

**ADDIS ABABA UNIVERSITY**  
**SCHOOL OF GRADUATE STUDIES**

**THE NEXUS BETWEEN INFLATION RATE, GROSS NATIONAL  
SAVING RATE AND PER CAPITA INCOME GROWTH RATE IN  
ETHIOPIA: THE CO-INTEGRATED VAR APPROACH**

**A Thesis Submitted to the School of Graduate Studies of Addis Ababa  
University in partial fulfillment of the requirements for the Degree of Master  
of Science in Economics (economic policy analysis)**

**By**

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This is to certify that the thesis prepared by Feyera Gudina, entitled: the nexus between Inflation rate, Gross national saving rate and Per capita income growth rate and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Economics (Policy analysis) complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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## **Abstract**

The nexus between Inflation rate, Gross national saving rate and Per capita income growth rate

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The study is aims at understanding the link between inflation rate, national saving rate and per capita income growth rate in Ethiopia. To achieve this objective co-integrated VAR approach was employed. The estimated models enable to understand the long run and short run relationship of the variables for the period 1980 – 2014 in Ethiopia.

The result shows that there is short run and long run relationship between the variables. The long run test results show that per capita income growth rate and inflation rate exert positive and significant impact on gross national saving rate; inflation rate and gross national saving rate exerts positive and significant impact on per capita income growth rate; per capita income growth rate exerts positive and significant impact on inflation rate where as gross national saving rate exerts negative and insignificant impact on inflation rate in the long run.

The short run test results show that the impact of per capita income growth rate on gross national saving rate is positive and insignificant whereas the impact of inflation rate on gross national saving rate is negative and insignificant; inflation rate and gross national saving rate exerts positive and significant impact on per capita income growth rate; gross national savings rate and per capita income growth rate influence inflation rate positively in the short run time period in Ethiopia. The impulse response function indicates that the variables are at fast movement towards long run time path.

Inferences drawn will have implications for all stakeholders in the economy and are particularly useful to monetary authorities or policy makers of the country.

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## **Acronyms**

ADF	Augmented Dickey-Fuller
AIC	Akaiki Information Criterion
ALR	Average Lending Rate
ARDL	Autoregressive Distributed Lag
CIVAR	Co-Integrated VectorAuto regression
CPI	Consumer price Index
CSA	Central statistical agency
DF	Dickey-Fuller
FPE	Final Prediction Error
AIC	Akaiki Information Criteria
GDP	Gross Domestic Product
DMY	Dummy Variable
GNS	Gross National Saving Rate
GTP	Growth and Transformation Plan

HQ	The Hannan-Quinn Information Criteria
I(0)	Integrated of Order Zero
I(1)	Integrated of Order one
IMF	International Money Fund
INF	Inflation Rate
IRF	Impulse Response Functions
JB	Jarque-Bera
LM	Lagrange Multiplier
LR	Likelihood Ratio test
MoFED	Ministry of Finance and Economic Development
NBE	National Bank of Ethiopia
OLS	Ordinary Least Squares
PCI	Per Capita Income growth rate
PP	Phillips-Perron
SC	Schwartz Criterion

SIC	The Schwartz Information Criteria
VAR	Vector Autoregressive
VECM	Vector Error Correction Model
VIF	Variance Inflation Factor
VIRF	Var Impulse Response Function

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# CHAPTER ONE

## 1. INTRODUCTION

### 1.1 Background

Inflation is one of the measures of macroeconomics performance indicator. It is defined as the continuous and sustained rise in general price level of goods and services in an economy. It is a condition where the amount of money pursuit or chase the available goods and services in an economy is too much, so result in continuous rise in general price level. Theoretically, it is accepted that a situation of high inflation is very bad on price stability of goods and service unless there is corresponding rise in income level, saving level, factor that affect capital accumulation of a nation. Hence, inflation is one of the macroeconomic problems that take the attention of macroeconomists, policy makers and central or national bankers of countries. It is the major concern of macroeconomic and principal focus of policy decision makers and the public issue and considered as one of very important agenda for government bodies and researchers due to its determinant factors for economic growth through its impact on national saving.

National saving rate is one of macroeconomic variables that can be affected by inflation. National savings rate in macroeconomic theory is defined as the combination of public and private saving rates of a nation. It plays very important role in economic growth and development. Low national savings rate is one of the most series impediments to achieving higher and more sustainable economic growth. That is, why classical and neoclassical models are seem to emphasize on higher savings for long run growth. Positive change in saving rate may promote

growth rate (Slow, 1956). After that endogenous growth model that is introduced by Romer (1986) and Lucas (1988) mentioned that economic growth depends on savings, technological change, and human capital.

Saving may be defined as the portion of disposable income not spent on consumption of consumer goods but accumulated or invested directly in capital equipment. It may be referred to or assumed suspend consumption, being income left over for future consumption on capital investment or precautionary and speculative motives. In brief, saving is disposable income less consumption. In Ethiopia, it is known that both public and private savings are the main sources of capital accumulation for investment purposes. As of theoretical viewpoint total savings of households, entrepreneurs, and corporate unit in an economy has positive correlation with per capita income. In most of the time, it is known that saving is the main source of capital investment. Higher level of national saving can leads to higher investment and hence higher growth (Krieckhaus, 2002). This indicates that the level of national saving affects the level of output per capita growth rate which is one of the indicators of macroeconomic situation of the country.

The main aim of macroeconomic policymakers in the world is to get high and sustainable economic growth with low inflation (Khan and Sehagji, 2001; Ahortor, et al., 2009). This is because high growth makes it possible to raise the living standards of the poor. Hence, it causes the opportunity for some people to be made better off in society without making others worse off (Douthwaite, 1977). In addition, low inflation and high long term growth improves the efficient allocation of resources and increases employment in the economy. Mubarik (2005) found that low and stable inflation promotes economic growth and high economic growth can cause inflationary problem.

The relationship between inflation and economic growth becomes issue of debate among the macroeconomists, policy makers and central monetary authorities. The argument is that whether inflation is necessary for economic growth or it is detrimental to growth. Basically the rate of economic growth depends primarily on the rate of capital formation and the rate of capital formation depends on the rate of savings and investment. Therefore, whether inflation affects economic growth depends on whether it affects savings and investment (Kanchan and Chandan, 2011). Economic growth and development of developing countries can be affected by high and variable inflation, low saving rate, and lower per capita income growth rate (Gokal and Hnif, 2004). At the macro level it has been considered that the amount of savings is beneficial for the economic growth of a country that can be affected by high and variable inflation.

Modigliani (1970) found that the rational people earn in the working age and save money in this era for older age. There are many other economists who believe that when income of individual increases, then the proportion of savings of that people will also increase. Keynes in his theory concluded that when the income of the people increased then along with consumption percentage of saving also increased. Saving is considered very important factor for the improvement of an economy of a country. Modigliani (1986) found that developing countries needed higher savings rate to grow faster. As saving rate increases per capita income growth rate also increases. This shows that saving rate plays a vital role in the individual's life by improving per capita income of the peoples of the country.

There are a lot of conflicting ideas regarding the impact of inflation on saving and economic growth. Some of the literature report that inflation has no impact on national saving (Celik and Kayali, 2009), some studies show that there is negative effect of inflation on saving (Fischer,1993; Romer,1999; Ahimad and Muhamood,2013;Osundinak and OsundinaJ, 2014).

Some theories show the positive effect of inflation on saving (Mundel,1963 and Tobin, 1965). The impact of inflation on economic growth is through its impacts on saving and investment (Iqbal and Nwaz, 2009). Targeting high economic growth rate per capita can lead to a rise in inflation rate. Growth which depends on productivity of labor resource can increase supply and reduce inflation (Beker and Gordon, 2005). In this case growth and inflation can be linked in both directions. That means inflation can affect growth per capita and growth per capita can affect inflation. Since saving and inflation have relationship, inflation can affect growth per capita through its impact on saving. The study of the link between inflation rate, national saving, and per capita income growth rate is very important in policy analysis in Ethiopia. Nevertheless, it was uncovered in the country.

There is interrelationship between inflation rate, gross national saving rate and per capita income growth rate. It is inevitable to face inflationary growth problem while targeting high economic growth of a country because of inflationary finance of investment projects (Aghevli, 1977). Saving is important for sustainable economic growth in developing country with labor resource intensive than technology intensive growth system (The World Bank, 2007). Policy makers in Ethiopia should consider impact of inflation on saving rate while proposes high economic growth target. So the analysis of relationship between the inflation rate, national saving and per capita income growth rate can contribute some ideas for policy makers of Ethiopia.

The impact of inflation on the two variables can increase income inequality (Bulier and Gulde, 1995). Food inflation is the series problem in Ethiopia and this increases income inequality due to high expenditure of poor on food items and the inflation problem in Ethiopia is due to increase in income in the country (Kbrom, 2008). Identifying the impact of the variables on each other in

the country is required so that policy makers consider these issues during their policy making decision.

Michael (2008);Tafere (2008);Asaminew (2010);Teshome (2011) and Abis (2013) studied the relationship between inflation and economic growth and found that there is positive relationship between inflation and economic growth. Abis (2013) also suggested further study on the relationship between inflation and economic growth by inclusion of some explanatory variables that can explain inflation. Michael (2008) studied the relationship between inflation and economic growth and found negative relationship between the variables. Other studies are also done on these two variables. None of the research papers raised the link between inflation rate, per capita income growth rate, and gross national saving rate. If the links between these variables are studied and inference is reached the above research works will be well equipped and useful for stakeholders.

Those researches performed in Ethiopia have limitation in consideration of dynamic relationship between the above variables. In other words, most of the researches did not consider the link between inflation rate, gross national saving rate, and per capita income growth rate in Ethiopia. The studies on interactions between inflation rate, gross national saving rate, and per capita income growth rate was limited in that each variable was not reflected endogenously using co-integrated VAR approach. This study, using the data between 1980 and 2014<sup>1</sup>, has been analyzed short run and long run relationship between inflation rate, gross national saving rate and per

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<sup>1</sup> See Appendix 12 for time series data used for the study,

capita income growth rate; likewise, the direction of relationship between the variables will also be estimated.<sup>2</sup>

## **1.2 The statement of the problem**

It is unquestionable that macroeconomic stability is crucial for sustainable economic growth and development. Fischer (1993) stated that there is positive link between growth and macro stability. Especially low and stable inflation and rising per capita income and near balance between saving and investment indicates stability and is positively related to sustainable economic growth. Policy design that affect saving negatively affects growth in the same direction. Levine and Renelt (1992) indicated that both saving and physical investment rates positively and significantly correlated with average growth rates.

In addition to dealing with economic growth, economists considered savings as a major macroeconomic factor which has a strong relation with inflation. Sidrauski (1967) in a general equilibrium framework found that money remained neutral in the time steady state. So, inflation has no impact on savings in the long run. But Den and Haan (1990) found that negative relationship between inflation and savings. This indicates that inflation affects investment and growth through the channel of saving.

Inflation can affect saving rate via its effect on per capita income. Barro (1995) showed that a 10% increase in inflation reduces per capita income by 0.2- 0.3 and investment to GDP by 0.4 – 0.6 percent points. den Haan (1990) showed in his model that a rise in inflation rate from 0% to 5% decreases savings rate by almost 10%. In the other hand, Feldstein (1982) argued that loose monetary policy can increase the real capital income tax burden in a nominally based tax system.

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<sup>2</sup> The direction of relationship is to mean that whether the variables interact positively or negatively.

Therefore, higher inflation rate reduces the return on savings and hence reduces national saving rate. The impact of inflation on channel of investment which is the impact of it on national saving is an important issue to be considered during economic policy making. This paper investigates this issue in Ethiopia.

According to consequent reports, fast economic growth has been recorded for more than a decade. This growth performance of the country is accompanied by wise government selective intervention in the economy by appropriate fiscal and monetary policy. Although government intervention in the economy is vital for economic growth and development, it may result in general price rise in the country in long run. The knowledge of short run and long run direction of relationships between inflation, gross national saving growth rate and per capita income growth rate is vital for appropriate policy design in order to develop sustainable growth and transformation plan (GTP) for policy making body of the country.

One of the challenges of implementation of GTP (Growth and Transformation plan) was low level of domestic saving to support the huge demand of country's investment for accelerating growth and development in the process of eradicating poverty (MoFED, 2010). According to the ministry, one of the macroeconomic objectives of GTP was maintaining macroeconomic stability there by encouraging saving and investment through adopting appropriate policies that are designed to promote rapid and broad based growth. Fiscal and monetary policies will be managed in a manner consistent with macroeconomic stability objectives of the country. But, inflation has remained a scourge (curse) of the Ethiopian economy (Kasahun, 2002 and Tadese et al, 2008). They complain that the problem with inflation is not unique to Ethiopia but what makes this special case is that the country is a low income country where high inflation hurts the society most. So the increase in National consumer price index has become very detrimental to

the low-income groups as it makes them poorer and poorer by reducing their income and saving ability (Teshome, 2011).

High and fast growing economy in per capita terms can be susceptible to high inflation and in economy where there is imbalance between demand and supply, higher growth of economy in per capita terms can lead to reduced inflation (chaturvedi et al,2009). Therefore, the relationship between growth per capita and inflation rate is in both directions. That means growth can increase inflation or reduce inflation. This shows that per capita income, saving and inflation are interrelated variables and the effect of variables on each other can be analyzed endogenously by co-integrated VAR approach.

It is important for policy makers to understand the relationship among per capita income, savings, and inflation and direction of relationship between the variables in Ethiopia for fast and sustainable economic growth.

Saving or capital accumulation is the main determinant of economic growth, which can be understood as sustainable long- term rise in income of a country. Saving directly translated to investment and prerequisite for economic growth Lewis (1954). Neoclassical growth theories support the importance of saving in the economic growth process. This implies that when there is higher saving there is higher investment and hence higher economic growth. From this fact one can assert that saving and growth are positively correlated and macroeconomic instability that affect savings also affects per capita output. Example, the endogenous growth theory (Barro and Sala-i-Martin,1995; Romer,2006) explained a positive relationship between long term growth and saving rate.

A lot of research has been done on the determinants of saving as inflation and per capita income and most of the studies used only saving as endogenous variables and the rest as exogenous variables. Kidane (2009) studied the determinants of domestic saving in Ethiopia. He used co-integration and error correction modeling, and found that growth of per capita income have significant positive influence on domestic saving while the current per capita income level is significant and negatively related with domestic saving in the long run, but turn to insignificant in the short run model. In fact, the methodology used were no problem, but how national saving affects inflation rate and per capita income growth rate was not studied. Worku (2010) studied causal links among saving, Investment and growth and determinants of saving in sub-Saharan Africa evidence from Ethiopia by using time series models. The study found that export, inflation and lag of government expenditure to have a statistically significant short and long term impact on the saving rate. He showed that growth of income has a positive effect on rate of saving. His impulse response function showed that the existence of neoclassical theory in that saving causes income growth. Haile (2013) used autoregressive distributed lag (ARDL) and error correction (ECM) and found that growth rate of income, budget deficit ratio (BDR) and inflation rate (INF) were long run determinants of domestic savings in Ethiopia. The impact of saving and inflation on per capita income and how saving and per capita income growth rate affect inflation rate in short run and long run should be built on this study so that it more strengthen the former studies. Abu and Worku (2004, 2010) have studied the determinants of domestic saving in Ethiopia using time series data. In these studies the growth rate of income, depositing interest rate, current account deficit, and inflation, degree of financial depth, foreign saving and dependency ratio were included to identify the major determinants of domestic saving.

In general the above empirical results found were not indicated the following nexus of variables:

The short run and long run impact of inflation rate and gross national saving rate on per capita income growth rate of the country, The short run and long run impact of inflation and per capita income growth rate on gross national savings of the country, The short run and long run impact of per capita income growth rate and gross national saving rate on inflation rate of the country.

The study can support the previous studies by filling the above gaps using CIVAR or vector error correction model (VECM) followed by impulse response and variance decomposition function.

### **1.3 Research Questions**

- What is short run and long run impact of inflation rate and gross national saving rate on per capita income growth rate of the country?
- What is short run and long run impact of inflation and per capita income growth rate on gross national saving rate of the country?
- What is the short run and long run impact of per capita income growth rate and gross national saving rate on inflation rate of the country?
- What policy suggestion should be provided to the policy makers of the country?

### **1.4 Objectives of the study**

#### **1.4.1 The general objectives**

The general objective of this study is to examine short run and long run relationship between inflation rate, gross national saving rate, and per capita income growth rate of Ethiopia.

#### **1.4.2 The specific objectives**

- To identify the short run and long run impact of inflation rate and gross national saving rate on per capita income growth of the country,
- To analyze the short run and long run impact of inflation rate and per capita income growth rate on gross national saving rate of the country,
- To investigate the short run and long run impact of per capita income growth rate and gross national saving rate on inflation rate of the country.

#### **1.5 Scope and significance of the study**

A vital component of any move towards economic growth and development is an integrated effort towards macroeconomic variable stability. The aim of this study is focused only on investigating the nexuses between the macroeconomic variables such as inflation rate, gross national saving rate, and per capita income growth rate in Ethiopia using annual data from 1980 to 2014. The study employed co-integrated VAR (VECM) approaches.

In general, the study is significant in the followings ways:

It will have effect on the efficiency and effectiveness of the use of policy tools in the stabilization of macroeconomic variables to stimulate fast and sustainable economic growth and development in Ethiopia,

Empirical support for the economic theory of the relationship between the variables in Ethiopian data case, and

It will provide an explanation for the short run and long run interaction between the variables and this may help as empirical support for the other studies, in that it builds the previous literature further.

### **1.6 Limitation of the study**

Important and reliable time series data, that could be included as explanatory or independent variables in the model are not available. This problem may exert impacts on predicting power of the model.

### **1.7 Organization of the study**

The study is organized into five chapters. Following the introductory chapter, chapter two gives review of both theoretical and empirical literature on inflation rate, gross national saving rate and per capita income growth rate. Chapter three discusses the model specification, data description and sources and estimation techniques used in the study. Chapter four deal with model estimation and interpretations of results. At the end, chapter five presents the conclusions and policy implications of the study.

## **CHAPTER TWO**

### **2. THEORETICAL AND EMPIRICAL LITERATURE**

#### **2.1 Introduction**

This chapter presents the relevant theoretical and empirical literature on the nexus between inflation rate, gross national saving rate and per capita income growth rate. The first section explores the theoretical framework of the study, the second section examines empirical literature of interest to the topic, and the last section draws conclusions from both the theoretical and empirical literature.

In the theoretical literature, the links between the variables to be studied with basic theories have been addressed from the earliest to the latest. In empirical literature, the links between the variables to be investigated with empirical research findings and the methodology used by the researchers has been discussed. Finally, the review will be closed by summary. In the summary part, the research gap that was found and the contribution of this paper to the gap have been discussed.

