INFLATION AND GROWTH: ESTIMATION OF THRESHOLD LEVEL OF INFLATION IN NEPAL

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By
Babita Bhattarai
Roll No.:-45/2066

Central Department of Economics

Tribhuvan University, Kirtipur

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TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF ECONOMICS
Office of the Head of the Department

LETTER OF RECOMMENDATION

This thesis entitled **"INFLATION AND GROWTH: ESTIMATION OF THRESHOLD LEVEL OF INFLATION IN NEPAL"** has been prepared by Ms. Babita Bhattarai under my supervision. I hereby recommend this thesis for examination to the Thesis Committee as a partial fulfillment of the requirements for the Degree of MASTER OF ARTS in ECONOMICS.

Mr. Ananta Kumar Mainaly
Associate Professor
Thesis Supervisor

Date:02/02/2014

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APPROVAL SHEET

We clarify that this thesis entitled **"INFLATION AND GROWTH: ESTIMATION OF THRESHOLD LEVEL OF INFLATION IN NEPAL"** submitted by Ms. Babita Bhattarai to the Central Department of Economics, Faculty of Humanities and Social Sciences, Tribhuvan University, in partial fulfillment of the requirements for the Degree of Masters of Arts in Economics has been found satisfactory in scope and quality. Therefore, we accept this thesis as a part of the said degree.

Thesis Committee

Associate Prof. Dr. Ram Prasad Gyanwaly
Head of Department

Dr. Dilli Ram Pokhrel
NRB, Monetary Division
External Examiner

Associate Prof. Ananta Kumar Mainaly
Thesis Supervisor

Date: 03/07/2014

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I bear sole responsibility for any errors and discrepancies that might have occurred in this Study.

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LIST OF ACRONYMS

AIC	-	Akaike Information Criterion
ADO	-	Asian Development Outlook
ARDL	-	Auto Regressive Distributed Lag Model
CBS	-	Central Bureau of Statistic
CPI	-	Consumer Price Index
FY	-	Fiscal year
GDP	-	Gross Domestic Product
JB	-	Jarque Berra Test
LM	-	Lagrange Multiplier Test
IMF	-	International Monetary Fund
MOF	-	Ministry of Finance
OLS	-	Ordinary Least Squares
NRB	-	Nepal Rastra Bank
RESET	-	Regression Specification Error Test
SBC	-	Schwarz Bayesian Criterion
UK	-	United Kingdom
USA	-	United States of America

CHAPTER ONE

INTRODUCTION

1.1 General Background of the Study

Economic growth is a topic of major importance for all economies, which is why the determinants of economic growth rate have been studied thoroughly during the last decades. Even the small change in countries' annual growth rates can cause large difference in economic activity over the long period of time. Hence, it is in each policy maker's interest to understand what factors influence output dynamics and to achieve higher and continuous economic growth. One of the pre-condition for economic growth is macroeconomic stability.

The concept of macroeconomic stability has been changing over the period of time. The period after the World War II was dominated by Keynesian concept and for them macroeconomic stability meant a mix of external and internal balance, which in turn implied in second case full employment and stable economic growth accompanied by low inflation. In the mid seventies western countries shifted monetarist economic policy and inflation control became the most important goal of economic policy. Later the emergence of new classical economists leads to the abandonment of monetarists in the early eighties. The new classical economists introduced the idea that the economy is always operating at full employment level and any form of expansionary policies will only generate inflation (Saad, 2007).

Different schools of economic thought advocate for different indicators of macroeconomic stability and different channels and mechanisms through which these variable affect the economic growth. The major indicators of macroeconomic stability are inflation, unemployment rate and Balance of Payment (BOP). A distortion in any of these leads to macroeconomic instability. This study concerns with the inflation.

Inflation is one of the major macroeconomic variables and according to Mankiew (2007), "it is simply defined as an increase in average price and the rate at which money is exchanged for goods or services." Inflation can be defined as a persistent

rise in general price level across the economy over time. Mild inflation is considered to be desirable for economic growth. However, high and variable inflation, in general, leads to uncertainties in income and expenditure decisions of the different group of the society, destors economic growth, lower saving and makes more expensive cost of capital. It hurts the poorest of the poor having fixed level of income as inflation erodes their real wealth. In other words, it further widens the income inequality in the society (NRB, 2007). High inflation complicates long-term economic planning, creating incentives for households and firms to shorten their horizon and spend their resources in managing inflation risk rather than focusing on the most productive activities (Bernank, 2006). On the other hand, low and stable inflation brings stability to financial system and fosters sustainable economic growth over the long run (Fergusson, 2005). Experiences of industrialized countries show that low and stable inflation is not only beneficial for growth and employment in the long run but also contributes to greater stability of output and employment in the short to medium-term. When inflation is well controlled, public expectation of inflation will also be low and stable. In a vicious circle, stable inflation expectation helps the central bank to keep inflation low. On the other hand instability in inflation and its expectations jeopardize the orderly functioning of the financial and commodity market as well (NRB, 2007).

One of the most fundamental objectives of macroeconomic policies of every developed and developing countries is to achieve sustainable economic growth coupled with low inflation. Low inflation may facilitate economic growth by encouraging capital accumulation and increasing price flexibility. Given the fact that prices are sticky downwards, moderate rise in level of price will provide greater relative price flexibility required for an efficient allocation of resources (Tobin, 1972). However, macroeconomic stability defined as a low inflation rate is a necessary, but not sufficient condition for sustained economic growth. This is evidenced by the experience in the France Zone during 1980s (Fisher, 1983).

Prior to the 1960s, little attention has paid to the effects of inflation on economic growth, both theoretically and empirical research. With the birth of Phillips curve, much attention has directed to the role of inflation that plays on employment and hence on economic growth. With the increase in inflation rate, there will decrease in unemployment rate, this leads economic towards higher rate of growth. By

implication, for an economy to grow moderate and high inflation should be tolerated (Phillips,1958). Since then, this issue has generated a debate between structuralists and monetarists. Structuralists are in favour of inflation for economic growth, whereas monetarists argue that inflation is harmful to economic growth (Mallik and Chowdhury, 2001).

The effects of inflation on growth has been questioned since the early 1990s and become quite extensive with the work of De Gergorio(1993) and Fischer(1993). They have found the existence of negative relationship between inflation and growth. To the date the relationship between inflation and economic growth remains controversial or somewhat inconclusive. Several empirical studies have confirmed three possibilities i.e; existence of either positive, negative or no relationship between these two variables. Moreover, with the time a general consensus evolved that low and stable inflation promotes economic growth and vice versa (Mubarik, 2005). Some studies have just used linear technique and investigated the nature of inflation – growth nexus. Recent studies have used non-linear techniques and argued that there exists a threshold or optimal level of inflation below which inflation may have no or even a positive effect on growth and above which inflation be detrimental to economic growth. This supports both the view of structuralists and monetarists up to a certain extent. Such studies include, among others, Sarel(1995), Bruno and Easterly (1998), Ghosh and Phillips (1998), Khan and Senhadji (2001), Moshiri and Sepehri (2004), who all have used cross-country panel data for both developing and industrial countries and found that there exists a negative relationship between inflation and growth after certain threshold level/s. Furthermore, the nature of link and relationship between inflation and growth also depends up on state of economy as the empirical evidence by recent research work differs substantially across the countries. In particular, medium and high inflation hampers economic growth due to adverse impact on efficient distribution of resources by changing relative prices (Fischer, 1993). However, low rate of inflation makes price and wage more flexible, which helps to promote the growth (Lucas, 1973).). If high inflation is harmful for economy and low inflation is beneficial, then it is natural to ask what the optimal level of inflation for an economy is?

Most of the research has focused on group of industrial and developing countries and there has been very little research on individual countries, including Nepal. Some of country-specific studies include Singh and Kalirajan (2003) for India, Ahmed and Mortaza (2005) for Bangladesh, Hussain (2005) and Mubarik (2005) for Pakistan. Most of the studies conducted on individual countries have employed the method of conditional least squares as suggested by Khan and Senhadji(2001) to estimate threshold level of inflation.

So, this study aims to consider the entire situation in the context of economy of Nepal to investigate inflation-growth relationship using the data of last 37 years of the economy.

1.2 Statement of Problem

The investigation in to the existence and nature of the link between inflation and growth has experienced a long history. A large number of literatures suggest inflation significantly matters for explaining economic growth. More over, there remains further debate among proponents of inflation-growth nexus; whether it affects negatively or positively or there exist a kind of nonlinear relationship. Although economists now widely accept that inflation has a negative effect on economic growth, researchers did not detect this effect in data. Series of studies in the IMF Staff Papers showed different forms of non-linearity in the inflation-growth relationship regarding nature of economy i.e; for developing countries and developed countries.

Low economic growth rate is a major challenge in the economic development process of Nepal. Even though ninenth five year plans and second three year plans have been implemented and current three year plan has been started since 16 July, 2010, only a few progress has been observed in the economic growth. Nepal's economy grew by 4.3 percent on an average from 1975 to 2007. The average growth of Nepalese economy in between 2007 to 2010/2011 stood at 4.6 percent (economic survey FY 2011/12). According to WDR and ADO (2011), the GDP growth rate of Nepal is least in comparison with other neighbor countries. Economists and policy makers think higher rate of inflation has become threat for growth and prosperity of the country. According to ADO (2011), Nepal experiences 10% inflation, which is second highest rate among SAARC. So, both the monetary and fiscal policies focus on the objective

to achieve high growth with low rate of inflation, considering high rate of inflation as a negative mover of economic growth. If high level of inflation is harmful for economic growth and low inflation is beneficial, then how low should inflation be? More generally, at what level of inflation does the relationship between inflation and growth become negative? These are the questions, have to be examined properly. However, review of literature reveals that very few actions have been taken to investigate the relationship between these two variables i.e; inflation and growth. In other words, although economic policies (monetary and fiscal policy) relay around the inflation and growth there has not any systematic study and investigation to derive the nature of link and relationship between these two variables. In this light, the study of threshold level of inflation for GDP growth in Nepal is necessary. This study will empirically re-investigate the inflation growth relationship to determine whether a threshold effect exists and if so, will estimate the optimal level of inflation which is conductive for economic growth in Nepal.

1.3 Research Question

Owing the stated theoretical possibilities and empirical works, the study aims to examine the nature of the relationship between inflation and growth in Nepal focusing specifically on the following questions:

1) Does inflation affect GDP negatively in Nepal?
2) Does inflation affect GDP positively in Nepal?
3) Is there a statistically significant threshold level of inflation above which inflation affects growth differently than at lower inflation rates?

1.4 Objectives of the Study

Keeping in view of above presented problems and issues regarding inflation and growth in Nepal; the study has following major objectives.

1) To analyze the impact of inflation on GDP growth including other control variables in Nepal. It is to evaluate the GDP growth performance and historical trends of its determinants in Nepal.

2) To examine the feasible threshold level of inflation for GDP growth. It is needed to explore whether the inflation in time series caused to reduce the GDP growth of economy or not.
3) To state the policy implication, keeping in view of the statistical significance of the estimated results about inflation and GDP growth relationship and its effects on the economy of Nepal.

1.5 Significance of the Study

The scope of this paper is to outline the theoretical framework and presents the models to analyse nonlinear relationship of two variables; inflation and growth. This study will provide basic information and general guideline to the policy makers, researchers, and planners. The extension of this model will help the researcher for further work.

1.6 Limitations of the Study

Main limitations of the study are:

a) This study covers only the period from 1975/76 to 2011/12.
b) This study will be based on the published secondary data and information and no attempts would be made to examine the reliability of the data.
c) The extent of the analysis may be constrained due to time and resources limitation.

1.7 Organization of the study

The study is organized in five chapters. The first chapter is an introductory part of the study covering the background of the study, statement of the problem, objectives of the study, rationale and study limitations. The second chapter covers the review of growth theories and review of empirical studies. The third chapter provides various methodologies used in the study. The fourth chapter covers the analysis of data and finally, the fifth chapter presents the summary, conclusions and recommendations.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

Various studies have been made on the issue of inflation and growth. The literature on the relationship between inflation and growth has witnessed significant increase, at least in the last two decades. The unified view of the macroeconomists and policy analysts on the inflation- growth nexus has led to massive interest by researchers in exploring the nature of link and relationship.

This chapter deals with the theoretical as well as empirical literature on the inflation-growth nexus. In case of empirical review, international reviews are in large numbers and show the long history on investigation of nature of link between inflation and growth. However, in Nepal; Review of Literature reveals that very few actions have been taken to investigate the relationship between inflation and growth. Although, economic policies (monetary and fiscal policy) relay around the inflation and growth, there has not any systematic study to derive the nature of link and relationship between these two variables.

This chapter is organized as follows: section 2.1 deals with the theoretical literature review, section 2.2 deals with the empirical review and in final section 2.3 conclusion is presented.

2.2 Theoretical Literature Review

Economic theories have given varying conclusions about the responsiveness of economic growth to inflation. There are several inflation growth theories ranging from pre-world war era to post-world war period. In the earlier period, the term 'persistent inflation' was absent so the inflation-growth theories were built on cyclical observation. The persistent inflation was regarded as a post world war II phenomenon.

Inflation was described to behave like a 'lazy dog' showing the linear, non-linear, positive, negative, short-run or long-run relationship with growth (Gokal & Hanif, 2004).

Classical economics recalls supply-side theories and more microeconomic in nature. It is developed during and after the period of Malthus and before the period of J.S. Mill. Actually, the classists were follower of David Ricardo. The whole classical economies relies on the three key assumptions- Say's Law of Market, Quantity Theory of Money (QTM) and Saving-Investment equality and views on long-run equilibrium phenomenon in the analysis of macroeconomics. These assumptions provide the conclusion of full employment, wage-price flexibility and neutral role of money. So, there is dictomy between real sector and monetary sector in the classical economy. Increase in money supply only increases the price level and continuous increase in money supply brings inflation in the economy but it does not cause to change in level of output. So, classical theory does not show any relationship between inflation and real output growth.

Keynesian model has shown two kinds of relationship between inflation and economic growth using Aggregate Demand (AD) and Aggregate Supply (AS) curves. The model has exhibited initial positive inflation-growth relationship using upward slopping short-run AS curve and after full employment, AS curve becomes vertical and cannot bring any change in the level of output with the change in price level.

According to Keynes, "so long as there is unemployment, employment will change in the same proportion as the quantity of money and when there is full employment prices will change in the same proportion as the quantity of money." Following the Keynes' opinion, prior to full employment there is positive relationship between inflation and economic growth; this is a short run phenomenon and post to full employment there will be no relationship between inflation and economic growth; this is a long run phenomenon. This holds with the fact that in the short run, changes in factors like expectations, labor, prices of other production factors and fiscal and or monetary policy drive inflation as well as output. But in the long run, those factors and the shock on the steady state of the economy result in "dynamic adjustment" of the model through a path which exhibits initial positive inflation- growth relationship and returns to negative at the latter part of the "adjustment path" (Dornbusch et al.,

1996). The model has also argued that the economy does not move directly to a higher inflation rate but it follows a transitional path where it rises then falls. Under this model, there is short-run trade-off between output and change in inflation but no permanent trade-off between the two variables. For inflation to be held steady at any level, output must equal the natural rate. Any level of inflation is sustainable; however, for inflation to fall there must be a period when output is below the natural rate (Gokal & Hanif, 2004).

Monetarism; laid by Milton Friedman has several important features that has focused on the long run supply side properties of the economy as opposed to short run dynamics (Dornbusch et al.,1996). He has emphasized on several key long-run properties of the classical economy, including the Quantity Theory of Money (QTM) and the Neutrality of Money and also his theory gives importance on money saying, money alone matters.

Friedman has proposed inflation as a product of an increase in the supply or velocity of money at a rate greater than the growth in the economy. He has argued that in the short-run, monetary factors do affect the level of output and employment which accounts also for cyclical nature of the economy. However, in the long-run it is real factors that determine the level of employment and output, not the monetary factors. Friedman has given these arguments based on adaptive expectation hypothesis. The expected level of inflation $(\quad)$ is given by previous level of inflation$(\quad -1)$. That is; $\quad = \quad -1$. Using Phillips curve equation and adaptive expectation hypothesis, he has derived the conclusion that, as long as expected income is greater than actual income real balance effect comes into play and change in monetary variables result in affecting output and employment. Hence, monetarism believes in short run positive real balance effect, where change in money supply is greater than change in price level. At full employment level, where expected income and actual income are equal, change in money supply only brings change in price level and does not affect the real output.

One of the earliest neo-classical models is postulated by Solow (1956) and Swan (1956). They have assumed that saving is not affected by wealth as community saves a constant proportion of income. They could not establish the inflation-growth

relationship in their growth theories as they have developed their theories ignoring the monetary sector. However, other neoclassists have taken the model including monetary sector to establish the link between monetary sector and real sector.

Mundell (1963) was first to articulate inflation-output growth relationship. He has used real interest rate mechanism to establish the relationship in the two assets world; shares and money. The model is based on the assumptions that the real investment depends on real interest rate and real saving on real balance, beside other key assumptions of classicists to show that real conditions in the economy are altered by purely monetary phenomenon and used the IS-LM schedule to determine interest rate.

According to the model, wealth-holders divide their assets between money and securities depending on the money rate of interest. Mundell has further argued, during the period of inflation money rate of interest rises but less than the rate of inflation and therefore, real interest rate falls during the inflation; where the inflation itself is generated by monetary expansion in excess of growth. So, inflation reduces people's real money balance and wealth which causes to increase in real saving. Real investment increases due to fall in real interest rate which brings acceleration of economic growth. Hence, inflation affects growth positively through interest rate mechanism.

