THE RELATIONSHIP BETWEEN INFLATION AND ECONOMIC GROWTH IN ZAMBIA (1980-2011)

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DECLARATION

I Chibwe Francis declare that this dissertation and its contents represent my own work and have not previously been submitted for a degree at this or any other university.

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CERTIFICATE OF APPROVAL

This dissertation of Chibwe Francis has been approved as partial fulfillment of the requirement for the award of the Master of Arts degree in Economics by the University of Zambia

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ABSTRACT

The study on the relationship between economic growth and inflation has attracted attention world over by researchers and policy makers. A high and sustained economic growth with low and stable inflation is the central objective of most policy makers. However, previous studies on the relationship between inflation and economic growth have revealed the complexity of this subject. These studies show that there might be no relationship, there might be a negative relationship or there might be a positive relationship between inflation and economic growth. Other studies further show that these variables might be related either in the short-run or long-run or both, with no consensus on the direction of causality. Therefore, the ambiguity of the relationship between inflation and economic growth as portrayed in both theory and empirical studies warrants an investigation into this matter in the context of Zambia. This is further qualified by the fact that, there is no study that depicts the exact relationship between these two variables in the context of Zambia for the period under study and years earlier.

The main purpose of this study is to ascertain the nature of the relationship between inflation and economic growth in Zambia. In doing so, the study seeks to unravel the short-run and long-run dynamics between inflation and economic growth as well as establishing the nature of causality. The study reviews both theoretical and empirical aspects of inflation-economic growth relationship. Time series analysis involving stationarity tests, cointegration tests, Granger causality tests and vector autoregressive analysis (VAR) are employed. Growth in the logarithm of the Consumer Price Index (CPI) is used to measure inflation and growth in real GDP as a measure of economic growth to examine the relationship. The study covers a period from 1980 to 2011 and the data is used as annual time series.

The study finds no cointegration between inflation and economic growth. The non-existence of cointegration implies that there is no stable long-run equilibrium relationship between inflation and economic growth. They have different trend processes and cannot stay in a fixed long-run relationship. However, the VAR analysis reveals that inflation significantly and negatively impacts economic growth in the short-run. The study further reveals that there is unidirectional Granger causality running from inflation to economic growth. These results concur with several studies reviewed; that inflation is and has been detrimental to economic growth. Impulse response analysis also shows that a one-standard-deviation shock in inflation changes GDP growth by about one percentage point in the current period.

One important policy implication of our study is that, by knowing the past values of GDP, we cannot predict what inflation rate will be in future. On the contrary, the past values of inflation help predict future rate of GDP. Furthermore, having established that it is inflation that causes GDP and this happens in a negative way, policy makers should worry more about controlling inflation in the short-run. Any measure that is likely to fuel inflation in the short-run will also depress economic growth. Policy makers should also aim at achieving the highest GDP growth rate possible, as doing so will not be a trade-off by introducing short-run inflationary pressures in the economy.

To

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LIST OF ACRONYMS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
BOZ	Bank of Zambia
CPI	Consumer Price Index
CSO	Central Statistical Office
DF	Dickey-Fuller
DF-GLS	Dickey-Fuller Generalised Least Squares
FEVD	Forecast Error Variance Decomposition
FPE	Final Prediction Error
FNDP	Fifth National Development Plan
GDP	Gross Domestic Product
GRZ	Government of the Republic of Zambia
HQIC	Hannan-Quinn Information Criterion
IMF	International Monetary Fund
INFL	Inflation rate
IRF	Impulse Response Functions
LM	Lagrange-Multiplier test
MAIC	Modified Akaike Information Criterion
NAIRU	Non-Accelerating Inflation Rate of Unemployment
NP	Ng-Perron Sequential t-test
OLS	Ordinary Least Squares
SBIC	Schwarz Bayesian Information Criteria
SC	Schwarz Information Criteria
SNDP	Sixth National Development Plan
TFP	Total Factor Productivity
VAR	Vector Autoregression
VECM	Vector Error Correction Model
WTO	World Trade Organisation

CHAPTER ONE

INTRODUCTION

1.0. Background to the Study

The relationship between economic growth and inflation is one of the most important macroeconomic subjects being debated currently. Definitely, one of the macroeconomic goals which every government strives to achieve is the maintenance of a stable domestic price level. This goal is pursued in order to avoid the costs associated with inflation and the uncertainties that follow where there is price instability.On the other hand, economic development is the dream of every society and economic growth is fundamental to economic development[1]. Therefore, high and sustained economic growth with low and stable inflation should be the central objective of macroeconomic policy makers. However, previous studies on the relationship between inflation and economic growth have revealed the complexity of this subject and inconclusive nature of the relationship.

Most empirical studies support a tradeoffbetween inflation and economic growth, especially when inflation is very high.However, for low or moderate inflation, there is no single agreement. Some studies show a zero relationship, while others show a statistically significant positive relationship. From the causal direction point of view, there are two opposite situations that exist. On one hand, it is believed that inflation could be advantageous to economic growth while others argue that growth could spur inflation.This means that, some empirical results reveal a unidirectional causality, moving from inflation to economic growth or vice-versa. Some evidence shows that, inflation-economic growth relationship is just a short-run phenomenon, while otherssshow that inflation-economic growth relationship can only be explained well in the long-run.

The discussion concerning inflation and output can be traced back to the classical economists and further developed through different schools of thought. Following the works of Keynes, the post-world war II economies were characterized by Keynesian

[1] Economic growth means more output while economic development implies both more output and changes in the technical and institutional arrangement by which it is produced, Ahuja (2007;719).

policies which saw the increase in aggregate demand causing both inflation and output to rise. This was particularly explained by the Keynesian theory of demand-pull inflation which purports that, in the short-run, there is a positive relationship between inflation and output.However, in the long-run when the economy is at full employment, this relationship ceases to hold as any increase in aggregate demand would not cause output to change, but price levels will increase (Ahuja, 2007).

Another important view that claims the existence of a positive relationship between inflation and economic growth comes from the Phillips curve approach. This approach assumes that, high inflation causes low rates of unemployment, meaning that the levels of employment will go up thereby affecting growth positively (Ahuja, 2007). However, empirical studies made subsequently have shown that, the positive relationship between the rate of inflation and the rate of unemployment is valid in the short-run in case of unanticipated inflation. Further, following the pioneering work of Tobin (1965) (which assumed demand for money to be the substitute for capital), there was a motivated optimistic conjecture on the positive relationship between inflation and output, which is often referred to as the Tobin effect. It claims that higher accumulated capital would lead to higher economic output. Therefore, models of inflation in the 1960s emphasized the portfolio substitution mechanism by which higher inflation made capital more attractive to hold relative to money, leading to higher capital intensity and in the transition period to higher growth (Fischer, 1983). A few of the earliest studies on inflation and growth, like Baer (1967) added to the literature on the positive relationship between inflation and growth. Furthermore, the relationship between low rates of inflation and high levels of economic growth has been confirmed to elicit positive impacts (De Gregorio 1991; Khan and Senhadji 2001).

In contrast to beliefs of positive relationship between inflation and economic growth, some empirical studies helped to shift the conventional empirical understanding of this relationship. This was motivated by high inflation rates recorded during the 1970s which were accompanied by the falling growth rates. The 1980's hyperinflation episodes, especially in Latin American countries increased the instability in those economies and affected the development process of those economies adversely. Those developments

strengthened the perception about the negative effects of inflation on growth. Recent studies have put up some evidence that has strengthened and further qualified the nature of this negative relationship. Furthermore, some studies have shown that the negative relationship found is non-linear in that, the marginal effect is stronger at lower inflation rates than at higher inflation rates, for example (Li, 2005).

Contrary to the studies which have shown either positive or negative relationship between inflation and economic growth, there are studies which have shown that there is no conclusive empirical evidence for either situation. One such seminal work is Sidrauski (1967) which established the unrelated relationship between these two variables, advocating that money is super-neutral in an optimal control framework considering real money balances in the utility function. Arai et al. (2002) further did not find any evidence supporting the view that inflation is in general harmful to economic growth.

Despite the surfeit of studies on inflation-economic growth relationship for both developing and developed countries, there is no conclusive and concrete study that depicts the exact relationship between inflation and economic growth in Zambia. This is despite policy direction towards high and sustained economic growth coupled with low inflation from both fiscal and monetary authorities. However, there have been studies on inflation in Zambia by Ng'andwe (1980), Mikkelsen (2008) Hangoma (2010) and Simatele (2004) among others, with their concentration precluding detailed inflation-economic growth relationship. These studies have paid much attention to studying the determinants of inflation in Zambia. The purpose of this study is therefore to empirically examine the relationship between inflation and economic growth in Zambia. It will help close the gap in this aspect and try to establish the foundation for further research on the exact relationship between inflation and economic growth in Zambia.

1.1. Historical overview of inflation and economic growth in Zambia

Immediately after independence and more than a decade later, policy making in Zambia followed a socialists' path. Government had a big role to play in the affairs of the economy. During this period, copper prices were rising and high profits were recorded in the mining sector, hence government enjoyed increased revenue to support its activities.

The macroeconomic performance of the country was generally satisfactory during this period, with stable and low inflation. However, the oil crisis of the early 1970's caused world commodity prices to collapse, as global demand dropped. Low demand for copper meant that Zambia's export earnings declined and rising oil prices meant that the country had to spend more to import oil. This situation drove the economy into a current account deficit and became highly indebted. During this period, the Bank of Zambia printed more money which exacerbated inflation.

By 1983, the country adopted Structural Adjustment Programs (SAPs) advocated for by the International Monetary Fund (IMF) and the World Bank. However, these regulations did not work as expected and mostly contributed to a rise in inflation rate from 11.7 percent in 1982 to 44.1 percent in 1986. During this period, growth in GDP was very low, in some cases negative. Due to devastating impact on the economy, the government decided to abandon the IMF/World Bank sponsored SAPs which led to suspension of credit from the World Bank and from most donors. The re-introduction of price controls and price monitoring systems on most commodities helped to lower inflation rate from 44.1 percent in 1986 to 38.1 percent in 1987. In the following year (1988), GDP grew at a high record of 6.09 percent, though inflation increased to 43.5 percent. The rate of inflation continued on an upward trend and rose sharply to 82.6 percent in 1989 but dropped to 73.9 in 1990. In this period, growth in real GDP was negative.

In 1991, the country abandoned the one party political system and adopted multiparty system. The rate of inflation rose sharply from 68.2 percent in 1991 to 104.1 in 1993. In the following year, Zambia recorded the lowest growth in real GDP of -9.02 percent. Policies such as devaluation and subsequent floatation of the kwacha, decontrol of prices and the removal of subsidies contributed to the acceleration of inflation in 1992 and 1993. In addition, the liquidity build up in the last quarter of 1991 contributed to inflationary pressures in the first quarter of 1992 (Adam, 1995). However, further measures to tighten fiscal policy involved the government operating a cash budget basis from January, 1993. These policies led to the rate of inflation dropping sharply from 104.1 percent in 1993 to 35.8 percent in 1996. GDP growth also responded by growing at 6.9 percent in the same year.

By 1997, government economic policy was directed towards maintaining macro-economic stability and stimulating economic growth through efficient allocation of resources after effective implementation of stabilization program of the preceding five years. To this effect, there are some positive macroeconomic signs rooted in reforms implemented during the early and mid-1990s. Inflation rate has been going down and GDP has been trending upwards. Zambia's floating exchange rate and open capital markets have provided useful discipline on the government, while at the same time allowing continued diversification of the export sector, growth in the tourism industry, and procurement of inputs for growing businesses (World Trade Organization, 2009). Table 1 provides a summary of trends in our two variables.

Table1.1: Time series of Inflation rate and GDP growth rate

Year	GDP	Inflation	Year	GDP	Inflation
1980	2.99053	14.928	**1996**	6.7152	35.8356
1981	5.98488	13.3531	**1997**	3.24554	21.8404
1982	-2.85301	11.7783	**1998**	-1.87626	21.8792
1983	-1.98593	20.0671	**1999**	2.20013	23.7361
1984	-0.3376	16.7054	**2000**	3.45631	23.1907
1985	1.60236	32.5422	**2001**	4.77886	19.3649
1986	0.721169	44.1833	**2002**	3.26347	20.0776
1987	2.64053	38.1368	**2003**	5.00011	19.394
1988	6.0915	43.484	**2004**	5.26276	16.5238
1989	-1.02882	82.602	**2005**	5.20363	16.8261
1990	-0.48237	73.9301	**2006**	6.03924	8.63576
1991	-0.03586	68.2085	**2007**	6.00929	10.1269
1992	-1.74637	97.7347	**2008**	5.52597	11.7296
1993	6.57654	104.118	**2009**	6.20632	12.5691
1994	-9.02042	43.574	**2010**	7.34386	8.15978
1995	-2.86198	29.9405	**2011**	6.26411	8.30421

Source: Author's calculations using the World Economic Outlook data, 2012

Historical overview of economic growth and inflation in Zambia has provided some insights into the nature of the relationship between our two variables. We have observed that, most of the years of high inflation are usually accompanied with low economic growth and vice versa. However, this cannot be the basis for a concrete conclusion of the relationship, until the formal tests using established econometric methodologies are employed. This work is left for chapter 4 of this study.

