ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

FACULTY OF BUSINESS AND ECONOMICS

THE RELATIONSHIP BETWEEN INFLATION AND ECONOMIC GROWTH IN ETHIOPIA

BY

YEMANE MICHAEL

JUNE, 2008

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BY
YEMANE MICHAEL

A Thesis Presented to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment of the requirements for the Degree of Masters of Science in Economic Policy Analysis.

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Abstract

It is widely believed that moderate and stable inflation rates promote the development process of a country, and hence economic growth. Moderate inflation supplements the return to savers, enhances investment, and therefore, accelerates economic growth of the country. This paper empirically explores the present relationship between inflation and economic growth in the context of Ethiopia. Using annual date set on real GDP and CPI as well as other variables, for the period 1971 to 2006, an assessment of the empirical evidence has been acquired through the co-integration and error correlation models. Furthermore, it explores an interesting policy issue of what is the threshold level of inflation for the economy. The empirical evidence demonstrates that there exists a statistically significant long-run negative relationship between inflation and economic growth for Ethiopia as indicated by a statistically significant long-run negative relationship between CPI and real GDP. In addition, the estimated threshold model suggests 16 percent as the threshold level (i.e., structural breakpoint) of inflation above which inflation adversely affects economic growth. These results have important policy implications for both domestic policy makers and the development partners working in the country.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Ethiopia is one of the least developed countries (LDCs) of the world. Despite its rich and varied endowment of natural resource base and ancient cultural heritage, historical relic, and a large population, the country remains poor.

Like many developing countries, agriculture still employs the great majority of the labor force in rural areas of Ethiopia, and the modern sector is small.

The main stay of the country's economy is agriculture in which more than 80 percent of the population is engaged either directly or indirectly. Besides, agriculture has a lion's share to GDP contribution (i.e., 55% of GDP) and is the most important export item both by volume and value 80% of total exports originate from this sector (World Bank, 2004).

The growth trend of the Ethiopian Economy during the period 1971/72-1994/95 was unsatisfactory (Ergete, 1998). The factors underlying this poor trend include draught, civil war (1974-1991), high population growth rate, low investment levels, poor infrastructure, volatile terms of trade, debt burden and so on. Moreover, heavy state intervention and a command economic system crippled the country's economy during the 1974-1991 socialist periods.

After the military government was toppled in 1991, and a new government took power, several policy measures have been implemented, aimed at stabilizing the economy and stimulating growth. Among the policy measures the following are worth mentioning.

The birr was devaluated by about 140 percent in October 1992.

Distortions in other key prices were corrected

A foreign exchange auction market was introduced in May 1993 and most prices were deregulated.

Private Banks and insurance companies were allowed to operate side by side with government owned ones.

Interest rates have been adjusted upwards.

Tariff and transport reform, the deregulation of agricultural marketing and limited privatization were launched under the structural adjustment program (SAP) initiated in October 1992.

Notwithstanding these measures and economic reforms, inflation remained low for most of the period following the changes.

The financial sector was one of the major areas where major liberalization measures were taken (Luleseged, 1996). Some of the liberalization measures as explained earlier include a significant devaluation of the Birr, allowing private banks and insurance companies to operate, and easing the restrictions on foreign exchange market. These liberalization measures are bound to necessitate a shift from direct methods of monetary control to indirect ones.

The presence of a stable money demand and supply function enhances the conduct of monetary policy as it informs policymakers how different variables are affected.

According to Judd and Scadding (1982) for monetary policy to exert a predictable influence on an economy, it is essential that money demand functions be stable. The implication of this is that in the absence of a stable money demand function the measures taken by monetary authorities might not go hand in hand with actual real developments and economic targets sought may not be achieved. Thus, having a stable money demand function enables policy makers to influence changes in important economic variables such as output, interest rates and prices by manipulating monetary variables namely money supply and the interest rate.

This paper will review several different economic theories and recent empirical literature to see the inflation-growth relationship. Classical economics dwells on supply-side theories which emphasize the need for incentives to save and invest if the country's economy is to grow. Keynesian theory provided the Aggregate Demand-Aggregate Supply (AD-AS) framework which is a more comprehensive model for linking inflation and growth. Monetarism focuses on the critical role of monetary growth in determining inflation. On the other hand, neoclassical and endogenous growth theories seek to attribute, the effects of inflation on growth through its impact on investment and capital accumulation.

1.2. Statement of the problem

Low and stable inflation has been a feature of the Ethiopian economy for most periods of its past history. The country had been characterized as a low inflation one in sub-Saharan African until recently. According to the National Bank of Ethiopia (2007) this was achieved due to a strong currency, prudent monetary and fiscal policies (1960-1973), general price control (1974-1992) and implementation of economic reform and stabilization programs (1992-2005). The historic peak level of inflation has been 21 percent, which was recorded in 1991/92 mainly due to the severe drought that hit agricultural production the most and the absence of peace in the country during the periods.

One of the fundamental objectives of macroeconomic policies in Ethiopia is to sustain high economic growth together with low and stable inflation. However, there exists considerable debate and contention on the nature of the inflation and growth relationship.

There is no consensus or unanimity among researchers of economics about the relationship of inflation and economic growth. Some regard inflation as a pernicious issue and recommend governments and policy makers to combat it. While others maintain the view that inflation below a certain threshold level could be beneficial and facilitate economic growth than retard it. In other words, some consensus exists, suggesting that macroeconomic stability, specifically defined as low inflations is positively related to economic growth.

The repercussion of inflation on economic growth is not well studied in the Ethiopian context. There are some research gaps, that is, there are no many studies done on inflation and economic growth in Ethiopia. And those that already exist are blurred and inconclusive. Thus, this paper attempts to fill this research gap.

"Macroeconomists, central bankers and policymakers have often emphasized the costs associated with high and variable inflation. Inflation poses negative externality on the economy when it interferes with an economy's efficiency "(Gokal and Hanif, 2004)

High and unpredictable inflation can possibly retard investment and economic growth because of investors' uncertainty that emanates due to erratic inflation and the rise in interest rate (i.e., cost of investment) associated with it.

Inflation has several economic and social costs. It also affects the distribution of income and wealth among society and has something to do with welfare. Especially when inflation increases at double digit, life becomes difficult and miserable particularly for people with low and medium income level. That is why Gerald Ford one of the ex-presidents of USA, declared it "public enemy number one", and President Ronald Reagan called it "the cruelest tax".

Unexpected inflation has an effect that is more deleterious (harmful) than any of the costs of steady, anticipated inflation. It arbitrarily redistributes wealth among individuals (Mankiw, 1992).

Hyperinflation is the most devastating type of inflation. This phenomenon occurs when there is excessive money supply or when the fiscal and monetary policies are not compatible.

Episodes of currency depreciation could generate an increase in inflation. Over the past decade or so in Ethiopia, there has been numerous and expansive programs of market liberalization that extend from financial and product markets to labor market. In almost all markets, there has been an increase in domestic competition and a shift away from centralized wage setting towards a decentralized one. Each of these developments is conducive to achieving lower and more stable inflation, at least in the short to medium-run and may reinforce the effect of reduced exchange rate.

Inflation is one of the highly researched areas in the economics profession. However, it is still one of the timely topics on the forefront of the research themes in the field of economics due to its complexity and controversy.

Inflation has been low for decades in Ethiopia. Nevertheless, recently the country is suffering from high inflation. This study attempts to identify the main macroeconomic variables that exacerbate inflation. Besides, it assesses the link between inflation and economic growth and tries to establish the direction of causality between the two variables.

In an attempt to compensate for the rising cost of living that occurred due to rising prices, the government increased the salary of civil servants and pensioners by some percentage. This

measure of increasing wages amidst the prevailing inflation has met sharp opposition from some groups claiming that increasing wages only' adds fuel to the fire."

Dornbusch (1998) suggests that wage and price controls alone are not adequate to keep inflation in check if the underlying fundamentals of fiscal and monetary policy are not consistent with low inflation.

At present, some strata of the society is agonizing from economic woes brought about by the unexpected and escalating price hikes. Thus, this paper tries to investigate the main determinants (causes) of inflation and see how inflation affects economic growth or vice versa.

As mentioned in the preceding paragraphs, Ethiopia's economy was characterized by stable prices for most of its past history. But recently, inflation is escalating at an alarming rate. Hence, the new developments in inflation give me a motivation for the study of the impact of inflation on economic growth.

The purpose of this paper is to empirically explore the present relationship between inflation and economic growth in Ethiopia. This paper further explores an interesting policy issue of how far the inflation rate is non-detrimental for the economic growth of Ethiopia, or in other words, what is the threshold level of inflation for the economy. All the empirical analysis of this paper has been conducted using annual data set on real gross domestic product (GDP) and consumer price Index (CPI) for the period 1971 to 2006.

1.3. Objective of the study

The main objective of the study is to examine the relationship between inflation and economic growth.

The specific objectives of the study include:

Analyze the basic factors that are the causes of high inflation in Ethiopia.

Examine the relationship between inflation and economic growth both in the short-run and in the long-run.

1.4. Methodology of the study

This study uses data on population, Gross Domestic Product (GDP). Consumer Price Index (CPI), Real Effective Exchange Rate (REER), money supply, price of imports, government expenditures, financing budget deficit and investment rates to investigate the contribution and significance of each of these variables for the inflation-growth relationship.

The study relies on secondary data collected from a variety of sources, both published and unpublished materials.

The causality between inflation and economic growth could be unidirectional or bidirectional. In an endeavor to attain this objective several diagnostic tests such as the normality test, the ADF (Augmented Dickey Fuller) test, Granger causality test and others will be utilized.

Time-series econometrics of the Johansson maximum likelihood approach will be applied. Besides, co-integration tests, unit root tests, and Phillips Peron test for unit root will be developed.

Essentially vector Auto Regression (VAR) models will be adopted to assess the relationship between inflation and economic growth in the short-run. An Error Correction Mechanism (ECM) model will be used to see the long-run relationship between the two variables.

1.5. Testable Hypothesis

In the Ethiopian case the preponderant (lion's share) of the income of the household is spent on consumption items. Besides, agriculture accounts for more than half of the GDP of the country. Hence, price movements imitate the pattern of agricultural output. In other words, when there is bumper harvest prices fall and the other way round when agricultural output declines due to various reasons. It is widely thought that high inflation retards economic growth. Thus, based on a priori economic theory the following tentative hypotheses are developed.

The causality between inflation and economic growth run two ways i.e., high inflation negatively affects economic growth and rapid economic growth triggers inflation.

Below a certain threshold level the relationship between inflation and economic growth is positive.

1.6. Significance of the study

The study will shed some light on the relationship between inflation and economic growth in Ethiopia. Moreover, this study will open the way for further research in the topic. It is hoped that the findings of the study will impart some knowledge to all people interested in this area.

The results of the empirical analysis provide guidance for both domestic policy makers and the development partners. Overall, the paper scrutinizes the complex nature of inflation and economic growth.

1.7 Limitations of the study

It should be recognized that this study has its own shortcomings of which the following are no exception.

The dearth of data on itself is a limiting factor. I am also skeptical about the accuracy of the various data compiled by the pertinent bodies. Besides, more might be learned of inflation and economic growth using a larger sample (i.e., quarterly data) over the same time period and control variables

CHAPTER TWO

LITERATURE REVIEW

2.1. Theoretical Literature

Various scholars of economics define the term inflation in slightly different ways. But all the definitions can be boiled down to the same theme. It is seen as a continuous upward movement (increase) in the general price level. Money loses purchasing power during inflationary periods since each unit of currency buys progressively fewer goods.

There are two main indices used to measure inflation the first one is the consumer price index (CPI) and the second one is the producer price index (PPI).

The theoretical analysis suggests some possible sources of inflation. According to Barro (1997) one way for the price level to increase is through a downward movement in the real demand for money. For example, a permanent downward shift in the production function would lower aggregate output, and thereby decrease the real quantity of money demanded. However, it should be known that a one-time shock of this type creates a single increase in the price level rather than a continuous series of increases in prices.

To generate inflation, we would need a succession of downward shifts to the production function. Adverse shocks to the production function such as oil crises, harvest failures, and strikes can influence the general level of prices over short periods. But there is no evidence that these forces can account for inflation in the sense of persistent rises in prices (Barro, 1997).

Different theorists arrive at different conclusions about the responsiveness of output growth to inflation. The monetarists claim that inflation inhibits growth while the structuralists support the opposite view, that is, inflation promotes growth. Theories are useful since they account for some observed phenomenon.

Inflation can lead to uncertainty about the future profitability of investment projects. This problem becomes highly pronounced when high inflation is associated with increased price variability which leads to more conservative investment strategies eventually resulting in lower levels of investment and economic growth.

Inflation may also reduce a country's international competitiveness by making its exports relatively more expensive thus impacting on the balance of payment. Moreover, inflation can interact with the tax system to distort borrowing and lending decisions.

There are several channels that can produce inflation. One of these possible factors that could bring about inflation is the overheating in the labor market. When the economy is overheated, there will be pressure for the real wages to increase. In other words, we should expect a real exchange rate appreciation and wages increases. Increases in the commodity prices or utility prices will push up the cost faced by the firms, and eventually forcing a consumer prices to increase. The second cause of inflation is the price of imports in particular commodities. The third one is the increase in the price of utilities. The other source of inflation is the financing of public deficit, meaning financing of fiscal deficit by printing of money.)

Based on Smith (1997), the most important type of inflation is called demand-pull or excess demand inflation. It occurs when the total demand for goods and services in an economy exceeds the available supply. So the price for them rises in a market economy. Historically this has been the most common type and at times the most serious. Every war produces this type of inflation because demand for war materials and manpower grows rapidly without comparable shrinkage elsewhere. Other types of inflation occur in conjunction with demand-pull inflation.

Another type of inflation is called cost-push inflation. The name suggests the cause i.e., the rise in the costs of production. The increase in the cost of production forces up the prices of finished goods and services. Often a rise in wages in excess of any gains in labor productivity is what raises unit costs of production and thus raises prices.

A third type of inflation could by called pricing power inflation, but is more frequently called administered price inflation. It occurs whenever businesses in general decide to boost their process to increase their profit margins. This does not occur normally in recessions (slumps) but when the economy is booming and sales are strong. It could be named oligopolistic inflation, because it is oligopolies that have the power to set their own prices and raise them when they decide the time is ripe. One can at such times read in the newspapers that business is just waiting a bit to see how soon they might raise their prices. An oligopolistic firm realizes that if it raises its prices, the other major firms in the industry will likely see that as a good time to widen their profit margins too without suffering much from price competition from the few other firms in the industry. The

fourth type is called sectoral inflation. The term applies whenever any of the other three factors hits a basic industry causing inflation, for example, agriculture.

Monetary growth is a good candidate as a source of inflation. Milton Friedman (1968) the prominent monetary economist once dubbed his famous statement "Inflation is always and everywhere a monetary phenomenon" (Barro, 1997).

2.1.1 The costs of inflation

While most economists agree that inflation is "bad" no consensus exists over how bad it is or what should be done about it. Some believe that inflation is a major, even catastrophic, evil, and argue that monetary policy or monetary reform should be geared toward its outright elimination. Many others argue that eliminating inflation would reduce output and employment, and the cost of the lost output and employment would more than offset the gains from establishing price stability, still others argue that the costs of inflation are small anyway, and could be dealt by other means like indexing the fiscal system (Dornbusch, 1997)

There is no direct loss of output from inflation, as there is from unemployment (Dornbusch, 1997). The relevant distinction is between inflation that is perfectly anticipated and taken into account in economic transactions, and imperfectly anticipated, or unexpected inflation.

2.1.1.1 The costs of perfectly anticipated inflation

Suppose that an economy has been facing a 5 percent of inflation for a long time, and that everyone accurately anticipates that the rate of inflation will continue to be 5 percent. In such an economy, all contracts would build in the expected 5 percent inflation.

Borrowers and lenders would know and agree that the dollars in which a loan is repaid will be worth less than the dollars given up by the lender when making the loan. Nominal interest rates would be raised 5 percent to compensate for the inflation. Long-term labor contracts would increase wages at 5 percent per year to take account of the inflation. In short, any contracts in which the passage of time is involved would take the 5 percent inflation into consideration. The tax laws would also be indexed. This means the tax brackets would be increased at the rate of 5 percent per year.[5]

Perfectly anticipated inflation has no real costs except for some qualifications. The first qualification arises because no interest is paid on currency (notes and coins) not least because it is very difficult to do so. This means that the costs of holding currency rise along with inflation.

The cost to the individual of holding currency is the interest forgone by not holding an interest-bearing asset. When the inflation rate rises, the nominal interest rate rises; the interest lost by holding currency increases, and the cost of holding currency therefore increases (Dornbusch, 1997). Thus, the demand for currency falls. Individuals have to keep less currency than they did before. As a result, they make more trips to the bank to cash smaller checks. The costs of these

[5] The taxation of interest would have to be on the real (after inflation) return on assets for the tax system to be properly indexed.

trips to the bank are often termed as "shoe leather" costs of inflation because walking to the bank more often causes one's shoes to wear out more quickly.

The second qualification is the "menu costs" of inflation. High inflation motivates firms to change their posted prices more frequently. Changing prices is sometimes costly because it requires printing and distributing a new catalogue. These costs are called menu costs, because when the rate of inflation is high, restaurants have to print new menus more repeatedly.

The other cost of expected inflation results from the tax laws. Many provisions of the tax code do not take into account the effects of inflation. Inflation can alter individuals' tax liability, often in ways that lawmakers did not intend (Mankiw, 2000).

Failure to index the tax structure implies that inflation moves the public into higher tax brackets and thus raises the real value of its tax payments or reduces real disposable income.

The inconvenience of living in a world with changing price level is another cost of inflation. Money is the yardstick with which we measure economic transactions. This yardstick changes when there is inflation.

2.1.1.2 The costs of imperfectly anticipated inflation

Countries with long inflationary histories in their economy like Brazil and Israel have made tremendous adjustments to inflation through the use of indexing. Other countries in which inflation has not been episodic in their economy have not adopted indexation. (Dornbusch, 1994)

One important effect of unexpected inflation is to change the real value of assets fixed in nominal terms. In other words, unanticipated inflation arbitrarily redistributes wealth among individuals. One can see how this works by examining long-term loans. Loan agreements specify a nominal interest rate i.e. interest rate that is expected to prevail in the future at the time of the agreement. If inflation turns out differently from what was expected, the ex-post real return that the debtor pays to the creditor differs from what both parties anticipated. If inflation turns out to be higher than expected, the debtor wins and the creditor loses because the debtor repays the loan with less valuable dollars or Birr. Whereas, if inflation turns out ,to be lower than expected, the creditor gains the benefit while the debtor is hurt because the loan repayment is worth much more than both parties expected.

Unanticipated inflation also hurts individuals on fixed income like pensioners. Highly variable and erratic inflation increases uncertainty for both creditors and debtors, which subjects them to arbitrary and potentially large redistributions of wealth.

The redistribution effect operates with respect to all assets fixed in nominal terms, in particular, money, bonds, savings account, insurance contracts, and some pensions (Dornbusch, 1994). This

implies that realized real interest rates are lower than nominal interest rates on assets and even possibly negative. Inflation could also redistribute income by benefiting capitalists or recipients of profit income, at the expense of wage earners. This occurs because when there is unanticipated inflation; prices rise faster than wages and therefore allow profits to expand.

There is a presumption that the old are more vulnerable to the costs of unanticipated inflation than the youth in that they own more nominal assets. Some studies also show that there is little evidence supporting the view that the poor suffer especially from unanticipated inflation.

Uncertain and highly variable inflation reduces the efficiency of the price system and thus reduces the efficiency with which the economy allocates goods and factors of production, and could affect the level of output.

2.2. Theories of economic and growth and inflation

This section will discuss a classical, Keynesian, neo-Keynesian, monetarist, Neo-classical and endogenous growth theories each with their respective contribution to the inflation-growth relationship.

2.2.1. Classical Theory

Classical theorists laid the foundation for a number of growth theories. The foundation for classical growth model was laid by Adam Smith. He pioneered a supply side driven model of growth and his production function was as follows:-

$Y = f(L,K,T)$ where Y is output, L is labor, K is capital and T is land.

Smith argued that growth was self-reinforcing as it exhibited increasing returns to scale. Besides, he considered savings as a creator of investment and hence growth.

The link between inflation and its 'tax' effects on profit levels and output were not specifically articulated in classical growth theories. However, the relationship between the two variables is implicitly suggested to be negative, as indicated by the reduction in firms. Profit levels through higher wage costs. (Gokal and Harif, 2004)

The relationship between inflation and growth remains a controversial one in both theory and empirical findings. There is immense debate between structuralists and monetarists as well as other schools of thought (economic theorists) regarding the issue.

The structuralists believe that inflation is essential for economic growth, where as the monetarists see inflation as detrimental to economic progress. There also exists a debate about the direction of causality. Friedman (1973:41) succinctly summarized the inconclusive nature of the relationship between inflation and economic growth as follows: "historically, all possible combinations have occurred: inflation with and with out development, no inflation with and without development."

