ADDIS ABABA UNIVERSITY

SCHOOLS OF GRADUATE STUDIES

INFLATION AND ECONOMIC GROWTH: AN ESTIMATING OF TRESHOLD LEVEL OF INFLATION IN ETHIOPIA

BY

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June, 2014

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A project submitted to the school of Graduate Studies of Addis Ababa University in partial fulfillment of the requirement for the Degree of Masters of Arts in Applied Economic Modeling and forecasting (Financial policy Analysis and Planning)

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Acknowledgement

First and foremost, I am grateful to the almighty God who gave me potential inside of me and strength me in all my endeavors.

I would like to forward the deepest my appreciation and gratitude to my advisor Adane Tuffa (Phd) for his patience and constructive advice. I credit every piece of strength of this study to my advisor and any weakness to myself.

I would also thanks to my wife for her moral support. She always stands beside me. I would like to thank my entire class mate for their providing useful information.

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Acronyms

ADF – Augmented Dickey Fuller

AIK- Akaike Information Criteria

CPI – Consumer Price Index

GDP- Gross Domestic Product

I(1)- Integrated Order One

MoFED- Ministry of Finance and Economic Development

NBE- National Bank of Ethiopia

OLS- Ordinary Least Square

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Abstract

One of the prime objectives of macroeconomic policy both in developed and developing countries are to achieve economic stability and obtain sustainable economic growth simultaneously with price stability. This study, therefore, seeks to estimate the optimal level of inflation using quarterly time-series data for the period 1991 – 2013, which is conducive for economic growth in Ethiopia by following the Khan and Senhadji (2001) methodology.

Based on the approach adopted, it is found some evidence that inflation has a threshold effect on economic growth. Estimated threshold model indicate that there is non-linear relationship between economic growth and inflation in the Ethiopian economy and the threshold level of inflation for GDP growth is **10 percent**.

As an inflation targeting country, this is a crucial finding as it provides a baseline study in search of the optimal level of inflation for growth. These findings are essential for monetary policy formulation by the National Bank of Ethiopia, whose primary objective is the achievement and maintenance of price stability, as it provides a guide for the Bank to choose an optimal inflation rate, which is consistent with long-term sustainable economic growth goals of the country.

CHAPTER ONE

1. Introduction

1.1 Background

One of the prime objectives of macroeconomic policy both in developed and developing countries are to achieve economic stability and obtain sustainable economic growth simultaneously with price stability. Accordingly, the principal objective of the monetary policy of the National Bank of Ethiopia is to maintain low price and support sustainable economic growth. Price stability is a proxy for macroeconomic stability which is vital in private sector economic decision on investment, consumption, international trade and saving. It is therefore widely believed that price stability promotes long-term economic growth, whereas high inflation is inimical to growth.

Price stability is taken and acknowledged as a major goal of monetary policy and its support has been growing worldwide mainly because high inflation is known to have many adverse effects: it imposes welfare costs on the society; hinder efficient resource allocation; discourages savings and investment by creating uncertainty about future prices and its mainly hits the poor excessively. Inflation may also cause the balance of payment problems by eroding a country's international competitiveness by making its exports relatively more expensive, and reduces long-term economic growth. (Ghosh and Phillips, 1998; Khan and Senhadji, 2001). Overall, businesses and households are thought to perform poorly in periods of high and unpredictable inflation. (Barro ,1996).

Though it is generally considered that inflation has undesirable consequences, most policymakers agree that they should not allow inflation to fall below zero because zero level of inflation or disinflation negatively impacts economic growth due to decreasing motivations of producers, (Billi and Khan,2008). Consequently, policymakers should aim at a moderate rate of inflation that maximizes general economic well-being. But how low should inflation be? Should the target inflation be 10 per cent or 5 per cent? This requires empirical study to determine at what level impedes economic growth.

During the past decade inflation in Ethiopia has been very high compared to many countries, both developed and developing. Though Ethiopia government has been targeted at working to at reduceing inflation to a single digits, it is required an empirical answer to the question regarding the threshold level above which inflation is considered harmful. An answer to this question will contribute a lot in guiding policy makers in choosing appropriate inflation target to improve macroeconomic management of the Ethiopian economy.

1.2 Statement of the problem

A considerable amount of literature examining the relationship between inflation and economic growth in both developed and developing economies are available. Several of those studies focused specifically on whether the relationship between inflation and long-run growth is negative or positive. However, Fischer (1993) who first identified the relationship between the two variables concluded that the relationship becomes a nonlinear

one: positive or nonexistent relationship at low rate of inflation but turn into negative at higher rates. If such a nonlinear relationship exists, then it should be possible, in principle, to estimate the turning point, or a threshold, at which the sign of the relationship between the two variables would switch. Consequently, Khan and Senhadji (2001) produced the threshold level for both developed and developing countries in a cross-country panel data framework. The authors arrived at a threshold level range of 11 - 12 percent for developing countries.

