Modelling and Forecasting Inflation in Tanzania: A Univariate Time Series Analysis.

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MODELLING AND FORECASTING INFLATION IN TANZANIA

A Univariate Time Series Analysis

By

Deogratius Wenceslaus Hinsley Kimolo

A Dissertation Submitted in (Partial) Fulfilment of the Requirements for the Degree of Master of Arts (Economics) of the University of Dar es Salaam

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September, 2011

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the University of Dar es Salaam a dissertation/thesis entitled: ***Modelling and Forecasting Inflation in Tanzania, a Univariate Time Series Analysis,*** in fulfilment of the requirements for the degree of Master of Arts in (Economics) of the University of Dar es salaam**.**

………………………………………….

Dr. Jehovaness Aikaeli

(Supervisor)

Date: -----------------------------

DECLARATION

AND

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I**, Deogratius W.H. Kimolo**, declare that this thesis is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

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ACKNOWLEDGEMENT

Pursuing M.A. programme in Economics is both painful and enjoyable experience. I would never have been able to finish my programme without the guidance of my Almighty God. God continues to make my life more beautiful and worth living. May your name be exalted, honoured, and glorified oh Jehovah. Psalm 106:1, *Praise the Lord! Oh, give thanks to the Lord, for He is good! For His mercy endures forever.*

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Lastly, any error or omission in this study is solely mine and should not therefore be related to any other person or institution.

DEDICATION

This study is dedicated to my beloved father, the late Mr. Wenceslaus H. Kimolo, my beloved mother, Irmina Gutta without whom i would not be who i am today, this dissertation is also dedicated to my beloved sister, the late Grace Kimolo though no longer with us, remains the compass of my life. I love you all.

ABSTRACT

Modelling and forecasting inflation remains a vital concern in most of developing country economies. Moreover, better understanding of country's inflation situation and future inflation can facilitate the policy makers to adopt appropriate policy measures to curb the problem. The study supplements the financial programming framework of the Bank of Tanzania by ascertaining the model that incorporates some key behavioural properties that are necessary in forecasting inflation.

The study employs the Box-Jenkins (1976) methodology that involves stages of identification, estimation, diagnostic checking, and forecasting of a univariate time series.

Findings of the study suggest that during the sample period the monthly inflation rate in Tanzania was non-stationary at level but stationary after taking the first difference, results indicate also that the model that contains AR (1, 3, 8, and 15) and MA (1 and 12) components outperformed other models in both in-sample and out-sample forecasts. Six months out-of-sample inflation forecasts are also provided by the study.

The study recommends the government through the Bank of Tanzania to adopt the flexible form of inflation targeting so as to improve the design and performance of monetary policy towards attainment of price stability. Results also indicate that inflation is expected to rise in the next six months; hence there is a need for government to react immediately to these inflationary pressures through appropriate fiscal and monetary policies.

TABLE OF CONTENTS

Page

Page

Page

Page

LIST OF TABLES

[1] Inflation statistics are in percentage.
[2] These are results obtained from the model that contains AR (1, 3, 8, and 15) and MA (1 and 12) components.

LIST OF FIGURES

Page

LIST OF APPENDICES

Page

CHAPTER ONE

INTRODUCTION

1.0 Background

Inflation constitutes one of the foremost economic problems in [3]emerging market economies. This has required monetary authorities to use tools and policies to put a stop to high prolonged and volatile inflation. The negative consequences of inflation to the economy are well known. Inflation can result in a decrease in the purchasing power of the national currency leading to the aggravation of social conditions and living standards. High prices can also lead to uncertainty that makes domestic and foreign investors reluctant to invest in the economy thus affecting investment, growth and poverty thereof. Moreover, inflated prices worsen the country's terms of trade by making domestic goods expensive on regional and world markets.

In Tanzania, inflation is one of the major macroeconomic problems that dominated the country especially during 1970's to 1990's. Inflation reached the highest level of 44.6 percent ever experienced in the economy in April 1985. From 1985 inflation continued to be high in double digits level before declining to single digit level of 9.1 percent in January 1999. Huge budget deficits, external shocks, especially during the first and second oil price shocks of 1973-74 and 1979, Kagera war of 1979, excessive government borrowing and structural rigidities are some of the reasons that caused and sustained high rates of inflation since the late 1970's. Inflation rose from

[3] Emerging markets are countries that are restructuring their economies along market-oriented lines and offer a wealth of opportunities in trade, technology transfers, and foreign direct investment

30.2 percent in January 1980 to 36.4 percent in January 1981.With tight fiscal and monetary policy framework inflation continued to decline from 9.1 percent to a lowest level of 3.4 percent in June 2004. However, since June 2004, inflation started to gain momentum and increased from 3.4 percent to 12.2 percent in December 2009. From January 1980 to December 2009 inflation in Tanzania averaged to 20.2 percent.

1.1 Statement of the Problem

For the purpose of spearheading the economic development of Tanzania, a better understanding of the country's inflation situation and future expected inflation is warranted to initiate appropriate policy measures to contain the price pressures.

According to the Bank of Tanzania Act 2006, Section 7, the primary objective of the Bank shall be to design, implement and monitor monetary policy directed to the economic objective of maintaining domestic price stability conducive to a balanced and sustainable growth of the national economy. The concern with inflation originates not only from the need to retain overall macroeconomic stability but also from the fact that inflation hits the poor particularly hard mainly through its impact on real wages because nominal wages fail to increase as fast as prices in episodes of rising inflation rates.

This requires development of effective monetary policy that in turn, requires the central bank to possess information on the economic situation in the country, especially on the behaviour and interrelationships of major macroeconomic indicators. Such information would enable the Bank of Tanzania to predict future macroeconomic developments and to react in a proper way to shocks the economy is subject to. Therefore, an effective monetary policy depends largely on the ability of the central bank to use a reliable model that could help understand the ongoing economic processes and predict future developments.

To the best of my knowledge inflation forecasting is done through financial programming framework in Tanzania. Although the BoT is using Financial Programming Model, it is not enough because forecasting capacity of it is actually low. It need that there should be an estimation model from which parameter for inflation forecasting can be obtained. Financial programming is actually not a parametric model. This framework is rather the kind of macro accounts which do not incorporate some key behavioural properties that are necessary in forecasting models. This dissertation aims at ascertaining an appropriate model for inflation forecasting in Tanzania.

1.2 Objective of the Study

The broad objective of this study is to ascertain inflation forecasting model of Tanzania. This broad objective will be accomplished through the following specific objectives:

a) To analyzes in detail the behaviour of headline inflation, its subcomponents, and core inflation so as to shed light on the dynamics of inflation in Tanzania.
b) To design for monetary policy purpose an appropriate Auto-regressive moving average (ARIMA) inflation forecasting model of Tanzania;
c) To provide short-run (six months ahead) inflation forecasts of Tanzania.

1.3 Significance of the Study

Forecasting inflation rate is of significance to policy making. Economic policy makers forecast inflation rate as a guide to policy-making. Firms use inflation forecasts as one of the key inputs in financial projections. Workers impute inflation forecasts in determining wages that they ask from their employers. Therefore, information on future inflation plays role in the formation of inflation expectations by economic agents.

This study is important since it is aimed at investigating the inflationary processes in Tanzania, developing an inflation forecasting model as also an ingredient to the inflation targeting, a regime to which the country may want to embark later.

As an extension of the knowledge frontier, this study contributes to the existing empirical literature on different methodologies used to forecast inflation in developing countries specifically in Tanzania in terms of specificity, variables used and coverage. This is achieved by employing Box-Jenkins methodology in forecasting inflation during the period of January 1980 to December 2009.

On policy grounds, the model adopted in this dissertation can also provide an iterative device for monetary policymaking. This will imply applicability of inflation targeting in Tanzania like many other country as a choice for anchoring inflation expectations.

Last but not least this dissertation is significant as a partial fulfilment of the requirements for the award of Masters of Arts Degree in Economics from the University of Dar es salaam.

1.4 Scope of the Study

The scope of this study is limited to forecasting inflation, not analyzing the determinants of inflation in Tanzania and their policy implications. The accuracy of these forecasts can thus have important repercussions in the economy.

By using monthly inflation data of Tanzania, the study covers the period from January 1980 to December 2009 this range of time is consistent with the Auto-Regressive Integrated Moving Average (ARIMA) forecasting technique that requires at least 50 observations to be available to build a proper model. Furthermore, the study provides short term (six months ahead) forecasts of inflation in Tanzania.

1.5 Organization of the Study

This study is divided into six chapters. The next chapter presents dynamics of inflation in Tanzania, followed by a review of literature on inflation and inflation forecasting in chapter three. Methodology and modelling methods are discussed in chapter four. Results of the study are provided in chapter five. Lastly, conclusion and policy implications have been presented in chapter six.

CHAPTER TWO

DYNAMICS OF INFLATION IN TANZANIA

2.0 Introduction

This Chapter presents dynamics of inflation in Tanzania from 1967 to 2009 by using annual data. The chapter has the following subsections. Section 2.1 presents brief introduction on the dynamics of inflation in Tanzania. Section 2.2 concentrates on growth phase while section 2.3 analyzes the shock phase; section 2.4 will shade some lights on the adjustment stabilization phase and finally section 2.5 presents the conclusion.

2.1 Growth Phase 1961-1973

The economic history of Tanzania is usually divided into three phases, that is, growth phase, shocks phase and stabilization phase. The growth phase covers the period immediately from independence 1961 to 1973.

During the 1960's and '70's, Tanzania implemented policies of self-reliance and protectionism, which entailed state taking the leading role in national development. With the Arusha declaration of January 1967, central planning and government control became the central economic approach with variety of strategies such as extensive compulsory villagization (ujamaa), nationalization, and price controls with the ultimate aspiration of achieving self-reliance for its people.

This strategy of centralized economic planning proved successful initially until the early 1970's and the country experienced short-run growth, but a long-run economic downturn. Most of the problems were much related to poor policies and structural weaknesses (Wangwe S.M. and et al 1998).

During the growth phase, the growth rate was averaged at 4.4 percent. During this period inflation averaged 4.4 percent while the growth rate of broad money was fairly low at an average of 20 percent. For the whole period the currency remained strong with an official exchange rate standing at an average of 7.1 Tanzanian Shillings per unit of US $. As presented in table 2.1.

Table 2.1: Performance of Selective Macroeconomic Indicators in Tanzania 1967-1973

Indicators	1967	1968	1969	1970	1971	1972	1973	Total	Average
Inflation (in percentage)	1.7	4.6	2.0	3.2	4.7	7.6	10.5	34.3	4.9
GDP growth rate (in percentage)	4.0	5.2	1.8	5.8	4.2	6.7	3.1	30.8	4.4
M1 growth rate (in Percentage)	1.8	1.8	21.3	19.9	21.6	12.1	17.2	95.7	13.7
M2 growth rate (in Percentage)	24.8	15.9	25.4	22.7	17.7	16.8	16.7	140.0	20.0
M0 growth rate (in Percentage)	3.3	3.3	14.5	35.3	20.5	21.8	-0.2	98.5	14.1
Nominal Exchange Rate (Tshs/US$)	7.14	7.14	7.14	7.14	7.14	7.14	7.02	49.9	7.1

Source: Own calculations based on Bank of Tanzania's various issues of Economic and Operational Reports.