2.2.2. Keynesian Theory

The traditional Keynesian model consists of the Aggregate Demand (AD) and Aggregate Supply (AS) curves, which aptly illustrates the inflation-growth relationship. According to this model, in the short-run, the As curve is upward sloping rather than vertical, which is its critical feature. If the AS curve is vertical, changes on the demand side of the economy affect only prices. However, if it

is upward sloping, changes in AD affect prices and output, (Dornbusch, et al., 1996). This holds with the fact that many factors drive the inflation rate and the level of output in the short-run. These are, expectations; labor force, prices of other factors of production, fiscal and/or monetary policy.

In the long-run "steady state" situation or (equilibrium) nothing is changing as the name suggests. The dynamic adjustment of the short-run AD and AS curves yields an "adjustment path" [6] which exhibits an initial positive relationship between inflation and growth, but eventually turns negative towards the latter part of the adjustment path.

The initial positive relationship between inflation and output usually happens due to the time inconsistency problem'. According to this concept, producers feel that only the prices of their products have increased while the other producers are operating at the same price level.

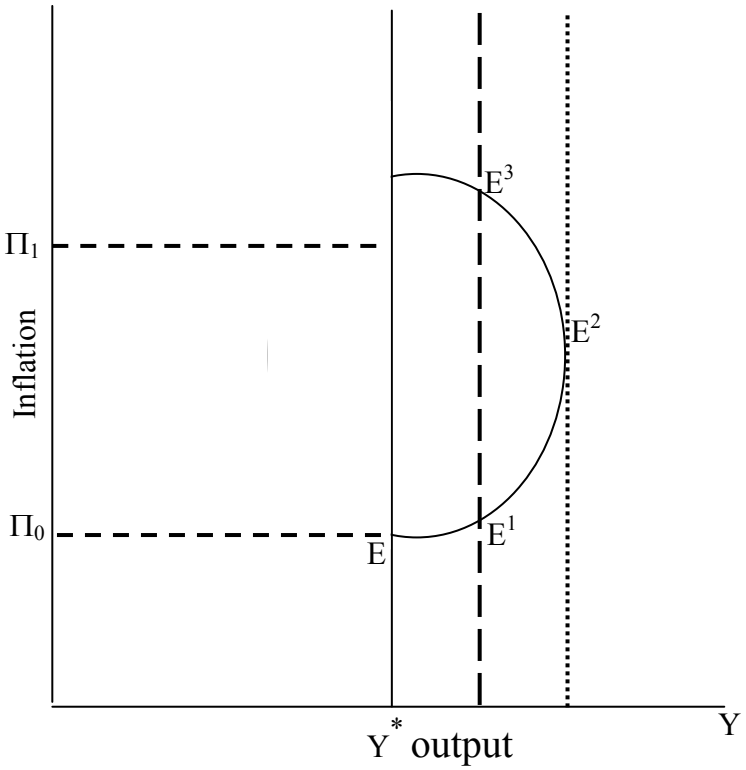
However, in reality, overall prices have increased. Hence, the producer continues to produce more and more output. Blanchard and Kiyotaki (1987) also believe that the positive relationship can be due to agreements by some firms to supply goods at a later date at an agreed price. Therefore, even if the prices of goods in the economy have increased, output would not decline, as the producers have to fulfill the demand of the consumer with whom the agreement was made.

There are also two other features of the adjustment process. Firstly, there are times when the output decreases and the inflation rate increases (between E2 & E3 in the figure below).

[6] See Dornbusch, et al., 1996

This negative relationship between inflation and growth is important as it occurs in practice, as attested by empirical literature. This phenomenon is called stagflation, when inflation rises as output falls or remains stable. Secondly, the economy does not move directly to a higher inflation rate, but follows a transitional path where inflation rises and them falls.

Figure 1: inflation and output relationship



Source: Gokal and Hanif (2004)

Under this model, there is a short-run trade-off between output and the change in inflation, but no permanent trade-off between output and inflation. For inflation to be held steady at any level, output must equal the natural rate. Any level of inflation is sustainable: however, for inflation to fall there must be a period when output is below the natural rate.

2.2.3. Monetarism

Monetarism a term coined by Milton Friedman has several essential features. This focuses on the long-run supply-side properties of the economy as opposed to short-run dynamics. Monetarism focused on several essential long run properties of the economy like the quantity theory of money and the neutrality of money. The quantity theory of money linked inflation and economic growth by simply equating the total amount of spending in the economy to the total amount of money in existence. Friedman proposed that inflation was the product of an increase in the supply or velocity of money at a rate greater than the rate of growth in the economy.

Friedman also challenged the concept of the Phillips curve. His argument was based on the premise of an economy where the cost of everything doubles. Individuals have to pay twice as much for goods and services, but they do not mind, because their wages are also twice as large. Individuals anticipate the rate of future inflation and incorporate its effects into their behavior. As such, employment and output is not affected. Economists call this concept the neutrality of money. Neutrality holds if the equilibrium values of real variables, including the level of GDP are independent of the level of the money supply in the long-run.

Super neutrality holds when real variables- including the rate of growth of GDP, are independent of the rate of growth in the money supply is the long-run. If inflation worked this way, then it would be harmless. In reality however, inflation does have real consequences for other macroeconomic variables. Through its impact on capital accumulation, investment and exports, inflation can adversely affect a country's growth rate, (Gokal and Hanif, 2004).

In a nutshell, monetarism suggest that is the long-run prices are mainly affected by the growth rate is money, while having no real effect on growth. If the growth in the money supply is higher than the economic growth rate, inflation will occur.

2.2.4. Neo-classical Theory

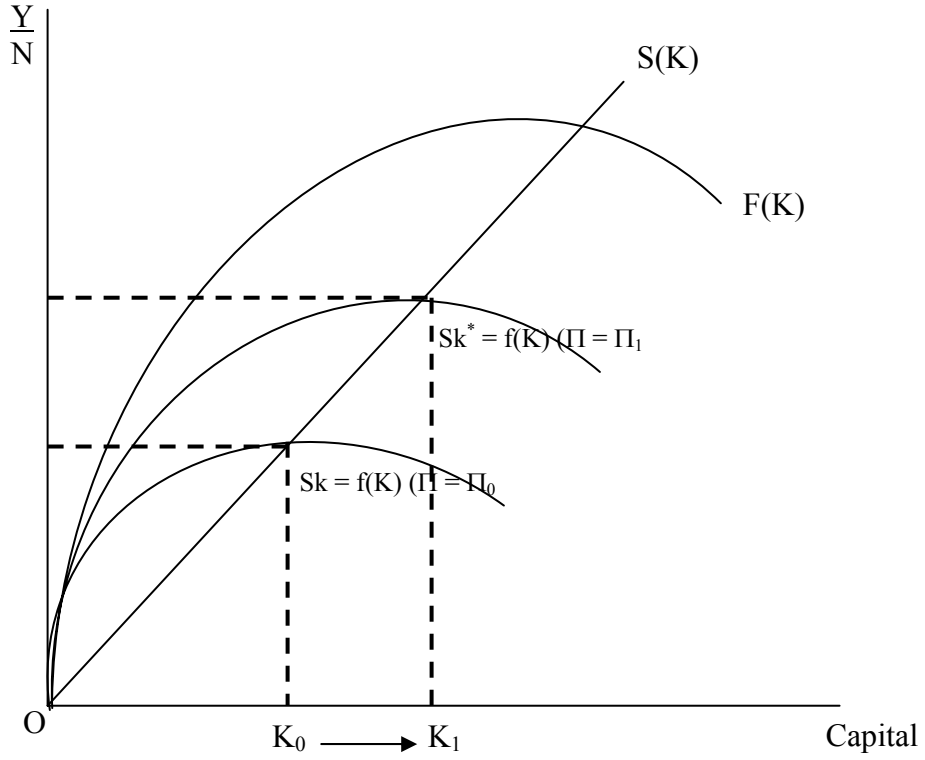
One of the earliest neo-classical models was developed by Solow (1956) and Swan (1956). The model exhibited diminishing returns to labor and capital separately and constant returns to both factors combined. Technological progress (change) replaced investment, that is growth of capital, as the primary factor explaining long-term growth and its level was assumed by Solow and other growth theorists to be determined exogenously, that is, independently of all other factors, including inflation (Todaro, 2000).

Mundell (1963) was one of the first to articulate a mechanism relating inflation and output growth separate from the excess demand for commodities. According to Mundell's model, an increase in inflation or inflation expectations immediately reduces people's wealth. This works on the premise that the rate of return on individuals' real money balances falls. To accumulate the desired wealth, people save more by switching to assets, increasing their price, thus driving down the real interest rate. Greater savings mean high capital accumulation and hence speedy output growth.

Tobin, another neoclassical economist (1965) developed mundell's model further by following Solow (1956) and Swan (1956) in making money a store of value in the economy. Individuals in this model substitute current consumption for future consumption, by either holding money or

acquiring capital. Under this setup, individuals maintain precautionary balances, in spite of capital offering a higher rate of return.

Figure 2 : portfolio allocation mechanism



The above figure illustrates the portfolio allocation mechanism. When inflation rate increases from Π_0 to $\Pi_{1,,}$ ($\Pi_1 > \Pi_o$) the return to money declines. Based on Tobin's portfolio mechanism, people will substitute away from money, which has lower return and shift towards capital. In figure 2, this substitution effect is portrayed by a movement in the Sk line to SK. The portfolio mechanism results in a higher steady state capital stock (from K0 to K1). Tobin's framework shows that a higher inflation rate permanently raises the level of output. But, the effect on output growth is temporary, occurring during the transition from steady state capital stock, K0 to the new steady state capital stock K1. The impact of inflation can be classed as having a 'lazy dog effect' where it

induces greater capital accumulation and higher growth, only until the return to capital falls. Therefore, higher investment will cease and only steady state growth will result. In deed, growth in the neoclassical economy is ultimately driven by exogenous technological advancement-upward shifts in the F(K) curve not by a one-off change in the inflation rate.

Quite simply, the Tobin effect proposes that inflation causes individuals to substitute out of money and into interest earning assets, which leads to greater capital intensity and promotes economic growth. In effect, inflation exhibits a positive relationship to economic growth. Tobin (1972) also argued that because of the down ward rigidity of prices including wages, the adjustment in relative prices during economic growth could be better achieved by the upward price movement of some individual prices.

Sidrauski (1967) proposed the role of money in the context of an infinitely-lived representative agent model as "super neutral" super neutrality, as mentioned in the preceding paragraphs holds when real variables like 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 economy is that an increase in the inflation rate does not affect the steady state capital stock. As such, neither output nor economic growth is affected.

Stockman (1981) developed a model in which an incentive in the inflation rate results in a lower steady state level of output and peoples' welfare declines. In stockman's model, money is a complement to capital, accounting for a negative relationship between the steady-state level of output and inflation rate. Stockman's insight is promoted by the fact that firms put up some cash in

financing their investment projects. Sometimes the cash is directly part of the financing packages, whereas at other times, banks require compensating balances. Since inflation erodes the purchasing power of money balances, people reduce their purchases of both cash goods and capital when the inflation rate rises. Correspondingly, the steady-state level of output falls in response to an increase in the inflation rate.

The stockman effect can also operate through the effects on the labor-leisure decision. Greenwood and Huffman (1987) developed the basic labor- leisure mechanism and Cooley and Hansen (1989) identified the implication for capital accumulation. In Greenwood and Huffman's research people hold money to purchase consumption goods and derive utility both from consumption and leisure. Fiat money[7] is used because there is a cash-in-advance constraint on consumption goods. Greenwood and Huffman show that the return to labor falls when the inflation rate rises. People substitute away from consumption to leisure, because the return to labor falls.

Cooley and Hansen (1989) extend the mechanism to consider capital accumulation. The key assumption is that the marginal product of capital is positively related to the quantity of labor. Thus, when the number of laborers declines in response to a rise in inflation, the return to capital falls, and the steady-state quantities of capital and output decline. Cooley and Hansen show that the level of output permanently falls as the inflation rate increases.

[7] money or currency issued by the government or central bank which is not covered by a special reserve, deposit or issue of securities.

This theoretical review demonstrated that models in the neoclassical framework can yield very different results with regard to inflation and growth. An increase in inflation can result in higher output (Tobin effect) or lower output (Stockman effect) or no change in output (Sidrauski effect).

2.2.5. Neo-Keynesian Theory

Neo-Keynesians originally emerged from the ideas of the Keynesians. One of the crucial developments under neo-Keynesianism was the concept of "Potential output", which is sometimes refereed to as natural output. This is a level of output where the economy is at its optimal level of production. In other words, the factors of production are fully utilized. This level of output also corresponds to the natural rate of unemployment. The natural rate of unemployment is also termed as the non-accelerating inflation rate of unemployment (NAIRU). NAIRU is the unemployment rate at which the inflation rate is neither rising nor falling. According to this theory, inflation depends on the level of actual output (GDP) and the natural rate of employment.

If GDP surpasses its potential and unemployment is below the natural rate of unemployment, other things held constant, inflation will accelerate as suppliers increase their prices and built-in inflation worsens.[8] This causes the Phillips curve to shift in the stagflationary direction, towards greater inflation and greater unemployment (lower output).

If the GDP falls below its potential level and unemployment is above the natural rate of unemployment, holding other factors constant, inflation will decelerate as suppliers attempt to fill excess capacity, reducing prices and undermining built-in inflation leading to disinflation. This

[8] Build-in inflation is often linked to the puice/wage spiral because of involves workers trying to keep their wages up with puces and then employers passing higher costs on to consumers as higher prices as part of the vicious circle.

causes the phillips curve to shift in the desired direction, towards less inflation and less unemployment.

Lastly, if GDP is equal to its potential and the unemployment rate is equal to NAIRU, and then the inflation rate will not change, as long as, there are no supply shocks. In the long run, the neo-Keynesians believe that the Phillips curve is vertical. This means, the unemployment rate is given and equal to the natural rate of unemployment, while there are a large number of possible inflation rates that can prevail at that unemployment rate.

The problem with this theory is that the exact level of potential output and natural rate of unemployment is generally unknown and tends to change over time. Inflation also seems to act in an asymmetric way, rising more quickly than it falls, mainly due to the downward rigidity in prices.

2.2.6. Endogenous growth theory

Endogenous growth theories describe economic growth, which is generated by factors within the production process. For example, economies of scale, increasing returns or induced technological change as opposed to outside or exogenous factors such as the increase in population. In endogenous growth, the growth rate has depended on one variable, that is, the rate of return on capital variables, like inflation, that decrease that rate of return, which in turn reduces capital accumulation and decreases the growth rate.

There is one basic difference between the endogenous growth models and the neo-classical economies. In the neo-classical economies, the return on capital declines as more capital is

accumulated. In the simplest versions of the endogenous growth models, per capita output continuous to increase because the return on capital does not fall below a positive lower bound. The basic intuition is that only if the return on capital is sufficiently high, will people be induced to continue accumulating it. Models of endogenous growth also permit increasing returns to scale in aggregate productions, and also focus on the role of externalities in determining the rate of return on capital (Gokal and Hanif, 2004).

Endogenous models that explain growth further with human capital develop growth theory by implying that the growth rate also depends on the rate of return to human capital, as well as physical capital. The rate of return on all forms of capital must be equal in the balanced-growth equilibrium. A tax on either form of capital induces a lower return. When such endogenous growth models are set within a monetary exchange framework Macallum and Goodfriend (1987) the inflation rate (tax) lowers both the return on all capital and the growth rate.

A tax on capital income directly reduces the growth rate, while tax on human capital would cause labor to leisure substitution that lowers the rate of return on human capital and eventually lower the growth rate.

Some versions of the endogenous growth economies find that the inflation rate effects on growth are small. Gomme (1993) studied an economy similar to the one specified by Cooley and Hansen, that is, an inflation rate increase results in a decline in employment. According to Gomme research, efficient allocations satisfy the condition that the marginal value of the last unit of today's consumption equals the marginal cost of last unit of work. A rise in inflation reduces the

marginal value of today's last unit of consumption, thus inducing people to work less. With less labor, the marginal product of capital is permanently reduced resulting in a slower rate of capital accumulation. Gomme found that in this economy, eliminating moderate inflation rate for example, 10 percent, result in only a very small less than 0.01 percent point, and gain in the growth of output.

Alternative models examine low inflation might directly affect capital accumulation and hence output growth. Marquis and Reffert (1995) and Haslag (1995) specify economies in which capital and money are complementary goods.. In Haslag research banks pool small savers but are required to hold money as deposits to satisfy a reserve requirement. Therefore, an inflation rate increase drives down the return to deposits, resulting in deposits being accumulated at a slower rate since capital is a fraction of deposits; capital accumulation and output growth are slow.

2.3. Empirical Literature Review: Inflation and Economic Growth

Several evidences link higher inflation will lower growth over the long term. But it is not yet certain what mechanisms produce the inflation and slow growth link.

There is considerable evidence that inflation has an identifiable negative effect on economic activity. Much of this evidence relates to the effect of inflation rate on economic and productivity growth. While few doubt that very high inflation is bad for growth, there have been mixed empirical studies presented as to their precise relationship.

Starting from 1984, inflation control has become the unquestioned objectives of economic policymakers worldwide. Based on part on the 1973 to 1984 period of macroeconomic distress experienced by the organization for Economic Cooperation and Development (OECD) countries, when inflation reached an average rate of 13 percent, monetary policymakers have assumed that faster sustainable growth can only occur in a climate where the inflation rate is controlled.

Andres and Hernando in an NBER working paper entitled "Does Inflation Harm Economic Growth?" analyze the correlation between inflation and growth in OCED countries during the 1960-1992 period and found that even low or moderate inflation rates have a temporary negative impact on growth rates leading to significant and permanent reductions in per capita income. A reduction in inflation of a single percent point leads to an increase in per capital income of 0.5 percent to 2 percent.

As the authors point out, their analysis leaves little room for interpretation. Inflation is not neutral, and in no case does it favor rapid economic growth. Higher inflation never leads to higher levels of income in the medium and long run which is the time period they analyze. This negative correlation persists even when other factors are added to the analysis, including the investment rate, population growth, schooling rates, and the constant advances in technology. Even when the other factor in the effects of supply shocks characteristic of a part of the analyzed period, there is a still a significant negative correlation between inflation and growth.

Inflation not only reduces the level of business investment, but also the efficiency with which productions factors are put to use. The benefits of lowering inflation are great, according to the

authors, but also dependent on the rate of inflation. The lower the inflation rate, the greater are the productive effects of a reduction, for example, reducing inflation by 1 percentage point when the rate of inflation is 20 percent may increase growth by 0.5 percent. But, at a 5 percent inflation rate, output increases may be 1 percent or higher. It is therefore more costly for a low inflation country to concede an additional point of inflation than it is for a country with a higher starting point.

The most widely cited study on the impact of inflation on real gross domestic product (GDP) is the macro-panel study of about 100 countries over three decades recently done by Robert Barro (1997). Barro found that inflation rates above 15 percent were definitely harmful for real growth. However, for countries and periods with average inflation rates below 15 percent, he could not detect any significant effect of inflation on real GDP. Other country-panel studies, give the same result. Example, Levine and Renelt, 1992; Sarel (1996), Sala-i-Martin 1997. They too fail to capture any statistically reliable effect of inflation in real GDP in periods of low to moderate inflation.

The most influential defense of the view that the cost of inflation rises very fast as soon as inflation becomes positive is that recently presented by Feldstein (1997). His study emphasized on the distortions caused by the interaction between inflation and capital income taxation. Feldstein constructs a numerical partial-equilibrium model to simulate the effect on economic welfare of reducing inflation from 2 percent to zero. The result is a large - permanent one-time increase in welfare valued at approximately 1 percent of GDP.

Among the first authors to analyze the inflation growth relationship included Kormendi and Meguire (1995). They helped to shift the conventional empirical wisdom about the effects of inflation on economic growth from a positive one to a negative one. They found a significant negative effect of inflation on growth. In pooled cross-section time series regressions for a large set of countries, Fischer (1993) and De Gregorio (1993) found evidence for a negative link between inflation and growth. This was also confirmed by Barro (1995, 1996). Barro's studies also found that the relationship may not be linear studies by Levine and Zervous (1993) and Sala-i-Martin (1997) suggested that inflation was not a robust determinant of economic growth. Inflations' significance declined as other conditioning variables are included.

Over the past few decades, the nexus between inflation and economic growth have drawn extensive attention of macroeconomists, policy makers and the central bankers of both developed and developing countries .specifically, the issue that whether inflation is necessary for economic growth or it is harmful generates a significant debate both theoretically and empirically. The issue originally evolves from the controversial notion between the structralist and the monetarists. [5] In this connection, Mundell (1965) and Tobin (1965) predict a positive relationship between the rate of inflation and the rate of capital accumulation, which in turn, implies a positive relationship to the rate of economic growth.[6] They argue that since money and capital are substitutable, an increase in the rate of inflation increases capital accumulation by shifting portfolio from money to capital, and thereby, stimulating a higher rate of economic growth (Gregorio, 1996). Conversely, Fischer and Modigliani (1978) suggest a negative and non linear relationship between the rate of inflation and economic growth through the new growth theory mechanisms (Malla, 1997). They

mention that inflation restricts economic growth largely by reducing the efficiency of investment rather than its level.