#### **2.2 Theoretical literature review**

A lot of theoretical and empirical research concerning the nexus between inflation, national saving and per capita income growth rate are available in the literature. Theories which have relation with the variables are included as the following,

### **2.2.1 The Mercantilists theory of inflation**

The mercantilists are the ancient economic thought before modern ones are come out. According to the mercantilists, high economic growth will be achieved by encouraging export surplus and discouraging import. They propound that balance of payment (BOP) deficit was considered as reduction of economic growth. The precious metals were used as money in most places of the world during that period. Export surplus was considered as an accumulation of gold bars and coins. This large amount of gold bars and coins in market decreases the values of them and increases the values of exchangeable goods (commodities) in the market. This increases price level in that period. Mercantilists support the idea of export surplus but they know that excess of them in the market increases price level. This shows that reduction in value of gold and bar money in the market and as a result causes inflation was the first thought about price level in economics (Abis, 2013: pp.16)

The first mercantilist known to identify the negative effect of excess gold bullion to inflation was William petty. He stated that increase in gold bullions and coins in the market increase inflation rate and this in turn reduces economic growth in the country. Increase in inflation in the country reduces competitive capacity of the country in the global market. This is because the value of domestically produced goods becomes expensive in the international markets and demand for domestic good will be reduced. Hence a present issue of inflation problem has its origin in mercantilists' period (Abis,2013: pp.17)

### **2.2.2 The classical theory**

Adam Smith was the founder of classical theory. According to Adam Smith, the three factors of production were land, labor, and capital. Hence he designed production function as:

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

Smith considered saving as the most important factor affecting the growth rate. In classical theories the taxing effect of inflation on income or profit level and output was not mentioned. However, the relationship between the two variables is implicitly negative by the reduction in firm's profit level and saving through higher wage costs (Gokal and Harif, 2004)

The classical theory of inflation attaches sustained price inflation to excessive growth in the quantity of money in circulation. For this reason, the classical theory is sometimes called the quantity theory of money. More specifically, the classical theory of inflation explains how the aggregate price level gets determined through the interaction between money supply and money demand. As a matter of fact, because it traces the behavior of an important economy-wide variable – inflation – back to the most basic forces of supply and demand, the classical theory must qualify as one of the oldest models in all of macroeconomics (Ireland, 2014: pp. 1-2).

The best and most persuasive evidence in support of the classical theory is presented in famous studies like Sargent's (1982), which focus on the hyperinflationary episodes that have occurred in various places in various times throughout world economic history. In each and every one of these episodes, where inflation rates were in excess of 100 percent per year, these high rates of inflation are inevitably accompanied by equally high rates of growth in the money supply. And in each and every one of these incidents, the hyper inflation is seen to stop as soon as the central bank takes decisive action to restrain the monetary expansion. Thus, these episodes come close to being controlled, laboratory experiments in which the independent variable-money growth-is deliberately manipulated holding all else constant and the dependent variable-inflation-changes in accordance with the prediction of theory. According to the classical theorists, society is

divided in to landlord, capitalist and workers. There is competition among the capitalists over workers. This competition among them raises wages of workers. This reduces profits of capitalists who are wealth creators of the social segments. This discourages them to invest in the economy. This is through which inflation especially wage inflation affects economic growth. From this idea, there is suggestion of classical theories that there is negative relationship between inflation and economic growth (Ireland, 2014: pp.3).

### **2.2.3 The Keynesian theory**

In 1936, John Maynard Keynes wrote the book “The general theory of employment, Interest and Money” which established the foundation of Keynesianism. Keynesians believes on the interventions of government to reach full production. They believe that intervention in economy by government through expansionary economic policies will boost investment and promote demand to reach full production. The Keynesian model consists of overall demand and supply curves. This relationship is appropriately shows the relationship between inflation and growth. In the Keynesian theory, the aggregate supply is upward sloping and unlike the classical economists who assume that aggregate supply is vertical. If the aggregate supply were in the way classical assume, only prices were affected. But if aggregate supply were in the way Keynesians assumes, both output and prices will be affected. So, according Keynesians theory, factors that affect inflation can affect output in the short-run (Xiao, 2009:pp. 5).

According to Keynesian economic theory, income has been considered the most important factor in the determination of the saving behavior of an individual. More income means, normally, more saving. Different forms of the functional relationship between saving and income have been tested. Some studies found a statistically significant effect of income on saving, and other studies found no significant effects on income on saving. Both the Keynes savings function

(1936) and the permanent income hypothesis indicates a positive effect of income on savings (Xiao, 2009: pp.6)

In Keynesian theory, the upward sloping curve shows that the increase in demand due to government intervention not only increases inflation but also output. Hence, there is positive relationship between inflation and economic growth in Keynesian theory. Whether Keynesian theory holds true or not should be tested in Ethiopia. This paper contributes to this gap in Ethiopian data.

#### **2.2.4 The monetarist theory**

According to monetarists, money supply is the only factor that determines price level in the economy. This idea was propounded by the modern influential economist Milton Friedman. Friedman and his followers complain that government intervention in the economy controls the growth rate of money to harmonize it with the growth rate of output in the long run. In other word; government balances monetary growth with output growth in the long run. Monetarist argues that inflation will occur when money supply growth rate rises faster than the rate of growth of national income. If money supply increases in line with output then there will be no inflation. But the effect of money supply is different for the long run and short run. In the short run, money supply has the dominant influence on the real variables (i.e. real GDP and employment) and price level. But in the long run the influence of variation in the money supply is primarily on the price level and on other nominal variables but not on real variable like real output and employment (Frozen and Guender,1998: pp.1 26).

Monetarism looks the concept of anticipation into Phillips curve and divide Phillips curve in to short run and long run. For this theory Phillips curve will hold in short run but not in the long

run. In the long run, anticipated inflation will be consistent with actual inflation. So inflation will not influence unemployment, output and other real economic variables. This concept is called neutrality of money. The concept of neutrality and super neutrality as 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 and super neutrality holds when real variables including the rate of growth of GDP, are independent of the rate of growth in the money supply in the long run. Inflation will be harmless in the case of neutrality and super neutrality. But this may not be true in reality. This is due to the fact inflation is bad for economy as it affects capital accumulation, investment and export and hence affects output (Fikirte, 2014: PP.16-17)

According to Gokal and Hnif (2004), the idea of the monetarist is that inflation is prejudicial to economic growth in the long run even though it has positive impact in the short run. Inflation leads distortions in the allocation of resources. In an inflationary setting there is a tendency for saving to be put into unproductive investments like accumulation of inventories, real estate or house building. All these are assets that best protect the saver against price increases or these techniques hedges against inflation attacks. This allocation of investment resources does not increase the productive capacity of the country, and thus hampers the long-run capacity of the country not to maximize its economic growth rate. Even if productive investment takes place under inflationary conditions, this investment will tend to be channeled more into projects with a short gestation period. Other projects will be avoided, since under inflationary conditions (When there is uncertainty about the rise in prices from one year to the next; in most inflations the rate varies from month to month and year to year) it is hard to predict changes in the costs of inputs and thus it is difficult to make long term investment plans. The idea of monetarists is that

hedging against inflation rate by economic agents possible and this affects economic growth negatively in the long run.

### **2.2.5 The neo-classical theory**

The neo-classical growth model was devised by Solow and Swan (1956). They developed growth model that shows scientific innovations or technological change influence long term economic growth and level of technological change is determined exogenously, that is independent of all other factors including, inflation. In neoclassical economics the theory of growth is built on a concept of diminishing returns to labor and capital separately and constant returns to both factors jointly. The determinants of output growth for neo-classical growth theory are technology, labor and capital.

The Solow model shows that the saving rate is a key determinant of the steady-state capital stock. According to Solow (1956), if the saving rate is high, the economy will have a large capital stock and a high level of output. If the saving rate is low, the economy will have a small capital stock and a low level of output. From Solow conclusion one can see that the long-run consequences of a reduced saving rate are a lower capital stock and lower national income. The neo classical economists gave their own explanation about the relationship between inflation and economic growth. Mundel (1963) has explained the effect of inflation on economic growth. According to him, inflation might permanently increase output growth rate by stimulating capital accumulation, because in response to inflation households would hold less in money balance and more in other assets (Gokal and Hanif, 2004).

Tobin (1965) also supported Mundell's idea that inflation is positively related to economic growth. He developed Mundell's model further by following Solow and Swan (1956) in making

money a store of value in the economy. Individuals in the model substitute current consumption for future consumption by either holding money or acquiring capital. Under this set up, individuals maintain precautionary balances, in spite of capital offering a higher rate of return. His argument is that inflation causes individuals to change the money into other assets, which leads to greater capital intensity and promotes economic growth. Quite simply, the Tobin effect suggests that inflation causes individuals to substitute out of money and into interest earning assets, which leads to greater capital stock and promote economic growth. In effect, inflation exhibits a positive relationship to economic growth. Tobin (1992) also argued that, because of downward 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.

Stockman (1981), Contrary to Mundell (1963) and Tobin(1965) idea developed a model that shows a negative relationship between inflation and economic growth. Stockman's model shows that an increase in the inflation rate results in a lower steady state level of output people's welfare level declines. In Stockman's model, money is a compliment to capital, accounting for a negative relationship between the steady state level of output and the inflation rate. Stockman's understanding is prompted by the fact that firms put up some cash in financing their investment projects. Sometimes the cash is directly part of the financing package, whereas other times, banks require compensating balances. Stockman models this cash investment as a cash-in-advance restriction on both consumption and capital purchases. Since inflation erodes the purchasing power of money balances, people reduce their purchases of both cash goods and capital when 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) develop the basic labor- leisure mechanism, and Cooley and Hansen (1989) identify 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 is used because there is a cash-in-advance constraint on consumption goods. Cooley and Hansen extended 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 quantity of labor declines in response to a rise in inflation, the return to capital falls and the steady-state quantities of capital and output declines. Cooley and Hansen show that the level of output permanently falls as the inflation rate increases. This theoretical review demonstrated that models in the neoclassical framework can yield very different results with regards 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 (Sidrausk effect).

### **2.2.6 The neo Keynesian theory**

It emerged from the ideas of Keynesianism and one of the major developments of neo Keynesian was the concept of potential output. This is the level of output when the economy is operating at the optimum level of production, given the institutional and natural constraints. This level of output also corresponds to the natural rate of unemployment or non accelerating inflation rate of unemployment.

According to this theory, inflation depends on the level of actual output (GDP) and the natural rate of unemployment. First, if GDP exceeds its potential and unemployment is below the natural rate of unemployment, inflation will increase as suppliers increase their price built in inflation worsen. Second, if the GDP falls below its potential and and unemployment is above the natural rate of unemployment, inflation will decelerate as suppliers reduce price as there will be excess

capacity this undermine built in inflation. This final case is when GDP equal to its potential and unemployment rate is equal to non accelerating inflation rate of unemployment, then inflation rate will not change as long as there is no supply shocks (Gokal and Hanif, 2004).

From this neo-Keynesian hypothesis, increase in output reduces inflation rate, and decrease in output increases inflation rate. Hence, increase in per capita income reduces inflation and decrease in per capita income increases inflation rate.

### **2.2.7 The endogenous growth theory**

According to endogenous growth theories, economic growth is determined by internal production process. Examples, economies of scale, increasing returns or induced technological change; as opposed to external factors. In endogenous growth theory, the economic growth rate depends on the return to capital. A variable such as inflation reduces returns to capital which on the other hand reduces accumulation of capital and hence reduces economic growth.

Endogenous growth theories further indicated that economic growth rate depends on returns from both physical and human capital. Inflation tax reduces income from both physical capital and human capital and this reduces economic growth. There are a lot of economic variables which are affected by inflation.

One of sustainable economic growth variables affected by inflation is domestic saving. There are two contradicting ideas about the effect of inflation on growth through the channel of saving-investment linkage. One is that of exogenous growth theory. According to this theory inflation has no impact on economic growth and hence per capita income. The second theory is that of endogenous growth theory which says inflation can affect economic growth and development (Gokal and Hanif, 2004 pp.16 – 18).

Inflation reduces growth and development by causing inefficiencies in allocations of resources and uncertainty for future investment by investors on their financial capital returns. According to Sala-i-Martin (2002), there is negative relationship between inflation and economic growth. Ahmad and Mahmood (2013) also found that inflation rate has negative impact on national saving and per capita income in both short run and long run.

Saving affects investment and investment affects growth. When inflation decreases saving, it reduces growth and it promotes growth when its effect on saving is positive via its effect on investment. The impact of inflation on saving is determined by the response of economic agents to rise in inflation. If savers divert their saving from money wealth to physical assets and consumer goods as a result of rise in inflation, then saving will be reduced. Investors may not invest their financial asset to physical asset due to inflation uncertainty (Chopra, 1988).

In most saving studies inflation is incorporated to capture the impact of macroeconomic uncertainty on saving behaviors. Buffer stock saving theory suggests that greater uncertainty would rise saving since risk averse consumers set resources aside as a precaution against possible adverse changes in income and other factors. Another effect of inflation is that since it increases nominal interest rate, it will lead to higher measured household income and saving. But, if interest rate is not adjustable to inflation rate changes, a rise in inflation rate will reduce real interest rate which causes a disincentive to save in financial assets (Loayza et al., 2000).

Easterly and Fischer (2001) have presented evidence showing that inflation damages the well-being of the poorest groups in society. Easterly and Fischer said that higher inflation and macroeconomic instability are correlated with less rapid growth of average income and lower equality. They conclude that a low inflation economic environment is likely to result in higher

income for poor overtime due to its favorable effects on long run growth and income inequality, both of which are adversely affected by high and variable inflation.

In summary, there is controversy among theorists about the link between inflation, income and savings. Classical economists and monetarists propound that there is negative relationship between inflation and economic growth or per capita output. Keynesians hypothesize that there is positive relationship between inflation rate and per capita output. According to Keynesians, saving ability of individuals is determined by national income. That means income growth rate causes economic growth rate. Neo-classical ideas about the relationship between inflation and economic growth are mixed. According to Mundell (1963) and Tobin (1965), there is positive relationship between inflation and economic growth, where as Sidrauski (1967) stated neutrality of inflation on output. In other words, Stockman (1981) and Romer-Lucas growth theory stated the existence of the negative relationship between inflation and capital accumulation. Likewise, according to neo-classical theory long run economic growth is achieved by long run saving rate. They stated that saving rate causes economic growth which is the inverse of Keynesian theory.

The disagreement among theorists about the relationship between inflation, output and saving situation may be due to the cross countries growth and development level. Heterogeneity problems may cause difference in hypothesis. This study can solve this gap by focusing on only one country, Ethiopia.

## **2.3 Empirical literature**

### **2.3.1 The nexus between the variables in developing countries**

Studies of the relationship between inflation, saving and income in developing countries have been conducted to identify the short run and long run interactions of variables. Most of the empirical studies showed mixed result regarding the impact of inflation on saving and income.

Cross country studies show mixed results for the relationship between inflation rate, gross national saving rate and per capita income growth rate. Sternberg (1981) stated that the true fall in the average propensity to save has been considerably lower than indicated by the statistics. The argument is that the increase in the rate of inflation has led to a net transfer of real resources away from the personal sector<sup>3</sup>. This transfer was due to the fall in the real value of the net monetary assets held by the personal sector, and issued by the public and business sectors of the economy. As a result, there is positive relationship between inflation rate and saving rate. Hussein and Thirlwall (1999) used panel data of 62 countries over the period of 1967-1995 and analyzed the determinants of inflation. A basic distinction is made between the determinants of the capacity to save and the willingness to save. The willingness to save is assumed to depend on financial variables such as the rate of interest, the level of financial deepening and inflation. So, Inflation exerts a mild positive effect on saving. Athukorala and Sen (2004) in their study of determinants of private savings in India, using time series data of 1954 -1998 using error correction technique, found a positive effect of inflation on savings confirming the argument that individuals save more in the face of increased uncertainty in economic environment. Ahmad (2006) found that inflation can influence savings; although one cannot a prior determine the

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<sup>3</sup> Personal sector is non business or corporate sector.

effect of inflation on savings. This is because in a period when inflation creates uncertainty about future asset values and future real incomes, savings would be encouraged in time of high inflation. Kwakwa (2013) used co-integration and error correction methods to test short run and long run relationship between National saving rate, inflation rate, and income growth rate in Nigeria over the 1981-2012. The study showed that there is short run and long run relationship between the variables in Nigeria. Per capita income growth rate and inflation rate are significantly causes national saving rate.

In the other hand, some literatures indicate negative relationship between inflation rate and national saving rate. Atiq and Ahmad (2006) used Johansen-Juselius technique and corresponding error correction model to determine the long run and short run dynamics of the system respectively using time series data for Pakistan over the period 1972-2003. The study found negative relationship between inflation rate and saving rate. Ahmad and Muhmood (2013) studied the determinants of national saving by using co-integration test, error correction methods and ARDL methods. They showed that inflation rate affects national saving rate negatively in the long run in Pakistan. Epaphra (2014) used co-integration test using time series data of 1970-2010 in Tanzania. The result displays that inflation exert negative impact on national savings of Tanzania. Osundinak and Osundina (2014) showed that inflation causes a negative effect on savings in Nigeria. Tariq et al.(2015) used dynamic regression model with ARMA specification using annual data for the period of 1980-2010 and found the existence of negative relationship between inflation and national saving. The studies showed the impact of inflation rate and per capita income on saving rate. Nevertheless, how saving rate affects inflation rate and per capita income is not included in the studies.