Tobin (1965) has made systematic study concerning inflation and output through portfolio mechanism. He has developed Mundell's model further by following Solow (1956) and Swan (1956) to discuss the role of monetary factors in determining the degree of capital intensity of an economy in the two assets world- monetary assets (government debt) with constant nominal return and real capital assets. In this model equilibrium capital intensity and interest rates are determined by portfolio behavior and monetary factors as well as saving behavior and technology.

According to the model inflation is beneficial to the output level because it lowers the return on monetary assets. Since, wealth owners wish to place all their wealth in assets with higher yield, they move towards capital assets. This portfolio mechanism results in a higher steady-state capital stock. Hence, Tobin's model shows that higher inflation rate raises the level of output.

However, the effect of inflation on output level is temporary during the transition from one steady state capital stock to new steady state. As capital accumulation increases the return on capital asset falls, thereafter higher investment will cease and only steady state growth will result. This effect of inflation on output level is known as "Tobin effect". Tobin (1972) has also argued that, because of the downward rigidity of prices (including wages), the adjustment in relative prices during economic growth can be better achieved by the upward price movement of some individual prices.

Freeman and Huffman (1991) have shown Tobin's effect in their simple portfolio-substitution model. According to the model, people either hold money or capital goods to fulfill their future needs. With the increase in rate of inflation, the substitution behavior of different wealth group of people will ultimately lead the economy to the steady-state level of output.

Sidrauski (1967) has proposed money-in-utility function model integrating the monetary sector of the economy in to the Solow-Swan model of the economic growth to analyze the problems related to the existence, uniqueness and stability of the growth path in the monetary economy in the two assets world; real capital and government debt.

The model has explained how money can affect the steady state growth path of the economy as well as how it may affect behavior of the economy when system is in equilibrium growth path. Sirdrauski has argued that the change in money supply only changes the price level and leaves the real variables of the economy unchanged, assuming saving as a constant proportion of income, wage and prices are flexible and money plays a neutral role, in both the long run and short run. Hence, there is no relationship between inflation and growth in Sirdrauski model.

Feenstra (1986) has demonstrated a functional equivalence between using real balance as an argument of utility function and entering money into liquidity costs which appears in the budget constraint to interpret Sidrauski's model. According to the model, an increase in inflation rate causes people to economize their money balances. That is, composition of output shifts from consumption goods to financial services but the total output, i.e; sum of consumption goods and financial services remain

unchanged. Hence, an increase in inflation rate only affects the composition of goods it does not affect the total volume.

Stockman (1981) has examined the effect of anticipated inflation on the steady-state capital stock in an economy in which money is introduced through a cash-in-advance type transitions constraint rather than directly in the utility function of individual. He has proposed a model in which individual wants to maximize his utility under two constraints- money (budget) constraint; in which individual allocates his wealth between money and capital and liquidity (cash-in-advance) constraint; explains that individual must be able to finance his purchase of current consumption and gross investment out of money balances carried over from the previous period plus transfers received at the beginning of the period.

The model is characterized by a negative long-run inflation-output relationship and also shows the role of inflation as a differential tax on goods whose purchase are more or less money intensive. According to the Stockman, at higher rate of inflation money is more costly to hold as it reduces the purchasing power of money, so the net return from investment becomes lower. People reduce their purchases of both cash goods and capital when the inflation rate rises. Correspondingly, the steady-state level of output falls with the increase in inflation rate.

Greenwood and Huffman (1987) have developed the basic labor-leisure mechanism to establish "Stockman effect". They have considered, people hold cash for consumption and leisure and returns to labor falls with the rise in inflation rate. Cooley and Hansen (1989) have extended the Greenwood and Huffman (1987) model, assuming marginal product of capital is positively related to the quantity of labor. When the quantity of labor declines in response to a rise in inflation, the return to capital falls and the steady-state quantity of capital and output decline. Cooley and Hansen show that the level of output permanently falls as the inflation rate increases.

In neo-classical model, long-run growth is driven by technological advancement. Inflation does not drive technological advancement, so, change in the price level affects the growth rate only along the transaction path from one steady-state value of capital-labor ratio to next. Hence, inflation may have permanent effect on level of output not on the growth rate of output. Furthermore, theoretical review demonstrates

that models in the neoclassical framework can be interpreted as the hypothesis presented by Tobin, 1965, that holds positive effect or negative effect (Stockman effect) or no change in level of output (Sidrauski model).

Endogenous growth theory has described economic growth which is generated by factors within the production process. In this model, the growth mainly depends on one variable; rate of return on capital and also focus on the role of externalities in determining the rate of return on capital. It has explained growth further with human capital, implying that the growth rate also depends on the rate of return to human capital, as well as physical capital. The models have shown mixed effects of inflation on output growth rate and earlier versions of endogenous models have found small effect of inflation on growth rate.

Gomme (1993) has used Lucas, 1988, endogenous growth with cash-in-advance exchange technology to derive significant negative effect of inflation on growth. According to Gomme efficient allocations satisfy the condition that the marginal value of the last unit of today's consumption equals the marginal cost of the last unit of work. A rise in inflation reduces the marginal value of today's last unit of consumption, thus inducing people to work less. So, the marginal product of capital is permanently reduced and so the rate of growth.

Jones and Manuelli (1995) have proposed a model in which inflation affects output growth rate through fiscal policy distortion. In their model tax rate include nominal depreciation allowance. According to the model, with the rise in inflation rate, the discounted value of depreciation tax credit falls and so, effective tax on capital income becomes higher. It reduces the after-tax return on capital. So, people accumulate capital at lower rate which leads reduction in growth rate.

Haslag (1995) has examined general equilibrium model with endogenous growth model merging literature on banking and growth with the literature on inflation and growth. In this model money and capital are complementary goods and the model shows how the monetary policy affects growth through banking system. According to the model an increase in inflation rate causes to reduce the return on bank deposit resulting in slower rate of deposit accumulation. Capital, being complementary to money deposit is also accumulated at lower rate. This reduction in accumulation rate

of capital goods ultimately causes to reduce in growth rate.

All the above models show inverse effect of inflation on growth, however, Haslag's (1995) model shows larger effects of inflation on growth than both Gomme's (1993) and Jones and Manuelli's (1995) models.

Zhang (2000), in his paper has developed a precuniary transaction cost (TC) approach using general TC function and labor-leisure choice to reexamine the relationship between inflation and growth. He has considered four types of goods in his model: consumption, production, investment and consumption as well as investment goods. He has argued negative Tobin effect for all cases, because increase in inflation as a result of high monetary growth rates lowers steady-state capital and labor, consumption and real money balance.

Gylfason and Herbertsson (2001) have developed a model incorporating money and finance into an optimal growth framework with constant return to capital. To show the negative inflation-growth relationship, they have extended Cobb-Douglas production function inserting real money balance in to the production function. That is the model is:

Where, N is labor, m= $\bar{}$ is real money balance, K is capital and Y gives aggregate output. They have shown negative effects of inflation on growth via four channels: a) saving and interest rates, b) velocity and financial development, c) government deficit through the inflation tax and tax erosion and d) efficiency in production through the return in real and financial capital. They have presented a simple model of simultaneous determination and interaction of inflation and growth and to estimate growth.

Ireland (1994) has explored positive association between inflation and growth using the consumption-saving pattern in the economy with two types of payment mechanisms: money and credit. Private financial sectors provide credit facility, for this people have to pay certain charge. According to him, when inflation increases, given a quantity of credit, cost declines over a time. So, people shift their composition

of consumption financed by money to consumption financed by credit. This leads to development of financial sector and greater capital accumulation hence faster rate of economic growth. Furthermore, he has argued that effects of anticipated inflation on growth are small, however, the effects of growth on monetary system are sustainable.

Gillman and Kejak (2005) have proposed to distinguish between physical capital models; labeled as 'Ak', human capital models; labeled as 'Ah' and combined models with physical and human capital. They have examined the effects of inflation on combined model as a resulting effect of Ak model and Ah model. They have argued that in the Ak model inflation works as a tax in the physical capital, implying a negative effect, where as in the Ah model inflation works as a tax on human capital, implying positive effect. Finally, in the combined model, inflation works more like a tax on human capital than on physical capital, resulting positive effect.

Several theoretical studies have argued that depending on its level, inflation can promote as well as harm economic growth. Lucas (1973) has explained how inflation allows overcoming rigidity of nominal prices and wages. In addition, inflation can realign relative prices in response to structural changes in production during fast modernization period. In such a situation inflation is quite important for economic growth. On the other hand, high inflation creates "shoe leather costs" and "menu costs" which discourages long-term investment and distorts a tax system (Romer, 2001).

In addition, there are several recent studies which have discussed interesting features of non-linearity in inflation-growth relationship.

Dostey and Sarte (2000) have developed a model introducing money via cash-in-advance constraint to show the effects of inflation variability on economic growth. According to them, inflation adversely affects long-run growth even when cash-in-advance constraint applies only to consumption. However, according to them, there is positive association between inflation and short-run growth. Furthermore, they have argued that inflation variability increases average growth through a precautionary saving motive.

Bose (2002) has presented a model in which he has investigated a negative, non-linear

relationship between the rate of inflation and rate of output growth passing through credit market mechanism. According to Bose, the credit market imperfections arise due to information gap between lender and borrowers. He has described two types of lending regimes: 'rationing regime', which saparates high and low risk borrowers by means of credit rationing and 'screening regime' where separation is done through costly information acquision.

He has argued that an increase in inflation rate alters lender's behavior as it increases cost of screening or incidence of rationing or it may even change the regime. Whatever may be the effect all affect growth adversely.

In Paal and Smith (2001) the relationship between money growth and real growth has shown to be characterized by a threshold. They have considered a money growth model with financial intermediaries to establish inflation-growth relationship passing through nominal interest rate mechanism. According to them the optimum allocation of bank portfolio between reserves and capital depends on the nominal rate of interest; where nominal interest rate is determined by the money growth rate.

In this model, they have argued that a low nominal rate of interest can have very negative impact on real growth. When nominal interest rate is nearly zero, banks have limited incentives to lend, this results a low rate of capital formation and a low rate of real growth. As money growth rate rises, the nominal interest rises too, increasing opportunity cost of holding reserves and therefore investment and growth. When the nominal interest rate grows beyond a certain threshold level, credit rationing affects lending adversely which reduces capital accumulation and growth. Hence, increasing rate of inflation due to higher long-run rates of money creation can promote long-run real growth over some range.

Funk and Kromen (2006) have extended the model of Funk and Kromen (2005). They have introduced a Keynesian friction; i.e; short-run price rigidity in to the standard "Schumpeterian" growth model to analyze the long-run relationship between inflation, employment and growth. They have developed the model by following the "quality ladder" models of Aghion and Howitt (1992) and Grossman and Helpman (1991) and introduced money into model by following Sidrauski (1967).

They have found that influence of short-term price rigidity is not only limited to the short-run, rather it allows inflation to affect both the long-run level of employment and output and argued that output growth is non-linear function of inflation. They have argued both the employment and growth are hump-shaped function of money growth due to four effects of money growth under price rigidity: 'erosion of its relative price' through inflation, 'initial mark-up' set in anticipation of influence in profits, 'dispersion of relative prices' and 'average mark-up'. Hence, according to them, a small positive rate of inflation is desirable both from a growth and an employment perspective.

Review of literature shows the variety of conclusions about inflation-growth relationship. Neo-classical growth theory is the first to incorporate inflation in the theory. In the neo-classical model role of money determines whether permanent increase in inflation impacts positively, negatively or has no effect on the level of output. In other words, if money is substitute to capital goods, inflation and output are positively related as in Tobin (1965) model. If money plays a role of complementary to capital goods, inflation adversely impacts level of output as in Stockman (1981). There is no inflation-output/output growth relationship when money is super-neutral and works as only a medium of exchange as in Sidrauski (1967) model. The neo-classical model has shown the effects of inflation to the level of output where as endogenous model has focused on effect of inflation on output growth rate. In endogenous model the role of money determines the degree of effectiveness of inflation on growth rate. That is whether the quantitative effects of inflation on growth are larger or negligible.

Furthermore, review of literature provides guideline to decompose the growth process into two subsets of problems: determination of real variables including rate of growth of the economy and determination of monetary variables. It also focuses on the effect of inflation on growth passing through the accumulation of either human capital or physical capital or both human and physical capital, through the credit market or through the product market.

2.3 Empirical Literature Review

This section briefly discussed previous research studies on the relationship between inflation and economic growth focusing on data used, methodology adopted to estimate nature of relationship and threshold level of inflation. Among first author to analyze inflation-growth relationship included Kormendi and Meguire (1985). They found significant negative effect of inflation on economic growth. Most of the studies conducted on the subject have used cross-country panel data with the coverage of large number of countries (Fischer, 1993; Sarel, 1996; Khan and Senhadji, 2001). There are some studies revealing peculiarity of certain economics, especially developing economies, use time series data to estimate threshold level of inflation for individual country. In this regard, the study identified some country specific studies, especially on developing economies, on the inflation- growth nexus.

This section further divided into two subsections; 2.2.1 review of cross-country empirical literature and 2.2.2 review of individual-country empirical literature, each with their respective contribution to the inflation-growth relationship.

2.3.1 Review of Cross-Country Empirical Literature:

Fischer (1993) has established a framework to identify possible channels from macroeconomic policy to growth. He has made a seminal contribution to assess the non-linear relationship between inflation and growth in the long run using both cross section and panel data set on several macroeconomic variables, including consumer price inflation of 93 countries that includes both industrial and developing economies.

Besides using simple panel regressions, Fischer has also used a simple alternative to the mixed regression, a production function based approach pioneered by Victor Elias, 1992. The approach is a regression analogue of growth accounting, which helps identify the channels through which macroeconomic variables affect economic growth. As a matter of accounting, growth can be attributed to increases in the supply of factors, and to a residual productivity category, reflecting changes in the efficiency with which factors are used. The approach is to examine relationship between growth and macroeconomic variables, and then between macroeconomic variables and changes in both supplies of factors and the residuals, or productivity (Fischer, 1993).

He has found a significant negative association between inflation and growth using simple panel regressions which confirm the relationships between inflation, inflation variability and growth. The growth accounting framework has made it possible to identify the main channels through which inflation reduces growth. The results of the paper has implied that inflation affects economic growth by reducing investment, and by reducing the rate of productivity growth. The study has made the conclusion that a large budget deficit and distorted foreign exchange market also affect economic growth negatively. Also, using arbitrary chosen break points 15% and 40% in spline regression, he has shown the presence of nonlinearities in the relationship between inflation and growth. Furthermore, his results reveal that the strength of relationship weakens for the inflation rate above 40%.

Barro (1995) to assess the effects of inflation on economic growth; has used a system of regression equation in which many determinants of growth other than inflation are held constant. The framework is based on the extended view of neoclassical growth model, as described in Barro and Sala-i-Martin (1995). The study has indicated that there exists a statistically significant negative relationship between inflation and economic growth with the coefficient of -0.024 for the data set of 100 economies for the period 1960 to 1990.

The findings of the study has shown that if the numbers of country's characteristics are held constant then an increase in average inflation by 10 percentage point per year causes to reduce the growth rate of real per capita GDP by 0.2 to 0.3 percentage points and decrease in the ratio of investment to GDP by 0.4 to 0.6 percentage points per annum.

The study concludes that the effects of inflation on growth are negative when some plausible instruments are used in the statistical procedures. However, statistically significant results emerge only when high-inflation experiences are included in the study. So, there are some reasons to believe that a high inflation reduces economic growth. Hence, the analysis provides a presumption that inflation is (bad idea) bad for economic growth.

Sarel (1995) has explored the possibility of non-linear effects of inflation on economic growth using annual panel data set on GDP, CPI, population, terms of

trade, real exchange rate, investment rates and government expenditures of 87 countries from 1970-1990. He has divided 20 year sample period into four equal periods and 248 observations into 12 equal groups assigning dummy variables to each group to run OLS regression estimation.

The result of the study reveals that, there is a significant structural break which occurs at annual average 8 percent rate of inflation, in the function that relates economic growth to inflation. The result shows that below that structural break, inflation does not have any effect; or has slightly positive effect on growth but after 8 percent inflation it has powerful negative effect on growth. Sarel has also concluded that failure to account for presence of structural break biases the estimated effect of inflation on economic growth for higher inflation rates decreased by a factor of three.

This study has added a new dimension to the empirical analysis of inflation- growth relationship showing the presence of structural break in the nexus. Earlier studies on the inflation-growth relationship had ignored structural break.

Bruno and Easterly (1995) have examined the determinants of economic growth using the data series that contained annual CPI inflation of 26 countries, that had inflation crisis at some point over the period of time 1961-1992. In carrying research, they have proposed a non-parametric definition of inflation crisis as "periods when annual inflation is above 40 percent".

Bruno and Easterly have identified countries, which had high inflation crisis of 40 percent and above by assessing how the country's growth has performed before, during and after its high inflation crisis. The robustness of the result has examined by controlling for other factors such as shocks including political crises, terms of trade shocks and wars.

They have found a negative relationship between inflation and growth when looking at the temporal association of growth with discrete high inflation crises. However, they have found the case for growth effects of low to moderate rates of inflation very much ambiguous. Their results are consistent with the view that costs of inflation only become significant at relatively high rates of inflation. At lower rates of inflation, growth and inflation may simply be jointly troubled by various demand and supply

shocks and hence shows no consistent pattern. The results also reveal strong recoveries of growth following successful reduction of high inflation. According to the result, if an inflation crisis does not affect the long-run average inflation rate, it would not alter the long-run average growth rates, if there was sufficient time to recover from the crisis in the period over which one is averaging. Inflation crises, as they have believed, have a temporary effect on output but no permanent effect on output growth as inflation crises may after all be just a cyclical phenomena.