To date, although the relationship between inflation and economic growth remains controversial or somewhat inconclusive, general empirical studies confirm the existence of either a positive or negative relationship between these two major macroeconomic variables. Moreover, with time, a general consensus evolved that low and stable inflation promotes economic growth and vice versa (Mubarik, 2005). This further raises the questions how low inflation should be. The answer evidently depends on the nature and structure of the economy and varies across countries. In this regard, recently macroeconomists have adopted an econometric technique simply by looking at a nonlinear or structural break effect which states that the impact of inflation on economic growth could be positive up to a certain threshold level and beyond this level the effect turns to be negative (Sweidan, 2004). This supports both the view of the structuralists and the monetarists up to a certain extent, that is, low inflation is helpful for economic growth but once the economy achieves faster growth then inflation is detrimental for the sustainability of such growth.

At very low rates of inflation (around 2-3 percent a year or lower) inflation and growth are positively correlated. Other wise, inflation and growth are negatively correlated, but the relationship is convex, so that the decline in growth associated with an increase from 10 percent to 20 percent inflation is much larger than that associated with moving from 40 percent to 50 percent. Their policy message suggests that even lowering moderate inflation rates can yield gains in GDP growth of up to 0.8-0.9 percentage points.

Sarel (1995, 1996) finds that there is evidence of structural break that is significant. The break is estimated to occur when the inflation rate is 8 percent. Below that rate, inflation does not have any significant effect on growth or it may even have a slightly positive effect. When the inflation rate is above 8 percent, however, the estimated effect of inflation on growth rates is negative, significant, robust and extremely powerful.

Fario and Carneiro (2001) find a zero long-run response of output to a permanent inflation shock in the context of a high inflation country, in this case Brazil. The results could be considered as evidence against the view that inflation and output are reliably related in the long run. These results are argued to support Sidrauski's (1967) super neutrality of money in the long run in that inflation does not affect long-run growth. However, in the short-run, it did provide contradictory evidence against Sidrauski's model. In the short-run, there is a negative impact of inflation on output.

Bruno and Easterly (1995) found a negative relationship between inflation and growth, which is firmly established when looking at the temporal association of growth with discrete high inflation crises. However, they found the case for growth effects of low to moderate rates of inflation very much ambiguous. According to the results obtained, causality remained problematic, but their results are consistent with the view that costs of inflation only become significant at relatively high rates of inflation. At lower rates of inflation, growth and inflation may simply be jointly affected by various demand and supply shocks and hence shows no consistent pattern.

From the findings of most of the papers cited in the foregoing paragraphs, the confidently repeated claim that nothing but price stability or very low inflation can maximize the level or growth rate or the standard of living goes far beyond the current state of knowledge.

CHAPTER THREE

INFLATION AND ECONOMIC GROWTH IN ETHIOPIA

This chapter deals with the relationship of inflation and economic growth in Ethiopia. To this end, section 3.1 tries to introduce the Ethiopian economy. Section 3.2 deals with the trend of inflation in Ethiopia in recent years and section 3.3 focuses on the performance of the economy.

3.1. Introduction to the Ethiopian economy

Starting from 1992 the government of Ethiopia has been introducing numerous reforms aimed at improving macro economic stability, accelerating economic growth, and reducing poverty. Tariffs have been reduced, quota constraints relaxed, licensing procedures simplified, foreign exchange controls eased, compulsory grain delivery and forced membership to cooperatives discontinued, a privatization process began, private banks flourished, interest rates decontrolled, and an inter-bank money and foreign exchange markets were introduced (Alemayehu and Tadese, 2004).

The other important departure from the past trend was the abandonment of planning, as an explicit mode of government economic policy formulation and implementation. However, beginning from 2002 the Ethiopian government has adopted a development strategy centered on the principal goal of poverty reduction. This strategy is officially coined as **sustainable development and poverty reduction program**. To achieve this program, the government has launched deeper fiscal decentralization, judicial and civil service reform, and pubic sector capacity building erected. By the beginning of the 1990s, the Ethiopian economy was in deep crisis. There were economic woes and chaos right after the demise of the military junta.

Economic reforms, initiated in 1988 by the Dergue government as a 'mixed economy' alternative to the controlled economy, were further implemented and took on the form of a structural adjustment program (SAP) with donor support from 1994. The return to relative peace after the defeat of the Dergue and the installation of an EPRDF government in 1991 provided an opportunity for recovery (Dercon, 2000).

Early measures taken by the current government included agricultural market liberalization, price liberalization, a large devaluation, tax reforms, and some steps towards international trade liberalization. During the latter part of the 1990s, reforms focused more on financial market liberalization, privatization, fertilizer market reforms, and initiatives regarding input and extension delivery. Sectoral policies included plans related to education, roads, health, and agricultural extension, mainly involving substantial donor financed capital expenditure (Dercon, 2000).

3.2. The Trend of Inflation in Ethiopia in Recent Years

In the past three years or so, Ethiopia has been experiencing a growing rate of overall inflation which is mainly caused by persistently high food price inflation. The food price inflation has pushed overall inflation into double digit figures; currently well above 20 percent (MOFED, 2006)

It has been the case in Ethiopia for food prices to be negatively correlated with agricultural output or availability of rainfall. The current food price development is unusual because the country has registered bumper harvest for four successive years.

Inflation has been low in Ethiopia for the most part of its past history. Prices were stable albeit bad weather sometimes led to unprecedented price variations.

During the Imperial era, inflation was not a problem in Ethiopia. The military Junta, i.e. the de facto Derg regime, also deliberately controlled prices artificially..

However, recently due to the various economic reform measures and pressures of international price hikes such as the price of oil and other materials, inflation is rising unabated.

Until recently, Ethiopia has been a low inflation country in sub-Saharan Africa. This was achieved due to a strong currency, prudent monetary and fiscal policies (1960s-1973), general price control (1974-1992) and implementation of economic reform and stabilization programs (1992-2005). The historic peak level of inflation has been 21 percent (NBE, 2006), which was recorded in 1991/92, mainly due to the severe drought that hit agricultural production the most and absence of peace in the country. On the other hand, a significant deflation was observed during fiscal year 2001/02 (-7.2 percent) basically due to the decline in food prices associated with the bumper agricultural production following the good weather condition of the period.

Table 3.1: Annual average inflation rates (in %)

National	*2003/04*	*2004/05*	*2005/06*	*Change in point*	*Percentage*
Item	*A*	*B*	*C*	*C-A*	*C-B*
Genera	*8.6*	*6.8*	*12.3*	*3.7*	*5.5*
Food	*11.6*	*7.7*	*14.0*	*2.2*	*6.3*
Non-food	*2.8*	*5.2*	*8.0*	*5.2*	*2.8*

Source: Central statistical agency and NBE

The deflationary situation observed during fiscal year 2001/02 continued until October 2002 after which prices continued to escalate at a significant pace reaching 15.1 percent by the end of 2002/03 fiscal year. The increase further continued and reached a peak level of 18.6 percent in October 2003. Since November 2003, however, the national annual average general inflation was on a continuous decline registering 8.6 percent annual average by the end of fiscal year 2003/04. Despite the relatively good weather conditions and better harvest in 2004/05, the price decline lasted until November 2004. Beginning from December 2004 on wards, for 12 months, general inflation has been steadily on the rise up to December 2005 characterized by fluctuation in the first six months of 2006.

Such developments in 2004/05 and 2005/06 were quite unusual in that price increase has been observed despite good agricultural produce. Moreover, non-food or core inflation, which takes up to 40 percent of the General CPI at country level, registered a significant increase influencing the upward movement of the general price level. Accordingly, general inflation at the end of fiscal year 2005/06 reached 12.3 percent, food inflation 14.0 percent and core inflation, as proxied by non-food prices 8.0 percent from their respective levels of 6.8., 7.7, and 5.2 percent in 2004/05 (NBE, 2007).

The increase in core inflation was basically due to the increase in house rent, prices of construction materials, water, and fuel and power subgroup of the CPI in connection with the increase in import prices of fuel and construction materials. Moreover, increasing prices of locally produced construction materials such as cement had also considerable impact on the inflation rate of the non-food items.

Fig1. Inflation and economic growth since 1992

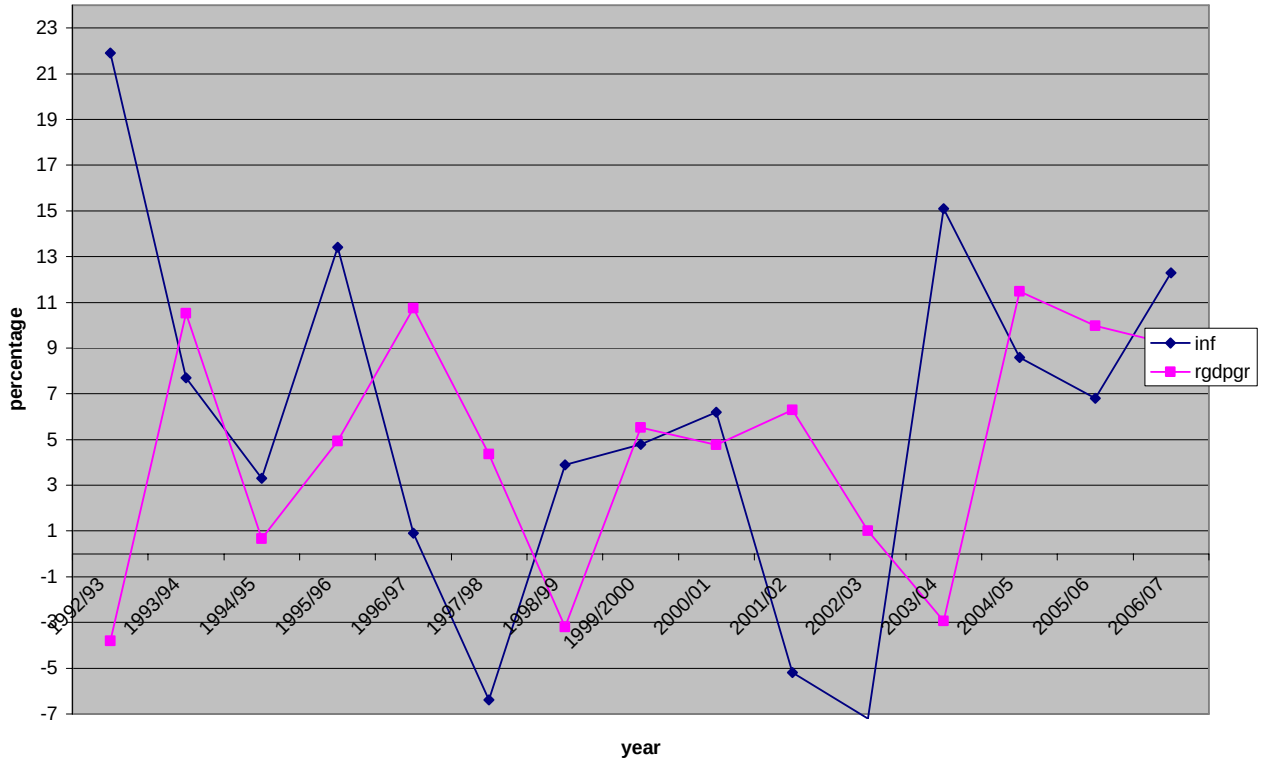


Table 3.2: National level average commodity price indices

Item	*Year*				
	2003/04	*2004/05*	*2005/06*	*Percentage Change*	
	A	*B*	*C*	*C/A*	*C/B*
General	*120.0*	*128.2*	*143.9*	*19.92*	*12.25*
Food	*129.4*	*139.3*	*158.8*	*22.72*	*14.00*
Cereals	*152.7*	*163.9*	*191.1*	*25.15*	*16.60*
Pulses	*117.4*	*119.6*	*124.9*	*6.39*	*4.43*
Oil and Fats	*126.2*	*127.4*	*126.2*	*0.00*	*-0.94*
Vegetables fruits	*117.2*	*118.3*	*132.4*	*12.97*	*11.92*
Non-fruits	*104.6*	*110.1*	*118.9*	*13.67*	*7.99*
Non-food	*99.5*	*100.3*	*107.2*	*7.74*	*6.88*
House rent & others	*112.7*	*123.2*	*139.1*	*23.43*	*12.91*

Source: CSA & NBE

3.2.1. Consumer price Development in regional states

Overall inflation increased in all regional states. The lowest regional inflation was registered in Afar (7.7 percent) and the highest in Gambella (17.6 percent).

In all the regions, the rising food inflation contributed significantly to higher overall inflation it was only in Tigray, Amhara, SNNP, Gambella and Benishangul Gumuz regions that non-food inflation had moderate influence on inflation rate.

Table 3.3: Regional Average Annual Inflation (2005/06 F.Y)

Region	*General*	*Food*	*Non-food*
Afar	*7.7*	*12.0*	*5.4*
Amhara	*13.3*	*14.6*	*9.9*
Benishangul	*8.0*	*8.6*	*6.7*
Dire Dawa	*11.0*	*13.6*	*7.1*
Gambella	*17.6*	*16.2*	*20.1*
Harari	*12.5*	*15.9*	*6.7*
Oromia	*10.1*	*12.6*	*4.2*
SNNP	*15.3*	*15.6*	*15.0*
Somalia	*13.6*	*20.2*	*3.4*
Tigray	*12.5*	*12.4*	*12.2*
Addis Ababa	*8.4*	*13.0*	*4.8*

Source: CSA & NBE

3.3. The performance of the Ethiopian Economy

In many ways, the performance of the Ethiopian economy has been remarkable in the recent decade. First, the transition from war to peace and from a controlled economy to more market-oriented economy in the early 1990s has been relatively smooth and accompanied by a quick return to broad macroeconomic stability. By the mid-1990s, a rapid convergence of the parallel

market exchange rate took place, while inflation was generally within one digit during this period, despite a large devaluation and domestic price liberalization. The fiscal deficit was also kept within reasonable bounds. Secondly, growth in GDP has been rather impressive between (fiscal years') 1990 and 2000, the economy grew by 4 percent per annum on average but limiting the period to 1993 to 2000, the growth rate was 5.2 Percent per year (Dercon, 2000). Ethiopia managed to establish fairly good relations with donors, who generally looked favorable on its economic policy decisions and donor support was substantial. The war between Eritrea and Ethiopia disrupted the favorable macro economic evolution. Defense expenditure rose quickly to about 10 percent of GDP on average in 1999 and 2000 Most aid flows were frozen, while fiscal stance weakened, resulting in cuts in capital expenditure to social sectors and large increases in domestic financing of the fiscal deficit, risking inflationary pressures(Dercon,2000).

During fiscal year 2005/06, GDP at constant prices grew by 9.6 percent. This high growth was achieved for the third time in a raw (i.e., 105 percent in 2004/05 and 11.9 percent in 2003/04), which places Ethiopia among the top performing economies in sub-Saharan Africa (NBE, 2007). Although all sectors contributed to this relatively high economic growth performance, agriculture stands first growing by 11.2 percent and contributing about 54 percent of the 9.6 percent overall GDP growth. Industry and service sectors also grew by 7.4 and 9.2 percent respectively.

Table 3.4: Sectoral contribution to GDP and GDP growth

Item		Fiscal Year					
		2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Real GDP in million Birr		64343.10	64990.70	62844.90	70345.10	77730.70	85184.10
Sector	Agriculture and allied activities	31438.70	30763.80	27258.00	31978.90	36250.00	40307.50
	Industry	8065.70	8737.10	9003.00	9900.30	10702.50	11496.00
	Services	25510.30	25947.60	27121.80	29093.80	31535.70	34438.40
Growth in Real GDP		7.20	1.00	-3.30	11.90	10.50	9.60
Real GDP per capita		985.00	967.00	909.00		1065.00	1134.00
Share in GDP(%)	Agriculture and allied activities	48.40	47.00	43.00		46.20	47.30
	Industry	12.40	13.30	14.30		13.80	13.50
	Services	39.60	39.90	43.20		40.60	40.40
Growth in Real GDP per capita		4.60	-1.80	-6.00		7.60	6.50
Agriculture and allied	Absolute growth	10.40	-2.10	-11.40		13.40	11.20
Industry	Contribution to GDP growth	5.00	-1.00	-5.40		6.00	5.20
Services	Contribution in %	70.60	-103.10	162.20		57.30	53.90
Industry	Absolute growth	5.10	8.30	10.00		8.10	7.40
	Contribution to GDP growth	0.60	1.00	1.40		1.10	1.00
	Contribution in %	9.00	103.70	12.00		10.90	10.60
Services	Absolute growth	3.80	1.70	7.30		8.40	9.20
	Contribution to GDP growth	1.50	0.70	3.10		3.50	3.70
	Contribution in %	21.30	67.50	-54.70	26.30	33.10	38.90

Source: MOFED & NBE

Note: Sectoral contributions will not add-up to overall GDP growth because of financial intermediary service indirect measurement (FISIM)

Ethiopian has registered continuous growth in the last four fiscal years. Recovering from the severe draught shock of EFY 1995 (2002/03), the economy continues to register a robust growth rate of 9.6 percent in real GDP during 2005/06. While the corresponding growth recorded in 2004/05 and 2003/04 were 10.5 and 11.9 percents respectively

The positive evolution of the Ethiopian economy in the 1990s has been a recovery from low GDP capita levels as compared with the early 1980s. In table 3.5, it can be seen that per capita GDP was by the mid 1990s still below the levels of the beginning of the 1980s.Only from 1996, real GDP per capita has passed the levels of the early 1980s.

Other indicators show that the recent years may not have been as systematically different from earlier periods. Throughout the 1980s, inflation had remained low .Government expenditure, revenue and deficits in the late 1990s also were not very different from the levels in the late 1980s. Only the form of financing had changed so that between 1994 and 1998, external assistance (grants and lending) provided a higher share than domestic borrowing. Overall, the performance does not look impressive in contrast with the situation in the early 1980s. Nonetheless, the data on exports and gross investment suggest that a more structural change has occurred, even taking into account that the figures for 1994-1997 for exports are affected by rather unusual movements in coffee prices.

Table 3.5: Macroeconomic Indicators,1982-1999

Year	*Real GDP per capita*	*Inflation (in %)*	*Trade as % of GDP*		*Fiscal performance (as % of GDP)*		*Financial deficient (as % of GDP)*		*Gross capital Formation*	
			Export	*Trade balance*	*Gov't revenu*	*Fiscal deficit*	*Domestic*	*External assistance*	*as% of GDP*	
1982-84	*240*	*5*	*10*	*-8*	*26*	*19*	*-7*	*4*	*4*	*14*
1985-87	*217*	*2*	*9*	*-8*	*25*	*19*	*-6*	*3*	*3*	*14*
1988-90	*237*	*7*	*8*	*-6*	*30*	*22*	*-8*	*4*	*4*	*16*
1991-93	*214*	*17*	*6*	*-9*	*21*	*12*	*-9*	*5*	*4*	*11*
1994-96	*232*	*4*	*13*	*-11*	*25*	*16*	*-9*	*0*	*8*	*17*
1997-99	*251*	*-1*	*16*	*-9*	*25*	*19*	*-6*	*1*	*5*	*17*

Table 3.6: Macro economic indicators, 1982-2000

Source: IMF financial statistics (CD-ROM)

N.A = not available (assigned)

3.3.1. Gross Domestic Product by Sectors of the Economy

In terms of sectoral distribution, agriculture has remained the major constituent of the economy contributing about 47.3 percent of the country's GDP followed by service and industry each accounting for 40.4 and 13.5 percentage share respectively in 2005/06 (NBE, 2007).

The bulk of agricultural output and value-added is generated by peasant production again emphasizing the significance of peasantry in the country. Of this peasant production, highland peasant farming is of a paramount importance.

As a whole, economic growth in Ethiopia has been highly associated with the performance of the agricultural sector. Nevertheless, the growth of the agricultural sector is unpredictable and erratic due to its dependence on rainfall and other vagaries of nature.

The increase in the 2005/06 agricultural outputs can largely be attributed to improved farmers productivity achieved through better utilization of modern agricultural inputs like selected seeds, fertilizers and the favorable weather condition in the year.

The crop sub-sector has been the major engine of growth in the agricultural sector. The non-agricultural sector of the economy combined registered 8.8 percent expansion during 2005/06. This was the combined effect of the 7.4 and 9.2 percent increase achieved in the industry and service sector.

The three year average growth of value added in the manufacturing sector was also 7.5 percent. While, public sector value added, particularly in the education and health sectors, registered a three year average growth rate of 12 and 13 percents respectively.

The recorded 7.4 percent growth of the industry sector largely came from the electricity and water sub-sectors which rose by 10.8 percent. The tremendous investment in hydroelectric power generating stations and expansion activities by the Ethiopian Electric and Power Corporation (EEPCO) has enhanced the growth in electricity.

Manufacturing, which accounts for about 40 percent of the industry sector value added, is heavily dominated by food, beverage, and textile industries .Output from this sub-sector, which comprises cottage and handicrafts, small, medium and large-scale enterprises, went up by 8.1 percent in the year under discussion.