Some empirical literatures indicate positive relationship between per capita income growth rate and national savings rate. Carrol and Weil (1994,2000) described that higher saving rates is obtained due to the increase in income per capita. Cheng and Li (2008) identified the determinants of Malaysian's saving. The research work is based on Life Cycle hypothesis using time series data from 1980-2006. The results showed that per capita income is positively related with savings. Ciftcioglu and Begovic (2010) showed economic growth and domestic saving rate seem to be positively correlated in a statistically significant manner. Akram and Farham (2011) identified the short run and long run relationship between income level and saving behavior in Pakistan along with inflation and age dependency ratio by using co-integration and error correction model(ECM) for the period of 1985-2009. The study used ARLD model, bounds testing approach to co-integration. The result shows that income levels acquire highly significant and positive relationship with the saving behavior in case of Pakistan. Igbatayo et al., (2012) used VAR approach and studied the relationship between inflation, saving and economic growth , using the data of the period of 1970 – 2010 in Nigeria and showed that output growth responds critically to saving. Output which is national income of the country can be affected by inflation but the effect of inflation on output is less than saving's effect on output. Jolaoshet et.al.,(2013) used vector auto regression(VAR) approach using time series data from 1980 to 2008 and found the impact of real interest rate on savings mobilization in Nigeria. The study revealed that real interest rate has negative effect on the level of savings mobilization in Nigeria. The need for government in Nigeria to link the existing gap between the lending and saving rates and increase per capita income, to stimulate savings for investment and economic growth were revealed by the study. Ogbokor (2014) used co-integration and error correction mechanism to establish the determinants of savings using time series data for Namibia for the period running from 1991 to

2012. The study used quarterly data derived from annual data set. The paper relied heavily on unit root tests, co- integration and error correction procedures. He used Augmented Dickey Fuller Test (ADF) to test unit roots. Johansen and Juselius co-integration test were used to test long run relationship between savings and its determinants. Co-integration test shows that there is long run relationship between savings and explanatory variables used in the study. The results suggest that per capita income causes positive impact on savings. Mauricien (2014) used Johansen co-integration and found that positive and statistically significant relationship between income and saving. Loayza et al. (2000) cross country study shows that per capita income growth rate and saving rates tend to go hand in hand.

Contrary to the above empirical literature, others explained negative relationship between per capita income growth rate and national saving rate. Edward (1995), analyzed the determinants of savings in the world economy, using panel data of 36 countries, from 1970 to 1992. The result indicates that per capita income related inversely with national saving rate. Ahmad and Mahmood (2013) explained the determinants of Pakistan's national saving rate. The study utilized ARLD bound testing approach and error correction model for short run dynamics during 1974-2010. The result shows that per capita income inversely related with national saving rate, both in the long and short run. All the studies showed the impact of per capita income on national savings, but the impact of gross national savings rate on per capita income is still untouched. Likewise, inconsistencies between results and contrary to theoretical relationship between the variables in the second studies indicate the existence of open research agendas about the link between the variables. This gap should be covered by this study.

### **2.3.2 The nexus between the variables in Ethiopia**

Many related researches have been done on inflation rate; gross national saving and per capita growth rate in Ethiopia, some of related empirical researches are mentioned as follows:

The literature review on the relationship between inflation rate, domestic saving rate, and per capita income growth rate is mixed in Ethiopia. Abu (2004) used unrestricted VAR approach and examined the determinants of domestic saving in the country. The study argues that the fiscal and monetary policies, the investment regime, and external factors interact exerting their respective influence on the behavior of economic agents and the domestic saving performance of the country. According to the study, the inflation rate indicates positive and statically significant effect on saving rate. In the other hand, Haile (2013) used ARLD bound methods and error correction (ECM) to identify short run and long run relationship between five variables and included growth rate of per capita income and inflation rate and found that there is short run and long run relationship between the variables in the country. The study showed that there is negative relationship between inflation and saving in the country. Aron et.,al.(2013) assessed saving culture in Ethiopia using chi-square test and descriptive statistics and found that one of the cause of in low saving rate in the country is high inflation rate. Hence, negative relationship between inflation rate and saving rate in the country. Kidane (2009) conducted time series analysis of the determinants of gross domestic saving in Ethiopia using co-integration and error correction econometric modeling, and employed data for the 1971 – 2009 periods collected from National bank of Ethiopia(NBE), CSA and world bank(WB) on annual base. The study revealed that growth per capita income have significant positive influence on domestic saving while the current per capita income level is significant and negatively related with domestic saving in the long run, but turns to insignificant in the short run model. The financial variables represented by

real deposit rate and development of broad money supply do not show any impact in improving the domestic saving. Inflation rate exerted negative effect on saving in Ethiopia through portfolio adjustment from real money balance toward real asset. The gross domestic saving growth negatively correlated with lagged domestic saving which indicated that there was no persistence in the behavior of domestic saving in Ethiopia over time. Worku (2010) used Engle-Granger cointegration test and Error Correction model to analyze the main determinants of saving and the connection among saving, investment and GDP in case of Ethiopia using a combination of time series models. The study found that inflation, export, lag government expenditure to have statistically significant short and long term impact on the saving rate. Inflation rate exerted a negative effect on rate of saving. Per capita income growth rate also exerted positive impact on saving rate in these studies.

Except Abu (2004), all studies used different methodologies and found the same result. All studies found negative impact of inflation on saving rate and positive impact of per capita income growth rate on saving rate in Ethiopia. Abu (2004) used Unrestricted VAR and found that inflation exerts positive impact on saving rate. The methodology he used shows that the variables are stationary at levels. This shows that there is a problem with a procedure of analysis. This is due to the fact that the variables cannot be stationary at levels. Haile (2013) used ARDL and found that there is negative relationship between inflation rate and saving rate. The studies show that the variables are integrated of different orders. That means some are stationary and the others non stationary at levels. But in my study, Augmented Dickey-Fuller(ADF) and Phillips-Perron(PP) test showed that the variables are integrated of the same order, I(1). Hence, ARDL cannot be used for long run co-integration test. The other limitation is that only the determinants of savings rate are included, but the impact of saving rate on inflation rate and per capita income

growth rate in the short run and long run is not studied. Hence, I used Johansen-Juselius co-integration and Vector Error Correction Model (VECM) to study the nexus between inflation rate, gross national saving rate, and per capita income growth rate in Ethiopia.

Abis (2012) used Engle-Granger and Johansen co-integration test to study the relationship between inflation and economic growth and found that there is positive relationship between the variables in the long run. There is short run adjustment toward long run equilibrium. The author also suggested that future research can be done by inclusion of other variable that can be affected by inflation. This study can be some of the response to Abis (2012) request for further research.

Fikadu (2012) used vector auto regression (VAR) and found that increase in economic growth decreases inflation where as inflation does not have significant effect on economic growth in the short run. Likewise, Granger causality test shows that economic growth has forecasting power about inflation while inflation does not have predicting power about economic growth. The Impulse response function shows that economic growth does not indicate any response to impulse of inflation while the response of inflation rate to impulse in growth is effective up to seventh year in the future.

Shegu (2004) used co-integration and the VECM model to examine the causal relationship between real economic growth and growth rate of real gross domestic savings for Ethiopia. The long-run relationship between real GDP and real gross domestic savings is explored by using the Johansen procedure. The results of the co-integration tests indicate that there is a long run bi-directionality relationship between real GDP and real savings in Ethiopia. Shimelis (2014) studied the relationship between savings, investment and economic growth in Ethiopia by using time series data from 1969 – 2010 by using ARDL bounds techniques. He found that there is

long run relationship between savings and economic growth in Ethiopia. In the other hand, Ramakrishna and Rao (2003) studied the long run relationship between saving and investment in Ethiopia using co-integration and ECM approach and found that there is no long run relationship between savings and investment in Ethiopia. According to this study the resource of investment in Ethiopia is foreign aid and loan. The result of the first two studies and the next are controversial. Hence, there exists inconclusiveness about the relationship between saving and economic growth in Ethiopia.

In Summary, the evidence from the above theoretical and empirical literature review show that the link between inflation rate, gross national saving rate and per capita income growth rate is mixed. Some studies found that inflation exerts negative impact on national saving rate, contrary to this result; others found that inflation exerts positive impact on national saving rate. The impact of gross national saving rate and per capita income growth rate on each other were studied. The causality between the two variables is different for different studies. The disagreement between the study results of variables holds true for Ethiopia and other developing countries. Most of these empirical studies are done for different countries with different social, economical and political set up. The problem with such kind of studies is that all countries are considered as the same or existence of similarity between the countries. This is practically impossible, because there is difference between countries in policy issues, political stabilities, and growth or development levels. These situations cause difference in time series information of the variables<sup>4</sup>. The other problem that caused mixed result is the kind of data used, methodology and procedural errors. Example, in some literature, the data used is quarterly data that are

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<sup>4</sup> Time series information means the data for the variables such as inflation rate, gross national saving rate and per capita income growth rate.

obtained from annual data. This creates errors as annual data is not uniform from year to year. These demand country specific and appropriately used econometric procedures to test the link between inflation rate, gross national saving rate and per capita income growth rate. The problem with methodology used is that some used ARDL and others used co-integration. But the use of this methodology depends up on unit root tests. If the variables are integrated of different orders, such as some are  $I(0)$ , and others are  $I(1)$  or  $I(2)$ , ARDL is employed. If all the variables are integrated of the same order or  $I(1)$ , Johansen-Juselius (1990) is used to test for co-integration. These may be the reason for difference in results in different research papers. My study differs from these studies in that it analysis the short run and long run link between inflation rate, gross saving rate, and per capita income growth rate by using Johansen-Juselius (1990) and Engle and Granger(1987) vector error correction Methods and including dummies for some structural breaks in time series data of the variables in Ethiopia.

## **CHAPTER THREE**

### **3. METHODOLOGY**

#### **3. 1 Theoretical frame work<sup>5</sup>**

##### **INFLATION AND SAVING**

In classical economics, the word inflation is known to be a general rise in prices measured against a standard level of purchasing power. It is measured by comparing two sets of goods at two points in time. There are many measures of inflation depending on the specific circumstances. The consumer price index (CPI) measures the percentage change through time in the cost of purchasing a constant basket of goods and service representing the average pattern of purchases made by a particular population group in a specific time period.

In the model of Stockman (1981), den Haan (1990), or Heer and Sussmuth (2006), growth is exogenous and inflation only affects the saving rate. Similarly, in models of endogenous growth, higher inflation decreases the growth rate via the very same mechanisms. In these models, a lower labor supply is associated with less growth. In general, however, the quantitative growth rate effects in these models are found to be rather modest. Most recent empirical studies are concerned rather with the effects of inflation on the growth rate than with those on the saving rate. In this frame of mind, Fisher (1991), Sala-i-Martin (1995), among others, have identified the inflation rate as an important determinant of economic growth. However, the long term correlation of savings and inflation has not received any attention until now.

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<sup>5</sup> These are theoretical justification for the models and are taken from Chaturvedi et al. (2009).

Many empirical research shows that inflation affects a lot of economic variables. One of the economic effects of inflation is savings. According to Barro (1995), inflation has negative effect on growth. Probably this is via its effect on saving and investment. On the contrary, it is also suggested that inflation decreases the real value of financial wealth fixed in nominal terms, and households trying to restore their wealth-income position will increase their savings.

### **INFLATION AND INCOME**

Gokal and Hanif,(2004) stated the endogenous growth model relation with inflation rate. The basic idea with endogenous growth model is that per capita income or per capita output continues to increase because the return on capital does not fall below a positive lower bound. Only if the return on capital sufficiently high, will people be induced to continue accumulating it. Endogenous growth 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 balanced growth equilibrium. A tax on either forms of capital induces a lower return. When such endogenous growth models are set within a monetary exchange framework, of Lucas(1980),Lucas and stokey (1987),or McCallum and Goodfriend (1987), The inflation rate which is other form of tax lowers both the return on all capital(physical and human capital) and the growth rate.

Inflation tax on capital income reduces growth rate, while a tax on human capital would cause labor to leisure substitution that lowers the rate of return on human capital and can also lower the growth rate.

## INCOME AND SAVING

The relationship between personal income and savings is one of the key economic indicators reported in the income expenditure accounts. Income and wealth play a very important role in deterring the level of saving. According to Keynes short run change in income influence consumption and saving. As income increases saving also increases and vice versa. Coombs & Freedman (1970) in their economic theory suggested that income is positively related to savings. Thus, the higher the income growth rate the higher is the saving rate.

Both Keynesian savings function (1936) and the permanent income hypothesis indicates a positive effect of income on savings. Using time series data for forty nine countries, Rossi (1988), for example, indicated the positive impact of current income levels on savings rate without differentiating types of income. The above literature indicates that the methodology used has theoretical framework.

### 3.2 Model specification

Three separate econometric models are developed to address the objectives of the study. The models are Inflation, gross national saving and per capita income growth. The inflation, gross national saving and per capita income equations are employed to analyze the long run and short run relationship among the three macro-economic variables under the study.

Depending up on the theoretical grounds, some of the most believable factors for rise or fall in inflation measured in cpi can be specified in the following equation.

$$INF_t = F(GNS, PCI, ALR DUMY)$$

$$INF_t = \text{Inflation growth rate at time } t$$

GNS<sub>t</sub>= Gross national saving growth rate at time t

PCI<sub>t</sub>= per capita income growth rate at time t

DUMY= Dummy variables for structural breaks such regime change (policy), environmental change, and international factors measured in binary form "0" or "1"

The independent variables that explain inflation rate in the model are derived from different literatures cited above. Dholakia (1990) and Barro (1995) justified the importance of per capita income growth rate on inflation. Athukorala and Sen (2004) stated the existence of relationship between inflation and per capita income. According to Chaturved (2009) explained that in supply constrained economy higher growth can leads to reduced inflation. Banks lending rate also has impact on inflation through its effect on deposit rate of savers. There also structural breaks in time series data of the variables in Ethiopia. Example, Wello drought in 1984/85, regime change in 1991/92, and drought in 1995/96, financial crises in 2008 are some of structural breaks which has its influence in inflation rate, gross national saving rate, and per capita income of Ethiopia. These are included as dummy variables and defined as "0" in the years where there occurs no influence of structural breaks and "1" in the years where there occur structural breaks. All these dummies exert either positive or negative influence on the variables. The inclusion of the dummy variables is depends up on Chow breakpoint tests. Hence, inclusion of the explanatory variables as independent variables in the model is theoretically supported.

The inflation equation 3.1 above can be written as logarithmic form as follows:

$$LINF_t = \alpha_0 + \alpha_1 LGNS_t + \alpha_2 LPCI_t + \alpha_3 LALR + \alpha_4 DMY + \varepsilon_t \dots\dots\dots(3.1)$$

Where, L stands for natural logarithm

$\alpha$ 's – Coefficients of the explanatory variables

$\varepsilon_t$ - Residual term

The Equation for gross national saving could be as follows,

$$GNS_t = F(\text{INF}, \text{PCI}, \text{ALR}, \text{DUMY})$$

The independent variables that explain gross national saving rate in the model are derived from different theoretical and empirical literatures. Atiq and Ahmad (2006), Ahmad and Muhmood (2013), Epaphra (2014) and Tariq et al.(2015) found negative impact of inflation on gross national saving. Sternberg (1981), Hussein and Thirlwall (1999), Igbatayo et al (2013) the impact of inflation on saving is positive. The impact of per capita income on gross national saving is expected to be positive. Banks lending rate also has impact on saving rate through its effect on deposit rate of savers.

$$LGNS_t = \alpha_0 + \alpha_1 LINF_t + \alpha_2 LPCI_t + \alpha_3 LALR + \alpha_4 DMY + \varepsilon_t \dots\dots\dots(3.2)$$

Depending up on the above theoretical framework, the Equation for per capita income growth rate could be as follows:

$$PCI_t = F(\text{INF}_t, \text{GNS}_t, \text{ALR}_t, \text{DUMY})$$

$$LPCI_t = \alpha_0 + \alpha_1 LINF_t + \alpha_2 LGNS_t + \alpha_3 LALR + \alpha_4 DMY + \varepsilon_t \dots\dots\dots(3.3)$$

The long run estimate of the variables is obtained by estimating models such as equations 3.1, 3.2, and 3.3.

### **3.3 Data description and source**

#### **3.3.1 Data Source**

The macroeconomic data of Ethiopia is found in different sources. Central Statistical Agency (CSA), national bank of Ethiopia (NBE) and Ministry of finance and economic development (MoFED) and International Monetary Fund (IMF), and the world bank etc. The data obtained from different sources has minor differences. The data source employed for this study was CSA, NBE, MoFED and due to lack of data from internal source the study employed gross national saving rate from IMF. The study employed internal data due to its more consistency with internal economic performance information.

#### **3.3.2 Data description**

The study uses three variables inflation rate, gross national saving rate, and per capita income growth rate.

**Inflation rate:-** Annual percentage change of inflation measured as consumer price index. Inflation is expected to have positive or negative impact on gross national saving and per capita income growth rate. The domestic consumer prices are compiled by CSA. Consumer Price Index(CPI) measures the average change in price paid by consumers for a fixed basket of goods and services. Central Statistical Agency collects data on market prices and uses large number of goods and services in the country.

**Gross national saving rate:-**Annual percentage change of gross national saving measured as percentage of GDP. It is derived by deducting financial consumption expenditure from gross national disposable income, and consists of personal saving, business saving and government

savings. Gross national saving rate can impact inflation and per capita income growth rate positively or negatively as theoretically explained above. The data is obtained from International Money Fund (IMF).

**Per capita income growth rate:** - Growth rate of GDP per total population of the country. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of products. It is calculated without making deduction for depreciation of fabricated assets or for depletion and degradation of natural resources. It is also expected that countries with high per capita income can have more savings and can impact inflation positively or negatively.

The problems with these data in Ethiopia are some structural breaks in time series. The Wello drought, regime change etc of 1984, 1991, 1995 and 2008 are some structural breaks which affect the reliability of estimates. This is because stationary variables may be perceived non stationary and result in spurious regression. The writer used Chow breakpoint test to see the significance of the structural breaks in the time series data of the variables.

### **3.4 Estimation techniques**

The analysis to be made in this study shall be based on time series data for inflation rate (INF), gross national saving rate (GNS), and per capita income growth rate (PCI). Secondary data will be used from national bank of Ethiopia (NBE), MoFED, CSA and world economic outlook data base (IMF).

Co-integrated VAR approach (VECM) has been used due to co integration relationship of the variables and it minimizes information loss of time series data when first differencing is performed

for non stationary variables. VECM, like VAR, treats all the variables as endogenous, but limits the number of variables to those relevant for a particular theory.

First unit root test has been performed by Augmented Dickey Fuller test (ADF) and Phillips-perron (PP) test for stationary check; second Johansen co integration test has been performed to check the presence of co integration of the variables or long run convergence of the variables. Johansen co-integration test has been chosen than other options such as ARLD for test of long run relationship of the variables because the variables are co-integrated of the same order or I(1). Since the Johansson co-integration test shows the existence of co integration of the variables; VECM has been followed. Impulse response function and variance decomposition function were also used to analyze the dynamic effect (interaction) of the variables on each other on their path to long run co-integration. Granger causality test was employed to test the direction of causes between variables. Diagnostic check, such as R square, normality, serial correlation and heteroscedasticity test are performed. The data used in this study was annual data from 1980 – 2014 periods. But these data are constrained by structural breaks such as policy change, regime change, environmental conditions and external factors etc. These factors affect the reliability and consistency of variable estimates. For example, the estimates from inflation rate, gross national savings and per capita income are not stable in the existence of structural breaks. To handle this constraint depending up on information obtained from sign of structural breaks in the variables on time series data, dummy variables were included in the analysis of the variables depending up the chow breakpoint test<sup>6</sup>. Besides the regression analysis, tables were used to examine the trend of the variables over

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<sup>6</sup> Wello drought of, regime change, world financial crises etc of 1984/85, 1991/92, 1995/96 and 2008 are some structural breaks in Ethiopia. Chow breakpoint test is Significant only for gross national savings rate in Ethiopia. Structural breaks affects time series data in unit root test. See data description section of this study.

the years. Eviews will be the selected econometrical tool during analysis as it's easy to apply in this project.