2.2 Shocks Phase 1974-1985

The Shocks Phase started from 1974 to 1985. In the economic history of Tanzania shock phase was marked by severe macro-economic imbalances from the first oil price shocks in 1973-1974, severe drought 1973-1974, followed by commodity boom in 1976-1977, a second oil price shock in 1979, and the war with Uganda under Idd Amin in 1979. All these events led to economic chaos and uncertainties.

These problems acted as a signal for the country's movement towards more market-oriented. In fact it is documented that in the attempt to block conditionality reforms prescribed by the World Bank and the IMF, Tanzania tried its own structural adjustment programs in early 1980s (the National Economic Survival Program (NESP) in 1981-1982 and the Structural Adjustment Program (SAP) in 1983-1985).

During the Shock phase period, Inflation rose from 19.2 percent in 1974 to 32.3 percent making an average of 22.1 percent higher than that during the growth phase. The economy continued to experience low rate of growth averaging to 2.4 percent. However the broad money (M2) and official exchange rate remained at the average of 22.1 percent and 9.7 Tanzanian Shillings per Unit of a US $ as presented in table 2.2.

Table 2.2: Performance of selective Macroeconomic indicators in Tanzania 1974-1985

Indicators	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total	[4]AVG
Inflation (%)	19.2	26.5	6.9	11.6	6.6	12.9	30.3	25.7	27.6	29.7	35.4	32.3	264.7	22.1
GDP growth rate (%)	2.5	5.7	6.6	0.4	2.1	2.4	3.0	-0.5	0.6	-2.4	3.4	4.6	28.4	2.4
M1 growth rate (%)	24.5	23.7	22.7	19.7	7.0	52.9	27.9	7.9	27.2	12.2	-0.1	23.0	248.6	20.7
M2 growth rate (%)	22.2	24.3	23.7	20.2	12.6	46.9	26.9	12.4	25.6	17.8	3.7	29.0	265.3	22.1
M0 growth rate (%)	26.6	15.7	18.0	14.9	22.5	39.1	29.3	7.1	42.2	2.6	27.8	21.5	267.3	22.3
NER (Tshs/US$)	7.13	7.37	8.38	8.29	7.71	8.22	8.20	8.28	9.28	11.14	15.29	17.47	116.8	9.7

Source: Own calculations based on Bank of Tanzania's various issues of Economic and Operational Reports.

[4] AVG is the Average of each of the indicator throughout the specified period of time

2.3 Adjustment-Stabilization Phase

Adjustment-Stabilization Phase runs from 1985 to 2009. The reform period is notable for the economic recovery programmes supported by the International Monetary Fund (IMF), World Bank and the donors.

The key reforms that the government pursued vigorously with donor community support were the macroeconomic and structural reforms involving both fiscal and monetary reforms as well as sound exchange rate policy aiming at raising output growth, bringing down the rate of inflation, restoring external balance and improving social services.

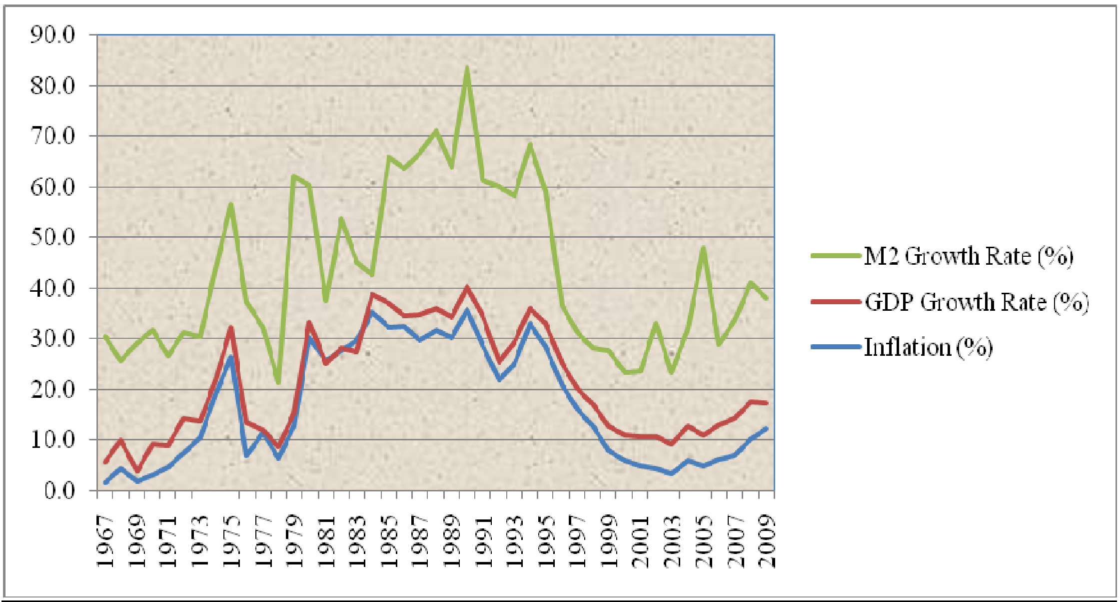
One of the impacts of the reforms were exchange rate liberalization that gradually led to a rapid depreciation of the Tanzanian shilling to an average of 983.3 Tshs in the last phase of 2000-2005. Despite some improvement in the growth rate averaging 3.9 percent in 1985-1989, 4.2 percent in 1990-19994, 4.3 percent in 1995-1999, 5.9 percent in 2000-2005, and 6.5 in 2006-2009, the trend of rate of inflation in Tanzania shows a downturn in the period 1985-2009 from an average of 31.4 percent to an average of 8.9 percent. Broad Money supply continued to decline from growth rate average of 31 percent in 1985-1989 to 19.7 in 200-2005 and 19.9 in 2006-2009. The trend of major Macroeconomic variables in Tanzania can be clearly shown by the aid of table 2.3 and figure 2.1.

Table 2.3: Performance of selective Macroeconomic indicators in Tanzania 1985-2009

Indicators	1985-1989	1990-1994	1995-1999	2000-2005	2006-2009
Inflation (in percentage)	31.4	28.9	17.2	5	8.9
GDP growth rate (in percentage)	3.9	4.2	4.3	5.9	6.5
M2 growth rate (in Percentage)	31	33.2	15	19.7	19.9

Source: Own calculations based on Bank of Tanzania's various issues of Economic and Operational Reports.

Figure 2.1: Growth rate of key determinants of Inflation in Tanzania 1967-2005



2.5 Conclusion

The chapter has provided the glance of how inflation and other variables, that is Growth domestic product growth, broad money growth, narrow money growth, reserve money growth and exchange rate have trended during the growth phase, shock phase and stabilization-adjustment phase. Analysis of the trend of inflation in Tanzania gives mixed results in different regimes. Rate of inflation in Tanzania was low during the growth phase with an average of 4.9 as shown in table 2.1, thereafter, inflation reached an average of double digits during the whole period of shock phase partly due to structural bottlenecks such as severe drought and oil price shocks of 1973-1974 and 1979, and later dropped to single digit in the last phase of adjustment-stabilization phase.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

This chapter provides theoretical and empirical literature on inflation process and its forecasting. The chapter is organized into two sections. Section 3.0 is an introduction; and section 3.1 is on theoretical literature review, section 3.2 is devoted to presentation of empirical literature review; these two sections are further discussed in subsection and lastly, conclusion is presented in section 3.3.

3.1 Theoretical Literature Review

3.1.1 Inflation

In mainstream economics, the word "inflation" refers to a sustained or continuous rise in the general price level or, alternatively, as a sustained or continuous fall in the value of money against a standard level of purchasing power.

There are different criteria used to categorize inflation; Basing on the rate at which general prices increase there are [5]creeping, galloping and hyper inflations. Basing on causes of inflation we have Cost-push and [6]demand pull inflation. Also, basing on

[5] Creeping inflation is a sustained annual rise in prices of less than 3 per cent per annum. Galloping inflation is when prices rise rapidly at the rate of 10 to 20 per cent per annum, Hyperinflation occurs when prices rise very fast at double or triple digit rates.

[6] Demand pull inflation is a result of excess aggregate demand while cost push inflation is a result of shift in the aggregate supply curve.

working of market mechanism we have [7]open and suppressed inflation. Lastly, basing on expectations we have anticipated and unanticipated inflation.

There are many prices used to measure of inflation depending on the specific circumstances. The most well known are the Consumer Price Index which measures consumer prices, and the GDP deflator. Ideally, the price index used should be broad based and one in which the individual prices are weighted to indicate their importance to the economy.

In Tanzania, the National Consumer Price Index (NCPI) covers prices collected in 20 towns in Tanzania Mainland. Prices are gathered for 207 items. All prices collected are the prevailing market prices. The weight attached to each groups in the NCPI are presented in table 3.1.

Table 3.1 Composition of the Tanzanian CPI

MAIN GROUP	WEIGHT
1. Food	55.9
2. Drinks and Tobacco	6.9
3. Clothing and Footwear	6.4
4. Rents	1.4
5. Fuel, Power and Water	8.5
6. Furniture & Household Equipment	2.1
7. Household Operation & Maintenance	2.1
8. Personal Care & Health	2.1
9. Recreation & Entertainment	0.8
10. Transportation	9.7
11. Education	2.6
12. Miscellaneous Goods & Services	1.5
Total All - Items Index	**100.0**

Source: Tanzania National Bureau of Statistics.

[7] Open inflation occur in a freely functioning of the market without interference from institutions.

3.1.1.1 Quantity Theory of Money

The dominant macroeconomic theory prior to the 1930's was the quantity theory of money. This theory was subscribed by classical economists to explain the determination of the nominal variables in the system.

By using Fisher's equation of exchange, the relationship is given by equation (3.1):

$$^{8}MV = PY \qquad (3.1)$$

Rearranging the equation 3.1 we find that price level is dependent on the nominal money supply is as given by;

$$P = MV / Y \qquad (3.2)$$

With V and Y constant, it is easy to see that P depends on M and that ΔM equals ΔP.

Therefore, the reason why inflation occurs in the classical model is that, if households and firms find themselves holding additional cash than they desire, the excess money balances are used to buy goods and services. Since the supply of goods and services is constrained by the predetermined full employment level of output, excess demand in the goods market causes the general price level to rise in proportion to the initial increase in the money supply.

3.1.1.2 Keynesian Theory and the Phillip's Curve

Keynesian Economists have in common a belief that the major upward pressure on prices comes from activities which would produce a fall in real output.