The share of the service sector has been growing up steadily in recent years reaching 40 percent in the stated year. This was mainly the result of the fast growth of the financial intermediation and education sub-sectors, which registered an annual average grown rate of 13.6 and 11 percents in the last five years respectively.

CHAPTER FOUR

METHODOLOGY AND ECONOMETRIC MODELING

To empirically investigate the relationship between inflation and economic growth in Ethiopia, econometric model will be developed that captures both the short-run and long-run dynamics.

The model developed here to empirically examine the relationships between inflation and economic growth in Ethiopia is a variant of the error correction model developed by Shamim and Golam (2005) for Bangladesh.

4.1. Model specification

This section develops econometric models for inflation and economic growth separately to assess the factors that determine each variable individually.

4.1.1. The inflation equation

Ethiopia's economy is predominantly agrarian. The mainstay of the majority of the population is agriculture which is highly vulnerable to the vagaries of nature. As a result the GDP of the country is erratic since the type of agriculture widely practiced is rain-fed. Moreover, as explained in the introductory chapter, movements in price follow the pattern of output in the economy. When there is good yield and Mother Nature turns to be bounty, prices fall.

It is difficult to identify a single cause for the current high inflation in Ethiopia. However, some of the most plausible factors that are supposed to be behind the escalating price , on theoretical ground, are given below.

To empirically analyze the factors that affect (determine) inflation, a general specification of the inflation equation is provided below.

$$INF_t = f(RGDP, M2, R, FISBAL, WCPI, REER, DEXR, CPI_{t-1} REM, \mu)$$

Where

INF_t=Inflation Rate at time t

RGDP = Real Gross Domestic Product as a proxy to real income at 2000 prices

M_2 = Money Supply or broad money

R : interest rate (lending)

FISBAL:fiscal balance

REER : Real Effective Exchange Rate

WCPI :World Consumer Price Index or Price of major trading partners

DEXR :Dummy for exchange rate or devaluation

REM:Remittance

μ_t :Disturbance term

CPI_{t-}:Consumer Price Index at time t-1 to capture expected inflation, inflation inertia

Real money supply can be derived by dividing the nominal money supply by CPI.That is,

RM2=M2/CPI where RM2: Real Money Supply

It is a common practice in the economic literature to take the logarithm of variables. Adopting this practice gives the logarithmic function. This is done in order to avoid or eliminate the problem of heteroskedasticity. In addition, it helps us to arrive at the elasticities of the variables.

$$lncpi_t = \alpha_0 + \alpha_1 lnrgdp_t + \alpha_2 lnrm_{2t} + \alpha 3lnr_t + \alpha_4 fisbal_t + \alpha_5 lnwcpi_t + \alpha_6 lnreer_t + \alpha_7 dexr + \alpha_8 rem + \alpha_9 lncpi_{t-1} + \mu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

N:B. α_S are the coefficients of the respective variables to be estimated.

Henceforth, lower case letters are utilized to represent logarithmic values and growth rates of the variables. Besides, the first difference of CPI and inflation rate is interchangeably used.

$$INF_t = \alpha_0 + \alpha_1 dlnrgdp_t + \alpha_2 dlnm2_t + \alpha_3 dlnr_t + \alpha_4 dfisbal_t + \alpha_5 dlnwcpi_t + \alpha_6 dlnreer_t + \alpha_7 dexr + \alpha_8 drem_t + \alpha_9 dlncpit_{-1} + \mu_t \text{ ----------(4.2)}$$

dfisbal=the first difference of fiscal balance. The other variables are the natural logarithms of their respective representations given above.

Econometric theory requires that the partial derivatives of the explanatory variables of inflation satisfy certain conditions. In other words, based on a priori economic theory the coefficients of RGDP, money supply, , government expenditure, price of major trading partners, real effective exchange rate, and expected inflation are supposed to be positive. However, the sign of real GDP growth rate and interest rate is likely to be negative.

4.1.2. The Growth equation

The growth model is derived from the aggregate production function which depends on labor and capital but also encompasses other variables.

$$Yt = A_t K_t^{x} (H_t)^{B} (L_t)^{1-x-B} \mu_t \quad \text{..... (4.3)}$$

It is supposed that variables like the growth rate of population, investment rate, and government expenditure, growth of export, inflation rate, and weather condition are some of the most plausible factors that influence the growth rate of an economy.

Y_t is output at time t

K_t is physical capital at time t

H_t is human capital at time t

l is labor input at time t

A_t is exogenously determined level of aggregate productivity or total factor productivity (TFP) at time t.

Taking log differences, the relationship for long-term growth can be specified as

$$(\log y_t - \log y_{t-1}) = (\log A_t - \log A_{t-1}) + x (\log K_t - \log k_{t-1}) + (1-\alpha-\beta) (\log L_t - \log L_{t-1}) + B(\log H_t - \log H_{t-1}) + \log \mu_t - \log \mu_{t-1} \ldots\ldots\ldots \text{ (4.4)}$$

Specifically the growth equation can be modeled as follows

$$GDPGR_t = f (GRPOP, RTINVR, TGE, REXV, INf, PSSER, DWECON, e_t)$$

Where

$GDPGR_t$: RGDP growth rate at time t

RTInv rate: Real Total investment

PSSER: primary and secondary school enrolment rate

TGE: Total Government Expenditure

REXV: Real Export Value

INF: Inflation Rate

Dwecon: dummy for Weather Condition

ε_t: error term at time t

Endogenous growth models allow a linkage between public policies and growth in the long-run by assuming aggregate production functions that exhibit non-decreasing returns to scale. Replacing, the log difference in human capital, alternatively, by primary and secondary school enrollment rate. We extend the growth model in (4.4) where ***y*** is expressed as real per capita GDP growth (log difference) to include policy and structural variables as regressors.

Hence, the model for the empirical analysis is presented as follows.

$$rgdpgr = \beta_0 + \beta_1 1dlnpopt_t + \beta_2 dlnrtinv_t + \beta_3 dlntge_t + \beta_4 dlnrexv_t + \beta_5 inf_t + \beta_6 dlnpsser + \beta_7 Dwecon + \eta_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.5)$$

Once, the equations are estimated individually and all the necessary tests are undertaken, the ECM is formed as given below.

4.2. Co-integration and error correction model

The error correction model (ECM) test is essential to see whether an economy is converging towards equilibrium in the long run or not. The ECM also shows short-run dynamics.

To examine the extent to which economic growth is related to inflation and vice versa, the theory of co integration and error correction model (ECM) is applied. With the help of this procedure it is possible to examine the short-run and long-run relationships between the two variables. The Engle-Granger (1987) two-step co integration procedure is used to test the presence of co- integration between the two variables.

The paper basically employs two econometric models to achieve the empirical results. The first one examines the short-run and long-run relationships between real GDP and CPI by applying co integration test the associated Error correction model (ECM)
The relationship between real GDP and CPI in turn implies the relationship between inflation and economic growth.

In the first stage, to test for the unit roots of the concerned time series variables, four popular techniques have been adopted. Namely:
The Dickey- Fuller (DF,) test
The Augmented Dickey Fuller (ADF) test
The Phillips Perron (pp) test
Kwiatkowski-phillips-Schmidt-shin (KPSS) test

These tests have been performed in the levels (i.e., log levels of the relevant variables) as well as in the first difference. If the two time series are integrated of the same order then the estimation of the following co integration regression will be valid.

$$INF_t = \alpha_0 + \alpha_1 dlnrgdp_t + \alpha_2 dlnm2_t + \alpha_3 dlnr + \alpha_4 dfisbal_t + \alpha_5\ dlnwcpi_t + \alpha_6 dlnreer_t + \alpha_7 dexr + \alpha_8\ dlnrem_t + \alpha_9 dlncpit_{-1} + \mu_t \text{ ---(4.6a)}$$

$$rgdpgr = \beta_0 + \beta_1 1 dlnpopt_t + \beta_2 dlnrtinv_t + \beta_3 dlntge_t + \beta_4 dlnrexv_t + \beta_5 inf_t + \beta_6 dlnpsser \quad \beta_7 Dwecon + \varepsilon_t \text{ ……(4.6b)}$$

U_t and ε_t are random error terms

Inflation rate and growth rate are used because these variables are found to be stationary unlike the CPI and GDP levels which are non-stationary.

Furthermore, the Real GDP Growth Rate i.e. rgdpgr, is approximated by dlnrgdp, which is the first difference of the logarithm of real GDP and inflation rate has been defined as dlncpi= INF_t in the subsequent parts of the paper. d stands for the first difference operator.

rgdpgr: Real GDP Growth Rate

INF: INFLATION Rate

In the second stage, the Error corrective model (ECM) is employed to see whether the economy is approaching equilibrium in the long-run or not and the short-run dynamics of the co-integrated time-series variables. The error correction model is internally consistent If the two time series variables are co-integrated of the same order or if they are stationary (Greene, 2003: 654).

To determine the non-stationary property of these time series variables, both in the levels and in the first difference, at first, the relevant DF, ADF tests have been employed with and without a time trend.

The ADF test is a modification over the DF test and lagged values of the dependant variables are added in the estimation of equation.

It is widely believed that both DF and ADF tests do not consider the cases of heteroskedasticity, and non-normality frequently revealed in raw data of economic time series variables. Thus, the **PP test** for unit root has been used in the empirical analysis.

Moreover, it has an advantage over the ADF test when the concerned time series has serial correlation and there is a structural break. Therefore, the pp test provides robust-estimates over the DF and ADF.

The DF, ADF, PP, and KPSS unit root tests have been employed for the residuals of equations (5.1) and (5.3) i.e. ε_t and μ_t the appropriate critical values of the t-statistics for the null hypothesis of non-stationarity are given by Mackinnon (1991).

When residuals are found to be integrated of order zero, I(0). Then it can be concluded that the series are co-integrated and thus a valid and stable long-run relationship exists between them. This also implies the existences of a stable long-run relationship between inflation and economic growth.

Similarly, the Johansen maximum likelihood test procedure is used for testing the co-integrating relationship between the concerned time series variables. This procedure gives two likelihood ratios (LR) test for the number of co-integrating vector, namely the trace test and the maximum Eigen value test.

Engle and Granger (1987) show that if two variables are co-integrated i.e., there is a valid long-run relationship, and then there exists a corresponding short-run relationship. This is popularly known as the Granger's Representation Theorem.

A vector Autoregressive (VAR) model for dlnrgdp and dlncpi is developed as follows.

$$Dlnrgdp_t=\Phi_{10}+\sum_{j=0}^{S}\Phi_{11j}dlncpi_{t-j}+\sum_{i=1}^{q}\Phi 1_{2i}dlnrgdp_{t-j}-\Theta_1\varepsilon_{t-1}+e_{1t}\text{------} \quad (4.7)$$

$$Dlcpi_t=\Phi_{20}+\sum_{j=0}^{S}\Phi_{21j}dlnrgdp_{t-j}+\sum_{i=1}^{q}\Phi 1_{2i}dlncpi_{t-i}-\Theta_2\varepsilon_{t-1}+e_{2t}\text{---------} \quad (4.8)$$

Where, d stands for the first differences operator, θ_1, θ_2 are the error correction terms,e_{1t} and e_{2t} are the random disturbance terms, and S and q are the number of lag lengths determined by the AKaike's information criterion (AIC).

The second model is developed to estimate the threshold level of inflation for Ethiopia above which inflation affects economic growth negatively.

Threshold Model Specification

The model is developed by Khan and Senhadji (2001) for the analysis of threshold level of inflation for industrialized and developing countries. Following the aforementioned work, this study is based on four-variable model consisting of economic growth, inflation, population growth rate and investment growth rate.

Population and investment growth rates are used as control variables.T he reason for choosing these variables is their authenticity in empirical literature on growth. Solow (1956) and Swan (1956) who developed the first neo-classical models of growth, take the rate of growth of population as one of the exogenous variables in their model to show that the faster the rate of population growth, the poorer the country. Fischer (1993) includes investment in his model to show that inflation reduces growth by reducing investment and productivity growth. Moreover, Mankiw et.al. (1992) also include investment growth and population growth in their growth model.

The threshold level of inflation is based on the following equation:

$$rgdpgr_t=\beta_0+\beta_1 inf_t+\beta_2 D(inf-K)+\beta_3 popgr_t+\beta_4 investgr_t+\mu_t \quad \text{..... (4.9)}$$

Where

popgr: population growth rate

Investgr: investment growth rate

μ: *error term*

Economic growth and inflation are computed as:

rgdpgr=100*d(lnrgdp)

inf=100*d(lncpi)

Growth rates for population and investment are computed using similar method.

Where, K is the threshold level of inflation (i.e., the rate of inflation at which structural break occurs) and μ_t is the random error term which represents measurement error in the explanatory variables. The dummy variable D is defined in the following way:

D = 1 if inf > K

= 0 if inf$\leq$ K

When population growth rate and investment growth rate are omitted from the model formulation,the equation to estimate threshold level of inflation can be written in the following conditional form:

$$rgdpgr_t=\beta_0+\beta_1 inf_t+\beta_2 D(inf-K)+\mu_t \quad \text{.....(4.9i)}$$

The coefficient of the dummy variable β_2 measures the effect of inflation rate on the economic growth when it is greater than the assumed structural break level (i.e., inflation is high) and the opposite for the coefficient of inflation rate β_1.In the above threshold model, the sum of the two coefficients ($\beta_1+\beta_2$)represents the annual growth rate of economic growth when inflation rate is doubled. By estimating regressions for different values of **K** which is chosen in an ascending order (i.e., 1, 2 and so on), the optimal value of K is obtained by finding the value that maximizes the $\mathbf{R^2}$ from the respective regressions. This also implies that the optimal threshold level is that which minimizes the

residual sum of squares (RSS). This procedure has become widely accepted in the literature on this topic. However, the process is tedious since it requires the estimation of the equation several times for different values of K.

4.2.1 Co- integration: The Engle-Granger Approach

Co-integration was developed by Granger (1981) and was further elaborated by Engle and Granger (1987). It addresses the issues of integrating short-run dynamics with long-run equilibrium. The presence of co integration implies that even if the dependent and the independent variables are non-stationary, the deviations (i.e., the residuals from the estimation of the equation) are stationary. According to Engle and Granger, if there is co-integration, the equation with non-stationary variables is best estimated by the Error correction model (ECM) for long-run equilibrium and short-run dynamics. .co integration refers to a situation of a long-run equilibrium relationship between variables that do not drift too far apart over time. In a two variable case, $\boldsymbol{X}$ and $\boldsymbol{Y}$, it occurs if:

i) both $\boldsymbol{x_t}$ and $\boldsymbol{Y_t}$ are integrated of the same order d: and

ii) There exists a linear combination of $\boldsymbol{X_t}$ and $\boldsymbol{Y_t}$ which is integrated of order'd'.

In multivariate case, co integration is possible when

a) The two variables are integrated of the same order.

b) The order of integration of the dependent variable is not greater than the order of integration of any of the explanatory variables. In addition there should be one or at least two explanatory variables integrated to an identical order or higher than that of the dependent variable.

The Engle-Granger procedure has two steps. Explanation of the equilibrium part of the ***ECM*** in order to establish whether the variables are co-integrated is the first step. One can be sure of co integration if the following results are obtained; high R^2 (close to unity), significant coefficients, a significantly non- zero co-integrating regression DW statistic and significant ***DF*** and ***ADF tests*** of residual from the levels' regression. The coefficient estimate from the levels' or static regressions can be interpreted as the long-run effects.

A series with no deterministic component which has a stationary invertible ARMA representation after differencing d times is said to be integrated of d, denoted by $Y_e \sim I$ (d). If it is true that two series are integrated, we can try to analyze if they are co-integrated. Granger and Engle (1987) consider that the components of the vector Y_t are co integrated of order (d, b) denoted by $Y_t \sim CI(d, b)$ if :

i) are the components of Y_t are ***I(d):*** and

ii) there exists a vector α given that $\alpha \neq o$ such that

$Z_t = \alpha' Yt \sim I(d,b), b>0$

The vector α is called the co-integration vector. The second step in the Engle-Granger two stage-procedures is the process of adding the lag of the residual from the levels' regression to the differenced variables to re-run the regression. This second step yields the ECM or the short-run model.

The chow test statistics (1960) will be used to test for the stability of the co-integrating regressions.

4.2.2. The Error Correction Mechanism (ECM)

Economic theory is usually concerned with the relationship between variables. Thus, differencing a series has to be dealt with in the context of regression model rather than separately. An Error Correction mechanism provides a room for considering both short-run and long-run factors while modeling differenced series. This takes the form of:

$\Delta Y_t = r\Delta X_t + \alpha(Y_{t-1}-\beta x_{t-1}) + \mu_t$ ……. for short run relationship .This is an ECM of a two variable case. It relates the change in y to changes in X and e_{t-1} $(=Y-Bx)_{t-1}$. The coefficient α shows the degree of adjustment of the dependent variable to its long-run solution. While α is expected to be negative and less than unity, it serves to influence the short-run movements in the dependent variable.

On top of the aforementioned procedures, other methods include test for structural break problem, multi-collinearity, and autocorrelation.

4.3. Data sources

Most of the data are obtained from the National Accounts of the Minority of Finance and Economic Development (MOFED). Other sources include the publications of the central statistical Authority (CSA) and the National Bank of Ethiopia (NBE).

The data set include: gross fixed capital formation (investment). Primary and secondary school enrollment rates as a proxy to measure human capital, population, and other conventional and policy related variables. The data cover 1971-2006.

In studies of this type, country specific time series data would help to identify country specific problems. Besides, most of the macro economic variables vary over time and may have an impact on changes in per capita GDP.

Because of data constraints it has been attempted to proxy the variables relevant to the growth model by the variables which are observable or quantifiable. For instance, in lieu of physical capital stocks in GDP, gross investment growth rates are used as a proxy. Moreover, human capital has been proxied by primary and secondary school enrollment rates. Data on labor force are usually unavailable and hence population is used as a proxy.

Periods of unfavorable weather condition, change of exchange rate and structural reform measures are taken care of using different dummies.

The data for the growth rates of the variables used in this study have been generated using the following simple formula:

$$dlnx = lnx_t - lnx_{t-1}$$

Where dlnx: the difference of the natural logarithm of variable x

$lnx_{t:}$ the natural logarithm of x at time t

$lnx_{t-1:}$ the natural logarithm of x at time t-1

4.4 Statistical methods and time series issues

R2 and **t- statistic** (value) are of great help to test the equation and the significance of the coefficient, once the variables are known to be co-integrated. Moreover, the residuals of the regression equations are tested for any systematic influence of omitted variables (autocorrelation). Since examining the equation from the point view of serial correlation is required, Lagrange Multiplier test (LM test) is utilized. In order to test significant "bias" in the estimates due to "omitted variables", the specification RESET test is used.

Apart from the usual statistics that are employed to test the model and the significance of the coefficients, time series analysis is carried out.

Most of the variables that one encounters in economics are non-stationary in the sense that the mean and variance depend on time. Working with such variables in their levels will yield a high likelihood for spurious regression results and invalid inferences. However, those

Non-stationary processes/models can be made stationary by differencing them

4.4.1. Stationary series and integrated process

A time series variables Y_t is said to be stationary if its mean. Variance and auto covariance are independent of time and

$\mathbf{E(y_t) = \mu}$

$\mathbf{Var\ (Y_t) = \sigma^2}$

$\mathbf{Cov\ (Y_t, Y_{t-j}) = \sigma_j}$

When one or more of the above conditions fail, the process Y_t is said to be non-stationary. A time series Y_t which is itself non-stationary but becomes stationary after first differencing.

i.e., $y_t = y_t - y_{t-1} = e_t$

the e_t that defines a stationary process is said to be integrated of order one, denoted by I(1). A series that is stationary, so that differencing, is not required is integrated of order zero, denoted by I(0). Similarly, a non-stationary series which can be transformed to stationary by differencing it "d" times is said to be integrated of order "d" i.e.,I(d).

4.4.2. Testing for the order of integration

Dickey and Fuller (1981) present a simple method for testing the order of integration based on the unit root test. This method proceeds as follows:

H_o: The variable is random walk (non-stationary with drift or without drift).

HA: The variable is stationary

$Y_t = \gamma + \delta_t + \alpha y_{t-1} + \varepsilon_t$ ---------- (DF)

$Y_t = \gamma + \delta_t + \alpha y_{t-1} + \sum_{i=1}^{T} \theta_j \Delta Y_{T-J} + \varepsilon_t$ ---------- (ADF)

Before employing any estimation technique, it is pertinent to examine the time series characteristics of the economic variables. The issue of stationarity is important because a priori theory suggests that most economic variables are non-stationary (See Adam, 1993).

4.5 Vector Auto regression (VAR) Model

The term auto-regression is used because of the appearance of the lagged value of the dependent variable on the right hand side and the term vector is coined because we are dealing with a vector of two or more variables.

According to Sims (1980) if there is true simultaneity among a set of variables, they should all be treated on an equal footing; there should not be any apriori distinction between endogenous and exogenous variables. This is the rationale (justification) of the foundation of the VAR model.