### **3.4.1 Stationarity Test**

It is common for macroeconomic variables to increase or, less frequently, decrease over time. Many economic theories suggest causal relations between economic series. Variables that increase over time are examples of non-stationary variables. There are also series that may not increase over time but where the effects of innovations do not die out with time. These are also non-stationary. In fact there is a major problem with regressions that involve non stationary variables as the estimators or errors produced are biased.

Inflation, gross national saving and Per capita income may be changed with policy change due to governmental change from socialist to EPDRF regime, world price impact on domestic price and some climatic effect on rain fall dependent agricultural sector. This leads to requirement for stationary test.

Empirical work based on time-series data assumes that the underlying time series is stationary<sup>7</sup>. Before estimating a macroeconomic time-series model of the type considered in this study, it is necessary to identify the time series properties of the data. Thus, whether the variables in the model are stationary and their order of integration are evaluated to avoid inappropriate model specification and misleading results.

When the distributions of the process are remains unchanged during shift in time by an arbitrary value, it is called stationary. In other words, a stochastic process is said to be weakly stationary if its mean and variance are remain the same over time and the value of the covariance between the

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<sup>7</sup> See Davidson and Mackinnon,1999

two time periods depends only on the distance or gap between the two time periods and not the actual time at which the covariance is computed or a time series is strictly stationary if all of the moments of its probability distribution are invariant over time (Gujarat, 2003). The mean and variance is the two moments of the stochastic process. Verification of the stationarity is done by standard Augmented Dickey-Fuller(ADF) and the Phillips-perron (PP) tests. A time series is said to be integrated of order d denoted I(d), if it becomes stationary after being differenced a minimum of d times (Dickey and Fuller,1979, and 1981). The stationarity test results may be sensitive to whether a constant and/or a time trend are/is included in the regression. The appropriateness of including a constant and/or a trend is checked by formally testing whether they are statistically significant in the respective stationarity test regression equations.

#### **3.4.1.1 Testing for unit roots**

The unit root test has become the most common method to test for stationarity. There are a lot of tests to test for the presence of a unit root: the Dickey-Fuller (DF) test, the Augmented Dickey-Fuller (ADF) test and Phillips-perron test. This thesis paper will employ the ADF and Phillips-perron tests to determine the presence of a unit root. The most common applied formal test for the existence of a unit in time series data is the Dickey-Fuller(DF) test and its simple extension, the Augmented Dickey Fuller(ADF) tests (Harris,1995). The augmentation is the addition of lagged values (P) of first differences of the dependent variable as additional regressors that are required to account for the possible occurrence of autocorrelation.

#### **Augmented Dickey-Fuller (ADF) Test**

The method for testing the stationarity of a time series variable using the null of the unit root (non stationarity) was developed by Dickey (1976), and Dickey and Fuller (1979,1981). Dickey

Fuller test used three equations and the error terms are assumed to be serially uncorrelated which is not real able as he assumed. That means the error terms are serially correlated. In order to reduce the problem of correlation among the error terms, Dickey and Fuller developed the augmented Dickey Fuller (ADF) test. Assuming the random walk model with drift around the stochastic trend as correctly specified by augmenting the lagged values of the explained variables  $\Delta y_t$ , the ADF test can be estimated using the following cases:

**Case 1: ADF equation when there is only intercept term is**

$$\Delta Z_t = \alpha_0 + \theta Z_{t-1} + \alpha_1 \Delta Z_{t-1} + \alpha_2 \Delta Z_{t-2} + \dots + \alpha_p \Delta Z_{t-p} + \varepsilon_t \dots \dots \dots (3.4)$$

t-statistics can be used on the  $\theta$  coefficients to test whether you need to difference the data to make it stationary or not.

The null hypothesis of the augmented Dickey-Fuller t-test is

$$H_0 : \theta = 0 \text{ (i.e the data need to be differenced to make it stationary)}$$

Versus the alternative hypothesis of

$$H_1 : \theta < 0 \text{ (i.e the data is stationary and does not need to be differenced)}$$

**Case 2: ADF equation when there is intercept and trend is**

$$\Delta Z_t = \alpha_0 + \theta Z_{t-1} + \alpha_1 \Delta Z_{t-1} + \alpha_2 \Delta Z_{t-2} + \alpha_1 t \dots + \alpha_p \Delta Z_{t-p} + \varepsilon_t \dots \dots \dots (3.5)$$

Then one can use the t-statistics on the  $\theta$  coefficients to test whether differencing the data to make it stationary or you need to put a time trend in the regression model to correct for the variables deterministic trend.

The null hypothesis of the Augmented Dickey-Fuller t-test is

$H_0 : \theta = 0$  (i.e. the data needs to be differenced to make it stationary)

Versus the alternative hypothesis of

$H_1 = \theta < 0$  (i.e. the data is trend stationary and needs to be analyzed by means of using a time trend in the regression model in steady of differencing the data)

**Case 3: ADF equation when there is no intercept and trend is**

$$Z_t = \theta Z_{t-1} + \alpha_1 \Delta Z_{t-1} + \alpha_2 \Delta Z_{t-2} + \dots + \alpha_p \Delta Z_{t-p} + \varepsilon_t \dots \dots \dots (3.6)$$

The null hypothesis of the Augmented Dickey-Fuller t-test is

$H_0 : \theta = 0$  (the data needs to be differenced to make it stationary)

Versus the alternative hypothesis of

$H_1 = \theta < 0$  (i.e. the data is stationary and doesn't need to be differenced)

Where,  $\varepsilon_t$  is the white noise error term,

**Phillips Perron(PP) Test**

The Dickey and Fuller (1981) unit root test is depends up on the assumption that error terms are independently and identically distributed (iid). When DF test is adjusted by adding lags of dependent variable for generation of independently and identically distributed error terms, it is known as ADF test. But Phillips and Perron (1988) unit root test is ignores that assumption.

To deal with the problem of serial correlation in the errors, non parametric statistical methods are used in the Phillips Perron test without including the lag terms. The Phillips and Perron(1988) test solve the serial correlation problem among error terms by using a correction factor which estimates the long- run discrepancy of error process with modification of the Newey-West formula. The Perron test does not require the disturbance term to be serially uncorrelated or to be homogeneous.

Because of the asymptotic distribution of the Phillips and Perron(1988) test is the same as Dickey Fuller test, the same critical values are used for both ADF and Phillips Perron test. Generally, the Phillips Perron test is found to be more powerful than the ADF test. There are a lot of techniques that are used for testing the unit root of time series data. But there is no agreement reached on the type of test to be utilized without any demerits. Although there are some demerits of using it, Augmented Dickey Fuller and the Phillips Perron tests are going to be employed in this study.

### **3.4.2 Econometric model**

#### **3.4.2.1 Vector auto-regression**

Vector auto regression (VAR) was introduced by Sim (1980) as a technique that could be used by macroeconomists to characterize the joint dynamic behavior of collection of variables without requiring strong restrictions of the kind needed to identify under structural parameters. It has become a prevalent method of time-series modeling.

The use of the VAR approach for various macroeconomic studies has been critically examined by learner (1985) and cooley and LeRoy (1985). These writers are critical of the common uses of the VAR approach; however, they note that the method has many uses. Learner acknowledges

that VAR is useful for forecasting or as a descriptive device without any underlying theoretical framework. He suggests that for VAR analysis to have any economic meaning variables have to be justified economically. The study tried to indicate this. Cooley and Leroy, in their critical examination of VAR approach, note that it provides complete flexibility and generality in specifying the correlations between past, present and future realizations of the system of variables. They also note that VAR models can be used to generate stylized facts about causal orderings of macroeconomic variables and this seems to be robust empirically.

The VAR approach has, in recent years, become quite a common tool for macroeconomic analysis. Jumah and Kunst (2008) have looked at the relationship between GDP, construction investment and equipment investment for the United Kingdom using co-integrated VAR approach. Co-integrated VAR, also called the vector error correction model (VECM), is used for analysis of non stationary time series variables.

In summary, some empirical evidence shows that co-integrated VAR approach has been used to analyze the nexus between macroeconomic variables that has co integration relationship this is done after unit root test or Johansen co integration test is performed. In case there exists co integration relationship co-integrated VAR or VECM is used. Alemnesh (2012) used Co-integrated VAR approach to analyze the nexus between public investment, trade openness, private investment and economic growth in Ethiopia. Hence analysis of the nexus between inflation rate, gross national saving and per capita income using CVAR approach will be appropriate and it is within theoretical framework.

## **Advantages and disadvantages of VAR**

### **Advantages**

Vector auto regression model has advantages over other regression model. Some of the advantages it has includes: the method is easy to use in that one does not have to worry about determining which variables are endogenous and which are exogenous, estimation is simple; the usual OLS method can be applied to each question separately, the forecasts obtained by this method are in many cases better than those obtained from the more complex simultaneous equation models, used for structural inferences and policy analysis.

### **Disadvantages**

Vector auto regression model is a theoretic because it uses less prior information. Because of its emphases on forecasting, strictly speaking, in m-variables VAR model, all the variables should be(joint) stationary. If they are not stationary, we have to transform (eg by first differencing) the data appropriately. If some of the variables are non-stationary, and the model contains a mix of  $I(0)$  and  $I(1)$  then the transforming of data will not be easy. Since the individual coefficients in the estimated VAR models are often difficult to interpret, the practitioners of this technique often estimate the so-called impulse response function. The impulse response function traces out the response of dependent variable in the VAR system to shocks in the error terms, and traces out the impact of such shocks for several periods in the future.

### **Johansen Cointegration Test**

Test of co integration performed to know if there is long run relationship between inflation rate, gross national savings rate and growth of per capita income growth rate in Ethiopia. When two

time series of the variables have the same stochastic trend, they are said to be co-integrated. Johansen co-integration test depends on his maximum Likelihood (ML) estimator of the parameters of the following VEC model of two co integrating variables.

$$\Delta X_t = \sigma \delta' X_{t-1} + \sum_{i=1}^{p-1} \mu_i \Delta X_{t-i} + \varepsilon_t \dots \dots \dots (3.7)$$

Where  $X_t = \begin{pmatrix} x \\ y \end{pmatrix}$  is  $(2 \times 1)$  vector of  $I(1)$  variables,  $\sigma$  and  $\delta$  are  $(2 \times r)$  parameter matrices with rank  $r < 2$ ,  $\mu_i$  are  $(2 \times 2)$  matrices of parameters, and  $\varepsilon_t$  is a  $(2 \times 1)$  vector of normally distributed errors. Let  $\pi_1$  and  $\pi_2$  be the two eigenvalues of sample variance covariance matrices and used in computing the log likelihood at the optimum and assume the eigenvalues are sorted from the largest  $\pi_1$  to the smallest  $\pi_2$ . If there are  $r < 2$  co integrating equations,  $\sigma$  and  $\delta$  have rank  $r$  and the eigenvalue  $\pi_2$  is zero. Johansen derives the following two Likelihood Ratio (LR) test for choosing the ranks of the above VEC model.

**The Trace statistic**

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

$$-T \sum_{i=r+1}^2 \ln(1 - \pi_i) \dots \dots \dots (3.8)$$

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

## **The Maximum Eigenvalue statistic**

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

Johansen derives the distribution of the trace statistic

$$-T \ln(1 - \pi_{r+1})$$

Where  $T$  is the number of observations and the  $\pi_I$  are the estimated eigenvalues used in computing the log likelihood.

## **The Vector Error Correction Model (VECM)**

The vector autoregressive (VAR) model is a general framework used to describe the dynamic interrelationship among stationary variables. So, the first step in time-series analysis should be to determine whether the levels of the data are stationary. If not, the first differences of the series will be trying again. Usually, if the levels (or log-levels) of your time series are not stationary, the first differences will be stationary.

If the time series are not stationary then the VAR framework needs to be modified to allow consistent estimation of the relationship among the series. The vector error correction (VEC) model is just a special case of the VAR for variables that are stationary in their differences (i.e.,  $I(1)$ ). The VEC can also take into account any co-integrating relationships among the variables.

Let us consider three time series variables,  $\text{inf}_t$ ,  $\text{gns}_t$  and  $\text{pci}_t$ . Generalizing the discussion about dynamic relationships to these two interrelated variables yields a system of equations:

The equations describe a system in which each variable is a function of its own lag, and the lag of the other variable in the system. In this case, the system contains two variables Y and X. Together the equations constitute a system known as a vector auto regression (VAR). In this example, since the maximum lag is of order one; we have a VAR (1).

If Y, X and Z are stationary, the system can be estimated using least squares applied to each equation. If Y, X and Z are not stationary in their levels, but stationary in differences (i.e., I(1), then the difference of the first is taken and estimated:

If  $\text{inf}$ ,  $\text{gns}$  and  $\text{pci}$  are I(1) and co integrated, then the system of equations is modified to allow for the co integrating relationship between the I(1) variables. Introducing the co integrating relationship leads to a model known as the vector error correction (VEC) model.

The VECM cover data on both the short run and long run properties of the model, with disequilibrium as a process of adjustment to the long run model. Depending up on the Granger representation theorem, if some variables are co integrated, the vector error correction model (VECM) picture can be written as follows.

$$\Delta Z_t = \psi\Omega + \Pi Z_{t-1} + \theta_1 \Delta Z_{t-1} + \dots + \theta_p \Delta Z_{t-p-1} + \varepsilon_t = \psi\Omega + \Pi Z_{t-1} - \sum_{i=1}^{p-1} \theta_i \Delta Z_{t-i} - \varepsilon_t \dots \dots \dots (3.9)$$

Where,  $\Delta Z_t$  represents the first differences of the variables;  $\theta_1 = \sum_{j=-i+1}^p \alpha_j$  is (n×n) coefficient matrix in the error correction term or which contains short run parameters.

$\Pi = \sum_{i=1}^p \alpha_i - I$  is  $(n \times n)$  matrix of long run responses, which contains information about long run relationships. Error terms are in the way Gaussian assumed it or it has good behavior.

During estimation with VECM selection appropriate lag length is very important. The reason is that the estimation result may be affected by lag length.

### The Model Selection Criteria

Economic theory does not provide any guidance to the appropriate choice of models; some additional criteria can be used to choose from alternative models that are acceptable from statistical point of view. The appropriate choice of P in practice should be known. This is known as problem of model selection. One approach to model selection is to choose P based on a Wald test.  $\sigma$

Another is to minimize the AIC or BIC information criterion assuming constant is included in the AR(p) model, e.g.

$$\text{AIC}(p) = \log \hat{\sigma}^2(p) + \frac{2(p+1)}{T}$$

Where  $\hat{\sigma}^2(p)$  is the estimated residual variance from an AR(p). This AIC model for AR model.

One ambiguity in defining the AIC criterion is that the sample available for estimation changes as p changes. (If you increase p, you need more initial conditions). This can induce strange behavior into the AIC. The best remedy is to fix an upper value  $\bar{p}$ , and then reserve the first  $\bar{p}$  as initial conditions, and then calculate the models AR(1), AR(2), ..., AR( $\bar{p}$ ) on this unified sample.

Alternatively one can use the BIC given by

$$\text{BIC}(p) = \log \hat{\sigma}^2(p) + \frac{2(p+1)}{T} \log T$$

If one is to choose between alternative models, The AIC and BIC information criteria are given by

$$\text{AIC} = \log \hat{\sigma}^2(p+q) + \frac{2(p+q+1)}{T}$$

$$\text{BIC} = \log \hat{\sigma}^2(p+q) + \frac{2(p+q+1)}{T} \log T$$

Both criteria are likelihood based and represent a different trade-off between ‘fit’, as measured by the log likelihood value, and ‘parsimony’, as measured by the number of free parameters,  $p + q + 1$ , (assuming the model include the constant). Usually the model with the smallest AIC or BIC value is preferred, although one can choose deviate from this if the differences in criterion values are small for a subset of the models.

### 3.4.3. Granger causality Test

Granger causality test is a term for a specific notion of causality in time series analysis. In multivariate time series analysis, the use of causality test is to identify which variable causes (leads or come first) another variable. This causality test is developed by Granger (1969) and advanced by Sims (1972). A variable  $x$  Granger causes  $y$  if  $y$  can be better predicted using the histories of both  $x$  and  $y$  than it can using the history of  $y$  alone. Sims (1992) points out that a necessary condition for  $x$  to be exogenous of  $y$  is that  $x$  fails to Granger-cause  $y$ . Similarly, variables  $x$  and  $y$  are only independent if both fail to Granger-cause the other. Granger causality test is thus a pretty powerful tool, in that it allows us to test for things that we might otherwise assume away or otherwise take for granted. If both  $x$  and  $y$  variables are granger cause each other, there is a bi-directional causality between  $x$  and  $y$ . According to Verbeek (2003) a time

series x is said to Granger-cause another time series y if it can be shown that the series x values provide statistically significant information about the future values of series y; if not, x does not Granger cause y.

Testing of co integration between variables precedes causality test. In case co integration exists between variables, in that case causality exists between variables (Granger, 1988). Causality can be only one direction or both directions. Example co integration may be from inflation rate to growth rate of per capita income, or from growth rate of per capita income to inflation rate. Or all the variables may cause each others.

#### **3.4.4 Diagnostic checks**

##### **Residual Vector Normality Test**

The test of residual normality is very important after estimation in empirical studies. Jarque-Bera(JB) test will be an important residual normality test in this study. According to Eviews user's manual this techniques compares the third and fourth moments of the residuals to those from the normal distribution. It is a joint asymptotic test and the test statistics is calculated from the skewness and kurtosis of the residuals.

$$JB= T/6[s^2 + (\beta_{3-3})^2/4] ,$$

Where T is the number of observation; S is the coefficient of skewness , $\beta_3$  is a measure of kurtosis; and the test statistic is  $\chi^2$  distributed. The joint test is based on the null hypothesis that the residuals are normally distributed (i.e., S=0 and  $\beta_3=3$ ). Non rejection of the null hypothesis at the standard critical values indicates normality of the residuals.