A lot of particular individual developing country studies have revealed a quite difference result across the country. Moreover, the divergence of results was quite wide in case of empirical studies which concentrated on estimation of threshold rate of inflation for individual countries. For example, Singh (2003) found no threshold level for India whereas Mubarik (2005) found a threshold rate of inflation as high as 9% for Pakistan. Furthermore, Frimpong and Eric Fosu (2010) tried to estimate the threshold effect of inflation for the period of 1960-2008 using threshold regression models. They found threshold level of inflation of 11% at which inflation starts to hurt economic growth in Ghana.

Bawa and Abdullahi (2010**)** utilized a quarterly time series data for the period 1981 – 2009 to estimate a threshold level of inflation for Nigeria. The study estimated a threshold inflation level of 13 per cent for Nigeria, using a threshold regression model developed by Khan and Senhadji (2001). Below this rate, inflation has a positive effect on economic activities, while above it, the magnitude of the negative effect of inflation on growth was high.

Emerta (2010) has estimated the optimal level of inflation in Ethiopia around which inflation affect economic growth optimally by adopting threshold approach on the annual data from 1971 -2010. He found that inflation level of about 8-10 percent is optimal for Ethiopia and conclude that any inflation level above and below this level may be a detrimental to long term and sustainable economic growth.

Some of the explanatory factors for significant variations in the results of the above studies may include data problems, methodological issues and estimation problems, etc. A number of studies followed linear approaches while others used non-linear techniques for the estimation of threshold rate of inflation for countries. Similarly, Khan and Senhadji (2001) used non-linear approach and found severe differences in threshold level of inflation between developing and industrialized countries.

This study, therefore, seeks to estimate the optimal level of inflation, which is conducive for economic growth in Ethiopia by following the Khan and Senhadji (2001) methodology. The study goes beyond the works of Emerta (2013) by extending the analysis to the estimation of the threshold effect of inflation on growth in Ethiopia, using quarterly time-series data for the period 1991 – 2013.

1.3 Objectives of the study

The consensus that moderate inflation helps economic growth, led to interesting policy issue of how much of inflation is too much; that is, how much inflation impedes economic growth?

This paper examines the nature of the relationship between inflation and growth, focusing specifically on the following questions:

• Is there a statistically significant threshold level of inflation above which inflation affects growth differently than at lower inflation rates? So far, the main aim of this paper is attempts to estimate the optimal level of inflation for Ethiopia based on quarterly data of the current Ethiopian Government period to avoid the structural break.

1.4 Significance of the Study

The results of this study may have importance for policy implementation regarding nature of the relationship between inflation and economic growth and therefore to keep inflation at that level which is not harmful for sustainable economic growth. Thus, these finding is essential for monetary policy formulation as it provides a guide for the policy makers to choose an optimal target for inflation, which is consistent with long-term sustainable economic growth goals of the country.

Moreover, the study may fill the gap in this area, i.e. investigation of the nexus between economic growth and inflation in Ethiopia economy.

1.5 Organization of the Paper

The rest of the paper is organized as follows. Section two reviews both theoretical and empirical literatures about the relationship between inflation and economic growth in general and papers on inflation and economic growth in Ethiopia in particular are included. An essay on the history overview of inflation and economic growth in Ethiopia is briefed in chapter three. The model that is going to be used and its estimation mechanism is included in chapter four. Part five contains discussions of the results and finally in part six conclusions and recommendations based on the findings are included.

CHAPTER TWO

2. Literature Review

2.1 Theoretical Framework

Economic theories reach a variety of conclusions about the responsiveness of output growth to inflation. Theories are useful, as they account for some observed phenomenon. The following sub-sections will discuss Classical, Keynesian, Monetarist, Neo-classical and Endogenous growth theories, each with their respective contribution to the inflation-growth relationship.

2.1.1 Classical Growth Theory

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

Y = *f* (L, K, T)

Where Y is output, L is labour, K is capital and T is Land, so output was related to labour, capital and land inputs. Consequently, output growth (gy) was driven by population growth (gL), investment (gK) and land growth (gT) and increases in overall productivity (g*f*). Therefore: gy = _ (g*f* , gK ,gL, gT)

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

saw income distribution as being one of the most important determinants of how fast (or slow) a nation would grow. He also posited that profits decline – not because of decreasing marginal productivity, but rather because the competition of capitalists for workers will bid wages up.