Nowadays vector auto regression methods have become the poplar choices in most of empirical macroeconometrics. Given the familiarity of VAR, according to Johansen and Juselius (1992) and Enders (1995) a VAR in standard form is represented as

VAR (K) model with lag length of K

$X_t = A_1X_{t-1}+A_2X_{t-2}$ +------+A_kX_{t-k}+ $\mu+\varphi D + E$---------- (4.10)

Where X_t = (Nx1) vector of stochastic non-stationary, or I (1) variables

μ = vector of deterministic components

(i.e. constant and trend)

Ai = (nxn) matrices of coefficient (i. = 1----k)

E_t = an (nx1) vector of error terms.

Tt = 1 -----T (T is the number of observation)

D = is a vector of dummy variables.

VAR modeling is appropriate since past cumulated level of inflation is presumed to affect the growth of the economy and investment. Conversely, when the economy is over heated, it can have an inflationary pressure. As mentioned is the foregoing paragraphs, the distinction of macro variables into endogenous and exogenous on a priori basis is problematic as they affect (influence) each other. Thus, VAR modeling avoids this entanglement (predicament).

4.5.1 Drawbacks of VAR modeling

Despite their advantage and popularity, VAR models can easily become over parameterized as variables are allowed to affect each other in a number of lags. The results could be sensitive to the chosen lag length, although there are many tests that can be used to determine the appropriate number of lags to be chosen.

Furthermore, VAR models focus on forecasting and are less suited for policy analysis .The other great problem with VAR modeling lies in the loss of the degrees of freedom. This problem becomes highly pronounced if the sample size is small.

4.5.2 Vector Error Correction (VEC) Model: the Johansen approach

If the variables to be included in a VAR are non-stationary, integrated of the same order and co-integrated, they can be represented by a VEC model. A variable is non-stationary when its means and variance are time dependent and there is no long-run mean to which the variable converges. The assumptions of classical regression model require that variables are stationary. Very often non-stationary, variables are rendered stationary by differencing. Since models with differenced variables do not cater for existing long-run relationships, the differenced variables must be modeled in a VEC frame work. A VEC model for co-integrated variables takes in to account both the short – run relationships between variables and deviations from the long-run equilibrium relationship.

A principal feature of co-integrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium. In an error-correction model, the short-term dynamics of the variables in the system are influenced by the deviation from equilibrium.

The above model (4.10) can be reparameterized to give a vector error correction model (VECM) that is adding and subtracting (Ak-1, ----A2-A1-I) X_{t-k} from equation (4.10)
”I “being the identity matrix, results in the following specification

$\Delta X_t = \Gamma_1 + \Delta X_{t-1} + \text{----------} \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu + \varphi D + E$ ---------- (4.11)

Simplifying equation 4.2 gives

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \mu + \varphi D + E_t \text{----------} (4.12)$$

Where i=1,--------,k-1, $\Gamma_{i-}(I - \sum_{j=1}^{i} A_j) = \boldsymbol{\Gamma_i}$ is allowed to vary with our restriction.

$$\Pi = -(I - \sum_{j=1}^{i} A_J)$$

The term ΠXt-k contains information about the long run relationship between the variables in the vector. Information about the number of co-integrating vectors is also found in the rank of Π (i.e. the maximum number of linearly independent stationary columns in Π)

4.6 Stationarity and Unit Roots

The standard classical methods of estimation are based on the assumption that all variables are stationary. However; most economic variables are not stationary. Models containing non-stationary variables will often lead to a problem of spurious regression, where by the results obtained suggest that there are statistically significant relationships between the variables in the regression model when in fact all that is obtained is evidence of contemporaneous correlations rather than meaningful causal relations. Furthermore, inferences based on the standard statistical tests (i.e. t and F tests will be invalid) Therefore it is necessary to test for stationarity of time-series variables before running any sort of regression analysis.

Often, non-stationary variables become stationary after differencing. Such a variable is said to have difference stationary process (DSP).Thus, it is possible to estimate using difference of variables if the differences are stationary. But such a procedure gives only the short run dynamics. And there would be a loss of considerable long-run information.

Among the methods of testing the presence of unit roots in the variable, Dickey-Fuller (DF), augmented dickey-fuller (ADF) and Phillip- perron(PP),and Kwiatkowski-Phillips-Schmidt-Shin(KPSS) tests are used in this study. The simplest DF test starts with the following first order autoregressive model.

$Y_{t=}\Phi$ Yt -1+ Ut…….. (4.12.1)

Subtracting Yt -1 from both sides gives

Δ Y t = δYt -1 + Ut ---------- (4.12.2)

Where $\delta = (\Phi-1)$,

The test for stationarity is conducted on the parameters δ.If $\delta=0$ or ($\Phi=1$) it implies the variable Y is not stationary.

The hypothesis is formulated as follows

Ho=δ=0 or (Φ-1),

H1=δ<0 or (Φ<1)

If including a constant (drift) to the regression is suggested, that is

ΔYt =$\propto$ + δYt -1 + U t ----------4.12.3

where $\propto$ is a constant term.

However, if a series contains a deterministic trend, testing for stationarity using equation 4.7.3 is not valid. Therefore it is important to incorporate time trend as follows.

ΔYt=$\propto$ + δYt-1 + BT+Ut----------4.12.4

where T is the trend element.

For the above equations the parameter δ is used while testing for stationalrity where the decision is made using a τ-statistics. If the calculated value of τ is less than the critical value (reported by dickey and fuller) the null hypothesis is accepted and not if otherwise. Rejecting the null hypothesis implies that there exists stationariy. If a variable that is not stationary in levels appears to be stationary after n^{th} difference, then the variable is said to be integrated of order n I (n).However, the DF test has a serious limitation in that it suffers from residual autocorrelation. To amend this weakness, the DF model is augmented with additional lagged first differences of the dependent variable. This is

called augmented dickey fuller (ADF). Thus, incorporating lagged first differences of the dependent term in the above equations gives:-

$$\Delta Y\ t = \delta Yt\text{-}1 + \sum_{i-1}^{k} \theta\ i\ \Delta\ Yt\text{-}1 + \mu\ t \text{----------} 4.12.5$$

$$\Delta Y\ t = \propto + \delta Yt\text{-}1 + \sum_{i-1}^{k} \theta\ i \Delta Y\ t\text{-}1 + \mu t \text{----------} 4.12.6$$

$$\Delta Yt = \propto + BT + \delta Y\ t\text{-}1 + \sum_{i-1}^{k} \theta\ i \Delta Yt\text{-}1 + \mu\ t \text{----------} 4.12.7$$

Where $\propto$ is constant (drift), T is a trend, K is the lag length and $\mu \sim IID\ (0.\sigma^2)$

Taking the variables in first difference form presents only the dynamic interaction among the variables with no information about the long run relationship.

4.6.1 Phillips and Perron-Test

Phillips and perron developed a generalization of the DF procedure that allows fairly mild assumptions concerning the distribution of the errors. Phillips perron procedure can be applied to mixed processes in the same way as the DF tests. But there is no requirement that the disturbance term is serially uncorrelated or homogenous, instead of DF assumption of independence and homogeneity, the Phillips-perron test allows the disturbances to be weakly dependent and heterogeneously distributed. The Phillips-perron test statistics are modifications of the DF test statistics that take in to the account the less restrictive nature of the error process, Enders (1995).

4.7 Co-integration :The Johansen Approach

Co-integrated variables presuppose that a linear combination of their data set is stationary even though the individual series are non stationary. Time series variables may be non stationary but their linear combination may be stationary. In such cases, we say there is co-integration; the Engle granger two step procedures and the Johansen's maximum likelihood estimation procedure are often used.

In the Engle-Granger two-step procedure, variables entering the co-integrating vector are tested for integration of the same order, order one I (1).The first step in this procedure is pre testing the variables for their order of integration. The second step is estimate the long run relationship. The third step in this procedure is to estimate the error correction model (ECM) that is the first difference of the dependent variables regressed on the first differences of the explanatory variables with their appropriate lags and the first lag of the residual obtained in the first step.

The Engle-Granger two-step method is believed to be weak in the testing co-integration among variables for the following reasons. First, it assumes that there is one co-integrating vector even though more than one equilibrium relationship governing the joint evaluation of the variables could be identified. Second, it categorizes variables as endogenous and exogenous with implication of simultaneity problem.

Co-integration test in this paper are conducted by Johansen maximum likelihood estimation procedure since the method is claimed to be superior to the Engle-Granger two step methods. The Johansen method does not require a priori endogenous exogenous distinction among variables and it can also identify multiple co-integrating vectors.

The Johansen procedure sets out to a maximum likelihood procedure for the estimation and determining the presence of co-integrating vectors in VAR system. Vector auto-regression (VAR) is one form of multivariate modeling where no variable in the system is assumed to be exogenous a priori. The starting point in this procedure is formulation of VAR model. (See equation 4.10, 4.11 & 4.12).

The term ΠXt-k contains information about the long run relationship between the variables in the vector. Information about the number of co-integrating vectors is also found in the rank Π(i.e. the maximum number of linearly independent stationary columns in Π).

In this connection, there are three cases worth mentioning.

(i) If the rank of Π is zero, r=0, then all the elements of Xt, are non-stationary, thus, there is no con-integrating relationship between the variables.

(ii) If, however,Π is full rank that is r=p, than all elements of Xt are stationary (the variables are stationary at levels and no error correction formulation is required).

(iii) In the intermediate case r<p, there are r non-zero co-integrating vectors among the elements of Xt and p-r common stochastic trend. If non-zero relationship is indicated by the test, a stationary long run relationship is implied. In the case where, 0<r<p, Π can be factored as (Π=∝β') where, ∝ and β' are both pxr matrices.

The matrix ∝ contains the adjustment parameters while the matrix β' is called the co-integrating matrix has the property that $\beta' x_t \sim I(0)$ where I(0) indicates integrated of order zero. Thus, we can interpret the relations of $\beta' x_t$ as stationary relations among potentially non stationary variables, that is, as co-integrating relations. Hence, in VAR models consisting of "p" variables there can be r=p-1 co-integrating vectors.

In identifying the number of co-integrating vectors, the Johansen procedure provides n Eigen value tests denoted by λ which is also called characteristic root. The magnitude of λ measures the extent of correlation of the co-integrating relations with the stationary elements in the model.

In general, to identify the number of co-integrating vectors in the system, the lambda matrix(λ max) and lambda trace (λ trace) statistics are used to determine the rank of Π,the maximum likelihood estimation procedure developed by and Johansen and Juselius(1992) are used. In the case where the rank of Π=r-p is true and we have Π=∝β', the column of β' after normalization represents long run parameters relating the variables in their equilibrium situation.

The matrix $\propto$ represents the error correction parameters, which measure the speed of adjustment from temporary disturbances in the equilibrium relation.

The test for the number of Eigen values that are not significantly different from unity can be conducted using the following two test statistics.

$\lambda trace(r) = -T\sum ln(1- \lambda\hat{}i)$----------(4.13.1)

$\lambda max (r, r+1) = -Tln(1-\lambda\hat{}r+1)$----------(4.13.2)

Where $\lambda\hat{}$ are estimated eigen values obtained from estimated Π matrix.

λtrace tests the null hypothesis that the number of co-integrating vectors is $\leq$ r against a general alternative.

λmax tests the null that the number of co-integrating vectors is r against the alternative r+1, T is the sample size.

The distribution of this test is non standard and depends only on the degrees of freedom (n-r).Johansen and Juselius (1992) provide the critical values of λmax and λ_{trace} statistics obtained using simulation studies.To test the hypothesis, compare the calculated statistics above with the tabulated ones.

4.8:Weak Exogeneity Test

Fully efficient estimation and inference takes place conditional on the fundamentals that the independent variables are weakly exogenous with respect to the parameters of interest. A likelihood ratio test (LR-test) for weak exogeneity is employed by imposing a zero restriction on the $\propto$ coefficient. This is simply a test whether the speed of adjustment of $\propto$ is different from zero in the equations for the variables tested.

CHAPTER FIVE

DATA ANALYSIS AND INTERPRETATION OF RESULTS

5.1 INTRODUCTION

In the preceding chapters, we have emphasized on the relationship between inflation and economic growth in Ethiopia. This chapter relies on an econometric analysis of the relationship between the two variables. Equations are estimated in log form to allow for an immediate interpretation of the coefficients in terms of elasticities.

In this chapter, both the Engle-Granger two-stage method and the Johansen Co-integration test method are used. Moreover, the Ordinary Least Squares (OLS) and Vector Error Correction (VEC) model methods are used to examine the determinants of inflation and economic growth separately. Furthermore, those methods are utilized to see the relationship between inflation and economic growth in Ethiopia.

The existence of a statistical relationship among the variables is carried out in four steps. Initially the order of integration of the variables is investigated using standard tests for the presence of unit roots. The second step involves the static or levels' regression to find the long run values (coefficients) for the various variables and interpret the results.

The third step involves testing for co-integration using the Johansen Maximum Likelihood approach (Johansen and Juselius, 1992). The Johansen-Juselius estimation method is based on the error correction representation of the VAR model. Although co

integration implies the presence of Granger Causality it does not necessarily identify the direction of causality. This temporal Granger Causality can be captured through the Vector Error Correction (VEC) model derived from the long run co-integrating vectors (Granger, 1988).

Finally, the fourth step involves the utilization of vector error correction modeling and testing for exogeneity of variables. Engle and Granger (1987) show that in the presence of co integration, there always exists a corresponding error correction representation. This implies that changes in the dependent variable are a function of the level of disequilibrium in the co integrating relationship, captured by the error correction term (ECT) as well as by changes in other explanatory variables.

The Wald-test is applied to the joint significance of the sum of the lags of each explanatory variable. The t-test of the lagged error correction term will imply statistically the Granger exogeneity or endogeneity of the dependent variable. The non -significance of the ECT is referred to as long run non- causality which is equivalent to saying that the variable under consideration is weakly exogenous with respect to the long run parameters (Hondroyiannis, Lolos, and Papepertou, 2004).

The absence of short run Granger Causality is established from the non significance of the sum of the lags of each explanatory variable. The non significance of all explanatory variables including the ECT in the VECM indicates the econometric strong exogeneity of the dependent variable that is the absence of Granger Causality.

The results of the VAR model are presented in the appendices for comparison .It is believed that providing those values does not pose lose of information to the reader. The reason for providing the VAR models in the appendices is the convenience of doing so. The residuals of the VAR models pass a number of diagnostic tests such as normality test,hetroskedasticity test,test of serial correlation and so on.

5.2 unit root tests

From table 5.1, it can be seen that all the variables are not integrated of order zero. They are non- stationary at level. In other words, they have unit roots. This means that at their levels, the critical values are greater than their coefficients (at 5% significance level) which imply the lack of sufficient evidence to reject the null hypothesis of the presence of unit root. Thus, all the variables are integrated of order one, I (1).

The stationariy tests of the variables are provided in Table 5.1 below. The time series variables have to be tested for unit roots before we can make any meaningful inference about the causal relationship between inflation and economic growth.

As mentioned earlier, before testing the causal relationship, it is necessary to examine the time series properties of the data. These are determined using the testing strategies of DF, ADF, PP and KPSS. Table 5.1 shows the DF, and ADF tests for unit root with and without trend both at level and first difference for the various variables.

Table 5.1: order of integration (unit root) tests of the variables using the DF and ADF methods (at 5% level of significance)

Variable	*Level*				*First difference*			
	DF		*ADF*		*DF*		*ADF*	
	Without trend	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*
Lncpi	*-0.263* *-1.951*	*-2.289* *-3.190*	*-1.444* *-2948*	*-2.200* *-3.548*	*-3.167* *-1.951*	*-3.167* *-1.951*	*-3.914* *-2.951*	*-4.199* *-3.548*
lnrgdp	*1.658* *-1.951*	*-1.555* *-3.190*	*2.340--* *2.954*	*-1.261* *-3.544*	*-6.164* *-1.951*	*-7.162* *-3.190*	*-6.139* *-2.954*	*-7.094* *-3.552*
Lnr	*-1.579* *-1.951*	*-1.654* *-3.190*	*-1.506* *-2.948*	*-1.491* *-3.544*	*-5.869* *-1.951*	*-5.993* *-3.190*	*-5.784* *-2.951*	*-5.824* *-3.548*
lnm2	*0.936* *-1.951*	*-1.353* *-3.190*	*0.647* *-2.948*	*-1.147* *-3.544*	*-4.325* *-1.951*	*-4.503* *-3.190*	*-4.391* *-2.951*	*-4.469* *-3.548*
Lnreer	*-1.882* *-1.951*	*-2.507* *-3.190*	*-1.855* *-2.951*	*-2.517* *-3.548*	*-4.303* *-1.951*	*-4.301* *-3.190*	*-4.240* *-2.951*	*-4.192* *-3.548*
lnwcpi	*-0.591* *-1.951*	*-2.249* *-3.190*	*-3.838* *-2.951*	*-4.348* *-3.548*	*-2.569* *-1.951*	*-3.143* *-3.190*	*-2.566* *-2.951*	*-3.337* *-3.548*
Lnrem	*0.475* *-1.951*	*-2.277* *-3.190*	*-0.287* *-2.948*	*-2.123* *-3.544*	*-6.006* *-1.951*	*-6.029* *-3.190*	*-5.927* *-2.951*	*-5.904* *-3.548*
lglncpi	*-2.200* *-3.548*	*-2.843* *-3.190*	*-1.444* *-2.948*	*-1.311* *-3.951*	*-5.825* *-1.951*	*-5.872* *-3.190*	*-5.751* *-2.951*	*-5.904* *-3.548*
Fisbal	*-2.289* *-3.190*	*-1.019* *-2.948*	*-1.321* *-2.948*	*-1.880* *-3.544*	*-6.143* *-1.951*	*-6.384* *-3.190*	*-6.057* *-2.951*	*-6.206* *-3.548*

Note: the first entries in the row of each variable are the calculated values (test statistic) while the second entries are the critical values. When the calculated value (i.e. the first entry in a row) exceeds the critical or tabulated value (i.e. the second entry in the row) we say there is no unit root or the variable under consideration is stationary and vice versa.

Table 5.2: order of integration (unit root) tests of the variables using the DF and ADF methods (at 5% level of significance)

Variable	*Level*				*First difference*			
	DF		*ADF*		*DF*		*ADF*	
	Without trend	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*
lnrgdp	*1.658* *-1.951*	*-1.555* *-3.190*	*2.340* *-2.954*	*-1.261* *-3.544*	*-6.164* *-1.951*	*-7.162* *-3.190*	*-6.139* *-2.954*	*-7.094* *-3.552*
lncpi	*-0.263* *-1.951*	*-2.289* *-3.190*	*-1.444* *-2948*	*-2.200* *-3.548*	*-3.167* *-1.951*	*-3.167* *-1.951*	*-3.914* *-2.951*	*-4.199* *-3.548*
lnrtinv	*-0.503* *-1.951*	*-2.873* *-3.190*	*-0.651* *-2.948*	*-2.966* *-3.544*	*-7.442* *-1.951*	*-7.770* *-3.190*	*-7.567* *-2.951*	*-7.663* *-3.548*
lnrexv	*-1.061* *-1.950*	*-2.007* *-3.190*	*-1.321* *-2.948*	*-1.880* *-3.544*	*-5.825* *-1.951*	*-5.872* *-3.190*	*-5.751* *-2.951*	*-5.700* *-3.548*
lnpsser	*-0.080* *-1.951*	*-2.453* *-3.190*	*-0.989* *-2.951*	*-2.533* *-3.548*	*-3.300* *-1.951*	*-3.310* *-3.190*	*-3.249* *-2.951*	*-3.209* *-3.190*
lnpopt	*0.048* *-1.951*	*-1.688* *-3.190*	*-1.169* *-2.948*	*-1.446* *-3.544*	*-6.143* *-1.951*	*-6.384* *-3.190*	*-6.057* *-2.951*	*-6.206* *-3.548*
lntge	*0.961* *-1.951*	*-2.257* *-3.190*	*-0.980* *-2.948*	*-2.377* *-3.544*	*-5.335* *-1.951*	*-5.526* *-3.190*	*-5.371* *-2.954*	*-5.487* *-3.552*

Note: the first entries in the row of each variable are the calculated values (test statistic) while the second entries are the critical values.

All the variables given in tables 5.1 and 5.2 are integrated of order one,I(1) except lnwcpi The log levels of all the variables except **lnwcpi** indicate that they have unit roots. They are non stationary all level. However, they become stationary at first differencing. As far as **lnwcpi** is concerned, it is non stationary at log level when we apply the DF test. Whereas, it becomes stationary as one applies ADF test to it. Moreover, it becomes

stationary at first differencing when DF test is utilized while it turns out to be non stationary at first differencing when the ADF test is used

The **lnwcpi** variable is found to be integrated of order one, I (1), when the DF and ADF tests are supplemented with PP and KPSS tests.

5.3 Empirical results of the long run model

The findings of this section are based on the Engle-Granger two stages method. The first step in the Engle-Granger two stages method is the estimation of coefficients from the levels' or static regression and interpret the results as the long-run effects if co-integration exists i.e. the residual is I(0).The second step is the process of adding the lag of the residual from the levels' regression to the differenced variables to re-run the regression .This second step gives the ECM or the short-run model.