1.2. Statement of the Problem

Although the debate on the precise relationship between inflation and economic growth is still open, the continued research on this subject has revealed some very important results. There is more or less a universal consensus that macroeconomic stability, in which inflation is defined to be low, is positively related to economic growth. Mostly, it is generally accepted that inflation has a negative effect on medium and long-term growth (Bruno and Easterly, 1998). Moreover, inflation is said to hamper efficient resource allocation by making the signaling role of relative price changes to be ambiguous, which is the most important guide to efficient economic decision making (Fischer, 1993).

The problem is that, the exact relationship between inflation and economic growth in Zambia remains unidentified through an empirical study for the period covered in this study and the years earlier. This is despite the policy direction towards higher economic growth and low inflation as pronounced by policy makers in the development plans.This lack of empirical evidence to guide monetary policy formulation has the potential to lead to ineffective and uninformed approach to managing inflation while stirring high and sustained economic growth.If high inflation really lowers economic growth, it obviously follows that policymakers should aim at achieving a low rate of inflation.On the other hand, if the relationship between inflation and economic growth is weak, policy makers should worry about other factors that may be hindering economic growth.

An important component of Zambia's movement towards macroeconomic stability and sustained economic growth should involve integrated effort towards price stability. Since independence, Zambia has had high rates of inflation coupled with low economic growth which has seen a lot of people continue living in poverty. Inflation has some negative effects, for example, at the individual level, inflation exerts a heavy toll on those with fixed income because it relatively favors debtors at the expense of creditors and at the firm level, inflation can affect output when firms have to incur costs as they adjust to the new price level. In addition, studies on inflation have revealed that, inflation can lead to uncertainty about the future profitability of investment projects. This leads to more conservative investment strategies than would otherwise be the case, ultimately leading to low levels of investment and economic growth.

However, this study does not focus on investigating the causes/determinants of inflation or determinants of economic growth, but limits itself to empirically investigating the relationship between inflation and economic growth. In this respect, we are trying to answer questions such as whether inflation has useful information in predicting economic growth other than that provided by economic growth itself and vice versa. The study also tries to establish the effect of shocks to the variables on each other. It is not sufficient to base the policies on theories, but empirical investigations add more value by providing precise insights into the relationships among variables. Hence, this study seeks to provide some insights into the relationship between inflation and economic growth.

1.3. Research Objectives

1.3.1. General Objective

The general objective of the study is to examine the nature of the relationship between inflation and economic growth in Zambia for the period 1980 to 2011.

1.3.2. Specific Objectives

The study seeks to achieve the following specific objectives:

i. To examine the short-run and long-run relationship between inflation and economic growth in Zambian.
ii. To verify the nature of causality, if any, between inflation and economic growth in Zambia.
iii. To identify policy implications of inflation-economic growth relationship for the economy of Zambia.

1.4. Research Questions

1.4.1. Main Research Question

How does inflation relate to economic growth in Zambia?

1.4.2. Subsidiary Research Questions

i. What is the nature of the relationship between inflation and economic growth?

ii. Is there a short-run or long-run relationship between the two variables?

iii. Is there causality between inflation and economic growth?

1.5. Statement of Hypotheses

The hypotheses to be tested in the course of this study are stated below:

Ho:There is no significant relationship between inflation and economic growth in Zambia.

H1:There is a significant relationship between inflation and economic growth in Zambia.

1.6. Justification and Significance of the Study

The justification for this study emerges from scanty evidence on the exact relationship between inflation and economic growth in Zambia. Yet, over the years, the existence of the link between these two variables has been the subject of considerable interest and debate, at both country specific and regional levels. Economic theories and empirical findings reach a variety of conclusions about the nature of the relationship between economic growth and inflation. They show that there might be no relationship, there might be a negative relationship or there might be a positive relationship between inflation and economic growth. Studies on inflation further fail to reach a consensus on the nature of direction of causality between inflation and economic growth.

In the quest to enhance people's welfare, Zambia has been preparing and implementing short-term to medium-term development plans. These development plans have a primary goal of improving social economic conditions of the Zambian people. For example, the Fifth National Development Plan (FNDP) set out its main goal to accelerate pro-poor growth by increasing the overall growth rate to an annual average of at least seven percent. During the same plan period, it was predicted that inflation could be reduced to single-digit. The importance of this is that high rates of inflation were seen, in the past, to have contributed to high interest rates, which constrained investment, especially in the agriculture and manufacturing sectors of the economy (GRZ, 2006). As with the FNDP, its successor the Sixth National Development plan (SNDP) has the same message of

fostering economic growth whilst keeping the rate inflation of inflation stable. Similar themes are also found in the long-term plan dubbed “Vision 2030”.

Zambia’s fiscal policy is designed in such a way that government achieves the set goals in various development plans. For instance, in the FNDP, government aimed at prudential implementation of fiscal policy by maintaining macroeconomic stability, improving budget execution, strengthening financial accountability and strengthening the revenue base. All this is in the view of attaining higher economic growth needed to reduce poverty. On the other hand, monetary and financial policies have focused on achieving and maintaining single-digit inflation. The current conduct of monetary policy is that; the central bank is given the inflation target and then programmes the broad money supply and reserve money growth consistent with the inflation target and economic growth objective (BOZ, 2011).

Therefore, it is clear and evident that, policies in Zambia have been in line with increasing economic growth at the same time reducing inflation rate. However, there seems to be gap between empirical evidence and the conjecture that inflation may hamper economic growth in Zambia. Hence, the study is significant in that it seeks to reveal some important inter-links between inflation and economic growth in Zambia, and attempt to provide an explanation for the nature of inflation-economic growth relationship over the period under study. Examining the nature of inflation-economic growth relationship is of crucial importance in testing empirical relevance of competing monetary models, and in advancing our understanding of the effect on economic activity of inflation and vice-versa.

1.7. Organization of the Study

The rest of study is covered under four chapters and organized as follows:Chapter two reviews both theoretical and empirical literature.Chapter three gives the methodology employed in the study. This same chapter also gives the definition and description of the variables used in this study. Chapter four presents and discusses the results of empirical analysis. Finally, chapter five gives a conclusion and policy implications of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0. Introduction

This chapter is devoted to reviewing literature. Section 2.1 reviews various theories which try to explain how inflation and economic growth relate. Section 2.2 reviews empirical studies while section 2.3 gives a summary of reviewed literature.

2.1. Theoretical Review

The phenomenon of inflation and its relationship with real economic variables has been discussed since the emergence of classical economic theory and studies on this matter have been promoted in subsequent periods as the development of modern economic theories. This section is devoted to the review of different economic theories, while focusing on the explanations of inflation and its relationship with economic growth under the framework of these theories without a lengthy explanation of the details of the theories themselves. We review six important theories thus; the Keynesian theory, cost-push theory, monetarists theory, structural theory of inflation, neo-classical theory and the new theory of growth.

2.1.1. Keynesian Theory of Inflation

Keynesian theories and the so called Keynesianism were born out of the works of John Maynard Keynes. His book "The General Theory of Employment, Interest and Money" played a key role in establishing the foundation of Keynesianism and also the modern macroeconomics. Keynesians believe that interventions in the economy by governments through expansionary economic policies will increase investment and promote demand to reach full production. Keynesians define the concept of potential output as a level of GDP where the economy is at its optimal level of production given institutional and natural constraints. This level of output corresponds to the Non-Accelerating Inflation Rate of Unemployment (NAIRU) or the natural rate of unemployment. If GDP exceeds its potential, that is unemployment is below the NAIRU, the theory says that inflation will accelerate as suppliers increase their prices and built-in inflation worsens. If GDP

falls below its potential level, that is unemployment is above the NAIRU, inflation will decelerate as suppliers attempt to fill excess capacity, cutting prices and undermining built-in inflation. Finally, if GDP is equal to its potential and the unemployment rate is equal to NAIRU, then the rate of inflation will remain unchanged, so long there are no supply shocks. Furthermore, Keynesians believe that the Phillips curve is vertical in the long-run. That is, the rate of unemployment is given and equal to the natural rate of unemployment, while there are a large number of possible inflation rates that can prevail at that unemployment rate (Gokal and Hanif, 2004).

In their linking of inflation to economic growth, Keynesian theorists use the Aggregate Demand (AD) and Aggregate Supply (AS) framework and attribute inflation to the demand-pull phenomenon. According to demand-pull inflation theory of Keynes, a policy that reduces any component of total demand is effective in reducing the pressure of demand and inflation. For instance, the reduction in government expenditure or tax increase and to control volume of money alone or together can be effective in reducing effective demand and inflation control. In difficult conditions, for example in times of hyperinflation, the control of volume of money or decrease in general expenditure may not be practical hence increase in tax can be used for control on demand (Keynes, 1936).

2.1.2. Monetarist Theory of Inflation

The 1970s were characterized by falling output and employment coupled with falling prices, the phenomenon referred to as ‘stagflation’. This led to the failure of the then ruling Keynesian theories which purported that,an increase in output is usually accompanied by rising prices, at least in the short-run. This failure of the Keynesians to explain stagflation culminated in the birth of ‘monetarism’. Monetarism refers to the followers of Milton Friedman (1912-2006) who hold that “only money matters”, and as such, monetary policy is a more effective instrument than fiscal policy in economic stabilization. According to Monetarists, money supply is the dominant, though not exclusive determinant of both the level of output and prices in the short-run and of the level of prices in the long-run; hence, long-run level of output is not influenced by the money supply (Totonchi, 2011).Monetarists put emphasis on the role of money in the economy. Friedman (1956) restated the quantity theory of money into what became the

modern quantity theory and propounded a dictum that "inflation is always and everywhere a monetary phenomenon" that arises from a more rapid expansion in the quantity of money than in total output.

Friedman (1956) contends that when money supply is increased in the economy, then there emerges an excess supply of real money balances with the public over the demand for money and this in turn disturbs the equilibrium. In order to restore equilibrium, the public will reduce money balances by increasing expenditure on goods and services. Hence, Friedman and other modern quantity theorists attribute excess supply of real money balances as a cause of increase in aggregate demand for goods and services by the public. If there is no proportionate increase in output, then the extra money supply will lead to excess demand for goods and services which will cause inflation. Friedman's monetarist theory of inflation is properly explained using the quantity equation written in percentage form:

$$\frac{\Delta P}{P} = \frac{\Delta M^s}{M^s} - \frac{\Delta Y}{Y} \qquad (1)$$

where; $P = \frac{MV}{Y}$, $\frac{\Delta P}{P}$is the rate of inflation, $\frac{\Delta M^s}{M^s}$ is the rate of growth of money supply and $\frac{\Delta Y}{Y}$ is the rate of growth of output. Therefore, using equation (1), we can infer that inflation rate is determined by the growth of money supply and the rate of growth of output, with velocity of circulation remaining constant.

Because monetarists argue that real income or aggregate output remains stable at full employment level in the long-run due to flexibility of wages, any increase in nominal income brought about by the expansion in money supply and resultant increase in aggregate demand will cause a proportionate increase in the price level. On the other hand, in the short-run when the economy is working at less than full employment, an expansionary monetary policy which leads to increase in nominal income partly induces expansion in real income and partly results in the price level increase. Therefore, like the Keynesians, monetarists view inflation as a demand pull variety, which is positively related to economic growth in the short-run.

2.1.3. Cost Push Theory of Inflation

Both Keynesians and Monetarists use demand pull theory of inflation to explain the relationship between inflation and output. However, we can visualize situations where, even if there is no increase in aggregate demand, prices may still be rising, leading to inflation. This usually happens when there is an increase in costs, independent of any increase in aggregate demand. This is what is known as cost-push inflation. Ahuja (2007) identifies four main causes of cost-push inflation thus; wage-push inflation as a result of wage increases enforced by trade unions; profit-push inflation as a result of the increase in profit margin by firms; rise in raw material prices or oil price shock and indirect effect of increase in oil prices or other raw material prices.

The most prominent and basic cause of cost-push inflation is the rise in money wages more rapidly than the productivity of labor. This usually comes about as labor unions press employers to grant wage increases noticeably, thereby raising the cost of production of goods and services. Employers respond to this rise in money wages by raising the prices of their products. These higher wages enable workers to buy as much as they could buy before, despite higher prices of goods and services. On the other hand, once it is realized that the increase in prices actually reduces the real wages, this induces unions to demand further higher wages. Consequently, the wage-cost spiral continues, thereby leading to cost-push or wage-push inflation. Cost-push type of inflation may be further provoked by an upward adjustment of wages to compensate for rise in the cost of living.

An important feature of cost push inflation is that, not only does it cause rise in prices but also brings about a fall in aggregate output and consequently lowers economic growth. In this case, we can infer that, cost-push theory of inflation predicts a negative relationship between inflation and economic growth. The mechanism by which cost-push inflation affects both prices and output is through the shift in aggregate supply curve. Keeping other things constant, any supply side factor which works to shift the supply curve to the left will lead to a simultaneous increase in prices and decrease in output.