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[8] M is nominal money supply, V is the velocity of money in circulation, P is the general price level and Y is real income.

According to Keynesians the inflationary gap come from supply side problem and poor demand management. This theory applies in many developing countries including Tanzania whose inflationary pressures emanate from supply side of the economy.

The Phillips curve deals with the debate over the relationship between inflation and unemployment and is one of the well-known relationships in macroeconomics (Smithin, 2002). By using data for the period 1948–57, Phillips founded and suggested the possible existence of a stable long-run negative relationship between wage inflation and unemployment. Later, through expectations augmented Phillips curve analysis, the trade off interpretation was criticised and long-run vertical Phillips curve at the natural rate of unemployment was suggested.

3.1.1.3 Monetarism

Friedman, (1970) suggested that ‘inflation is always and everywhere a monetary phenomenon in the sense that it can be produced only by a more rapid increase in the quantity of money than in output’. Monetarists argue that inflation can only be reduced by slowing down the rate of growth of the money supply. This implies that in the conduct of economic policy the authorities should follow some rule for monetary aggregates to ensure long-run price stability. Many studies on inflation in Tanzania confirm that money supply is the major determinant of inflation in the country.

3.1.1.4 Structuralism

Other explanations of inflation come from structural bottlenecks in the economy. These bottlenecks include the monopolistic pricing behaviour of OPEC that lead to imported inflation due to rising price of crude oil, major crop failures due to mismatch between supply and demand of agro-products or changes in the terms of international trade produced by a decline in the foreign exchange value of the Tanzanian shilling and also mismatch between public spending and revenues.

3.1.1.5 Rational Expectations

The key assumption of the [9]rational expectation theory is that economic agents are rational; that is, agents are continuous optimizers subject to the constraints that they face, firms maximize profits and labour and households maximize utility.

Expectations are an important element in the inflationary process because different people and groups have different attitudes to inflation. Expectations of inflation will influence behaviour concerns wage negotiations between trade unions and employers. One of the assertions of rational expectations theory is that actors will seek to "head off" central-bank decisions by acting in ways that fulfil predictions of higher inflation. This means that central banks must establish their credibility in fighting inflation, or have economic actors make bets that the economy will expand, believing that the central bank will expand the money supply rather than allow a recession.

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[9] The key figure in the development of adaptive and rational expectation theory was Robert E. Lucas Jr.

3.1.2 Inflation Forecasting

Econometric forecasting involves the application of statistical and mathematical models to forecast future developments in the economy. Econometric forecasting allows economists to review past economic trends and forecast how recent economic changes will alter the patterns of past trends.

A time series data of inflation consists of observations generated successively over time. Such data are ordered with respect to time and successive observations may be dependent. The observed time series is generally referred to as time series realization of an underlying process. The data may indicate that there is a trend over time, that is. There is a long term behaviour underlying the data. The trend, if observed over a long time, may be increasing, decreasing, or may remain unchanged. There may be a cyclical fluctuation, which is a pattern of ups and downs over time. In addition, the data may show that the underlying process has periodic fluctuations of constant length, which is seasonal behaviour. The purpose of modelling is to capture this underlying process using the observed time series so that one can predict what would be the likely realization at a time point in future.

Many economic decisions, whether made by policymakers, firms, investors, or consumers, are often based on inflation forecasts. In forecasting macroeconomic time series variables like inflation one has many possible types of models to choose from: vector error correction models, autoregressive conditional heteroskedasticity (ARCH)-based models, or various possible combinations. But, as most forecasters know, it’s difficult to forecast the macro-economic behaviour and, despite decades of effort, researchers find it surprisingly hard to find new models that outperform the simple Box Jenkins type autoregressive (AR) models.

3.1.2.1 Vector Error Correction Models

A Vector Error Correction Model (VECM) can lead to a better understanding of the nature of any non-stationarity among the different component series and can also improve longer term forecasting over an unconstrained model.

The VECM (*p*) form is written as

$$\Delta y_t = \delta + \mu y_t + \Sigma \sum_{i=1}^{p-1} \Phi_j^{\,k} \Delta y_{t-i} + \varepsilon_t \tag{3.4}$$

Where $\mathbf{\Delta}$ is the differencing operator, such that.

$$\Delta y_t = y_{t-1} \tag{3.5}$$

It has an equivalent VAR (*p*) representation as described in the preceding section.

$$y_t = \delta + (I_k + \mu + \Phi_1^{k)}) y_{t-1} + \sum_{i=2}^{p-1} (\Phi_{j-1}^{k}) y_t - \Phi_{p-1}^{k} y_{t-p} + \varepsilon_t \tag{3.6}$$

3.1.2.2 Auto-Regressive Conditional Heteroskedasticity Models

The autoregressive conditional heteroskedasticity model was introduced by Engle (1982) to model the volatility of UK inflation. As the name suggests, the model has the following properties: Firstly is Auto-regression - Uses previous estimates of volatility to calculate subsequent (future) values.

Hence volatility values are closely related. Second property is heteroskedasticity - The probability distributions of the volatility vary with the current value of the specified variable.

3.1.2.3 Auto-Regressive Moving Averages

To build an Auto-Regressive Moving Averages model (ARMA) one essentially uses Box-Jenkins methodology (1976), which is an iterative process and involves four stages; identification, estimation, diagnostic checking and forecasting of time series.

In contrast to other techniques, Box-Jenkins is a procedure which uses a variable's past behaviour to select the best forecasting model from a general class of models. It has a large class of models to choose from and a systematic approach for identifying the correct model form. There are both statistical tests for verifying model validity and statistical measures of forecast uncertainty.

Therefore, most of traditional forecasting models offer a limited number of models relative to the complex behaviour of many time series with little in the way of guidelines and statistical tests for verifying the validity of the selected model.

Box-Jenkins approaches to forecasting provide some of the most accurate short-term forecasts. However, it requires a very large amount of data.

3.2 Empirical Literature Review

3.2.1 Studies outside Tanzania

Over the years, there have been a considerable number of empirical researches in the field of inflation. Most of researches in the field of inflation forecasting was carried in developed countries especially those which adopted inflation targeting.

Meyler, et al (1998) outlined ARIMA time series models for forecasting Irish inflation. It considered two alternative approaches, which suggests that ARIMA forecast has outperformed. Kenny, et al (1998) focused on the development of multiple time series models for forecasting Irish Inflation. The Bayesian approach to the estimation of vector autoregressive (VAR) models is employed. The results confirm the significant improvement in forecasting performance.

Toshitaka Sekine (2001) estimated an inflation function and forecasts one-year ahead inflation for Japan. He found that mark-up relationships, excess money and the output gap are particularly relevant long-run determinants for an equilibrium correction model of inflation.

Aidan Meyler, Geoff Kenny and Terry Quinn (1998) have considered autoregressive integrated moving average (ARIMA) forecasting. ARIMA models are theoretically justified and can be surprisingly robust with respect to alternative (multivariate) modelling approaches. Indeed, Stockton and Glassman (1987) upon finding similar results for the United States commented that “it seems somewhat distressing that a simple ARIMA model of inflation should turn in such a respectable forecast performance relative to the theoretically based specifications."

To the best of my knowledge, most of the studies on inflation in Africa were concerned with the analysis of the determinants of inflation. Dordunoo (1994) argues that rapid exchange rate depreciation and resultant increases in import prices are the main causes of Inflation in Ghana. Also, with the aid of error correction model, Sowa (1996) estimated an inflation equation for Ghana and concluded that its inflation was influenced more by output volatility than monetary factors.

Chhibber et al (1989) developed a detailed econometric model that models both monetary and structural factors of inflation in Zimbabwe. The study showed that nominal monetary growth, foreign prices, exchange and interest rates, unit labour costs and real income are determinants of inflation in the country.

3.2.2 Studies in Tanzania

In Tanzania, to the best of my knowledge, most of the works were directed towards the establishment of the causal agents (determinants) of inflation. A study by Ndulu (1975) cites population pressure and food supply deficiencies, industrial consumer goods demand pressure and supply inadequacies, and imports inability to make up for the insufficiency of the essentials and budget deficits predominant in the economy, as the main causes of inflation in Tanzania.

Rwegasira (1974), in a study which linked deficits with rising prices, concluded that government expansionary finance which characterized the economy from 1963-72, had been one of the sources of rising prices. He also indicated that other important determinants of inflation, like inelasticities in agriculture and falling import capacity, led to upward pressure on the general price level.

A study by Rutasitara (2004) used ordinary least squares to analyze effect of exchange rate regimes on inflation in Tanzania, over time. The study founded that inflation was driven by monetary and fiscal factors, on the one hand, and by structural constraints, on the other. Thus, although the model did not confirm the relationship between money supply and inflation, an indirect association between the two could be established from movement of inflation and government bank borrowing over the years.

Hyuha and Osoro (1982) concluded that inflation has been significantly caused by excessive money supply in the Tanzanian economy; however, these studies were done before the economic reform policies period. A study by Kilindo (1982, 1992) suggested that expansionary and fiscal policies bring about inflation in Tanzania. Therefore this study will extend the period of analysis from pre-reform period to post re-form period.

Laryea and Sumaila (2001) used ordinary least squares to estimate the determinants of inflation in Tanzania. In the short run, output and monetary factors are the main determinants of inflation. However, in the long run, the parallel market exchange rate also plays a key role, in addition to output and money supply. The findings also suggest that in the long-run, monetary factors have a bigger impact on the rate of inflation in Tanzania, compared to output effects. This is because the long run elasticity of money and output were 0.8 and –0.09 respectively. This finding also supports the monetarist argument on the power of monetary factors on inflationary process in the long run. The positive coefficients on the exchange rate variable reflect the effect on inflation via trade in goods, mainly through imports in the informal sector.

Minungu (2004) investigated whether inflation in Tanzania during the period 1966—2002 is a Monetary Phenomenon. He used Vector Auto-Regressive Model and Cointergration to estimate the secondary annual time series data of money supply, nominal exchange rate, gross domestic product growth rate, deficit financing and food inflation on inflation rate. The results in the impulse response functions indicated that food supply and GDP growth contributed significantly towards movement in inflation over time. The variance decomposition of the VAR model suggests that 71 percent variation in inflation is due to its own innovations with the remaining percentage being to other variables. He concluded that monetary expansion is driven mainly by expansionary monetary policies which explain to a large degree the inflation process in Tanzania.

Ottaru (2001) studied the behaviour of prices in Tanzania during 1966-2000 by using Error correction model. Analysis from the model estimation showed that, in the long run inflation emanates from the movements in money growth, interest rates, exchange rates and gross domestic product. He also discovered that the dynamics of inflation is influenced by external shocks such as war, drought and oil crises.