The combined results from all unit root tests performed (DF, ADF, PP, and KPSS) suggest that all the series under consideration appear to be integrated of order one, I (I).

Once we checked for stationarity and determine the order of integration, the next step is estimation of the long run relationship using the Engle-Granger co integration estimation techniques.

The variables used in this model are **lncpi, lnrgdp, lnm$_2$, lnr, lnrem, lnwcpi, lnreer**, **lglncpi, fisbal, dexr**. These variables respectively stand for the logs of **cpi** , real **GDP,** money supply, lending interest rate, remittance, price index of major trading partners,

real effective exchange rate lag of cpi (expected inflation) as well as fiscal balances and dummy for exchange rate (devaluation).

The regression of the long run models of inflation and economic growth are valid because the residuals obtained from each regression are I (0) which implies the existence of a long run meaningful relationship between the dependent variables and the other variables in each model.

5.3.1 The Empirical Results of the Inflation Equation

The variables that are supposed to affect inflation in Ethiopia, in this paper, are the growth rate of real GDP, money supply, lending interest rate, remittance, real effective exchange rate, the price index of major trading partners, dummy for exchange rate (devaluation) and expected inflation. Wage rate is also expected to have an impact on the overall inflation but is left out from this study due to lack of consistency of the data and reliability.

$$lncpi = 0.677 - 0.288lnrgdp + 0.265lnm_2 + 0.139lnr + 0.026lnrem + 0.362lnwcpi$$
$$(0.681)\quad (-2\text{-}262)\qquad (2.867)\qquad (4.389)\quad (1.340)\qquad (1.649)$$
$$+0.019dexr + 0.381lglncpi - 9.270fisbal + 0.171lnreer \text{-------- (5.1)}$$
$$(0.332)\qquad (2.819)\qquad (-1.313)\qquad (3.162)$$

Diagnostic tests

R^2	*0.9968*
Adj-R2	*0.9955*
F-statistic	*739.048*
DW	*1.980*

The numbers in parentheses are the t –values

Test	*test statistics*	*p-value*
Jarque-Bera normality test	*0.49*	*0.78*
Ramsey's RESET test	*2.20*	*0.10*
Breush-Godfrey LM test	*3.45*	*0.19*
ARCH test	*0.23*	*0.63*
White heteroskedasticity test	*14.44*	*0.64*

The 0LS regression was run conditional on Newer- West HAC (Hetroskedasticity and Autocorrelation Consistent) standard errors and covariance. In other words, the OLS results are corrected for heteroskedasticity and autocorrelation

As the diagnostic tests indicate, the test results of the long run model have no problems of auto correlation, non normality, heteroskedasticity, model misspecification. This could be verified based on the Breusch-Godfrey test for serial correlation, the Jarque-Bera normality test, the ARCH test, and the Ramsey's RESET test respectively.

An auto regression of order one, AR (1) is utilized to check for first order autocorrelation of the error terms. This AR (1) shows that the error terms are not serially correlated. Thus the OLS coefficients are unbiased consistent and efficient.

The variables real GDP, money supply, lending interest rate, real effective exchange rate, and expected inflation captured by lagged value of CPI are found significant at the 5-percent significance level. Whereas, remittance, the price index of major trading partners, fiscal balance and dummy for exchange rate (devaluation) are insignificant at the 5-percent significance level. The lagged value of CPI which captures peoples' expectation about inflation is found significant at 5%.

As the above regression result shows, real GDP (lnrgdp) has a price depressing effect. The elasticity of cpi with respect to real GDP(rgdp) is about -0.288, suggesting that if real GDP goes up by 1 percent, on average, the cpi decreases by about 0.288 percent keeping other things constant. Thus, the CPI is not very responsive to changes in real GDP.

On the other hand, money supply has a price increasing effect. The elasticity of CPI with respect to money supper (m2) is about 0.265, suggesting that if money supply goes up by 1 percent, on average, CPI will increase by 0.265 percent, ceteris paribus. Similarly, the CPI is not very sensitive to changes in money supply. The other results could be interpreted in a similar way.

The preceding equation is a log-log or double log of the cpi equation. However, of we adopt a long log model with inflation as the dependent variable we arrive at a slightly different result.

$$Inf = 243 - 438 - 48.748\ lnrgdp + 33.601\ lnm_2 + 7.883 lnr + 5.616 lnrem +$$
$$(2.630) \quad (-2.259) \quad (3.828) \quad (2.293) \quad (2.630)$$
$$21.152\ lnwcpI + 0.864 dexr - 62.562\ lglncpi - 9.321 fisbal + 13.244 lnreer \quad (5.2)$$
$$(1.259) \quad (0.156) \quad (-1.320) \quad (2.681)$$

The numbers in parentheses are the t –values

Diagnostic tests

R^2	*0.7018*
Adj-R2	*0.5899*
F-statistic	*6.276*
DW	*1.8475*

Test	*test statistics*	*p-value*
Jarque-Bera normality test	*0.63*	*0.73*
Ramsey's RESET test	*1.68*	*0.43*
Breush-Godfrey LM test	*0.69*	*0.71*
ARCH test	*0.08*	*0.77*
White heteroskedasticity test	*19.82*	*0.28*

The slope coefficient of about -48.7 for **lnrgdp** means that an increase in real GDP of 1 percent, on average, leads to a decline in inflation by about 0.487 percent. (* the estimated slope coefficients are divided by 100 for interpretation)

The coefficient of remittance which was insignificant in the cpi equation now becomes significant in the inflation equation at the 5- percent significance level.

The empirical result that devaluation is insignificant in explaining inflation is consistent with the reality observed in the county after the huge devaluation of the birr against the US Dollar. In other words, the devaluation in 1992 was not followed by inflation Thus; devaluation which is denoted by dexr does not explain much of the current rise in inflation.

Like the previous model, this model is rectified to solve the heteroskedasticity and auto correlation problems signifying that the OLS results are unbiased, consistent and efficient.

5.3.2 The Empirical Results of the Growth Equation

The variables included in this model include real total investment, real export value, total population, consumer price index, primary and secondary school enrollment rate, total government expenditure and dummy for weather condition. These variables are respectively represented by **lnrtinv lnrexv, lnpopt, lncpi, lnpsser, lntge**, and **dwecon**

lnrgdp= the logarithm of real GDP

$lnrgdp_t$=-20-600-0.121 $lncpi_t$+0.170 $lnrtinv_t$+0.128$lnrexv_t$+ 1.752$lnpopt_t$

(-4.304) (-2.50,) (+2.696) (3.016) (6.344)

+0.135 $lnpsser_t$-0.1$lntge_t$+-0.089dwecon

(3.305) (-1.554) (-2.974) -------- (5.3)

The numbers in parentheses are the t –values

Diagnostic tests

R^2	*0.9778*
Adj-R2	*0.9700*
F-statistic	*126.6347*
DW	*1.9707*

Test	*test statistics*	*p-value*
Jarque-Bera normality test	*4.64*	*0.09*
Ramsey's RESET test	*2.56*	*0.11*
Breush-Godfrey LM test	*0.30*	*0.86*
ARCH test	*0.01*	*0.97*
White heteroskedasticity test	*11.63*	*0.56*
Stability test (Chow break point test)	43.38	0.00

The evaluation of the over all significance of the model and the goodness of fit of the predicted values using the F-statistic and the coefficient of determination show that the regressors explain the regressand fairly well

Though it is insignificant at the 5% significance level, government expenditure has a negative sign which is in sharp contrast with the apriori expected economic theory. An increase in government expending is supposed to boost economic growth and not to retard it. Nonetheless, this situation can occur if government investment 'crowds out' private investment instead of 'crowding in' private investment. When the decline in private investment exceeds the increase in government investment, the net effect will be negative implying that growth falls as government investment increases.

The stability of all the models is tested using the Chow breakpoint test .This test shows that there are structural breaks in the parameters estimated when we use the year 1992 where there was change of government and exchange rate regime.

5.4 Tests for Co-integration

The residuals of equations 5.1 to 5.3 are stationary (see table 5.5 below). This occurs because the calculated values are larger than the critical values in parentheses. The letter "s" in parenthesis indicates that there is no unit root or that the error term is stationary. This in turn implies that there is co integration among the variables.

Table 5.3: Tests for unit roots for the residuals equations 5.1-5.3(at 5% significance level)

Variable and equation no	*DF*		*ADF*		*PP*		*KPSS*	
	Without trend	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*
μ (5.1)	*-4.920 (-1.951) S*	*-5.053 (-3.190) S*	*-5.038 (-2.954) S*	*-4.960 (-3.553) S*	*-5.035 (-2.954) S*	*-4.955 (-3.533) S*	*0.066 (0.463) S*	*0.066 (0.146) S*
μ (5.2)	*-4.960 (-1.951) S*	*-5.072 (-3.190) S*	*-5.176 (-2.954) S*	*-5.102 (-3.553) S*	*-5.159 (-2.954) S*	*-5.081 (-3.553) S*	*0.058 (0.463) S*	*0.058 (0.146) S*
μ (5.3)	*-3.774 (-1.952) S*	*-4.337 (-3.190) S*	*-4.403 (-2.960) S*	*-4.219 (-3.563) S*	*-4.403 (-2.960) S*	*-4.403 (-3.563) S*	*0.101 (0.463) S*	*0.103 (0.146) S*

- The numbers in parentheses are the critical values while the remaining ones are the calculated values.
- The DF, ADF and PP tests are based on the hull hypothesis of unit reacts while the KPSS test assumes the null hypothesis of stationary.

5.5 Error correction Model: the Engle-Granger Approach

The co-integrating result assured us the existence of long-run relationship among the non-stationary variables. However, obtaining long-run estimates of the co-integration is only a first step to estimate the complete model (Harris, 1995). The short-run structure of the model is of a paramount importance because it captures the short run adjustment dynamics of economic variables. Moreover, it shows the long-run impacts of policy changes.

The short run error correlation model of inflation is given by

$$dlncpi_t = -0.44dlnrgdp_t + 0.2dlnm2_t + 0.08dlnr_t + 0.01dlnreer_t + 0.04dlnrem_t + 0.31dlnwcpi_t +$$
$$(-2.13) \quad (1.43) \quad (1.85) \quad (0.17) \quad (1.78) \quad (0.96)$$
$$0.53dlglncpi + 0.004dexr - 0.48ECT_{t-1}$$
$$(4.00) \quad (0.36) \quad (-2.43)$$

Diagnostic tests

Test	*test statistics*	*p-value*
Jarque-Bera normality test	*2.09*	*0.35*
Ramsey's RESET test	*7.32.*	*0.03*
Breush-Godfrey LM test	*3.16*	*0.21*
ARCH test	*0.37*	*0.54*
White heteroskedasticity test	*18.14*	*0.38*

The preceding error correction model for inflation (dlncpi) shows that a disturbance of the inflation due to a shock from its long-run value is adjusted by 48% annually.

The diagnostic tests also indicate that the model is not a bad one.

However, most of the variables are insignificant in explaining the short run dynamics of inflation.

The adjustment of real GDP growth rate (rgdpgr) towards its long run equilibrium is given by the error correction model given below.

$rgdpgr_t = 0.088dlnrtinv_t + 0..085dlnrexv_t + .071dnpsser_t + 0.958dlnpopt_t -$

(2.824) (4.171) (1.677) (3.727)

$0.002dinf_t - 0.113dlntge_t - 0.06dwecon - 0.678ECT_{t-1}$

(0.283) (-1537) (-3.05) (-2338)

The numbers in parentheses are the t –values

Diagnostic tests

R^2	*0.4522*
Adj-R2	*0.3047*
F-statistic	*120.6415*
DW	*1.7858*

Test	*test statistics*	*p-value*
Jarque-Bera normality test	*2.20*	*0.33*
Ramsey's RESET test	*4.95*	*0.08*
Breush-Godfrey LM test	*1.51*	*0.47*
ARCH test	*7.59*	*0.11*
White heteroskedasticity test	*18.66*	*0.23*

ETC_{t-1} stands for the first lag of the co-integrating vector error correction model. The values in parentheses are the t-values. The diagnostic tests indicate that the model is well specified.

The important parameter in the estimation of this short run dynamic model is the error correction term which measures the speed of adjustment of the real GDP growth rate to its long run equilibrium level. The sign of this term is negative and satisfies the theoretical expectation.

The magnitude of the coefficient of the error correction term (ECT) which is -0.678 implies that about 67.8 percent of the disequilibrium in real GDP growth rate is adjusted annually. In other words, the impact of a shock to rgdpgr is corrected by 67.8 percent per annum.

The coefficients of the short run dynamics of real total investment, real export value, and total population are found significant at the 5% level of significance and have positive

effect. The positive sign of population growth is striking because population growth is supposed to erode resources and hamper progress. However, there is a counter argument to this view that claims more people mean more ideas and more innovation. As the saying goes “necessity is the mother of invention”.

Inflation has insignificant negative impact on real GDP growth rate. The significant negative effect of total government expenditure on growth is contrary to economic theory The coefficient of real total investment, 0.088 implies that when investment grows by 1 percent, the growth rate of real GDP increases by 0.088 percent. On the other hand, when inflation increases by 1 percent, the growth rate of real GDP declines by about 0.2 percent.

5.6 Johansen Co-integration Model

The results for co-integration test and long run coefficients for **lncpi** specification are reported as follows. As it is shown in tables 5.4 and 5.5 below, the number of co integrating rank in the model can be identified using the two likelihood ratio tests of co integration such as maximal Eigen value test (λ max) and trace test (λ trace). Good insights to test for endogeneity and exogeneity of variables, when we have two and more than two co-integrating vectors is found in Alemayehu, Ndung’u, and Daniel (2007).

Table 5.4: Test for the number of co-integrating vector on inflation (Johansen and Juselius co-integration test)

a) the maximal eigen value test

H_0:rank =r	*H_1*	*Eigen value*	*Maximum eigenvalue statistic*	*0.05critical value*
r=0	*r =1*	*0.859044*	*66.61**	*52.36*
r =1	*r =2*	*0.769545*	*49.90 **	*46.23*
r =2	*r =3*	*0.631171*	*33.91*	*40.07*
r =3	*r =4*	*0.583379*	*29.76*	*33.97*
r =4	*r =5*	*0.552448*	*27.33*	*27.78*
r =5	*r =6*	*0.276361*	*10.99*	*21.13*
r =6	*r =7*	*0.035127*	*1.21*	*14.26*
r =7	*r =8*	*0.010621*	*0.36*	*3.84*

* denotes rejection of the hypothesis at the 0.5 level

b) The trace tests

H_0:rank =r	*H_1*	*Eigen value*	*Trace statistics*	*0.05critical value*
r≤0	*r≥1*	*0.859044*	*220.11**	*159.52*
r≤1	*r≥2*	*0.769545*	*153.49**	*125.61*
r≤ 2	*r≥3*	*0.631171*	*103.59**	*95.75*
r≤ 3	*r≥4*	*0.583379*	*69.68*	*69.81*
r≤ 4	*r≥5*	*0.552448*	*39.91*	*47.85*
r≤ 5	*r≥6*	*0.276361*	*12.57*	*29.79*
r ≤6	*r≥7*	*0.035127*	*1.57*	*15.49*
r≤ 7	*r≥8*	*0.010621*	*0.36*	*3.84*

* denotes rejection of the hypothesis at the 0.5 level

The maximal eigen value test of the null hypothesis is that there are at most there are r co- integrating vector against the alternative of r+1. The result from table 5.4 (a) shows that the null hypothesis of no co-integrating vector (r=0) is rejected. The test statistic (166.61) is greater than the 5% critical value of 52.36.This shows that there is at least one co-integrating vector. The null hypothesis of r=1 against r=2 can be rejected which implies that there is more than one co integrating vector. In Short, the maximum Eigen value test shows that there are two co-integrating equations.

On the other hand, in table 5.5 (b) the trace test of the null hypothesis reports that there is at most $r \leq 0$ co integrating vector against the alternative of $r \geq 1$ co-integrating vector. Since the trace statistic of 220.11 exceeds the 0.5 critical values of 159.52, it is possible to reject the null hypothesis of no co integrating vectors and accept the alternative of one or more co integrating vectors. Likewise the next null hypothesis that reports there are at

most r≤1 co-integrating vectors is rejected. The trace test indicates that there are 3 co-integrating equations. The trace test and maximum eigen value test methods yield conflicting results. Hence the co-integrating rank has to determined based or the interpretability of the model.

Table 5.5: test for the number of co-integrating vectors on real GDP growth rate (rgdpgr) Johansen and Juselius co-integration test

a) The Maximum Eigen Value test

H_0 rank =r	*H_1*	*Eigen value*	*Maximum eigen value statistic*	*0.05 critical value*
r=0	*r=1*	*0.879938*	*72.07**	*46.23*
r=1	*r=2*	*0.745100*	*46.47 **	*40.07*
r= 2	*r=3*	*0.639370*	*34.67 **	*33.87*
r= 3	*r=4*	*0.528849*	*24.87*	*27.58*
r= 4	*r=5*	*0.416127*	*18.29*	*21.13*
r= 5	*r=6*	*0.264924*	*10.46*	*14.26*
r= 6	*r=7*	*0.020867*	*0.71*	*3.84*

* denotes rejection of the hypothesis at the 0.5 level

- maximum eigen value test indicates 4 co integrating relations

b) The Trace Test

H_0 rank=r	*H_0*	*Eigen value*	*Trace statistic*	*0.5 critical value*
r≤0	*r≥1*	*0.879938*	*207.57**	*125.61*
r≤1	*r≥2*	*0.745100*	*135.50**	*95.75*
r≤ 2	*r≥3*	*0.639370*	*89.02 **	*69.81*
r≤ 3	*r≥4*	*0.518849*	*45.34*	*47.85*
r≤ 4	*r≥5*	*0.416127*	*29.47*	*29.79*
r≤ 5	*r≥6*	*0.264924*	*11.18*	*15.49*

* denotes rejection of the hypothesis at the 0.5 level
Trace test indicates 4 co integrating equations at the 0.5 level

5.7 Empirical Estimation of the Threshold Level of Inflation

The threshold level of inflation is the level of inflation above which inflation significantly slows growth. In this paper, the threshold level of inflation is defined as the level of inflation which maximizes the value of R^2 and minimizes the residual sum of squares. .

As stated earlier in this empirical model, the first difference of the logs of CPI and rgdp are used to approximate inflation and economic growth. This means that inflation rates (inf) are calculated from the first difference of the logarithms of cpi and economic growth rates (rgdpgr) are calculated from the first difference of the logarithm of real GDP.

In table 5.6 below, the results of the unit root tests on the concerned variables have been reported. The test for unit root shows that **rgdpgr** is stationary based on DF, ADF, PP, and KPSS tests. The same is true for **inf.** Thus, the findings of unit root tests suggest that both variables are integrated of order zero, I (0).Besides, table5.6 shows that both the logs of cpi and rgdp (i.e. lncpi and lnrgdp respectively) are integrated of order one based on the above listed tests. Therefore they are non-stationary, I(1).

Table5.6: unit root tests with DF, ADF, PP and KPSS

Variable	*DF*		*ADF*		*PP*		*KPSS*	
	Without trend	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*	*Without trend*	*With trend*
lncpi	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*
lnrgdp	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*	*I(1)*
inf	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*
rgdpgr	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*

- Lag length for DF and ADF tests have been decided on the basis of AIC.
- All tests have been performed on the basis of 5 percent significance level using Econometric views 5(Eviews 5) package.
    - The DF,ADF,and PP tests are based on the null hypothesis of unit roots while the KPSS test assumes the null hypothesis of stationarity.

Table 5.7 below depicts the estimated results of lncpi and lnrgdp equations respectively.

Table5.7: estimation of lncpi and lnrgdp

a) Dependent variable: lncpi

Method: OLS, Newey-West HAC standard errors and covariance

Sample: 1971-2006

Variable	*Coefficient*	*Std.error*	*t-statistic*	*probability*
constant	*-162.82*	*20.09*	*-8.10*	*0.00*
lnrgdp	*-1.03*	*0.31*	*-3.24*	*0.00*
time	*0.08*	*0.01*	*8.0*	*0.00*

Diagnostic tests

R^2	*0.9590*
Adj-R^2	*0.9546*
F-statistic	*218.5483*
DW	*0.4368*

b) Dependent variable: lnrgdp

variable	*Coefficient*	*Std.error*	*t-statistic*	*probability*
constant	*-82.41*	*13.61*	*-6.05*	*0.00*
lncpi	*-0.32*	*0.09*	*-3.46*	*0.00*
time	*0.04*	*0.01*	*4.00*	*0.00*

R^2	*0.9467*
Adj-R^2	*0.9414*
F-statistic	*177.8514*
DW	*0.92314*

The diagnostic tests of the above equations indicate that both models suffer from the problem of autocorrelation. However, the Newey-West HAC standard errors and covariance are used to rectify the problem. In addition, since the objective of the models here is estimation and not prediction or inference, the presence of autocorrelation does not invalidate the model as the OLS estimators in the presence of autocorrelation are consistent.