### **Residual serial correlation Test**

The test of serial correlation of residuals is another means to check the strength of regression result. The Breusch-Godfrey Lagrange Multiplier (LM) test, which is multivariate test for residual serial correlation will be employed in this study. The test statistic for the chosen lag order (L) is computed by performing an auxiliary regression of residuals ( $\epsilon_t$ ) on the original variables and the lagged residuals ( $\epsilon_{t-L}$ ).

$$LM = (T-q) R_{\epsilon}^2$$

Where q is degree of freedom  $R_{\epsilon}^2$  is the coefficient of determination obtained from the auxiliary regression, and the LM test is statistic is  $\chi^2$  distributed. The LM tests the null hypothesis of no serial correlation against an alternative of auto correlated residuals.

### **Heteroscedasticity Test**

One of the basic assumptions of the classical linear regression model is that the variance of each disturbance term  $u_i$ , conditional on the chosen value of explanatory variables, is some constant number equal to  $\sigma^2$ . This assumption of homoscedasticity or equal spread, that equal variance.

$$\text{Symbolically } E(u_i^2) = \sigma^2 \quad (i=1,2,\dots,n)$$

If the assumption is violated i.e the variance of the disturbance term are not the same i.e

$V(u_i) \neq \sigma^2$ , then the problem of heteroscedasticity arises. White's test is used to evaluate the heteroscedasticity of the residuals. White's test tests the null hypothesis that the residuals are both homoscedastic and that there is no problem of misspecification.

### 3.4.5 Impulse Response Functions and Variance decomposition

#### 3.4.5.1 Impulse Response Function (IRF)

Impulse response function (IRF) of a dynamic system is its output when presented with a brief input signal, called an impulse. More generally, an impulse response refers to the reaction of any dynamic system in response to some external change. Standard IRF production uses estimates from the estimated VAR model. The usual methodology for generating IRF<sub>s</sub> involves non-linear (at horizons greater than one) functions of the estimated VAR parameters; here on this method is called VIRF, and the resulting IRF<sub>s</sub> called VIRF<sub>s</sub>.

Impulse Response function traces out the effect on the dependent variables in the VAR to shocks to all the variables in the VAR to shocks to all the variables in the VAR. Therefore in a system of 2 variables, there are four impulse response functions and with three (3) variables there are nine (9) response functions. The shock occurs through the error term and affects the dependent variables over time. If the time path of the impulse response function becomes zero over time, the system of the equations is stable, however they can explode if unstable.

According to Hamilton (1994), a VAR can be written in vector Moving Average(MA) form as follows.

$$\mathbf{Y}_t = \boldsymbol{\beta} + \boldsymbol{\varepsilon}_t + \boldsymbol{\alpha}_1 \boldsymbol{\varepsilon}_{t-1} + \boldsymbol{\alpha}_2 \boldsymbol{\varepsilon}_{t-2} + \dots$$

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

A plot of  $\partial Y_{i(t+s)} / \partial \epsilon_{jt}$  as a function of  $S$  is called the impulse response function. It describes the response of  $Y_{i(t+s)}$  to a one-time impulse in  $\epsilon_{jt}$  with all other variables dated  $t$  or earlier held constant. So, this method is used to know the consequences of one unit increase in inflation rate, gross national saving rate and growth of per capita income on current and future values of each other.

#### **3.4.5.2 Variance decomposition function (VDF)**

Variance decomposition function indicates the amount of information each variable contributes to the other variables in the auto regression. It determines how much of the forecast error variance of each of the variables can be explained exogenous shocks to the other variables. The variance decomposition function is the percentage of the variance of the error made in forecasting a variable due to a specific shock at a given horizon. This method is used to know the forecast error of inflation rate, gross national saving rate and growth rate of per capita income of the variables on each other.

Variance decomposition function provides a different method of depicting the system dynamics. Impulse response function traces the effect of a shock to endogenous variable in VAR system. By contrast, variance decomposition decomposes variation in an endogenous variable into the component shocks to the endogenous variables in the VAR system. The variance decomposition gives information about the relative importance of each random innovation to the variables in the VAR.

## **CHAPTER FOUR**

### **4. EMPIRICAL ANALYSIS AND FINDINGS**

#### **4.1 Time series properties of the data**

##### **4.1.1 Multicollinearity**

Multicollinearity test is one of the pre-estimation diagnostic tests in empirical analysis. When independent variable is multicollinearity then the data cannot tell, with desired precision, about which of independent variable has effect on dependent variable. The individual coefficients are insignificant even though the coefficients are significant in practice. This is due to the fact that problems created in standard error. When standard error becomes high t statistics lowered and this causes the p value to rise and causes the variables to be insignificant even if the coefficients are significant in reality.

A lot of classical tests for identification of collinearity problems to increase the results from the simple pair-wise correlation matrix, but this study focuses on only one, the variance inflation factor (VIF). This test is the easiest and commonly used one. For non collinearity of explanatory variables, the VIF must be less than 5 and if the explanatory variables are collinear, VIF must be greater than 5. Using the VIF and its reciprocal – the tolerance, it is found that VIF is less than 5. This shows the absence of multicollinearity.

##### **4.1.2 Unit Root Tests**

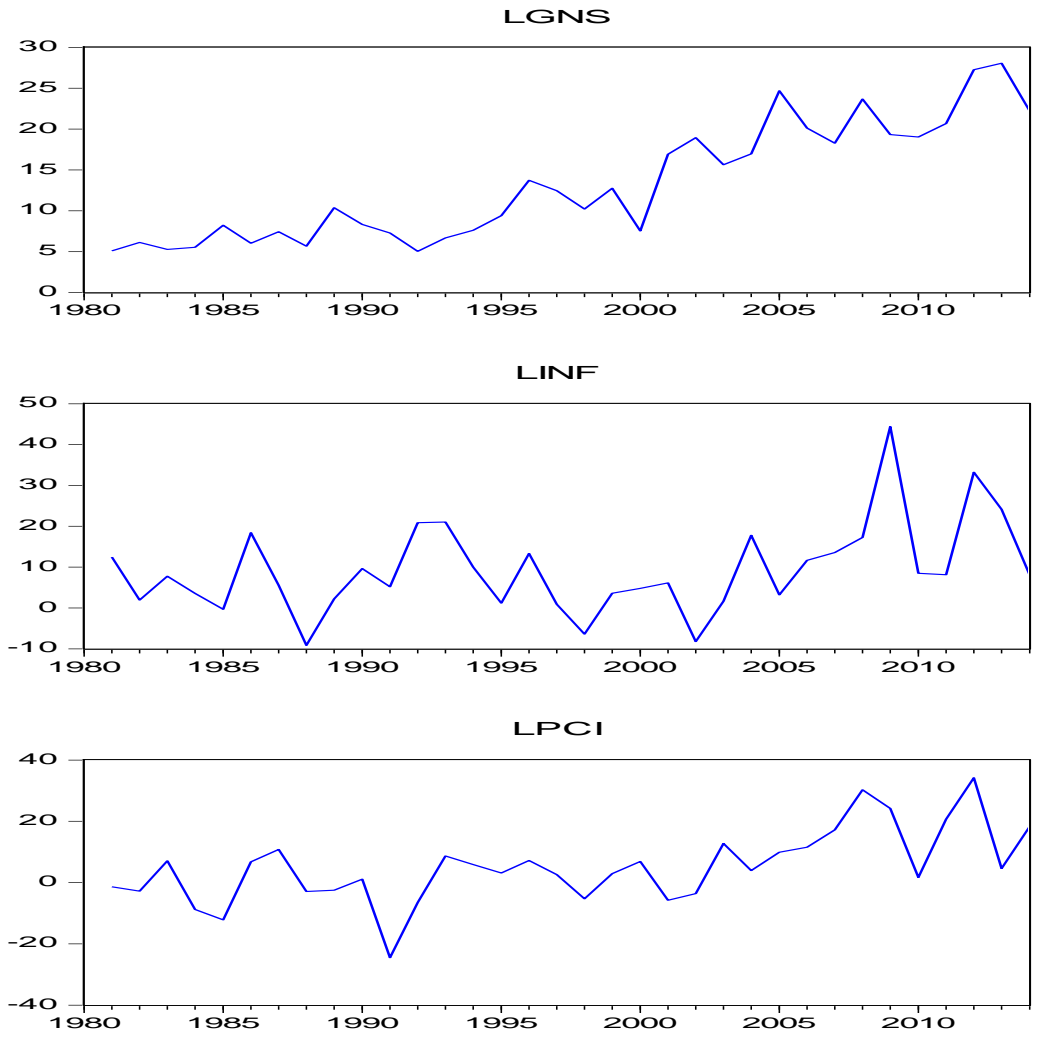
Many economic time series data exhibit trending behavior or non stationarity in the mean. Exchange rate real GDP etc. are leading examples. An important econometric task is determining the most appropriate form of the trend in the data. During econometric modeling the

data must be transformed to stationary form prior to analysis. If the data are trending, then some form of trend removal is required. If this behavior of the time series variable is left uncorrected, it would lead to the problem of spurious regression when there is a need to model relationships among variables.

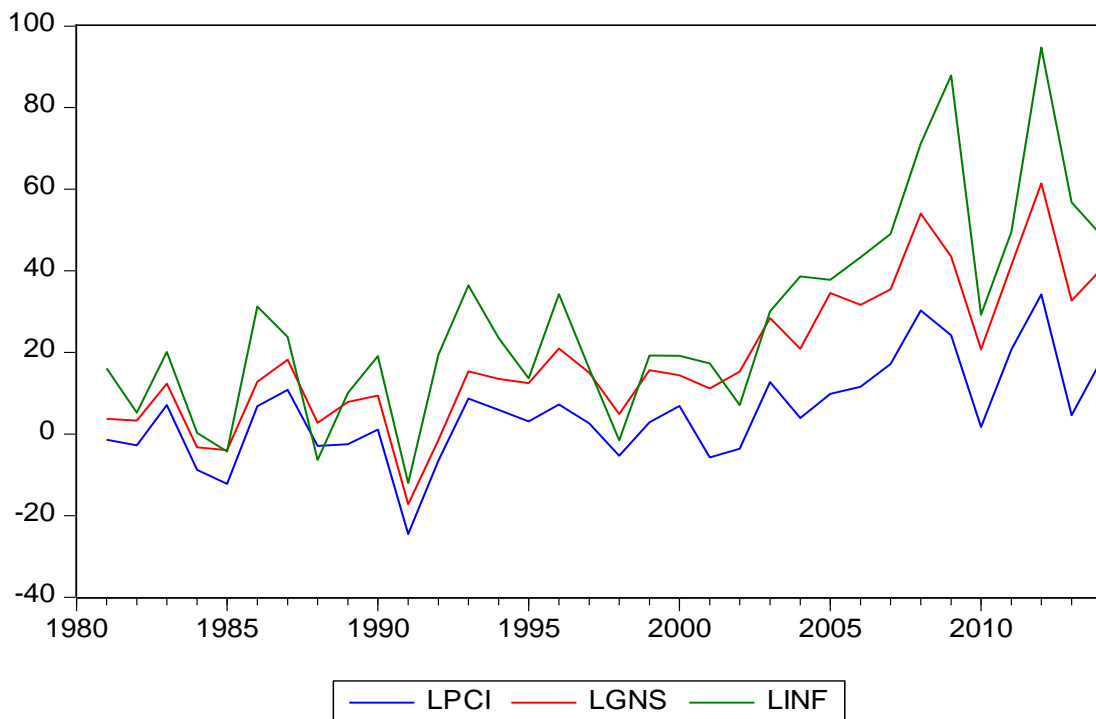
Two common trend removal or de-trending procedures are first differencing and time-trend regression. First differencing is appropriate for I(1) time series and time trend regression is appropriate for trend stationary I(0) time series. Unit root tests can be used to determine if trending data should be first differenced or regressed on deterministic functions of time to render the data stationary.

Formal Testing for stationarity and the order of integration of each variable are primarily undertaken using different methods. As discussed in methodology part of this paper the most common method are ADF and PP. The test with these methods is performed with different trend assumptions such as only intercept, both linear trend and intercept, and no intercept and no trend. Performing the tests under all three alternatives will identify whether only the intercept or both the trend and intercept are significant.

The results from stationarity test equation under the ADF (Tabl 1) demonstrates that an intercept must be included in only LGNS in testing for stationarity, while LINF and LPCI are tested with no trend and intercept. A linear trend is found to be insignificant in all of the test equations. The results show that all of the variables included in the model are integrated of order 1, i.e., I (1). The following graph shows the behavior of the variables overtime.



**Figure 1:** The graph for time series variables at levels



**Figure 2:** Line plot for the three Variables

**Table 1: Augmented Dickey-Fuller (ADF) Stationarity Test Result**

Variable	Test Statistic Under Different Assumptions			Order of integration
	Intercept	Trend and intercept	No trend and No intercept	
LGNS	-0.020635	-4.299923	1.753715	I(1)
D(LGNS)	-6.8858*	-6.8254	-6.269433	
LINF	-4.2387	-4.79421	-0.5721	I(1)
D(LINF)	-8.71752*	-8.613334	-8.83829	
LPCI	-0.709139	-2.640049	-0.273283	I(1)
D(LPCI)	-9.490134*	-9.503631	-9.530897	
LALR	-1.925105	-1.993046	-0.792406	I(1)
D(LALR)	-5.2167*	-5.129621	-5.300354	

**Source:** Owen computation based on the given data

Notice that D shows the variable is differenced once. Mackinnon (1996) one sided critical values for rejection of a unit root are used here. \* shows the result is significant at 1% level of significance.

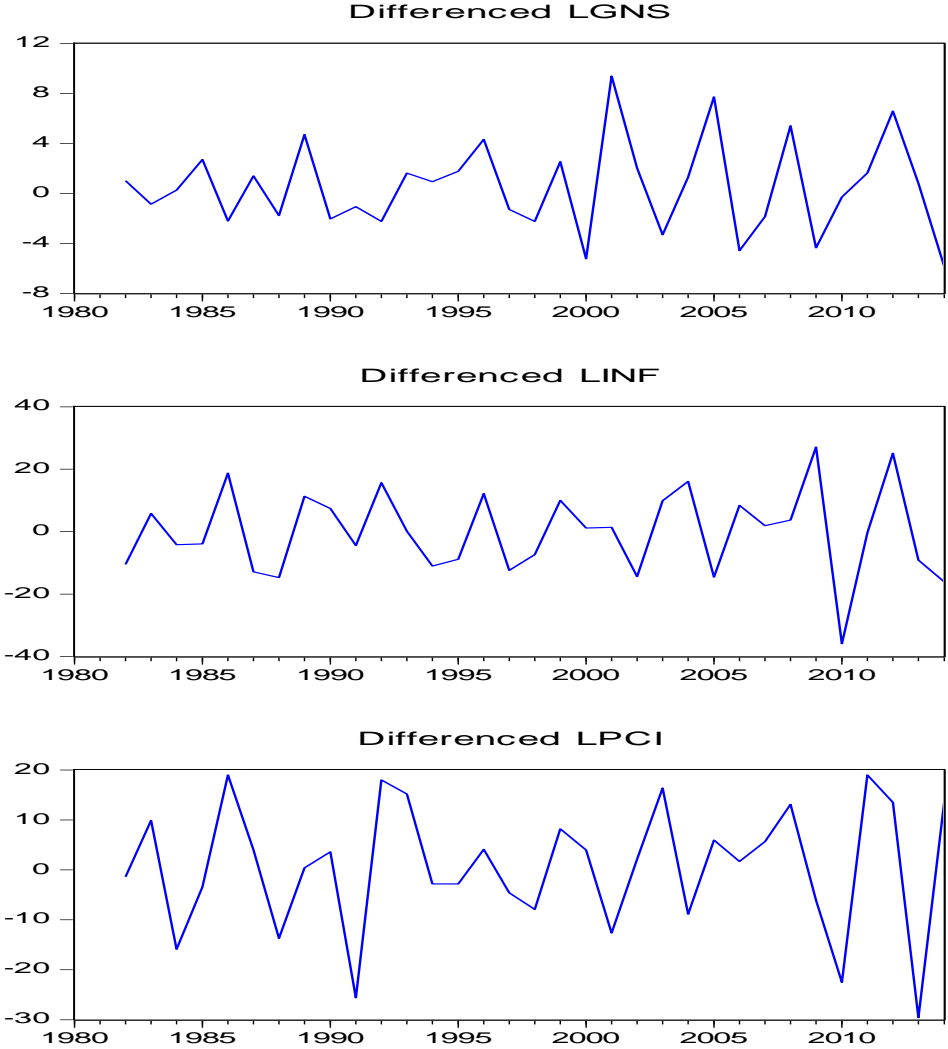


Figure 3: The graph for time series variables when differenced

The Phillips-Perron test result is almost similar, consistent and supports Augmented Dickey Fuller Test (see appendix 1). Hence both Augmented Dickey Fuller and Phillips-Perron test results are harmonious with each other and shows that all variables contained within the model

are integrated of order 1, i.e., I(1). The null hypothesis of no breaks at specified break points is not rejected. The Chow breakpoint test is found at appendices (9-11).

## 4.2 Econometric Analysis

### 4.2.1 Results for Co integration Test and Vector Error correction Model

#### 4.2.1.1 Co-Integration Test Result

##### Lag Order Selection for Endogenous variables

The number of lags included in endogenous variables determines Johansen co-integration test and vector error correction estimate results during estimation under VAR environment. This indicates the importance of determining optimum lag order before the test of co-integration and vector error correction methods. The optimum lag order selection can be performed with the Likelihood Ratio test statistics (LR), the Final prediction Error (FPE), the Akaike Information Criteria (AIC), the Schwarz Information Criteria (SIC), and the Hannan-Quinn Information Criteria (HQ). As indicated by the table below in table 2 all the LR, FPE, AIC, SC and HQ propose an optimal lag of one all at a 5% level of significance. Out of six information criteria three suggested lag one as an optimum lag length.

**Table 2:** Optimal lag Order selection criteria

Lag	Log likelihood	LR	FPE	AIC	SC	HQ
0	-382.5248	NA	1824669	25.76832	25.95515	25.82809
1	-345.6564	61.44725*	459614.1	24.37710	25.31123*	24.67593*
2	-330.8606	20.71420	530736.0	24.45737	26.13881	24.99528
3	-307.9221	25.99691	395766.7*	23.99481	26.42355	24.77178
4	-287.5389	17.66544	424448.6	23.70259*	26.87864	24.71864

Test for determination of the appropriate lag length in the model indicate that the right lag length is one at 5% level of significance. Table 2 presents a summary of the different VAR lag length selection criteria used.

