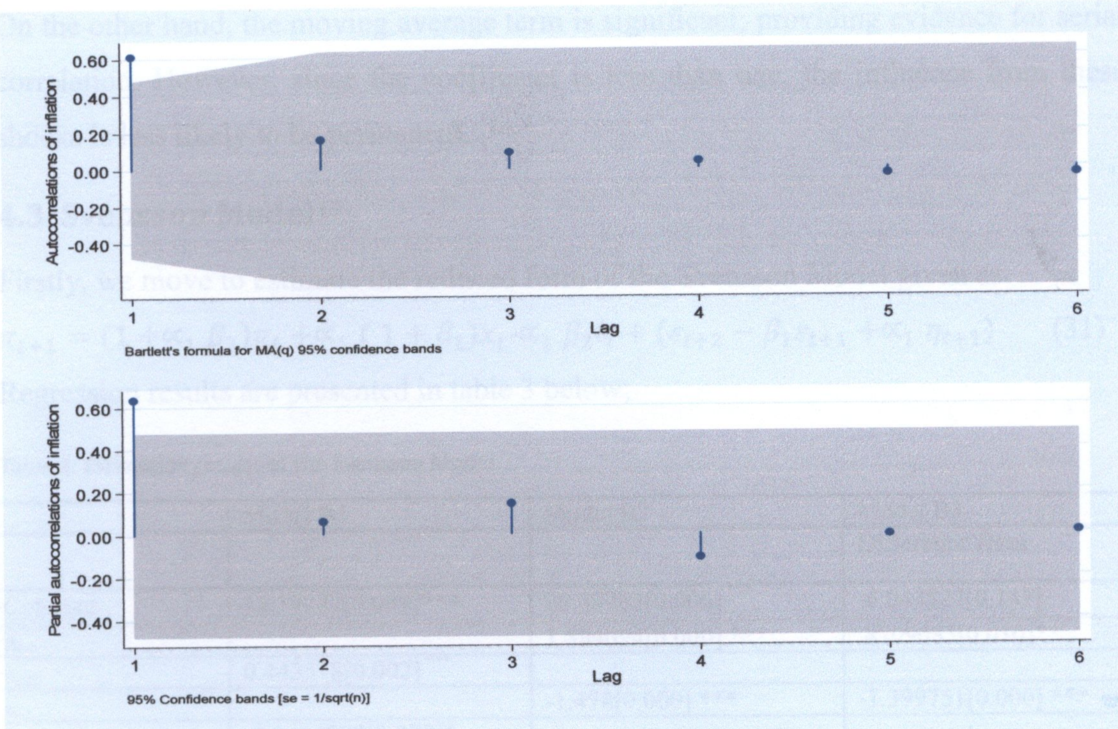
[9] P is the number of lags in an autoregressive model while and q is the number of lags in moving average model.

[10]An AR(P) can be represented as $Y_t = b_1 + b_2Y_{t-1} + b_3Y_{t-2} + \dots\dots\dots + b_{p-1}Y_{t-p}$

[11] An MA(q) can be represented as $Y_t = \mu_t + \mu_{t-1} + \dots\dots\dots + \mu_{t-q} + \alpha$, where α is a white noise term

[12] In general an ARMA (p, q) process is an Autoregressive Integrated Moving Average ARIMA (p, r, q) where r is the order of integration. Since Inflation is I (0) it becomes an ARIMA (p, 0, q) which is equivalent to ARMA (p, q).

Figure 2: Correlogram of inflation showing inflation as ARMA (1, 1)



The fitted ARMA (1, 1) of inflation is;

$\pi_t = 16.96125 + 0.509745\pi_{t-1}$

[0.0000]*** [0.0000] ***

$\mu_t = \varepsilon_t - 0.989818\varepsilon_{t-1}$

[0.0000]*** , where *** indicates significance at 1% levels.

There is strong evidence of persistence of inflation considering that the coefficient of lagged inflation has a p-value of zero. This means that inflation takes a considerable time for it to converge to its long run equilibrium after an initial disturbance. This has consequences for inflation targeting. Tillman (2009) holds 'persistence measures the speed at which shocks to inflation die out and the inflation rate returns to its mean. As such, the nature of inflation persistence is likely to reflect the underlying monetary regime. Strong anti-inflation credibility and well-anchored expectations are generally thought of as reducing inflation persistence'. High inflation persistence in Zambia might be as a result of the failure of monetary targeting in providing an effective nominal anchor.

On the other hand, the moving average term is significant; providing evidence for serial correlation. However, since the coefficient is less than one, the influence from these shocks is less likely to be permanent.