3.3 Conclusion

This chapter has presented both theoretical and empirical literature on inflation and inflation forecasting. Most of the studies on inflation forecasting were carried in the developed countries and hence call upon an extension into Sub Saharan countries. In Tanzania, studies on inflation concentrated much on establishing causal relationship between inflation and its determinants both in the short run and in the long run. Many studies founded that inflation in Tanzania is driven by output and monetary factors.

CHAPTER FOUR

METHODOLOGY AND MODELLING

4.0 Introduction

The key references from which these theoretical models are drawing are Auto-regressive moving average process and Box Jenkins methodology. Therefore this chapter is organized as follows. Apart from this introductory section, Section One presents issues on Autoregressive Integrated Moving Average (ARIMA), Section two presents conceptual framework of Box-Jenkins Methodology, section three shades light on data type and source. Conclusion of the chapter will be presented in section four.

4.1 Auto-regressive Integrated Moving Average (ARIMA) Process

4.1.1 An Auto-regressive (AR) Process

Let Π_t represent inflation at time *t*. If we model Π_t as

$$(\Pi_t - \delta) = \alpha_1(\Pi_{t-1} - \delta) + \mu_t \qquad 4.1.1$$

where δ is the mean of Π_t and where μ_t is an uncorrelated random error term with zero mean and constant variance σ^2 (i.e., it is *white noise*), then we say that Π_t follows a first-order autoregressive, or AR (1). But if we consider the model,

$$(\Pi_t - \delta) = \alpha_1(\Pi_{t-1} - \delta) + \alpha_2(\Pi_{t-2} - \delta) + \mu_t \qquad 4.1.2$$

Then we say that Π_t follows a second-order autoregressive, or AR (2), process. Therefore, the general pth-order autoregressive, or AR (p), process of Π_t is given by the following expression.

$$(\Pi_t - \delta) = \alpha_1(\Pi_{t-1} - \delta) + \alpha_2(\Pi_{t-2} - \delta) + ... + \alpha_p(\Pi_{t-p} - \delta) + \mu_t \qquad 4.1.3$$

4.1.2 A Moving Average (MA) Process

The AR process just considered is not the only means that may have generated Π_t. Consider modelling Π_t as follows;

$$\Pi_t = \varphi + \beta_0\mu_t + \beta_1\mu_{t-1} \qquad 4.1.4$$

Where φ is a constant and μ, as before, is the white noise stochastic error term. Here Π at time *t* is equal to a constant plus a moving average of the current and past error terms. Thus, in the present case, we say that Π_t follows a first-order moving average, or an MA (1), process. This analysis can be extended to MA (*q*) process which is given as follows;

$$\Pi_t = \varphi + \beta_0\mu_t + \beta_1\mu_{t-1} + \beta_2\mu_{t-2} + ... + \beta_q\mu_{t-q} \qquad 4.1.5$$

4.1.3 An Autoregressive and Moving Average (ARMA) Process

It is quite possible that Π_t has features of both AR and MA and is, therefore, ARMA. Thus, Inflation (Π_t) follows an ARMA (1, 1) process if it can be written as

$$\Pi_t = \theta + \alpha_1 \Pi_{t-1} + \beta_0 \mu_t + \beta_1 \mu_{t-1} \qquad 4.1.6$$

The analysis again can be extended to ARMA (*p*, *q*) process, which contains *p* autoregressive and *q* moving average terms.

4.1.4 An Autoregressive Integrated Moving Average (ARIMA) Process

Therefore, if we have to difference a time series *d* times to make it stationary and then apply the ARMA (*p, q*) model to it, we say that the original time series is ARIMA (*p, d, q*), that is, it is an autoregressive integrated moving average time series, where *p* denotes the number of autoregressive terms, *d* the number of times the series has to be differenced before it becomes stationary, and *q* the number of moving average terms.

4.2 Conceptual Framework of Box-Jenkins Methodology

The study focuses on the Box-Jenkins (1976) approach that involves stages of identification, estimation, diagnostic checking, and forecasting a univariate time series. Each stage is analysed in the following subsections.

4.2.1 Identification stage

The initial stage in Box-Jenkins methodology is making sure that the time series under consideration is stationary before identifying the suitable ARMA model. A stationary process is one whose statistical properties are the same over time. In particular, such a time series fluctuates around a fixed mean value.

However, the existence or inexistence of unit root in inflation behaviour has to be tested formally by using statistical procedures. The autocorrelation function (AF) and partial Autocorrelation function (PACF) provide useful information. Nevertheless, Augmented Dickey-Fuller (ADF) test and Phillip Peron tests (PP) are mostly used to test the stationarity of variables.

With a stationary series in place, a basic model can now be identified. Three basic models exist; auto-regressive (AR), moving average (MA) and a combined auto-regressive Moving Average (ARMA) in addition to the previously specified regular differencing (RD) combine to provide the available tools. When regular differencing is applied together with AR and MA, they are referred to as ARIMA, with I indicating "integrated" and referencing the differencing procedure.

The main tools in identification are the autocorrelation function (ACF), the partial autocorrelation function (PACF), and the resulting correlograms, which are simply the plots of ACFs and PACFs against the lag length. Mathematically;

$$\rho_k = corr(\Pi_t, \Pi_{t-k}) \qquad 4.1.7$$

Where ρ_k is the autocorrelation of kth series.

Table 4.0 Behaviour of Correlogram and Partial Correlogram for Various Models

	Correlogram	Partial Correlogram
AR	Dies Down	Cuts Off
MA	Cuts Off	Dies Down
ARMA	Dies Down	Dies Down

Theoretically speaking, Box-Jenkins model identification is no doubt a highly subjective exercise and depends entirely on the skill and experience of the researcher/forecaster. Therefore we use iterative methods and select the best model on the basis of following criteria; relatively small [10]Akaike's information criteria (AIC) or [11]Schwarz's information criteria (SBIC), relatively small standard error, relatively high adjusted *R*-squared and white noise residuals of the model (which shows that there is no significant pattern left in the ACFs and PACFs of the residuals).

---

[10] This is a criterion, introduced by Akaike in 1969, for choosing between competing statistical models, it is defined as $-2L_m + 2m$ where L_m is the maximized *log-likelihood* and m is the number of parameters in the model. The index takes into account both the statistical goodness of fit and the number of parameters that have to be estimated to achieve this particular degree of fit, by imposing a penalty for increasing the number of parameters. Lower values of the index indicate the preferred model, that is, the one with the fewest parameters that still provides an adequate fit to the data."

[11] An index used as an aid in choosing between competing models. It is defined as $2L_m + m\ln n$ where n is the sample size, L_m is the maximized *log-likelihood* of the model and m is the number of parameters in the model. The index takes into account both the statistical goodness of fit and the number of parameters that have to be estimated to achieve this particular degree of fit, by imposing a penalty for increasing the number of parameters.

4.2.2 Model Estimation Stage

Estimation stage is about selecting the numerical values of the parameters. The method used to estimate the ARIMA model is the ordinary least squares (OLS), in which the sum of squared errors of the fitted model (i.e., the sum of squares of the estimated innovations) is made as small as possible.

4.2.3 Model Diagnostic Stage

In the model diagnostics for Box-Jenkins models the error term is assumed to follow the assumptions for a stationary univariate process. The residuals should be white noise (or independent when their distributions are normal) drawings from a fixed distribution with a constant mean and variance. If the Box-Jenkins model is a good model for the data, the residuals should satisfy these assumptions.

If these assumptions are not satisfied, we need to fit a more appropriate model. That is, we go back to the model identification step and try to develop a better model. The analysis of the residuals can provide some clues as to a more appropriate model.

4.2.4 Forecasting and Forecasts Evaluation Stage

In forecasting we usually distinguish between in-sample forecasting and out-of-sample forecasting. In-sample forecasting essentially tells us how the chosen model fits the data in a given sample. Out-of-sample forecasting is concerned with determining how a fitted model forecasts future values of the regressand, given the values of the regressors.

In forecasting, more consideration is put on the following issues:

a) The degree of accuracy required – if the decisions that are to be made on the basis of the inflation forecast have high risks attached to them, and then it stands to reason that the forecast should be prepared as accurately as possible.
b) The availability of data and information - in some countries there is a wealth of available inflation data; in others it is hard to find reliable, up-to-date data.
c) The time horizon that the inflation forecast is intended to cover. The study covers short run period of six month ahead.

There are various measures of forecasting accuracy that have been developed and are widely used in examining the forecasting performance of the different techniques. These measures are discussed hereunder.

4.2.4.1 Root Mean Squared Error (RMSE)

Root mean squared error (RMSE) measure the differences between values predicted by a model or an estimator and the values actually observed from the thing being modelled or estimated as given by the following formula.

$$RMSE\left(\hat{\theta}\right) = \sqrt{MSE\left(\hat{\theta}\right)} = \sqrt{E\left(\left(\theta \hat{-} \theta\right)^2\right)} \qquad 4.1.8$$

4.2.4.2 Mean Absolute Error (MAE)

Mean absolute error (MAE) is a number used to evaluate how close forecasts or predictions are to the eventual outcomes. The mean absolute error is given by the following formula.

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|f_i - y_y\right| = \frac{1}{n}\sum_{i=1}^{n}\left|e_i\right| \qquad 4.1.9$$

Where f_i is the prediction and y_i the true value and e_i is an average of the absolute errors

4.2.4.3 Mean Square Error (MSE)

In statistics, the mean squared error (MSE) of an estimator is one of many ways to quantify the difference between values implied by an estimator and the true values of the quantity being estimated. The MSE of an estimator $\hat{\theta}$ with respect to the estimated parameter θ is defined as;

$$MSE\left(\hat{\theta}\right) = E\left[\left(\hat{\theta} - \theta\right)^2\right] \qquad 4.1.10$$

4.2.4.4 Mean Forecast Error (ME)

The mean error (ME) of forecasts (f) relative to analyses (a) can be defined as follows;

$$ME = \overline{(f - a)} \qquad 4.1.11$$

Where the over-bar denotes an average over a large sample in time and space.

With a perfect forecasting system, all these measures would be equal to zero. A high value for any of these measures indicates a poor forecasting technique. One indication that the model specification could be improved is if the ME for each of the five forecasts is either all positive or all negative. This would indicate that the model is either forecasting too low on average (if positive) or too high on average (if negative). If the ME is of the same magnitude as the MAE this would also indicate that the model is forecasting consistently either too low (if the ME is positive) or too high (if the ME is negative). The RMSE will always be at least as large as the MAE. They will only be equal if all errors are exactly the same.