### Granger Causality Test/Block Exogeneity Test

The presence causality between the variables is tested by Granger causality test. This is performed to understand the bidirectional causality between the variables. This is explained by Granger. Table 4 indicates the existence of bi directional causality between growth rate of Gross National saving rate and Inflation Rate (INF). Per Capita income growth rate (PCI) does not Granger cause Gross National saving rate and Inflation rate. Gross national saving rate Granger-causes Per capita income growth rate (PCI) and Inflation rate (INF). Inflation rate Granger-causes Gross National Saving rate (GNS) and Per capita income growth rate (PCI). Average Lending Rate (ALR) Granger causes per capita income growth rate and inflation rate; it does not Granger causes gross national saving rate.<sup>8</sup>

**Table 3:** Results of the Granger causality/Block Exogeneity Wald Test

Equation	LPCI	LGNS	LINF	LALR
Excluded				
LPCI		0.83 (0.362)	3.05 (0.08)	0.391 (0.532)
LGNS	0.102 (0.740)		1.24 (0.267)	0.430 (0.51)
LINF	4.37 (0.037)	1.43 (0.231)		2.10 (0.147)
LALR	0.176 (0.675)	0.565 (0.452)	2.38 (0.123)	

<sup>8</sup> Average lending rate is added to the variables to increase fitness.

**Note:** Numbers in parenthesis show the P-values for corresponding chi-square statistics.

One important thing of time series vector auto regression is that we could test “causality” in some sense. This test is first proposed by Granger (1969), and therefore we refer to it as Granger causality. From the Granger causality guideline, X is said to Granger-cause Y if current or lagged values of X help to predict future values of Y. If a test in Granger causality shows that X fails to Granger-cause Y, we can say that X is exogenous in the time series sense with respect to Y, or X is not linearly informative about future Y. A variable X is said to Granger-cause another variable Y, if Y can be better predicted from the past of X and Y together than the past of Y alone, other relevant information being used in the prediction (Pierce, 1977).<sup>9</sup>

Granger-causality/Block Exogeneity Wald test result shows that the lagged values of the variables have significant roles in explaining the current and future values of the variables, and this effect occurs in both directions in some of the cases (inflation rate and growth of gross National Saving rate). Therefore, due to the understood dynamic relationship among the variables, there is legality of using the VAR model and the Johansen procedures, as opposed to the single-equation approach of Engel and Granger.

### **The Johansen Co-integration Test Result**

The Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) test results show that all the variables are non-stationary at levels and stationary at first difference, and this result can be followed by Johansen-co-integration test. Consequently, the number and the presence of co-integration test should be evaluated with trace and maximum eigenvalue. Johansen co-integration

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<sup>9</sup> This taken from Alemnesh (2012) pp 65

test is better than Engle-Granger two-step procedure to test for co-integration because it tests more than one co-integration tests.

The number of lags of endogenous variables and trend assumption determine the results of Johansen co-integration test in the VAR environment. Since the results of the tests are varying with these factors, selection of them should be done carefully.

**Table 4: Unrestricted Co-integration Rank Test**

Test	Null hypothesis	Alternative Hypothesis	Eigenvalue	Cointegration test statistics	Critical value(5%)
Trace statistics	HO: $r \leq 0$	HA: $r > 0$	0.702468	90.12049	69.81889
	HO: $r \leq 1$	$r > 1$	0.572693	51.32903	47.85613
	HO: $r \leq 2$	$r > 2$	0.382042	24.12096	29.79707
	HO: $r \leq 3$	$r > 3$	0.228354	8.718256	15.49471
Maximum Eigenvalue	Ho : $r \leq 0$	$r > 0$	0.702468	38.79146	33.87687
	HO : $r \leq 1$	$r > 1$	0.572693	27.20807	27.58434
	HO : $r \leq 2$	$r > 2$	0.382040	15.40271	21.13162
	Ho : $r \leq 3$	$r > 3$	0.228354	8.295342	14.26460

**Note:** \* denotes rejection of null hypothesis at 5 percent level.

The problem with the johansen co-integration test above is that the number of co-integrating relationship implied by trace test and maximum eigenvalue test are different. As the above table (table 5) indicates the trace value test identified two co-integrating relationship at 5% level of significance and Eigen value tests identified one co-integrating relationship. However, because of high power of trace test over maximum eigenvalue test the existence of two co-integrating relationship is accepted for vector error correction model. The Johansen co-integration test indicates that there is significant co-integration relationship among inflation rate, gross national

saving rate, per capita income growth rate, and average lending rate. In the other hand, Johansen co-integration test shows that there is long run co-integration relationship between the variables. The result approves the appropriateness of the use of co-integrated VAR approach or Vector Error Correction model (VECM). The importance of using co-integrated VAR approach is that it minimizes the information loss due to first differencing of non stationary variables.

### **Model Stability Test**

The estimated VAR is stable if all roots have modulus less than one and lie inside the unit circle. If the VAR is not stable, certain results such as impulse responses and standard error are not valid. Therefore model stability test is vital for reliability of impulse response and variance decomposition function estimates of the regression. The companion matrix shows the roots of characteristic polynomial and corresponding modulus presented below in figure 4 and appendix 4 shows that the modulus is less than unity and lies within unit circle. This indicates the stability of the estimated VAR coefficients.

## Inverse Roots of AR Characteristic Polynomial

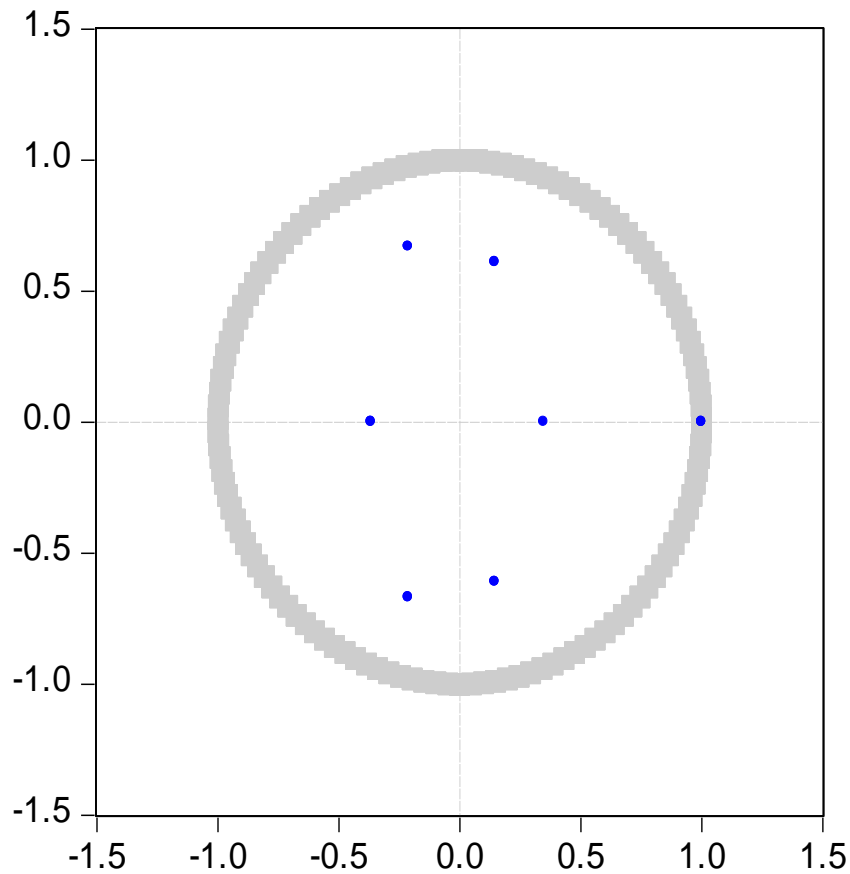


Figure 4: **Inverse roots of AR**

### 4.2.1.2 Vector Error Correction Model (VECM)

The optimum lag length determines Johansen co-integration test and vector error correction model results. To solve this problem, the optimum lag of one is chosen depending up on information criteria results. Both Johansen co-integration test and Vector Error Correction Model are estimated by using this optimum lag length. The Vector Error Correction Model (VECM) is used to perform long and short run analysis.

## Long-run Relationship

The target of this study is to investigate the impact of inflation rate and gross national savings rate on per capita income growth rate; the impact of inflation rate and per capita income growth rate on gross national savings rate and the impact of per capita income and gross national saving rate on inflation rate. Johansen co-integration test indicates the presence of these two co-integrating equations. This test also approves the appropriateness of selecting these three equations.

**Table 5:** The Estimated Long-Run Model for LGNS (Gross National Saving Rate)

Variable	LPCI	LINF	LALR	C
Coefficients	6.239049	1.928802	-8.516694	-170.2970
	( 6.0678)	(2.013468)	( 2.09732)	(6.75996)

Values in parentheses are t-statistics<sup>10</sup>

R-squared=0.76, Adj.,R-squared=0.60

The result is the following:

$$\text{LGNS}_t + 170.2970 - 6.239049\text{LPCI}_t - 1.92880\text{LINF}_t + 8.5167\text{LALR}_t = 0 \dots\dots\dots 4.1$$

This is the long run equation for gross national saving rate that relates it to per capita income growth rate, inflation rate, and average lending rate. The long run impact of per capita income growth rate on gross national saving is positive and significant. This result shows that 1 percent point increase in per capita income growth rate increases gross national saving rate by 6.2390

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<sup>10</sup> t statistic shows significance at 5% level for per capita income growth rate and inflation rate

percent point in the long run, *ceteris paribus*. This finding is in line with the theoretical prediction of Keynesian theory which states that increase in growth increases saving. This means the country should encourage growth per capita in order to save more. The model indicates that Per capita increment encourages growth in long run time period in Ethiopia. The result has consistency with Keynesians and permanent income hypothesis which states that income growth rate and saving rate have long run positive relationship.

The result of this study supports Loayza et al (2000). According to Loayza et al (2000), the influence of income on savings is greater in developing countries than industrialized countries. They argue that a double in per capita income, *ceteris paribus*, raises the long- run private saving rate by 10 percentage points of disposable income. This result is consistent with the empirical researches such as Carrol and Weil (1994, 2000), Cheng and Li (2008), Ciftcioglu and Begovic (2008) and Akram and Farham (2011).

The impact of inflation rate on gross national saving rate is positive and significant. When inflation rate increases national saving rate also increases. The result shows that 1 percent point increase in inflation rate increases gross national saving rate by 1.929 percent points in the long run in the country.

This result is consistent with former studies of Sternberg (1981), Hussein and Thirlwall (1999), Athukorala and Sen (2004), Ahmad (2006), and Abu (2004), KwakWa (2013) and inconsistent with other studies such as Atiq and Ahmad (2006), Ahmad and Muhmood (2013), Epaphra (2013), Osundinaka and Osundina (2014), Tariq et al (2015), Haile (2013), Kidane (2009), and Worku (2010).

The result supports the aggregate demand-aggregate supply framework which could account for a positive correlation between inflation and output growth. In that theory, the chief mechanism is a positive association between aggregate demands and the growth rate of money. Inflation and faster output growth are joint products of faster money growth.

The result of this study is consistent with some theories. Mundel (1963) was the first to articulate a mechanism relating inflation and output growth. According to him, an increase in inflation immediately reduces people’s wealth. To accumulate the desired wealth, people save more, thus driving down the real interest rate. Greater saving means greater capital accumulation and thus faster output growth. The result also supports the neoclassical economists such as Tobin’s (1965). According to him inflation affects saving positively.

There is negative and insignificant relationship between average lending rate and gross national savings rate. This result shows that as average lending rate increases business firms and public investment and contribution to saving can decline.

**Table 6:** The Estimated Long-Run Model for LPCI (per capita income growth rate)

Variable	LINF	LGNS	LALR	C
Coefficients	0.3092	0.1602	-1.365063	-27.2954
	(2.1374)	(0.51096)	(-2.1140)	(-4.819)

Values in parentheses are t-statistics

R-square= 0.6107,Adj.R-squared=0.4971

$$LPCI_t + 27.295 - 0.3090LINF_t - 0.1602LGNS_t + 1.365LALR_t = 0 \dots\dots\dots 4.2$$

The result shows that inflation rate and gross national saving rate exert significant long run effects on the per capita income growth rate, but average lending rate exerts positive and insignificant long run effects on per capita income growth rate of the country over the period of 1980 – 2014. A 1 percent point increase in inflation rate increases per capita income growth rate of the country by 0.309 percent point. The result is in line with structuralist economic view of inflation and economic growth relationship. They argued that moderate inflation rate and economic growth are positively related. Their argument is that inflation stimulates economic growth since input prices such as wages may be lag behind commodity price. Keynesian economic perspective also assumed that moderate inflation can promote economic growth by raising the rate of profits, and hence motivates private investment. The result is consistent with Cooley and Hansen (1989), Teshome(2008), Kibrom (2008), Ayalew (2000),Fekadu (2012),but inconsistent with Baro (1995), Bruno and Easterly (1996),Khalil and Mahamood (2013),and Fischer (1993).

As gross national saving rate increases public and business investment increases in the economy. This increases per capita income growth rate via increment in profits of businesses and employment opportunities in the society. This result is in line with neoclassical hypothesis especially Solow and Swan (1956) of long run positive relationship between saving and economic growth. The result is consistent with Shegu (2004) and Shimelis (2004), but inconsistent with Ramakirishna and Venkateshwar (2012) in Ethiopia. The positive impact of average lending rate on per capita income growth rate is through its effect on real balance of income. Increasing national saving rate with optimal inflation rate can promote income per capita income in long run in Ethiopia.

**Table 7:** The Estimated Long-Run Model for LINF (inflation rate)

Variable	LPCI	LGNS	LALR	C
Coefficients	3.23467	0.51846	-4.41553	-88.2915
	(6.50447)	(0.5160)	(2.09127)	(4.6060)

Values in parentheses are t-statistics

$$\text{LINF}_t + 88.2920 - 3.2347\text{LPCI} - 0.5185\text{LGNS} + 4.41553\text{LALR} = 0 \dots \dots \dots 4.3$$

The result shows that per capita income growth rate exert significant positive effect on inflation rate in the long run. The effect of gross national saving rate on inflation rate is positive but insignificant in the long run. Average lending rate causes negative and significant long run effect on inflation rate. The model shows that 1 percent point increase in growth of per capita income increases inflation rate by 3.23467 percent points and 1 percent point increase in average lending rate decreases inflation rate by 4.4155 percent points, ceteris paribus. The impact of gross national saving rate on inflation rate is positive but insignificant. Increase in per capita income increases inflation rate in the long run may be due to some unproductively earned income in the economy in the long run. In the other hand, as national saving rate increases in the economy money circulated in the economy may be increased and this induces inflation rate in the long run period. Likewise, as average lending rate increases the value of money increases and hence reduces inflation in the long run time period. The result is consistent with Keynesian theory of inflation rate and per capita income growth rate.

**Table 8:** The Estimated Long-Run Model for LALR (Average Lending Rate)

Variable	LPCI	LGNS	LINF	C
Coefficients	-0.732567	-0.11742	-0.22697	19.996
	(-6.31905)	(1.6121)	(-2.81566)	(5.429)

Values in parentheses are t-statistics

R-squared=0.84, adj.R-squared=0.574

$$\text{LALR}_t - 19.996 + 0.73257\text{LPCI}_t + 0.1174 \text{LGNS}_t + 0.227\text{LINF}_t = 0 \dots \dots \dots 4.4$$

The result indicates that both per capita income growth rate and inflation rate exert negative and significant effect on average lending rate in the long run. The long run effect of per capita income growth rate on average lending rate is negative and significant, where as the long run effect of gross national saving rate on average lending rate is negative but insignificant. A 10 percent point increase in per capita income growth rate decreases average lending rate by 7.326 percent points in the long run. Likewise, a 10 percent point increase in gross national saving rate reduces average lending rate by 11.74 percent points insignificantly in the long run. A 10 percent increase in inflation rate causes average lending rate to decrease by 2.26 percent points in the long run.

**The Short run Relationship**

The result of the following tables shows the short run impact of the variables (per capita income growth rate, gross national savings rate, inflation rate and average lending rate) on each other. The coefficients of one period lagged difference in the table can be interpreted as the short run parameters representing the short run impact of the variables on each other.

**Table 9: Short run coefficients when dependent variable is D (LINF)**

Error Correction	Dependent variable: D(LINF)	
	Coefficient	t-value
Coint. Eq <sub>1</sub>	-1.0295	[-3.9063]
Coint. Eq <sub>2</sub>	0.1195	[0.5645]
D(LPCI(-1))	0.3954	[1.7485]
D(LGNS(-1))	0.5445	[1.112530]
D(LALR(-1))	2.043746	[1.5421]
Dmy	21.24506	[4.07154]
C	-7.5574	[-3.04197]

$R^2 = 0.6419$

Adj.  $R^2 = 0.537469$

F-static = 6.14608

Prob(F-statistic) = 0.000344

The co-integration guideline says that if the coefficient of co-integration is negative and significant there is long run causality from the independent variables to dependent variable. As it can be observed from table 10, coefficient of co-integration is negative and significant. This shows that there is long run causality from independent variables such as per capita income growth rate, gross national savings rate, and average lending rate to dependent variable (inflation rate) during the period of 1980 - 2014. There is long run equilibrium relationship between the variables. In case there is deviation from long run equilibrium in the short run, the speed of

adjustment toward long run equilibrium is -1.0295. It takes less than a year to be corrected toward long run equilibrium.

The coefficients below the co-integration coefficients are short run coefficients. The result of short run coefficients indicates that there is no short run causality from independent variables to dependent variable. There is no short run causality but long run causality from independent variables (per capita income growth rate, gross national savings rate and average lending rate) to dependent variable (inflation rate). Normally growth of output decreases inflation, but growth which never balances demand which is raised as a result of increase in income causes inflation rate in the long run in Ethiopia. Such problem may be caused due to lack of productivity of input during production process in the country. The result is consistent with Keynesian theory of inflation and per capita income growth rate in the short run. The result is consistent with Abis (2012) and inconsistent with empirical literatures such as Fekadu (2012). Inflation rate and per capita income growth rate going together in the short run.

The coefficient of dummy variable is positive and significant. This indicates that a structural break such as policy change has significant impact on inflation rate in Ethiopia in the short run in Ethiopia.

**Table 10:** Short run coefficients when dependent variable is D (LPCI)

Error Correction	Dependent variable: D(LPCI)	
	Coefficients	t-value
Coint. Eq <sub>1</sub>	-1.403364	[-4.711918]
Coint. Eq <sub>2</sub>	0.5889	[2.61962]
D(LGNS)(-1)	0.7432	[3.2697]
D(LINF(-1))	-0.4396	[-2.0897]
D(LALR(-1))	-0.552628	[-0.41954]
DMY	15.45857	[2.9807]
C	-4.5093	[-1.8262]

$R^2 = 0.610712$ , Adj. = 0.497

F-statistic: 5.3787, Prob(F-statistic=0.000840)

As it can be observed from table 11, coefficient of co-integration is negative and significant. There is long run causality from independent variables such as inflation rate, gross national savings rate, and average lending rate to dependent variable (per capita income growth rate) during the period of 1980 - 2014. There is long run equilibrium relationship between the variables. In case there is deviation from long run equilibrium in the short run, the speed of adjustment toward long run equilibrium is -1.403364. It takes less than a year to be corrected toward long run equilibrium. This result is consistent with Haile (2013).