Christoffersen and Doyle (1998) have addressed some issues on panel data studies of growth in transition. They have highlighted some areas of concern using the panel data set of annual real GDP, population, the share of exports, transition reform index, the direction of trade to 1996, war dummy and export market growth rates. The data set is somewhat 'unbalanced' where the longest series is from 1990 to 1997.

They have adopted a similar approach to Sarel (1995), modeling the kinked relationship between inflation and output. Thus, two inflation terms are used; namely log inflation and log inflation less than threshold. They have set the series zero, below the threshold level. Firstly, they have involved in reproducing the key findings of the earlier work and if possible encompassed it. Secondly, they have investigated how disinflation affected output as described in the earlier work. Thirdly, they have conducted robustness tests and checked how parameter estimates are affected by inflation outliers and the exclusion of countries one at a time from the panel. Finally, the reported *p*-values were computed using White's heteroskedacity-consistent standard errors.

The results show that export market growth is strongly associated with output transition. According to Christoffersen and Doyle, even given the external shocks, structural reform and disinflation can stimulate growth. Moreover, they have found that there is no evidence that disinflation necessarily incurs significant output costs, even at moderate inflation rates. Losses only appear to arise when moderate inflation is stabilized in the presence of exchange rate pegs. They have also found no evidence of countries closer to the inflation-output threshold simply aiming to stay there without proceeding further towards industrial country inflation rates. They have suggested that, for countries now well below the estimate disinflation-output threshold, no evidence is found that output will be boosted by raising inflation. Thus,

such countries should aim to lock in their low rates of inflation.

The study has focused on the role of export market growth and structural reforms and tries to ascertain the relationship between output and inflation as well as the impact of disinflation unlike previous studies, which omitted export market growth and therefore overstated the output costs of inflation. These issues are fundamental to understand the transition and therefore to the design polices in transition economies.

Ghosh and Phillips (1998) have argued that while there is no doubt about the fact that high inflation is bad for growth, there is less agreement about the effect of moderate inflation using the complete data set of 3,603 annual observations on real per capita GDP growth, and average consumer price inflation, corresponding to 145 countries over the period 1960-1996.They have used panel regression as an analytical tool which allows for a nonlinear treatment of the inflation growth relationship with an extensive examination of robustness. They have also checked the existence of inflation-growth relationship in multivariate regression analysis.

In general, the result reveals that, there is a statistically and economically significant inverse association between inflation and growth in both the time and cross-section dimensions of the data and it is quite robust. The study has discovered two nonlinearities; at very low inflation rates inflation and growth are positively associated and at higher rates the relationship is negative and convex, meaning that the decline in growth associated with an increase in inflation from 10 percent to 20 percent is greater than that associated with moving from 40 percent to 50 percent. They have also found a threshold at 2.5 percent, and a significant negative effect above this level. Their policy message suggests that even lowering moderate inflation rates can yield gains in GDP growth of up to 0.8-0.9 percentage points.

They have showed that inflation-growth relationship is not likely to be simple one, in a multivariate case it becomes more complicated. The inclusion of other variables affects the relationship as some of included determinants may be the functions of inflation themselves. In this paper, they have tried to address these various methodological problems in an attempt to examine the relationship between inflation, disinflation and output growth. They have also found evidence that deflation is costly especially at low inflation rate.

Khan and Senhadji (2001) have analyzed the inflation and growth relationship separately for industrial and developing countries using the unbalanced data set covering 140 countries over the period 1960-1998. They have taken the data from the World Economic Outlook (WEO) database, with the growth rate in GDP recorded in local currencies at constant 1987 prices and inflation is measured by the percentage change in the CPI index. The authors re-examine the issue of the existence of "threshold" effects in the relationship between inflation and growth, using econometric techniques initially developed by Chan and Tsay (1998), and Hansen (1999, 2000). The paper specifically focused on the following questions:

- Is there a statistically significant threshold level of inflation above which inflation affects growth differently than at a lower rate?
- Is the threshold effect similar across developing and industrial countries?
- Are these threshold values statistically different?
- How robust is the Bruno-Easterly finding that the negative relationship between inflation and growth exists only for high-inflation observations and high-frequency data?

They have estimated a log model of inflation to test for the existence of a threshold effect. The authors have suggested that regressions of real GDP growth on the level of inflation instead of the log, would give greater weight to the extreme observations, with the potential to skew the results. They have proposed that the log transformation eliminates, at least partially, the strong asymmetry in the inflation distribution. With the threshold level of inflation unknown, the authors have estimated it along with the other regression parameters non-linear least squares (NLLS) estimation method would be appropriate to estimate the result. However, since the threshold level of inflation has entered the regression in a non-linear and non-differentiable manner, the NLLS technique has become inappropriate. So, they use conditional least square method.

The empirical results verify the existence of a threshold level of inflation beyond which it would have negative effect on growth. Significant thresholds at 1-3 percent and 11-12 percent inflation levels for industrialized and developing countries have

been found, depending on the estimation method used. The thresholds are statistically significant at 1 percent or less, implying that the threshold estimates are very precise. The negative and significant relationship between inflation and growth above the threshold level is argued to be robust with respect to type of estimation method used.

They have suggested that while the results of the paper are important, some caution should be borne in mind. The estimated relationship between inflation and growth does not provide the precise channel through which inflation affects growth, beyond the fact that, because investment and employment are controlled for, the effect is primarily through productivity. This also implies that the total negative effect may be understated. The results in this paper provide strong evidence for supporting the view of low inflation for sustainable growth. This is one of the most important contributions to the inflation growth literature in the last decade. Since Khan and Senhadj's (2001) work, subsequent studies have had their methodologies.

Mallik and Chowdhury (2001) have studied the relationship between inflation and GDP growth for four Asian countries, namely, Bangladesh, India, Pakistan and Sri Lanka using un-even sample size of 1974-97 for Bangladesh, 1961-97 for India, 1957-97 for Pakistan and 1966-97 for Sri Lanka; data set on CPI and real GDP retrieved from International Monetary Fund (IMF) International Financial Statistics (IFS) to measure inflation rates and economic growth, respectively.

They have found evidence of a long-run positive relationship between inflation and GDP growth rate for all the four countries with significant feedbacks. According to the authors, moderate inflation level helps economic growth but faster growth feedbacks into inflation. Thus, the countries are on a "knife-edge". However, this study has not estimated what the moderate inflation rate (threshold level).

Burdekin et al. (2004) have determined the threshold level of inflation using annual time series data of 21 industrial countries for the period 1965-1992 and 51 developing countries over the period 1967-1992. They have employed Panel Generalized Least Square (PGLS) with fixed effect and spline technique.

Their findings provide two threshold levels of inflation; 8% and 25% for industrial countries. Below 8% level of inflation inflation-growth relationship is negative and

statistically insignificant, it becomes significant for inflation rate 8% to 25%. When inflation exceeds 25% effects of inflation diminish but remain statistically significant. Furthermore, they have found three threshold levels; 3%, 50% and 102% of inflation for developing countries. Below the 3% rate of inflation the inflation-growth relationship is positive and statistically significant, the relationship becomes significant negative for inflation rate 3% to 50%. For inflation rate 50% to 102%, there exists negative insignificant relationship between inflation and economic growth. The relationship again becomes significant and negative when inflation rate exceeds 102%. These results show negative and non-linear effects of inflation on growth and the nature of relationship differs by country type.

Lee and Wong (2005) have estimated threshold level of inflation for Taiwan and Japan using quarterly data from 1965-2002 foe Taiwan and from 1970-2001 for Japan. They have estimated 7.25% inflation threshold for Taiwan and two thresholds; 2.52% and 9.66% for Japan.

Pollin and Zhu (2006) have examined non-linear relationship between inflation and economic growth for 80 countries (comprising middle income and low income countries) over the period 1961-2000. They have found inflation thresholds between 15% and 18%. Below 15% inflation is beneficial to economic growth and after 18% it becomes detrimental to growth.

Li (2006) has estimated a non-linear inflation-growth relationship for 27 developing and 90 developed countries over the period 1961-2004. The results of study reveal threshold levels of 14% and 38% for developing countries. When inflation rate is below 14%, the effects of inflation on growth are positive and insignificant, the effects are strongly negative and significant for inflation rate 14% to 38% and above 38% the effects diminish but remain significantly negative. Furthermore, the study reveals 24% threshold level of inflation for developed countries, above which the effects of inflation on growth are negative and statistically significant.

Schiavo and Vaona (2007) have examined the non-linearities between inflation and economic growth and also the existence of threshold level of inflation. They have used nonparametric and semiparametric instrumental variable (IV) estimator on dataset of 167 countries (comprising developed and developing countries) covering

the period 1960-1999. The result provides 12% threshold level of inflation, above which inflation is harmful to economic growth. Due to high variability of growth performances in developing countries, the study could not find precise threshold level of inflation.

Kremer et al. (2009) have examined the effect of inflation on long-term growth using large panel data set of 124 countries (comprising industrial and non-industrial countries) over the period 1950-2004. Using the dynamic threshold model they have determined threshold level of inflation for growth. Their findings reveal that inflation affects growth when it exceeds 2 per cent threshold for industrial countries and 17 percent for non-industrial countries, and that below these levels the impacts of inflation on growth remains insignificant.

However, they have suggested that the inflation threshold in non-industrial countries and the appropriate level of inflation target might be country specific. Therefore, they recommended that the identification of country specific threshold might provide useful information about the appropriate location and width of an inflation targeting band.

Kan and Omay (2010) have examined the threshold effects in the inflation-growth nexus for six industrialized countries (Canada, France, Italy, Japan, UK and USA) over the period 1972-2005. They have employed the Panel Smooth Transition Regression (PSTR) technique which takes into account the non-linearity in the data. They have controlled for unobserved heterogeneity at both country and time levels. The result reveals threshold level of 2.52%, above which inflation negatively affects economic growth and statistically significant.

2.3.2 Review of Individual-Country Empirical Literature:

Faria and Carneiro (2001) have analysed the inflation growth relationship in Brazil using data set for the period of 1980 t0 1985. Applying bivariate time series model that they have found that there is short run negative relationship, however there exists no relationship in the long run in the inflation growth relationship. Their empirical results also support the super neutrality concept of money in the long run.

Kalirajan and Singh (2003) have examined the existence of threshold level of inflation in India using annual data for the period 1971 to 1998 based on non linear least square technique. The findings suggest that the increase in inflation from any level has a negative effect on economic growth. This implies there is no threshold level of inflation in India.

Ahmed and Mortaza (2005) have found a statistically significant long-run negative relationship between inflation and economic growth for Bangladesh using annual time- series data on real GDP and CPI covering the period 1980 to 2005. The study has utilized co-integration and error correction models to empirically establish the inflation-growth relationship in addition to calculate an inflation threshold. They have estimated an inflation threshold level of 6 percent (structural-break point) above which inflation will adversely affect economic growth. They have concluded that their findings have direct relevance to the conduct of monetary policy by the Bangladesh Bank.

Mubarik (2005) has also found, based on Khan and Senhadji (2001), using annul data for the period 1973-2000 the presence of a threshold level of inflation for Pakistan. He has estimated that an inflation threshold level of 9% is growth enhancing above which inflation becomes inimical to growth in the Pakistani economy.

Hussain (2005) has also investigated the threshold level of inflation for Pakistan using annual time series from 1973 to 2005. He has suggested the level of inflation ranging from 4% to 6% could be taken as threshold level beyond which inflation would be disincentive for economic growth.

Hodge (2005) has conducted a study on the relationship between inflation and growth in South Africa in order to test whether South African data support the findings of cross-section studies that inflation has long-run negative effect on growth and if higher growth can be gained at the cost of higher inflation in the short-run.

According to Hodge, inflation drags down growth over the long-term, while in the short run growth above its trend requires accelerating inflation. It is generally noted in literatures that high inflation has negative impact on economic growth in the long run and relates positively in the short run. Therefore, Hodge has estimated a threshold at

which authorities needed to take measures to ensure inflation does not hamper economic growth.

Munir and Mansur (2009) have analyzed the nonlinear inflation-growth relation for the economy of Malaysia over the period of 1970-2005.Using annual data and applying new endogenous threshold autoregressive model (TAR) proposed by Hansen (1996, 2000), they have found threshold value of inflation for Malaysia and verified the view that there exists non-linear inflation-growth relationship in Malaysia.

They have estimated 3.89 percent as a structural break-point of inflation above which inflation significantly harms real GDP growth rate. In addition, they have found statistically significant positive relationship between inflation rate and GDP growth below the threshold point.

For Nigeria, Salami and Kelikume (2010) have also drawn heavily on the work of Khan and Senhadji (2001) to find a threshold effect. Using a non-linear inflation-growth model over the period 1970-2008, they have established an inflation threshold of 7% although failing the significance test.

Marbuah (2010) has made study for Ghana using the annual data set on macroeconomic variables over the period 1955-2009, based on Khan and Senhadji (2001). The study has found evidence of significant threshold effect of inflation on economic growth with and without structural break. Specially, the evidence has shown both the minimum and maximum inflation threshold levels of 6% and 10% respectively.

The major contribution of the paper is that to a very large extent the question of which level of inflation below or beyond which growth is either enhanced or constrained in Ghana has been empirically answered given the evidence.

For Nepal, Bhusal and Silpakar (2011) have estimated the threshold level of inflation using annual data for the period 1975 to 2010 on two variables; real GDP growth rate and CPI inflation. The study has estimated 6 percent threshold level of inflation for the economy of Nepal, beyond which inflation will deter economic growth.

They have conducted their research based on Khan and Senhadji (2001) and using the

framework developed by Ahmed and Mortaza (2005) for Bangladesh. This is the first work done in Nepal to establish inflation-growth relationship systematically.

2.4 Conclusion

Review of literature reveals that various studies have had various conclusion/findings regarding the inflation growth relationship. The earlier studies have established negative effect of inflation on growth. Fisher (1993) was the first to introduce the concept of non-linear inflation-growth relationship. Sarel (1995) has tested for possibility of existence of structural break in the inflation-growth relationship. Since, then there come the new thought among the researcher. One of the most important contributions to the inflation growth literature in the last decade has been made by Khan and Senhadji (2001) to establish threshold relationship between inflation and growth using modern econometric techniques. Since then, various studies have been following their methodologies.

Moreover, there is quite divergence among the findings of empirical studies concentrated to estimate the threshold level of inflation in both cross-country panel study and individual country specific study. For example, Mubarik (2005) has found 9% threshold level of inflation for Pakistani economy while for the same country Hussain (2005) has suggested 4%-6% threshold level of inflation. The variation in results/findings may be due to variation in data used, methodological issues and estimation problem. A number of studies have followed linear estimation method while some studies have followed non-linear estimation method. For example Khan and Senhadji (2001) have used non-linear estimation method. And also, depending up on the nature and data of the individual country the estimated threshold level of inflation is different among the countries. However, all the literatures have reached to the same conclusion that high inflation is detrimental to growth but there are some chances that a low inflation rate might have a positive impact on growth.

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1 Introduction

This chapter is a discussion of the methodology used in this study. The methodology is divided in to two stages. In the first stage, cointegration and Error Correction Model (ECM) are applied to investigate the long-run and short-run relationship of economic growth rate and its determinants. In the second stage Hansen (1996, 1999 & 2000) threshold model is applied to estimate threshold level of inflation for growth. 3.2 presents the estimation of growth equation with inflation, section 3.2.1 presents variable selection criteria, section 3.2.2 presents the empirical model and variable details, section 3.2.3 discusses the ARDL modeling to cointegration analysis, section 3.2.4 presents the hypothesis, section3.3 provides a discussion on the various econometric tools and tests used in the study, section 3.4 provides methodology for estimating threshold level of inflation, and finally section 3.5 discusses the data sources.

3.2 Estimation of Growth Equation with Inflation

This section deals with various determinants of GDP growth including inflation. The recent empirical literature on economic growth has identified a number of variables that are partially correlated with the rate of economic growth. Barro (1991) has developed a standard framework to estimate the rate of growth. King and Levine (1993) have extended the framework to include measure of financial depth in the model.

Variables like the initial level of income, the investment rate, various measure of education, population growth rate, terms of trade, some policy indicators like inflation, black market premium, fiscal surplus and many other variables have been found significant in these studies. The basic methodologies of such studies consist of running a cross-section regression of the following form:

$$= + \sum_{=1} + \ldots\ldots\ldots (3.1)$$

Where, c is constant term, represents a vector of ith explanatory variable in the regression, Gr represents a vector of growth rates and is error term. This principle can be conveniently applied to a single country time series data with specific consideration to the characteristics of the country under study. It is proposed to include inflation along with other right hand side variables to explain GDP growth and systematically vary the other variables to test the robustness of the inflation coefficient (Sing and Kalirajan, 2003).

3.2.1 Selection of Variables

A common problem of empirical studies on economic growth model is that they could not give the exact list of explanatory variables that can affect the growth. So, the study has used two approaches; approach based on theoretical framework (macroeconomic theory and international trade theory) and approach based on empirical studies to choose the explanatory variables.

Macroeconomic theory suggests consumption, investment and population growth rate as explanatory variables of growth. In particular, neoclassical growth model developed by Cass (1965) and Koopmans (1965) have found that increase in investment together with decrease in population growth rate can promote economic growth. In addition, theory of international trade suggests to include openness of the economy in the growth model. A model of monopolistic competition with heterogeneous firms developed by Melitz et al. (2003) has predicted that greater trade openness of the economy leads to higher economic growth.