4.2.4.5 Theil's U Statistic

This statistic calculates the ratio of the RMSE of the chosen model to the RMSE of the 'naive' (i.e., assuming the value in the next period is the same as the value in this period - no change in the dependent variable) forecasting model. Thus, a value of one for the Theil statistic indicates that, on average, the RMSE of the chosen model is the same as the 'naive' model. A Theil statistic in excess of one would lead one to reconsider the model as the simple 'naive' model performs better, on average. A Theil statistic less than one does not lead to automatic acceptance of the model, but does indicate that, on average, it performs better than the 'naive' model. The advantage of the Theil statistic is that it is 'unit less' as it compares the RMSE of the chosen model to that of the 'naive' forecast model. The ME, MAE and RMSE all vary depending on the dimension (or scale of measurement) of the dependent variable. The Theil statistic also provides a quick comparison with the 'no change' model and, as such, is a measure for one step ahead forecasts of the additional forecasting information the model provides beyond a random walk model.

An additional test of the ARIMA model would be to compare its performance with competing models including alternative ARIMA specifications models.

4.3 Proposed Model

Therefore, by using Box-Jenkins methodology of modelling Auto-regressive moving average processes the proposed ARIMA (p, d, and q) model will take the following form;

$$\Pi_t = \alpha_0 + \alpha_1 \Pi_{t-1} + ...+ \alpha_n \Pi_{t-p} + \beta_1 \mu_{t-1} + ...+ \beta_n \mu_{t-q} \qquad 4.1.12$$

Coefficients of the Autoregressive scheme are given by $\alpha_{i's}$ where *i* start from 0 to n, whereas the coefficients of the moving average scheme are given by $\beta_{i's}$ where i start from 0 to n respectively. This is the proposed model that has to be estimated by using Ordinary least Squares so as to obtain the values of the parameters as well as useful test statistics.

4.4 Data Type and Sources

Extensive time series data is required for univariate time series forecasting. Chatfield (1996) recommends at least 50 observations. Many others would recommend at least 100 observations.

The forecasting in this study is based on monthly time series data for the period of January 1980 to December 2009. The Data used in this study were obtained from Economic and Operation Reports of the Bank of Tanzania. This implies that the study will deal with inflation time series of Tanzania with 360 observations hence qualifying the rule of thumb of having more than 50 observations in Box-Jenkins Methodology of time series forecasting.

The E-views, Stata and Ms Excel were used as the main statistical software's for estimation. Stata and Ms Excel were used for summarizing and obtaining descriptive statistics of the data, while, E-views was intensively used in identification, estimation and forecasting stages.

4.5 Conclusion

This chapter has presented an overview on the Autoregressive Integrated Moving Average (ARIMA), moreover the chapter has shade some light on the conceptualization of the Box-Jenkins Methodology as the main modelling tool of the study, source and data used in the study. The empirical findings of the study follow in the next chapter.

CHAPTER FIVE

EMPIRICAL RESULTS

5.0 Introduction

This chapter presents empirical findings on the inflation forecasting model of Tanzania. The chapter is organized into six sections. After introduction of the chapter, section 5.1 presents exploratory data analysis. Section 5.2 is on test for stationarity, section 5.3 presents estimation results, section 5.4 outlines out-of-sample forecasts, section 5.5 presents post forecasting evaluation, and conclusion of the chapter is in the last section.

5.1 Descriptive Data Analysis

The period of January 1980 to June 1987 the inflation was on average of 31.2 with standard deviation of 4.98, this implies that inflation was in double digits though continued to vary from one period to another. After June 1987, inflation continued to vary in almost the same range until December 1994 with the average of 29.4 and standard deviation of 5.2. From January 1995 to June 2002 inflation demonstrated downward trend to an average of 13.5 with standard deviation of 8.7. From January 1980 the inflation was successfully put under in single digit after decades of double digits with average of 6.96 and standard deviation of 2.89. Low standard deviation indicates that inflation was relatively consistently getting stable compared to other periods in the sample period. Table 5.1, presents descriptive statistics of inflation in

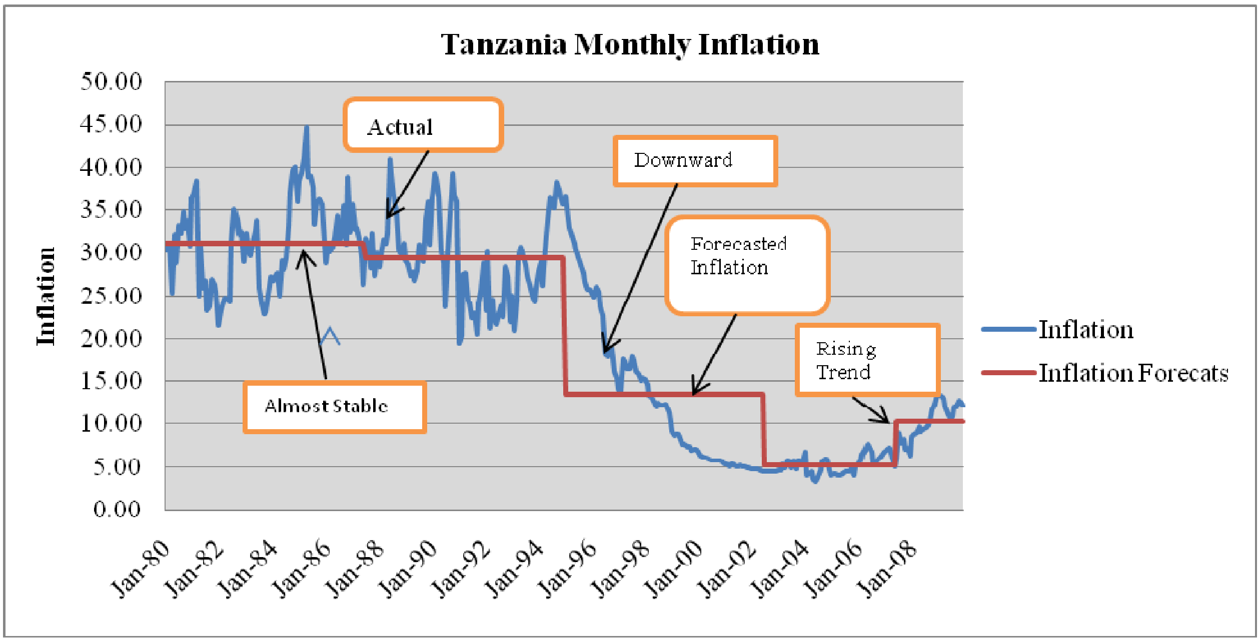
Tanzania, and figure 5.1 displays the trend of inflation in Tanzania from the period of January 1980 to December 2009.

Table 5.1 Summary Statistics for Tanzanian Monthly [12]Inflation

Period	Average	Standard Deviation	Maximum	Minimum
Jan-1980 to Jun-1987	31.19	4.98	44.65	21.57
Jul-1987 to Dec-1994	29.35	5.18	40.89	19.44
Jan-1995 to Jun-2002	13.51	8.73	36.74	4.5
Jul-2002 to Dec 2009	6.96	2.89	13.5	3.4
Overall Period	20.25	11.84	44.65	3.4

Source: Own calculations based on Bank of Tanzania's various issues of Economic and Operational Reports.

Figure 5.1 Monthly inflation and forecasted inflation (based on averages) in Tanzania



[12] Inflation statistics are in percentage.

5.2 Test for stationarity

5.2.1 Augmented Dickey-Fuller Test Results

The standard augmented Dickey-Fuller (ADF) test was employed to test the stationarity of inflation. This is a ‘t’ test that relies on rejecting the hypothesis that the time series in question is a random walk in favour of stationarity. The unit root testing has been computed using the ADF unit root formula taking into account the intercept and the time trend and the lags to get rid of any serial correlation problems.

The log-level results provided in Table 5.2 suggest that during the sample period the monthly inflation rate in Tanzania was non-stationary.

Table 5.2 Augmented Dickey-fuller Unit Root Test Results

ADF Test Statistic	-2.353910	1% Critical Value*	-3.9877
		5% Critical Value	-3.4241
		10% Critical Value	-3.1348
*MacKinnon critical value			

5.2.2 Phillip Peron (PP) Test

For robustness reasons, this test was also used. Phillips and Peron’s test statistics can be viewed as Dickey–Fuller statistics that have been made robust to serial correlation by using the Newey–West (1987) heteroskedasticity- and autocorrelation-consistent covariance matrix estimator.

As for the case of ADF test, the log-level results of PP test provided in Table 5.3 also suggest that during the sample period the monthly inflation rate in Tanzania was non-stationary.

Table 5.3 Phillip Peron Unit Root Test Results

PP Test Statistic	-2.353910	1% Critical Value*	-3.9874
		5% Critical Value	-3.4240
		10% Critical Value	-3.1347
*MacKinnon critical value			

Lag truncation for Bartlett kernel: 5 (Newey-West suggests: 5)
Residual variance with no correction 6.397688
Residual variance with correction 4.448558

Non-stationarity in the data was eliminated by differencing. This means that, the null hypothesis of the presence of unit root in inflation was rejected after taking the first difference and therefore the data is said to be integrated of order (1). The following tables provide results for unit root test after first difference for the case of ADF Test.

Table 5.4 Augmented Dickey-fuller Unit Root test after first difference

ADF Test Statistic	-11.36477	1% Critical Value*	-3.9877
		5% Critical Value	-3.4241
		10% Critical Value	-3.1348
*MacKinnon critical value			

Phillip Peron Unit root test results after differencing is provided in table 5.5.

Table 5.5 Phillip Peron Unit Root Test Results after first difference

PP Test Statistic	-25.25869	1% Critical Value*	-3.9875
		5% Critical Value	-3.4240
		10% Critical Value	-3.1347
*MacKinnon critical value			

Lag truncation for (Newey-West suggests: 5)
Bartlett kernel: 5

Residual variance with no correction 6.283851

Residual variance with correction 4.642965

5.2.3 Sample Auto-correlation Function (ACF)

Apart from unit root tests, the autocorrelation function (AF) of inflation, shown in Figure 5.2 below, also provides very useful information that it is typical of a non-stationary process, where the autocorrelation declines slowly as the number of lags increases. This behaviour is expected of time series likely to have random walk behaviour.