2.1.4. Structural Theory of Inflation

Structural theory of inflation has been put forward as an explanation of inflation in developing countries especially of Latin America. The well-known economists Myrdal and Streeten who have proposed this theory have analyzed inflation in these developing countries in terms of structural features of their economies (Ahuja, 2007).

It has been argued by exponents of the structural theory of inflation that, economies of developing countries are structurally underdeveloped as well as highly fragmented due to the existence of market imperfections and structural rigidities of different types. Ahuja (2007) identifies four significant bottlenecks which lead to structural imbalances thus; agricultural bottlenecks which in most developing countries limit the supply of food grains to increase adequately despite growing demand for food; resources gap or government's budget constraint which refers to lack of resources for financing economic development; foreign exchange bottleneck whereby developing countries face a shortage of foreign exchange for financing needed imports for development; and physical infrastructural bottlenecks, for example lack of power, transport and fuel which stand in the way of adequate growth in output. According to the Structuralist school of thought, the bottlenecks mentioned above are rooted in the social, political and economic structure of these developing countries. Therefore, according to this school of thought, a broad based strategy of development which aims to bring about social, institutional and structural changes in these economies is needed to bring about economic growth without inflation.

2.1.5. Neo-Classical Growth Theory

The neo-classical growth theory lays stress on capital accumulation and the decision to save as an important determinant of economic growth. The Solow growth model is the basic reference point of analysis of growth in the neo-classical framework. In the Solow model, long-run growth of output per worker depends only on technological progress. However short-run growth can result from either technological progress or capital accumulation. Solow (1956) adopts growth accounting to give a direct expression of the composition of economic growth based on the Solow model as shown in equation 2.

$$\frac{\dot{Y}(t)}{Y(t)} - \frac{\dot{L}(t)}{L(t)} = \alpha_t(t)\left[\frac{\dot{K}(t)}{K(t)} - \frac{\dot{L}(t)}{L(t)}\right] + R(t) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where Y is output, L is labour, K is capital and the term R(t) is called the "Solow residuals". All quotients in the above equation represent growth rate of the variables. Equation 2 shows the channel through which variables will affect economic growth. It is obvious that, growth under the Solow model will relate to the growth of capital, labour and the Solow residuals. The Solow residuals are also referred to as Total Factor Productivity (TFP) which is regarded as the index of technological progress.

Although growth accounting method highlights channels through which variables influence economic growth, it does not directly explain the relationship between inflation and economic growth. Mundell (1963) was among the first economists to put forward a coherent mechanism relating inflation and output growth separate from the excess demand for commodities. Mundell's model shows that an increase in inflation or inflation expectations immediately reduces people's wealth. This is because the rate of return on individual's real money balances falls. Therefore, in order to accumulate the desired wealth, people save more by switching to other assets, increasing their price and thus driving down the real interest rate. Therefore, in Mundell's view, greater savings imply greater capital accumulation and thus faster output growth.

Tobin (1965) is also another neo-classical economist who worked on improving Mundell's model. In his model, Tobin purports that individuals substitute current consumption for future consumption by either holding money or acquiring capital. The basic idea is that, not only do people care about the expected return on one asset versus another when they decide what to hold in their portfolio, but they also care about the riskiness of the returns from each asset. The Tobin effect suggests that inflation causes individuals to substitute money for interest earning assets, which leads to greater capital intensity and promotes economic growth. In effect, inflation exhibits a positive relationship with economic growth. Tobin further argues that, because of the downward rigidity of prices and wages, the adjustment in relative prices during economic growth could be better achieved by the upward price movement of some individual prices.

Sidrauski (1967) proposed another major development, with his seminal work in the context of an infinitely-lived representative agent model where money is Super-neutral. Super-neutrality holds when real variables, including the growth rate of output, are independent of the growth rate in the money supply in the long-run. Sidrauski's approach to money, inflation, and growth question emphasized portfolio substitution as the basic driving force in determining the relationship between inflation and growth. For instance, in his descriptive model, an increase in the growth rate of money leads to an increase in the expected rate of inflation, thereby reducing the demand for real balances. With the savings rate given, more of savings takes the form of physical capital and less is in money, equilibrium capital intensity is thereby increased. Sidrauski concluded that there is no conclusive relationship between inflation and economic growth.

Stockman (1981) developed a model in which an increase in inflation rate results in a lower steady state level of output and people's welfare declines. He pointed out the possible existence of an inverse Tobin effect, whereby an increase in inflation rate causes capital stock to decrease, assuming cash in advance constraint for capital accumulation and given that inflation raises the cost of money holding. Hence, in Stockman's model, money is a complement to capital, accounting for a negative relationship between the steady-state level of output and inflation rate. Stockman modeled the cash investment as a cash-in-advance restriction on both consumption and capital purchases. Since inflation erodes the purchasing power of money balances, people reduce their purchases of both cash goods and capital when inflation rate rises. In the same way, the steady-state level of output falls in response to an increase in inflation rate.

The review of theory regarding the neoclassical framework reveals that models in this framework can lead to ambiguous results with regard to inflation-economic growth nexus. Tobin views a positive relationship; Sidrauski views a null relationship whereas Stockholm views a negative relationship between inflation and economic growth.

2.1.6. Endogenous Growth Theory

The Endogenous growth theory (also known as new growth theory) extends the classical theory by making the rate of technological progress or the rate of population growth or

both endogenous (Ahuja, 2007). Technological knowledge, like other forms of capital, can be accumulated with the expenditure of current economic resources (for example research and development expenditures) and can be used to augment future production possibilities (Howitt, 2007). In this theory, technological progress arises from decisions to save. Some savings go to finance the accumulation of physical and human capital and some go to finance research and development that causes technological knowledge to accumulate. Thus, if society saves a larger fraction of national income, the pace of technological progress rises, permitting a higher rate of economic growth to be sustained indefinitely (Howitt, 2007).

In the monetary framework of endogenous growth models such as those developed by Lucas (1988), the rate of inflation (which can be likened to tax) lowers both the return on all capital and economic growth rate. The argument is that, taxing capital income has a direct negative impact on the economic growth rate; where as a tax on human capital is likely to cause a substitution of leisure for labour which lowers the rate of return on human capital and has the potential to lower the economic growth. Nevertheless, some representations of the endogenous growth economies reveal that inflation rate effects on economic growth are insignificant.

2.2. Review of Empirical Research

There is a large amount of research done on inflation-economic growth relationship both at country specific and cross-country level.However, empirical studies reviewed in this section are chosen due to their relevance to this study. Particularly, most studies reviewed are done in developing countries; hence they could bring outproxies of variables and methodologies that are vital to this study.

As stated in the introduction, models of inflation and growth used in the sixties emphasized the portfolio substitution mechanism by which higher inflation made capital more attractive to hold relative to money, leading to higher capital intensity and in the transition period to higher economic growth. However, empirical evidence by Fisher (1983) was that,economic growth and inflation were negatively correlated. Reasons for this negative correlation were investigated, and then embodied in a simple monetary

maximizing model. Higher inflation was found to be associated with lower economic growth because lower real balances reduce the efficiency of factors of production, and because there may be a link between government purchases and the use of the inflation tax. Comparative steady states and comparative dynamics were analyzed and the general negative relationship between inflation and economic growth, both in steady states and in transition processes, was demonstrated.

Gomme (1993) studied an economy in which an increase in inflation rate results in a decline in employment. Gomme's research reveals that, efficient allocations satisfy the condition that the marginal value of the last unit of today's consumption equals the marginal cost of the last unit of work. A rise in inflation reduces the marginal value of today's last unit of consumption, thus inducing people to work less. With less labour, the marginal product of capital is permanently reduced, resulting in a slower rate of capital accumulation. He found that in this economy, eliminating a moderate inflation rate (for example, ten percent) results in only a very small (less than 0.01 percentage point) gain in the growth of output.

In another study, Fischer (1993) used a regression analog of growth accounting to present cross-sectional and panel regressions showing that economic growth is negatively associated with inflation, large budget deficits and distorted foreign exchange markets. The study presented both pure cross-sectional regressions as well as panel regressions, which exploit time series as well as cross-sectional variation in the data. It also explored non-linearities in the relationship between inflation and economic growth. The study revealed that, inflation reduces economic growth by reducing investment and productivity growth. Further, budget deficits also reduce both capital accumulation and productivity growth. Thestudy concludes that, while low inflation and small deficits are not necessary for high growth even over long periods, high inflation is not consistent with sustained economic growth.

Barro (1995) used the five-year average data of around 100 countries over the period of 1960-1990 by using the Instrumental Variable (IV) estimation method to assess the effects of inflation on economic performance. The study used a system of regression

where many variables were held constant. The framework was an extension of the neo-classical growth model. The study identified reduction in the propensity to invest as a likely channel through which inflation decreases growth and showed that the clear evidence for adverse effects of inflation is from the experiences of high inflation. Using different instrumental variables, it was revealed that, an increase in average inflation by ten percentage points per year would slow the growth rate of real per capita GDP by 0.2 to 0.3 percentage points per year. The study further revealed that,although the adverse influence of inflation on economic growth appeared small, over long periods those changes on growth rates might have dramatic effect on the standards of living.

Ghosh and Philip (1998) used a complete data set consisting of 3,603 annual observations on real per capita GDP growth and consumer price inflation, corresponding to 145 countries over the period of 1960-1996.Using panel regressions and allowing for a nonlinear specification, they found a statistically and economically significant negative relationship between inflation and growth, which holds robustly at all, but the lowest inflation rates. A "decision-tree" technique was used and identified inflation as one of the most important determinants of growth. They also discovered that short-run growth costs of disinflation are only relevant for the most severe disinflations, or when the initial inflation rate is well within the single-digit range. The summary of the findings was that there are two important nonlinearities in the inflation-growth relationship. At very low inflation rates (around 2-3 percent a year, or lower), inflation and economic growth are positively correlated, otherwise, inflation and economic growth are negatively correlated.Nonetheless, the relationship is convex, so that the decline in economic growth associated with an increase from ten percent inflation is much larger than that associated with moving from 40 percent to 50 percent inflation.

Bruno and Easterly (1998) examined the determinants of economic growth using annual CPI of 26 countries which experienced inflation crises at some point during the period between 1961 and 1992. In their empirical analysis, they proposed a nonparametric definition of high inflation crises as "periods when annual inflation is above 40 percent". The study found an inconclusive relationship between inflation and economic growth below this threshold level when countries with high inflation crises are excluded from the

sample. In addition, empirical analysis suggests that, there exists a temporal negative relationship between inflation and economic growth beyond this threshold level. According to the results obtained, causality remained problematic, but the results are consistent with the view that, costs of inflation only become significant at relatively high rates of inflation. At lower rates of inflation, growth and inflation may simply be jointly troubled by various demand and supply shocks and hence shows no consistent pattern.

Mallik and Chowdhury (2001) used cointegration and error correction models to empirically examine long-run and short-run dynamics of the inflation-economic growth relationship for four South Asian countries (Bangladesh, India, Pakistan, and Sri Lanka) using annual data. The authors employed a bivariate analysis for all four countries and found two motivating results. Firstly, the long-run relationship between inflation and economic growth was found to be positive and statistically significant for all four countries. Secondly, the sensitivity of inflation to changes in growth rates was larger than that of growth to changes in inflation rate. There were also significant feedbacks between inflation and economic growth. The authors argue that the results have important policy implications in that, although moderate inflation promotes economic growth, faster economic growth absorbs into inflation by overheating the economy. Therefore, the authors conclude that, these four countries are on the turning point of inflation-economic growth relationship.

Paul et al (1997) studied the relationship between inflation and economic growth for 70 countries for the period of 1960-1989. Their study used Granger methodology to examine both the direction and pattern of causality between inflation and economic growth in these countries using annual data. The study found that, the relationship between inflation and growth was non-uniform across countries. It was found that, 40 percent of the countries studied revealed no causality, one-third exhibited unidirectional causality and about one-fifth of countries showed bidirectional causality. In addition, a vast majority of countries that showed either unidirectional or bi-directional causality belonged to the industrial group, and the low world inflation regime could on balance redistribute real growth opportunities away from the developing countries towards the industrialized countries.

Erbaykal and Okuyan (2008) studied the relationship between inflation and economic growth in Turkey using data covering 1987:1-2006:2 periods. The existence of long term relationship between these two variables was examined using Bound Test. Although no statistically significant long term relationship could be detected within the Autoregressive Distributed Lagged (ARDL) model, a negative and statistically significant short term relationship was found. Further, causality relationship between the two series was examined using the Toda Yamamoto methodology. Whereas no causality relationship was found from economic growth to inflation, causality relationship was found from inflation to economic growth.

Yeh (2009) estimated the causal interrelationships between inflation and economic growth within a simultaneous equations framework and obtained identification using a novel heteroscedasticity based method. After removal of the simultaneous bias, it was found that, inflation and growth were significantly interrelated. Using cross sectional data of 140 countries over the period of 1970-2005, the study found a bilateral causal relationship between growth and inflation. The results indicated that inflation is harmful to growth whereas the effect from growth to inflation is beneficial.

Using annual data of 21 countries covering 1961-1987, Grimes (1991) found a positive relationship between inflation and the economic growth for a short term, and a negative relationship between them in the long-run. Smyth (1994) has also shown that inflation acceleration impacts growth negatively in the USA. To test and evaluate the strength of this effect, inflation variables were included in an empirical growth relationship for the USA private business sector. Both the rate of inflation and the change in the rate of inflation were found to have significant negative effects on output growth.