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

2.1.2 Keynesian Theory

The Traditional Keynesian model comprises of the Aggregate Demand (*AD*) and Aggregate Supply (*AS*) curves, which appropriately illustrates the inflation – growth relationship. According to this model, in the short run, the (*AS*) curve is upward sloping rather than vertical, which is its critical feature. If the *AS* curve is vertical, changes on the demand side of the economy affect only prices. However, if it is upward sloping, changes in *AD* affect prices and output, (Todaro, 2000). This holds with the fact that many factors drive the inflation rate and the level of output in the short-run. These include changes in: expectations; labour force; prices of other factors of production, fiscal and/or monetary policy.

According to this concept, producers feel that only the prices of their products have increased while the other producers are operating at the same price level. However in reality, overall prices have risen. Thus, the producer continues to produce more and output continues to rise. It is also believe that the positive relationship can be due to agreements by

some firms to supply goods at a later date at an agreed price. Therefore, even if the prices of goods in the economy have increased, output would not decline, as the producer has to fulfill the demand of the consumer with whom the agreement was made.

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

2.1.3 Monetarism

Monetarism has several essential features, with its focus on the long-run supply-side properties of the economy as opposed to short-run dynamics. Milton Friedman, who coined the term "Monetarism", emphasized several key long-run properties of the economy, including the Quantity Theory of Money and the Neutrality of Money. The Quantity Theory of Money linked inflation and economic growth by simply equating the total amount of spending in the economy to the total amount of money in existence. Friedman proposed that inflation was the product of an increase in the supply or velocity of money at a rate greater than the rate of growth in the economy.

Friedman also challenged the concept of the Phillips Curve. His argument was based on the premise of an economy where the cost of everything doubles. Individuals have to pay twice as much for goods and services, but they don't mind, because their wages are also twice as large. Individuals anticipate the rate of future inflation and incorporate its effects into their behavior. As such, employment and output is not affected. Economists call this concept the

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

In summary, Monetarism suggests that in the long-run, prices are mainly affected by the growth rate in money, while having no real effect on growth. If the growth in the money supply is higher than the economic growth rate, inflation will result.

2.1.4 Neo-classical Theory

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

Mundell (1963) was one of the first to articulate a mechanism relating inflation and output growth separate from the excess demand for commodities. According to Mundell's model, an increase in inflation or inflation expectations immediately reduces people's wealth. This

works on the premise that the rate of return on individual's real money balances falls. To accumulate the desired wealth, people save more by switching to assets, increasing their price, thus driving down the real interest rate. Greater savings means greater capital accumulation and thus faster output growth.

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

Stockman (1981) developed a model in which an increase in the inflation rate results in a lower steady state level of output and people's welfare declines. In Stockman's model, money is a compliment to capital, accounting for a negative relationship between the steady-state level of output and the inflation rate. Stockman's insight is prompted by the fact that firms put up some cash in financing their investment projects. Sometimes the cash is directly part of the financing package, whereas other times, banks require compensating balances. Stockman models this cash investment as a cash-in-advance restriction on both consumption and capital purchases. Since inflation erodes the purchasing power of money balances, people reduce their purchases of both cash goods and capital when the inflation rate rises. Correspondingly, the steady-state level of output falls in response to an increase in the inflation rate.

The *Stockman Effect* can also operate through the effects on the labour-leisure decision. Greenwood and Huffman (1987) develop the basic labour-leisure mechanism, and Cooley and Hansen (1989) identify the implication for capital accumulation. In Greenwood and Huffman's research, people hold money to purchase consumption goods and derive utility both from consumption and leisure. Fiat money is used because there is a cash-in-advance constraint on consumption goods. Greenwood and Huffman show that the return to labour falls when the inflation rate rises. As such, people substitute away from consumption to leisure, because the return on labour falls.

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

This theoretical review demonstrates that models in the neoclassical framework can yield very different results with regard to inflation and growth. An increase in inflation can result in higher output (Tobin Effect) or lower output (Stockman Effect).

2.1.5 Endogenous Growth Theory

Endogenous growth theories describe economic growth which is generated by factors within the production process, for example; economies of scale, increasing returns or induced technological change; as opposed to outside (exogenous) factors such as the increases in population. In endogenous growth theory, the growth rate has depended on

one variable: the rate of return on capital. Variables, like inflation, that decrease that rate of return, which in turn reduces capital accumulation and decreases the growth rate. Other models of endogenous growth explain growth further with human capital. The implication is that growth depends on the rate of return to human capital, as well as physical capital. The inflation acts as a tax and hence reduces the return on all capital and the growth rate.

