Relationship between Inflation and Economic Growth in Ethiopia:

An Empirical Analysis, 1980-2011

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Preface

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Table contents

Preface.....II

Summary.....1

1. Introduction.....2
2. Recent Economic Growth and Inflation in Ethiopia……..4

2.1 Overview of the Economy……...……...4

2.2 Sources of the Recent Growth in Ethiopia…...……..……..….5

2.3 The Recent Inflation in Ethiopia……..……...……..7

3. Review of Related Literatures…….……..……...……10

3.1 Theoretical Review……...……10

3.2 Empirical Review……....…...13

3.3 Empirical Studies: Inflation and Economic Growth in Ethiopia……...…….....16

4. Model Specification……...…..…..……20

4.1. Stationarity Tests…….…….……20

4.1.1 The Augmented Dickey-Fuller (ADF) Test…...……..…..…….……20

4.1.2 DF-GLS Test...……..……..21

4.2. Vector Autoregression Model……...……...22

4.2.1. Granger Causality Test……....…....……..…..……23

4.2.2. Impulse Response Function……..……....……..23

4.2.3. Forecast Error Decomposition…….……..…..……24

4.3. Johansen Cointegration Test...……24

4.3.1 The Trace Statistic……...25

4.3.2 The Maximum Eigenvalue Statistic……....…….……25

4.4. Vector Error Correction Model (VECM)……....…….….25

5. Results and Discussions…….…..……27

5.1 Data Sources and Descriptions...……...…..…..……27

5.1.1 Trends of Inflation Rate…...……..…….…….…….28

5.1.2 Trends of Economic Growth..……..…….……....29

5.2. Unit Root Test Results……..…….31

5.3. Vector Autoregression (VAR) Estimation Results…….……..…….32

5.3.1 Granger Causality Test Results…..……..…….…….……35

5.3.2 Impulse Response Function Results……36
5.3.3 Error Forecast Decomposition Results……37
5.4. Cointegration Test Results……38
5.5. Vector Error Correction (VEC) Estimation Results……39
6. Conclusions……41
References……44
Data Annex……47

List of Tables

Table 2.1 Sectoral Percentage Contribution to GDP……5
Table 2.2 Sectoral Growth Rates……..6
Table 5.1 Descriptive Statistics of the Variables……27
Table 5.2 Augmented Dickey-Fuller (ADF) Unit Root Test in Level……31
Table 5.3 Augmented Dickey-Fuller Unit Root Test in Difference……31
Table 5.4 DF-GLS Unit Root Test Results ……32
Table 5.5 Lag Selection ……32
Table 5.6 LM test of Residual Autocorrelation of VAR……34
Table 5.7 Skewness and Kurtosis Test……34
Table 5.8 Granger Causality Wald Tests Results……35
Table 5.9 Forecast Error Decomposition (Fed)……36
Table 5.10 Johansen Test of Cointegration……39
Table 5.11 LM Test for Residual Autocorrelation of VEC ……40

List of Figures

Figure 5.1 Inflation Rates in Ethiopia……28
Figure 5.2 Economic Growth in Ethiopia……29
Figure 5.3 Inflation and Economic Growth ……30
Figure 5.4 Eigenvalue Stability Condition ……35
Figure 5.5 Impulse Response Function ……36
Figure 5.6 Forecast Error Decomposition…..38

Summary

Ethiopia's recent growth performance and considerable development gains are challenged by macroeconomic problem of high inflation. If high economic growth is accompanied by soaring amount of inflation, it is interesting to identify the relationship between inflation and economic growth in Ethiopia Therefore, the objective of this study is to analyze the short run and long run relationship between economic growth and inflation for the period 1980-2011.

Using Vector Autoregression (VAR) model, the short run relationship between inflation and economic growth is examined. It is shown that an increase in economic growth decreases inflation whereas inflation does not have significant effect on economic growth in the short run. I included money supply and exchange rate to control their effects on the relationship between inflation and economic growth. Increase in money supply results in a high inflation during the study period while an increase in exchange rate does not have significant effect on inflation. The earlier conclusion that an increase in economic growth indicates a fall in inflation in the short run remains the same.

Using a Granger Causality test, I showed that economic growth has forecasting power about inflation while inflation does not have predicting power about economic growth. The Impulse Response Function shows that economic growth does not indicate any response to impulse of inflation while the response of inflation rate to impulses in growth is effective up to seventh year in the future. The Forecast Error Decomposition supports the earlier conclusion which shows that more than 20 percent of inflation volatility is explained by output growth innovations. Both inflation and economic growth respond significantly to their own shocks through time.

Cointegration test shows that there exist a long run relationship between economic growth and inflation in Ethiopia. Vector error correction estimates indicate that economic growth significantly reduces inflation in short run while inflation does not have any significant effect on economic growth. If inflation had previously been larger than normal share, then economic growth causes inflation to be lower in the long run.

1. Introduction

Ethiopia is one of those countries in Sub Saharan African with moderate economic growth in recent years. Despite a series of setbacks that have kept it among Africa's poorest nations, government statistics indicate double digit growth for the past several years. International Monetary Fund (IMF) projection however shows that the country's economic growth rate is around 5 percent in 2012. The IMF lowers the forecast over the coming years, citing faster inflation and restrictions on bank lending as major causes. The World Bank in its part indicated that the country's growth rate was 7.2 percent in 2011. According to African Development Bank, the main driving force for the recent growth of the country is improvement in agricultural sector due to favorable climatic condition and improved supply of fertilizers. The growth base is also broadening with increasing contributions of service and manufacturing sector to GDP. Even if there is a dispute on the statistics by how much the country is growing, it is obvious that the country is in a good sign of economic progress.

However, the country's economic progress is accompanied by sustained inflationary problems. The country level overall inflation rate (annual change based on 12 months moving average) rose by 32.0 percent in July 2012 as compared to the one observed in a similar period a year ago. The country level food inflation increased by 39.2 percent as compared to the one observed a year ago. The country level non-food inflation rate increased by 21.5 percent in July 2012 as compared to the one observed in July 2011. The 12 months moving average inflation rate shows the longer term inflationary situation in the country (CSAE[1], 2012). It is unlikely that inflation will rapidly fall towards the growth and transformation plan goals of single digits within 2013. Instead of stimulating economic growth, inflationary pressure in Ethiopia seems to be on the verge of distorting the allocation of resources and is likely to be a deterrent to undertaking productive investments. People who are living on a fixed income are those who suffer greatly from this sustained inflation.

There are different empirical studies on the possible sources of this inflationary situation in the country. The major sources of inflation discussed in the literature are increase in money supply unwarranted by the level of output growth, the nature of investment in the country, the widening of the national deficit and ways of financing it, the inefficiency within government controlled organizations, soaring of oil prices and others (Geda and Tafere, 2008; Goodo,

[1] Central Statistics Agency of Ethiopia

2008; Seid, 2008). In contrast, the government argues that the inflation is due to rapid economic expansion that has happened in country. They also indicate that oil prices and increase in world food prices as the possible sources of the inflation.

In this context, it is interesting to know the relationship between economic growth and inflation in the country. If high economic growth is accompanied by soaring amount of inflation, what is the exact relationship between inflation and economic growth in Ethiopia? Is the relationship between these two variables robust? Does inflation level tell us something about growth in the country and vice versa? In light with these questions, the primary objective of this study is to examine the short run and long run relationship between inflation and economic growth in Ethiopia.

By estimating vector autoregression model, the short run relationship between economic growth and inflation is examined. Error correction term that measures deviations of inflation and economic growth from equilibrium is also examined to understand the long run relationship between the two variables. Impulse Response Function and Forecast Error Decomposition methods are also used to understand the responses of each variable to the impulses of other variables. STATA is used in all estimations and tests of the models.

The paper is organized into six parts. The first part is introduction which describes the situation of current inflation and economic growth in the Ethiopia. An essay on the current situation of inflation and economic growth in Ethiopia is briefed in chapter two. In the third chapter, both theoretical and empirical literatures about the relationship between inflation and economic growth in general and papers on inflation and economic growth in Ethiopia in particular are included. The model that is going to be used and its estimation mechanism is included in chapter four. Part five contains discussions of the results and finally in part six conclusions and recommendations based on the findings are included.

2. Recent Economic Growth and Inflation in Ethiopia

2.1. Overview of the Economy

Ethiopia's economy is based on agriculture, which accounts for 42 percent of GDP and 80 percent of employment. The country's five year Growth and Transformation Plan (GTP) unveiled in October 2010 presents the government led effort to achieve the country's ambitious development goals. Ethiopia's GTP over 2010-2015 emphasizes agricultural transformation and industrial development as drivers of growth. The economy continued to progress over the past six years. Moreover, growth has continued to be broad-based with industry, services and agriculture sectors gradually progressing. The agricultural sector grew by 6.4 percent as a result of the good weather in 2011. The expansion in agriculture production has been driven by increases in the area of land cultivated and favorable weather conditions in cereal growing areas, rather than major improvements in productivity. Given the current technological conditions and the structure of production, pushing the production frontier further is difficult due to the already existing pressures on the land (ADB[2], 2010).

The agricultural sector continues to face major challenges. It is extremely vulnerable to weather shocks due to dependency on rainfall, weak marketing infrastructure, limited use of improved farming practices, and rising cost of key agricultural inputs. There has been a general decline in per capita food production as high population growth rates have contributed to a decline in farm size. However, the potential for growth in agriculture is huge, especially considering that less than 15 percent of the arable land is cultivated while productivity is still among the lowest in sub-Saharan Africa. Agricultural sector growth in 2012 and 2013 is thus projected to increase gradually (ADB, 2012).

The contribution of the service sector to the country's GDP grew in the last five years. This impressive growth in services was driven by the rapid expansion in financial intermediation, public administration and retail business activities. These services sub-sectors grew by more than 10 percentage point in GDP share during the past five years. The services sector is expected to continue to grow rapidly, though at a slower pace than in previous years. The progress of industrial sector performance in 2011 was driven by gradual expansion of mining and manufacturing subsectors.

[2] African Development Bank

Although Ethiopia's industrial base is still relatively small, the growth prospects of this sector is significant, as new industries are coming on stream and new projects are planned in other areas including steel, chemicals and pharmaceuticals. This momentum is expected to continue given the priority accorded to industrialization, both for exports and import substitution, in the government's plan.

Table 2.1 Sectoral Percentage Contribution to GDP

Year	Agri .	Serv.	Indu.	Export	Import	Total Revenue	Tax Revenue
2002	43.5	42.6	13.9	12.6	26.6	12.9	9.8
2003	41.9	44	14.1	13.3	27.4	13.2	9.2
2004	44.2	41.8	14	14.9	31.6	12	9.6
2005	46.7	40.4	12.9	15.1	35.4	11	8.8
2006	47.9	39.4	12.7	13.9	36.6	8.9	8.3
2007	46.2	40.5	13.3	12.7	32	8.3	7.9
2008	43.9	43.1	13	11.4	30.8	7.8	7.4
2009	50.8	38.5	10.7	10.6	28.9	9.4	6.6
2010	47.7	38	14.3	11.4	32.5	12.1	9.8
2011	41.9	45.5	12.6	11.7	28.9	-	-

*all values are indicated as a percentage of GDP

Source: World Bank

Ethiopia's overall growth prospects are good, with public investment in infrastructure, transformation of agriculture and non-traditional exports are expected to continue driving growth. However, several risks to growth prospects exist, among them high inflation, slowdown in the global economy, and recurrence of drought.

2.2. Sources of the Recent Growth in Ethiopia

Ethiopia's recent growth performance has been associated with a number of policy successes and favorable external conditions, in addition to good weather conditions. The major sources behind the recent surge in growth are:

Investment in Major Infrastructures

The intensive investment in infrastructure has been a particularly important factor in driving growth. Over the past five years, the government and public enterprises have invested billions of Birr in roads, telecommunication, and energy sector. For example, the power generation capacity has nearly doubled and the paved road network increased three fold**.** Overall, the heavy public investment in infrastructure and social services has created a major expansion in domestic demand, raising overall growth (ADB, 2010). But, sources of financing these investments are the main factors behind the current macroeconomic problems such as inflation in the country.