The findings of the estimated equations in table 5.9 imply that there is linear causation between CPI and rgdp in Ethiopia.

The estimated coefficients are statistically significant at 5% level of significance and are negative implying that both CPI and real GDP affect each other negatively. In other

words, inflation is detrimental for economic growth and economic growth helps to curb inflation in Ethiopia.

Table 5.8 shows the DF,ADF,PPand KPSS unit root tests for the residuals of lncpi and lnrgdp equations. The results portray that the residuals are integrated of order zero,I(0). Hence, it can be concluded that the two series, lncpi and lnrgdp are co-integrated.This implies that there exists a valid and stable long-run relationship between the two variables which also implies the existence of long-run relationship between inflation and economic growth.

Table 5.8; Unit root tests for the residuals of lncpi and lnrgdp

Error	*DF*	*ADF*	*PP*	*KPSS*	*Decision*
μ, lncpi equation	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*
μ, lnrgdp equation	*I(0)*	*I(0)*	*I(0)*	*I(0)*	*I(0)*

- Lag length for DF and ADF tests have been decided on the basis of AIC.
- All tests have been performed on the basis of 5 percent significance level using Econometric views 5(Eviews 5) package.
    - The DF, ADF, and PP tests are based on the null hypothesis of unit roots while the KPSS test assumes the null hypothesis of stationarity.

Moreover, the results of the Johansen maximum likelihood test reported in table 5.9 again substantiate the rejection of the null hypothesis of no co-integration between lncpi and lnrgdp .The computed trace and maximum eigen value statistics and their corresponding critical values indicate that the null hypothesis of no co-integration(r=0) can be rejected under both of these tests at the 5 percent level of significance. Both maximum eigen value and trace tests indicate one co-integrating equation at 5 percent level of significance. This again confirms a long-run relationship between inflation and economic growth in Ethiopia.

Table 5.9: Johansen Co-integration test

a) trace test

H_0: rank=r	H_1	Eigen value	Trace statistic	0.05 critical
r≤0	r≥1	0.408514	21.94*	12.32
r≤1	r≥2	0.113445	4.09	4.12

*denotes rejection of the null hypothesis at the 0.05 level.

- Trace test indicates one co-integrating equation at the 0.05 level.

b) maximum eigen value test

H_0: rank=r	H_1	Eigen value	Maximum eigen value	0.05 critical
R=0	r=1	0.408514	17.85*	11.22
R=1	r=2	0.113445	4.09	4.12

*denotes rejection of the null hypothesis at the 0.05 level.

- Maximum eigen value statistic indicates one co-integrating equation at the 0.05 level.

The presence of co-integration implies that there exists an Error Correction Model (ECM) that incorporates both short-run and long-run effects. The terms in the error correction model are supposed to be stationary so that standard regression techniques are valid (Harris, 1995). The estimated coefficients of the error correction term (long-run effects) and the differenced lags of the two series (short-term effects) are presented in table 5.10

Vector Error Correction Model: The Johansen Co-integration Approach

Vector Auto-regression (VAR) model is used to see the relationship between economic growth and inflation. The restricted form of VAR model, which is the Vector Error Correction model, is used here. The model passes most of the diagnostic tests.

In the vector error correction model, we begin with a model having many explanatory variables based on their relevance and availability of data. Then we follow Hendry's

approach of general to specific modeling. Eventually, we drop the insignificant explanatory variables to arrive at the relatively sound model having strong significance. Having established the existence of long-run relationship among the relevant variables by utilizing the Johansen test, we proceed to the setting up of a vector error correction model in which vector error correction terms are included.

The first step is to determine the optimal lag length of the VAR model using AIC test system. The lag length selection is made by taking into consideration the problem of small sample size which affects the short run behavior. Besides, long lag length erodes the degrees of freedom. Based on the Akaike information criterion (AIC) the appropriate lag length of this equation is two

Table5.10: The Vector error correction model for inflation and economic growth.

	dlncpi	dlnrgdp
ECT_{t-1}	-0.117879	-0.280470
	[-0.92991]	[-2.35333]
dlncpi(-1)	-0.212026	0.324468
	[-1.03146]	[1.67891]
dlncpi(-2)	-0.018313	0.001870
	[-0.10628]	[0.01154]
dlnrgdp(-1)	-0.130355	0.419159
	[-0.33544]	[1.14725]
dlnrgdp(-2)	0.471038	-0.122198
	[1.66669]	[-0.45989]
C	-0.001171	0.000999
	[-0.10481]	[0.09513]

The numbers in brackets are t-values.

Diagnostic tests

Test	*test statistic*	*p-value*
Normality test	*1.134*	*0.29*
Serial correlation	*3.08*	*0.54*
White heteroskedasticity test	*18.33*	*0.79*
Wald test	*11.57*	*0.00*

The Granger-Causality test is the most commonly used method in the economics literature. This is because it not only tests the correlation between two variables, but also specifies the direction of causality.Table5.11 below, reveals the test results. The table depicts that the null hypothesis that real GDP growth rate (rgdpgr) does not Granger-Cause inflation can be rejected at the 5% level of significance, with two lags.. Contrarily, the null hypothesis that inflation does not Granger-Cause rgdpgr is accepted. Hence, the results suggest that Granger-Causality runs only one way inEthiopia using the data for the period 1971-2006.The causality is from growth to inflation and not from inflation to growth.

This occurrence is referred to as uni-directional causality. Thus, the tentative hypothesis stipulated in chapter one which says causality runs two ways (bi-directional causality) is rejected based on the empirical result.

Table 5.11 Granger causality

Null hypothesis	*F-statistic*	*Probability*
rgdpgr does not Granger Cause inf	*2.016*	*0.013*
Inf does not Granger Cause rgdpgr	*1.254*	*0.193*

The empirical results in the previous section show the existence of short nun and long-term relationships between CPI and real GDP in Ethiopia. This, in turn, implies short run and long run relationships between inflation and economic growth is the country. The estimated coefficient of the error correction term of real GDP growth rate (rgdpgr) which is found to be 28.7% is significant at 5 percent level with an appropriate negative sign.

That means in the long run if real GDP is out of equilibrium, it will adjust quickly to reduce the disequilibrium. However, the adjustment mechanism is very slow 11.7% for inflation. If due to a shock inflation is disturbed from its equilibrium, it does not immediately return to its long run equilibrium.

The coefficient of the error creation term in the above error correction model for real GDP shows that 28 percent of the deviation of the real GDP from its long-run equilibrium level is corrected each year. However, only 11.8 percent of the deviation of the CPI from its long run equilibrium is corrected each year. The estimated results in the ECM also show that short run changes in CPI affect real GDP negatively, and vice verse. Therefore inflation rates affect economic growth rates, and vice verse.

By using Ordinary Least Squares (OLS), table 5. 7 gives the exact value of the threshold inflation level and also shows the impact of that inflation level on economic growth by estimating equation 4.9 (see chapter four). As mentioned earlier, the threshold level of inflation is the one that maximize the value of R^2 and minimizes the Residual Sum of Squares RSS).

The variable K is assigned the values 1, 2, 3, ----, N in ascending order.

Table 5.12: Economic Growth Model with the structural break term: **D(inf-k**)

Dependent variable: **rgdpgr**

K	*variable*	*coefficient*	*std.error*	*t-statistic*	*probability*	R^2
11%	*inf*	*-0.4526*	*0.2194*	*-2.06*	*0.059*	
	D(inf-K)	*0.0101*	*3.7312*	*0.27*	*0.788*	*0.3965*
	Constant)	*4.006*	*1.5993*	*2.51*	*0.019*	
12%	*inf*	*-0.4526*	*0.2194*	*-2.06*	*0.059*	
	D(inf-K)	*0.0101*	*3.7312*	*0.27*	*0.788*	*0.3965*
	Constant)	*4.006*	*1.5993*	*2.51*	*0.019*	
13%	*inf*	*-0.2291*	*0.1911*	*-1.20*	*0.241*	
	D(inf-K)	*-0.0387*	*3.2910*	*-1.18*	*0.250*	*0.4243*
	Constant)	*3.8273*	*1.5073*	*2.54*	*0.017*	
14%	*inf*	*-0.0983*	*0.1801*	*-0.55*	*0.590*	
	D(inf-K)	*- 0.0711*	*3.250*	*-2.19*	*0.038*	*0.4859*
	Constant)	*3.8283*	*1.4237*	*2.69*	*0.012*	
15%	*inf*	*-0.0983*	*0.1801*	*-0.55*	*0.590*	
	D(inf-K)	*- 0.0711*	*3.250*	*-2.19*	*0.038*	*0.4859*
	Constant)	*3.8283*	*1.4237*	*2.69*	*0.012*	
16%	*inf*	*-0.1037*	*0.1617*	*-0.66*	*0.527*	
	D(inf-K)	*-0.0811*	*3.1820*	*-2.55*	*0.017*	*0.5123*
	Constant)	*3.3348*	*1.4035*	*2.51*	*0.025*	
17%	*inf*	*-0.2723*	*0.1627*	*-1.67*	*0.106*	
	D(inf-K)	*0.0427*	*3.5644*	*-1.20*	*0.241*	*0.4254*
	Constant)	*3.4889*	*1.5418*	*2.26*	*0.032*	

The results of the estimated equation reveal that at low inflation levels, that is below 16 percent, there is a statistically insignificant negative relationship between the level of inflation and economic growth (at 5% level of significance).

As k increases, starting from 14% a statistically significant negative relationship is observed between inflation and economic growth at 5% level of significance. Starting from 14% the coefficient of the threshold level of inflation has a negative sign signaling that excessive inflation affects the economy negatively. When the value of K is 16%, the R^2 is maximized indicating that the threshold level of inflation is attained at that point. This is the point where structural break takes place.

The p-values on β_1 suggest that for low inflation levels (K<14%) there is an insignificant negative relationship between output growth and inflation. For higher inflation (K>14%) there is a significant negative relationship between output growth and inflation. The insignificant negative relationship is translating into significant one as the threshold level of inflation, K increases above 14 percent and reaches 16%. Finally, 16 percent inflation level is a threshold level which is obtained by finding that value of K that maximizes R^2 and minimizes the Residual Sum of Squares. If inflation increases above threshold level, growth is estimated to decline by 0.18% .Beyond that level, there might be a shock to economic performance of the country.

The threshold level of inflation in derived at 16 percent level which maximizes the value of R^2. Inflation rates below this level have an insignificant negative effect on economic

growth (at 5%level. finally, inflation rates about 16% hamper economic growth rather than enhancing it. Hence, the empirical results suggest that high inflation rater above 16%) negatively affect economic growth and its performance implying that inflation should be kept in control.

From this study, it is found that the threshold level of inflation in Ethiopia is 16 percent. An inflation rate of 13 percent has no significant negative impact on the Ethiopian Economy. It is only when the inflation rate exceeds 13 percent (i.e. 14% and above) that inflation becomes detrimental to economic growth.

The 16% threshold level of inflation obtained for Ethiopia is slightly higher than that predicted for developing countries by Khan and Senhadji (2001) which is in the ranges of 7% to 11%.However, it is below the threshold level of inflation estimated for developing countries by Drukker Porqueras, and Verme (2005) which is 19.16 percent.

The results in this study are not robust and should be interpreted with care. The lack of robustness could be attributed to the methodology used, which is linear estimation technique in this case, and the quality of the data. Hence, further research needs to be made in this topic in the Ethiopian case.

CHAPTER –SIX

CONCLUSION AND RECOMMENDATION

This chapter presents the core points from the findings of the study and tries to extend some policy recommendations based on the results of the study.

6.1 Conclusions

Low and stable inflation has been the feature of the Ethiopian economy for most periods of its past history. The country had been characterized as a low inflation one in the Sub-Saharan Africa until recently.

There is no consensus among researchers of economics about the relationship of inflation and economic growth. The monetary economists regard inflation as a pernicious issue and recommend governments and policy makers to combat it. While others like the structural economists maintain the view that inflation below a certain threshold level could be beneficial and facilitate economic growth than retard it. In other words, some consensus exists, suggesting that macroeconomic stability, specifically defined as low inflation is positively related to economic growth.

Despite the numerous reform measure and market liberalization inflation remained low in Ethiopia till recently. Nonetheless, in the past three years or more inflation is rising due to both internal and external factors.

The Engle-Granger two stages method is used in the analysis of this paper. The paper used the pertinent macroeconomic data on the variables that are supposed to affect inflation and economic growth.

To analyze the long-run inflation equation variables such as real GDP, money supply, lending interest rate, remittance, price index of major trading partners, real effective exchange rate, expected inflation captured by lagged value of CPI, as well as fiscal balance and dummy for exchange rate(devaluation) are used. Based on the findings of the study, the variables real GDP, money supply, lending interest rate, real effective exchange rate and expected inflation are found to be significant determinants of inflation at the 5% level of significance. Whereas, remittance, the price index of major trading partners, fiscal balance and devaluation are insignificant at the 5 percent significance level in the long-run. The price index of major trading partners becomes significant at 10 percent significance level.

From the regression of the long-run inflation equation, it is found that real GDP has a price depressing effect while money supply has a price increasing effect.

The other variables used in the growth equation to see its determinants include consumer price index(CPI),real total investment, real export value, total population primary and secondary school enrolment rate, total, government expenditure and dummy for weather condition.

Though it is insignificant at the 5% significance level, government expenditure has a negative sign which is in sharp contrast with the apriori expected economic theory. An increase in government spending is supposed to boost economic growth and not to retard it. However, if government expenditure crowds-out private investment, the net effect could be negative if the decline in private investment more than offset the increase in public investment.

The error correction models are also utilized to see the short-run dynamics of both inflation and economic growth separately. The important parameter in the estimation of the short-rum dynamic model is the error correction term which captures the speed of adjustment of the variable under scrutiny to its long-run equilibrium.

The magnitude of the error correction term (ECT) which is -0.678 for the growth equation implies that about 67,8% of the disequilibrium in real GDP growth rate that occurred due to a one time shock is adjusted annually. In other words the impact of a shock to real GDP growth rate is corrected by 67.8% per annum.

In this study the data from 1971-2006 on inflation and economic growth is used to estimate the threshold level of inflation for Ethiopia. This threshold level of inflation for the country is found to be 16%. However this result becomes vague and ambiguous when other macroeconomic variables like population growth rate and investment growth rate are added to the growth equation. Hence, more research needs to be geared in this area before any meaningful conclusions are made. Besides, the OLS estimation technique is used to arrive at this result. Nevertheless, other non-linear estimation methods might yield a better result.

Recommendation

In light of the findings of the study, the following recommendations are forwarded. One of the mot fundamental objectives of macroeconomic policies in Ethiopia is to sustain high economic growth together with low inflation. As a result inflation should be kept below the threshold level since high inflation does not sustain growth. High inflation retards growth by reducing investment and bringing inefficiency to the system. Thus, excessive inflation has a growth inhibiting effect.

Inflation can lead investors to uncertainty about the future profitability of investment projects. This particularly happens when high inflation is associated with increased price variability. This leads to more conservative investments strategies eventually leading to lower levels of investment and economic growth. It may also reduce a country's competitiveness by making its exports more expensive, thus impacting on the balance of payments. This manifests itself that maintaining a low inflation is a viable option.

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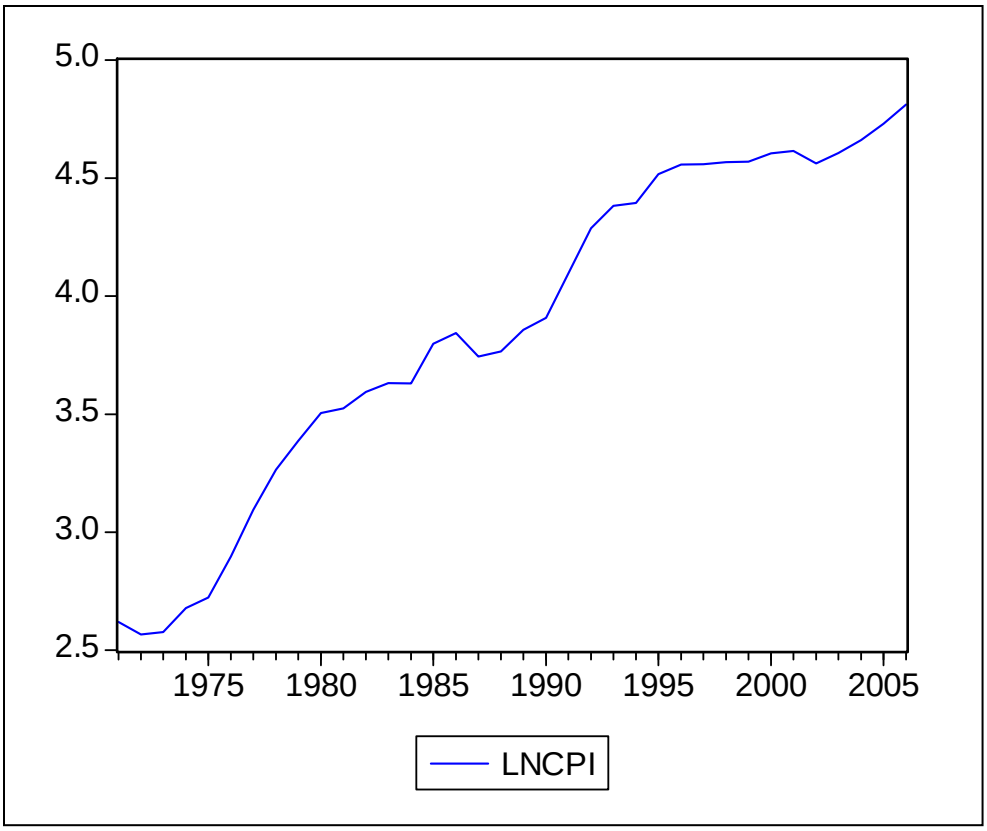
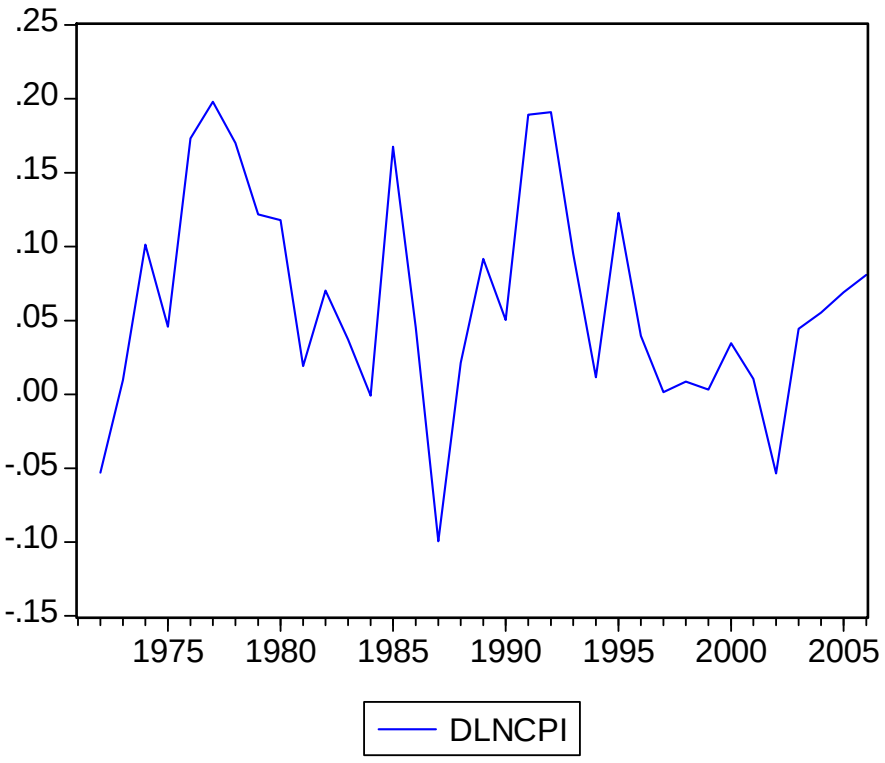
APPENDIX A: Graphic Illustration of Some of the Variables in Levels and First Differences.