4.3. Svensson Model[13]

Firstly, we move to estimate the reduced form of the Svensson Model given as:

$$\pi_{t+1} = (1 + \propto_1 \beta_2)\pi_t + \propto_1 (1 + \beta_1)x_t - \propto_1 \beta_2 i_t + (\varepsilon_{t+2} - \beta_1 \varepsilon_{t+1} + \propto_1 \eta_{t+1}) \quad (31)$$

Regression results are presented in table 3 below;

Table 3: Estimation results of the Svensson Model

	Model B1	Model B2	Model B3 Difference form
Constant	13.19732[0.009]***	20.89263[0.006]***	-6.043827[0.147]
π_{t-1}		1.584094[0.000] ***	.8709683[0.010]**
π_{t-2}	0.443578[0.002]***		
I_{t-1}		-1.478[0.000] ***	-1.399751[0.000] ***
I_{t-2}	-0.2464002[0.085]*		
X_{t-1}		-401.7868[0.010]**	19.82287[0.907] ^
X_{t-2}	-194.2202 [0.045]**		
R^2	0.7331	0.9174	0.8733
Adjusted R^2	0.6603	0.8967	0.8388
F-statistic	10.07[0.0017]***	44.41[0.0000]***	25.28[0.0000]***
Ramsey RESET test	0.46[0.7187] ^	1.39[0.3012] ^	0.84[0.5032] ^
LM test for ARCH	0.169[0.6809]	0.280[0.5969] ^	1.564[0.2110] ^
Breusch-Godfrey LM test for Serial Correlation	1.001[0.3171] ^	2.423[0.1196] ^	0.018 [0.8922] ^
Durbin-Watson d	1.722794	1.548815	2.004912
Orthogonal decomposition IM test (Hetero, skewness, Kurtosis)	1.39 [0.8457] ^	0.95[0.9170] ^	3.13[0.5361] ^
Shapiro-Wilk W test for normality	0.308 [0.37889] ^	-0.904 [0.81712] ^	-1.589 [0.94395] ^
Residual unit root	-4.660[0.0001]***	-3.308[0.0145] **	-3.465[0.0089]***
Variance inflation factor (VIF)	1.00	1.00	1.00

***Significant at 1%, **Significant at 5%, ^ fail to reject the hypothesis. [ ] are p-values while ( ) are critical values

[13] Inflation is the dependent variable for all the models we are running hereafter.

Model B1 has the lag structure as that presented by Svensson in equation (31) above. We are interested in the signs and significance of lagged inflation, nominal interest rate and output gap. It can be seen that the model as a whole is highly significant as indicated by the p-value of the F statistic. The diagnostic tests show that the model is well specified with the residuals showing no evidence of; serial correlation, non-stationarity, ARCH effect, heteroskedasticity and non-normality. The RESET test shows that the regression model as whole is not misspecified with 66 percent of variations in inflation been explained by the model. Further, the low variance inflation factor (VIF) shows that there is no evidence of multicollinearity among the explanatory variable. The coefficients of lagged inflation and interest rate are both significant with the expected signs. However lagged output gap though significant, has a negative sign when we expect a positive one. The coefficient is also highly biased. We thus fit model B2 with the inflation rate being lagged one period according to the results of our correlogram which shows that inflation in Zambia has an AR (1) term. Interest rate and output gap are also lagged one period. The results show that interest rate becomes highly significant and returns the correct sign. One period lagged inflation is also highly significant while lagged output gap maintains its significance and an unexpected sign. This model has more explanatory power than B1 with 89.7 percent of the variations in inflation being explained by the explanatory variables. While all the other diagnostic tests are met, the Durbin Watson d of 1.548815 shows some evidence of first order serial correlation in the residuals of this model. We thus take this model in its first difference form to get Model B3. The improvement of the Durbin Watson d to 2.0049 is noteworthy. All diagnostic tests are met. Firstly, as can be seen in table 3, the coefficient of lagged inflation and interest rate remain significant with the expected signs. However, output gap becomes insignificant, albeit with the correct sign.

We now compare model B3 with model B1. On the overall, the model with the lag structure specified in Model B3 seems to perform better than model B1 as it explains 83.9 percent of the variation in inflation as compared to 66 percent for model B1. On the overall, the p-values of the F-statistics for the two models shows that model B3 is more superior. Model B3 is thus our preferred model.

We run rolling regressions for the two specifications, model B1 and Model B3. A rolling analysis of a time series model is often used to assess the model's stability over time. We use a window period of 5. The method employed here is recursive least squares. Recursive because we are holding the starting period of the estimation fixed while the window grows from 5 to 17. We present the recursive least square estimates in the tables below while the plots for each of the two models; B1 and B3 are presented in the appendix.