Goldsbrough et al. (2007) tried to summarize the evidence on the links between inflation and growth, as well as the International Monetary Fund (IMF) targets for inflation. They conclude that, the weight of theoretical and empirical evidence suggests that programs should generally avoid pushing inflation below, say, 5 percent in low-income countries. This is because of risks of an unintended contractionary stance in the event of shocks and such risks can be greater in low income countries because they typically suffer from

larger shocks. However, the authors conclude that, this is not the central issue in the debate over the appropriateness of macroeconomic frameworks in IMF program design. This is mainly because there is no stable, permanent trade-off through which a more expansionary monetary policy can spur higher growth. Thus, targeting very low inflation, when there is a significant risk that temporary adverse shocks may require significant shifts in relative prices, can be costly in terms of lost output.

De Gregorio (1996), while advocating for the existence of independent central banks put up an argument that, inflation may limit economic growth by reducing the efficiency of investment rather than its level. The study reviewed both theory and evidence on the inflation-economic growth relationship on a large cross-section of countries. The reported evidence suggests a robust negative relationship between inflation and economic growth. De Gregorio further argues that, an independent central bank can be effective in reducing inflation if the public perceives that it is tough on inflation. The study finally concludes that there is a negative correlation between central bank independence and inflation especially in developed countries, but the effects on growth are less conclusive.

Dipietro and Sawhney (1999) did a study on inflation and economic growth using data for 98 countries for the period 1970-1993. Granger causality analysis with three lags was used on 98 countries to examine whether or not growth causes inflation. The study found that in only 17 of the 98 countries studied was the null hypothesis of no causation running from growth to inflation rejected. Therefore, in 83 percent of the countries studied, there was no evidence that growth causes inflation. These results contrast with those who maintain that growth causes inflation.

Faria and Carneiro (2001) investigated the relationship between inflation and economic growth in the context of Brazil. Analyzing a bivariate time series model with annual data for the period between 1980 and 1995, they found that although there is a negative relationship between inflation and economic growth in the short-run, inflation does not affect economic growth in the long-run. Their empirical results also support the super neutrality concept of money in the long-run. This in turn provides empirical evidence against the view that inflation affects economic growth in the long-run.

Gokal and Hanif (2004) using data set consisting of 34 annual observations (1970-2003) examined whether a significant connection between inflation and economic growth existed in Fiji. The study employed Granger causality followed by a correlation matrix. The study found a weak link between inflation and economic growth which did not surprise the authors given the structure of the economy and factors which influence inflation there. Correlation coefficients showed only a weak negative link, while causality was shown to run from economic growth to inflation. The argument was that, with the majority of Fiji's inflation being imported, the influence of domestic factors is limited.

Ahmed and Mortaza (2005) using annual data set on real GDP and CPI for the period 1980-2005 and applying co-integration and error correction models examine inflation-growth nexus in Bangladesh. The empirical evidence demonstrates that there exists a statistically significant long-run negative relationship between inflation and economic growth for the country. This is indicated by a statistically significant long-run negative relationship between CPI and real GDP. Furthermore, the estimated threshold model suggests six percent as the threshold level of inflation above which inflation unfavorably affects economic growth.

Mubarik (2005) studied inflationand economic growth for Pakistan using an annual data set from the period between 1973 and 2000. He employed Granger causality test as an application before estimating the threshold model. Granger causality analysis revealedthat, there existed a unidirectional Granger causality running from inflation to economic growth. This means that it is inflation that causes economic growth in Pakistan and not the other way round. An estimation of the threshold model further suggested that, an inflation rate beyond nine percent is detrimental to economic growth of Pakistan. This in turn, suggests that inflation rate below the estimated level of nine percent is conducive for the economic growth.

Guerrero (2006) used cross sectional data and found that countries that have experienced hyperinflation tend to display significantly lower inflation rates than countries that have not. He used past hyperinflationary experiences to obtain instrumental variables estimates of the effects of inflation on growth. The instrument was based on a strong cross-

sectional feature embedded in the data. The study established that, economies that have had hyperinflation displayed substantially lower rates of inflation. Equally important, past hyperinflationary experiences were not affected by growth performance, government policies, or other factors that affect growth. The new instrument produced estimates of the adverse effects of inflation on long-term economic growth that are in line with earlier evidence. The results provided no indication that Ordinary Least Square (OLS) estimates obtained overstated the effects of inflation. Further, the results suggest that inflation has an adverse effect on growth that is economically significant and quite robust.

Saaed (2007) analyzed the relationship between inflation and economic growth in the context of Kuwait using annual data set on real GDP and CPI for the period of 1985 to 2005. An assessment of empirical evidence was obtained through co-integration and error correction models. Empirical evidence showed that there exists a statistically significant long-run negative relationship between inflation and economic growth for the country. Overall findings showed that 56 percent of the deviation of the real GDP from its long-run equilibrium level was corrected each year. The estimated results in the ECM also showed that short-run changes in CPI affected real GDP negatively, and vice versa. Consequently, the conclusion from this study is that, inflation rate affects economic growth rates negatively, and vice versa.

Xiao (2007) used annual time series data for the period of 1978-2007 to study the relationship between inflation and economic growth of China. He also sought to examine the relationship between inflation and capital formation in China. The study employed co-integration and error correction models accompanied with correlation matrix and Granger causality test to examine the relationship between inflation and economic growth. Correlation coefficients and Granger causality test revealed that inflation both related to economic growth and capital accumulation and the causal direction of both relationships was two-way. In the analysis of co-integration and error correction models, results showed that only inflation and economic growth has the long-run positive equilibrium relationship. For capital accumulation growth, there was no long-run relationship with inflation but would correlate with economic growth in the short-run.

Datta and Mukhopadhyay (2011) studied the relationship between inflation and economic growth in Malaysia with the data covering 1971-2007. The study used time series methods of unit root tests, error correction models and Granger causality tests. The authors further studied the innovation accounting by looking at the impulse response functions and variance decompositions. The study reveals that, in the short-run, inflation plays an important role in affecting economic growth negatively. On the other, hand in the long-run, economic growth leads to positive change in inflation. The study further shows that, response of growth due to impulse of inflation is insignificant where as the response of inflation due to shocks in growth is effective up to fourth year in future. The results from variance decomposition analysis show that, more than 13 percent variability of inflation is accounted for by growth innovations over the time horizon.

Although a plethora of literature on the relationship between inflation and economic growth comes from Western and Asian countries, there have been studies done on this subject specifically in Africa. For example,Seleteng (2004) estimated a model of inflation in Lesotho which showed that inflation affects economic growth negatively when it goes beyond ten percent. Nell (2000) also examined the issue of whether or not inflation was detrimental to economic growth of South Africa by using (VAR) technique. Data for the period from 1960-1999 was used and the empirical results suggested that, inflation within the single-digit zone may be beneficial to economic growth, while inflation in the double digit zone tends to limit economic growth.

Hodge (2002) further examined the relationship between inflation and economic growth in South Africa over both the medium to long term and the short run. Twobase models were used to estimate these relationships. The focus was on the direction and magnitude of the relationship in each case. The sample for the medium to long term model comprised annual observations of the growth rate and the inflation rate, including other variables believed to influence growth over the longer-term (1950-2002). The results suggest that South Africa conforms to the general finding of various large sample cross-section studies that,there is a significant negative relationship between inflation and economic growth over the medium to long term.

Ogbokor (2004) studied the impact of inflation on the Namibian economic growth for the period 1991-2001. The methodology used in this study involved estimating a general model, which provides for capturing the impact of inflation as well as imported inflation interactively with economic openness on economic growth. The study employed logistic regression analysis and found that economic growth reacted in a predictable fashion in all the regressors of the model. The study found that, inflation could have a negative repercussion on economic growth if not controlled.

Chimobi (2010) used cointegration method and Granger causality test to examine the relationship between inflation and economic growth in Nigeria for the period 1970-2005. The study found no cointegrating relationship between inflation and economic growth in Nigeria within the period of the study. To validate this assertion, Granger causality test at the second and fourth lags was used to analyze this view. The results obtained revealed unidirectional causality moving from inflation to economic growth. Marbuah (2010) further investigated the relationship between inflation and economic growth to ascertain whether a significant threshold effect existed in the case of Ghana over the period 1955-2009. The study found evidence of significant threshold effect of inflation on economic growth with and without structural break.

Despite many studies on the relationship between inflation and economic growth outside Zambia, there have been a few studies on inflation in Zambia. Notwithstanding, these studies have concentrated on detailing the determinants of inflation. Ng'andwe (1980) is among the earliest to do a study on inflation in Zambia. His study identifies excess in money supply, budget deficits and rising wages as some of the inflationary factors.

Simatele (2004) attempted to investigate whether monetary aggregates have useful information for predicting inflation other than that provided by inflation itself in Zambia for the period 1994-2001. The results show that monetary aggregate M2 (Money supply) contains most information and its growth rate is significant in the inflation model. Foreign sector variables were also considered and showed that they are more important for movements in prices than monetary aggregates even in the long-run.

Baldini (2006) did an empirical study on inflation and "fiscal dominance[2]" in Zambia for the period 1980 to 2004 using Vector Autoregressive analysis. The study concludes that the persistently high inflation and the large extraction of seigniorage revenues suggests that decisions about the supply of base money were dictated by the fiscal authorities rather than by the central bank.

Hangoma (2010) also did a study on the appropriateness of inflation targeting as a monetary framework for Zambia. A recommendation from this study is that inflation targeting as a monetary framework should be adopted by the central bank of Zambia as there was found to be no stable relationship between monetary aggregates and inflation for the studied period. Other studies relating to inflation in Zambia include Mwansa (1998), Mutoti et al. (2011) and Musongole (2011).

Thus, though there are several studies on inflation in Zambia, there is hardly any on the relationship between inflation and economic growth. Yet again, there are policy papers that have highlighted some constraints to economic growth and what can be done to enhance economic growth. Though copper accounted for a larger percentage of exports and drove Zambian growth for decades, growth in the past decade has also been accompanied by total factor productivity improvements and a more diversified export base. There has also been a significant increase in FDI flows as well as gross investment as a percentage of GDP (GRZ, 2011).

However, following the "Constraint Analysis" done for the Ministry of Finance, some constraints to inclusive growth were identified. These constraints include: "Low levels of skilled human capital", rooted in the low employability of the Zambian population; "poor infrastructure services", especially electricity, road connectivity, rail infrastructure and water supply and sanitation in rural and peri-urban areas; and "coordination failures", as the country fails to provide sufficient non-traded inputs or complementary goods and services to help private investors to be profitable and competitive GRZ (2011). Of the constraints mentioned, however, none is directly linked to inflation.

[2]In a "fiscally dominant" regime, the fiscal authorities set the primary budget balance independently of public sector liabilities. As a result, persistent budget deficitsmay, over time, force the monetary authorities to monetize the debt, creating inflation.

2.3. Summary of Literature review

This chapter revealed both theoretical and empirical literature on the relationship between inflation and economic growth. Literature suggests that, models developed to support the theories do not have a common conclusion on the exact relationship between inflation and economic growth. This is true for both growth and inflation theories. The aggregate demand and aggregate supply framework under Keynesian theory predicts a positive relationship, monetarist theory also predicts a positive relationship, while cost push theory predicts a negative relationship. The growth theories reviewed also showed mixed predictions about the relationship between the two variables. Different models developed under the neo-classic growth theory predict apositive relationship, a negative relationship or null relationship. However, the monetary framework of the endogenous growth models predicts a negative relationship.

Empirical studies reviewed have further revealed mixed results about the relationship between inflation and economic growth. Some studies found a negative relationship between the two variables; some found a positive relationship between inflation and growth while other studies did not find any evidence supporting the view that inflation is in general harmful to economic growth or the other way round. Further, some studies revealed a short-run relationship while others revealed a long-run relationship or both. Concerning the nature of causality, some studies have found a bidirectional/feedback relationship between inflation and economic growth, some showed a unidirectional causality running from inflation to economic growth while a few studies found a unidirectional causality running from economic growth to inflation.

Literature shows that the relationship between inflation and economic growth is not a simple one, both theoretically and empirically. In the case of Zambia, literature shows that there has been no study on this topic explicitly. Besides,literature review has elicited different methodologies employed in understanding the relationship between inflation and economic growth. This is very important in guiding us as to which methodology to employ in this study. This study attempts to fill the gap in terms of adding new literature, specifically on Zambia, to the existing global and regional literature.

CHAPTER THREE

METHODOLOGYAND ANALYTICAL FRAMEWORK

3.0. Introduction

Time series analysis involving unit root test, cointegration test, Granger causality test and other tests are employed in this study. Vector Autoregressive (VAR) analysis is employed in the study using Stata software. This study adopts the VAR methodology because of its advantages over single equation methods. For example, the VAR framework provides a systematic way to capture rich dynamics in time series. As Sims (1980) and others argued in a series of influential early papers; "VARs held out the promise of providing a coherent and credible approach to data description, forecasting, structural inference, and policy analysis". Stock (2001) further recommends the use of VAR models in the sense that, because they involve current and lagged values of time series, they capture co-movements that cannot be detected in univariate models. In addition, Standard VAR summary statistics (Granger causality tests, impulse response functions, and variance decompositions) are well accepted and widely used methods for portraying these co-movements. One limitation of this methodology is that, most estimates are based on asymptotic properties of data, and therefore sensitive to specification errors in limited samples.