Table 2.2 Sectoral Growth Rates

Year	Agriculture	Industry	Manuf.	Service	Export	Import
2000	3.1	5.4	7.5	10.0	29.3	-0.1
2001	9.6	5.1	3.6	5.2	4.9	1.0
2002	-1.9	8.3	1.3	4.3	13.3	8.8
2003	-10.5	6.5	0.8	5.9	15.3	5.3
2004	16.9	11.7	6.6	6.1	36.4	19.9
2005	13.5	9.4	12.8	12.7	3.4	23.8
2006	10.9	10.2	10.6	12.8	0.2	17.9
2007	9.4	10.2	8.4	15.2	10.4	31.4
2008	7.5	10.4	7.1	15.3	-3.4	12.6
2009	6.4	8.9	12.3	14.6	6.9	16.4
2010	5.8	8.8	9.8	14.7	14.4	15.9
2011	6.4	9.5	8.9	6.8	21.9	0.5

Source: World Bank

Expansion of Exports and Remittances

The country's exports have also been growing strongly, averaging about 11.8 percent per annum since 2002. While coffee remains the largest source of merchandize export earnings, other exports have registered faster growth. Indeed, the continued rapid expansion of the economy is likely to sustain the growth in Ethiopia's exports in the medium term. Likewise, remittances and FDI have also been growing at an impressive rate. Remittances by Ethiopians

living abroad to relatives and investment in Ethiopia have also played a significant role (ADB, 2010). Imports have been growing by about 15.3 percent on average since 2002. Except 2011, for the last five years growth of imports is more than double of exports growth which has an important implication for the high inflationary situation in the country.

Increased Tax Collection and Aid

Government revenue has increased by about 29 percent on average in 2010 compared to 2009. Tax revenue reached about 59 billion Birr in 2010 from about birr 11 billion in 2003, which makes tax revenue 9.8 percent of GDP. Official Development Assistance (ODA) has increased in recent years, reaching USD 3.5 billion in 2010 from USD 1.3 billion in 1990's (OECD, 2012). This surge in external aid, alongside improved domestic revenue mobilization, has enabled the government to increase spending on infrastructure, thereby stimulating growth.

2.3. The Recent Inflation in Ethiopia

Despite the recent economic growth, the country still faces some structural weaknesses that present significant challenges in the medium term. Its growth performance and considerable development gains is challenged by macroeconomic problem of high inflation. Pressures on prices and the balance of payment heightened as a result of the global food and economic crisis. Ethiopia's economy is highly vulnerable to exogenous shocks by virtue of its dependence on primary commodities and rain fed agriculture. It has experienced major exogenous shocks during the past five to seven years. These are notably droughts and adverse terms of trade in commodities like coffee and fuel (ADB, 2010). There is a strong correlation between weather conditions and its growth performance.

The growing domestic supply-demand gap, in the context of the surge in growth, contributed to a rise of inflation. The country level overall inflation rate (annual change based on 12 months moving average) rose by 32.0 percent in July 2012 as compared to the one observed in a similar period a year ago. The country level food inflation increased by 39.2 percent as compared to the one observed a year ago. The country level non-food inflation rate increased by 21.5 percent in July 2012 as compared to the one observed in July 2011. The 12 months moving average inflation rate shows the longer term inflationary situation (CSAE, 2012). It is unlikely that inflation will rapidly fall towards the growth and transformation plan goals of single digits within 2013.

Monetary factors played a key role in driving the inflation rate in Ethiopia. For instance, reserve money used by the National Bank as monetary policy anchor grew by 51 percent in February 2011. This was largely due to the accumulation of foreign exchange reserves without any offsetting mechanism and increased borrowing by public enterprises for infrastructure investment which in effect contributed to the increase in money supply (World Bank, 2012). Broad money-supply growth was 35 percent at the end of March 2012 which had previously projected growth of 22 percent (IMF, 2012). Such a major inflationary period could reverse the significant progress in poverty reduction in rural areas, and might exacerbate Ethiopia's chronic food insecurity.

The other important dimension of the current inflation is the huge investment in the last decade which is not warranted by the level of domestic saving. The average gross domestic saving and gross investment as percentages of GDP for the 1997-2006 period stood at 6.6 and 24 percent respectively, leading to a wider saving gap. In the last five years of the period under consideration, average domestic saving has fallen to 4.2 percent of GDP but average investment has increased to 23.9 percent of GDP (Geda, 2008). This gap has led to a widening national deficit, which in turn has implication to inflation depending on the nature of financing this deficit. Seid (2008) mentioned low interest rate, souring oil prices, increase in money supply from abroad, war expenditures, remittances, inefficiencies within party controlled organization, the monetization of food aid, and others as a possible source of the current rampant inflation in the country. The inflationary pressure in the country is due to the combination of both cost push and structural economic problems which includes increased oil prices and raw materials, increased government consumption, increase in investment demand, increase in money supply and increase in demand for goods (Goodo, 2008). On the other hand, the government argues that the cause of the inflation is due to progress in the economy, higher global food and fuel costs, but not due to loose monetary policy. The government argues that price increases in Ethiopia is imported inflation; it is not domestic-driven inflation. Oil has soared because of the Middle East problem and if that problem is sorted somehow then immediately the price will go down. So it is a temporary problem that is pushing inflation in Ethiopia.

High inflation can cause serious problems. It would bring a large distribution of income. Higher food price would hurt the urban poor who spend most of their income on food. Moreover, although it would have a positive effect on the rural food producers, it would have

an adverse effect on the rural food buyers, which may consist of about half of population in the rural Ethiopia. Thus, higher inflation, particularly through higher food price, could worsen the economic inequality. High inflation would also increase uncertainty about future inflation.

In an effort to control inflation and the rising cost of living, the government has been taking various measures including imposing tight cash controls on government expenditure, temporarily cracking down business people whom it blames for the recent inflation and increasing the salary of civil servants by 35-39 percent. According to Goodo (2008), the government targeted the wrong cause of inflation and hence its measure is bound to be counterproductive. The policy response at the time focused mostly on developments in urban areas. Goodo relates the country's inflation with fall of aggregate supply and thus, he recommends that any measure to control inflation should be around structural economic problems. In early January 2012, the National Bank of Ethiopia lowered reserve requirement after the banking sector faced severe liquidity problem. It also lowered the minimum reserve ratio of deposit from 15 percent to 10 percent, at the same time the amount of liquid assets as a proportion of deposits was also reduced from 25 percent to 20 percent. However, this measure was not accompanied by the appropriate sterilization mechanism and contributed to a sharp increase in money supply from 32 percent in December 2011 to 35 percent at the end of January 2012 (World Bank, 2012). This creates further increase in price level and also increases inflation expectation in the country.

3. Review of Related Literature

3.1 Theoretical Review

The relationship between inflation and economic growth remains controversial in both theory and empirical findings. Theoretical models analyze the impact of inflation on growth focusing on the effects of inflation on the steady state investment and output. There are different possible results of the relationship between inflation and economic growth in these theoretical models. These are positive, neutral, negative or non linear relationship between the two variables. The first result is originally related with the work of Mundell (1963) and Tobin (1965) that concludes positive relationship between economic growth and inflation.

Mundell (1963) is the first to show that expected inflation has a real economic effect using the IS-LM curves. He argues that the money rate of interest rises by less than the rate of inflation and therefore that the real rate of interest falls during inflation. He assumes that real investment depends on the real interest rate and real saving on real balances and also inflation decreases real money balances. This creates decline in wealth which in turn stimulates increased saving. He claims that the advantages and disadvantages of inflation are not only due to the failure of the community to anticipate it. Expectation of fluctuations in the rate of inflation has real effects on economic activity. When prices are expected to increase, the money rate of interest rises by less than the rate of inflation giving impetus to an investment boom and an acceleration of growth and vice versa.

Tobin (1965) assumes money as a store value in the economy and shows that inflation has positive effect on economic growth. Money serves no useful role other than as a financial capital asset like physical capital. Tobin effect suggests that inflation causes individuals to acquire more capital than holding money because money and capital ratio depends negatively on the inflation rate, which leads to greater capital intensity and promotes economic growth. Tobin's framework shows that a higher inflation rate raises the level of output. However, the effect on output growth is temporary, occurring during the transition from one steady state capital stock to another steady state capital. Output and consumption therefore rise in the steady state. He also argues that, because of the downward rigidity of prices, the adjustment in relative prices during economic growth could be better achieved by the upward price movement of some individual prices.

Drazen (1981) studies the effect of inflation on demand for capital and the aggregate capital labor ratio in a finite-horizon utility-maximization model. The result shows that deriving saving and asset choice decisions from utility maximization do not in itself lead to superneutrality and that a finite horizon is crucial in explaining this difference. It is further shown that it is possible under very general conditions to show that increases in the rate of inflation will increase the aggregate capital-labor ratio which supports the conclusion of Mundell and Tobin.

The other result is related with the idea of Sidrauski (1967). He analyzes the super neutrality in optimal control framework considering real money balances in the utility function with his seminal work on the context of an infinitely-lived representative agent. 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. The main result in Sidrauski's work is that an increase in the inflation rate does not affect the steady state capital stock because the representative individual's real discount rate is unaffected by inflation. However, some of the Sidrauski's assumption are open to criticism which includes the infinite horizon of individuals involved, individuals are identical with the same discount rate, individuals like consumption equally in each periods and others. Danthine, Doladson and Smith (1987) examine the robustness of Sidrauski result by incorporating uncertainty in the model. They find that qualitatively super neutrality fails to obtain in their model. They point out that Sidrauski's (1967) article is important for it derived a proposition on the real impact of an increasing money growth rate which was completely different from Tobin effect a dominant view at the time.

Stockman (1981) developed cash in advance transactions constraint model which considers money as complimentary to capital. Stockman assumes that firms put up some cash in financing their consumption and investment goods. Real purchases of these goods decrease with decreased of money holding. He obtains that an increase in the inflation rate results in a lower steady state level of output, since inflation erodes the purchasing power of money balances; people reduce their holding of cash and purchase of capital when the inflation rate rises. Correspondingly, the steady-state level of output falls in response to an increase in the inflation rate. This is the other possible result of the relation between inflation and economic growth in theoretical models.

Cooley and Hansen (1989) extended the cash in advance constraint model to consider capital accumulation. They assume that marginal product of capital is positively related to the quantity of labor. Thus, when the quantity of labor declines in response to a rise in inflation, the return to capital falls and the steady-state quantities of capital and output declines. Employment decreases because individuals substitute leisure for work due to inflation tax on consumption. They show that the level of output permanently falls as the inflation rate increases. Gillman, Harris and Matyas (2001) using a theoretical model with endogenous growth strengthens Stockman's result of negative relation between inflation and economic growth. They also specify an econometric model which is consistent with the result obtained in the theoretical model. Haslag (1995) also shows that in an economy in which money and capital are complimentary goods, banks pool all savers but are asked to hold money as a deposit to satisfy a reserve requirement. Hence, an increase in inflation rate decreases the return on deposits because return on deposit is an average of return on money and capital. If saving goes down due to less return on deposits, there is less amount of capital accumulation which in turn impedes economic growth.

Manuelli and Jones (1995) consider models of endogenous growth with formulation of supply of effective labor to show the effect of money growth on welfare and economic growth. They assume that demand for money is generated for transaction purpose. If nominal depreciation is included in the tax code, real marginal tax rate on investment income is altered by inflation rate. As inflation rate rises, the discounted value of depreciation tax credits decreases, and therefore the effective tax on capital income gets higher. People slow their rate of capital accumulation due lower after tax return on capital. This decreases the rate of economic growth

Recently many economists started to believe that the relationship between inflation and economic growth is not linearly related. Espinosa and Yip (1999) reviewed the interaction between inflation and growth using model of endogenous growth with explicit financial intermediation. They use risk preference as their basis for identifying the effect of one variable on another which means the relation depends on the relative risk aversion of agents. If agents are fairly risk averse, higher rate of inflation decreases economic growth. If agents relative risk aversion low enough, there is positive relationship between the two variables which is in line with convectional claims of Philips curve. Hung (2001) studies the relationship between inflation and economic growth based on a model with adverse selection

and costly state verification problems. He shows that if banking costs shows no externality, there is positive relationship between inflation and economic growth. However, if banking cost shows economies of scale, the relationship between the two variables depends on initial inflation rates. If initial inflation rate is high, an increase in inflation rate decreases economic growth and vice versa.