The empirical literatures on growth, especially work of King and Levine (1993), Levine and Renelt (1992) and Sala-i-Martin (1997) have provided a set of variables to explain the growth. Levine and Renelt(1992) have extended previous model including financial development as an explanatory variable of the economic growth. According these models, investment, inflation, consumption, population growth rate, tax system, theory of black market premium, terms of trade, total trade volume, no of schooling children, employment rate, financial development are among the major explanatory

variables of the economic growth. However, all these variables may not be equally significant and also cannot pass robustness test for all country. And also, empirical studies have shown the varying effects of these variables according to the stage of development.

Therefore, based on the nature and peculiarity of the nation and also availability of data set, the study has used following variables: consumption to GDP ratio, investment to GDP ratio, broad money supply to GDP ratio, total trade volume to GDP ratio and annual population growth rate as set of control variables of growth model including inflation. The selection of variable is consistent with Khan and Senhadji (2001), Singh and Kalirajan (2003) and Hussain (2005).

3.2.2 The Linear Empirical Model

The main objective of the simple linear regression is to show trend relationship and impact of inflation on GDP growth. Following the different time series literatures and depending on nature and peculiarity of the country, the study has employed following model to measure the impact of inflation on GDP growth.

$$= + _1 + _2 + _3 + _4 + _5 + _6 + \ldots\ldots\ldots\ldots(3.2)$$

Where,

$> 0,$ = intercept

$, = 1, \ldots, 6$ are slope parameters.

The details of all the variables used in the formulation of equation (3.2) and used in this study have been presented in table 3.1.

Table 3.1

Variable Details

Variables Name	Details
	Real GDP growth rate defined by (100*d(log RGDP)). Where, real GDP is defined by nominal GDP deflected by the implicit GDP deflactor (FY 2005/2006), is GDP at constant price of (FY 2005/06). Here, first implicit GDP deflactor (FY 2000/2001) is transferred to GDP deflactor (FY 2005/6).
	Annual inflation rate defined by (100*d(log CPI))
CPI	Consumer price index (FY 2005/06=100)
	Consumption to GDP ratio at constant price of (FY 2005/06). Here consumption is total consumption and real consumption is defined by nominal consumption adjusted by CPI (FY 2005/06).
	Investment to GDP ratio at constant price (2005/06). Investment is proxied by gross total capital formation. Real gross capital formation defined by nominal gross capital formation adjusted by CPI (2005/06).
	Annual population growth rate of Nepal.
	Financial development is proxied by broad money supply to GDP ratio at constant price (2005/06). Real broad money supply defined by nominal broad money supply adjusted by CPI (2005/06).
	Openness of economy is proxied by total trade volume to GDP ratio at constant price. Real total trade volume defined by nominal total trade volume adjusted by CPI (2005/06).

3.2.3 Autoregressive Distributed Lag Model (ARDL) to Cointegration Analysis

ARDL model to cointegration analysis is proposed by Pesaran and Pesaran (1997), Pesaran and Shin (1995, 1999) and Pesaran et al. (1996). Pesaran et al. (2001) has further extended the ARDL model to cointegration. Due to the low power and other problems associated with other methods for cointegration test, the ARDL approach to cointegration has become popular in recent years. The ARDL cointegration approach has numerous advantages in comparison to other cointegration methods such as Engle and Granger (1987), Johansen (1991), and Johansen and Juselius (1990) techniques. The advantages are: (i) ARDL procedure does not require the unit root pretesting of the variables in the model unlike other techniques such as Johensen model. (ii) It is applicable irrespective of whether underlying regressors are purely I(0), purely I(1) or mutually cointegrated but the limitation of the model is that, the procedure will collapse in the presence of I(2) series. (iii) ARDL approach provides more significant result of cointegration relation in small samples than other conventional techniques. (iv) ARDL procedure allows to use the variables having different optimal lags, while it is impossible with conventional cointegration procedures. (v) once the orders of the lags in the ARDL model have been selected, the cointegration relationship can be estimated using a simple OLS method. (vi) ARDL technique generally provides unbiased estimates of the long-run model and validates the t-statistics even when some of the regressors are endogenous. (vii) the short-run as well as long-run parameters of the model could be estimated simultaneously. (viii) ARDL procedure employs only a single reduced form equation, while the conventional cointegration procedures estimate the long-run relationships within a context of system equations. (ix) ARDL also can provide the information about structural break in the time series.

Following the Pesaran et al. (1996, 2001), an ARDL representation of equation (3.2) can be written as:

$$\Delta \quad = \quad _{p}+ \quad . \quad \Delta \quad _{-1} + \quad . \quad \Delta \quad _{-} + \quad + \sum_{j=1}^{p}$$

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 x_{t-1} + \alpha_3 z_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{i=0}^{q} \gamma_i \Delta x_{t-i} + \sum_{i=0}^{r} \delta_i \Delta z_{t-i} + \varepsilon_t \quad \ldots (3.3)$$

Where, Δ is the first difference operator, α_0 is drift component. The coefficients: α_1, α_2, α_3, α_4, α_5, α_6 and α_7 represent the long-run relationship and β_1, β_2, β_3, β_4, β_5, β_6 represent the short-run dynamics of the model. ε_t is the usual white noise residual.

i) Cointegration

When traditional Ordinary Least Square (OLS) is run then it is assumed that data are stationary on the levels. However, in most of the cases, time series data are not stationary rater these are non-stationary on the levels. If OLS method is run for non-stationary variables then the relationship may be spurious. However, if they are cointegrated then the parameters will not be spurious rather they will be super consistent. The concept of cointegration has first introduced by Granger (1981) and Engle and Granger (1987). In the case where the variables are non-stationary at levels but are difference stationary, cointegration methodology allows researchers to test for the presence of long run equilibrium relationships between economic variables. If the separate economic time series are stationary after differencing or they are integrated of order one, but a linear combination of their levels is stationary, then the series are said to be cointegrated. In other words, two or more I (l) time series are said to be cointegrated if some linear combination of them is stationary. Formally, given x_t and y_t are integrated of order one [I (1)] or are difference stationary processes, they are

said to be cointegrated if there exists a parameter β such that $u_t = y_t - \beta x_t$ is a

stationary process or is integrated of order zero [I (0)]. The cointegration equation of ARDL model (3.3) is;

$$y_t = \alpha_1 + \alpha_2 x_t + \alpha_3 z_t + \alpha_4 x_{t-1} + \alpha_5 y_{t-1} + \alpha_6 z_{t-1} + \varepsilon_t \quad \ldots \ldots \ldots \ldots 3.4)$$

Where, $_1 = -\left(\frac{_2}{_1}\right)$, $_2 = -\left(\frac{_3}{_1}\right)$, $_3 = -\left(\frac{_4}{_1}\right)$, $_4 = -\left(\frac{_5}{_1}\right)$, $_5 = -\left(\frac{_6}{_1}\right)$ and $_6 = -\left(\frac{_7}{_1}\right)$ are the OLS estimators obtained from equation (3.3).

Tests for cointegration seek to discern whether or not a stable long-run relationship exists among such a set of variables. The existence of a common trend among the variables means that in the long run the behavior of the common trend will drive the behavior of the variables. Shocks that are unique to one time series will die out as the variables adjust back to their common trend (Bhatta, 2011).

ii) Error Correction Modeling

When two variables are cointegrated i.e; there is long run relationship between them there may be disequilibrium in the short run. The error term in the cointegrated regression equation is called equilibrium error term. This error can be used to tie the short run behavior of dependent variable to its long run value. The error correction model (ECM) first introduced by Sargan (1984). The error correction representation of ARDL equation (3.3) is;

$$\Delta \quad = \quad _0 + \quad . \quad \Delta \quad _ + \quad . \quad \Delta \quad _ + \quad + \sum_{j=1}^{p} \quad _6 \Delta \quad _{-1} + \qquad _{-1} + \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.5)$$

In the above equation (3.5), the coefficients of the lag variables i.e. $_1, _2, _3, _4, _5$ provide the short-run dynamics of the model. is the speed of adjustment parameter ECM and shows the divergence/convergence towards the long-run equilibrium. Positive value of indicates divergence and negative value indicates convergence. ECM is residual which is obtained from the estimated cointegration model of equation (3.3). The error correction term (ECM) is thus defined as;

$$= \quad - _1 - _2 - _3 - _4 - _5 - _6 \quad \ldots.. \ldots\ldots \ldots 3.6)$$

Where, $_1$, $_2$, $_3$, $_4$, $_5$ and $_6$ have same meaning as in equation (3.4)

3.2.4 Hypothesis

In order to examine the existence of long-run relationship among the variables in the system, the study has employed the bound test approach developed by Pesaran et al. (2001). The bound test is based on the wald test or F-statistic test. To test the long-run relationship between the variables, the hypotheses are:

Null Hypothesis (₀): $_1 = _2 = _3 = _4 = _5 = _6 = _7 = 0$ i.e. there is no cointegration or long-run relationship.

Alternative Hypothesis (₁): $_1 \neq _2 \neq _3 \neq _4 \neq _5 \neq _6 \neq _7 \neq 0$ i.e. there exists long run relationship between the GDP growth rate and its determinants.

Above null hypothesis (₀) of no relationship has tested against the alternative hypothesis by means of F- test. The F-test can be used to test the hypothesis about one

or more parameters of the k-variable regression model. The F statistic is calculated

by the formula:

$$F = \frac{(RSS_R - RSS_{UR}) / m}{RSS_{UR} / (n-k)};$$

Where,

RSS_R =RSS of the restricted regression,

RSS_{UR} = RSS of unrestricted regression,

m= number of restrictions,

k= number of parameters in unrestricted regression and

n=number of observations

In this study equation (3.3) is unrestricted regression equation. To test the existence of cointegration relationship, the null hypothesis is ( ): $= = = = = = 0$. So, for the study restricted regression is given by dropping the cointegrating or level variables of equation (3.3). Therefore the restricted regression equation is;

$\Delta = + \quad . \quad \Delta + \quad . \quad \Delta + \sum_{j=1}^{p} \Delta + \quad$ …… ….. ….. ……..3.7)

The asymptotic distribution of the F-static are non standard irrespective of whether the variables are I(0) or I(1). Pesaran et al. (2001) have provided the two sets of critical values. The lower critical bound assumes that all the variables in the ARDL model are I(0) and upper critical bound assumes I(1). If the calculated value of F-statistic is greater than upper critical value of bound, then the null hypothesis of no cointegration is rejected. If such statistics is below the lower critical value of bound, the null hypothesis cannot be rejected. Finally, if it lies within the lower and upper bounds, the result would be inconclusive.

After the conformation of the existence of cointegration between the variables, next step is to estimate long-run coefficients of real GDP growth rate and associated ARDL error correction model. The estimation of the long-run relationship is based on lag selection criteria such as adjusted R^2, Schwarz Bayesian Criterion (SBC), Akaike Information Criterion (AIC) and Haann Quinn (HQ) Criterion. Based on the long-run coefficients, the dynamic error correction model (ECM) has also employed for the short-run dynamics of the model.

3.3 Econometric Tools

3.3.1 Time Series Properties of the Variables

A time series is said to be stationary if its mean, variance and auto covariance remain the same no matter at what point they are measured; i.e. they are time invariant. Such a time series will tend to return to its mean and fluctuations around this mean will have broadly constant amplitude. If a time series is not stationary, it is called a non-stationary time series (Gujarati and Sangeetha, 2007).

If time series is stationary at level it is also called time series integrated of order zero or I(0) process. A time series is said to be integrated of order one or I(1) process if it is not stationary at level but stationary at first difference. In general, time series is said to be integrated of order d, denoted by I(d), if it has to be difference d times to get a stationary series.

Most economic time series are generally I(1); that is , they generally become stationary only after taking their first differences (Granger,1986).

3.3.2 Diagnostic Tests and Other Tests

i) JB Test for Normality

Jarque Bera (JB) Test of Normality is an asymptotic large sample test based on the OLS residuals. The test statistic is defined by

$$= \frac{}{6\left[{}^{2} + \frac{(- 3)^{2}}{4} \right]}$$

Where n= sample size, S= skewness coefficient, K = kurtosis coefficient. For a normally distributed variable, S= 0 and K = 3. Therefore, the JB test for normality is a test of joint hypothesis that S and K are 0 and 3 respectively. In that case, the value of the JB statistic is expected to be zero. Under the null hypothesis that the residuals are normally distributed, Jarque and Bera showed that asymptotically the JB statistic follows the chi-square distribution with 2 degree of freedom. If the computed p-value of the JB statistic is sufficiently low or the value of the statistic itself is very different from zero, the null hypothesis that the residuals are normally distributed is rejected. On the contrary, if the p-value is reasonably high or the value of the statistic is close to zero, the normality hypothesis is not rejected (Gujarati and Sangeetha, 2007).

ii) LM Test for Serial Correlation

In the models which contain lagged values of the regressand, the Durbin-Watson d-statistic is often around 2 implying that there is no first order autocorrelation. Thus, there is a bias against discovering first order autocorrelation in such models. This does not mean that autoregressive models do not suffer from autocorrelation problem. To

solve this problem, Durbin has developed Durbin h-test but it is less powerful in statistical sense than the Breusch-Godfrey test popularly known as the LM test for serial correlation. The LM test allows for the lagged values of the regressand, higher order autoregressive scheme and simple or higher order moving averages of the white noise error term.

The null hypothesis under this test is:

H_0: $\rho_1 = \rho_2 = \rho_3 = \ldots\ldots \rho_p = 0$ i.e. there is no serial correlation of any order.

Where u_t follows the p^{th} order autoregressive, AR (p), scheme as follows:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \ldots\ldots\ldots + \rho_p u_{t-p} + \varepsilon_t \qquad (3.8)$$

Test statistic is given by

$$(n-p)R^2 \sim \chi^2_p$$

Where the R^2 is calculated from the auxiliary regression equation given by

$$\hat{u}_t = \alpha_0 + \alpha_i X_{ti} + \hat{\rho}_1 \hat{u}_{t-1} + \hat{\rho}_2 \hat{u}_{t-2} + \ldots\ldots\ldots + \hat{\rho}_p \hat{u}_{t-p} + \varepsilon_t$$

Where X_{ti} are explanatory variables

For large sample, this statistics follows the chi-square distribution with p df. If $(n-p)R^2$ exceeds the chi-square critical value at the chosen level of significance in which case null hypothesis is rejected that is to say there is the presence of serial correlation of some order.

iii) Ramsey's RESET Test

This test is the regression specification error test (RESET). It is used to check whether the specified functional form is correct or not.

The Procedure for F-Version is as follows:

Let the simple regression model is

$Y = \beta_1 + \beta_2 X + u$ .... 3.9)

From equation (3.9), $\hat{Y}$ is found and the following regression is run by adding $\hat{Y}$ in some form as an additional regressors starting with $\hat{Y}^2$, e.g.

$Y = \beta_1 + \beta_2 X + \beta_3 \hat{Y}^2 + \beta_4 \hat{Y}^3 + u$.....

3.10)

Let the R^2 obtained from equation (3.9) is R^2_{old} and that from Equation (3.10) is R^2_{new}. Then, the following F statistics is constructed:

$$F = \frac{(\quad - \quad)/}{(\quad - \quad)/(\quad - \qquad)}$$

If the computed F value is found significant, say, at 5%, one can accept the hypothesis that the model is mis-specified.

Alternative to F-version is the LM version where the calculated statistic nR^2 follows the chi-square distribution with df equal to the number of restrictions imposed for large samples. If the calculated value exceeds the critical value of χ^2 at the chosen level of significance, the null hypothesis is rejected and concluded that the model is mis-specified.

iv) Model Selection Criteria

Model selection criteria are used to choose a model from the alternative models.

- **Adjusted R^2 criterion**

It is calculated as:

$$\bar{R}^2 = 1 - \frac{/ \; -}{/ \; -1}$$

Where,

RSS= residual sum of square

TSS= Total sum of square

n = number of observations

k = number of parameters in the regression model

On the basis of this criterion, a model with highest $\bar{R}^2$ is chosen.

- **Akaike Information criterion(AIC)**

AIC is calculated as:

$$\text{AIC} = e^{2k/n} * \frac{RSS}{n}$$

Where, k= number of parameters,

It can also be writes as:

ln AIC = 2k/n + ln (RSS/n)

Where, ln = natural logarithm and 2k/n is the penalty factor.

AIC imposes harsher penalty than $\bar{R}^2$ for adding more regressors. In comparing the models, the lowest value of AIC is preferred.

- **Schwarz Bayesian Criterion (SBC)**

SBC is calculated as:

$$\text{SBC} = \frac{k}{n} . \ln n + \ln\left(\frac{RSS}{n}\right)$$

Here, $\frac{k}{n} . \ln n$ is the penalty factor. So SBC imposes a harsher penalty than AIC. Like AIC, lower value of SBC is preferred.

v) CUSUM Test and CUSUMSQ Test

- **CUSUM Test**

The CUSUM test (Brown, Durbin, and Evans, 1975) is based on the cumulative sum of the recursive residuals. This option plots the cumulative sum together with the 5% critical lines. The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines.

The CUSUM test is based on the statistic

$$W_t = \sum_{r=k+1}^{t} \frac{w_r}{s}$$

For t=k+1,..T , where W_t is the recursive residual and *s* is the standard error of the regression fitted to all sample points T. If the vector of the parameter remains constant from period to period, E (W_t) = 0, but if this vector changes, W_t will tend to diverge from the zero mean value line. The significance of any departure from the zero line is

assessed by reference to a pair of 5% significance lines, the distance between which increases with t.