3.1. Data Sources and Variable Description

An adequate source of data and the construction of variables are necessary not only for empirical analysis but also for validity of the research. The methodology and variables in this study have been selected taking into consideration their relative importance on the theoretical and empirical basis. This is also consistent with data chosen by other researchers. The data covers the period from 1980 to 2011. The variables are taken on annual basis from the World Economic Outlook (2012) of the IMF in comparison with publications from the Central Statistical Office (CSO) and the Bank of Zambia. This period was adopted due to the availability of accurate annual data and the methodology used in the analysis.

3.1.1. Economic Growth

Economic growth is defined as the sustained annual increases in an economy's real gross domestic product (GDP) over a long period of time (Ahuja, 2007). In this case, real GDP refers to inflation-adjusted measure that reflects the value of all goods and services produced in a given year, expressed in base-year prices. Real GDP growth is a more accurate look at the rate of economic growth because it is not distorted by the effects of extreme inflation or deflation. Thus, an upward trend in real GDP means growth in the domestic economy. In this study, the first difference of natural logarithm of annual indices of GDP volume multiplied by 100 has been used to reflect domestic economic growth of Zambia for every one year.

3.1.2. Inflation

Inflation is formally defined as a rise in the general level of prices of goods and services in an economy over a period of time, usually a year (Barro, 1997). In other words, inflation is the persistent rise in the general price level rather than a once-for-all rise in the price. In this regard, inflation rate can be defined as a percentage rate of change in the price level over time.

In this study, inflation is calculated by taking the first difference of the natural logarithm of Consumer Price Index (CPI) and multiplying it by 100. This is consistent with the way inflation is calculated by the Bank of Zambia. This also has an advantage of controlling for heteroscedasticity and non-normality in the residuals of the variable as advocated for by Li (2005). We have used the average annual inflation rate as opposed to quarterly or monthly to control for seasonal effects. A CPI measures changes in the prices of goods and services that households consume. Such changes affect the real purchasing power of consumers' incomes and their welfare. As the prices of different goods and services do not change at the same rate, a price index can only reflect their average movements. A price index is typically assigned a value of unity or 100, in some reference period and the values of the index for other periods of time are intended to indicate the average proportionate/percentage change in prices from this price reference period (IMF, 2012).

3.2. Model Specification

In this study, we endeavor to examine the relationship between inflation and economic growth while taking into consideration the methodology of VAR. There have been arguments against using a lot of variables in the inflation-economic growth model. For example, Ghosh and Phillips (1998) have put up an argument that using multivariate methodology can reduce the robustness of the findings due to conditioning variables. They point out that these conditioning variables may also depend upon inflation rate and the indirect effects can give the wrong impression about the inflation-growth relationship. Hence, this study uses a bivariate VAR to analyze the relationship between inflation and economic growth. The advantages and limitations of this methodology are outlined in the introduction to this chapter.

The relationship between inflation and economic growth can be specified using the general multivariate VECM system.

$$\Delta Y_t = v + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \qquad (1)$$

Where;$Y_t$is a $K \times K$vector of endogenous variables,$\Pi = \sum_{j=1}^{j=p} A_j - I_k$, $\Gamma_i = \sum_{j=1}^{j=p} A_j$ and $A_j's$ are $K \times K$matrices of parameters where as$\varepsilon_t$isa $K \times 1$vector of disturbances. The specification of equation (1) reduces to a VAR specification in case the variables are not cointegrated, that is, when$\Pi = 0$, meaning that all variables entering the model are stationary. Therefore, if we find no cointegration between our variables, we can go on to analyse the unrestricted VAR with no error correction term.

3.3. Econometric Approach and Estimation Procedure

The study tests for unit roots in the series and applies the Johansen test of cointegration. The VAR model is estimated and diagnostic tests are done on it. The study further employs Granger causality test to enable us reveal the relationship of either no causality, unidirectional causality or feedback causality between the variables of interest. Impulse response and forecast error variance decomposition analyses are also done.

3.3.1. Testing for Parameter Stability

Considering that our data set incorporates two regimes, that is, the free market and government controlled regime; we might suspect that the policy change might have affected the parameters of our model. This is equivalent to suspecting a structural change. Testing for structural change is cardinal because forecasting depends crucially on a stable relationship, and standard inference on the estimates will be useless if estimates vary in apermanent fashion; persistent changes will render a fixed model misleading (Elliot and Müller, 2006). Enders (2004) stresses that, testing for structural change is very important because, structural breaks in the data bias the test statistics of the usual formal tests of unit root towards the nonrejection of the unit root. There are many tests for structural break, however, this study employs Elliot and Müller (2006)'s Quasi-Local Level (qLL) test to find out whether there is structural instability in the parameters or not.

3.2.1.1. EM's Quasi-Local Level (qLL) test

Elliot and Müller (2006) provide a test statistic for structural stability that is simple to compute, avoid any need for searching over high dimensions when there are many breaks, is valid for a wide range of data-generating processes and has good power and size properties even in heteroskedastic models. This test also works well for small samples as compared to other tests which depend on asymptotic properties of data (Baum, 2007). The EM tests the null hypothesis of a stable linear model

$$Y_t = X_t'\bar{\beta} + Z_t'\delta + \epsilon_t \qquad (2)$$

Against the alternative of a partially unstable model

$$Y_t = X_t'\beta_t + Z_t'\delta + \epsilon_t \qquad (3)$$

With non-constant β_t, where $Y_t$is a scalar,$X_t$and $\beta_t$are $K \times 1$ vectors, $Z_t$and δ are $d \times 1$vectors, $\{Y_t, X_t, Z_t\}$ are observed where as, β, $\bar{\beta}$and $\delta$are unknown and$\epsilon_t$is a zero-mean disturbance.

The EM tests whether the coefficient vector that links the observables X_t to $Y_t$remains stable over time, while allowing for other stable links between $Y_t$and the observables throughZ_t. The null hypothesis of parameter stability is rejected for small values of $\widehat{qLL}$that is, values more negative than the critical values.

3.3.2. Unit Root Analysis

Unit root analysis is the univariate time series analysis which seeks to find out whether the series are stationary or not. A stochastic process, say $Y_t$is stationary if it has time-invariant first and second moments. In other words, a series of data is stationary if its mean and variance are not time dependent and the covariance does not depend on time, but on the distance in time between the two members of the process (Enders, 2004). The presence of a unit root in the time series representation of a variable has important implications for both the econometric method used and the economic interpretation of the model in which that variable appears. For example, if the time series data is non-stationary, the estimation will either give spurious results[3] or the variables may be related in the long-run. Therefore, it is indispensable that we apply unit root tests before estimation, to see whether the time series data is stationary or not.

There are a number of methods for testing the stationarity of data. Although there is no test which is uniformly most powerful, this study uses one new generation method which is superior to the traditional Dickey-Fuller and Phillips-Perron tests. The method used in this study isDickey-Fuller Generalised Least Squares (DF-GLS).

3.3.2.1. DF-GLS Unit Root Test

The DF-GLS test for a unit root in a time series performs the modified Dickey–Fuller (DF) test proposed by Elliott, Rothenberg and Stock (1996) as specified in equation 4.

$$\Delta Y_t^* = \alpha + \beta Y_{t-1}^* + \sum_{j=1}^{p} \Upsilon_j \Delta Y_{t-j}^* + \epsilon_t \qquad (4)$$

Where Y^* is the GLS transformed variable

The maximum lag length p in the above regression is chosen using a modified version of the Schwert (1989) criterion as implemented in Stata software given by the formula,

$$p_{max} = \left[12 \left\{ \frac{T+1}{100} \right\}^{0.25} \right] \qquad (5)$$

[3]In statistics, a **spurious** relationship is a mathematical relationship in which two events or variables have no direct causal connection, yet it may be wrongly inferred that they do, due to either coincidence or the presence of a certain third, unseen factor also known as the confounding factor.

The maximum lag length p to use is chosen by either of the three methods, which are Ng-Perron (NP) sequential t-test, modified Akaike information criterion (MAIC) or the Schwarz information criterion(SC). This test has the null hypothesis that Y_t is not stationary, perhaps with drift. There are two possible alternative hypotheses for the DF-GLS test; Y_t is stationary about a linear time trend or Y_t is stationary with a possibly nonzero mean, but with no linear time trend.

3.4. Cointegration Test

Once the variables have been classified as integrated of order I(0), I(1), I(2) and so on, it is possible to set up models that lead to stationary relations among the variables, and where standard inference is possible. The necessary criterion for stationarity among non-stationary variables is called cointegration. The basic idea behind cointegration is that, if in the long-run, two or more series move closely together, even though the series themselves are not stationary, the difference between them is constant (Dickey and Fuller, 1979). It is possible to regard these series as defining a long-run equilibrium relationship, as the difference between them is stationary. Lack of cointegration suggests that such variables have no long-run relationship, in principal they can wander arbitrarily far away from each other (Engle and Granger, 1987).

Testing for cointegration is a necessary step to check if one is modelling empirically meaningful relationships. If variables have different trend processes, they cannot stay in fixed long-run relationship, implying that it is not possible to model the long-run relationship, and there is usually no valid base for inference based on standard distributions (Lütkepohl, 2005). If there is no cointegration, it is necessary to continue to work with variables in differences instead.

There are a number of methods of testing for cointegration in literature. These methods include Augmented Engle-Granger (AEG) test, Cointegrating Regression Durbin-Watson (CRDW) test and the Johansen test of cointegration. This study employs the Johansen's maximum likelihood framework because it has a lot of desirable statistical properties and it has been found to be particularly useful in several comparative studies including Lütkepohl and Saikkonen (2001). The weakness of the test is that it relies on asymptotic

properties, and is therefore sensitive to specification errors in limited samples. However, this weakness has been supressed by the new econometric techniques embedded in the statistical software (Stata) used in this study which is able to report small sample statistics.

3.4.1. The Johansen Test of Cointegration

The Johansen (1995) method tests the restrictions imposed by cointegration on the unrestricted VAR involving time series. The general Johansen framework (which also includes the possibility of deterministic trends) can be specified as below.

$$\Delta y_t = v + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \delta t + \varepsilon_t \qquad (6)$$

The test for cointegration implemented in the Johansen's methodology asserts that, if the log likelihood of the unconstrained model that includes the cointegrating equations is significantly different from the log likelihood of the constrained model that does not include the cointegrating equations; we can reject the null hypothesis of no cointegration. In his original work, Johansen derived two tests, the λ–max (or maximum eigenvalue test) and the trace test as shown below.

$$\lambda_{max} = -T\ln\left(1 - \hat{\lambda}_{r+1}\right) \qquad (7)$$

$$\lambda_{trace} = -T \sum_{i=r+1}^{p} \left(1 - \hat{\lambda}_i\right) \qquad (8)$$

The maximum eigenvalue statistic compares the null hypothesis of the model containing r cointegrating relations with the alternative model that contains $r + 1$ cointegrating relations.The trace statistic compares the null hypothesis that there are r or fewer cointegrating relations with the alternative hypothesis that there are more than r cointegrating equations. Sjö(2008) argues that the trace test is the better test since it appears to be more robust to skewness and excess kurtosis. Furthermore, the trace test can be adjusted for degrees of freedom, which can be of importance in small samples. Therefore, in most practical work, the decision is based on the trace statistic as done in this study.

3.5. Vector Autoregression (VAR) Analysis

If there is no cointegrating relationship between the variables, we can only estimate a VAR to find out whether they are related to each other in the short-run. Lütkepohl (2005) points out that, a VAR process is a suitable model class for describing the data generating process of a small or moderate set of time series variables. Restrictions are imposed with statistical techniques during data analysis instead of prior beliefs based on uncertain theoretical considerations. Sims (1980) main criticism of the classical type of analysis is that, macro-econometric models are often not based on sound economic theories or the available theories are not capable of providing a completely specified model. If economic theories are not available to specify the model, statistical tools must be applied. VAR models represent a class of loose models that may be used in such an approach. The VAR system in two variables is specified as below.

$$\Delta GDP_t = \phi_{10} + \sum_{i=1}^{p} \phi_{11i} \Delta GDP_{t-j} + \sum_{i=1}^{p} \phi_{12i} \Delta INFL_{t-i} + \varepsilon_{1t} \quad (9)$$

$$\Delta INFL_t = \phi_{20} + \sum_{i=1}^{p} \phi_{21i} \Delta INFL_{t-i} + \sum_{i=1}^{p} \phi_{22i} \Delta GDP_{t-i} + \varepsilon_{2t} \quad (10)$$

Where ΔGDP and ΔGDP are the first difference of GDP and INFL respectively, and p is the lag length in a VAR. To avoid serial correlation in the error terms, it is vital to choose the correct number of lags to enter the VAR system. Too many lags will distort the information by introducing errors in forecasting and too few lags will leave out important information. The lags included in our VAR were selected using AIC, HQIC and SBIC.