The coefficients below the co-integration coefficients are short run coefficients. The result of short run coefficients indicate that there is short run causality from independent variables to

dependent variable except average lending rate for which its coefficient is negative but not significant. There is short run causality and long run causality from independent variables (inflation rate, gross national savings rate and average lending rate) to dependent variable (per capita income growth rate). The impact of inflation on per capita income growth rate is negative. This result is consistent with Worku (2010) and. This shows that increase in per capita income causes inflation in the short run and this hampers growth of per capita income in Ethiopia.

**Table 11:** Short run coefficients when dependent variable is D (LGNS)

Error correction	Dependent Variable: LGNS	
	coefficient	t-value
Coint Eq <sub>1</sub>	0.164467	[0.542206]
Coint Eq <sub>2</sub>	-0.865818	[-2.20587]
D(LGNS(-2))	-0.861782	[-2.285867]
D(LGNS(-3))	-0.494465	[-1.289681]
D(LPCI(-1))	0.069633	[0.406082]
D(LPCI(-2))	0.162379	[1.120015]
D(LPCI(-3))	-0.053696	[0.495683]
D(LINF(-1))	-0.067005	[-0.356249]
D(LINF(-2))	-0.199126	[-1.304666]
D(LINF(-3))	-0.144742	[-1.291549]
D(LALR(-1))	0.740648	[0.927287]
D(LALR(-2))	-0.261654	[-0.3773392]
D(LALR(-3))	-0.046132	[0.068726]
DMY	1.250	[0.757]
C	1.749275	[1.625323]

$R^2=0.55, \text{Adj. } R^2=0.46$

F-statistics =1.1447, Prob(F-statistics =0.403)

Co-integration equation coefficient is neither negative nor significant for gross national saving rate as dependent variable for first cointegration but negative and significant for second cointegration. The impact of per capita income growth rate on gross national saving rate is positive and insignificant whereas the impact of inflation rate on gross national saving rate is negative and insignificant. The result is inconsistent with existing theories between the variables. This may be due to less explanatory variables to be included for gross national saving rate as dependent variables.

**Table 12:** Short run coefficients when dependent variable is D(LALR)

Error correction	Dependent variable: LGNS	
	coefficients	t-value
Coint.Eq <sub>1</sub>	-0.157188	[-2.4561]
Coint.Eq <sub>2</sub>	-0.178330	[-0.9380]
D(LALR(-2))	-0.075160	[-0.42120]
D(LPCI(-1))	-0.001435	[-0.03661]
D(LPCI(-2))	-0.019343	[0.55930]
D(LINF(-1))	-0.093961	[-2.693467]
D(LINF(-2))	-0.046149	[-1.540000]
D(LGNS(-1))	0.155900	[1.898968]
D(LGNS(-2))	0.12435	[1.6640000]
C	0.232100	[0.7020000]
Dmy	-1.121640	[-1.821226]

### 4.2.1.3 Post-estimation diagnostic checking

In regression model, the Gaussian assumptions should not be disregarded or violated so that the estimation results and inferences are reliable. Whether to use impulse responses and variance decomposition function or not could be verified by diagnostic checking tests. Residual vector serial correlation LM tests, residual vector normality (Jarque-Bera) Tests and residual vector heteroskedasticity tests are performed as follows.

**Table 10.1:** diagnostic test result when dependent variable is D (LINF)

Test	Statistic		
	Lags	Chi-square	P-value
Residual vector serial correlation LM	1	1.272	0.2593
	2	1.5451	0.4618
	3	1.6453	0.6492
Residual vector normality(Jarque-Bera)		43	0.07
Residual vector heteroskedasticity		5.5211	0.7867

From the above table  $R^2 = 64.19\%$ , F- statistic =6.14608(p value =0.000344).

**Table 11.1:** diagnostic test result when dependent variable is D (LPCI)

Test	Statistic		
	Lags	Chi-square	P-value
Residual vector serial correlation LM	1	2.2415	0.1343
	2	5.7892	0.553

	3	6.6855	0.0826
Residual vector normality(Jarque-Bera)		2.4066	0.300198
Residual vector heteroskadasticity		7.2367	0.6125

From the table 11  $R^2 = 0.610712\%$ , F- statistic =5.3787(p value =0.000840).

**Table 12.1:** diagnostic test result when dependent variable is D(LGNS)

Test	Statistic		
	Lags	Chi-square	P-value
Residual vector serial correlation LM	1	0.011325	0.9153
	2	2.42856	0.2969
	3	6.4303	0.0924
Residual vector normality(Jarque-Bera)		1.009717	0.6036
Residual vector heteroskadasticity		20.87104	0.2321

From the above table 12  $R^2 = 0.55\%$ , F- statistic =1.1447(p value =0.403)

**Table 13.1:** diagnostic test result when dependent variable is D(LALR)

Test	Statistic		
	Lags	Chi-square	P-value
Residual vector serial correlation LM	1	1.953	0.1623
	2	2.0487	0.3590
	3	2.0896	0.5540
Residual vector normality(Jarque-Bera)		25.29074	0.00003
Residual vector heteroskadasticity		16.25	0.2358

### **Residual Vector Serial Correlation LM Tests**

Tables (10.1, 11.1, 12.1, 13.1) show that there is no symptom of the presence of serial correlation at the first through the third lags. In the tables the P-values are greater than 5% level of significance. This indicates that the null hypothesis of no serial correlation at lag 1 to lag 3 cannot be rejected. This is to say that the chi-squared statistics at all lags are not large enough to reject the null hypothesis of no serial correlation. Therefore, there is no serial correlation problem in the residuals.

### **Residual Vector Normality (Jarque-Bera) Test**

The commonly used test for normality in most research papers is Jarque-Bera test. The Jarque-Bera test result shows the presence of normality for the models such as inflation rate, per capita income growth rate, and gross national savings at 5% level of significance. But the normality test result for average lending rate indicates the rejections of the null hypothesis of residuals are normally distributed. That means the Jarque-Bera test result shows that the residuals are not normally distributed. This problem may be raised as a result of lack of large sample property of the variables. This problem can be solved by increasing the sample size of variable. This is impossible due to reliable data constraints in concerned institutions of the country.

### **Residual Vector Heteroskedasticity Test**

The results in tables (10.1, 11.1, 12.1, and 13.1) suggest that the null hypothesis of homoskedasticity is not rejected at 5% level of significance. Therefore there is no problem of heteroskedasticity in residuals. That means the residual variances are homoskedastic (constant variance)

The pre and post diagnostic test shows the Gauss-Markov assumptions are fulfilled and then the rationality of estimated results has no problem.

In summary, R-squared indicates good condition for the fitness of the models. Because of the null hypothesis of all the coefficients of the variables are equal to zero is rejected in F- statistics, this indicates that the independent variables jointly (together) cause the dependent variables in all the models. The F-statistics shows, absence of misspecification of the model.

As tables 11.1 - 13.1 indicate, the null hypothesis of residual are not serially correlated cannot be rejected and hence there is no serially correlated residuals in all the models. In a Jarque-Bera test, the null hypothesis of residual vectors are normally distributed is accepted at 5% level. The residuals are also homoskedastic at 5% level of significance.

In general, residual vectors have no serial correlation, no normal distribution problem and they have homoskedastic (constant variance). Since the Gaus-Markove's assumptions are fulfilled, the effects of shocks or innovations and contributions of each shocks (impulses) or innovations to forecast error variance (Variance decomposition function) of the models will be performed as follows.

#### **4.2.1.4 Impulse Response Function (IRF)**

Impulse response function identifies the responsiveness of the dependent variables (endogenous variables) in the VAR when a shock is put to the error term. Impulse response functions measure the effects of shocks (impulses) or innovations on adjustment path of variables. It describes how one unit standard deviation positive shocks generated from any of the variables affect other variables. Although the ordering of the variables and lag length affects it, Cholesky's impulse response function analysis is used.

The response of per capita income growth rate to one standard deviation positive shock of gross national savings and average lending rate in the future ten years is positive where as its responses to inflation rate is negative. This indicates that there is positive relationship between per capita income growth rate and gross national savings rate. But negative response of the per capita income will be expected in future 6<sup>th</sup> year (See appendix 3). There is positive relationship between per capita income growth rate and average lending rate, and negative relationship between per capita income growth rate and inflation rate in short run period in Ethiopia.

One standard deviation positive shock of per capita income growth rate and average lending rate to inflation rate is negative. This shows that there is negative relationship between per capita income growth rate and inflation rate; negative relationship between inflation rate and average lending rate, but positive relationship between inflation rate and gross national saving rate in short run period in Ethiopia.

One standard deviation shock of per capita income growth rate affects gross national saving rate positively, one standard deviation shocks of inflation rate affects gross national savings rate negatively in short run period in Ethiopia. One standard deviation positive shock of average lending rate to gross national saving rate is inconclusive in the country.

The response of average lending rate to one standard deviation shock of per capita income growth rate and inflation rate is positive and this implies that average lending rate has positive relationship between these variables in Ethiopia in short run period. The response of average lending rate to one standard deviation shock of gross national saving rate is positive at initial period but decrease and become negative at latter period in the country. The response of each variable to one standard deviation shock of itself is positive (for all variables).

#### **4.2.1.5 Variance Decomposition Function (VDF)**

Appendices (5-8) Present variance decomposition analysis. The contribution of each variable to prediction error variance of other variable is measured by variance decomposition. It helps to determine the proportion in the total variance of one variable explained by innovation or shocks in the volatility of other variables.

The results show that in the 3rd period, 9 percent of instability or volatility in per capita income growth rate is caused by shock to inflation rate in short time period. But through time in long run only 5 percent of per capita income volatility is explained by inflation rate innovation (shock). The impact of inflation on per capita income variability is reducing through time in Ethiopia data case. Eight percent variability in per capita income is explained by gross national saving rate. The impact of gross national saving rate on per capita income variability increases through time in the long run. Its contribution to per capita income growth rate would be 23 percent at 40 years. The role of average lending rate in per capita income growth variability is 4 percent and its role increases through time in the long run which is about 21 percent at 40 years time. Hence the effect of per capita income growth rate to inflation rate variability is constant over the long run time period. The influence of per capita income growth rate to inflation rate variability is 22 percent in the short run and constant over the long run period. Hence the effect of per capita income growth rate to inflation rate variability is constant up to 40 years time period. The contribution of gross national saving rate and average lending rate to inflation rate is different. Its contribution to inflation rate variability is lower in the short run and becomes higher and higher in the long run. Hence, promoting per capita income growth rate does not affect inflation rate in long run in Ethiopia.

The contribution of per capita income growth rate and inflation rate to gross national saving rate variability is constant both in short and long run. Average lending rate effect to gross national saving rate variability is almost zero in both short and long run time period. The impact of per capita income growth rate, inflation rate, and gross national saving rate to average lending rate variability is almost constant. So, national saving rate will not be affected by economic growth activities in the country.

## CHAPTER FIVE

### 5. CONCLUSIONS AND POLICY IMPLICATIONS

#### 5.1 Conclusions

The study investigated whether there is interrelationship between inflation rate, gross national savings rate, per capita income growth rate and average lending rate in Ethiopia during the period of 1980 – 2014. The study employed co-integrated VAR approach or vector error correction method to identify the relationship among the variables in the short run and long run. The study applied the shocks or impulse accounting to study such as the response of the variables on each other and percent contributions of volatility of a variable on other variables. The analysis of the nexus between inflation rate, per capita income growth rate, and gross national savings rate have substantial contribution to knowledge and information on theories and empirical research that has not yet done on the relationship between the variables.

Per capita income growth rate and inflation rate has long run and short run impact on gross national savings rate. Both per capita income growth rate and inflation rate exert positive and significant impact on gross national saving rate in the long run but their impact in the short run is negative and insignificant.

Inflation rate, gross national saving rate and average lending rate has long run and short run impact on per capita income growth rate of the country. Inflation rate and gross national saving rate exert positive and significant impact on per capita income growth rate in the long run but average lending rate exert negative and insignificant impact on the per capita income growth rate in the long run. The coefficient of co-integration equation is negative and significant indicates

that there is causality from inflation rate, gross national savings rate and lending rate towards per capita income growth rate in the long run. Inflation rate and gross national saving rate exert impact on per capita income growth rate in the short run significantly. Gross national savings exerts positive and significant impact on per capita income growth rate while inflation rate exert negative and significant impact on per capita income growth rate in the short run time period in the country. Average lending rate exerts negative and insignificant impact on per capita income growth rate in the short run.

Per capita income growth rate, gross national savings rate and average lending rate causes both long run and short run impact on inflation rate. Per capita income growth rate exerts positive and significant impact on the inflation rate while gross national saving rate exerts positive and insignificant impacts on inflation rate in the long run. Average lending rate exerts negative and significant impact on inflation rate in the long run. On the other hand, there is causality or impact from per capita income growth rate, gross national savings rate and average lending rate to inflation rate in the short run time period in Ethiopia.

Per capita income growth rate, gross national saving rate and average lending rate exert positive and insignificant impact on inflation rate in the short run.

Per capita income growth rate, gross national saving rate, and inflation rate exert both long run and short run impact on average lending rate. Per capita income growth rate causes negative and insignificant impact on average lending rate in the long run and short run. Gross national saving rate exerts positive and insignificant impact on average lending rate in the short and long run. Impact of inflation rate on average lending rate is negative and significant in both short and long run time period.

In addition, dynamic response of the variables to each other is analyzed using impulse response function and variable decomposition function. The impulse response function analysis of the variables shows that much of the variation in each variable is caused by other variables. Dynamic variability in per capita income growth rate is caused by shocks in the gross national savings rate, inflation rate, and average lending rate. The impulse response function indicates that per capita income growth rate in Ethiopia is at fast movement towards long run time path. In similar way, the variance decomposition function informs that the variation in per capita income growth rate is explained by the variation in gross national savings rate, inflation rate, and lending rate in the country.

The result of impulse response function in gross national saving rate indicates the short run variation or fluctuation in this variable is due to significant shocks to itself, per capita income growth rate, inflation rate, and average lending rate.

Regarding the inflation rate, the impulse response function indicates that the short run fluctuation in the variable is due to significant shock to itself, per capita income growth rate, gross national saving rate and average lending rate.

Variance decomposition function for gross national saving rate point out that forecast error variation of gross national saving rate is explained by gross national saving rate itself, inflation rate, per capita income growth rate and average lending rate. The variance decomposition function shows that forecast error variation due to gross national saving rate itself, per capita income growth rate and inflation rate is significant where as forecast error variance due to average lending rate on gross national savings rate is insignificant. This imply that effect of per capita income growth rate and inflation rate on gross national saving rate is important. The

results of this study (Table 6 & 7) indicate that the causality between per capita income growth rate and gross national saving rate is bi-directional in Ethiopia. As there is long run positive impact of per capita income growth rate on gross national saving rate there is also long run positive impact of gross national saving rate on per capita income growth rate. Since gross national saving rate causes positive impact on long run per capita income, government can increase gross national saving rate to promote per capita income growth rate.

The problem with the study is that the impact of structural breaks such as Wello drought, regime change, international financial crises etc on the time series data of the country especially on gross national saving rate may biases the estimate.

Because the result from the relationship between inflation rate, gross national saving rate, per capita income growth rate, and average lending rate have policy implication, policy suggestions obtained from this study are explained in the next section.

## **5.2 Policy Implication**

The study result shows that the inflation rate, per capita income growth rate, gross national saving rate, and average lending rate exert short and long run impact on each other. Inflation rate has long run positive impact on gross national saving rate and gross national saving rate exert positive and significant impact on per capita income growth rate of the country. The policy implications that could originate from this study are organized as follow.

There is positive relationship between gross national saving rate and per capita income growth rate in the short and long run time period. This indicates that increase in per capita income growth rate increases gross national saving rate in the long run. Government policy which encourages per capita income growth rate promotes gross national saving rate in the country. The

implication of this fact is that government should follow the policy which creates favorable situation for growth per capita so that high national saving rate will be at momentum in Ethiopia. Carefully managed expansionary fiscal and monetary policy should not be disregarded in Ethiopia. This policy stimulates per capita income growth rate and hence promote saving and investment in the country. Similarly, policy which can increase tax base can increase government revenue as well as households and businesses' income which on other words increases national savings rate.

There is positive relationship between inflation rate and gross national savings rate in the long run and negative relationship between them in the short run. This means that inevitable inflationary problem during economic growth increases national saving rate in the country in the long run and reduces it in the short run. Government should target appropriate threshold level of inflation rate so that optimal level of national saving rate would be obtained.

The positive impact of gross national saving rate on per capita income growth rate in short and long run shows that government should intervene to increase national saving rate to promote long run per capita income growth rate. Government can do this by domestic saving mobilization, increase tax base, and encouraging private businesses are vital.

The long run positive relationship between inflation rate and per capita income growth rate indicates that the sustained economic growth per capita increases long run inflation rate. The suitable measure to solve this problem is using inflation rate targeting at correct inflation rate threshold level. At present MoFED uses 6% inflation rate target annually and this should be practically implemented. Therefore policy makers of the country should use inflation rate targeting system which will be more optimal for economic growth.