Table 4: Recursive least squares of model B1

	start	end	b_inf	b_I	b_x	_b_cons
1.	1992	1996	.0994901	-.3313164	0	61.28881
2.	1992	1997	-5.278545	1.154653	4026.922	477.3615
3.	1992	1998	.4065625	-.3372954	-141.1343	22.82695
4.	1992	1999	.3539431	-.3279828	-99.63333	27.12292
5.	1992	2000	.3640433	-.3200818	-105.1717	25.28063
6.	1992	2001	.3775892	-.3228774	-110.7353	23.82389
7.	1992	2002	.3891619	-.3247843	-117.5212	22.69461
8.	1992	2003	.366703	-.3101408	-102.4395	23.74878
9.	1992	2004	.3832608	-.3160135	-113.6294	22.55482
10.	1992	2005	.3983635	-.3172446	-126.3263	21.27379
11.	1992	2006	.4197085	-.2592586	-165.5242	15.85878
12.	1992	2007	.4404644	-.2464412	-190.8745	13.42311
13.	1992	2008	.443578	-.2464002	-194.2202	13.19732

Table 4 collects ordinary least square coefficients of 13 recursive samples for the period 1992 to 2008. Coefficients of lagged inflation and interest rate appear stable throughout the period.

The rolling analysis for model B3 is given below;

Table 5: Recursive least squares of model B3

	start	end	b_inf	b_i	b_x	_b_cons
1.	1992	1996	.858435	-1.463412	0	-14.79779
2.	1992	1997	.6827779	-1.424878	142.3734	-13.90338
3.	1992	1998	.719393	-1.402225	90.9216	-15.7675
4.	1992	1999	1.050669	-1.545125	-78.17694	-9.275768
5.	1992	2000	1.160574	-1.587295	-118.4551	-4.960111
6.	1992	2001	1.157666	-1.585171	-118.0564	-5.09675
7.	1992	2002	1.069281	-1.543322	-48.36384	-2.437243
8.	1992	2003	.9891082	-1.496383	-16.87757	-4.221043
9.	1992	2004	.9689439	-1.479792	-14.97289	-5.071571
10.	1992	2005	.8947625	-1.398093	-11.61443	-7.488634
11.	1992	2006	.8978553	-1.398936	-11.10464	-7.12247
12.	1992	2007	.8679371	-1.395852	14.64055	-6.615632
13.	1992	2008	.8709683	-1.399751	19.82287	-6.043827

As we did in table 4, in table 5 we collects coefficients for the 13 recursive samples for model B3. It can be seen that lagged inflation and interest rate have the correct signs in all the sub samples. The coefficient of interest rates appears stable and significant throughout the period for model B3. The upward bias in the coefficient of interest rate is eliminated as the sample advances to 2008.

Evaluation of the Svensson Model in the Zambian Context

While the coefficient of interest rate has been found to be significant with the correct sign in the Svensson model giving prospect for the use of nominal interest rate as a monetary policy instrument, the coefficient of output gap has been found to be insignificant in our preferred model B3 and with a wrong sign in the model with the Svensson specified lag structure, model B1. But it is the output gap that is emphasized as driving inflation by the proponents of inflation targeting[14]. In fact, it is the output gap concept that they use to model aggregate demand in the economy. Should we then say that aggregate demand is insignificant in generating inflation in Zambia? Chand and Singh (2005) have argued that using output gap to model aggregate demand in developing countries amounts to structural misspecification. Thus before we conclude that inflation is not demand driven by using the output gap concept, we introduce what can be called the "alternative interpretation of the inflation generating process"- nominal excess demand growth (ed).

4.4 Chand and Singh Model

4.4.1 Demand Side

Model B4 in table 6 below shows the Svensson's interpretation of the inflation generating process in terms of output gap while model B5 is the Chand and Singh interpretation in terms of Nominal excess demand growth (ed). It can be seen that while for both models lagged inflation is significant, the coefficient of the output gap is insignificant for model B4 while that of ed is highly significant in model B5.

[14] Specifically, this understanding is derived from a variant of the Phillips curve which specifies that there is a stable and predictive positive relationship between inflation and output gap. This is specified as;

$$\pi = \pi^e + \delta(y - y^f),$$

Where π is inflation, π^e is expected inflation, δ is a constant and $y - y^f$ is the output gap; the deviation of actual output y from potential y^f.

The Svensson's interpretation can be seen to explain 74.4 percent of the variations in inflation while the alternative interpretation in model B5 explains 98.2 percent of the variations in inflation. We can thus conclude that demand is important in generating inflation in Zambia and the Svensson interpretation misspecifies the demand side of the inflation generating process in Zambia. We now move to fit the Chand and Singh specification of the demand side.