In general from the theoretical models discussed above, it is clear that the results depend on the assumption about the economy identified and also depend on the set up of the models. All the models try to make their conclusion in line with economic theories. Accordingly, inflation may have positive, negative, neutral or non linear relationship on economic growth in these theoretical models.

3.2 Empirical Review

Up until the mid of 1970s there was little empirical evidence for any relationship between inflation and economic growth and even there were doubts in which direction the relationship should be. Like the theoretical models, results of empirical studies change through time from the widely known traditional point of view of positive relationship between inflation and economic growth to non linear relationship in recent years. Now many economists are convinced that low but positive inflation is good for the betterment of a given economy.

The traditional point of view does not consider inflation as an important factor in growth equation. Gillman and Nakov (2003) studies effects of inflation within an endogenous growth monetary economy. The result shows that accelerating inflation raises the ratio of the real wage to the real interest rate, and so raises the use of physical capital relative to human capital across all sectors. Their result is consistent with a general equilibrium, Tobin-type, effect of inflation on input prices and capital intensity.

Nevertheless, the traditional point of view changed when high and chronic inflation was present in many countries in the 1970s. As a result, different researchers showed that inflation has a negative impact on output growth. Fisher (1993) has investigated the link between inflation and growth in time-series, cross section and panel data sets for a large numbers of countries. The main result of these works is that there is a negative impact of inflation on growth. Fisher (1993) argued that inflation hampers the efficient allocation of resources due

to harmful changes of relative prices. At the same time relative prices appear to be one of the most important channels in the process of efficient decision-making.

Barro (1996) analyses the effect of inflation and other variables like fertility, democracy and others on economic growth in different countries for a period of 30 years. He uses system of regression equation in which other determinants of growth are held constant. To estimate the effect inflation on economic growth without looking at the endogeneity problem of inflation, he includes inflation as explanatory variable over each period along with other determinants of economic growth. The result indicates that there is a negative relationship between inflation and growth with a coefficient of -0.024. One problem arising from the above conclusion is that the regression may not show causation from inflation to growth. Inflation is an endogenous variable that my respond to growth and other variables related to growth. For example an inverse relationship between inflation and growth may arise if an exogenous falling down of growth rate tended to generate higher inflation rate. He uses instrumental variables like independence of the central bank, lagged inflation and prior colonial status, each these variables are related to inflation, to avoid this problem. The result is statistically significant and strengthens the negative relationship between the inflation and growth. Thus, there is some reason to believe that the relation reflect causation from higher long term inflation to reduced growth. Finally, he concludes that even though the results looks small, the long-term effects on standards of living can be substantial.

Singh and Kalirajan (2003) using the annual data from India for the period of 1971–1998 analyze the threshold effect of inflation economic growth. The findings clearly suggest that the increase in inflation from any level has negative effect on economic growth and substantial gains can be obtained by focusing the monetary policy towards maintaining price stability. Andres and Hernando (1997) obtain a significant negative relationship between inflation and economic growth during long periods. Inflation reduces the level of investment as well as the efficiency with which factors of are used. It has a negative temporary impact on long term growth rates, which in turn generates permanent fall in per capita income. They conclude that the long run cost of inflation is large and the effort to keep inflation down will pay off in terms of better economic growth.

Faria and Carneiro (2001) investigate the relationship between inflation and output in an economy facing persistently high inflation shocks. The authors impose minimal structure and made use of the idea that inflation shocks can be broken down into permanent and temporary

components. The result indicates that in the long run the response of output to a permanent inflation shock in a high inflation country is not significantly different from zero. The results could be considered as evidence against the view that inflation and output are reliably related in the long run. These results support Sidrauski's (1967) superneutrality of money in the long-run, in that inflation does not affect growth. However, in the short run, it provides contradictory evidence against Sidrauski's model. In estimating a short run model for changes in output against changes in inflation, the authors find that inflation has negative impact on output.

Recently, numerous empirical studies found that inflation growth interaction is non linear and concave. Bruno and Easterly (1995) defining a period of inflation crisis as a period when inflation rate exceeds 40 percent, try to assess how the country perform before, during and after the crisis period. The result shows at higher level of inflation, there is a negative relationship between inflation and economic growth in which the cost of inflation will be higher. At smaller and moderate level of inflation the result is ambiguous which shows no consistent pattern. They believe that there will be recovery of the economy if there is successful reduction in inflation after the crisis. Sarel (1995) using data of 87 countries also strengthens the idea that inflation and economic growth are nonlinearly related. He finds that 8 percent is the appropriate threshold of inflation. Below the threshold, inflation has insignificant or even has little positive effect while above the threshold it has negative and significant effect on economic growth. The study also demonstrates that when the threshold is taken into account, the estimated effect of inflation on economic growth increases by a factor of three.

Khan and Senhadji (2001) analyze the threshold effect between inflation and economic growth using a data set which consists of 140 countries from a period of 1960-1998. They look at the relation between inflation and growth for developed and developing countries separately. Conditional least squares estimation method was used by forming log inflation model to avoid the strong asymmetry in inflation distribution. The empirical results suggest the existence of a threshold beyond which inflation exerts a negative effect on growth. Inflation levels below the threshold levels of inflation have no or little positive effect on growth. The result also show that the threshold is small for developed countries compared to developing countries (1-3 percent and 11-12 percent respectively) and the estimates were statistically significant.

Hwang and Wu (2011) using growth accounting equation as basis of their model examine the possible threshold effect of inflation on economic growth in China. They find that the inflation threshold effect is highly significant and robust. Above the 2.50 percent threshold level, every 1 percentage point increase in the inflation rate impedes economic growth by 0.61 percent; below this threshold, every 1 percentage point increase in inflation rate stimulates growth by 0.53 percent. This indicates that inflation harms economic growth whereas moderate inflation benefits growth in China.

There are some empirical studies on the relationship between inflation and growth in Africa. Tabi and Ondoa (2001) study the link between economic growth, inflation and money in circulation. They analyze the major importance of monetary variables on economic growth in Cameroon. Using data from 1960-2007, they constructed VAR model to identify the possible link between the variables mentioned above. The result shows that money in circulation causes growth and growth causes inflation. The interesting conclusion is that increase in money in circulation does not necessarily induce an increase in general price level. Chimobi (2010) try to ascertain if there is relationship between growth and inflation using Nigeria's consumer price index from 1970-2005. He concludes that there is no long run relationship between inflation and economic growth in Nigeria but shows that inflation has an impact on growth. Nell (2000) studies the cost and benefit of inflation by dividing the South Africa's inflationary experience into four episodes. The empirical results suggest that there is nonlinear relationship between inflation and economic growth. Within the single-digit zone inflation is beneficial to growth, while it costs in terms of slower growth at higher level. However, further results indicate that even during periods when deflationary policy yielded growth benefits as a result of a more stable economic environment, the costs of deflation outweighed the benefits. Leshero (2012) using the regression method developed by Khan and Senhadji (2001) shows that inflation threshold is 4% in South Africa. At inflation level below the threshold there is positive relationship between inflation and economic growth and the relationship is insignificant. But at inflation level above the threshold the relationship is negative and significant.

3.3 Empirical Studies: Inflation and Economic Growth in Ethiopia

Literatures on the issue of inflation and economic growth in Ethiopia are not many probably due to the fact that there was low inflation experience in the country before some years. Most of the papers focus on the source and impacts of the current rampant inflation in the country.

However, methodologies of most of the studies are theoretical description with individual argumentations.

Teshome (2011) explains the relationship between inflation and economic growth in Ethiopia using statistical analysis, even though the method he applies for the analysis is open to critique. Accordingly, he states that it is difficult to specify the exact relationship between inflation and growth. However, one must study the structure of government spending and the nature of economic growth. By comparing the rate of inflation and economic growth of Ethiopia to that of Sub Saharan Africa, he explains how inflation affects economic growth through time. Using statistical comparison of the rate of inflation and economic growth, he tries to figure out the relation between them from 2004 to 2010. Accordingly, inflation affects economic growth nonlinearly in the country. Between 2004-2006 inflation and economic growth has positive relationship while from 2006-2008 they have negative relationship. Despite the variation in the magnitude between 2008 and 2010, he states that inflation and economic growth has positive relationship.

Durevall, Loening and Birru (2010) develop error correction terms that measure deviations from equilibrium in the money market, external sector, and agricultural market to evaluate the impact on inflation of excess money supply, changes in food and non-food world prices, and domestic agricultural supply shocks in Ethiopia. Even though the paper is not about the relationship between inflation and growth, it is important mentioning it here. Their primary purpose is to show the determinants of the current rampant inflation in the country. Since Ethiopia is a developing country with large agriculture sector dominance, it is crucial to give due emphasis to food inflation. The result shows that overall inflation in Ethiopia is closely associated with agriculture and food in the economy, and that the international food crisis had a strong impact on domestic food prices in the long run. An agricultural supply shock affects food inflation in short run. The evolution of money supply does not affect food prices directly, though money supply growth significantly affects non-food price inflation in the short run.

Geda and Tafere (2008) states that the Ethiopian economy has been characterized by erratic nature of output growth as the economy have been highly dependent on fortune of nature and external shocks. Since agriculture accounted for over 50 percent of GDP for most of the recent past, whenever weather conditions turned to be unfavorable, agricultural production

contracted and GDP followed suit. With this systematic relationship between GDP (output) and rainfall there followed a systematic price trend. Prices followed the inverse of output growth trend. During years of good rainfall as output rises prices often dropped considerably. Even within any particular year prices have been lower during harvest periods. This co-movement appeared to have reversed in the post 2002 period. From 2003 onwards, output is on average reported to have grown by 11.8 percent per annum. Despite this reported significant increase in output (especially in agriculture) prices continued to rise. Thus, during the same period the general price level has recorded an average annual rise of 12 percent. The 2007 budget year alone witnessed prices jump by 18.4 percent, the food inflation being 49 percent in August 2008. This co-movement that contradicts the hither too pattern of negative co-movement in price and output growth has puzzled many and led many more to suspect the credibility of the stories of fast economic growth (and hence the official data) over the past five years.

Getachew (1996) in his study of inflation in Ethiopia using monthly data from July 1990 to February 1995 found that in the short run money stock has been significant determinant of inflation in Ethiopia. In the long run he founds that inflation in Ethiopia is determined by supply factors. He recommends that in the short run controlling money supply is important to control inflation while in the long run he suggests that removing the bottlenecks of the supply side of the economy should be policy priority. The short conclusion of Getachew is supported by the findings of Yohannes (2000) in which money supply is the basic determinant of inflation in Ethiopia. He also shows that inflation inertia and world inflation level affect the country's inflation in the short run. Yohannes argues that controlling inflation is not the feasible policy instead the government should have to focus on solving the supply side problem of the economy.

Desta (2009) argues that using the full-employment model, it is possible to assume that if a nation achieves full employment, economic growth is likely to precipitate an inflationary situation. Since the 10 percent increase in nominal GDP cannot keep pace with a 40 percent inflation rate, the acceleration of economic growth seems to be overstated. In fact, it is possible to assert that double digit inflation in Ethiopia is nothing but a clear sign of an unhealthy economy. The inflationary situation in a country could have a negative-structural-break effect on economic growth, if the sustained increase in prices is more than 15 percent.

Finally, Loening and Takada (2008) study the dynamics of inflation in short run using error correction model fitted with monthly observations. The result shows that increased money supply and the nominal exchange rate significantly affect inflation in the short run and that monetary policy in Ethiopia triggers price inertia, which has large and persistent effects. A simulation suggests that monetary policy alone may be unfeasible to control inflation effectively. To circumvent an extreme tightening with discouraging impacts on growth, additional measures are needed. These should improve the transparency and credibility of monetary policy, and reduce structural barriers that affect price formation and market efficiency.