However, before interpreting VAR results, we need to do diagnostic tests to make sure that our fitted VAR is worth drawing conclusions from. In this study, we employ the eigenvalue stability condition to check whether our fitted VAR is stable to allow us proceed with interpretation and other post VAR analysis such as innovation accounting. In addition, the study uses Jarque-Bera statistic to test the normality of residuals and test for autocorrelation in the residuals using the Lagrange-Multiplier (LM) test. We also test for the correct lag structure in a VAR using the Wald lag exclusion test.

3.6. Granger Causality

The concept of Granger causalitywas originally proposed by Granger (1969) and has been extensively used in the literature to describe the relationship between variables to date. Croux and Reusens (2011) observe that, whereas correlation between two variables indicates co-movement, Granger causality relates to the idea of incremental predictive power of one time series for forecasting another time series. It is a statistically testable criterion based on the ideas of precedence and predictive power. As such, a stationary variable $Y_t$is said to Granger cause another stationary variable $X_t$if the past of $Y_t$improves the one period ahead prediction of $X_t$above the information included in the past of X_t. Based on the estimated OLS coefficients for equation (9) and (10), there are four hypotheses which can be formulated for relationship between GDP and INFL, thus:

1) Unidirectional Granger causality fromINFL to GDP. In this case, inflation rate increases the prediction of economic growth rate and not the other way round. Thus,$\sum_{i=1}^{p} \phi_{12i} \neq 0$ and$\sum_{i=1}^{p} \phi_{11i} = 0$
2) Unidirectional Granger causality from GDP to INFL. In this case, growth rate of the economy increases the prediction of inflation rate and not the other way round. Thus, $\sum_{i=1}^{p} \phi_{21i} = 0and\sum_{i=1}^{p} \phi_{22i} \neq 0$.
3) Bidirectional (feedback)Granger causality. In this case, economic growthrate increases the prediction of inflation rate. At the same time, inflation rate increases the prediction of economic growth rate. Thus, $\sum_{i=1}^{p} \phi_{22i} \neq 0$ and $\sum_{i=1}^{p} \phi_{12i} \neq 0$
4) Independence betweenGDP and INFL. In this case, there is no Granger causality in any direction. Thus, $\sum_{i=1}^{p} \phi_{12i} = 0$ and $\sum_{i=1}^{p} \phi_{22i} = 0$

Therefore, if we get any one of the results above, then we can detect the causality relationship between inflation and economic growth.

3.7. Impulse Response Functions and Forecast Error Variance Decomposition

This section is devoted to explaining the analyses of impulse response functions and forecast error variance decomposition. The mathematics behind these tools of interpreting VAR models has been omitted and can be found in Lütkepohl (2005).

3.7.1. Impulse Response Functions (IRF)

In both academic and applied work, it is often of interest to know the response of one variable to an impulse in another variable in a system that involves a number of variables. Impulse response functions describe how the endogenous variables react, over time, to a one-time shock to one of the disturbances. They trace out the response of current and future values of each of the variables to a unit increase in the current value of one of the VAR errors, assuming that this error returns to zero in subsequent periods and that, all other errors are equal to zero. Because the disturbances may be contemporaneously correlated, these functions do not explain how one variable reacts to a one-time increase in the innovation of another variable after a given period, holding everything else constant. However, this inadequacy can be overcome by using orthogonalized innovations so that the assumption to hold everything else constant is practical (Stock and Watson, 2001).

3.7.2. Forecast Error Variance Decomposition (FEVD)

Forecast Error Variance Decomposition (FEVD) measures the extent to which each shock contributes to the unexplained movements (forecast errors) in each variable. They show how each shock contributes to the variation in each variable. In other words, the forecast error decomposition is the percentage of the variance of the error made in forecasting a variable due to a specific shock at a given horizon. The FEVD can also help us to find out if sequence of variables used in a VAR is endogenous or exogenous. If the shocks of variable Y do not explain the forecast error variance of variable X, then it can be concluded that the sequence of the variable X is exogenous. On the other hand, if the shocks of variable Y explain all the forecast error variance of the variable X, then it can be concluded that it is endogenous.

CHAPTER FOUR

EMPIRICAL ANALYSIS

4.0. Introduction

This chapter gives a comprehensive presentation and discussion of empirical findings of the study. Section 4.1 gives the overview of time series properties of data, which include descriptive statistics, unit root test and cointegration test. Section 4.2presents results on VAR analysis. Section 4.3presentsresults on Granger causality test. Section 4.4 gives results for impulse response functions and section 4.5 looks at the forecast error variance decomposition analysis. Finally, section 4.6 discusses the results.

4.1. Time Series Properties of the Data

4.1.1. Descriptive Statistics

The first step to understanding the properties of data is to present their basic statistics. The table below reports the descriptive statistics (mean, median, maximum, minimum, standard deviation) of the variables included in the study.

Table 4.1: Descriptive Statistics of the Data

Variable Name	Symbol	Mean	Stnd. Dev.	Minimum	Maximum
Economic Growth	GDP	2.527928	3.855421	-9.02042	7.34386
Inflation	INFL	31.67124	26.19317	8.15978	104.118

Note: The usable observations in our analysis total 32, representing the sample size.

4.1.2. EM test for structural stability

Table 4.2 Results of EM test for structural stability

Test statistic	1% critical value	5% Critical Value	10% Critical Value
-6.787	-11.05	-8.36	-7.14

Table 4.2 presents EM test results. Since the absolute value of the computed statistic is less than the critical values of any conventional level of significance, we fail to reject the null hypothesis of parameter stability; hence no structural break can be detected. This means that the parameters during the study period remain constant.

4.1.3. Unit Root Analysis

This section presents results of the unit root test.The method used to test for unit roots in this study is the DF-GLS of Elliott–Rothenberg–Stock.

4.1.3.1. DF-GLS Unit Root Test

The results of the DF-GLS are presented in tables 4.3 and 4.4 below.

Table 4.3: Results of DF-GLS Unit Root Test on data in level form

Variable	DF-GLS Statistic (With trend)	DF-GLS Statistic (without Trend)	Selected Lags
GDP	-0.888	-0.220	4{MAIC}
INFL	-2.257	-2.179	3{SC, NP}

1. Lag 4 critical values are -3.770, -3.075, - 2.738 at 1%, 5% and 10% respectively
2. Lag 3 critical values are -3.770, -3.199, - 2.861 at 1%, 5% and 10% respectively

The results in table 4.3 show that we cannot reject the null hypothesis of unit root for both variables, with or without trend. This is because the absolute values of the DF-GLS statistics are less than the critical values at all conventional levels of significance. Therefore, it suffices to conclude that the variables at hand are not stationary.

Table 4.4: Results of DF-GLS Unit Root Test on data in first difference form

VARIABLE	DF-GLS STATISTIC(NO TREND)	No. OF LAGS IN DF-GLS
DGDPR	-6.569	1{NP, SC}
DINFL	-2.652	2{MAIC,SC, NP}

1. Lag 2 critical values are at -2.650, -2.439, -2.110 at 1%, 5% and 10% respectively
2. Lag 1 critical values are -2.650, -2.498, -2.165 at 1%, 5% and 10% respectively

Table 4.4 reports the test statistic for the DF-GLS for the first difference of GDP and INFL. At all conventional levels of significance, we reject the null hypothesis of unit root for both variables. This is because the absolute values of the DF-GLS statistics are greater than the critical values at all conventional levels of significance. Therefore, we conclude that, at these levels of significance, the first difference of GDP and INFL series are stationary. In this case, both inflation and economic growth can be classified as being integrated of order one, that is I(1).

4.1.4. Cointegration Test

Unit root testshave shown that both inflation and economic growth are integrated of order one. Therefore, we had to test for cointegration between these two variables to check whether they have a stable long-run equilibrium relationship. The Johansen test of cointegration using the trace statistic was conducted. The lags to enter the system were chosen using FPE, AIC HQIC and SBIC which all chose lag three. The results using the trace statistic are presented in the table below.

Table 4.5: Johansen Test for Cointegration

maximum rank	LL	Eigen-value	Trace statistic	5% critical value
0	-214.30352	.	8.0046**	19.96
1	-211.15537	0.19516	1.7084	9.42
2	-210.3012	0.05721		

**indicate the significance of the results at 5% level of significance

Since the trace statistic at r = 0 of 8.0046 is less than its critical value of 19.96, we cannot reject the null hypothesis that there are zero cointegrating equations at five percent level of significance. Therefore, we conclude that inflation and economic growth are not cointegrated. This means that, a linear combination of inflation and economic growth will not lead to a long-run stable equilibrium relationship.

4.2. Vector Autoregression (VAR) Analysis

The results from the VAR are presented in table 4.6. The top part of the table reports the fit of the two equations estimated in a VAR. The second part of the model reports the summary statistics of these two equations estimated by OLS in a VAR. However, interpretation of the results from a VAR model requires that the model is stable, the residuals are normally distributed and that there is no presence of autocorrelation among the residuals. Therefore, we perform diagnostic tests in the next section to see if our VAR model fits well.

Table 4.6: Vector Autoregression Results

Equation	parameters	RMSE	R-squared	F	P -Value
ΔGDP	7	3.14143	0.6452	6.366051	0.0006
ΔINFL	7	14.227	0.4105	2.437153	0.0603
Dep. Var.	**Indi. Var.**	**Coefficient**	**Std. Error**	**t-statistic**	**P-Value**
ΔGDP	ΔGDP_{t-1}	-0.91407	0.195209	-4.68***	0.000
	ΔGDL_{t-2}	-0.62954	0.179285	-3.51***	0.002
	ΔGDP_{t-3}	-0.28836	0.158864	-1.82*	0.084
	$\Delta INFL_{t-1}$	0.008981	0.041581	0.22	0.831
	$\Delta INFL_{t-2}$	-0.11219	0.039311	-2.85***	0.010
	$\Delta INFL_{t-3}$	-0.04937	0.046802	-1.05	0.303
	CONSTANT	0.650997	0.598985	1.09	0.289
ΔINFL	ΔGDP_{t-1}	0.072833	0.884065	0.08	0.935
	ΔGDL_{t-2}	0.528579	0.811951	0.65	0.522
	ΔGDP_{t-3}	-0.72370	0.719466	-1.01	0.326
	$\Delta INFL_{t-1}$	0.269835	0.188311	1.43	0.167
	$\Delta INFL_{t-2}$	-0.47981	0.178030	-2.7**	0.014
	$\Delta INFL_{t-3}$	0.577687	0.211957	2.73**	0.013
	CONSTANT	-0.29785	2.712700	-0.11	0.914

Note: The asterisk *,**,*** indicate significance of the t-values at 1%, 5% and 10% respectively

4.2.1. Diagnostic Tests of the Bivariate VAR Model

4.2.1.1. Stability Test of a VAR

For the model to be valid, one key property is that the model must be stable. A VAR is stable if the modulus of each eigenvalue of a companion matrix[4] is strictly less than one. Lütkepohl (2005) has shown that, if a VAR is stable, it is invertible, has an infinite order vector moving average representation and the impulse response functions and forecast error variance decompositions have known interpretations. If any eigenvalue with modulus greater than one is found in a companion matrix, then the VAR is unstable and

[4] The definition of a companion matrix can be found in Lütkepohl (2005)

forecasts will explode. This means that either the variables in the model are non-stationary or the model is misspecified.

Table 4.7: Results of Test for VAR stability

Eigenvalue stability condition	
Eigenvalue	**Modulus**
-.3447693 + .7642506i	0.838418
-.3447693 - .7642506i	0.838418
-.04000698 + .8027029i	0.803699
-.04000698 - .8027029i	0.803699
0.7330991	0.733099
-0.6077841	0.607784

Table 4.7 above shows the eigenvalue condition test for stability of the VAR. Since the modulus of each eigenvalue in our model is strictly less than one, the estimates satisfy the eigenvalue stability condition. This means that our estimated VAR model is stable and meaningful interpretation of the results is guaranteed.

4.2.1.2. Normality test of the Residuals

Here we test the null hypothesis that the residuals are normally distributed. The normality assumption is important for the validity of estimated statistics of a VAR. Table 4.8 reports the Jarque-Bera test results.

Table 4.8: Results of Jarque-Bera Test for Normality

EQUATION	chi2	df	P-value
DGDP	1.067	2	0.5865
DINFL	0.017	2	0.9917
ALL	1.084	4	0.8968

In our model, the null hypothesis of normal distribution of the residuals is not rejected at all conventional levels of significance for the variables individually and jointly. This is because all the p-values for the calculated chi-square test statistic are greater than the conventional levels of significance. In this case, our model is not misspecified.

4.2.1.3. Lagrange-Multiplier (LM) test

The LM tests for autocorrelation in the residuals of VAR models as demonstrated in Johansen (1995). We test for autocorrelation of the residuals in a VAR because most of the post-estimation analysis from a VAR assumes that the residuals from a VAR are not autocorrelated. Table 4.9 presents results of LMtest for autocorrelation in the residuals.