Table 6: Estimation results of the alternative interpretation and Chand & Singh Model demand side

	Model B4	Model B5	Model B6	Model B7
constant	15.29[0.000] ***	-4.61[0.040]	-53.81[0.102] ^	-147.95 [0.031]**
π_{t-1}	0.26 [0.000] ***	1.19[0.000] ***	3.38[0.033]**	6.89 [0.034]**
REER				0.28 [0.082]*
X_{t-1}	-60.93[0.177] ^			
nas			-3.18[0.050]*	-5.84 [0.068]*
i_{t-1}			-0.029 [0.719] ^	-1.31[0.000] ***
Dd_{t-1}			-3.77 [0.828] ^	
ed		1.14[0.000] ***		
R2	0.7803	0.9840	0.8691	0.9256
Adjusted R2	0.7437	0.9815	0.8168	0.8986
F-statistic	21.31[0.000] ***	399.81[0.0000] ***	16.60[0.0002] ***	34.23[0.0000]***
Ramsey RESET test	0.80[0.5231] ^	0.85[0.4987] ^	1.45[0.2923] ^	1.16[0.3720] ^
LM test for ARCH	0.12 [0.7284] ^	0.009[0.9257] ^	0.086 [0.7688] ^	0.006[0.9378] ^
Breusch-Godfrey LM test for Serial Correlation	1.24 [0.2655] ^	0.344[0.5575] ^	0.002 [0.9661] ^	2.703 [0.1001] ^
Durbin-Watson d	2.032076	2.055603	1.833686	1.74533
IM test (Hetero, skewness, Kurtosis)	6.40 [0.1712] ^	5.25[0.2623] ^	6.52 [0.1633] ^	1.81 [0.7705] ^
Shapiro-Wilk W test for normality	1.57 [0.05771] ^	0.755 [0.22505] ^	-0.737[0.76958] ^	-0.415[0.66083] ^
residual unit root test	-2.84[0.0535]*	-4.44[0.0003] ***	-4.392[0.0003] ***	-3.349[0.0128]**
Variance inflation factor (VIF)	1.03	2.26	739.45	904.18

***Significant at 1%, **Significant at 5%, *Significant at 10%, ^ fail to reject the null hypothesis.

The reduced form of the Chand and Singh demand side specification is:

$$\pi_{t+1} = \pi_t - \alpha(\pi_t + \widehat{q_{t+1}} - c) + \propto \beta_1 Dd_t - \alpha\beta_2 D(i_t - \pi_t) + \alpha\square_{t+1} + \varepsilon_{t+1}$$

The estimated results of this regression are presented as model B6 above. In this model only two variables are significant; lagged inflation and nominal aggregate supply (nas) defined as growth in potential output valued at the previous year's inflation (which as seen is a determinant of ed). The coefficient of nas as well as lagged inflation has the expected sign. Of note however, is the insignificance of the coefficient of fiscal deficit ratio. This has implications on the policy instruments that are derived in the Chand and Singh model. It means that the policy instrument of fiscal deficit ratio would not be appropriate for Zambia. Further, that the interest rate does not need to be modified in order for it to respond to fiscal deficit ratio as suggested by Chand and Singh. Under standard inflation targeting however, this is good news; no fiscal dominance. Fiscal dominance dampens the effectiveness of inflation targeting. All diagnostic tests have been satisfied except that the variance inflation factor is extremely high suggesting possible multicollinearity.

Given that the reduced form of the Chand and Singh has not performed well despite the fact that the interpretation of aggregate demand in terms of ed is significant in driving inflation, we move to investigate other demand variables that affect ed and thus inflation. Exchange rate is said to affect aggregate demand because an appreciation (depreciation) leads to low (high) competiveness in exports which, depending on the elasticity of exports, can cause a reduction (increase) in aggregate income, and in this case ed, and subsequently inflation. [15]. However, the net effect of a depreciation or appreciation depends on the Marshall- Lerner condition. An appreciation (depreciation) can also reduce (increase) the price of imported goods leading to a reduction (increase) in inflation. We thus introduce real effective exchange rate (REER) in the model. We also introduce money supply (M2). This undertaking is based on the quantity theory of money and the subsequent understanding by the quantity theorist that money supply changes affect nominal income (a component of ed) and thus inflation rate. Fiscal deficit ratio has been found to be insignificant in the Zambian situation.

[15]"Pass through" is the term used to describe the effect of exchange rate changes on inflation.

This is possibly due to its low levels in the sample period. Moreover as noted in the literature, the relationship between fiscal deficit and inflation depend on how the budget deficit is financed. In our sample period, fiscal deficit has been financed mainly by borrowing on the financial markets. Fiscal deficit is more likely to be inflationary if it is financed by printing money. In this vein, we arrive at model B7 in table 6 above. We dropped money supply due to high multicollinearity but we introduce it later. The model shows that all the variables; lagged interest rate, lagged inflation, real effective exchange rate, and nominal aggregate supply growth are all significant with the expected signs. All diagnostic tests are satisfied.