4. Model Specification

In this study, time series data are used to analyze the relationship between inflation and economic growth in Ethiopia for the period 1980-2011. In econometric analysis when time series data are used the preliminary statistical step is to determine the order of integration of each time series used. A time series Y_t is stationary if its probability distribution does not change over time, that is, if the joint distribution of $(Y_{s+1}, Y_{s+2}, \ldots, Y_{s+T})$ does not depend on s; otherwise, Y_t is said to be non stationary. If the series is not stationary, then inference procedures are invalid. Results derived from the regression models would produce spurious results if non stationary data is used. Therefore, the first task is to check for the existence of stationarity property in the series of growth rate and inflation rate. To check the stationarity of the data the Augmented Dickey-Fuller (ADF) test is applied.

4.1 Stationarity Tests

4.1.1 The Augmented Dickey-Fuller (ADF) Test

The Augmented Dickey-Fuller (ADF) test for autoregressive unit root tests the null hypothesis H_0: μ=0 against the one sided alternative H_1: μ< 0 in the regression

$$\Delta Y_t = \beta_0 + \mu Y_{t-1} + \delta_1 \Delta Y_{t-1} + \delta_2 \Delta Y_{t-2} + \cdots + \delta_p \Delta Y_{t-p} + u_t \quad (1)$$

Under the null hypothesis μ=0, Y_t has a unit root; under the alternate hypothesis, Y_t is stationary. The ADF statistic is the OLS t-statistic testing μ=0 in the equation above. If instead the alternate hypothesis is that Y_t is stationary around a deterministic linear time trend, then this trend t (the period number), must be added as an additional regressor in which case the Dickey-Fuller regression becomes

$$\Delta Y_t = \beta_0 + \alpha t + \mu Y_{t-1} + \delta_1 \Delta Y_{t-1} + \delta_2 \Delta Y_{t-2} + \cdots + \delta_p \Delta Y_{t-p} + u_t \quad (2)$$

Where α is an unknown coefficient and the ADF statistic is the OLS statistic testing μ=0 in the above equation. The lag length p can be chosen using the Akaike's Information Criteria (AIC) because it known as the best information criteria to use. Burnham and Anderson (2004) argue that AIC has theoretical as well as practical advantage because it is derived from principles of information criteria. Yang (2005) also argues that the rate at which AIC converges to the optimum is the best possible. The general form for calculating AIC is

$$\text{AIC} = \frac{2p}{T} - \frac{2lnL}{T} \quad (3)$$

Where L is likelihood value, p is the number of parameters and T is number of observation. Given a set of candidate values for the data, the preferred value is the one with the minimum AIC value.

The ADF test does not have a normal distribution under the null hypothesis, even in large samples. Critical values for the one sided ADF test depends on the first two equations used above. The null hypothesis of non-stationarity is tested using the t-statistic with critical values calculated by MacKinnon. The null hypothesis that Y_t is non-stationary time series is rejected if μ are less than zero and statistically significant for each. The ADF test is unable to distinguish well between stationary and non stationary series with a high degree of autoregression. For example inflation, which is highly autocorrelated, is in fact stationary although the ADF test shows that it is non stationary. The ADF test may also incorrectly indicate that a series contain a unit root when there is a structural break in the series (Culver and Papell, 1997). Given the inherent weakness of this test to distinguish between the null and the alternative hypotheses, DF-GLS test is also used.

4.1.2 DF-GLS Test

I also use the modified Dickey–Fuller test proposed by Elliott, Rothenberg and Stock. Essentially the test is an augmented Dickey–Fuller test except that the time series is transformed via a generalized least squares (GLS) regression before performing the test. Elliott, Rothenberg and Stock and later studies have shown that this test has significantly greater power than the previous versions of the augmented Dickey–Fuller test.

DF-GLS performs the test for the series of models that include 1 to k lags of the first differenced, detrended variable, where k can be set by the user. The test is performed on equation 1 above as the ADF test except that it uses a detrended data. The null hypothesis of the test is that Y_t is a random walk, possibly with drift while the alternative hypothesis is that Y_t is stationary.

If the data are stationary in a level, estimations of the models proceed using the variables in a level. But if the time series variables are non stationary, problems of using it are avoided by taking the difference of the variable depending on the results of unit root test. Then, a Vector Autoregression (VAR) model is used to forecast inflation from the lagged values of its own

and the lagged value of GDP growth rate and vice versa, to use Impulse Response Function and Forecast Error Decomposition

4.2 Vector Autoregression Model

A Vector Autoregression (VAR) expresses each variable as a linear function of its own past values, the past values of all other variables being considered, and a serially uncorrelated error term. It is a set of k time series regression in which the regressors are lagged values of all k series. When the number of lags in each of the equations is the same and is equal to p, the system of the equation is called a VAR (p).

VAR with two time series variables consists of two equations

$$G_t = \beta_{10} + \beta_{11}G_{t-1} + \cdots + \beta_{1p}G_{t-p} + \alpha_{11}I_{t-1} + \cdots + \alpha_{1p}I_{t-p} + u_{1t} \quad (4)$$

$$I_t = \beta_{20} + \beta_{21}G_{t-1} + \cdots + \beta_{2p}G_{t-p} + \alpha_{21}I_{t-1} + \cdots + \alpha_{2p}I_{t-p} + u_{2t} \quad (5)$$

Where the β's are unknown coefficients and u_{1t} and u_{2t} are error terms.

The errors terms in these regressions are the "surprise" movements in the variables, after taking its past values into account. If the different variables are correlated with each other, as they typically are in macroeconomic applications, then the error terms in the model will also be correlated across equations.

The number of lagged values to include in each equation can be determined by different methods. The F-statistic approach or the Information Criterion approach can be used to determine the number of lags to be included in VAR model. The F-statistic approach starts with model of many lags and performs hypothesis test on the last lag. If the last lag is significant at the respective significance level, then the lag will be included in the model. Otherwise, the lag will be dropped from the model and proceeds to test the next lag and continue until lag that is significant will be obtained. The AIC approach is also applied to choose the lag length of the VAR model.

One application of VAR in time series forecast is to test whether the lags of included variable has useful predictive content above and beyond others variables in the model. The claim that a variable has a predictive content corresponds to the null hypothesis that the coefficients on all

lags of that variable are different from zero. Granger causality test is used to know the predictive content of regressors.

4.2.1. Granger Causality Test

Granger Causality test examines whether lagged values of one variable helps to predict another variable. It is the F statistic testing the hypothesis that the coefficients on all the values of one variables in the above equation (for example the coefficients on $I_{t-1}, \dots, I_{t-p}$) are zero. Granger causality means that if I_t Granger causes G_t, then I_t is useful predictor of G_t whereas past values of G_t don't help to predict I_t when controlling for past values of I_t. It does not mean that change in I_t causes subsequent change in G_t. Therefore, in the VAR model we can identify whether inflation predicts GDP growth or GDP growth predicts inflation using Granger Causality test.

As it is hard to interpret parameters of VAR model directly, it is common to use the Impulse Response Function and Forecast Error Decomposition of the variables.

4.2.2. Impulse Response Function (IRF)

Impulse responses trace out the response of current and future values of each of the variables to a one 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. More generally, an impulse response refers to the reaction of any dynamic system in response to some external change. According to Hamilton (1994), a VAR can be written in vector Moving Average (MA) form as follows

$$\boldsymbol{Y_t} = \boldsymbol{\beta} + \boldsymbol{\varepsilon_t} + \boldsymbol{\alpha_1 \varepsilon_{t-1}} + \boldsymbol{\alpha_2 \varepsilon_{t-2}} + \cdots \quad (6)$$

Thus, the matrix $\boldsymbol{\alpha}_s$ has the interpretation $\partial \mathbf{Y}_{t+s} / \partial \boldsymbol{\varepsilon}'_t = \boldsymbol{\alpha}_s$ that is, the row i, column j element of $\boldsymbol{\alpha}_s$ identifies the consequences of one unit increase in the j'th variable's innovation at date t (ε_{jt}) for the value of the i'th variable at time t+s ($Y_{i(t+s)}$), holding all other innovations at all dates constant.

A plot of $\frac{\partial Y_{i(t+s)}}{\partial \varepsilon_{jt}}$ as a function of s is called the impulse response function. It describes the response of $Y_{i(t+s)}$ to a one-time impulse in ε_{jt} with all other variables dated t or earlier held constant. So, this method is used to know the consequences of one unit increase in inflation on current and future values of GDP growth and vice versa

4.2.3. Forecast Error Decomposition

Forecast Error Decomposition indicates the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. 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. This method is used to know the forecast error of rate inflation explained by exogenous shocks to GDP growth rate and vice versa.

After estimation of a VAR model, it is advisable to check if the disturbances of the model are not autocorrelated and normally distributed and it is also important to check if the estimations of the VAR model are stable. The Lagrange Multiplier (LM) method is used to check if the disturbances of the VAR model are not autocorrelated. The normality of the disturbances after VAR is checked by skewness and kurtosis test statistic and the stability of the VAR is checked by eigenvalue stability conditions.

4.3 Johansen Cointegration Test

Test of cointegration is performed to know if there is long run relationship between inflation and economic growth in Ethiopia. When two series has the same stochastic trend, they are said to be cointegrated. Johansen Cointegration test depends on his Maximum Likelihood (ML) estimator of the parameters of the following VEC model of two cointegrating variables.

$$\Delta \boldsymbol{x}_t = \boldsymbol{\sigma}\boldsymbol{\delta}' \boldsymbol{x}_{t-1} + \sum_{i=1}^{p-1} \boldsymbol{\mu_i} \Delta \boldsymbol{x}_{t-i} + \boldsymbol{\varepsilon}_t \qquad (7)$$

where $\boldsymbol{x}_t = \begin{pmatrix} G_t \\ I_t \end{pmatrix}$ is a (2 x 1) vector of I(1) variables, $\boldsymbol{\sigma}$ and $\boldsymbol{\delta}$ are (2 x r) parameter matrices with rank r < 2, $\boldsymbol{\mu}_i$ are (2 x 2) matrices of parameters, and $\boldsymbol{\varepsilon}_t$ is a (2 x 1) vector of normally distributed errors. Let π_1 and π_2 be the two eigenvalues of sample variance covariance matrices and used in computing the log likelihood at the optimum and assume the eigenvalues are sorted from the largest π_1 to smallest π_2. If there are r < 2 cointegrating equations, $\boldsymbol{\sigma}$ and $\boldsymbol{\delta}$ have rank r and the eigenvalue π_2 is zero. Johansen derives the following two Likelihood Ratio (LR) tests for choosing the ranks of the above VEC model.

4.3.1 The Trace Statistic

The null hypothesis of the trace statistic is that there are no more than r cointegrating relations. Restricting the number of cointegrating equations to be r or less implies that the remaining 2-r eigenvalues are zero. Johansen derives the distribution of the trace statistic

$$-T\sum_{i=r+1}^{2}\ln(1-\hat{\pi}_i) \quad (8)$$

Where T is the number of observations and the $\hat{\pi}_i$ are the estimated eigenvalues used in computing the log likelihood. For any given value of r, large values of the trace statistic are evidence against the null hypothesis that there are r or fewer co integrating relations in the VEC model.

4.3.2 The Maximum Eigenvalue Statistic

The alternative hypothesis of the trace statistic is that the number of cointegrating equations is strictly larger than the number r assumed under the null hypothesis. Instead, in the maximum eigenvalue test statistic, we could assume a given r under the null hypothesis and test this against the alternative that there are r+1 cointegrating equations. Johansen derives an LR test of the null of r cointegrating relations against the alternative of r+1 cointegrating relations. Johansen derives the distribution of the trace statistic

$$-Tln(1-\hat{\pi}_{r+1}) \quad (9)$$

Where T is the number of observations and the $\hat{\pi}_i$ are the estimated eigenvalues used in computing the log likelihood.