.25
.20
.15
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-.05
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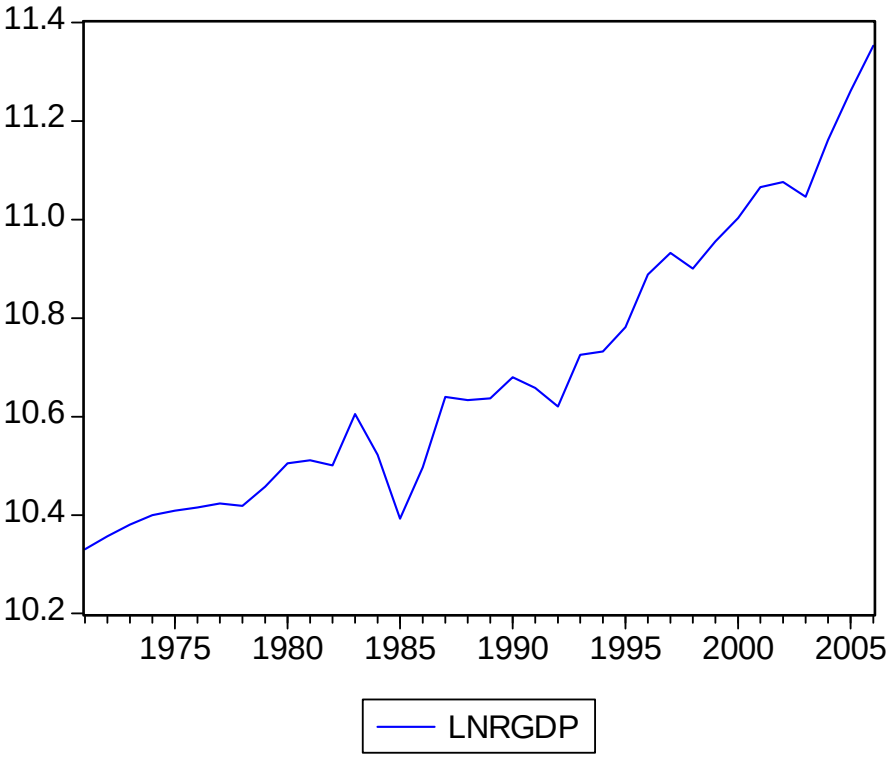
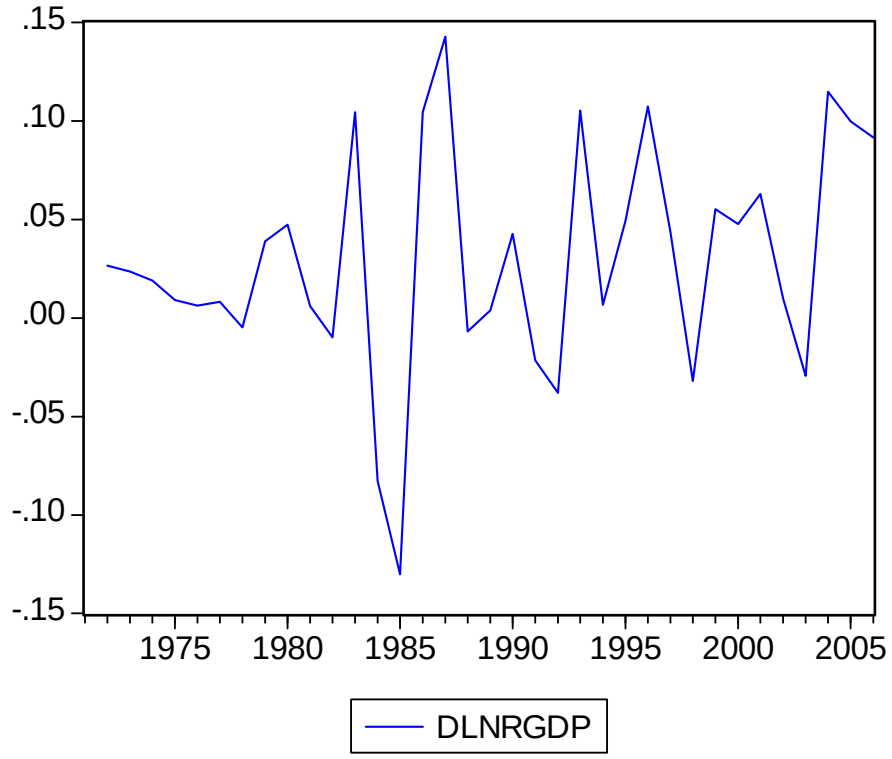
1975
1980
1985
1990
1995
2000
2005
DLNCPI


11.4
11.2
11.0
10.8
10.6
10.4
10.2
1975
1980
1985
1990
1995
2000
2005
LNRGDP


.15
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-.15
1975
1980
1985
1990
1995
2000
2005
DLNRGDP

APPENDIX B: VAR Estimation of the Growth Equation.

Vector Autoregression Estimates
Date: 06/13/08 Time: 23:11
Sample (adjusted): 1973 2006
Included observations: 34 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LNRGDP	LNCPI	LNRTINV	LNREXV	LNPOPT	LNPSSE
LNRGDP(-1)	0.754074	0.027633	0.778430	1.230100	0.026916	-0.34675
	(0.23580)	(0.25116)	(0.66276)	(0.94530)	(0.03495)	(0.38787
	[3.19799]	[0.11002]	[1.17453]	[1.30128]	[0.77017]	[-0.89399
LNRGDP(-2)	-0.324066	0.080738	0.146958	2.259421	-0.054996	1.08819
	(0.32959)	(0.35106)	(0.92638)	(1.32130)	(0.04885)	(0.54215
	[-0.98325]	[0.22999]	[0.15864]	[1.71000]	[-1.12584]	[2.00720
LNCPI(-1)	0.426566	1.388853	-1.727336	-1.055193	0.121094	-0.08995
	(0.33203)	(0.35366)	(0.93326)	(1.33111)	(0.04921)	(0.54618
	[1.28470]	[3.92703]	[-1.85087]	[-0.79271]	[2.46067]	[-0.16471
LNCPI(-2)	-0.522748	-0.505400	1.621869	1.125224	-0.076103	0.14919
	(0.28266)	(0.30107)	(0.79448)	(1.13317)	(0.04189)	(0.46496
	[-1.84939]	[-1.67866]	[2.04142]	[0.99298]	[-1.81657]	[0.32088
LNRTINV(-1)	0.144978	-0.021999	-0.193150	-0.106132	0.033205	0.14143
	(0.11314)	(0.12051)	(0.31801)	(0.45359)	(0.01677)	(0.18611
	[1.28137]	[-0.18254]	[-0.60736]	[-0.23398]	[1.98011]	[0.75995
LNRTINV(-2)	0.007209	-0.002750	0.134858	-0.153514	0.035563	-0.44266
	(0.08069)	(0.08595)	(0.22681)	(0.32350)	(0.01196)	(0.13274
	[0.08934]	[-0.03200]	[0.59459]	[-0.47455]	[2.97353]	[-3.33494
LNREXV(-1)	-0.039820	-0.026720	-0.007707	0.211481	-0.022534	-0.03768
	(0.06265)	(0.06673)	(0.17608)	(0.25115)	(0.00928)	(0.10305
	[-0.63563]	[-0.40044]	[-0.04377]	[0.84206]	[-2.42688]	[-0.36570
LNREXV(-2)	0.068523	0.026721	0.005709	-0.082426	0.016052	0.14520
	(0.05482)	(0.05839)	(0.15408)	(0.21976)	(0.00812)	(0.09017
	[1.25001]	[0.45763]	[0.03705]	[-0.37506]	[1.97566]	[1.61025

LNPOPT(-1)	-0.514169	-2.501571	2.138049	-4.602791	0.444139	-1.42472
	(1.06849)	(1.13810)	(3.00323)	(4.28353)	(0.15836)	(1.75760
	[-0.48121]	[-2.19803]	[0.71192]	[-1.07453]	[2.80454]	[-0.81061
LNPOPT(-2)	1.134847	2.758236	-1.954395	0.880378	0.341035	1.23740
	(1.07752)	(1.14772)	(3.02863)	(4.31976)	(0.15970)	(1.77246
	[1.05320]	[2.40323]	[-0.64531]	[0.20380]	[2.13543]	[0.69813
LNPSSER(-1)	0.030892	0.079216	0.418153	0.697403	-0.036441	1.04322
	(0.12974)	(0.13819)	(0.36466)	(0.52012)	(0.01923)	(0.21341
	[0.23811]	[0.57324]	[1.14669]	[1.34085]	[-1.89509]	[4.88827
LNPSSER(-2)	-0.036211	-0.064613	-0.543155	-0.899639	0.020919	-0.34396
	(0.13818)	(0.14718)	(0.38838)	(0.55395)	(0.02048)	(0.22729
	[-0.26206]	[-0.43901]	[-1.39851]	[-1.62404]	[1.02143]	[-1.51330
LNTGE(-1)	-0.013361	-0.071080	0.214987	0.690805	-0.017298	-0.04889
	(0.11513)	(0.12263)	(0.32360)	(0.46156)	(0.01706)	(0.18938
	[-0.11605]	[-0.57962]	[0.66435]	[1.49668]	[-1.01369]	[-0.25818
LNTGE(-2)	0.008726	0.033341	0.138205	-0.104876	0.032374	0.19275
	(0.08574)	(0.09133)	(0.24100)	(0.34373)	(0.01271)	(0.14104
	[0.10177]	[0.36508]	[0.57347]	[-0.30511]	[2.54751]	[1.36668
C	-5.923143	-4.825759	-4.270732	35.52747	3.498258	0.45197
	(8.14663)	(8.67734)	(22.8980)	(32.6595)	(1.20744)	(13.4007
	[-0.72707]	[-0.55613]	[-0.18651]	[1.08781]	[2.89726]	[0.03373
DWECON	-0.090860	0.120005	-0.380192	-0.541445	0.005216	-0.13452
	(0.04355)	(0.04638)	(0.12240)	(0.17458)	(0.00645)	(0.07163
	[-2.08648]	[2.58721]	[-3.10618]	[-3.10144]	[0.80822]	[-1.87799
R-squared	0.982974	0.996604	0.961091	0.921432	0.999588	0.99413
Adj. R-squared	0.968787	0.993774	0.928666	0.855958	0.999245	0.98924
Sum sq. resids	0.042925	0.048700	0.339119	0.689887	0.000943	0.11614
S.E. equation	0.048834	0.052015	0.137259	0.195773	0.007238	0.08032
F-statistic	69.28243	352.1399	29.64087	14.07336	2912.011	203.402
Log likelihood	65.22518	63.07941	30.08811	18.01508	130.1347	48.3033
Akaike AIC	-2.895599	-2.769377	-0.828712	-0.118534	-6.713806	-1.90019
Schwarz SC	-2.177312	-2.051090	-0.110425	0.599753	-5.995518	-1.18190
Mean dependent	10.71136	3.939646	8.927676	7.822095	17.67759	15.0586
S.D. dependent	0.276408	0.659196	0.513915	0.515833	0.263380	0.77466

Determinant resid covariance (dof adj.)	6.61E-19
Determinant resid covariance	7.71E-21

Log likelihood	449.5954
Akaike information criterion	-19.85855
Schwarz criterion	-14.83054

VAR Lag Order Selection Criteria
Endogenous variables: LNRGDP LNCPI LNRTINV LNREXV LNPOPT LNPSSER LNTGE
Exogenous variables: C DWECON
Date: 06/19/08 Time: 18:59
Sample: 1971 2006
Included observations: 34

Lag	LogL	LR	FPE	AIC	SC	HQ
0	120.5456	NA	4.48e-12	-6.267386	-5.638885	-6.053049
1	360.3228	352.6136	6.55e-17	-17.48958	-14.66132	-16.52506
2	449.5954	94.52392*	9.84e-18*	-19.85855*	-14.83054*	-18.14386*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

APPENDIX C: Granger Causality Test.

Pairwise Granger Causality Tests
Date: 06/19/08 Time: 18:59
Sample: 1971 2006
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LNCPI does not Granger Cause LNRGDP	34	2.15324	0.13431
LNRGDP does not Granger Cause LNCPI		3.06147	0.06219
LNRTINV does not Granger Cause LNRGDP	34	0.27818	0.75916
LNRGDP does not Granger Cause LNRTINV		4.54679	0.01916
LNREXV does not Granger Cause LNRGDP	34	0.20004	0.81982
LNRGDP does not Granger Cause LNREXV		1.68311	0.20344
LNPOPT does not Granger Cause LNRGDP	34	1.31535	0.28392
LNRGDP does not Granger Cause LNPOPT		0.75809	0.47762
LNPSSER does not Granger Cause LNRGDP	34	1.15797	0.32823
LNRGDP does not Granger Cause LNPSSER		1.60113	0.21899
LNTGE does not Granger Cause LNRGDP	34	1.99033	0.15489
LNRGDP does not Granger Cause LNTGE		4.74548	0.01648
LNRTINV does not Granger Cause LNCPI	34	0.55094	0.58232
LNCPI does not Granger Cause LNRTINV		5.12024	0.01246
LNREXV does not Granger Cause LNCPI	34	0.67141	0.51875
LNCPI does not Granger Cause LNREXV		0.94484	0.40038
LNPOPT does not Granger Cause LNCPI	34	4.06386	0.02781
LNCPI does not Granger Cause LNPOPT		0.07806	0.92510

LNPSSER does not Granger Cause LNCPI	34	1.56322	0.22660
LNCPI does not Granger Cause LNPSSER		2.94280	0.06861
LNTGE does not Granger Cause LNCPI	34	0.56716	0.57330
LNCPI does not Granger Cause LNTGE		1.29546	0.28915
LNREXV does not Granger Cause LNRTINV	34	0.21599	0.80703
LNRTINV does not Granger Cause LNREXV		1.03348	0.36850
LNPOPT does not Granger Cause LNRTINV	34	3.69514	0.03719
LNRTINV does not Granger Cause LNPOPT		3.71577	0.03659
LNPSSER does not Granger Cause LNRTINV	34	8.78244	0.00104
LNRTINV does not Granger Cause LNPSSER		0.92921	0.40630
LNTGE does not Granger Cause LNRTINV	34	3.52855	0.04250
LNRTINV does not Granger Cause LNTGE		0.82473	0.44837
LNPOPT does not Granger Cause LNREXV	34	2.99200	0.06587
LNREXV does not Granger Cause LNPOPT		9.05590	0.00088
LNPSSER does not Granger Cause LNREXV	34	9.21729	0.00080
LNREXV does not Granger Cause LNPSSER		0.25908	0.77353
LNTGE does not Granger Cause LNREXV	34	1.36806	0.27055
LNREXV does not Granger Cause LNTGE		0.45644	0.63801
LNPSSER does not Granger Cause LNPOPT	34	5.36957	0.01038
LNPOPT does not Granger Cause LNPSSER		2.71414	0.08308
LNTGE does not Granger Cause LNPOPT	34	4.75082	0.01642
LNPOPT does not Granger Cause LNTGE		2.21816	0.12694
LNTGE does not Granger Cause LNPSSER	34	3.27078	0.05237

LNPSSER does not Granger Cause LNTGE	2.79322	0.07774

APPENDIX D: Vector Error Correction Model of Real GDP Growth Rate.

Vector Error Correction Estimates

Date: 06/19/08 Time: 19:04

Sample (adjusted): 1974 2006

Included observations: 33 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Error Correction:	D(LNRGDP)	D(LNCPI)	D(LNRTINV)	D(LNREXV)	D(LNPOPT)	D(LNPSSER
ECT_{t-1}	0.020804	-0.035612	-0.159829	0.310098	0.015951	-0.057183
	(0.04478)	(0.05070)	(0.13143)	(0.17188)	(0.00771)	(0.08454
	[0.46456]	[-0.70238]	[-1.21604]	[1.80414]	[2.06884]	[-0.67640
D(LNRGDP(-1))	0.004682	0.021081	0.360796	-0.571171	-0.027765	-0.563813
	(0.24630)	(0.27885)	(0.72286)	(0.94532)	(0.04241)	(0.46495
	[0.01901]	[0.07560]	[0.49912]	[-0.60421]	[-0.65476]	[-1.21262
D(LNRGDP(-2))	-0.635714	0.721474	-1.214645	-0.321413	0.002676	0.205268
	(0.27041)	(0.30615)	(0.79363)	(1.03787)	(0.04656)	(0.51047
	[-2.35093]	[2.35659]	[-1.53049]	[-0.30969]	[0.05748]	[0.40211
D(LNCPI(-1))	0.222780	0.399970	-1.637230	-0.831051	0.048533	-0.112960
	(0.33512)	(0.37942)	(0.98356)	(1.28625)	(0.05770)	(0.63264
	[0.66477]	[1.05416]	[-1.66459]	[-0.64610]	[0.84115]	[-0.17855
D(LNCPI(-2))	-0.102937	-0.229926	1.299665	3.375992	0.050017	0.341363
	(0.29772)	(0.33708)	(0.87379)	(1.14270)	(0.05126)	(0.56203
	[-0.34575]	[-0.68212]	[1.48739]	[2.95441]	[0.97576]	[0.60737
D(LNRTINV(-1))	-0.021699	-0.009218	-0.050116	-1.698802	-0.044280	0.294756

	(0.16995)	(0.19241)	(0.49878)	(0.65228)	(0.02926)	(0.32082
	[-0.12768]	[-0.04791]	[-0.10048]	[-2.60440]	[-1.51332]	[0.91875
D(LNRTINV(-2))	-0.038006	-0.115818	0.270928	-0.637873	-0.005337	-0.168508
	(0.09675)	(0.10953)	(0.28394)	(0.37132)	(0.01666)	(0.18263
	[-0.39285]	[-1.05737]	[0.95417]	[-1.71784]	[-0.32039]	[-0.92265
D(LNREXV(-1))	-0.029005	-0.028484	-0.161744	0.127857	-0.010870	-0.076810
	(0.05694)	(0.06447)	(0.16713)	(0.21856)	(0.00980)	(0.10750
	[-0.50936]	[-0.44181]	[-0.96780]	[0.58500]	[-1.10868]	[-0.71453
D(LNREXV(-2))	0.007366	0.012943	-0.085187	-0.341707	0.003952	0.084983
	(0.05365)	(0.06074)	(0.15746)	(0.20591)	(0.00924)	(0.10128
	[0.13730]	[0.21308]	[-0.54102]	[-1.65948]	[0.42784]	[0.83911
D(LNPOPT(-1))	-2.334660	-2.030066	-4.607202	-18.83186	-0.031385	-3.643327
	(1.30903)	(1.48206)	(3.84190)	(5.02423)	(0.22538)	(2.47115
	[-1.78350]	[-1.36976]	[-1.19920]	[-3.74821]	[-0.13926]	[-1.47434
D(LNPOPT(-2))	-1.414292	0.673555	-8.897320	-8.972518	-0.071226	-2.781737
	(1.39876)	(1.58365)	(4.10526)	(5.36863)	(0.24083)	(2.64055
	[-1.01110]	[0.42532]	[-2.16730]	[-1.67129]	[-0.29576]	[-1.05347
D(LNPSSER(-1))	-0.054018	0.179092	-0.194041	0.653997	-0.021321	0.364176
	(0.14779)	(0.16732)	(0.43375)	(0.56724)	(0.02545)	(0.27899
	[-0.36551]	[1.07033]	[-0.44736]	[1.15295]	[-0.83790]	[1.30532
D(LNPSSER(-2))	0.066194	-0.074590	-0.046317	0.010468	0.009883	-0.069150
	(0.13534)	(0.15323)	(0.39720)	(0.51944)	(0.02330)	(0.25549
	[0.48911]	[-0.48680]	[-0.11661]	[0.02015]	[0.42414]	[-0.27066
D(LNTGE(-1))	-0.129275	0.046284	-0.280251	-0.686001	-0.017754	-0.202998
	(0.09757)	(0.11046)	(0.28635)	(0.37448)	(0.01680)	(0.18419
	[-1.32497]	[0.41900]	[-0.97868]	[-1.83188]	[-1.05688]	[-1.10213
D(LNTGE(-2))	-0.080315	0.068176	-0.566473	-1.166846	0.020165	-0.202025
	(0.09038)	(0.10233)	(0.26526)	(0.34689)	(0.01556)	(0.17062
	[-0.88864]	[0.66626]	[-2.13557]	[-3.36376]	[1.29587]	[-1.18409
C	0.170155	0.045182	0.604401	0.923678	0.025550	0.279110
	(0.07949)	(0.08999)	(0.23328)	(0.30508)	(0.01369)	(0.15005
	[2.14070]	[0.50207]	[2.59083]	[3.02769]	[1.86695]	[1.86010
DWECON	-0.080853	0.086673	-0.374067	-0.415315	0.001258	-0.121356
	(0.04806)	(0.05442)	(0.14106)	(0.18448)	(0.00828)	(0.09073
	[-1.68219]	[1.59275]	[-2.65175]	[-2.25132]	[0.15208]	[-1.33748

R-squared	0.629592	0.667750	0.757209	0.784949	0.681743	0.65236
Adj. R-squared	0.259183	0.335500	0.514418	0.569899	0.363487	0.30473
Sum sq. resides	0.042722	0.054763	0.368001	0.629354	0.001266	0.15225
S.E. equation	0.051673	0.058504	0.151658	0.198330	0.008897	0.09754
F-statistic	1.699723	2.009782	3.118771	3.650068	2.142118	1.87661
Log likelihood	62.89243	58.79560	27.36197	18.50791	120.9483	41.9242
Akaike AIC	-2.781359	-2.533067	-0.627998	-0.091389	-6.299894	-1.51056
Schwarz SC	-2.010431	-1.762139	0.142930	0.679539	-5.528966	-0.73963
Mean dependent	0.029450	0.067713	0.041126	0.038676	0.025735	0.08448
S.D. dependent	0.060036	0.071769	0.217637	0.302414	0.011151	0.11698

Determinant resid covariance (dof adj.)	6.28E-19
Determinant resid covariance	3.95E-21
Log likelihood	447.3937
Akaike information criterion	-19.47840
Schwarz criterion	-13.76447

ECT=Error Correction Term.