Thus, we can conclude that our results show that inflation in Zambia is demand driven. But the question that is still unanswered is: are supply side variables insignificant in the determination of inflation so that their effect can be considered white noise? We address this question in the next section.

4.4.2 Supply Side

The Chand and Singh model also has a supply side. As has been indicated, the Chand and Singh model attempts to estimate what is called a Triangle model of inflation which models expectations, demand factors and supply side factors as determinants of inflation. This is contrary to the conventional thinking of the Phillips curve approach where only demand factors and expectation are modeled while supply side factors are not explicitly brought in the analysis. They are left in the error term as supply shocks. The reasoning behind the Chand and Singh model is that while in developed countries supply side variables can be considered white noise, they can be significant in developing countries. In this vein, the rate of inflation can be interpreted as a weighted average of the cost inflation of different inputs.

Model B8 in table 7 below presents regression results of supply side variables. We find that only change in oil prices has a significant impact on inflation. The variables, change in earnings and change in price of fertilizer are not significant.

We then combine change in oil prices, the only significant supply side variable, with demand side variables to come up with model B9. When combined with demand side variables, even change in oil prices becomes insignificant. This might validate the assertion that the supply shocks such as oil prices are white noise. They affect inflation, but their effect is only transitory.

Table 7: Estimation results of the Chand and Singh supply side and the parsimonious model

	Model B8	Model B9	Model B10 First difference	Model B11 First difference
constant	-4.19 [0.676] **	-16.17[0.276] ^	-3.781333 [0.299] ^	-2.2072[0.293] ^
Π_{t-1}		1.13 [0.000] ***	1.066039 [0.000] ***	1.095 [0.000]***
D(Log(FER))	-14.76 [0.671] ^			
D (Log(OIL))	123.22 [0.000]***	7.14[0.643] ^		
D (Log(EARN))	26.32[0.369] ^			
ed		0.98[0.001]***	0.6905656[0.002] ***	.72609[0.000]***
$Reer_{t-1}$		0.079 [0.339] ^	0.0274857 [0.783] ^	
i_{t-1}		-0.13[0.469] ^	-0.5925218 [0.019]**	-0.569 [0.008]***
Ms2			.0000134 [0.546] ^	
R^2	0.8533	0.9858	0.9670	0.9654
Adjusted R^2	0.8133	0.9779	0.9487	0.9560
F-statistic	21.33[0.0001] ***	125.14[0.0000] ***	52.78[0.0000] ***	102.31[0.0000]***
Ramsey RESET test	2.97[0.0895]*	1.01 [0.4313] ^	1.36[0.3157] ^	1.37[0.3129] ^
LM test for ARCH	0.102[0.7499]^	0.409 [0.5224] ^	0.558 [0.4550] ^	0.794 [0.3730] ^
Breusch-Godfrey LM test for Serial Correlation	0.263 [0.6078] ^	0.504 [0.4777] ^	0.666[0.4144] ^	0.649 [0.4205] ^
Durbin-Watson d	2.043022	2.044852	2.265624	2.005181
Orthogonal decomposition IM test (Hetero, skewness, Kurtosis)	2.75 [0.6010] ^	1.80[0.7732] ^	4.07 [0.3961] ^	3.25 [0.5162]^
Shapiro-Wilk W test for normality	-1.599[0.94511] ^	-1.033 [0.84913] ^	0.812 [0.20838] ^	-0.075 [0.52992]^
Cointegration test (residual unit root)	-3.196[0.0202]**	-3.89[0.0021] ***	-3.967[0.0016] ***	-4.066[0.0011]***
Variance inflation factor (VIF)	1.32	9.38	6.39	1.00

***Significant at 1%, **Significant at 5%, *Significant at 10%, ^ fail to reject the null hypothesis.

We are now in a position to answer the question; are supply side variables insignificant in the determination of inflation in Zambia? Our results show that indeed, supply side variables are insignificant in the determination of inflation in Zambia so that their effect can be considered white noise.

Lastly we remain to ascertain which variables remain significant. Model B10 presents results for all the demand side variables including money supply. The model is presented in first difference form as the RESET test shows evidence of specification error when the model is estimated in level form. In difference form, all diagnostic tests are satisfied. The model shows that while change in lagged inflation, change in nominal excess demand growth and lagged interest rate are significant, the change in money supply and change in real effective exchange rate are not significant in explaining changes in inflation. Thus, we fit a parsimonious model, a model consisting of only significant variables, and the results are presented as model B11.