4.4 Vector Error Correction Model (VEC)

There can be a long run relationship between two series in a bivariate relationship if each series is integrated of the same order or have the same stochastic trend. If I_t and G_t are co integrated, the first difference of I_t and G_t can be modeled using a VAR, augmented by including G_{t-1}-πI_{t-1} as an additional regressor. VEC with two time series variables is:

$$\Delta G_t = \beta_{10} + \beta_{11}\Delta G_{t-1} + \cdots + \beta_{1p}\Delta G_{t-p} + \alpha_{11}\Delta I_{t-1} + \cdots + \alpha_{1p}\Delta I_{t-p} + \delta_1(\mathrm{G}_{t-1} - \pi I_{t-1}) + u_{1t} \quad (10)$$

$$\Delta I_t = \beta_{20} + \beta_{21}\Delta G_{t-1} + \cdots + \beta_{2p}\Delta G_{t-p} + \alpha_{21}\Delta I_{t-1} + \cdots + \alpha_{2p}\Delta I_{t-p} + \delta_2(\mathrm{G}_{t-1} - \pi I_{t-1}) + u_{2t} \quad (11)$$

Where Δ is difference operator, $(G_{t-1} - \pi I_{t-1})$ is the error correction term and u_t is random term.

In VEC model, past values of the error correction term help to predict future values of ΔY_t and ΔX_t. It describes how variables behave in the short run being consistent with the long run cointegrational relationship. A significant coefficient of the error correction term indicates any short term fluctuations between the independent variable and dependent variable will give rise to a stable long run relationship. To identify the long run relationship between inflation and economic growth in Ethiopia, this model is applied.

5. Results and Discussions

5.1 Data Sources and Descriptions

The data in this thesis are taken from the World Economic Outlook (WEO) database of the IMF. The database contains selected macroeconomic data series from the statistical appendix of the World Economic Outlook report, which presents the IMF staff's analysis and projections of economic developments at the global level, in major country groups and in many individual countries. Although national statistical agencies are the ultimate providers of historical data and definitions, international organizations are also involved in statistical issues, with the objective of harmonizing methodologies for the compilation of national statistics, including analytical frameworks, concepts, definitions, classifications, and valuation procedures used in the production of economic statistics. The WEO database reflects information from both national source agencies and international organizations

GDP Growth (G_t) is annual percentages change of constant price GDP from 1980-2011. Expenditure-based GDP is total final expenditures at purchasers' prices (including the f.o.b. value of exports of goods and services), less the f.o.b. value of imports of goods and services. Gross value of the GDP is expressed in billions of Birr (local currency of the country).

Inflation Rate (I_t) is the annual percentage change in consumer price index (CPI) in Ethiopia from 1980- 2011. 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 all change at the same rate, a price index can only reflect their average movement. 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, or percentage, change in prices from this price reference period. CPI is expressed in averages of the year in the data.

Table 5.1 Descriptive Statistics of the Variables

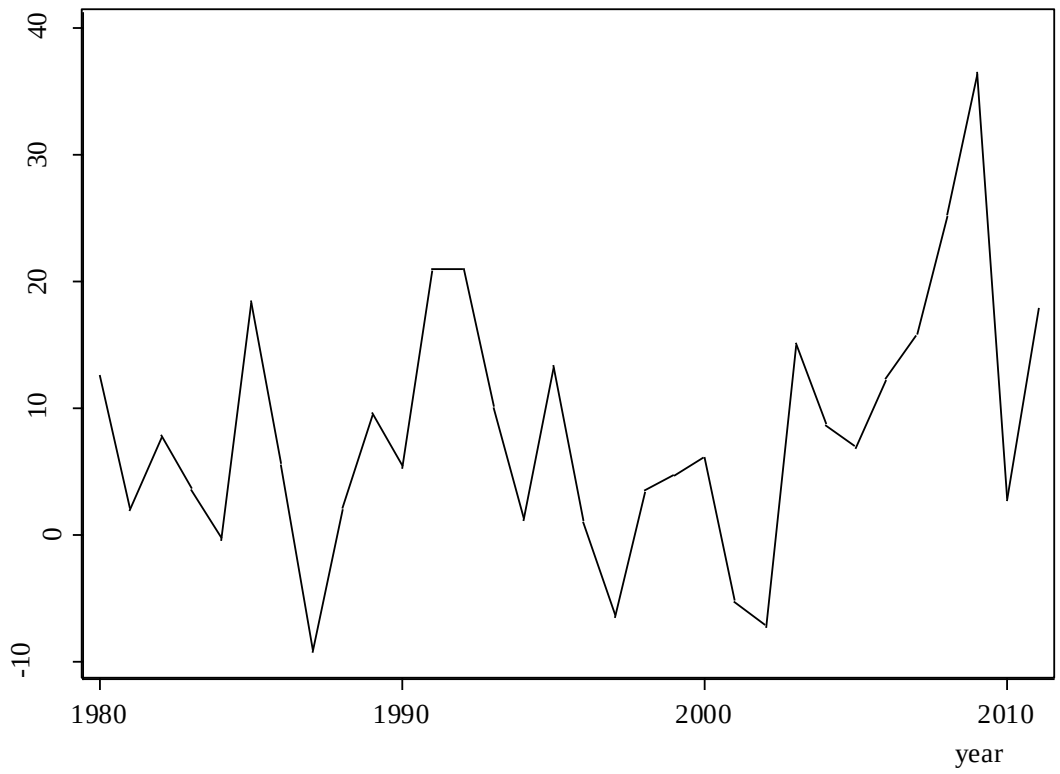
Variable	Obser.	Mean	Std.deviation	Min	Max
GDP growth (G_t)	32	4.63	6.80	-11.41	13.87
Inflation(I_t)	32	8.17	9.96	-9.146	36.399

The table shows that output grows at an average rate of 4.63 percent from 1980-2011 in Ethiopia. However, the average of inflation rate is more than the average of output growth with a maximum value of up to 36.4 percent. The standard deviation shows that the spread of inflation from its mean is higher than the spread of economic growth.

5.1.1 Trends of Inflation Rate

Trends of inflation show moderate ups and downs from 1980 to 2002 with exceptions of 1985, 1991-92, 1998 and 2003. In 1985 there was a devastating drought which claims the life of many Ethiopian and also created the current image of the country in the world. Since the country depends on rain fed agriculture as a main source of income, the drought diminished output growth which in turn has a significant influence on the increment of inflation by around 18 percent. In 1991-92 there was a political transition in country. It was a time when a group of guerilla fighters overthrow the extreme dictatorial government which ruled the country for 17 years and later in 1998 there was a war with Eritrea which also affected progress of the economy.

Figure 5.1 Inflation Rate in Ethiopia

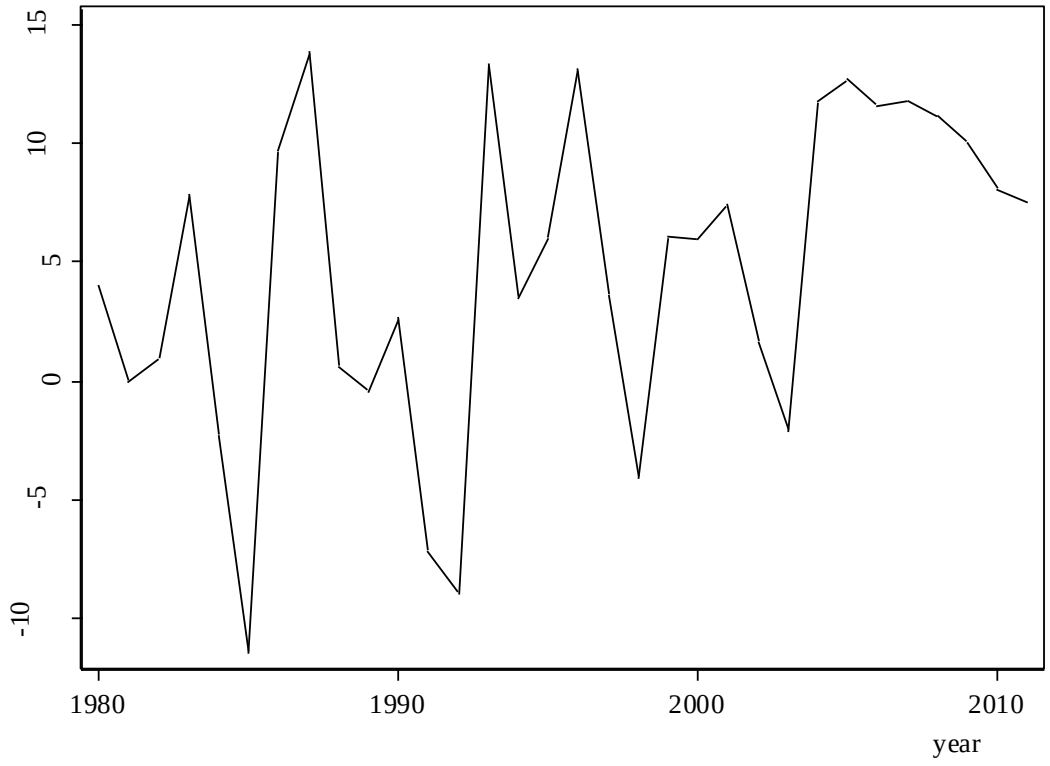


During these periods economic growth declined and the rate of inflation climbed to over 20 percent due to supply shortages and devastation by war. Aisen and Veiga (2005) explain that higher numbers of cabinet changes or government crises during war greatly affect the way governments conduct monetary and fiscal policies, generating higher inflation. In 2003 the economy again suffered from drought which resulted in a fall of GDP. This in turn increased the inflation level by over 15 percent compared to the preceding year. After that, the inflation rate never returned back to its previous levels. The major sources which make the inflation rate to increase at an alarming rate includes increase in money supply, the nature of investment in the country, widening of the national deficit and ways of financing it, and others (Geda and Tafere, 2008; Goodo, 2008; Seid, 2008).

5.1.2 Trends of Economic Growth

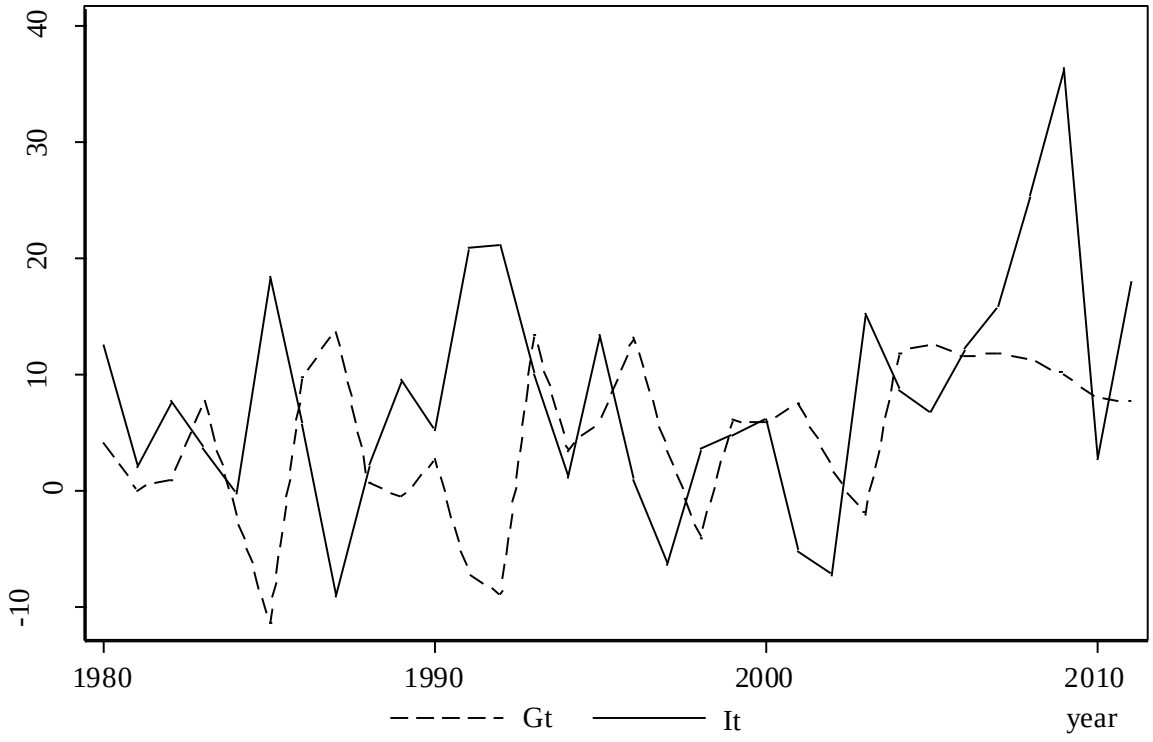
Trends of GDP growth look the same with trends of inflation rate. The rate of change of the economy declines four times from 1980 to 2011 because of the combined effects of internal conflict, war and drought. As mentioned earlier, the first was during the disastrous drought in the country with GDP declined by 3 percent and over 11 percent consecutively for two years. After that production started to increase probably due to the good fortune of weather.