Figure 5.2 Correlogram of inflation

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******|	.|*******|	1	0.975	0.975	344.82	0.000
.|*******|	.|** |	2	0.961	0.214	680.72	0.000
.|*******|	.|. |	3	0.942	-0.045	1004.9	0.000
.|*******|	.|* |	4	0.933	0.152	1323.5	0.000
.|*******|	.|* |	5	0.924	0.083	1637.1	0.000
.|*******|	.|* |	6	0.920	0.092	1948.3	0.000
.|*******|	*|. |	7	0.908	-0.084	2252.7	0.000
.|*******|	.|. |	8	0.899	0.019	2552.1	0.000
.|*******|	*|. |	9	0.883	-0.113	2841.6	0.000
.|*******|	.|. |	10	0.869	-0.053	3122.7	0.000
.|*******|	.|* |	11	0.859	0.096	3398.2	0.000
.|*******|	.|. |	12	0.850	-0.007	3668.5	0.000
.|*******|	.|* |	13	0.846	0.132	3937.5	0.000
.|****** |	.|. |	14	0.843	0.059	4205.1	0.000
.|****** |	*|. |	15	0.833	-0.092	4467.3	0.000
.|****** |	.|** |	16	0.834	0.231	4730.5	0.000
.|****** |	.|. |	17	0.829	-0.009	4991.3	0.000
.|****** |	*|. |	18	0.822	-0.090	5248.8	0.000
.|****** |	.|. |	19	0.819	0.063	5504.9	0.000
.|****** |	.|. |	20	0.815	-0.005	5759.3	0.000
.|****** |	*|. |	21	0.808	-0.086	6010.1	0.000
.|****** |	.|. |	22	0.804	-0.002	6259.1	0.000
.|****** |	.|. |	23	0.795	-0.018	6503.6	0.000
.|****** |	.|. |	24	0.791	0.008	6746.0	0.000
.|****** |	.|. |	25	0.783	-0.037	6984.4	0.000
.|****** |	.|. |	26	0.773	-0.047	7217.5	0.000
.|****** |	.|. |	27	0.767	0.065	7447.8	0.000
.|****** |	.|. |	28	0.757	-0.051	7672.6	0.000
.|****** |	.|. |	29	0.748	-0.007	7892.7	0.000
.|****** |	.|. |	30	0.743	0.051	8110.5	0.000
.|****** |	*|. |	31	0.730	-0.106	8321.7	0.000
.|****** |	.|. |	32	0.721	0.022	8528.4	0.000
.|***** |	*|. |	33	0.711	-0.068	8730.0	0.000
.|***** |	.|. |	34	0.700	-0.015	8926.0	0.000
.|***** |	.|. |	35	0.691	0.030	9117.7	0.000
.|***** |	.|. |	36	0.684	-0.026	9306.0	0.000

5.3 Estimation Results

Modelling results that have been estimated by using OLS method are presented in table 5.4.

Table 5.6 [13]Box-Jenkins Modelling Results of Inflation in Tanzania

Dependent Variable: INFLATION				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	**9.314823**	18.06923	0.515507	0.6065
AR(1)	**0.995459**	0.005340	186.4305	0.0000
SAR(3)	**-0.176200**	0.051010	-3.454195	0.0006
SAR(8)	**0.130098**	0.050313	2.585778	0.0101
SAR(15)	**-0.148069**	0.048383	-3.060371	0.0024
MA(1)	**-0.181951**	0.053567	-3.396703	0.0008
SMA(12)	**-0.292427**	0.052354	-5.585594	0.0000
R-squared	0.964476	Mean dependent var		19.70029
Adjusted R-squared	0.963843	S.D. dependent var		11.80128
S.E. of regression	2.244005	Akaike info criterion		4.474540
Sum squared resid	1696.983	Schwarz criterion		4.552693
Log likelihood	-762.6209	F-statistic		1524.912
Durbin-Watson stat	1.956960	Prob(F-statistic)		0.000000
Inverted AR Roots	1.00	.85+.17i	.85 -.17i	.70 -.55i
	.70+.55i	.46+.76i	.46 -.76i	.09+.89i
	.09 -.89i	-.25+.82i	-.25 -.82i	-.61+.65i
	-.61 -.65i	-.79 -.34i	-.79+.34i	-.92
Inverted MA Roots	.90	.78+.45i	.78 -.45i	.45+.78i
	.45 -.78i	.18	-.00 -.90i	-.00+.90i
	-.45+.78i	-.45 -.78i	-.78 -.45i	-.78+.45i
		-.90		

5.3.1 Interpretation of the Estimation Results

Table 5.4 shows the coefficient estimates of various Autoregressive and moving Average schemes of Inflation in Tanzania. All coefficients are statistically significant

[13] These are results obtained from the model that contains AR (1, 3, 8, and 15) and MA (1 and 12) components.

at 5 and 10 percent, respectively. R-squared and Adjusted R-square are very high which implies high goodness of fit. Durbin-Watson statistic is close to 2 which indicate absence of both positive and negative autocorrelation.

5.3.2 Comparison with other ARIMA Models

However, the [14]above model was compared with other alternative model and by using model selection criteria such as R-squared, Adjusted R-squared, S.E. of regression, Durbin-Watson statistic, Akaike information criterion, Schwarz criterion, F-statistic, and other measures, the above model outperform other competing models as presented in Table 5.5

Table 5.7: Evaluation of various ARIMA models

	AR(1), MA(1)	**AR(1), SAR(3), SAR(8), SAR(12), SAR(15), MA(1)**	**AR(1), SAR(3), SAR(8), SAR(12), SAR(15), MA(1) SMA(12), SMA(15)**	**AR(1), MA(1), SAR(3), SAR(8), SMA(12)**	**AR(1), SAR(3), SAR(8), SAR(15), MA(1), SMA(12)**
R-squared	0.955416	0.963909	0.964381	0.962032	**0.964476**
Adjusted R-squared	0.955165	0.963266	0.96353	0.961482	**0.963843**
S.E. Of Regression	2.508094	2.261844	2.253704	2.326974	**2.244005**
Durbin-Watson stat	2.003181	1.948258	1.97903	1.977281	**1.95696**
Akaike info criterion	4.685245	4.490377	4.488842	4.54396	**4.47454**
Schwarz criterion	4.717696	4.568529	4.589324	4.609957	**4.552693**
F-Statistic	3814.428	1500.071	1133.749	1748.317	**1524.912**
Skewness	-0.73703	-0.021452	-0.225174	-0.18521	**-0.050728**
Kurtosis	10.38443	7.168567	7.443483	7.584489	**7.101032**
Jarque-Bera	848.1772	249.096	285.9121	309.3883	**241.2122**
Root Mean Squared Error	2.497593	2.238713	2.224027	2.306999	**2.221056**
Mean Absolute Error	1.585662	1.481466	1.47876	1.504421	**1.476917**
Mean Abs. Percent Error	8.092673	7.833781	7.812966	7.957413	**7.876074**
Theil inequality Coefficient	0.053456	0.048872	0.048408	0.049774	**0.048487**
Bias Proportion	0	0.000003	0.001511	0.000021	**0.000006**
Variance Proportion	0.011449	0.007679	0.001377	0.007426	**0.007677**

[14] The model that contains AR (1, 3, 8, and 15) and MA (1 and 12) components.

5.3.3 The Best Model

Based on estimation results presented in table 5.4 and evaluation of various ARIMA model as presented in table 5.5 the model can be re-written as follows.

$$\Pi_t = 9.315 + 0.996\Pi_{t-1} - 0.176\Pi_{t-3} + 0.13\Pi_{t-8} - 0.148\Pi_{t-15} - 0.18\mu_{t-1} - 0.29\mu_{t-12}$$

....Equation 5.1

5.4 Out-of-sample Forecasts

The emphasis of the study is on forecast performance which suggests more focus on minimising out-of-sample forecast errors than on maximising in-sample ‘goodness of fit. Thus, the approach followed is unashamedly one of ‘model mining’ with the aim of optimising forecast performance.

The table below reports the various measures of forecasting errors from the estimated model, namely the root mean squared error (RMSE), mean absolute error (MAE), Theil inequality coefficient, and variance proportion.

Table 5.8 Results on various measures of forecasting errors

	AR(1), MA(1)	AR(1), SAR(3), SAR(8), SAR(12), SAR(15), MA(1)	AR(1), SAR(3), SAR(8), SAR(12), SAR(15), MA(1) SMA(12), SMA(15)	AR(1), MA(1), SAR(3), SAR(8), SMA(12)	**AR(1), SAR(3), SAR(8), SAR(15), MA(1), SMA(12)**
Root Mean Squared Error	2.49759	2.238713	2.224027	2.306999	**2.221056**
Mean Absolute Error	1.58566	1.481466	1.47876	1.504421	**1.476917**
Mean Abs. Percent Error	8.09267	7.833781	7.812966	7.957413	**7.876074**
Theil inequality Coefficient	0.05346	0.048872	0.048408	0.049774	**0.048487**
Bias Proportion	0	0.000003	0.001511	0.000021	**0.000006**
Variance Proportion	0.01145	0.007679	0.001377	0.007426	**0.007677**

Therefore, apart from within sample forecasts which are presented in the appendix, the study has also estimated six months out-of sample forecasts of the model in order to measure forecasting ability.

Results indicate that inflation will continue to be in the single digit bundle until August 2011 with a rate of 9.7 before hitting double digit level of 10.5 in September 2011. Inflation is expected to start falling from the month following September 2011 to a single digit level of 9.3 percent in November.

The forecasting power of the model is very high as indicated by small difference between Actual and fitted values as presented in Table 5.6.

Table 5.9 Six Months ahead Inflation Forecasts

Observation	Actual	Fitted	Residual
2011:01	6.4	5.64056842194	0.759431578059
2011:02	7.5	6.22533558226	1.27466441774
2011:03	8	7.34643728271	0.653562717292
2011:04	8.6	8.05607075429	0.543929245709
2011:05	9.7	8.75624743146	0.943752568539
2011:06	NIL	9.80227422745	NIL
2011:07	NIL	9.95399120544	NIL
2011:08	NIL	9.71155659325	NIL
2011:09	NIL	10.4950641562	NIL
2011:10	NIL	10.0847558784	NIL
2011:11	NIL	9.28347480376	NIL

5.5 Post-Forecasting Examination

5.5.1 Present trend of Inflation in Tanzania

Despite the robust socio-political instability that faces Tanzania in recent times, the country is highly affected with economic instability. Among the major economic challenges in 2011 comprise that of increasing general price level. By January 2011, the official inflation rate was about 6.4 percent compared to 5.6 per cent in December 2010. Movements of prices since January have been on the increase. In most cases prices of electricity, fuel, steel, sugar, transport and many other goods and services were on increase. Reducing inflation below the policy target of five per cent seems to be a difficult task to the government. This is due to the real situation on the ground both at local and international scenes as discussed in what follows.

5.5.2 Power rationing

Power rationing in Tanzania has badly affected industrial production in Tanzania and hence scarcity in the supply side of the economy thereby leading to an increase in the general price level. Inflation is also reflected by rising cost of production due to escalating price of electricity. Despite being endowed with abundant of natural resources some of which could be used as alternative source of energy like coal.

5.5.3 Agriculture Productivity

Rainfall has an outsized influence on inflation on the agrarian economies like Tanzania, leading to higher food prices due to decline in rainfall based-agriculture production. This is because food expenditure item has a weight of 47.8 per cent in the Mainland Consumer Price Index (CPI) and 57.4 per cent in Zanzibar's. The government has already warned about occurrence of drought and hunger in various parts of the country, this is expected be translated in the general price level.