The most notable diagnostic test is the variance inflation factor of 1 eliminating any possibility of multicolinearity. It is the lowest for all the models we have estimated. All the other diagnostic tests are satisfied with the explanatory variables explaining 95.6 percent of the variations in inflation. The F-statistic shows that the model as a whole is highly significant. The model shows that that when interest rate reduces (increases) by 1 percentage point in the current year inflation increases (decreases) by about 0.57 percentage points in the following year. When growth in nominal excess demand increases (decreases) by 1 in the current year, inflation increases (decreases) by about 0.73 percentage points in the following year. Inflation here, like in most empirical studies, shows a coefficient of more than unity, to be exact 1.095. This has come to be termed "upward bias of inflation".

We now undertake a rolling analysis and the graph of the recursive least square coefficients is given in the appendix. Recursive least squares for the thirteen sub samples in our data are collected and present in table 8 below.

Table 8: Recursive least squares of model B11

	start	end	b_inf	b_i	b_ed	_b_cons
1.	1992	1996	1.517916	0	1.340215	17.81857
2.	1992	1997	.9841046	-1.184547	.2553892	-8.582465
3.	1992	1998	.9837087	-1.12253	.2955755	-8.849176
4.	1992	1999	1.039494	-1.042303	.382476	-6.071719
5.	1992	2000	1.090158	-.8810598	.5196639	-3.610998
6.	1992	2001	1.092511	-.8842751	.5187852	-3.470381
7.	1992	2002	1.124784	-.7286695	.6377395	-.838925
8.	1992	2003	1.10806	-.6916432	.6522706	-1.63019
9.	1992	2004	1.092482	-.6743245	.6545173	-2.388554
10.	1992	2005	1.083078	-.5817279	.7098306	-2.896617
11.	1992	2006	1.081642	-.5841985	.7074907	-2.98627
12.	1992	2007	1.087369	-.5747814	.7183105	-2.597446
13.	1992	2008	1.095331	-.5691338	.7260966	-2.207265

In the table, b_inf are the coefficients of inflation, b_i are the coefficients of interest rate, b_ed are the coefficients of the growth in nominal excess demand and _b_cons are the coefficients of the constant term. All variables are in first difference form. The table shows that all the coefficients have remained stable throughout the sample period.

Our parsimonious model demonstrates that inflation in Zambia is demand driven. Supply shocks, though with an effect on inflation, are simply white noise. It also shows that expectations are an important determinant of inflation. Lagged inflation shows inflation expectation while nominal excess demand growth (ed) has a component of producer inflation expectations. The significance of coefficients of these variables reviews the importance of expectations as drivers of inflation. In this case, the expectations are adaptive in nature. Change in interest rate is also significant and with a coefficient of less than unity (no bias) and a correct sign. Change in lagged Inflation has a coefficient of about one as postulated in our model. This is called the "inflation bias". Change in nominal excess demand growth has a coefficient of less than unity and the correct sign. This is actually the key driver of inflation which replaces the Philips curve version of output gap.

Of particular interest is the significance of interest rate. When TB rate is adjusted, our policy rate in this case, inflation changes. Other interest rates will also change in response to a change in the policy rate. The change in other interest rates is expected to cause changes in consumer and investment spending. Of the many interest rates that change, lending rate is of special interest to us since it represents the cost of finance. It deserves a little discussion.

The lending rate is very high and beyond the reach of many small businesses and farmers. While big businesses and commercial farmers get concessional rates, small ones are generally left to face the high cost of borrowing. This high cost of business finance is also compounded by difficulties faced by these small businesses in their access to credit. They are usually required to have collateral or fulfill many stringent requirements which in general, they cannot fulfill. Therefore, even though lending rate is responsive to other interest rates, it might not be very effective in affecting investment. What matters is that the lending rate does not apply to many small businesses and consumers. It must be noteworthy that small businesses constitute a considerable proportion of Zambia's economic activity. Recent literature has demonstrated that the informal sector is a very significant portion of the economy that cannot be ignored. What happens therefore is that such small businesses rely on informal credit arrangements which are not affected much by monetary policy. Some of these arrangements increase the cost of finance as interest rates go as far as 100%. An example of such an arrangement is "*Kaloba*"[16]. It would be very helpful to make credit accessible and cheaper for small businesses.

[16] "*Kaloba*" is a term used to describe informal credit arrangement in Zambia where if one borrows money, he/she is expecting to pay an interest of between 50-100% plus principle at the end of the month.

CHAPTER FIVE

5.1 Conclusion and Policy Options

We had two specific objectives in this study. Firstly, we wanted to find out if supply side inflation drivers in Zambia dominate demand side factors to make inflation targeting inapplicable. Secondly, we wanted to determine if the fiscal deficit ratio is significant enough to warrant a modification of the policy rule of inflation targeting. We addressed these concerns by fitting two competing models; the Svensson model and the Chand and Singh model.