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# Appendices

## Appendix 1: Phillips-Perron Stationarity Test Result

Variable	Test statistic under different Assumptions			Order of integration
	Intercept	Trend and intercept	No Trend, No intercept	
LINF	-4.3182	-4.6908	-3.0944	I(1)
D(LINF)	-11.1539	-10.7672	-11.3523	
LPCI	-3.1033	-4.97308	-3.10334	I(1)
D(LPCI)	-12.37998	-12.2343	-11.11541	
LGNS	-1.082085	-4.407064	1.2941	I(1)
D(LGNS)	-14.37404	-19.6331	-8.572972	
LALR	-2.13065	-2.216914	-0.812054	I(1)
D(LALR)	-5.302893	-5.21733	-5.3852	

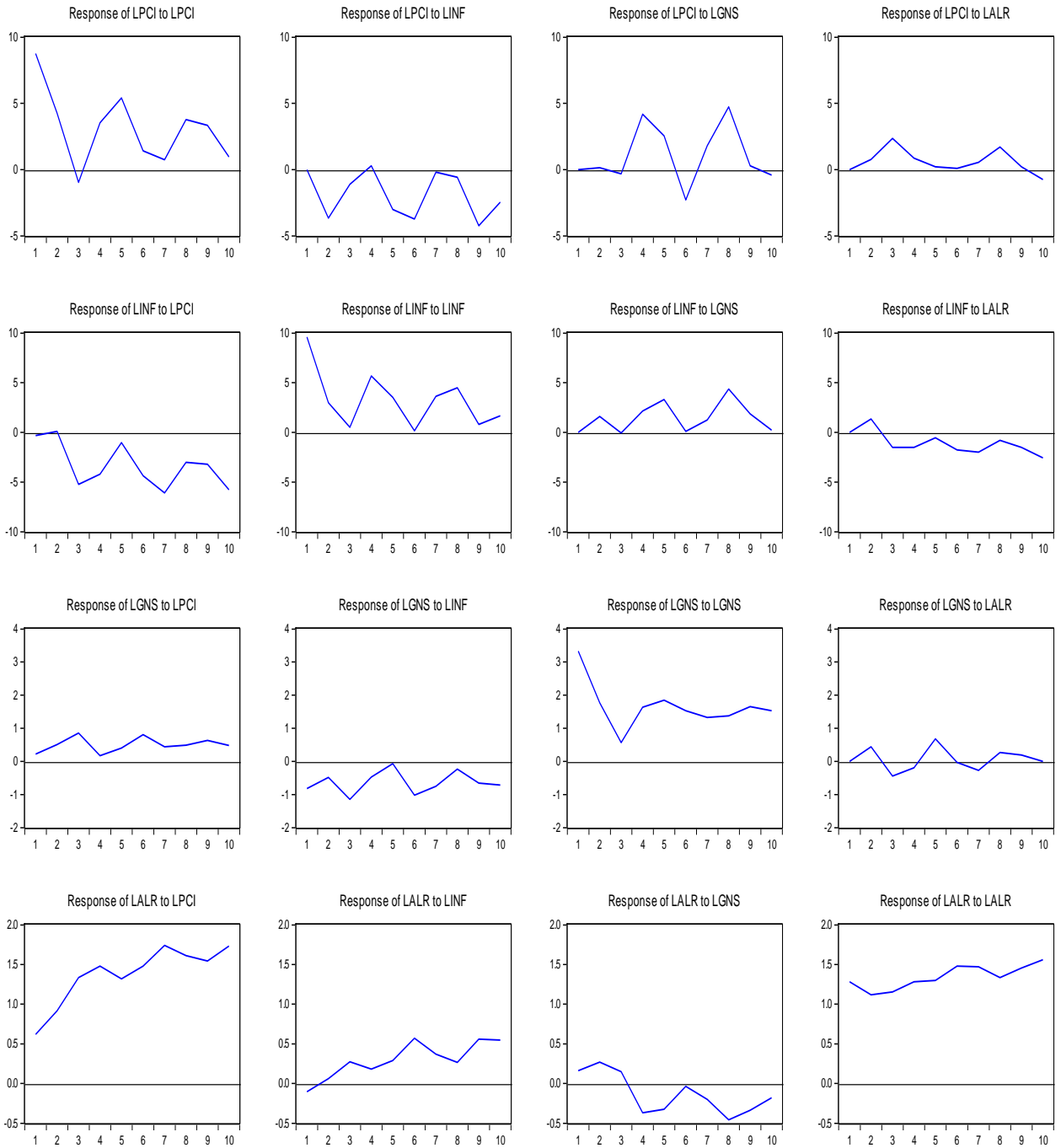
Appendix 2: Variance Inflation Factor (VIF) for the Test of Multicollinearity

Variable	VIF	Coefficient
LPCI	2.4048	0.08117
LGNS	1.699	0.0306
LINF	3.0257	0.112372
LALR	2.1126	0.00399
Mean VIF=2.310526		

Notice that:  $VIF < 4$  or  $5$  indicates that no multicollinearity problem in regression coefficients

### Appendix 3: Impulse response function

#### Response to Cholesky One S.D. Innovations



## Appendix 4: Roots of characteristic polynomial

Roots of Characteristic Polynomial

Endogenous variables: LPCI LINF LGNS LALR

Exogenous variables: DMY

Lag specification: 1 1

Date: 04/30/15 Time: 09:12

Root	Modulus
1.000000	1.000000
1.000000	1.000000
-0.202267 - 0.647873i	0.678713
-0.202267 + 0.647873i	0.678713
0.088945 - 0.638527i	0.644693
0.088945 + 0.638527i	0.644693
-0.361915	0.361915
0.315210	0.315210

VEC specification imposes 2 unit root(s).

No root lies outside the unit circle

VAR satisfies the stability condition

## Appendix 5: Variance Decomposition of LPCI

Period	S.E.	LPCI	LINF	LGNS	LALR
1	9.219362	100.0000	0.000000	0.000000	0.000000
2	9.962199	89.50547	4.102628	4.617829	1.774075
3	10.95301	78.25566	9.089135	8.487978	4.167224
4	11.63091	73.28466	9.001094	9.673538	8.040706
5	12.36110	70.91593	11.58684	9.214085	8.283152
6	12.47347	70.11486	11.54275	9.955167	8.387226
7	12.76751	67.68832	11.74879	11.22199	9.340890
8	13.12801	66.04623	11.13197	12.08535	10.73645
9	13.36581	65.02400	10.99370	12.65309	11.32921
10	13.56400	64.19587	10.67524	13.31888	11.81001
11	13.81322	63.21443	10.29378	14.00658	12.48522
12	14.05211	62.27368	9.971505	14.62289	13.13193
13	14.26771	61.46675	9.686530	15.18511	13.66161
14	14.48845	60.72866	9.399689	15.70988	14.16177
15	14.70943	60.01175	9.130654	16.20879	14.64880
16	14.92221	59.32427	8.882161	16.68710	15.10646
17	15.13305	58.68134	8.643882	17.13585	15.53892
18	15.34278	58.07882	8.418436	17.55528	15.94747
19	15.54822	57.50624	8.206884	17.95483	16.33205
20	15.75070	56.96062	8.005110	18.33615	16.69812
21	15.95148	56.44259	7.812746	18.69715	17.04751
22	16.14958	55.95066	7.630519	19.03988	17.37894
23	16.34493	55.48217	7.457027	19.36688	17.69393
24	16.53817	55.03519	7.291241	19.67878	17.99479
25	16.72927	54.60840	7.133060	19.97634	18.28220
26	16.91809	54.20063	6.982019	20.26072	18.55663
27	17.10484	53.81065	6.837472	20.53278	18.81910
28	17.28961	53.43724	6.699051	20.79322	19.07048
29	17.47241	53.07932	6.566425	21.04285	19.31140
30	17.65331	52.73601	6.439200	21.28232	19.54247
31	17.83238	52.40644	6.317051	21.51219	19.76432
32	18.00967	52.08978	6.199695	21.73305	19.97747
33	18.18523	51.78528	6.086850	21.94544	20.18243
34	18.35911	51.49226	5.978256	22.14982	20.37967
35	18.53137	51.21009	5.873682	22.34662	20.56960
36	18.70203	50.93817	5.772909	22.53628	20.75263
37	18.87115	50.67596	5.675731	22.71918	20.92913
38	19.03877	50.42294	5.581960	22.89566	21.09945
39	19.20493	50.17864	5.491421	23.06605	21.26389
40	19.36966	49.94261	5.403949	23.23068	21.42276

**Appendix 6: Variance Decomposition of LINF**

Perid	S.E.	LPCI	LINF	LGNS	LALR
1	9.275833	13.20314	86.79686	0.000000	0.000000
2	9.864829	15.64768	76.98845	0.405706	6.958165
3	10.37129	22.66814	69.82414	1.202555	6.305166
4	10.70795	22.17600	68.58123	3.075985	6.166786
5	10.81772	22.09592	67.20733	4.640430	6.056321
6	10.95862	22.46035	65.49146	5.961666	6.086528
7	11.18842	23.04670	64.16083	6.861052	5.931421
8	11.29270	22.81250	63.46885	7.893945	5.824702
9	11.39492	22.70630	62.35847	9.150474	5.784760
10	11.53594	22.83407	61.14013	10.25184	5.773960
11	11.66060	22.80335	60.31948	11.18014	5.697027
12	11.76622	22.76919	59.46000	12.14061	5.630190
13	11.88237	22.79440	58.51200	13.10724	5.586356
14	12.00015	22.79125	57.66168	14.00763	5.539436
15	12.11087	22.77335	56.87320	14.86629	5.487159
16	12.22164	22.77802	56.08009	15.70243	5.439456
17	12.33338	22.78119	55.31570	16.50839	5.394713
18	12.44279	22.77350	54.59020	17.28581	5.350495
19	12.55096	22.77046	53.88404	18.03739	5.308104
20	12.65897	22.77105	53.19976	18.76189	5.267296
21	12.76585	22.76854	52.54197	19.46206	5.227436
22	12.87157	22.76562	51.90481	20.14055	5.189022
23	12.97663	22.76422	51.28677	20.79695	5.152071
24	13.08091	22.76255	50.68942	21.43189	5.116142
25	13.18424	22.76048	50.11102	22.04724	5.081255
26	13.28679	22.75879	49.54979	22.64388	5.047534
27	13.38860	22.75720	49.00566	23.22229	5.014848
28	13.48961	22.75550	48.47799	23.78341	4.983096
29	13.58987	22.75390	47.96573	24.32809	4.952283
30	13.68940	22.75240	47.46825	24.85698	4.922376
31	13.78822	22.75089	46.98505	25.37074	4.893317
32	13.88632	22.74942	46.51545	25.87005	4.865075
33	13.98374	22.74802	46.05887	26.35549	4.837620
34	14.08049	22.74665	45.61480	26.82763	4.810916
35	14.17657	22.74530	45.18274	27.28702	4.784932
36	14.27201	22.74400	44.76219	27.73416	4.759643
37	14.36682	22.74274	44.35271	28.16954	4.735018
38	14.46100	22.74150	43.95386	28.59361	4.711033
39	14.55458	22.74030	43.56523	29.00681	4.687662
40	14.64755	22.73913	43.18644	29.40955	4.664883

**Appendix 7: Variance Decomposition of LGNS**

Perid	S.E.	LPCI	LINF	LGNS	LALR
1	3.733433	5.160684	5.841644	88.99767	0.000000
2	4.541548	8.285862	10.67293	80.79767	0.243538
3	5.571996	10.48025	19.13456	69.99077	0.394419
4	6.213555	10.54574	20.49024	68.33446	0.629563
5	6.813623	10.69868	20.16188	68.56491	0.574527
6	7.395136	10.92567	20.73862	67.83006	0.505653
7	7.933895	11.03327	21.52258	66.94715	0.497004
8	8.425010	11.14876	21.85788	66.49031	0.503052
9	8.892653	11.25348	22.05392	66.20145	0.491156
10	9.338498	11.30482	22.27531	65.94114	0.478731
11	9.762660	11.35164	22.46658	65.70978	0.472007
12	10.16979	11.40805	22.62308	65.50187	0.466997
13	10.56146	11.45038	22.75817	65.32910	0.462359
14	10.93839	11.48089	22.86883	65.19218	0.458106
15	11.30293	11.51114	22.96504	65.06970	0.454126
16	11.65646	11.53926	23.05476	64.95521	0.450778
17	11.99938	11.56261	23.13383	64.85552	0.448036
18	12.33263	11.58341	23.20194	64.76917	0.445479
19	12.65723	11.60261	23.26378	64.69054	0.443069
20	12.97374	11.61978	23.32064	64.61863	0.440952
21	13.28265	11.63530	23.37186	64.55376	0.439070
22	13.58455	11.64957	23.41831	64.49479	0.437326
23	13.87990	11.66261	23.46103	64.44065	0.435718
24	14.16909	11.67454	23.50033	64.39088	0.434250
25	14.45249	11.68559	23.53653	64.34499	0.432898
26	14.73044	11.69582	23.57003	64.30251	0.431644
27	15.00324	11.70529	23.60113	64.26310	0.430480
28	15.27117	11.71411	23.63004	64.22645	0.429398
29	15.53448	11.72234	23.65702	64.19225	0.428388
30	15.79340	11.73003	23.68226	64.16027	0.427445
31	16.04814	11.73723	23.70589	64.13031	0.426561
32	16.29890	11.74400	23.72808	64.10219	0.425730
33	16.54586	11.75037	23.74896	64.07572	0.424949
34	16.78919	11.75637	23.76864	64.05078	0.424213
35	17.02905	11.76203	23.78722	64.02724	0.423518
36	17.26557	11.76739	23.80478	64.00497	0.422860
37	17.49889	11.77246	23.82142	63.98389	0.422238
38	17.72915	11.77727	23.83719	63.96389	0.421648
39	17.95645	11.78184	23.85218	63.94490	0.421087
40	18.18091	11.78618	23.86642	63.92684	0.420554

**Appendix 8: Variance Decomposition of LALR**

Perid	S.E.	LPCI	LINF	LGNS	LALR
1	1.287872	4.747358	0.365989	0.265045	94.62161
2	1.864503	18.03608	0.710154	2.053899	79.19987
3	2.540250	29.99291	2.752124	2.420321	64.83465
4	3.095842	31.33878	3.213481	3.673997	61.77374
5	3.556406	29.85149	4.298930	4.453113	61.39647
6	3.994566	29.98110	4.757645	4.754892	60.50636
7	4.379699	30.73033	4.625097	4.868615	59.77596
8	4.716646	30.89631	4.698806	5.005961	59.39892
9	5.042608	30.84376	4.928834	5.140520	59.08689
10	5.354476	30.91848	4.999081	5.231683	58.85075
11	5.642455	31.01406	5.009028	5.293331	58.68358
12	5.915318	31.06561	5.061339	5.346715	58.52633
13	6.179079	31.10502	5.112385	5.394922	58.38767
14	6.431777	31.13993	5.140249	5.435595	58.28423
15	6.673949	31.16883	5.165690	5.469231	58.19625
16	6.907990	31.19706	5.191204	5.498067	58.11367
17	7.134539	31.22221	5.211722	5.523714	58.04235
18	7.353922	31.24191	5.229875	5.546590	57.98163
19	7.566987	31.25955	5.246813	5.566781	57.92686
20	7.774276	31.27659	5.261369	5.584721	57.87732
21	7.976120	31.29168	5.274295	5.600919	57.83311
22	8.172977	31.30485	5.286397	5.615629	57.79313
23	8.365237	31.31699	5.297359	5.628985	57.75666
24	8.553166	31.32822	5.307186	5.641161	57.72343
25	8.737041	31.33843	5.316262	5.652327	57.69298
26	8.917133	31.34780	5.324669	5.662607	57.66492
27	9.093663	31.35648	5.332388	5.672095	57.63903
28	9.266826	31.36451	5.339526	5.680879	57.61508
29	9.436812	31.37197	5.346173	5.689036	57.59283
30	9.603791	31.37891	5.352357	5.696630	57.57210
31	9.767916	31.38539	5.358125	5.703719	57.55276
32	9.929328	31.39145	5.363525	5.710350	57.53467
33	10.08816	31.39714	5.368587	5.716567	57.51771
34	10.24453	31.40248	5.373340	5.722408	57.50178
35	10.39854	31.40750	5.377815	5.727905	57.48678
36	10.55031	31.41224	5.382035	5.733087	57.47264
37	10.69993	31.41671	5.386020	5.737982	57.45928
38	10.84748	31.42095	5.389790	5.742613	57.44665
39	10.99305	31.42496	5.393361	5.747000	57.43468
40	11.13672	31.42876	5.396749	5.751162	57.42333

## Appendix 9: The Chow Breakpoint Test for detection of Structural Breaks (PCI)

Chow Breakpoint Test: 1984 1991 1995 2008

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 1981 2014

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F-statistic	1.371098	Prob. F(12,19)	0.2608
Log likelihood ratio	21.20831	Prob. Chi-Square(12)	0.0774
Wald Statistic	16.45317	Prob. Chi-Square(12)	0.1714

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## Appendix 10: The Chow Breakpoint Test for detection of Structural Breaks in (GNS)

Chow Breakpoint Test: 1984 1991 1995 2008

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 1981 2014

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F-statistic	1.474654	Prob. F(12,19)	0.2175
Log likelihood ratio	22.37964	Prob. Chi-Square(12)	0.0335
Wald Statistic	17.69585	Prob. Chi-Square(12)	0.1252

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## Appendix 11: The Chow Breakpoint Test for detection of Structural Breaks in (INF)

Chow Breakpoint Test: 1984 1991 1995 2008

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 1981 2014

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F-statistic	1.367010	Prob. F(12,19)	0.2627
Log likelihood ratio	21.16124	Prob. Chi-Square(12)	0.0581
Wald Statistic	16.40412	Prob. Chi-Square(12)	0.1734

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**Appendix 12: The time series data used for the study:**

year	INF	PCI	GNS	ALR	dmy
1980	12.437	-1.4	5.094	6.00	0
1981	1.937	-2.8	6.116	6.00	0
1982	7.774	7.1	5.263	6.00	0
1983	3.569	-8.8	5.524	6.00	0
1984	-0.334	-12.2	8.235	6.00	0
1985	18.403	6.8	6.022	6.00	0
1986	5.550	10.8	7.432	6.00	0
1987	-9.146	-2.9	5.664	6.00	0
1988	2.206	-2.5	10.379	4.00	0
1989	9.633	1.1	8.337	4.00	0
1990	5.206	-24.5	7.279	4.00	0
1991	20.869	-6.5	5.04	4.00	0
1992	21.019	8.7	6.671	4.00	0
1993	9.990	5.9	7.618	4.00	0
1994	1.166	3.1	9.394	10.00	0
1995	13.334	7.2	13.728	10.00	1
1996	0.919	2.6	12.449	10.00	1
1997	-6.420	-5.3	10.214	10.00	1
1998	3.600	2.9	12.751	7.00	1
1999	4.772	6.9	7.528	6.00	1
2000	6.159	-5.8	16.926	6.00	1
2001	-8.238	-3.6	18.952	6.00	1
2002	1.654	12.8	15.641	6.00	1
2003	17.762	3.9	16.956	3.00	1
2004	3.221	9.9	24.694	3.00	1
2005	11.656	11.6	20.116	3.00	1
2006	13.556	17.2	18.268	3.00	1
2007	17.245	30.3	23.681	3.00	1
2008	44.371	24.2	19.331	3.00	1
2009	8.479	1.7	19.037	4.00	1
2010	8.134	20.7	20.676	4.00	1
2011	33.232	34.2	27.265	4.00	1
2012	24.119	4.6	28.068	5.00	1
2013	8.030	18.3	22.204	5.00	1
2014	6.192	13.6	24.634	5.00	1