5.5.4 Imported Inflation

Rising inflation in China posses another threat to prices in Tanzania due to bilateral trade ties of the two countries. The inflation rate in China was last reported at 5.4 percent in March of 2011. From 1994 until 2010, the average inflation rate in China was 4.25 percent reaching an historical high of 27.70 percent in October of 1994 and a record low of -2.20 percent in March of 1999. High inflation not only endangers China's status as the low-cost workshop for the world but also act as imported inflation to other countries in the world.

5.5.5 Depreciation of shillings

Depreciation of Tanzania Shilling against major currencies also leads to rise in inflation via the route of goods and services imports, increased production and travel costs, and higher consumer prices. This could in the end inflate the cost of living. The shilling, though opened the year stronger, began losing ground rapidly in the end of March 2011 to trade between 1,510/- and 1,520/- in the money shops. The Bank of Tanzania official rate indicates that the shilling has depreciated by almost 3.0 per cent from 1,440/45 to 1,481/74 per US dollar as of Monday, 18th April 2011. The depreciation is purely on demand following a high oil bill as prices have gone up due to Middle East unrests. Therefore the depreciation of Shilling is expected to further drive up the inflation in Tanzania.

5.6 Conclusion

This chapter presented and discussed results from the empirical analysis. Ordinary least square technique was employed to estimate the appropriate auto-regressive moving average model of inflation in Tanzania. The best model was presented in equation 5.1. Findings on the six months ahead forecasts were reported in table 5.9. Findings concluded that Tanzania's inflation contains AR (1, 3, 8, and 15) and MA (1 and 12) components that are significant for forecasting purposes.

CHAPTER SIX

CONCLUSION AND POLICY IMPLICATIONS

6.0 Introduction

This chapter concentrate on the presentation of the Conclusion and Recommendations on the Inflation Forecasting model of Tanzania. The chapter is organized into four sections. Section 6.1 is an introduction to chapter 6. Section 6.2 is on Summary, Section 6.3 is devoted to presentation of main findings of the study, and lastly, Section 6.4 present Policy implication, Limitation of the study and Areas for further research.

6.1 Summary

The aim of the study was to ascertain an inflation forecasting model of Tanzania based on Box-Jenkins methodology and providing short-run (six months ahead) inflation forecasts of Tanzania.

Through collection and examination of monthly inflation data of Tanzania; determining the order of integration; model identification; diagnostic checking; model stability testing; and forecast performance evaluation the best ARIMA model was proposed inn equation 5.1 based on given criteria. The unit root tests which include Augmented Dickey-Fuller (ADF) test and Phillip Peron (PP) test have been used for testing stationarity. Moreover, the ordinary least square (OLS) method has been used for estimating the model.

6.2 Main Findings

The first main empirical finding of the study is the model that has been ascertained for forecasting inflation as presented here below.

$$\Pi_t = 9.315 + 0.996\Pi_{t-1} - 0.176\Pi_{t-3} + 0.13\Pi_{t-8} - 0.148\Pi_{t-15} - 0.18\mu_{t-1} - 0.29\mu_{t-12}$$

This is the forecasting model of inflation in Tanzania that is recommended for consistent forecasting. All coefficients were statistically significant at 5 and 10 percent respectively. R-squared and Adjusted R-square were very high which implies high goodness of fit. Durbin-Watson Statistic is close to 2 which indicate absence of both positive and negative autocorrelation.

Various ARIMA models with different order of Autoregressive and Moving Average terms were compared based on their performance, checked and verified by using the statistics such as AIC, RMSE, MAE, MB and MAE. The results indicate that the proposed model performed well in terms of both in-sample and out-of-sample.

The second empirical finding of the study is the six months ahead inflation forecasts of Tanzania. The out of sample short term forecasts obtained indicate a rising trend until September 2011 something which is in line with the expectations on ground based on the on-going trend of factors that affect inflation such as increasing food prices due to scarcity of rains, rising prices of oil due to political crisis in the Arab world, rising inflation in china and ongoing Power crisis in Tanzania.

6.3 Policy implication

The main implication from this study is that the Bank of Tanzania should adopt a flexible form of inflation targeting in the near future. Forecasts of inflation either originating from central Bank or from other agents have special roles in the inflation-targeting regime (Debelle, 1997).

Inflation targeting is not a policy just for industrial countries. Although its prerequisites, which are identified as central bank independence, including lack of fiscal dominance and commitment to another nominal anchor, and a stable relationship between monetary policy instruments and inflation rate, are largely absent in developing countries, more than a dozen of developing countries have started to implement inflation targeting with successful results. The main argument in favour of inflation targeting According to Bernanke et al (1999)is that an official announcement of an inflation target makes a central bank's policy more credible, which helps to alleviate the dynamic inconsistency problem, and thus should lead to lower (expectations of) inflation and inflation variability.

The purpose of the study in forecasting was to tell a story about the likely future events, to highlight potential future stresses. According to the results there is expectation of rising inflation in the next six months, this requires the government to these inflationary pressures through appropriate fiscal and monetary policies react immediately to these inflationary pressures through appropriate fiscal and monetary policies.

6.4 Limitation of the study and Areas for further research

Inflation can never be forecast with perfect accuracy. The overall inflation measure is the result of millions of pricing decisions made by businesses large and small. The calculation of the retail price index although extremely thorough, is always subject to error and omission. Furthermore, the nature of the inflation process makes it very difficult to forecast, even when inflationary conditions in the economy appear to be benign.

External economic shocks can make forecasts inaccurate. For example, a sharp jump in world oil prices (an inflationary shock) or deep falls in global share prices (a deflationary shock); both have big feedback effects through the economic system. The exchange rate might also fluctuate leading to volatility in the prices of imported goods and services.

The study is also limited by Box-Jenkins approach of modelling univariate time series with Autoregressive Moving Average despite availability of other approaches such as Phillips curve, P star model, leading Indicators and the price equation derived from the money demand, vector error correction models, autoregressive conditional heteroskedasticity (ARCH)-based models, or various possible combinations.. These alternative modelling techniques incorporate theoretical factors that affect inflation. Therefore the study calls for further analysis of the inflation dynamics by using alternative models.

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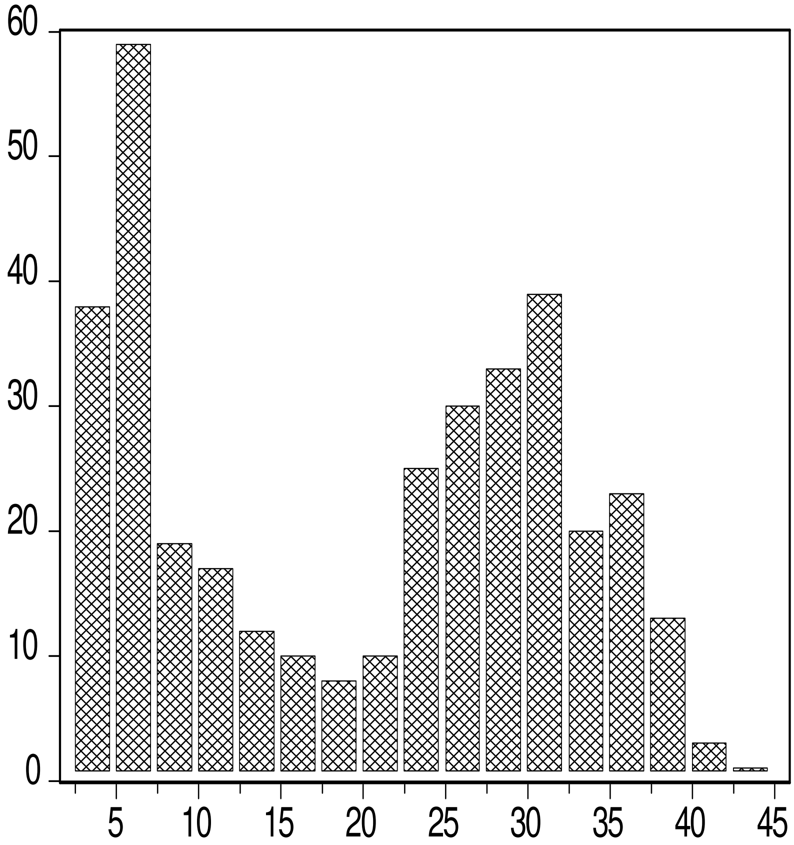
APPENDIX

Appendix 1.1 Statistical properties of inflation data



Series: INFLATION
Sample 1980:01 2009:12
Observations 360

Mean	20.25108
Median	23.32500
Maximum	44.65000
Minimum	3.400000
Std. Dev.	11.84019
Skewness	-0.040776
Kurtosis	1.516168
Jarque-Bera	33.12612
Probability	0.000000

Appendix 1.2 Correlogram of the first difference of Inflation

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
**|. |	**|. |	1	-0.241	-0.241	21.113	0.000
.|* |	.|. |	2	0.089	0.033	23.989	0.000
*|. |	*|. |	3	-0.167	-0.147	34.190	0.000
.|. |	*|. |	4	-0.039	-0.122	34.734	0.000
*|. |	*|. |	5	-0.078	-0.113	36.977	0.000
.|* |	.|* |	6	0.125	0.068	42.731	0.000
.|. |	.|. |	7	-0.054	-0.034	43.821	0.000
.|* |	.|* |	8	0.150	0.101	52.151	0.000
.|. |	.|. |	9	-0.032	0.052	52.529	0.000
*|. |	*|. |	10	-0.094	-0.106	55.828	0.000
.|. |	.|. |	11	0.003	0.002	55.832	0.000
*|. |	*|. |	12	-0.157	-0.158	64.990	0.000
.|. |	*|. |	13	0.003	-0.094	64.992	0.000
.|* |	.|* |	14	0.121	0.077	70.474	0.000
*|. |	**|. |	15	-0.163	-0.202	80.492	0.000
.|* |	.|. |	16	0.089	-0.035	83.469	0.000
.|. |	.|* |	17	0.048	0.087	84.353	0.000
*|. |	.|. |	18	-0.066	-0.042	85.999	0.000
.|. |	.|. |	19	0.023	-0.004	86.198	0.000
.|. |	.|* |	20	0.063	0.109	87.704	0.000
*|. |	.|. |	21	-0.076	-0.014	89.947	0.000
.|* |	.|. |	22	0.097	0.011	93.566	0.000
*|. |	.|. |	23	-0.084	-0.017	96.315	0.000
.|* |	.|. |	24	0.075	0.036	98.479	0.000
.|. |	.|. |	25	0.048	0.042	99.384	0.000
*|. |	*|. |	26	-0.099	-0.084	103.23	0.000
.|* |	.|. |	27	0.099	0.057	107.07	0.000
.|. |	.|. |	28	-0.025	-0.001	107.32	0.000
*|. |	.|. |	29	-0.082	-0.047	109.99	0.000
.|* |	.|* |	30	0.120	0.088	115.67	0.000
*|. |	*|. |	31	-0.103	-0.077	119.85	0.000
.|. |	.|* |	32	0.040	0.070	120.47	0.000
.|. |	.|. |	33	0.028	0.021	120.78	0.000
.|. |	.|. |	34	-0.046	-0.051	121.62	0.000
.|. |	.|. |	35	-0.023	0.022	121.83	0.000
.|. |	.|. |	36	0.003	-0.054	121.83	0.000