We first estimated the Svensson model which is considered as the standard theoretical formulation of inflation targeting. This model assumes that inflation is demand driven and supply side shocks are white noise. By demand driven, it is meant that lagged inflation and output gap are the drivers of inflation. Thus, to control inflation, nominal interest rates are adjusted to respond to output gap and the deviation of expected inflation from target; this is the policy rule. We then brought in the Chand and Singh model into the analysis. This model has a demand side and a supply side. The demand side of the Chand and Singh model does two things: firstly, it reformulates the Svensson demand side by introducing nominal excess demand growth as a driver of inflation in place of output gap. The argument is that the output gap concept is a structural misspecification of the inflation process in developing countries. Secondly, it introduces fiscal deficit in the demand space. Granted therefore, a policy rule that does not respond to fiscal deficit is less likely to be effective. The Chand and Singh model also has a supply side. The reasoning is that supply side inflation drivers can be very significant even to render inapplicable the inflation targeting framework.

Our major finding is that inflation targeting is applicable. In general, we have found that inflation is demand driven and a nominal interest rate can be used as a policy rule. However, it might not be appropriate to view inflation as being generated by output gap. The more realistic view is that inflation is generated by nominal excess demand growth as construed by Chand and Singh. This finding, however, does not invalidate Svensson's formulation; it in fact, consolidates it by identifying the correct demand driver of inflation in Zambia. Despite the good explanatory power of the Chand and

Singh interpretation of the inflation generating process, the fiscal deficit ratio was not significant. The insignificance of fiscal deficit ratio means that there is no need to modify the policy rule of inflation targeting so that the policy rate also responds to fiscal deficit. We explored other factors that might explain inflation directly or through the aggregate demand channel. While real effective exchange rate was significant in our initial model, it turned out to be insignificant in the model that we finally estimated and we did not include it in our parsimonious model. Money supply was also found to be insignificant in explaining inflation. Literature shows that the link between monetary aggregates and inflation is no longer clear. This has implications for the current framework where the setting of monetary targets indicates the direction of monetary policy. We have also found persistence to be very high under this framework. The adoption of inflation targeting would thus reduce the persistence of inflation.

As to whether the supply side factors are significant to make ITF inapplicable, our results show that of all supply side variables, only oil price inflation is significant in explaining inflation. But when allowed to simultaneously determine inflation with demand side variables, it becomes insignificant. However, the insignificance of the supply side factors does not mean their continued insignificance even in future.

Lastly, the significance of interest rate gives prospects of its use as a policy rule. One would argue that our financial markets are not deep enough since most people do not have access to the banking system. While this is true, the more relevant question rests on determining what ratio of GDP is handled by the banking sector. It must be noted that large commercial farmers, manufacturers and miners that control a large proportion of the GDP interact with the banking system. While we used the Treasury bill rate for our analysis, any other interest rate can be chosen as a policy rate. There are practical challenges that have to be faced, however, in implementing an interest rate policy. One of these is the huge liquidity overhang in the banking system that gives less or no incentive for interbank borrowing or borrowing from the central bank. This problem arises from government wings that deposit money which remain unused for several months in a year. This might make rates such as the interbank rate and the Bank of Zambia rates less potent as candidates for the policy instrument.

The Government is trying to deal with this problem. The way this will work is that if the government releases money to a particular department's account at a commercial bank and the money is not used within a specified period of time, the account will be automatically debited. At the same time, the Government account at BoZ will be credited with the same amount. The Bank of Zambia hopes that if this works out, the discount window would be utilized by commercial banks. This will improve the efficacy of the BoZ rate.

The other interest rate BoZ is considering is the overnight rate. Its effectiveness is also determined by liquidity conditions in the banking system. The TB rate would be a good target but it is not under the full control of BoZ. For inflation targeting to work, instrument independence is very important. With TB rate under the control of government, instrument independence is not assured.

The Bank of Zambia has to confront the challenge of an absence of a smooth transmission mechanism. There are various distortions in the transmission mechanism that are generally symptomatic of inefficiency. One of these is a very slow response of interest rates to changes in key interest rates. It should be noted, however, that the coming in of new big banks is likely to improve competition and hopefully, the inefficiencies might wear out.

The other problem seems to be information asymmetry. The lack of perfect information on the part of consumers on which banks are offering which products and at what rates is probably one of the important inefficiencies that ought to be addressed. The Government and the Bank of Zambia should consider finding ways of dealing with information asymmetry in the banking system.