The 5% significance lines are found by connecting the points

$[k, \pm -0.948(T\text{-}k)^{1/2}]$ and $[T, \pm 3\times 0.948(T\text{-}k)^{1/2}]$

Movement of outside the critical lines is suggestive of coefficient instability.

- **CUSUMSQ Test**

The CUSUM of squares test (Brown, Durbin, and Evans, 1975) is based on the test statistic

$$W_t = \sum_{r=k+1}^{t} w_r^2 \Big/ \sum_{r=k+1}^{T} w_r^2$$

The expected value of under the hypothesis of parameter constancy is E (S_t) = t-k/T-k which goes from zero at to unity at. The significance of the departure of from its expected value is assessed by reference to a pair of parallel straight lines around the expected value. The CUSUM of squares test provides a plot of against and the pair of 5 percent critical lines. As with the CUSUM test, movement outside the critical lines is suggestive of parameter or variance instability.

vi) Augmented Dickey-Fuller (ADF)Test

The study has employed Augmented Dickey-Fuller (ADF) test to test the stationary (or non-stationary) of the variables or to find the order of integration. ADF can be explained in the following form:

$$\Delta x_t = \eta + \gamma t + \alpha x_{t-1} + \sum_{j=1}^{k} \delta_j \Delta x_{t-j} + \varepsilon_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{3.11)}$$

Where x_t is any variable used in this study, that is, , , , , , . Δ indicates the first difference operator and k is the length of lag which ensures residuals to have white noise empirically. The ADF statistic is simply the t-value of

the coefficient α in equation (3.11). The null hypothesis is that x_t has a unit root, that is, H_0: α = 0 and is rejected if the calculated ADF statistic is above the critical value implying that x_t has no unit root or x_t is stationary.

vii) Multicollinearity Test

When there exists high correlation between two or more than two independent variables of the model, problem of multicollinearity arises. Existence of multicollinearity makes significant variable insignificant increasing standard error, due to which there may arise problem of misinterpretation of the model. The study had employed correlation analysis to test whether there is problem of multicollinearity among the explanatory variables.

3.4 Threshold Model

3.4.1 Model Specification

The study has employed the model proposed by Khan and Senhadji (2001) and used by Sweidan (2004) for Jordan, Mubarik (2005) and Husain (2005) for Pakistan, Shamim and Mortaza (2005) for Bangladesh, Li (2006) for developed and developing countries and Munir and Munsar (2009) for Malaysian economy. The model is:

$$= + _1 + _2 (-) + _3 + _4 + _5 + _6 + _7 + \ldots \quad \ldots\ldots$$
… …. ……… … …… …3.12)

Where, > 0 is intercept and $, = 1, \ldots, 6$; slope parameters

$= 0 \quad <$

$= 1 \quad \geq$, is dummy variable.

k is threshold level of inflation. All other variables have similar meaning as in equation (3.2).

The parameter or threshold value k has a unique property that expresses the inflation and growth association as a low inflation $(_1)$ and high inflation$(_1 + _2)$. The implication of high inflation here means that when long run inflation

estimate is significant, then (1 + 2) will be the impact on the growth at the threshold level of inflation. The value of k is choosen arbitrarily for estimation purposes in ascending order to estimate the threshold model. The optimal value of k is then obtained by finding the corresponding k value which minimizes the residual sum of square (RSS) in each estimated regression model. In other words, it is the point at which the coefficient of determination (2) is maximized. It is at this level that inflation has a significant impact on growth (Mubarik, 2005 and Salami and Kelikume, 2010).

3.4.2 Estimation Method and Inference

i) Estimation Method

If the threshold value (k) is known, then the model can be easily estimated by the OLS procedure. However, k is unknown so it has to be estimated along with other parameters. Furthermore, k enters the regression in a non-linear and non-differentiable manner so both OLS and non-linear least square (NLLS) methods are inappropriate. In such a case Khan and Senhadji have proposed conditional least squares method developed by Hansen (1996, 2000), which can be described as follows (Khan and Senhadji, 2001):

For any k, the model is estimated by OLS, yielding the sum of squared residuals as a function of k. The least squats estimates of k is found by selecting the value of k which minimizes the sum of squared residuals. Hence the optimum threshold value is given by;

$$\hat{k} = argmin\{S_1(k), k = \underline{k} \ldots\ldots \overline{k}\}$$

Where 1( ) is residual sum of squares for different values of threshold parameter. _ is lower value of threshold parameter and − is upper value of threshold parameter.

ii) Inference

To test the significance of threshold parameter, the null hypothesis of no threshold effect is tasted against the alternative hypothesis. The hypotheses are given as follows:

$H_0: \gamma_2 = 0$ i.e. there is no threshold effect

$H_1: \gamma_2 \neq 0$. There exists threshold effect

Hansen (1999) has noted that, under the null hypothesis threshold level k is not identified, so classical tests such as t-test, F-test have non-standard distribution. The asymptotic distribution of D is non standard and strictly dominates the χ^2 distribution. The distribution of D depends in general on the moments of samples, thus the critical values cannot be tabulated. So, in order to test the significance of threshold Hansen (1996, 1999, 2000) has suggested following bootstrap technique to simulate asymptotic distribution of following Likelihood Ratio (LR) test of H_0:

$$D = \frac{S_0 - S_1}{\hat{\sigma}^2} \quad \text{……..3.13)}$$

Where S_0 and S_1 are residual sum of squares under null hypothesis of no threshold effect and alternative hypothesis of presence of threshold effect. $\hat{\sigma}^2$ is residual variance under alternative hypothesis(H_1). This technique also allows to compute p-values which are asymptotically valid Hansen (1996). The null hypothesis will be rejected if p-value is less than some critical value.

iii) Confidence interval

In case of threshold effect $(\gamma_2 \neq 0)$ the estimated threshold is consistent with true value of threshold say (γ_0) and its distribution is highly non-standard. Hansen (1997) has argued that the best way to construct a confidence interval for this threshold k is by forming the "no-rejection region" using the LR statistic for testing the null hypothesis that the threshold( ) is equal to γ_0. Hence to taste the null hypothesis of $= \gamma_0$. The LR statistics is computed as follows;

$$LR_1(\gamma_0) = \frac{[S_1(\gamma_0) - S_1(\hat{\gamma})]}{\hat{\sigma}^2} \quad \text{… … … ….3.14)}$$

Where $_1(\ _0)$ is a likelihood ratio function of threshold level, $_1(\ _0)$ is residual sum of squares for given threshold ($_0$) and $_1(\ )$ is residual sum of squares for threshold $_0$, which is estimated in equation (3.12). ^{2} is variance of residuals for threshold $(\ )$.

Hansen (1999) has demonstrated that the asymptotic distribution LR statistics has a inverse form which is given as:

$$(\ ) = -2\log(1 - \sqrt{1 - \ }) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.15)$$

Where, $(\ )$ is a critical value and is level of significance, so $(1 - \ )$ is confidence level. If $(\ ) \leq (\ )$ then null hypothesis of $_0: \ = \ _0$ cannot be rejected.

3.4.3 Econometric Tools

Various digonistic tests; such as JB test for normality, LM test for serial correlation, Ramsey RESET test for omitted variables and Augumented Dickey-Fuller test for unit root has been applied for the model. Similarly CUSUM test and CUSUMSQ test has been employed to test whether the model is stable. The detail of procedures of these tests has already discussed in section (3.3.5).

3.5 The Data

This study is based on the secondary data. The data sources are Quarterly Economic Bulletin published by Nepal Rastra Bank (NRB), Economic Survey published by Ministry of Finance (MOF) and US Central Bureau of Statistics (CBS). The data set of GDP, total consumption, investment, total trade volume and GDP deflector are extracted from Economic Survey of MOF (FY 2009/2010) and (FY 2012/13). Data set of broad money supply and CPI are obtained from Quarterly economic bulletin of NRB (Mid-April 2013). Annual population growth series is taken from international data base of US CBS.

CHAPTER FOUR

ANALYSIS OF DATA

This chapter presents the analysis of data with the estimated results. Section 4.1 presents the results from the ADF test to test the order of integration of the variables, section 4.2 presents the results from the bounds test to test the long run relationship between the variables, the estimated short run model, long run model and the resulting error correction model for growth equation, section 4.3 presents the results of the CUSUM and CUSUMSQ tests for model and section 4.4 presents the results of estimation of threshold level of inflation.

4.1 Time Series Properties of the Variables

The underlying assumption of ARDL procedure that each variable in growth equation is I (1) or I(0). Thus, there is no need to check whether the variable is I (0) or I (1). However, if any variable is integrated of higher than order one, then the procedure is not applicable because if any variable is I (2) or of some higher order, the table values given by Pesaran (1997) do not work. Thus, it is still necessary to perform unit root tests to ensure that none of the variables in equations is I (2) or higher order. Augmented Dickey-Fuller (ADF) unit-root test has been applied to test the order of integration of the variables. Before conducting the ADF test, an attempt is made on whether to include the trend as a variable in the ADF regression or not. To confirm this, the time series plot of the variables has been presented in Fig.4.1, Fig.4.2, Fig.4.3 and Fig.4.4.

The time series plot in Fig.4.1, Fig.4.2 and Fig.4.3 shows that , , , are not trended variable so only intercept is included while running ADF test on them. On the other hand, in Fig.4.4 is trend variable so trend is included while testing its order of integration. From the time series plot, it is obvious that the relevant ADF statistic for checking the order of integration in case of , , , is the ADF statistic from the ADF regression including constant but no trend whereas the relevant ADF statistic for checking the order of

integration in case of is the ADF statistic from the ADF regression including constant and trend as shown in Fig.4.3. Annual population growth rate is neither trended variable nor depends on constant term. So, for checking the order of integration of , ADF statistics is from no constant and no trend.

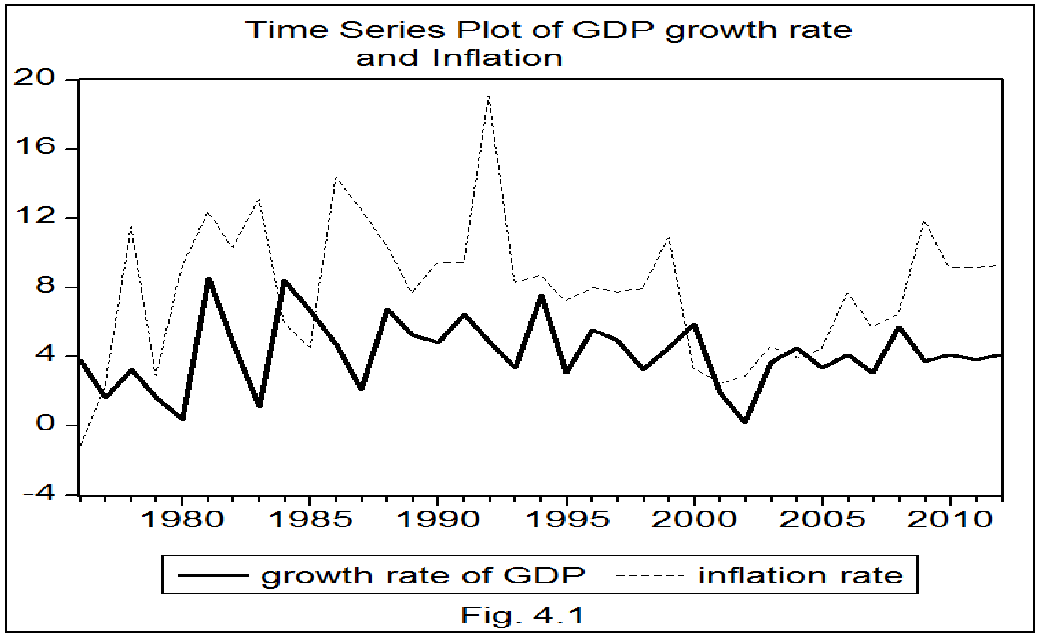

Fig. 4.1

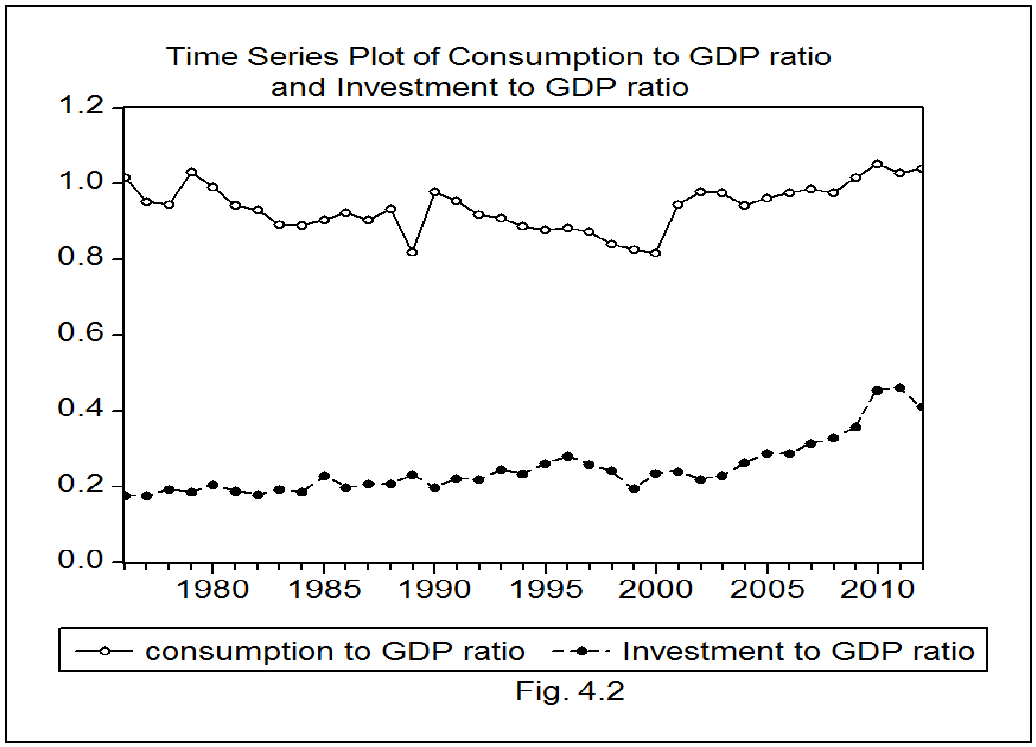

Fig. 4.2

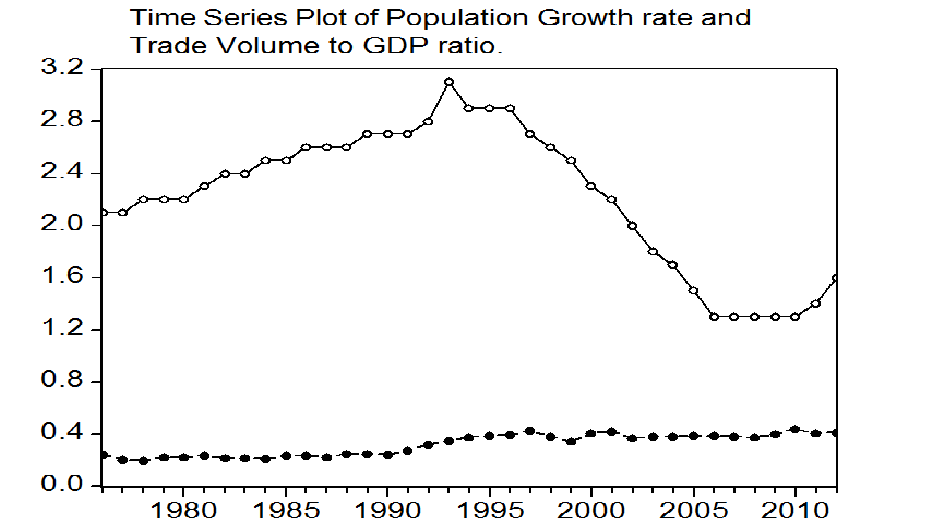

Fig 4.3

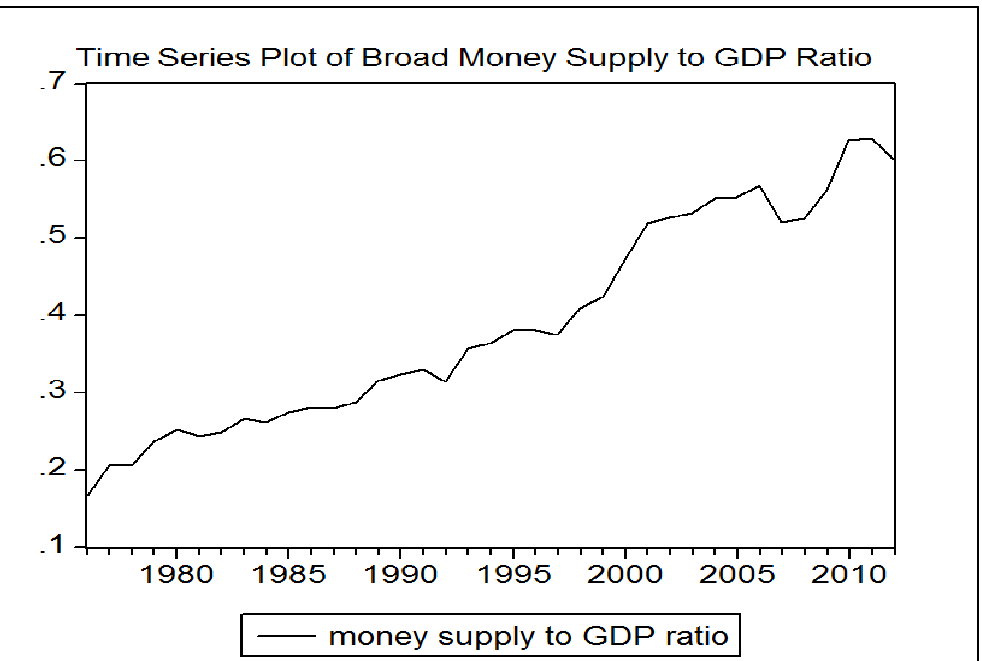

Fig. 4.4

Table 4.1 presents the results of the ADF test. Since the data is annual, following Pesaran and Shin (1999), only one lag has been included (p=1).