Table 4.9: Results of LM test for Autocorrelation

Lags	Chi-square	Degrees of freedom	P-value
1	4.6587	4	0.32415
2	6.7629	4	0.14896
3	6.0670	4	0.10298

Table 4.9 reports the calculated chi-square values for the lags one through to three, the degrees of freedom and the p-values. The null hypothesis for LMtest is that there is no autocorrelation at lagi. At all lags and all conventional levels of significance, we fail to reject the null hypothesis of no autocorrelation in the residuals. This means that the residuals of our VAR model are not autocorrelated. This result also amplifies the correct specification of our VAR model.

4.2.1.4. Wald Lag-Exclusion Test

After fitting a VAR, one hypothesis of interest is that all the endogenous variables at a given lag are jointly zero. This guides us on whether or not we should place some constraints on the coefficients in a VAR model. The Wald lag exclusion statistic tests the hypothesis that the endogenous variables at a given lag are jointly zero for each equation and for all equations jointly. Table 4.10 presents the results of the test.

Table 4.10: Results of Wald Lag-Exclusion Statistics

		Equation: DGDP		Equation: DINFL		Equation: All		
lag	df	F	P-value	F	P-value	df	F	P-value
1	2	11.1933	0.0005*	1.091	0.354	4	7.099	0.0009***
2	2	13.8013	0.0001*	3.633	0.044**	4	8.299	0.0004***
3	2	2.29168	0.1258	4.108	0.031**	4	3.788	0.0180**

Note: The asterisk *,**,*** indicate significance of the F-values at 1%, 5% and 10% respectively

The two equations seem to have different lag structures. In the first equation, we cannot reject the null hypothesis that both endogenous variables have zero coefficients at the third lag, at all conventional levels of significance. On the other hand, we cannot reject the null hypothesis that both endogenous variables have zero coefficients in the second equation at first lag, at all conventional levels of significance. In contrast, in the first equation, the coefficients on the first and second lags of both variables are jointly significant at one percent level of significance. Similarly, we can reject the hypothesis that the coefficients on the second and third lags of our variables are zero in the second equation. Furthermore, we strongly reject the hypothesis that the coefficients on the first and second lags of the variables are zero in both equations jointly at one percent level of significance. However, the null hypothesis that the coefficients on the third lag of both variables are zero in both equations jointly is rejected at five percent level of significance. Given the results above, there is no need to re-fit the VAR with a different lag structure.

4.3. Bivariate Granger Causality Analysis

Granger causality statistics examine whether lagged values of one variable helps to predict another variable. The formal definition of Granger causality asks whether past values of $x_t$aid in the prediction of y_t conditional on the fact that we have already accounted for the effects on $y_t$of past values of y_t and of past values of other variables. If this is the case, then $x_t$is said to Granger cause y_t. Table 4.6of the VAR model shows that the first equation models the first difference of GDP as a linear function of its past values plus the past values of the first difference of inflation.

Table 4.11: Results for Granger Causality Wald tests Test

Null Hypothesis	F	df	P-Value
INFL does not Granger cause GDP	3.3542	3	0.0383**
GDP does not Granger cause INFL	1.0062	3	0.4096

Note: The asterisk *,**,*** indicate significance of the F-values at 1%, 5% and 10% respectively

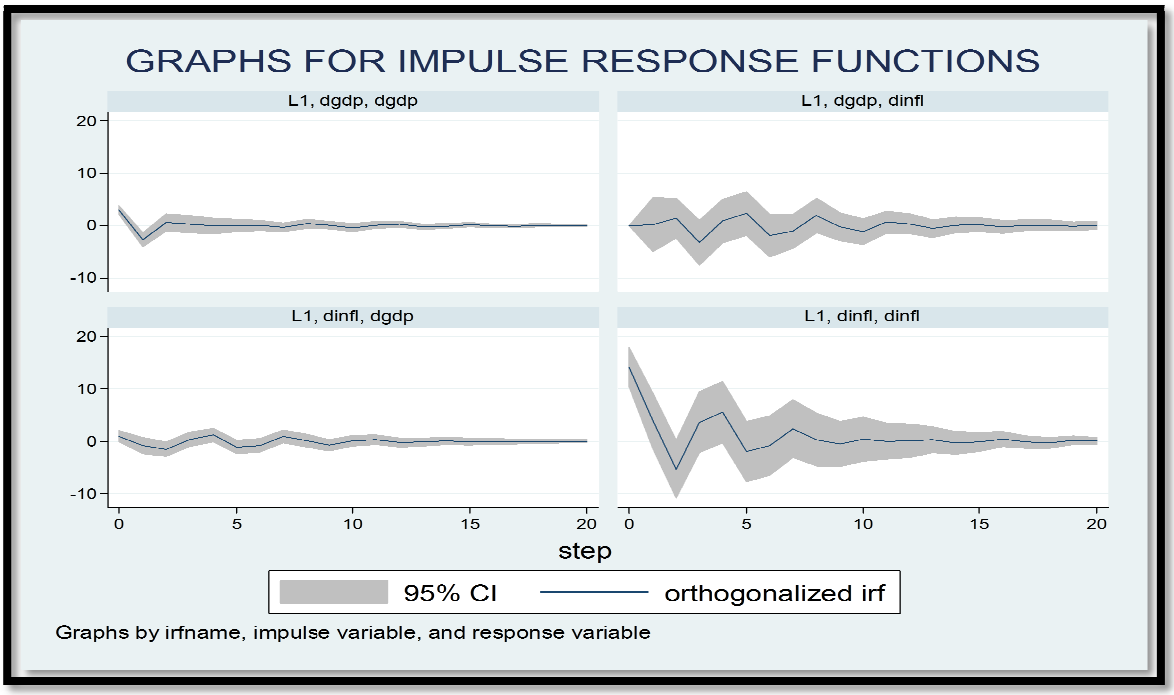
For each equation in a VAR, we test the hypotheses that each of the other endogenous variables does not Granger cause the dependent variable in that equation. The first Wald test is that, the coefficients on the three lags of INFL under the equation for GDP are

jointly zero. From table 4.11, the probability of obtaining the F-statistic is less than 5 percent, hence we reject the null hypothesis that INFL does not Granger cause GDP. This means that, we are 95 percent confident that inflation Granger causes GDP in the short-run. On the other hand, we fail to reject the null hypothesis that GDP does not Granger-cause INFL as the probability of obtaining the F-statistic is greater than the conventional levels of significance. Therefore, we can conclude that there is a unidirectional causality running from inflation to economic growth. There is no feedback causality running from economic growth to inflation.

4.4. Impulse Response Analysis

Figure 4.1 reports the graphs of the impulse response functions. This study adopts theCholesky decomposition method to decompose the contemporaneous correlations into orthogonal components. In our ordering, we selected our preferred identification pattern, interpreting the contemporaneous correlation as the effect of inflation on economic growth as guided by the results of Granger causality. This means that inflation should be first in our ordering and economic growth is second.

Figure 4.1: Impulse Response Functions



The top-left and the bottom-right panels in figure 4.1 show the effects of shocks to each variable on future values of its own. We can observe that, in both cases, the shock dies out quickly reflecting the stationarity of the variables included in a VAR. A one-standard deviation shock to GDP growth in the top-left panel is just over three percent and a corresponding shock to inflation is about the fifteen percent.

The bottom-left and top-right panels of figure 4.1 show the effects of each variable's shock on the path of the other variable. In the bottom-left panel, we see that a one-standard-deviation (about 3 percentage points) shock to inflation changes growth by about 1 percentage point in the current period, then decreases in the next period as the lagged effect comes in. The pattern goes on till the lag of about eight, from which the effect dies out quickly towards zero. In the top-right panel, we see the estimated effects of a shock to economic growth on inflation. We notice without surprise that the effect is zero at lag zero. This is a direct result of our identification assumption where we imposed the condition that economic growth has no immediate effect on inflation in order to identify the shocks. Table A1 of the appendix reports the numerical version of IRF.

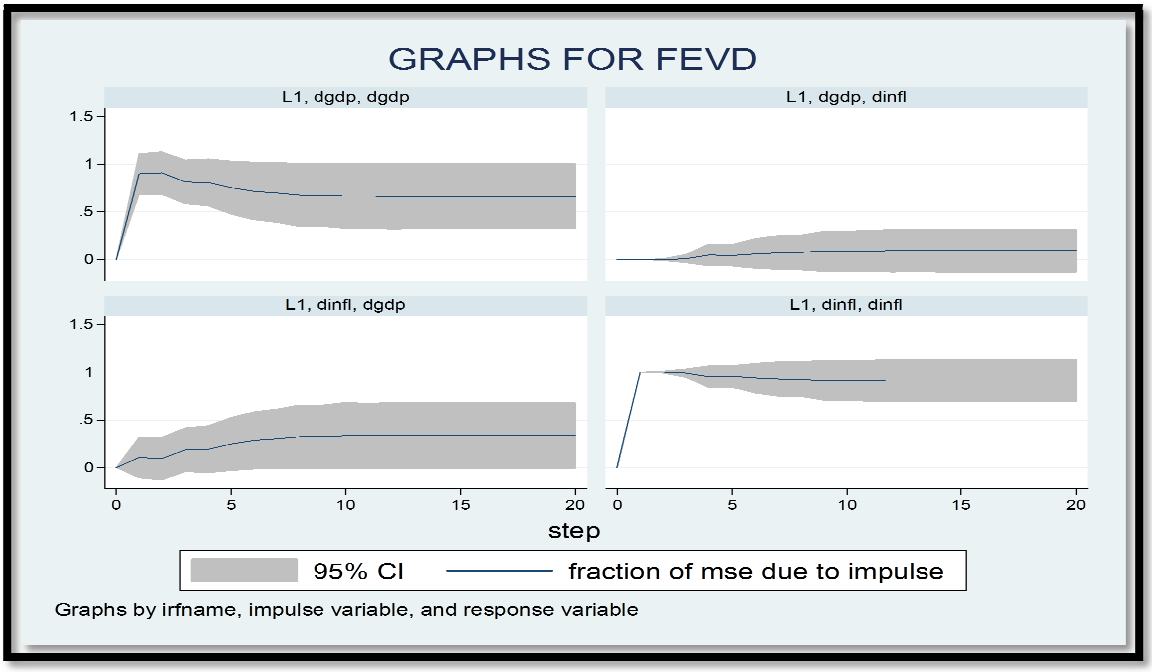
4.5. Forecast Error Variance Decomposition (FEVD)

Once the VAR has been identified, the FEVD analysis can be done besides the impulse response analysis.From figure 4.2, the graphs show that the variables are able to explain the shocks to each other, but the percentage explained differs. This is evidence enough to conclude that both variables entering the VAR are endogenous.

The left-column panels show that GDP growth shock contributes about 90 percent of the variance in the one-period-ahead forecast error for GDP growth, with inflation shock contributing the other ten percent. As the forecast horizon moves further into the future, the effect of the inflation shock on GDP growth increases and the shares converge to less than 70 percent of variation in GDP growth being due to GDP growth shock and more than 30 percent due to the inflation shock. The right-column panels indicate that less than three percent of the variation in inflation is attributable to GDP growth shocks in the short-run or long-run where as more than 97 percent of variation in inflation is attributed

to inflation shocks. This result further amplifies our Granger causality findings that it is inflation that causes GDP.

Figure 4.2: Forecast Error Variance Decomposition



It is important to understand, however, that Granger causality and forecast error variance decompositions are quite different concepts because Granger causality and instantaneous causality are different concepts. Lütkepohl (2005) points out that, while Granger causality is a uniquely defined property of two subsets of variables of a given process, the forecast error variance decomposition is not unique.

4.6. Discussion of Results

The analysis started with testing the data for existence of any structural break for the period under study. The study found no structural breaks indicating the constancy of parameters for this period. This also necessitated us to proceed to estimate and make inferences on the parameters using the methodologies at hand, thus unit root tests and VAR analysis. Unit root tests reveal that, both inflation and economic growth are integrated of order-one. This means that analyzing inflation and economic growth in the level form might give spurious results if the variables are not cointegrated. Therefore, we

went on to test for cointegration between these two variables in order to check whether they have a stable long-run equilibrium relationship.

The study finds no existence of cointegration between inflation and economic growth. This result in line with empirical findings of Chimobi (2010), Faria and Carneiro (2001) and Erbaykal and Okuyan (2008) but contrasts with studies by Datta and Mukhopadhyay (2011), Saaed (2007) and Ahmed and Mortaza (2005), among others. Theimplication of this result is that,a linear combination of inflation and economic growth will not lead to a long-run stable equilibrium relationship. This result is not surprising given the nature of the economy of Zambia and its sectors. Most of the drivers to economic growth have been identified as supply side factors, which might not be affected by inflation directly in the long-run[5].

Furthermore, unlike developed countries, in a developing country like Zambia, with less elastic nature of supply of output, increase in investment creates additional demand which is not matched by supply. In a bid to scale up investment by accumulating capital in order to foster economic growth, government makes huge investment expenditures such as infrastructure development. This leads to a sharp increase in aggregate demand for consumer goods, especially agricultural products. However, this increase in expenditure does not match the supply due to various tailbacks, hence inflationary pressures ensue. In a poor country like Zambia, we expect the income elasticity of demand for agricultural products to be high. Since the agricultural products account for most part in the CPI, an increase in demand for these products will lead to rise in the price and inflation may result. Now, due to the nature of investments made by the government like investments in roads, or dams, with long gestation period, they can only help to increase supply of consumer goods in the long-run. On the other hand, in the short-run, prices generally go up under the pressure of excessive demand for goods, leading to loss of real income and erosion of purchasing power.