Figure 5.2 Economic Growth in Ethiopia



The second contraction of economy was due to political instability in the country in 1991-92. The country was in political transition from military junta to a group of guerilla fighters and since the country did not have appropriately running government, production of the economy suffered greatly. The third contraction of the GDP was observed during the Ethio-Eriterian war of 1998-2000. It is obvious that during war some resources of the economy are diverted to sustain the war. This greatly harms economy of one country especially poor countries like Ethiopia. The fourth contraction of the economy occurred in 2003 when drought has occurred due to shortage of rainfall all over the country. As mentioned earlier agriculture employs majority of labor force and it has the highest share in GDP of the country. The country depends greatly on the good outcomes of agriculture. In general, rate of economic growth and rate of inflation moves with the same trend as shown below on the graph.

Figure 5.3 Inflation and Economic Growth



5.2 Unit Root Test Results

Stationarity of the data is checked using the Augmented Dickey-Fuller (ADF) test. The null hypotheses of a random walk (H0: $\mu=0$) against the alternate hypothesis of a stationary process (H1: $\mu<0$) is tested by using Dickey and Fuller critical value.

Table 5.2 Augmented Dickey-Fuller (ADF) Unit Root Test in Level

Variables in level	Computed ADF at lag(constant only)		Computed ADF at lag (constant and trend)	
	1	2	1	2
G_t	-4.075**	-2.012	-5.434**	-2.968
I_t	-3.058*	-1.512	-3.354	-1.893
Critical values at 1% significance level	-3.716	-3.723	-4.334	-4.343
Critical values at 5% significance level	-2.986	-2.989	-3.580	-3.584

*=reject the null hypothesis at 5% significance level
**=reject the null hypothesis at 1% significance level

Results of the stationarity test indicate that inflation is non stationary at both significance levels. However, GDP growth is nonstationary at both significance levels only if we use two lags. Based on the lag selection criteria discussed in chapter 4 (AIC), two lags of the autoregressive variable best describes the data. Therefore, we cannot reject the hypothesis that both variables are nonstationary if we use two lags in the ADF test. The next task is to check if the variables are stationary in difference. The same test is used to check stationarity of GDP growth and inflation in difference.

Table 5.3 Augmented Dickey-Fuller Unit Root Test in Difference

Variables in differences	Computed ADF at lag(constant only)		Computed ADF at lag (constant and trend)	
	1	2	1	2
ΔG_t	-4.075	-3.997	-5.434	-3.928*
ΔI_t	-7.032	-4.112	-7.018	-4.070*
Critical values at 1% significance level	-3.723	-3.730	-4.343	-4.352
Critical values at 5% significance level	-2.989	-2.992	-3.584	-3.588

*=reject the null hypothesis at 5% significance level

Results of the unit root test show that the variables should be stationary in difference at both lags except that GDP growth in difference is only stationary at 5 percent significance level when we use two lags. Therefore, the two variables can be modeled as I (1). If a variable is non stationary at level and stationary in differences, it is said to be integrated of order one I (1). To cross check the result of the above test, the DF-GLS test is also applied.

Table 5.4 DF-GLS Unit Root Test Results

Dependent Variable	DF-GLS test statistic at the Optimal lag using			Critical Values at 5% S. level		
	Ng-Perron	SIC	AIC	Ng-Perron	SIC	AIC
G_t	-3.196	-3.606*	-2.295	-3.199	-3.428	-3.322
I_t	-	-2.545	-1.664	-	-3.428	-3.322
ΔG_t	-6.379	-6.379	-3.162	-3.428	-3.428	-3.322
ΔI_t	-5.294	-5.294	-3.162	-3.428	-3.428	-3.322

*reject the null hypothesis at 5% significance level

The results confirm our earlier conclusion that the variables should be non stationary in level and stationary in differences. Therefore we continue to estimate a VAR model by differencing the variables only once because they are integrated of order one.

5.3 Vector Autoregression (VAR) Estimation Results

Both GDP growth and inflation rate are stationary in first differences. Before estimating the VAR model, the first task is to choose the number of lags that should be included in the model. Based on the AIC criteria discussed in chapter three, two lags are chosen.

Table 5.5 Lag Selection

Lag	LR	df	p	AIC
0	-	-	-	14.958
1	19.472	4	0.001	4.533
2	10.373	4	0.035	14.445*
3	2.7101	4	0.607	14.641

*= lag with minimum AIC

Estimation results of a VAR model for inflation and economic growth with two lags are shown below.

$$\Delta I_t = 0.789 - 0.558\Delta G_{t-1} + 0.0285\Delta G_{t-2} - 0.571\Delta I_{t-1} - 0.324\Delta I_{t-2} \quad (1)$$

(t value) 0.47 -2.17* 0.11 -3.01* -1.35

R squared= 0.43 chi2= 18.195 prob > chi2= 0.0011

$$\Delta G_t = 0.32 - 0.303\Delta G_{t-1} - 0.461\Delta G_{t-2} + 0.194\Delta I_{t-1} + 0.096\Delta I_{t-2} \quad (2)$$

(t value) 0.27 -1.70 -2.47 1.47 0.58

R squared= 0.46 chi2= 20.82 prob > chi2= 0.0003

Chi-Square test cannot reject the claim that at least one of the predictors' regression coefficient is not equal to zero in the model.

The first equation indicates that economic growth has negative short run effect on inflation during the sample period of 1980-2011. The result is statistically significant at 5 percent significance level. However, the second equation shows that effects of inflation on economic growth in Ethiopia are statistically insignificant at 5 percent significance level. The joint hypothesis test that both lagged value of inflation does not have any effect on economic growth supports the finding. We cannot reject the null hypothesis that states the coefficients of both lagged values of inflation are not significantly different from zero.

Literatures about inflation in Ethiopia indicate that an increase in money supply and exchange rate are the major sources of inflation in the country. Thus, I included money supply in a level and twice differenced exchange rate to control their effects on the relationship between inflation and economic growth. Increase in money supply results in a high inflation during the study period while an increase in exchange rate does not have significant effect on inflation. The earlier conclusion that an increase in economic growth indicates a fall in inflation remains the same.

After estimation of a VAR model, it is advisable to check if the disturbances of the model are not autocorrelated. If the disturbances are autocorrelated, it shows that there are some variables missing or there is some misspecification of the VAR model. The LM test for

autocorrelation in the residuals of a VAR model discussed in Johansen (1995) is implemented. The null hypothesis of the test is that there is no autocorrelation at lag j.

Table 5.6 LM Test of Residual Autocorrelation of VAR

Lags	chi2	df	Prob > chi2
1	1.4747	4	0.83112
2	3.1486	4	0.53327
3	3.9620	4	0.41118
4	5.7421	4	0.21926
5	0.7426	4	0.94598

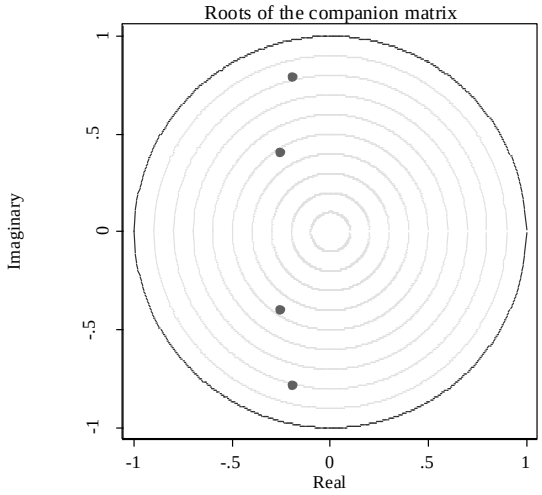
From the above table, since we cannot reject the null hypothesis that there is no autocorrelation in the residuals up to a maximum of five lags, this test gives no suggestions of model misspecification. It is also important to know if the disturbances in the VAR model are normally distributed since the sample size is small. The skewness and kurtosis test statistic are used to check the normality of the disturbances. The null hypothesis of the test is that the disturbances in the VAR are normally distributed. Both results of the skewness and kurtosis test statistic show that the disturbances in the VAR model are normally distributed for the single and joint equations because the null hypothesis cannot be rejected at 5 percent significance level. This shows that there is no misspecification in the model.

Table 5.7 Skewness and Kurtosis Test

Equation	Skewness test statistic			Kurtosis test statistic		
	chi2	df	prob>chi2	chi2	df	prob>chi2
ΔG_t	1.903	1	0.16769	0.159	1	0.69008
ΔI_t	3.277	1	0.07024	4.582	1	0.07124
ALL	5.181	2	0.07499	4.741	2	0.09341

Finally, the stability conditions of the VAR model estimated should be checked using the eigenvalue stability condition. If the VAR is stable, impulse response functions and forecast error variance decompositions have known interpretations. Hamilton (1994) shows that if the modulus of each eigenvalue of companion matrix is strictly less than one, the estimated VAR is stable. A companion matrix is a coefficient matrix which is obtained while rewriting a VAR(p) as VAR(1).

Figure 5.4 Eigenvalue Stability Condition



Because the modulus of each eigenvalue lies within a unit circle, the estimates of the VAR model satisfy the eigenvalue stability condition.

5.3.1 Granger Causality Test Results

The result of a Granger causality test shows that economic growth Granger-cause inflation at 10% significance level in a sense that lagged values of economic growth have an incremental forecasting power when added to equation of inflation rate in univariate autoregressive model.