Table 4.1

ADF Test Results (p=1)

Variable	No constant, No Trend	Constant	Constant and trend
Ygt		-5.00*	-4.96*
		-3.78*	-4.06*
Cgt		-1.60	-1.84
Igt		0.029	-1.44
Mgt		0.29	-2.81
Tgt		-1.03	2.04
Pgt		-0.89	-1.77
Δ Ygt		-9.87*	-9.76*
Δ		-7.13*	-6.97*
Δ Cgt		-5.35*	-5.52*
Δ Igt		-4.31*	-4.65*
Δ Mgt		-4.49*	-4.39*
Δ Tgt		-6.13*	-6.02*
Δ Pgt	-2.11*	-2.089	-1.77

*represents the rejection of null hypothesis at 5% level of significance.

Here, the critical values for ADF test are: -1.95, -2.95, -3.54 with no costant & no intercept, only constant and constant & intercept at 95% level of significance for both level and first difference of the variables.

From the results in table 4.1, it becomes clear that none of the variables are integrated of higher than order one. All the variables are at most integrated of order one. To confirm the order of integration of the variables besides ADF test, the autocorrelation function for each variable has been examined which leads to the conclusion that the variables , , , are integrated of order one or are I (1) processes whereas the variables are integrated of order zero or are I (0) processes (calculated value of autocorrelation have been provided in Appendix C). If the auto correlation coefficient starts with a high value and diminishes slowly, the variables are non-stationary processes at level. Since, the variables are of mixed order; the ARDL modeling is the most appropriate approach to this model as suggested by Pesaran and Shin (1997).

The study has also followed the correlation analysis to test whether there exists problem of multicollinearity among the explanatory variables. The test shows that there is no serious problem of multicollinearity among the independent variables, i.e; correlation coefficients of real variables such as coefficients of Cgt & Igt, Cgt & Tgt and Igt and Tgt are not so high. Similarly, coefficient of and Mgt is also low. So, no explanatory variable is removed from the model (correlation coefficient of explanatory variable is given in appendix D).

4.2 Estimation Results of Trend Relationship

Since one of the main objectives of the study is to test the existence of long-run relationship between the variables included in the growth equation, the study follows the ARDL approach. Following the Pesaran et al. (2001), presence of long run relationship in the growth model is tested using bound test approach. Table 4.2 shows the results of the calculated F-statistics for the 1 lag order.

Table 4.2

(Bound Test)

Test Statistics	Value	d.f.	Probabitity
F statistic	6.729092*	(7,16)	0.0008
Chi-Square	47.10364	7	0.0000

Note: The relevant critical value bounds are (with intercept and no trend; number of regressors = 6) 2.476 – 3.646 at the 95% significance level and 2.141– 3.250 at the 90% significance level.

* denotes that the F-statistic falls above the95% upper bound.

The result of table 4.2 shows that the calculated F-Statistics for the model is higher than the upper bounds (critical value) at 5% level of significance. Therefore, the null hypothesis of no cointegration is rejected, implying long-run relationship among the variables.

In the second step, equation (3.3) is estimated and different model selection criteria are used to justify the lag orders of each variable in the system. Only an appropriate lag selection criterion will be able to identify the true dynamics of the model. As the data are annual and there are only 37 observations, maximum lag order is set to 2

following Pesaran and Shin (1999). With this maximum lag order, the adjusted sample period for analysis becomes 1977 to 2011. This setting also helps save the degree of freedom, as the sample period for analysis is quite small. Following the lag order criteria based on different criteria on eviews and Henerys general to specific procedure, the maximum number of lag p is selected. The ARDL (1, 0,1, 0,1,1,1) model is selected on the basis of all criteria like Adjusted R^2, Schwarz Bayesian Criterion (SBC), Akaike Information Criterion (AIC) and Haann Quinn criterion for the model. According to Pesaran (1997), AIC and SBC perform relatively well in small samples, although the SBC is slightly superior to the AIC (Pesaran and Shin, 1999). Besides, SBC is parsimonious as it uses minimum acceptable lag while selecting the lag length and avoid unnecessary loss of degrees of freedom. Therefore, SBC criterion has been used, as a criterion for the optimal lag selection, in all cointegration estimations.

After selecting the appropriate lag orders for each variable in the system, equation (3.3) is re-estimated. The Results of such estimation along with the short run diagnostic statistics are presented in table 4.3.

Table 4.3

Full-information of ARDL Estimate Results (Growth Equation)

ARDL (1,0,1,0,1,1,1) selected based on Schwarz Bayesian Criterion

Dependent variable is Δ

35 observations used for estimation from 1977 to 2011

Variable	Coefficients	Std.Error	T-Ratio[Probability]
C	57.58*	17.62	3.27[0.0048]
−1	0.27	0.19	1.41[0.18]
−1	-58.78*	16.35	-3.59[0.0024]
−1	27.86*	13.00	2.14[0.048]
−1	21.17	10.13	2.09[0.053]
−1	-35.61*	14.59	-2.44[0.027]
−1	1.37	1.74	0.79[0.44]
−1	-2.7*	0.45	-6.05[0.00]
Δ	0.34*	0.16	2.15[0.046]
Δ	-13.7	9.61	-1.42[0.17]
Δ	33.16	18.56	1.79[0.093]
Δ	-17.4	18.27	-0.95[0.35]
Δ	-5.97	19.25	-0.31[0.76]
Δ	1.48	4.28	0.34[0.73]
Δ −1	11.61	10.33	1.12[0.28]
Δ −1	-36.47	17.95	-2.03[0.059]
Δ −1	34.69*	16.058	2.16[0.046]
Δ −1	6.28	4.20	1.49[0.15]
Δ −1	0.84*	0.26	3.16[0.006]
—	0.856007	Adjusted R-squared	0.694016
. .	1.63244	F-statistic[prob]	5.284[0.0008]
	4.120984	Schwarz criteron	4.965316

Diagonostic Tests

Tests	F-Statistics	Probability
Serial Correlation (LM)	0.843771	0.450829

Functional Form (Reset)	6.112004	0.025884
Normality Test (JB)	0.793199	0.672603

*denotes the significance of coefficient at 5% level

Table 4.3 indicates that the overall goodness of fit of the estimated ARDL regression model is good with the result of R^2 =0.856007. From the diagnostic tests, it is clear that the model passes all of the tests. Also from this table, null hypothesis of normality of residuals and null hypothesis of no first order serial correlation are accepted at 5% level of significance. Also, the null hypothesis of no misspecification of functional form can be accepted at 5%level of significance. Since the LM version of misspecification test is a large sample test, it is more appropriate to conclude on the basis of F-version of RESET test. On the basis of F-version, the null hypothesis of no misspecification can be easily accepted even at 5% level of significance. Not much interpretation can be attached to the short run coefficients. These coefficients will be interpreted in the error correction ARDL model in table 4.5.

The long-run model of the corresponding ARDL (1, 0, 1, 0,1,1,1) for the growth equation can be written as follows:

$$= 21.30222 + 0.098871 \quad - 21.7468 \quad + 10.3068 \quad + 7.833174 \quad - 13.1738 \quad + 0.50805$$

The long-run coefficients are the value of , $= 2,3 \ldots .7$ of equation (3.3) normalized on dividing the coefficients by coefficient $(- \ 1)$.

The long-run coefficients are presented in table 4.4. All the long run coefficients except coefficients of inflation rate, broad money supply to GDP ratio and population growth rate are statistically significant. Coefficients of inflation rate, investment to GDP ratio, broad money supply to GDP ratio and population growth rate are positive while coefficients of consumption to GDP ratio and total trade volume to GDP ratio are negative in sign.

The coefficient of inflation is positive i.e; 0.09887, however it is statistically insignificant. So, inflation rate does not affect economic growth rate significantly in the long run. This implies economic growth rate remains independent of inflation rate in the long run. This finding is consistent with the findings of Faria and Carneiro

(2001) for Brazil, Chimobi (2008) for Nigeria and Erbaykal and Okuyan (2008) for Turkey. This empirical result also supports the super neutrality concept of money in the long run.

The coefficient of consumption to GDP ratio is negative. Quantitatively, increase in consumption to GDP ratio by 1 will cause to reduce growth rate by 21.75%, which is highly significant as reflected by t-statistics 3.594. As consumption increases, this will reduce share of investment in GDP and also consumption in Nepal is import dominant consumption which causes the outflow of domestic currency. So, with the increase in share of consumption in GDP, GDP growth will decrease.

Table 4.4

Estimated Long Run Coefficients using the ARDL Approach

ARDL (1,0,1,0,1,1,1) selected based on Schwarz Bayesian Criterion

Dependent variable is

35 observations used for estimation from 1977 to 2011

Variable	Coefficients	Std.Error	T-Ratio[Probability]
	0.0989	0.19	1.41[0.18]
Cgt	-21.7468*	16.35	-3.59[0.0024]
Igt	10.3068*	13.00	2.14[0.048]
Mgt	7.8332	10.13	2.09[0.053]
Tgt	-13.1738*	14.59	-2.44[0.027]
Pgt	0.5082	1.74	0.79[0.44]
C	21.3022*	17.62	3.27[0.0048]

*shows the significance of coefficients at 5% level of significance

The coefficients of investment to GDP ratio and total trade volume to GDP ratio are also significant. From the table 4.4, Igt affects growth rate positively where as Tgt affects negatively. Quantitatively increase in investment to GDP ratio by 1 causes economic growth rate to increase by 10.3068%. Increase in investment to GDP ratio implies the diversification of resources towards production utilizing and mobilizing both human resources and physical resources; which in turn uplifts the economic growth rate. So, the positive sign of investment to GDP ratio for growth rate is obvious.

Total trade volume to GDP ratio affects economic growth rate negatively. Increase in total trade volume to GDP ratio by 1 reduces economic growth rate by 13.1738%. In Nepal, trade volume consists larger volume of imports and only small size of exports or even is in fixed volume for many years. So, increase in trade volume in Nepal implies increase in imports being export almost fixed. So, with the increase in trade volume to GDP ratio allows more outflow of domestic currency. This in turn reduces economic growth.

The coefficients of broad money supply to GDP ratio (7.8332) and population growth rate (0.5082) are positive but statistically insignificant. The statistically insignificant coefficients implie that in the long run economic growth rate remains independent of both Mgt and Pgt. Insignificant sign of Pgt is consistent with theory. However, insignificant coefficient of Mgt shows two possibilities: either broad money supply is not a good proxy of financial development or financial sector could not facilitate the growth related activities in the economy. In Nepal financial sector are not lending their credit on production activities and long term return big projects such as hydroelectricity, mining, tourisms sectors, agricultural projects and many other industrial activities. They are making consumption oriented (land purchase, home loan and vehicle loan etc.) loan seeking low risk. Also, financial sectors are city centered and so larger part of the country is not monetized. This may the cause behind insignificant role of Mgt for economic growth.

The estimates of the error correction representation of the ARDL (1,0, 1, 0,1,1,1) model selected by the SBC criterion are presented in Table 4.5. The long run coefficients are used to generate the error correction term i.e; ECM= Ygt-21.30-0.0989* +21.3468*Cgt-10.3068*Igt-7.8332*Mgt+13.1738*Tgt-0.5082*Pgt.

The computed F-statistic clearly rejects the null hypothesis that all regressors have zero coefficients. The JB test for normality shows that the residuals of the error correction modeling are normally distributed. Importantly, the error correction coefficient has the expected negative sign and is highly significant as shown by the probability value being zero. This helps to reinforce the existence of cointegration as provided by the F-test. Specifically, the estimated value of $ECM_{(-1)}$ is -2.68. The absolute value of the coefficient of $ECM_{(-1)}$ is substantially high indicating the fast speed of adjustment to equilibrium following short-run shocks; about 268% of the

disequilibrium, caused by previous period shocks, converges back to the long-run equilibrium in one period. The short-run coefficients show the dynamic adjustment of these variables. Only two short run coefficients; short run coefficient of inflation rate and short run coefficient of first lag on total trade volume to GDP ratio are significant coefficients.

Table 4.5

Error Correction Representation for the Selected ARDL Model

Autoregressive Distributed Lag Estimates

ARDL (1,0,1,0,1,1,1) selected based on Schwarz Bayesian Criterion

Dependent variable is Δ

35 observations used for estimation from 1977 to 2011

Variable	Coefficients	Std.Error	T-Ratio[Probability]
Δ $_{-1}$	0.84*	0.26	3.16[0.006]
Δ	0.34*	0.16	2.15[0.046]
Δ Cgt	-13.7	9.61	-1.42[0.17]
Δ Igt	33.16	18.56	1.79[0.093]
Δ Mgt	-17.4	18.27	-0.95[0.35]
Δ Tgt	-5.97	19.25	-0.31[0.76]
Δ Pgt	1.48	4.28	0.34[0.73]
Δ $_{-1}$	11.61	10.33	1.12[0.28]
Δ $_{-1}$	-36.47	17.95	-2.03[0.059]
Δ $_{-1}$	34.69*	16.058	2.16[0.046]
Δ $_{-1}$	6.28	4.20	1.49[0.15]
ECM(-1)	-2.68*	0.33	-8.04[0.000]
R-squared	0.855789	S.E. of regression	1.393206
Adjusted R-squared	0.777128	F-static[Prob]	10.87951[0.00001]
Normality(JB)	0.7684	Prob[Normality]	0.6809

ECM= Ygt-21.30-0.0989* +21.3468*Cgt-10.3068*Igt-7.8332*Mgt+13.1738*Tgt-0.5082*Pgt

Note: R-Squared and R-Bar-Squared measures refer to the dependent variable ΔYgt

and in cases where the error correction model is highly restricted, these measures could become negative.
*shows the significance of coefficients at 5% level of significance.

The short run coefficients of inflation, investment to GDP ratio, population growth rate, first lag of consumption to GDP ratio, first lag of trade volume to GDP ratio and first lag of population growth are positive while coefficients of consumption to GDP ratio, broad money supply to GDP ratio, trade volume to GDP ratio and first lag of broad money supply to GDP ratio are negative in sign.

In the short run inflation affects growth positively. Quantitatively, 1% change in inflation leads economic growth rate to increase by 0.34%. In this study, all the channels through which change in inflation rate affects growth are not quantitatively identified. However inflation variation may play significant role on induced decision making of common people, investors and decision makers in developing countries, like Nepal. This may play accelerating role on investment, speculation and trade. This in turn uplifts economic growth rate in the short run. Hodge (2005) for South Africa has also concluded significant effect of inflation on growth rate in the short run. This study cannot accept the conclusion of Bhusal and Silpakar (2011) that inflation in the long run has significant positive effect on economic growth and in the short run growth remains independent of inflation rate.

In the short run first lag of total trade volume to GDP ratio also affects economic growth rate positively. Increase in total trade volume to GDP ratio by 1 in previous year increases economic growth rate by 34.69%.

The finding of the study regarding inflation-growth relationship is somewhat consistent with Keynesian opinion that, prior to full employment there is positive relationship between inflation and economic growth. This is short rum phenomenon. This holds with the fact that in the short run, changes in factors like expectation,

labour, prices of other production factors (capital, technology, raw materials etc), fiscal and monetary policy derive inflation as well as output. However, in the long run i.e; post to the full employment level growth rate remains independent of inflation Monetarists have also advocated for short run positive inflation-growth relationship and no relation in the long run. They have concluded this relationship using real balance effect where change in money supply is greater than change in price level. However, inflation in Nepal is supply socks or demand pull inflation rather pure monetary one (correlation coefficient of inflation and Mgt is -0.144). Both, monetarists and Keynesian had made the same conclusion of short run positive nexus between inflation and growth and no relationship in the long run with different mechanisms. In Nepalese case the nature of inflation follows Keynesian mechanism.

4.3 Stability Test

Finally, the stability of the long run coefficients together with the short run dynamics is examined. In doing so, Pesaran and Pesaran (1997) have been followed and the CUSUM and CUSUMSQ tests proposed by Brown, Durbin, and Evans (1975) have been applied. The tests are applied to the residuals of the two models following Pesaran and Pesaran(1997). Specifically, the CUSUM test makes use of the cumulative sum of recursive residuals based on the first set of *n* observations and is updated recursively and plotted against break points. If the plot of CUSUM statistics stays within the critical bounds of 5% significance level represented by a pair of straight lines drawn at the 5% level of significance whose equations are given in Brown, Durbin, and Evans (1975)], the null hypothesis that all coefficients in the error correction model are stable cannot be rejected. If either of the lines crosses, the null hypothesis of coefficient constancy can be rejected at the 5% level of significance. A similar procedure is used to carry out the CUSUMSQ test, which is based on the squared recursive residuals. Figure 4.5 and figure 4.6 show the graphical representation of the CUSUM and CUSUMSQ plots applied to the model selected by the SBC criterion. Neither CUSUM nor CUSUMSQ plots cross the critical bounds, indicating no evidence of any significant structural instability. Since all the graphs of

CUSUM and CUSUMSQ statistics stay comfortably well within the 5 percent band, it is safe to conclude that the estimated growth equation is stable.