Another implication of lack of long-run relationship between economic growth and inflation is that, it may signal the neutrality of money in the long-run. This is because the

[5] For clear exposition, refer to the study titled “An Analysis of Constraints to Inclusive Growth in Zambia” done for the Ministry of Finance in 2012.

neutrality of money is theoretically considered a plausible scenario over long-term, but not over short time periods. In the short term, changes in the money supply seem to affect real variables like GDP, mainly because of price stickiness and imperfect information flow in the markets. The fact that inflation outcomes in Zambia have been associated with increase in money supply, the effect of inflation (which is a monetary phenomenon) might have a limited impact on economic growth in the long-run.

The results from VAR analysis are presented in table 4.6of the previous section with two equations estimated using the OLS methodology. The computed F-statistics of the two equations are significant with the equation where GDP is the dependent variable being significant at one percent level of significance whereas the other equation is significant at five percent level of significance. The R-squared for both equations are 0.6077 and 0.4105 respectively. The VAR was diagnosed for necessary requirements of a being a good fit. All the necessary tests passed and hence we proceeded to make inferences on the parameters and post-estimation analysis.

In a VAR, the magnitude of the coefficients is not of much interest but their sign and significance. For the equation where GDP is the dependent variable, two of the lags of the first difference of GDP are significant with a negative sign, that is lag one and lag two. In the same equation, the first difference of inflation rate is only significant at lag two with a negative sign. This implies that inflation hampers economic growth with a lag of two years. In the second equation, where inflation is the dependent variable, only lags two and three of the first differences of inflation are significant at five percent with positive and negative signs respectively.In summary, the VAR results show that there is a statistically negative short-run relationship between inflation and economic growth.

Granger causality was tested naturally using a VAR. If inflation Granger causes GDP, then some or all of the lagged inflationvalues have non-zero effects, that is, lagged inflation affects GDP conditional on the effects of lagged GDP. On the other hand, if GDP Granger causes inflation, then some or all lagged values of GDP have non-zero effects, that is, lagged GDP affects inflation conditional on the effects of lagged inflation. The result of Granger causality analysis shows that inflation Granger causes economic

growth while economic growth does not Granger cause inflation. This means that, inflation impacts economic growth in Zambia and not the other way round. This result of unidirectional Granger causality running from inflation to economic growth concurs with empirical studies by Dipietro and Sawhney (1999), Mubarik (2005), Erbaykal and Okuyan (2008), Chimobi (2010), Saaed (2007) and so on, but contrasts with studies by Datta and Mukhopadhyay (2011) and Gokal and Hanif (2004), among others.

The question is; should Zambian policy makers worry about the effects of higher growth on inflation?The answer is no as dictated by the results of this study. There are situations when policy makers are concerned about the effects of economic growth on inflation. For example, when growth rates are low, then the central bank is not likely to raise interest rates as present growth rates are considered to be too low to stimulate inflation. On the other hand, when growth rates are high, the central bank is likely to increase interest rates to slow the growth rates of the economy, in order to prevent the upsurge in inflation. Dipietro and Sawhney (1999) argue that these kinds of policies have been implemented before in countries like the United States of America (USA) where at one point the Federal Reserve was to slow the economy to an annual rate of 2.5 percent to avoid significant acceleration of inflation.

But how can we visualize a situation where economic growth causes inflation? A possible way is by looking at the equation of exchange as postulated in the monetary theory of inflation. When money supply is given and the velocity of money is constant, the equation of exchange shows a negative relationship between real economic growth and inflation. However, in this situation, higher rates of growth rates will be associated with higher rates of inflation only when growth in the money supply exceeds growth in real economic output. But this can only happen if we assume that increase in money supply leads to increase in economic growth, that is, at higher levels of economic growth, increase in money supply must be greater than increase in the growth rate in order to acquire higher rates of growth.However, this study reveals that economic growth does not exacerbate inflation.

CHAPTER FIVE

CONCLUSION AND POLICY IMPLICATIONS

5.0. Introduction

This chapter gives a summary of the main findings of the study. Policy implications of the study are also highlighted. The chapter ends with the presentation of some limitations to the study.

5.1. Main Findings of the Study, Conclusion and Policy Implications

The main purpose of this study is to explore the nature of the relationship between inflation and economic growth in Zambia.The methodology employed in this study is time series analysis using cointegration test, VAR and Granger causality analysis. Growth in the logarithm of the CPI has been used to measure inflation and growth in real GDP as a measure of economic growth to examine the relationship. Since data contains two regimes, we have carried out a structural stability test which points to the fact that the parameters have been constant for the period under study. Stationarity tests have also been carried out using the DF-GLStest toascertain the order of integration of the variables. Stationarity is found only in the first difference of the variables. This means that the variables used in this study are integrated of order one. Test of cointegration has alsobeen conductedand the results show that, for the period under study, there is no cointegrating relationship between inflation and economic growth for Zambian data.

The finding of no cointegration implies that there is no stable long-run equilibrium relationship between inflation and economic growth. This result necessitated the use of unrestricted VAR analysis as opposed to using models which take care of the long-run effects such as the VECM. The VAR analysis reveals that inflation significantly and negatively impact economic growth in the short-run. Further effort is made to check the direction of causality that exists between the two variables by employing the VAR-Granger causality test at lags one to three as chosen by the lag selection criteria. Granger causality test indicates that there is a unidirectional causality running from inflation to economic growth. These results are in conformity with several studies reviewed

inliterature which reveal that inflation is and has been detrimental to economic growth. Hence, the study through the empirical findings maintains the fact that the causality that runs from inflation to economic growth is an indication of a relationship showing that inflation indeed has an impact on economic growth.

The study further investigates impulse response functions and forecast error variance decomposition. It has been revealed that a one-standard deviation shock to GDP growth is just over three percent and a corresponding shock to inflation is about 15 percent. The study further finds that a one-standard-deviation shock in inflation changes GDP growth by about one percentage point in the current period, then decreases in the next period as the lagged effect comes in. Therefore, the conclusion from impulse response analysis is that increase in inflation is followed by decrease in economic growth. Forecast error variance decomposition further shows that more variability in economic growth is explained by shocks to inflation and not vice versa.

The most striking result of our findings is that, economic growth does not help predict future inflation rate, having taken into account the information provided by economic growth itself. By knowing the past values of growth in real GDP, we cannot predict what inflation rate will be in future. On the contrary, it is inflation which helps predict the future rate of real GDP growth. Therefore, the study shows that, given the current situation in Zambia, government should give inflation reduction a primary focus.

5.2. Limitations of the Study and Recommendations for Future Research

This study has been successful at examining the nature of the relationship between inflation and economic growth in Zambia. However, this has not been done without limitations. Firstly, the data used in the study is somehow sensitive to different modeling. For example by changing the proxies of inflation and economic growth, one might expect slightly different results. The other limitation is the short span of data used in this study considering the methodology employed. However, the statistical package used in this study has the flexibility of reporting small sample statistics. Future research should consider employing non-linear models and probably include more countries within the region to repeat the estimation process and check the robustness of the results.

APPENDIX

Table A1. Impulse Response Functions

Results from gdpinf

step	(1) oirf	(1) Lower	(1) Upper	(2) oirf	(2) Lower	(2) Upper	(3) oirf	(3) Lower	(3) Upper
0	3.14143	2.31865	3.9642	4.57656	-.554957	9.70807	0	0	0
1	-2.83039	-4.23265	-1.42813	1.46372	-4.102	7.02943	.120979	-.9773	1.21926
2	.109245	-1.6694	1.88789	-.346559	-4.87656	4.18344	-1.58916	-2.96364	-.214683
3	.382869	-1.25252	2.01826	-1.91359	-6.68593	2.85875	.25448	-1.12978	1.63874
4	.346868	-1.23997	1.93371	2.62949	-2.35592	7.6149	1.20807	-.043344	2.45948
5	-.334197	-1.59632	.927924	1.57606	-2.86939	6.02152	-.996622	-2.26322	.269979
6	-.209659	-1.22246	.803141	-2.05991	-6.32764	2.20782	-.733557	-2.02357	.556455
7	-.023113	-.970384	.924158	-.235967	-3.84801	3.37607	.990996	-.193482	2.17547
8	.400651	-.526609	1.32791	1.96451	-1.57678	5.50581	.009819	-1.1953	1.21494
9	-.145407	-.978743	.68793	-.377975	-3.06144	2.30549	-.716595	-1.7989	.365715
10	-.324784	-1.10467	.455103	-.962983	-3.44804	1.52207	.263222	-.776395	1.30284
11	.209654	-.478801	.898108	.665917	-1.4977	2.82953	.273298	-.658591	1.20519
12	.187429	-.429927	.804786	.37221	-1.40522	2.14964	-.283516	-1.16971	.602676
13	-.233477	-.790442	.323488	-.415862	-1.93847	1.10675	-.013148	-.769438	.743141
14	-.043403	-.5062	.419395	.024227	-1.35714	1.40559	.120318	-.583061	.823696
15	.161105	-.257815	.580025	.158877	-.991446	1.3092	-.078155	-.700391	.544081

step	(4) oirf	(4) Lower	(4) Upper
0	13.4708	9.94264	16.9989
1	3.63489	-1.42728	8.69706
2	-5.47375	-10.838	-.109503
3	4.50904	-1.02122	10.0393
4	5.03386	-.506147	10.5739
5	-2.5947	-8.18964	3.00025
6	-.128806	-5.57691	5.3193
7	2.66369	-2.74621	8.07359
8	-.312669	-5.1169	4.49156
9	-.381425	-4.7125	3.94965
10	.82169	-3.38694	5.03032
11	-.142605	-3.53797	3.25276
12	.024564	-3.205	3.25412
13	.483046	-2.12715	3.09325
14	-.312429	-2.53108	1.90622
15	-.094889	-2.09365	1.90388

95% lower and upper bounds reported
(1) irfname = gdpinf, impulse = dgdp, and response = dgdp
(2) irfname = gdpinf, impulse = dgdp, and response = dinfl
(3) irfname = gdpinf, impulse = dinfl, and response = dgdp
(4) irfname = gdpinf, impulse = dinfl, and response = dinfl

Table A2. Forecast Error Variance Decomposition

Results from gdpinf

step	(1) fevd	(1) Lower	(1) Upper	(2) fevd	(2) Lower	(2) Upper	(3) fevd	(3) Lower	(3) Upper
0	0	0	0	0	0	0	0	0	0
1	1	1	1	.103479	-.110162	.317121	0	0	0
2	.999182	.984297	1.01407	.106021	-.118993	.331035	.000818	-.014067	.015703
3	.87568	.66642	1.08494	.093637	-.112738	.300013	.12432	-.08494	.33358
4	.873816	.653658	1.09397	.098843	-.088601	.286287	.126184	-.093973	.346342
5	.817113	.540317	1.09391	.111097	-.105211	.327405	.182887	-.09391	.459683
6	.783198	.473667	1.09273	.115757	-.103395	.334909	.216802	-.092728	.526333
7	.76597	.4488	1.08314	.127566	-.113349	.368481	.23403	-.083139	.5512
8	.735755	.390809	1.0807	.124928	-.113591	.363447	.264245	-.080701	.609191
9	.737445	.3969	1.07799	.135166	-.12018	.390511	.262555	-.077991	.6031
10	.722863	.370143	1.07558	.135482	-.120517	.39148	.277137	-.075583	.629857
11	.722054	.370341	1.07377	.13763	-.122562	.397823	.277946	-.073766	.629659
12	.720442	.367457	1.07343	.138777	-.121899	.399453	.279558	-.073426	.632543
13	.718592	.364318	1.07287	.139137	-.122331	.400605	.281408	-.072866	.635682
14	.719176	.366284	1.07207	.139488	-.121498	.400474	.280824	-.072069	.633716
15	.718797	.365472	1.07212	.139449	-.121161	.400058	.281203	-.072122	.634528

step	(4) fevd	(4) Lower	(4) Upper
0	0	0	0
1	.896521	.682879	1.11016
2	.893979	.668965	1.11899
3	.906363	.699987	1.11274
4	.901157	.713713	1.0886
5	.888903	.672595	1.10521
6	.884243	.665091	1.1034
7	.872434	.631519	1.11335
8	.875072	.636553	1.11359
9	.864834	.609489	1.12018
10	.864518	.60852	1.12052
11	.86237	.602177	1.12256
12	.861223	.600547	1.1219
13	.860863	.599395	1.12233
14	.860512	.599526	1.1215
15	.860551	.599942	1.12116

95% lower and upper bounds reported
(1) irfname = gdpinf, impulse = dgdp, and response = dgdp
(2) irfname = gdpinf, impulse = dgdp, and response = dinfl
(3) irfname = gdpinf, impulse = dinfl, and response = dgdp
(4) irfname = gdpinf, impulse = dinfl, and response = dinfl

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