5.2 Appendix

Figure 3: Recursive plots of Model B1-Svensson Model

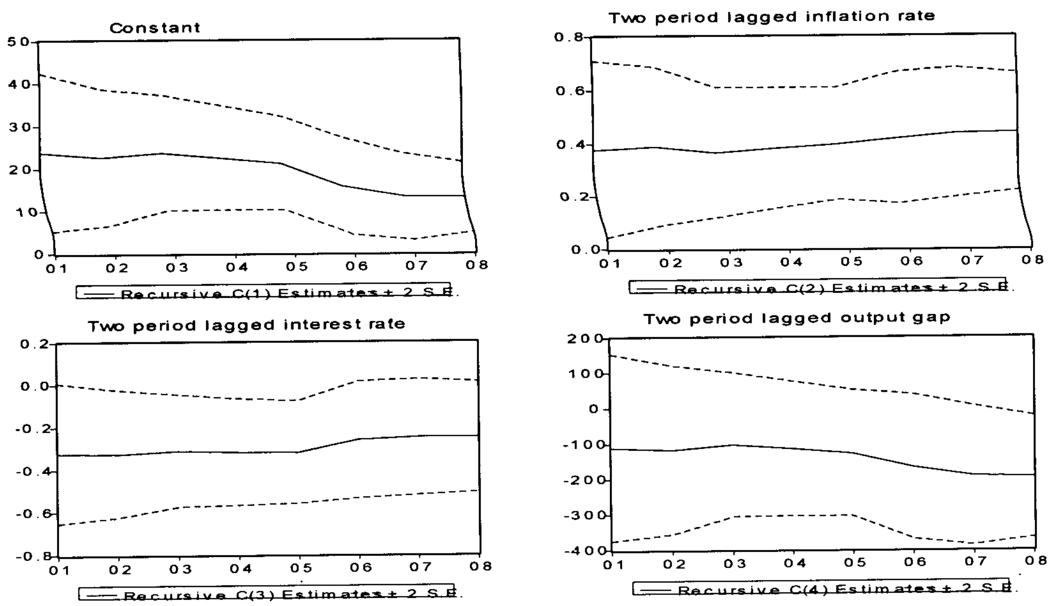


Figure 4: Recursive plots of model B3-Svensson model

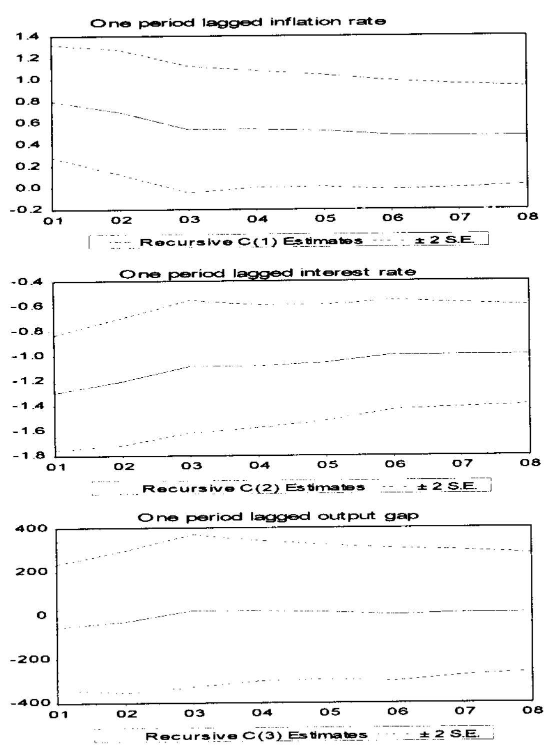
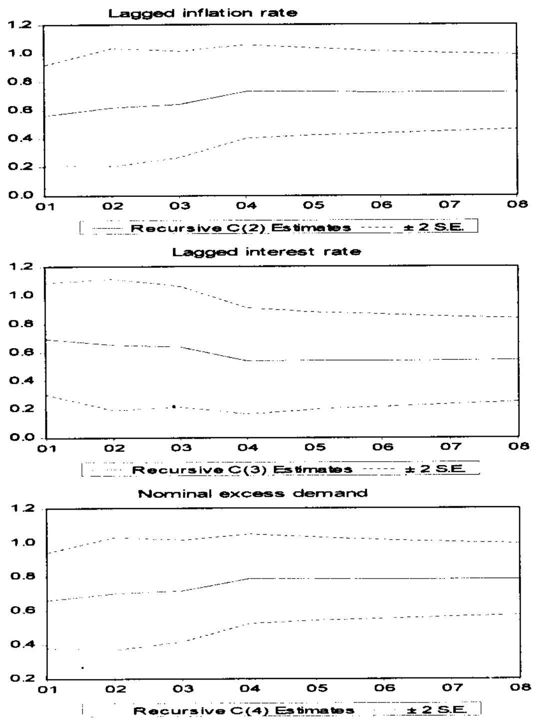


Figure 5: Recursive plots of model B11-Parsimonious model



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