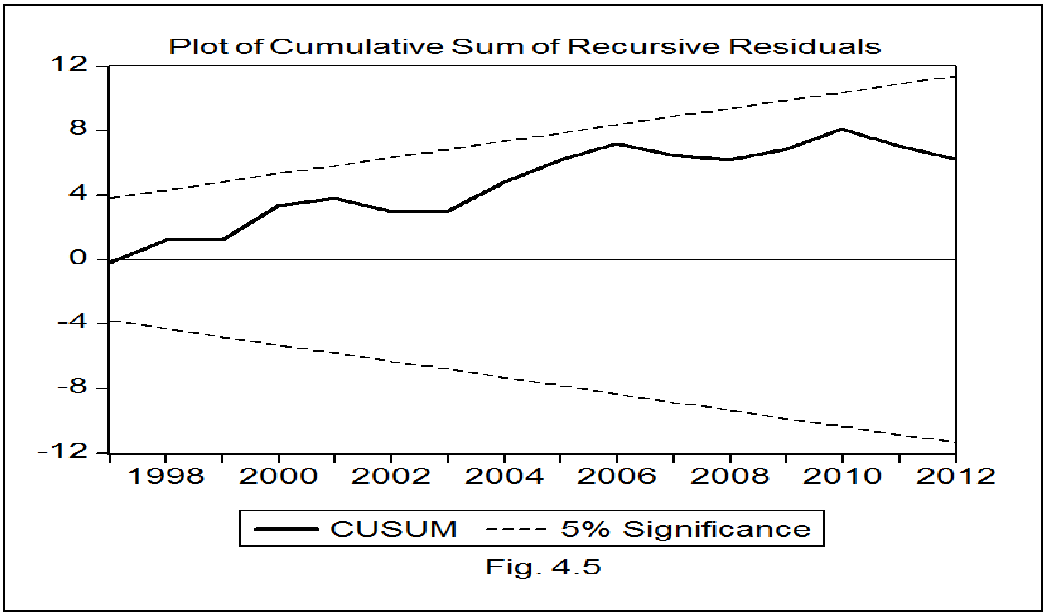

Fig. 4.5

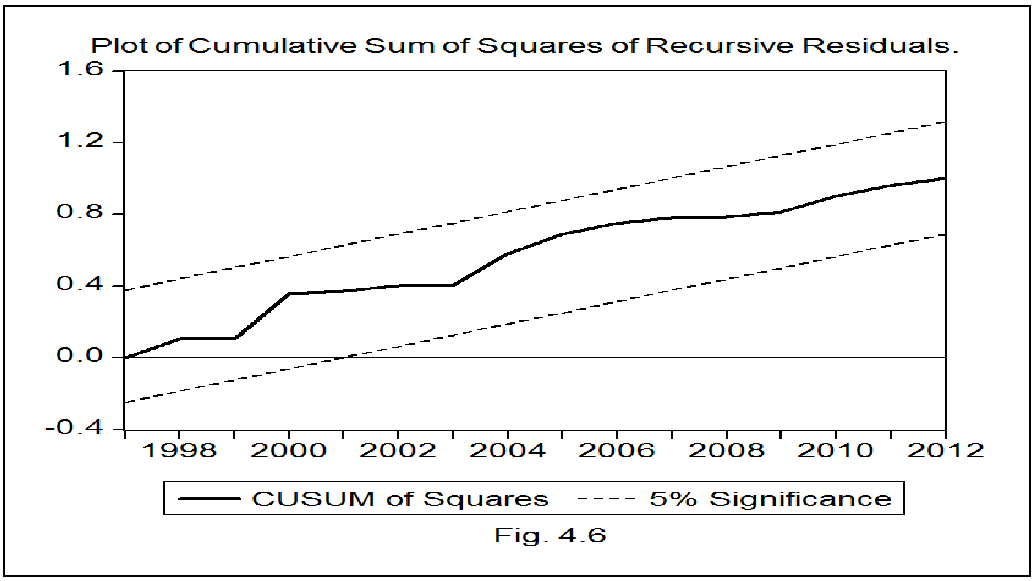

Fig. 4.6

Thus, on the basis of all statistical tests applied, it can be concluded that a statistically robust growth equation can be modeled using the ARDL model proposed by Pesaran and Shin (1997). There exists long-run cointegrating relationship between real GDP growth rate and variables included in the model.

4.4 Estimation of Results of Threshold Relationship

It is argued that inflation has an adverse effect on economic growth only after it crosses a threshold limit, below which inflation has a positive effect on growth. In this section, an attempt is made to explore the non-linearity inflation growth relationship in case of Nepal. In other words, the questions that are addressed here are: (1) Is there any threshold level of inflation in Nepal, below which inflation is desirable for growth? (2) Does such threshold inflation affect significantly?

To estimate the threshold level of inflation, the study has employed a conditional least square technique. This implies to minimize the residuals in the growth regression conditional on particular threshold level, repeating the procedure for different threshold values ranging from 1% to 15%. Overall calculation of threshold value is shown in table 4.6. Most of the earlier studies have used logarithmic transformation of inflation due to the non symmetric nature of inflation on growth. However, in Nepalese context for the period considered, the inflation series is somewhat symmetric, so, the study has used inflation at level to estimate threshold level.

Table 4.6

Calculation of Threshold Level of Inflation

k	γ_1	γ_2	T value [prob]of γ_2	RSS	R-square	LM Test	Heteroskedasticity	JB Test	RESET
k=1	-.6594	.70763	0.5421 [0.5919]	122.4101	.15789	2.3080 [.13992]	1.0396 [.450653]	0.3136 [.4548]	4.461 [.0437]
K=2	-.4325	.4815	.5421 [.5919]	122.4101	.1579	2.3080 [.1399]	1.0396 [.450653]	0.3136 [.4548]	4.461 [.0437]
K=3	-.0369	.0708	0.9793 [.9227]	123.61	.1496	2.1329 [.1552]	0.9520 [.5254]	0.1978 [.9058]	3.182 [.0852]
K=4	0.4188	-.4412	.7366 [.4673]	121.3797	.1650	2.1854 [.1504]	.9938 [.4906]	.1130 [.9450]	.1695 [.6836]
K=5	.4329	-.4940	1.0114 [.3202]	119.4371	.1783	2.361 [.1356]	.9660 [.5137]	.0927 [0.9564]	.1154 [.7365]
K=6	.3481	-.4293	1.0485 [0.3030]	119.133	.1804	2.3481 [.1366]	.9881 [.4252]	0.0900 [.9559]	.4372 [.5138]
K=7	.2087	-.2715	.7396 [.4654]	121.360	.1651	2.2794 [.1423]	.9591 [.5194]	.0764 [.9625]	1.8236 [.1876]
K=8	.1367	-.1867	.5589 [.5805]	122.33	.1584	2.2279 [.1467]	.9731 [.5077]	0.0889 [.9565]	2.371 [0.1348]

K=9	.1220	-.1918	.5913 [.5583]	122.17 7	.1594	2.1767 [.1512]	0.9854 [.4975]	.0679 [.9667]	2.41 [0.1317]
K=10	.1076	-.2023	.6186 [.5410]	122.03	.1604	2.063 [.1619]	1.18 [.3526]	.0871 [.9573]	2.6169 [.1169]
K=11	.0755	-.1567	.4551 [.6524]	122.77	.1553	2.100 [.1583]	1.2667 [.3008]	.1180 [9426]	2.994 [.0945]
K=12	.0510	-.999	.2657 [7923]	123.35	.1515	2.2234 [.1471]	.9676 [.5122]	.1259 [.9389]	3.1596 [.8634]
K=13	.0248	.0254	.05928 [.9531]	123.63	.1494	2.3727 [.1376]	1.2937 [.2858]	0.2034 [.9032]	2.6273 [.1162]
K=14	.0234	.0436	.0853 [.9326]	123.61	.1495	2.3329 [.1368]	1.3437 [.2597]	.2091 [.9007]	2.57 [.1195]
K=15	.0240	.05044	.0802 [.9366]	123.62	.1495	2.303 [.1403]	1.0816 [.4191]	.2043 [.9028]	2.5958 [.1183]

In table 4.6, $_1$ is coefficient of inflation and $_2$ is coefficient of difference of inflation and threshold value of inflation, which are briefly defined in equation (3.12). Here k indicates threshold value. Defination of 'k' indicates 6% threshold level of inflation for Nepal in terms of minimum RSS (199.133) or maximum R-square value (0.180431). Also, the null hypothesis of no serial correlation of residual, normality and no heteroskedasticity cannot be rejected at 5% level of significance. So, there is no problem of autocorrelation, normality, heteroskedasticity and stability of the model at 6% threshold level of inflation. Hence from the above result the short run effect of inflation on growth is $_1$, where is long-run impact is ($_1$ -0.4293).

Now to test the effect of the threshold level of inflation on growth the study has employed the LR test to test the null hypothesis of no threshold level of inflation. This provides whether threshold level exist significantly or not. The F-statistics and value of log likelihood ratio test for null hypothesis is shown in table 4.7.

Table 4.7

(LR Test)

Test Statistics	**Value**	**Probability**
F statistics	1.0996	0.3030
Log likelihood ratio	1.3768	0.2406

From above table the null hypothesis of no threshold level cannot be rejected at 5% level of significance. So, study has made the conclusion that there is not any significant threshold level of inflation for growth in Nepal. This result is consistent with the many other studies of developing countries and some cross country studies; such as Kalirajan and Singh (2003) for India, Hussian (2005) for Pakistan and Salami & Kelikume (2010) for Nigeria have made the conclusion of no significant threshold level of inflation for economic growth. Similarly, Christoflersen and Doyle (1998), on their panel data study have made the same conclusion of no threshold value of inflation for growth. Schiavo and Vaona (2007) also could not find threshold level of inflation for developing countries in their cross country study covering both industrialized and developing countries.

This study cannot accept the conclusion of Bhusal and Silpakar (2011) that there exists significant (6%) threshold level of inflation in Nepal.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study is primarily meant to investigate the long-run relationship between economic growth (real GDP growth) and inflation including other control variable and to estimate threshold level of inflation for Nepal using annual data over the period 1975-2011. It has followed the ARDL approach to cointegrating and error correction model developed by Pesaran and Shin (1999) and Pesaran et. all (2001) to examine the trend relationship. It has also employed conditional least square technique followed by Khan and Senhadji (2001) to estimate the threshold level of inflation. This chapter is the concluding chapter of the present study. Section 5.1 summarizes the findings from the study and draws some conclusions. Section 5.2 has some recommendation that can be made from the conclusions of the study.

5.1 Summary of the Findings and Conclusions

The main purpose of the study is to examine long-run relationship between economic growth and variables included in the mode and to estimate threshold level of inflation for Nepal. It has included the variables that were found relevant by the previous literature on growth model and analyzed the growth equation using both linear and

threshold model over the period 1975-2011. The major findings and conclusions of the study are:

1. There exists a cointegrating relationship between economic growth and variables included in the model.
2. The most significant determinants of economic growth rate in case of Nepal are; consumption to GDP ratio, investment to GDP ratio and total trade volume to GDP ratio.
3. Investment to GDP ratio affects economic growth rate positively whereas, consumption to GDP ratio and total trade volume to GDP ratio affect economic growth rate negatively. The negative effect of total trade volume to GDP may be due to dominancey of imports. The negative sign of consumption to GDP ratio may be due to import dominance consumption pattern and reduction in share of investment in GDP.
4. Inflation rate, broad money supply to GDP ratio and annual population growth rate have positive impact on economic growth rate but are statistically insignificant implying that GDP growth rate is independent of these variable in the long-run in Nepal.
5. Coefficient of error correction has a negative sign reinforcing the long-run equilibrium relationship between the variables in the growth model.
6. The study has also found that there is no evidence of threshold effect of inflation in case of Nepal. The result is sharp contrast to the findings of Bhusal and Silpakar (2011).

5.2 Recommendations

From the conclusions of the study, the following recommendation can be made:

1. The study has found that inflation at level can not affect growth significantly, so growth rate is independent of inflation in the long-run. However, rate of change in inflation affects growth rate positively. And also, there is no evidence of significant threshold level of inflation in case of Nepal. Broad money supply to GDP ratio has positive impact on growth, but statistically insignificant. So, NRB could adopt expansionary monetary policy for supporting economic growth.

2. NRB should regulate the financial sector along with financial sector liberalization policy to divert their lending capacity towards productive activities. This will bring significant role of financial sector on economic growth.
3. Investment to GDP has positive impact on growth while consumption to GDP ratio and total trade volume to GDP has negative impact on growth. These negative impacts may be due to dominancy of imports. So, policy makers should seek the channels to mobilize factors on productive sectors by withdrawing import dominant luxurious consumption.

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APPENDIX

APPENDIX A

Data Processing for Study (In Ten Million Rs.)

Years	Nominal GDP	GDPdefl (2000/01)	GDPdefl (2005/06)	RealGDP (2005/06) (GDP/GDPdefl)	CPI	Investment (INV)	Real Investment (INV/CPI)	M2	Real M2 (M2/CPI)	Nominal Trade Volume(TV)	Real Trade Volume (TV/CPI)	Nonimal Consumption(Con)	Real Consumption (Con/CPI)
1974	1657.1	12.64	10.01585	16544.78	8.9	-	-	-	-	.	.	1490.9	14885.41
1975	1739.4	12.78	10.12678	17176.23	8.8	263.2	2990.909	252.4	2868.182	361.75	4110.795	1535.4	15161.77
1976	1728	12.49	9.896989	17459.86	9	276.8	3075.556	322.3	3581.111	317.27	3525.222	1494.9	15104.59
1977	1973.2	13.81	10.94295	18031.7	10.1	350.7	3472.277	377.21	3734.752	351.58	3480.99	1719.2	15710.57
1978	2221.5	15.3	12.12361	18323.75	10.4	351.4	3378.846	451.14	4337.885	418.15	4020.673	1963	16191.54
1979	2335.1	16.02	12.69414	18395.11	11.4	427	3745.614	528.53	4636.228	463.06	4061.93	2076	16354.01
1980	2730.7	17.2	13.62916	20035.72	12.9	480.8	3727.132	630.77	4889.69	603.69	4679.767	2433.3	17853.63
1981	3098.8	18.62	14.75436	21002.61	14.3	531.4	3716.084	745.8	5215.385	642.18	4490.769	2791	18916.44
1982	3376.1	20.07	15.90333	21228.89	16.3	662.8	4066.258	922.24	5657.914	744.6	4568.098	3087.4	19413.55
1983	3939	21.53	17.06022	23088.8	17.3	735.1	4249.133	1045.52	6043.468	821.82	4750.405	3550.4	20810.98
1984	4444.1	22.73	18.01109	24674.24	18.1	1018.4	5626.519	1229.66	6793.702	1048.27	5791.547	4034.8	22401.75
1985	5321.5	25.98	20.58637	25849.63	20.9	1059.9	5071.292	1515.9	7253.11	1241.92	5942.201	4984.7	24213.59
1986	6114	29.23	23.16165	26397.09	23.7	1289.8	5442.194	1749.82	7383.207	1389.76	5863.966	5654.3	24412.34
1987	7317	32.7	25.91125	28238.7	26.3	1523.7	5793.536	2142.26	8145.475	1799.12	6840.76	6930.2	26745.91
1988	8583.1	36.4	28.84311	29757.89	28.4	1941.5	6836.268	2660.51	9367.993	2045.9	7203.873	7912	27431.16
1989	9970.2	40.3	31.93344	31221.82	31.2	1907.6	6114.103	3155.24	10112.95	2348.11	7525.994	9527.3	29834.87
1990	11612.7	44	34.86529	33307.34	34.3	2507.4	7310.204	3771.25	10994.9	3061.4	8925.364	1085.6	3113.698
1991	14493.3	52.3	41.44215	34972.36	41.5	3161.9	7619.036	4567.05	11004.94	4564.65	10999.16	13328	32160.49
1992	16535	57.7	45.72108	36164.94	45.1	3965.3	8792.239	5832.25	12931.82	5647.21	12521.53	14830.2	32436.24
1993	19159.6	62	49.12837	38999.06	49.2	4464.4	9073.984	6977.71	14182.34	7086.42	14403.29	17005.2	34613.81
1994	20997.6	65.9	52.2187	40210.88	52.9	5523.1	10440.64	8098.47	15309.02	8131.87	15372.16	18671	35755.39