Table 5.8 Granger Causality Wald Tests Results

Equations	Variables Excluded	Chi2	df	Prob > chi2
ΔG_t	ΔI_t	2.1833	2	0.336
ΔI_t	ΔG_t	4.9024	2	0.086*

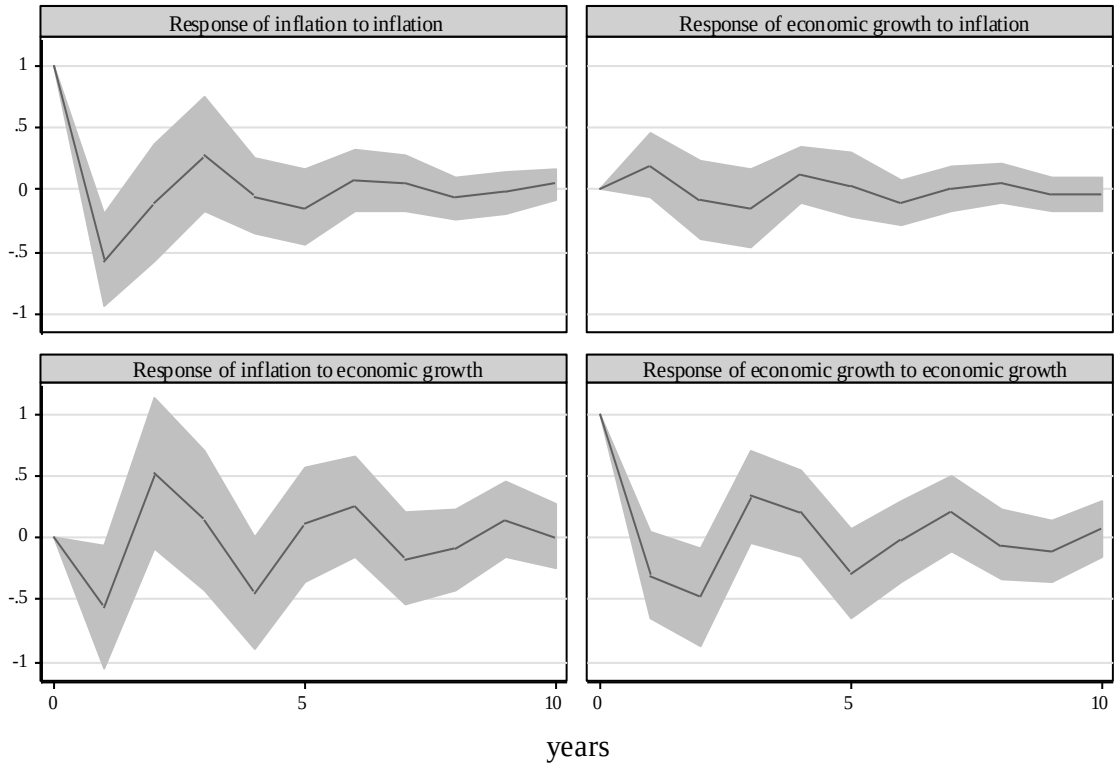
*reject the null hypothesis

In contrast inflation rate does not Granger-causes economic growth at any traditional significance level. This means that inflation rate does not predict anything about the short run properties of economic growth while the latter significantly suggest something about short run behavior of inflation rate in Ethiopia during the study period of 1980-2011

5.3.2 Impulse Response Function Results

The VAR model allows us to study the impulse response of endogenous variables to onetime shock of other variables in the model. The following figure shows the impulse response of inflation to shock observed on economic growth and vice versa. It also shows the effect of one time shock to one of the innovations on current and future values of the variable itself. From the figure it is clear that economic growth does not respond well for any impulse from inflation which supports our earlier VAR finding that inflation does not Granger-cause economic growth. However, the response of inflation rate to shocks in growth is effective up to seventh year in the future. After that it gradually shows almost insignificant responses to shocks of growth rate. This is also in line with our earlier finding that economic growth Granger-causes inflation in the country. The response of each variable to its own shocks is also effective up to some years in the future.

Figure 5.5 Impulse Response Function



The shaded area shows a 95 percent confidence interval level.

5.3.3. Forecast Error Decomposition Results

Forecast error decomposition measures the contribution of each type of shock to the forecast error variance. It helps to determine the proportion in the total variance of one variable explained by innovations in the volatility of the other variables. Table 5.9 shows the forecast error decomposition of the variables.

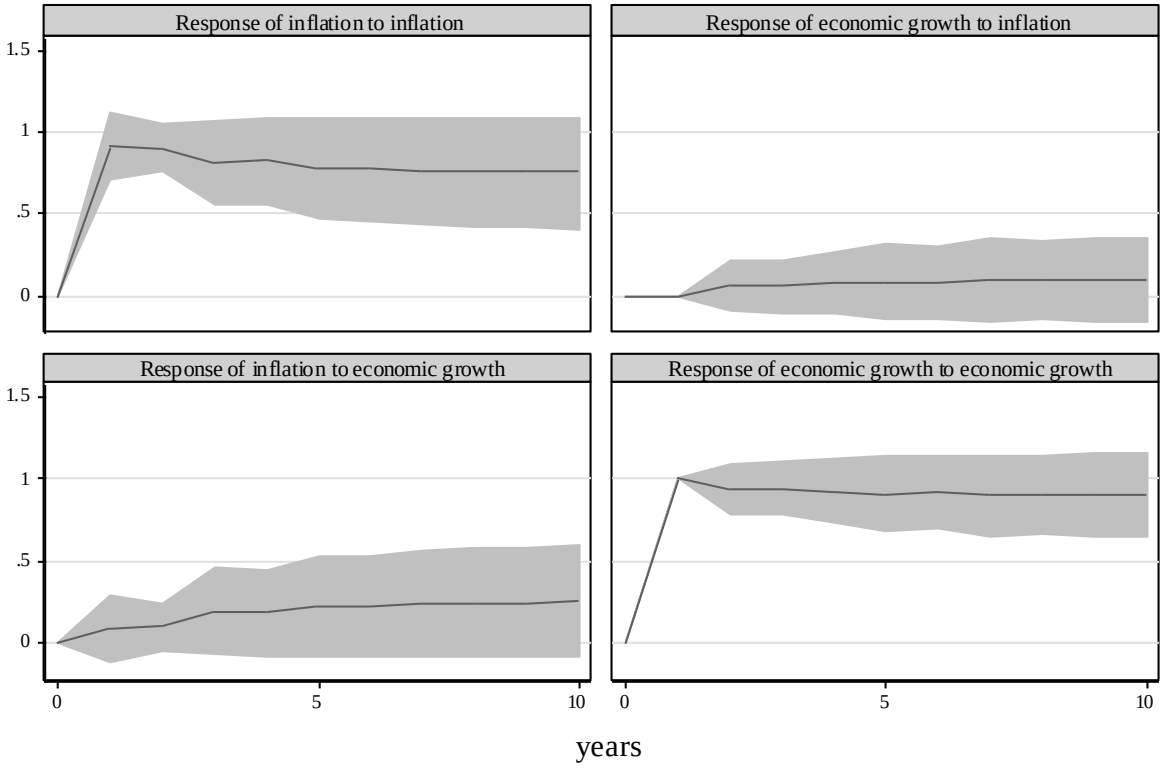
The results show that the variance of inflation in Ethiopia is much explained by innovations of volatility to economic growth. In the first period, around 8 percent of volatility in inflation is explained by shocks to economic growth. Through time more than 20 percent of inflation volatility is explained by output growth innovations. This tends to support the historical events happened earlier that significantly reduced economic growth of the country with a consequences of high inflation. For example in 1985 and 2003 when the country was affected by severe drought, there was a negative shock to output growth which resulted in high level of inflationary period. As discussed in the VAR model, the volatility of growth is less explained by volatility of inflation. However, as time horizon increases the responsiveness of economic growth to innovations in inflation shocks increases and remains below 10 percent in the coming ten years.

Table 5.9 Forecast Error Decomposition (Fed)

Period	Fed of Growth		Fed of Inflation	
	Growth	Inflation	Growth	Inflation
1	1	0	.089304	.910696
2	.941779	.058221	.101357	.898643
3	.943454	.056546	.191396	.808604
4	.926052	.073948	.182131	.817869
5	.91118	.08882	.224173	.775827
6	.913694	.086306	.228002	.771998
7	.903547	.096453	.237478	.762522
8	.905437	.094563	.245022	.754978
9	.902079	.097921	.245363	.754637
10	.901693	.098307	.250143	.749857

The forecast error decomposition can also be shown graphically as follows. The graph shows that economic growth is almost non responsive to shocks of inflation over the time horizon. Both inflation and economic growth respond significantly to their own shocks through time. The shaded area shows a 95 percent confidence interval level.

Figure 5.6 Forecast Error Decomposition



5.4. Cointegration Test Results

Before proceeding to estimate vector error correction model, the first task is to check whether the two variables are cointegrated. If the two variables are cointegrated of the same order, then there is a long run relationship between the two variables. Table 5.10 below shows the result of cointegration test using Johansen (1995) trace statistic and maximum eigenvalue statistic.

Table 5.10 Johansen test of cointegration

		Lags used while estimating the statistic			Critical value at 5% s. level
		0	1	2	
Trace statistic at rank	0	19.5514	33.1719	19.5514	20.04
	1	3.4585	10.5236*	3.4585	6.65
Max statistic at rank	0	16.0929	22.6483	16.0929	14.07
	1	3.4585	10.5236*	3.4585	3.76

*= rejects the null hypothesis at 5% significance level.

Because Johansen's method for estimating r is to accept the first rank which does not reject the null hypothesis, one rank is chosen when we use zero lag and two lags. However, when we use one lag of the variables, the statistic rejects the null hypothesis at both possible ranks. But, we are estimating a VEC model for two variables in which the maximum possible rank is only one. Therefore, one rank is selected and the two variables are said to be cointegrated.

5.5. Vector Error Correction (VEC) Estimation Results

When two variables are cointegrated, there is a long run relationship between the two variables. The cointegrating equation is $I_t - 2.157G_t + 1.75660 = \varepsilon_t$. This equation shows the long run relationship between inflation and economic growth in Ethiopia.

Estimation results of the VEC model are shown below:

$$\Delta I_t = 0.464 - 0.935\Delta G_{t-1} - .299\Delta I_{t-1} + 0.592ECT_{t-1} \quad (5)$$

(t-value) 0.28 -4.10* -1.51 2.13*

R squared= 0.47 chi2= 23.285 prob > chi2= 0.0001

$$\Delta G_t = 0.369 + .155\Delta G_{t-1} + .027\Delta I_{t-1} - 0.745ECT_{t-1} \quad (6)$$

(t-value) 0.28 1.02 0.20 -4.03*

R squared= 0.54 chi2= 30.896 prob > chi2= 0.0000

Chi-Square test cannot reject the claim that at least one of the predictors' regression coefficient is not equal to zero in the model.

The error correction terms measure deviations of the series from the long run equilibrium relations. The coefficient of economic growth in the equation of inflation is statistically significant at 5 percent significance level. The VEC model describes how one series behaves on the other series in the short run being consistent with the long run cointegrational relationship. The first equation indicates that an increase in output growth decreases inflation in the short run during the sample period of 1980-2011. This result supports our earlier finding in the VAR model.

The second equation shows that inflation does not have significant effect on economic growth in short run. Since the coefficient of the ECT is significantly negative in the second equation, Hamilton (1994) shows that if inflation had previously been larger than normal share of economic growth, then that causes inflation to be lower for any values of economic growth in the long run. The VEC model estimation shows that the error correction terms in both equations are statistically significant at 5 percent significance level. This means if the two series are out of equilibrium, growth rate will adjust to reduce the equilibrium error in the long run and vice versa.

Finally the LM test for residual autocorrelation is performed and the result in the table below shows that we cannot reject the null hypothesis of no autocorrelation in the residuals of the VEC model up to a maximum of five lags.

Table 5.11 LM Test for Residual Autocorrelation of VEC

Lag	Chi2	df	prob > chi2
1	2.2594	4	0.68817
2	4.7301	4	0.31613
3	0.7080	4	0.95033
4	2.0611	4	0.72452
5	2.1011	4	0.71717

The skewness test shows that the VEC model disturbances are normally distributed at 5 percent significance level. The stability test shows that the disturbances of the VEC are probably not stationary. However, the predicted error term after estimating the VEC model looks stationary at least graphically.

6. Conclusions

The study analyzes the relationship between economic growth and inflation in Ethiopia using yearly data obtained from the world economic outlook database of IMF for the period 1980 to 2011. A vector autoregression model is estimated by differencing the variables once to avoid problems related to using nonstationary data. The estimation results show that economic growth has negative effect on inflation in the short run. This finding should be interpreted cautiously as it depends on the nature of the economy being studied and the underlying sources of inflation and economic growth in the country. Economic growth reduces inflation if the underlying sources of economic growth are noninflationary which includes increase in production and productivity. But if economic growth comes from sources which increase money supply above the level of output production, it creates problems of too much money chasing too few goods which in turn results in price increment. The estimated model appears robust to standard misspecification tests.

According to Henderson (1999), economic growth must decrease inflation because the more goods are produced, the lower the prices of goods. This connection between the level of production and the level of prices also holds for the rate of change of production (that is, the rate of economic growth) and the rate of change of prices (that is, the inflation rate). He argues using the well known equation of exchange which is stated as:

$$MV=PY \quad (1)$$

where M is money supply, V is velocity of money, P is price and Y is the real output of the economy. If the growth rate of real GDP increases and the growth rates of M and V are held constant, the growth rate of the price level must fall. But the growth rate of the price level is just another term for the inflation rate; therefore, inflation must fall. However, he argues that the source of economic growth should come from productivity growth and other sources which are noninflationary in nature. But if economic growth is followed by more than proportionate increase in money supply, it may further increase the price level.