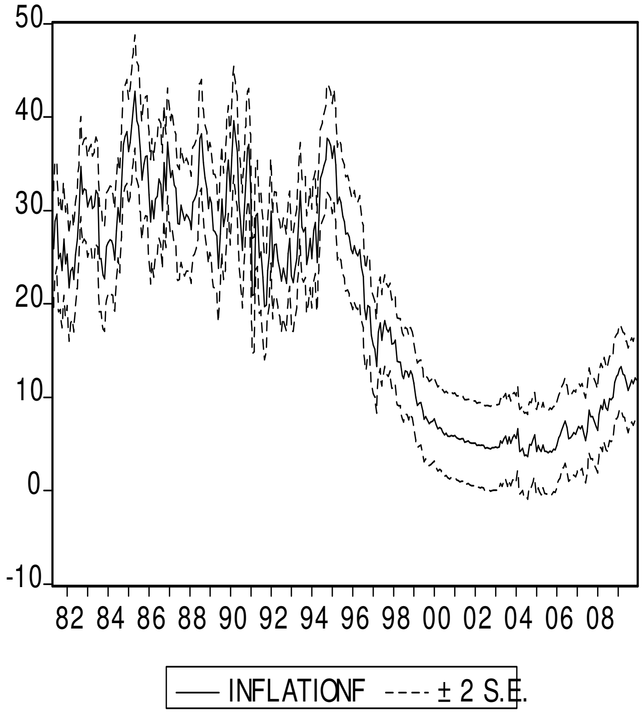
Appendix 1.3 In-sample inflation forecasts 1981: 05-1990: 12

Observat ion	Actual	Fitted	Residual
1981:05	30.8600	25.8637	4.99631
1981:06	25.8800	28.8886	-3.00859
1981:07	26.7400	29.5279	-2.78785
1981:08	23.3300	24.8495	-1.51950
1981:09	23.6600	25.3254	-1.66542
1981:10	26.8800	23.5532	3.32677
1981:11	26.3200	26.9267	-0.60672
1981:12	25.4800	24.2992	1.18076
1982:01	21.5700	25.3280	-3.75803
1982:02	23.3000	21.7080	1.59197
1982:03	24.2700	23.5226	0.74742
1982:04	24.7600	23.8711	0.88892
1982:05	24.5300	22.6139	1.91615
1982:06	24.3000	25.2722	-0.97220
1982:07	31.1900	26.8863	4.30373
1982:08	35.1400	29.6832	5.45682
1982:09	33.9100	34.7366	-0.82659
1982:10	32.2000	31.7726	0.42740
1982:11	32.5000	32.2976	0.20236
1982:12	28.9300	32.1832	-3.25316
1983:01	32.2600	30.3379	1.92212
1983:02	29.9200	31.1367	-1.21675
1983:03	29.6900	31.4939	-1.80386
1983:04	31.3000	30.1851	1.11491
1983:05	32.5800	30.4621	2.11788
1983:06	33.8300	32.1495	1.68050
1983:07	25.8700	31.7849	-5.91493
1983:08	24.0000	24.7951	-0.79512
1983:09	22.9000	24.8162	-1.91617
1983:10	23.0800	23.0319	0.04815
1983:11	25.1600	22.6551	2.50493
1983:12	27.1700	26.1660	1.00397
1984:01	26.8300	26.5475	0.28246
1984:02	27.2700	26.8955	0.37451
1984:03	27.7100	26.7411	0.96894
1984:04	25.0000	26.3404	-1.34040
1984:05	29.1400	24.7061	4.43392
1984:06	28.0900	27.8450	0.24498
1984:07	29.4400	30.2498	-0.80977
1984:08	33.2000	28.7519	4.44814
1984:09	37.1000	32.7599	4.34009
1984:10	39.6000	37.0825	2.51746

1984:11	40.0100	37.9593	2.05072
1984:12	35.9100	38.4756	-2.56562
1985:01	38.4000	36.2567	2.14334
1985:02	39.3000	37.2621	2.03794
1985:03	41.0000	39.0962	1.90380
1985:04	44.6500	41.0458	3.60422
1985:05	38.9400	42.7458	-3.80576
1985:06	39.0400	39.5719	-0.53189
1985:07	37.7700	39.0561	-1.28615
1985:08	33.4000	36.3451	-2.94515
1985:09	35.9000	33.1969	2.70311
1985:10	36.2000	34.9022	1.29785
1985:11	35.6000	35.7682	-0.16823
1985:12	33.3000	35.8061	-2.50613
1986:01	28.8100	31.7000	-2.89000
1986:02	31.2000	28.7690	2.43099
1986:03	30.1900	31.0358	-0.84583
1986:04	30.5500	29.1073	1.44270
1986:05	31.8500	31.2515	0.59851
1986:06	34.3800	31.5375	2.84251
1986:07	31.4600	33.4131	-1.95311
1986:08	31.9100	32.8034	-0.89342
1986:09	35.4500	29.9728	5.47722
1986:10	30.9500	35.0937	-4.14371
1986:11	38.9200	32.1118	6.80821
1986:12	32.4000	37.3609	-4.96089
1987:01	35.7300	34.7512	0.97880
1987:02	32.7500	33.5948	-0.84484
1987:03	32.9200	34.2273	-1.30731
1987:04	31.7700	32.7036	-0.93360
1987:05	29.4700	32.3155	-2.84547
1987:06	26.2900	28.6016	-2.31163
1987:07	31.7500	28.4717	3.27835
1987:08	30.8800	30.5882	0.29184
1987:09	28.1900	29.6528	-1.46278
1987:10	32.3900	28.9543	3.43568
1987:11	27.4000	29.5550	-2.15496
1987:12	30.0000	29.2690	0.73096
1988:01	28.4100	28.8655	-0.45548
1988:02	29.7600	27.9464	1.81358
1988:03	31.5200	30.8767	0.64329
1988:04	31.2100	31.1592	0.05080
1988:05	32.2800	31.7325	0.54748
1988:06	40.8900	32.7944	8.09562
1988:07	37.7700	37.8143	-0.04429

1988:08	35.5600	38.1983	-2.63833
1988:09	34.7300	35.1171	-0.38713
1988:10	30.2500	33.4715	-3.22148
1988:11	29.7000	32.2341	-2.53412
1988:12	31.2000	30.2040	0.99599
1989:01	29.0600	31.3568	-2.29681
1989:02	28.7400	30.7269	-1.98690
1989:03	27.3900	27.8499	-0.45992
1989:04	27.7800	27.7097	0.07027
1989:05	26.8000	27.2567	-0.45671
1989:06	28.0000	23.8362	4.16381
1989:07	31.0000	27.5011	3.49889
1989:08	30.0000	31.2381	-1.23815
1989:09	29.0000	28.3244	0.67558
1989:10	34.0000	29.5953	4.40467
1989:11	36.0000	33.9932	2.00685
1989:12	31.0000	35.4244	-4.42439
1990:01	36.5000	32.0594	4.44058
1990:02	39.3000	35.9278	3.37223
1990:03	38.7000	39.5996	-0.89961
1990:04	36.7000	37.9062	-1.20620
1990:05	30.1200	36.3409	-6.22095
1990:06	28.8000	30.7855	-1.98555
1990:07	23.6800	28.7644	-5.08441
1990:08	29.8000	25.6663	4.13374
1990:09	34.7000	29.4484	5.25158
1990:10	39.3000	33.1824	6.11762
1990:11	36.8000	36.7387	0.06126
1990:12	35.9000	37.1025	-1.20249

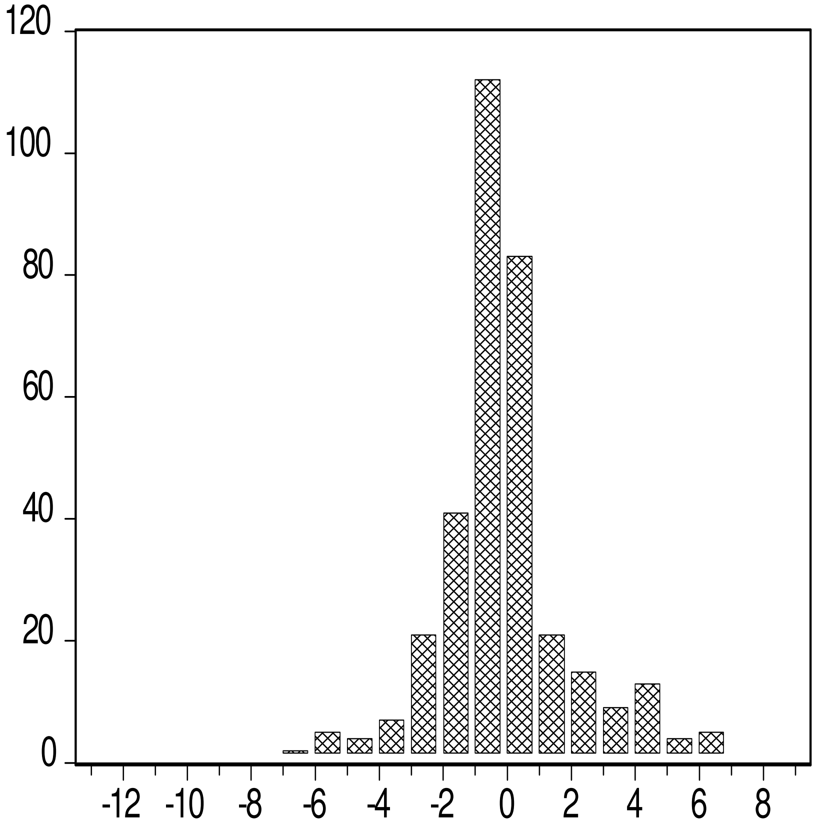
Appendix 1.4 In-sample Forecasting Output



Forecast: INFLATIONF
Actual: INFLATION
Forecast sample: 1980:01 2009:
Adjusted sample: 1981:05 2009:
Included observations: 344

Root Mean Squared Error	2.221056
Mean Abs. Percent Error	1.476917
Mean Absolute Percentage Error	7.876074
Theil Inequality Coefficient	0.048487
Bias Proportion	0.000006
Variance Proportion	0.007677

Appendix 1.5 Residual Normality Test



Series: Residuals
Sample 1981:05 2009:12
Observations 344

Mean	0.005333
Median	-0.164024
Maximum	8.096515
Minimum	-12.59544
Std. Dev.	2.224285
Skewness	-0.050728
Kurtosis	7.101032
Jarque-Bera	241.2122
Probability	0.000000

Appendix 1.6 Actual and Residual plot