1995	23938.8	71.1	56.33914	42490.53	57.3	6801.7	11870.33	9265.22	16169.67	9433.56	16463.46	21448.7	38070.69
1996	26957	76.2	60.38035	44645.32	61.9	7108.4	11483.68	10372.06	16756.16	11618.99	18770.58	24135.1	39971.78
1997	28979.8	79.3	62.83676	46119.18	67	7472.8	11153.43	12646.26	18875.01	11651.55	17390.37	25940.7	41282.68
1998	33001.8	86.3	68.38352	48259.87	74.7	7006.1	9378.983	15280.02	20455.18	12320.16	16492.85	29547.3	43208.22
1999	36625.1	90.3	71.55309	51185.91	77.2	9227.2	11952.33	18612.08	24108.91	15832.76	20508.76	32191.1	44989.11
2000	41342.9	100	79.2393	52174.74	79.1	9864.9	12471.43	21445.42	27111.78	17134.13	21661.35	39001.7	49220.15
2001	43039.7	103.9	82.32963	52277.29	81.4	9301.9	11427.4	22398.83	27516.99	15433.38	18959.93	41584.3	50509.52
2002	46032.5	107.1	84.86529	54241.84	85.2	10538.3	12368.9	24591.12	28862.82	17428.27	20455.72	45009	53035.82
2003	50069.9	111.4	88.27258	56721.92	88.6	13167.1	14861.29	27731.01	31299.11	19018.78	21465.89	47368.5	53661.62
2004	54848.5	118	93.50237	58660.01	92.6	15590.7	16836.61	30044	32444.92	20817.93	22481.57	52130.1	55752.7
2005	61111.8	126.2	100	61111.8	100	17563.3	17563.3	34742.18	34742.18	23401.44	23401.44	59532.7	59532.7
2006	67585.9	135.4	107.29	62993.65	105.9	20877.9	19714.73	34682.41	32750.15	25407.77	23992.23	65637.4	61177.55
2007	75525.7	142.9	113.233	66699.39	113	24727.2	21882.48	39551.82	35001.61	28120.42	24885.33	73547	64951.93
2008	90952.8	165.8	131.3788	69229.45	127.2	31302.9	24609.2	49537.71	38944.74	35216.71	27686.09	89504.2	68126.84
2009	108341.5	189.6	150.2377	72113.38	139.4	45648.9	32746.7	63052.12	45231.08	43515.92	31216.59	108529.2	72238.32
2010	125648.2	211.7	167.7496	74902.23	152.7	52726.8	34529.67	71959.91	47125.02	46051.4	30158.09	125142.1	74600.53
2011	139613.9	225.8	178.9223	78030.44	167.5	53554.5	31972.84	78828.14	47061.58	53592.87	31995.74	135953.9	75984.86

Source: Economic Survey MOF (FY 2009/10) & (FY2012/13)

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APPENDIX B

Data Used for the Estimation of Models

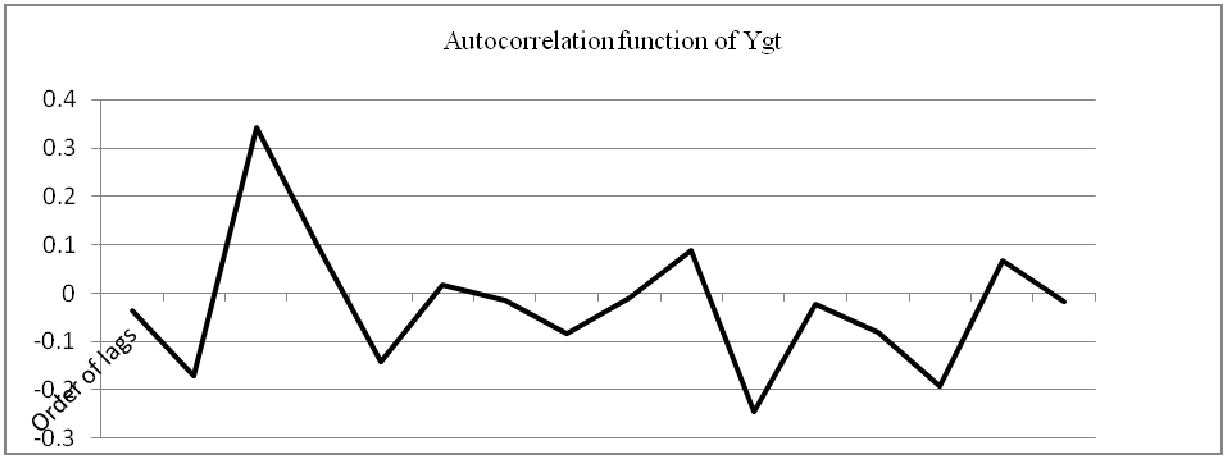
Years	Real GDP Growth rate(Ygt)	Inflation ( )	Consumption to GDP ratio (Cgt)	Investment to GDP ratio (Igt)	Money supply to GDP ratio (Mgt)	Trade volume to GDP ratio (Tgt)	Population growth rate (Pgt)
1975	3.745608	-1.12996	1.015806	0.23933	0.166985	0.23933	2.1
1976	1.637757	2.247286	0.951325	0.201904	0.205105	0.201904	2.1
1977	3.222728	11.53108	0.943992	0.193048	0.207121	0.193048	2.2
1978	1.606619	2.927038	1.030084	0.219424	0.236736	0.219424	2.2
1979	0.388696	9.180755	0.989966	0.220816	0.252036	0.220816	2.2
1980	8.543183	12.3614	0.941458	0.233571	0.244049	0.233571	2.3
1981	4.713007	10.30322	0.929289	0.21382	0.248321	0.21382	2.4
1982	1.071637	13.09056	0.892232	0.215183	0.26652	0.215183	2.4
1983	8.398454	5.954139	0.888853	0.205745	0.261749	0.205745	2.5
1984	6.641216	4.520544	0.903441	0.23472	0.275336	0.23472	2.5
1985	4.653647	14.38372	0.922653	0.229876	0.280589	0.229876	2.6
1986	2.095744	12.57259	0.903805	0.222144	0.279698	0.222144	2.6
1987	6.743969	10.40939	0.933137	0.242248	0.288451	0.242248	2.6
1988	5.240105	7.682021	0.817868	0.242083	0.314807	0.242083	2.7
1989	4.80228	9.402895	0.978041	0.241049	0.323906	0.241049	2.7
1990	6.466052	9.472726	0.952836	0.26797	0.330104	0.26797	2.7
1991	4.878041	19.05481	0.918316	0.31451	0.314675	0.31451	2.8
1992	3.353207	8.318882	0.909249	0.346234	0.357579	0.346234	3.1

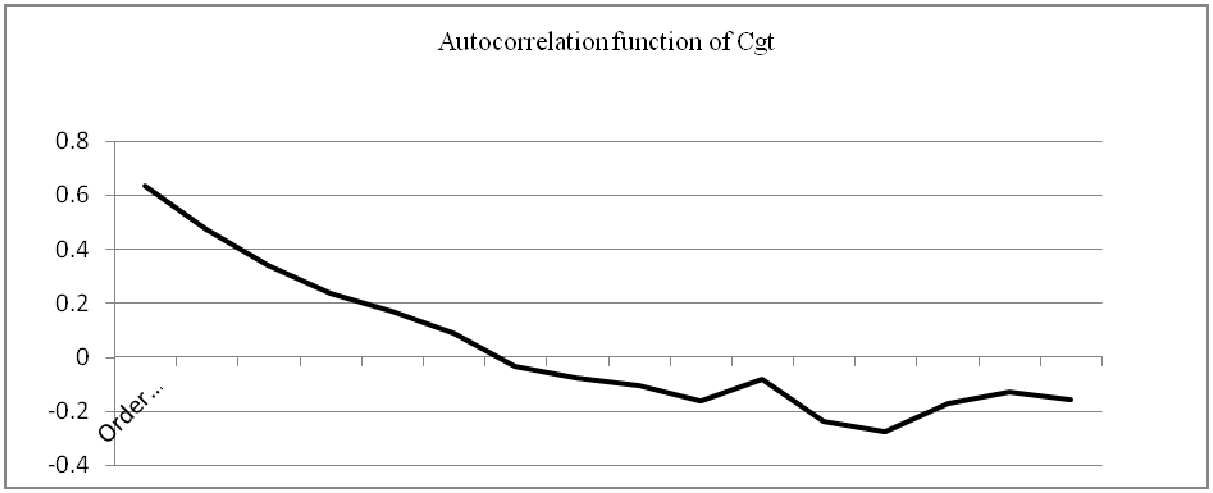
1993	7.544734	8.701138	0.886263	0.369324	0.363658	0.369324	2.9
1994	3.060019	7.250972	0.877745	0.382288	0.380718	0.382288	2.9
1995	5.514353	7.989728	0.880956	0.387462	0.380548	0.387462	2.9
1996	4.94683	7.721956	0.873338	3	0.375317	0.420438	2.7
1997	3.247937	7.917244	0.839509	5	0.409266	0.377075	2.6
1998	4.53716	10.87875	0.825165	0.341751	0.423855	0.341751	2.5
1999	5.886383	3.291936	0.814644	0.400672	0.471007	0.400672	2.3
2000	1.913418	2.431342	0.945033	0.415169	0.519634	0.415169	2.2
2001	0.196353	2.86624	0.977219	0.36268	0.526366	0.36268	2
2002	3.689064	4.562616	0.973925	0.377121	0.532113	0.377121	1.8
2003	4.470801	3.913042	0.942551	0.378441	0.551799	0.378441	1.7
2004	3.359751	4.415728	0.9597	0.383252	0.553101	0.383252	1.5
2005	4.094681	7.688104	0.97416	0.382928	0.568502	0.382928	1.3
2006	3.0329	5.732507	0.983917	0.380867	0.519896	0.380867	1.3
2007	5.716189	6.489257	0.975809	0.373097	0.524767	0.373097	1.3
2008	3.723054	11.83728	1.016402	0.399918	0.562546	0.399918	1.3
2009	4.081324	9.158685	1.050658	0.432882	0.627222	0.432882	1.3
2010	3.794407	9.112771	1.028217	0.402633	0.629154	0.402633	1.4
2011	4.091534	9.250814	1.04019	0.410042	0.603118	0.410042	1.6

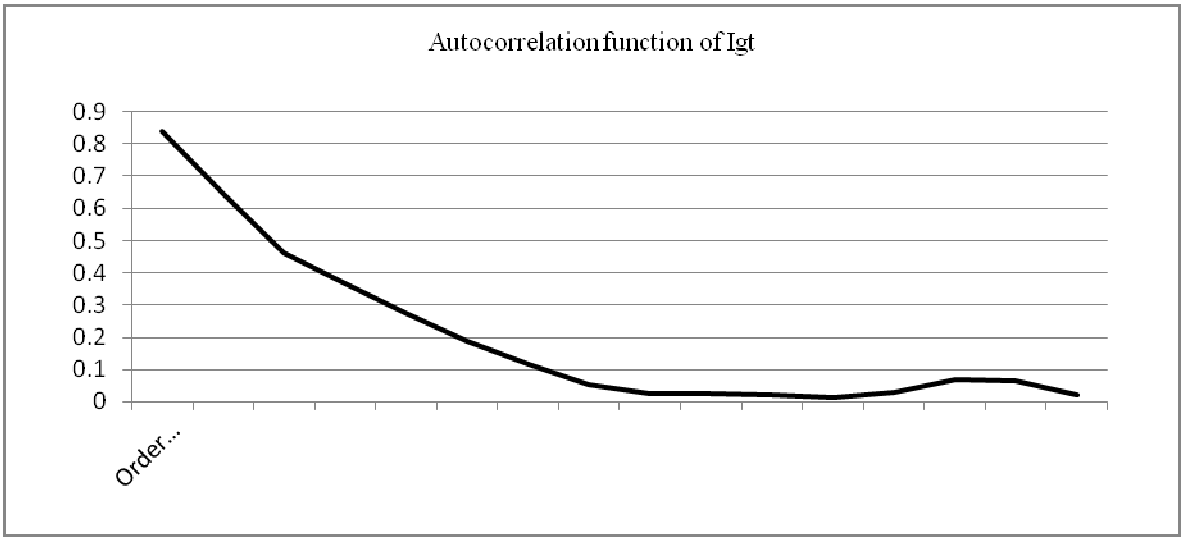
Source: US CBS, International Database (population growth rate)

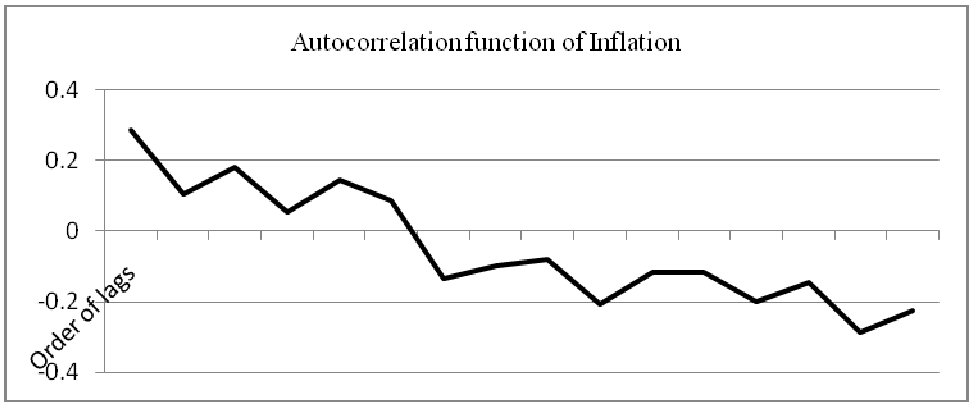
APPENDIX C

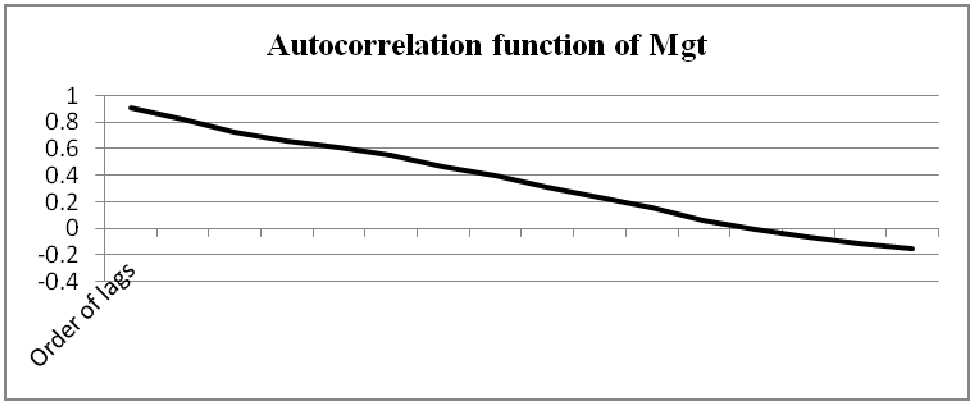
PLOT OF AUTOCORRELATION FUNCTION OF VARIABLES

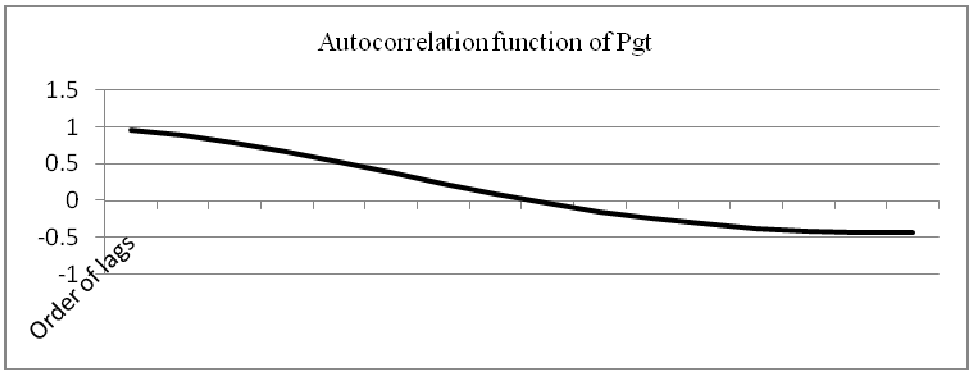


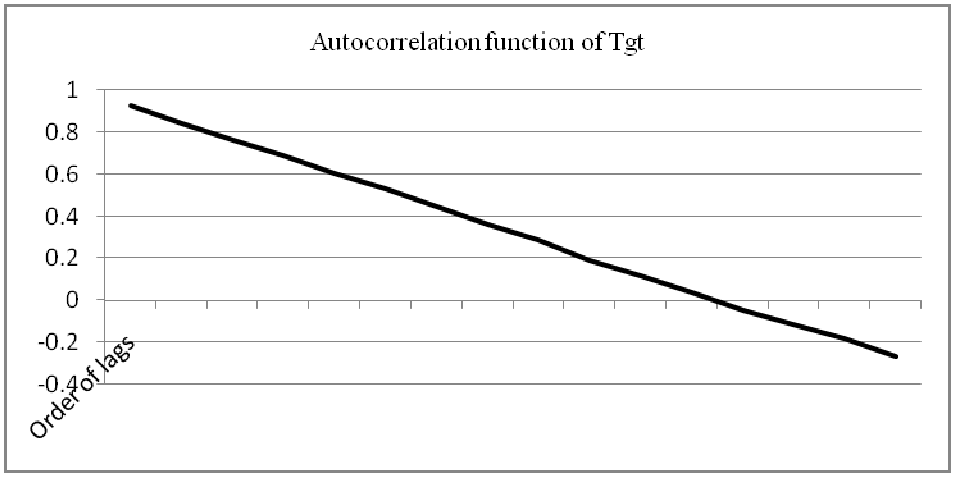





Autocorrelation function of Inflation
0.4
0.2
0
-0.2
-0.4
Order of lags


Autocorrelation function of Mgt
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
Order of lags


Autocorrelation function of Pgt
1.5
1
0.5
0
-0.5
-1
Order of lags


Autocorrelation function of Tgt
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
Order of lags

APPINDEX D

Correlation Coefficients of Explanatory Variable

		Cgt	Igt	Mgt	Tgt	Pgt
	1.0000	-0.1398	0.0328	-0.1448	-0.1756	0.2564
Cgt	-0.1398	1.0000	0.4544	0.3029	0.0808	-0.6785
Igt	0.0328	0.4544	1.0000	0.8113	0.7134	-0.6288
Mgt	-0.1448	0.3029	0.8113	1.0000	0.8793	-0.665
Tgt	-0.1756	0.0808	0.7134	0.8793	1.0000	-0.3873
Pgt	0.2564	-0.6785	-0.6288	-0.665	-0.3873	1.0000