In Ethiopia, there is economic growth as well as high level of inflation at the same time. So it is important to look at the possible sources of the country's current economic progresses and inflation. If sources of the growth are inflationary way of financing different investments, this aggravates the problems of high inflation existing in the country by increasing money supply

in the economy. As discussed earlier, a rise in money supply increases inflation during the study period. Geda and Tafere (2008) also argue that money supply growth has been one of the prime sources of long run inflation in Ethiopia because one major source of government finance is money creation which increases money supply in the market. They argue that the government should adopt conservative fiscal and monetary policy to curb the problem of inflation. However, this may decrease economic growth in the short term. Therefore policy makers should find the appropriate balance between economic growth and macroeconomic stability. However, if the growth comes from productivity increases, inflation will tend to decrease in short run.

The other possible implication of the negative effect of economic growth on inflation in Ethiopia during the study period is drought and war. In the past 30 years the country was affected by drought and war which significantly reduced economic growth of the country. For example during the drought of 1985, economic growth decreased by around 11.4 percent which increased the inflation level of the country from around zero to 18 percent. From 1991-1992 the country was in a regime change after long period of war between a group of guerilla fighters and military junta which ruled the country at the time. Economic growth of the country during these periods were severely affected which resulted in high level of inflation. Therefore, war and drought has important implication about the negative effect of economic growth on inflation in Ethiopia.

The second equation of the VAR model shows that inflation does not have significant effect on economic growth in the short run. The joint hypothesis test also shows that coefficients of inflation in the economic growth equation are not significantly different from zero. This supports Sidrauski's theoretical model in which he argues that increase in inflation rate does not affect the steady state capital stock because the representative individual's real discount rate is unaffected by inflation. However, this result seems to have little significance in explaining the recent situation of the country.

Granger Causality test shows that economic growth Granger-causes inflation which means that economic growth can predict movements in inflation. It also shows that inflation does not have any forecasting power about economic growth in the short run. The IRF indicates that economic growth does not show any response to impulse of inflation while the response of inflation rate to impulses in growth is effective up to seventh year in the future. If a shock like

drought which significantly reduces output occurs, then the response of inflation will be very high. The response of inflation to growth impulse gradually disappears over the time horizon. Forecast Error Decomposition also supports the earlier conclusion which shows that more than 20 percent of inflation volatility is explained by output growth innovations. This supports the historical events that have happened in Ethiopia. For example in 1985 and 2003, the country was severely affected by drought which significantly shrinks its economy. The reduction in country's production increased the rates of inflation to historical high values.

Cointegration test shows that there exist a long run relationship between economic growth and inflation in Ethiopia. Vector error correction estimates indicate that economic growth significantly reduces inflation in short run. If inflation had previously been larger than normal share, then economic growth causes inflation to be lower in the long run. The error correction terms are statistically significant which shows that if both inflation and economic growth are out of equilibrium, inflation will adjust to reduce the equilibrium error in the long run.

Therefore, economic growth should increase from noninflationary sources of financing to tackle problems emanating from the current high inflation rates in the country. Since agriculture is the main source of GDP, measures to boost and stabilize domestic agricultural production and productivity, particularly production of major food staples, have great importance because movement of inflation in the country is highly derived by price of food staples. So increasing productivity of domestically consumed products must be given priority by providing incentives to the agricultural sector and by transforming the sector from rain dependent ways of production to commercial farming system.

References

African Development Bank (2012): "Ethiopia 2012, African Economic Outlook", http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Ethiopia%20Full%20PDF%20Country%20Note.pdf

Aisen A. and Vega F. (2005): "Does Political Instability Lead to Higher Inflation? A Panel Data Analysis", IMF working paper, Vol. 05 No. 49

Andres J. and Hernando I. (1997): "Does inflation harm economic growth? Evidence for the OECD", National Bureau of Economic Research working paper, Wp. 6062

Barro R. (1996): "Inflation and Economic Growth," National Bureau of Economic Research working paper, Wp. 5326

Bruno M. and Easterly W. (1995): "Inflation crises and long run growth", National Bureau of Economic Research working papers, Wp. 5209

Burnham K. and Anderson D. (2004): Multimodel Inference: Understanding AIC and BIC in Model Selection, Sociological Methods and Research, 33:261

Chimobi (2010): The relationship between economic growth and inflation in Nigeria, Journal of Sustainable Development, Vol. 3 No. 2

Cooley F. and Hansen D. (1989): The Inflation Tax in a Real Business Cycle Model, The American Economic Review, Vol. 79 No. 4, 733-748

CSAE (2012): "Country and regional level consumer price indices" available at http://www.csa.gov.et/index.php?option=com_rubberdoc&view=category&id=53&Itemid=111&limitstart=60

Culver S. and Papell D. (1997): is there a unit root in the inflation rate? Evidence from sequential break and Panel data models, Journal of Applied Economics, Vol. 12, 435-444

Danthine J., Donaldson J. and Smith L (1987): On the superneutrality of money in stochastic dynamic macroeconomic model, Journal of Monetary Economics, Vol. 20, 475-499

Desta A. (2009): "Economic Growth for Inflation: The Ethiopian Dilemma", Dominican University of California

Drazen A. (1981): Inflation and Capital Accumulation under a finite horizon, Journal of Monetary Economics, Vol. 8, 247-260

Durevall D., Loening J. and Birru Y. (2010): "Inflation Dynamics and food prices inflation in Ethiopia", University of Gothenburg working paper series, Vol. 478

Espinosa A. and Yip K. (1995): "Fiscal and Monetary policy interaction in an endogenous growth model with financial intermediaries", Federal Reserve Bank of Atlanta working paper series, Vol. 95 No. 10

Faria J. and Carniero F. (2002): Does high inflation affect growth in the long and short run? Journal of Applied Economics, Vol. 4 No. 1, 89-105

Fisher S. (1993) "The Role of Macroeconomic Factors in Growth," Journal of Monetary Economics, Vol. 32, 485-512.

Geda A. and Tafere K. (2008): "The Galloping Inflation in Ethiopia: A Cautionary Tale for Aspiring 'Developmental States' in Africa", Addis Ababa University working paper series

Getachew W. (1996): "Economic Analysis of inflation in the short run and long run perspectives (the case of Ethiopia)", Vienna University of Natural Resource and Life sciences

Gillman M., Harris M. and Matyas L. (2001): "Inflation and Growth: Some Theory and Evidence", Central European University Working Paper, Wp. 1

Gillman M. and Nakov A. (2003): A Revised Tobin Effect from Inflation: Relative Input Price and Capital Ratio Realignments (USA and UK, 1959–1999), Econometrica, Vol. 70 No. 279, 439-450

Hamilton D. (1994): Time Series Analysis, Princeton: Princeton University press

Haslag H. (1995): "Inflation and Intermediation in a Model with Endogenous Growth", Federal Reserve Bank of Dallas working paper, Vol. 95 No. 02

Henderson D. (1999): "Does Growth Causes Inflation?" Cato Institute Policy Report, Vol. 21 No. 6

Hung S. (2001): Inflation and Economic growth in financial markets with adverse selection and costly state verification, Academia Economic papers, Vol. 29 No. 1, 67-89

Hwang T. and Wu J. (2011): Inflation and Economic Growth in China: An Empirical Analysis, China and World Economy, Vol. 19 No. 5, 67-84

IMF (2012): Statement by an IMF Staff Mission on the 2012 Article IV Consultation with Ethiopia, IMF Press Release No. 12/224

Johansen S. (1995): Likelihood-Based Inference in Cointegrated Vector Autoregressive Models, Oxford: Oxford University Press.

Johansen S. and Juselius K. (1990): Maximum Likelihood estimation and Inference on cointegration with application to the demand theory for money, Oxford bulletin of Economics and Statistics, Vol. 52 No. 2

Khan S. and Senhadji S. (2001): "Threshold Effects in the Relationship between Inflation and Growth", IMF Staff Papers, WP. 48 No. 1, 1-21

Leshero T. (2012): "Estimating the inflation threshold for South Africa", Economic Research Southern Africa working paper, Wp. 285

Loening J. and Takada H. (2008): Inflationary Expectations In Ethiopia: Some Preliminary Results, Applied Econometrics and International Development, Vol. 8 No. 2

Manuelli E. and Jones E. (1995): "Growth and the effects of inflation", National Bureau of Economic Research working paper series, Wp. 4523

Mudell R. (1963): Inflation and Interest rate, Journal of Political Economy, Vol. 71 No. 3, 280-283

Ncube M., Lafumpa C. and Leonce N. (2010): "Ethiopia's Economic Growth Performance: Current Situation and Challenges", African Development Bank Group, Vol. 1 Issue. 5

Nell K. (200): "Imported inflation in South Africa: An Empirical study", University of Kent

OECD (2012): "Development Aid at Glance: Statistics by Region", available at http://www.oecd.org/investment/aidstatistics/42139250.pdf

Sarel M. (1995): "Non Linear effects of inflation on economic growth", IMF working paper, Wp. 96

Sidrauski M. (1967): Inflation and Economic Growth, Journal of Political Economy, Vol. 75 No. 6, 796-810

Singh K. and Kalirajan K. (2003): The inflation-growth nexus in India: an empirical analysis, Journal of Policy Modeling, Vol. 25 No. 4, 377-396

Stock J. and Watson M. (2007): Introduction to Econometrics, Boston: Pearson International

Stockman C. (1981): Anticipated inflation and the capital stock in a cash in advance economy, Journal of Monetary Economics, Vol. 8, 387-393

Tabi H. and Ondoa H. (2011): Inflation, Money and Economic Growth in Cameroon, International Journal of Financial Research, Vol. 2 No. 1

Tobin J. (1965): Money and Economic Growth, Econometrica, Vol. 33 No. 4, 671-684

Teshome A. (2011): "Sources of Inflation and Economic Growth in Ethiopia", Ethiopia Civil Service University

Yang Y. (2005): Can the strengths of AIC and BIC be shared? A conflict between model indentification and regression estimation, Biometrika, Vol. 92 No. 4, 937-950

Yohannes A. (2000): "The dynamics of inflation in Ethiopia", Addis Ababa University

World Bank (2012): "Economic Overview of Ethiopia", available at http://www.worldbank.org/en/country/ethiopia/overview

Data Annex

Year	GDP Growth Rate	Inflation Rate	Money Supply Growth	Official Exchange Rate
1980	3.997	12.437	4.203255388	2.07
1981	0.005	1.937	11.00938315	2.07
1982	0.961	7.774	10.29729608	2.07
1983	7.845	3.569	14.45606625	2.07
1984	-2.305	-0.334	9.737603836	2.07
1985	-11.413	18.403	17.12745455	2.07
1986	9.693	5.55	11.39099094	2.07
1987	13.87	-9.146	5.631770264	2.07
1988	0.574	2.206	11.07545314	2.07
1989	-0.457	9.633	15.5729906	2.07
1990	2.602	5.206	19.87413428	2.07
1991	-7.218	20.869	15.92659336	2.07
1992	-8.907	21.019	15.21812424	2.8025
1993	13.363	9.99	8.782097975	5
1994	3.486	1.166	23.17488556	5.465
1995	6.121	13.354	9.030010106	6.1583
1996	13.157	0.919	9.04520467	6.3517
1997	3.543	-6.42	19.82504653	6.7093
1998	-4.045	3.6	-1.093424235	7.1159
1999	6.042	4.772	13.70535649	7.9423
2000	5.927	6.159	13.07387494	8.2173
2001	7.418	-5.214	9.67575066	8.4575
2002	1.634	-7.224	15.93412781	8.5678
2003	-2.099	15.061	12.4379238	8.5997
2004	11.729	8.616	19.26447175	8.6356
2005	12.644	6.842	18.59189642	8.6664
2006	11.539	12.255	19.99365998	8.6986
2007	11.795	15.838	22.21259982	8.966
2008	11.187	25.316	23.38968982	9.5997
2009	10.03	36.399	-	11.778
2010	8.008	2.786	-	14.41
2011	7.535	18.111	-	16.899
Source	IMF	IMF	WB	WB