2.2 Empirical Literature

This section examines related empirical studies on the relationship between inflation and economic growth with particular interest on data used, methodology adopted, nature of the relationship and the estimated inflation thresholds. Most studies on the threshold effect of inflation on economic growth are dominated by cross-country panel studies (Sarel, 1996; Khan and Senhadji, 2001; Mallik and Chowdhury, 2001; and Kremer *et al*., 2009). On the other hand, due to the peculiarity of certain economies, especially developing economies, specific country studies might reveal specific evidences fundamental to the country under study. This is what instigated the study. In this regard, we identified some country specific studies, especially on developing countries, on the inflation-economic growth nexus, which include Ahmed and Mortaza (2005) for Bangladesh; Hussain (2005) and Mubarik (2005) for Pakistan; Singh (2003) for India; Hodge (2005) for South Africa.

Sarel (1996) examined the non-linear effects of inflation on economic growth using annual panel data on GDP, CPI, population, terms of trade, real exchange rate, investment rates and government expenditures of 87 countries from 1970-1990. The 20 year sample period was divided into four equal periods of five years each, obtaining a total of 248 observations

for the study. He found a significant structural break (inflation threshold) in the function that relates economic growth to inflation. The threshold was estimated at 8 per cent, below which inflation did not have any effect on economic growth or it may have a slight positive effect. When it rose above the 8 per cent threshold, however, the estimated effect of inflation was significant, robust and extremely powerful. He demonstrated that when the existence of the structural break is ignored, the estimated effect of inflation on economic growth for higher inflation rates decreased by a factor of three.

Khan and Senhadji (2001) re-examined the issue of the existence of threshold effects in the relationship between inflation and economic growth using a new econometric technique that allows for appropriate estimation procedures and inference. They utilized an unbalanced panel dataset covering the period 1960-1998 from 140 countries, comprising industrialized and developing countries. They estimated inflation threshold levels of 1-3 per cent and 11-12 per cent for industrialized and developing countries, respectively. The empirical results suggested that beyond threshold levels of 3 and 12 per cent for industrialized and developing countries, respectively, the relationship between inflation and economic growth became negative. The authors noted that the peculiarities of industrialized economies remained different from those of the developing economies. However, they did not acknowledge the peculiarities existing among developing countries in terms of resources base, population size, level of corruption, poverty level, etc.

Mallik and Chowdhury (2001) studied the relationship between inflation and GDP growth for four Asian countries, namely, Bangladesh, India, Pakistan and Sri Lanka. The study used un-even sample size of 1974-97 for Bangladesh, 1961-97 for India, 1957-97 for Pakistan

and 1966-97 for Sri Lanka. The variables used for the study were CPI and real GDP to measure inflation rates and economic growth, respectively. They 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 did not estimate what the moderate inflation rate (threshold level) that will help economic growth in the four countries should be.

A study by Kremer *et al*. (2009) using panel data from 63 countries (comprising industrial and non-industrial countries) confirmed the effect of inflation on long-term economic growth. Their findings revealed that inflation affected growth when it exceeded 2 per cent threshold for industrial countries and 12 per cent for non-industrial countries, and that below these levels the relationship between inflation and economic growth was significantly positive. However, they 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. The authors' recommendation is valid because it is indeed an important policy issue for economies adopting or planning to adopt inflation targeting approach to monetary management to study the relevant threshold level to serve as a guide.

In Bangladesh, Ahmed and Mortaza (2005) found a statistically significant long-run negative relationship between inflation and economic growth using annual data on real

GDP and CPI covering the period 1980 to 2005. The study utilized co-integration and error correction models. They estimated an inflation threshold level of 6 per cent (structural-break point) above which inflation will adversely affect economic growth. They concluded that their findings have direct relevance to the conduct of monetary policy by the Bangladesh Bank.

Hussain (2005) and Mubarik (2005) examined inflation and growth in Pakistan using annual time series data for the periods 1973-2005 and 1973-2000, respectively; and estimated the threshold levels of inflation to be 4-6 per cent and 9 per cent, respectively, beyond which inflation will deter economic growth. Similarly, Singh (2003) suggested an inflation threshold range of between 4-7% for India. It is noted that both Pakistan and India are both developing countries but the findings of the authors differ significantly from the findings of Khan and Senhadji (2001) and Kremer *et al.* (2009) for developing countries. This might be partly because of difference in methodology adopted or data set used. This reiterate the validity of Kremer *et al.* (2009) recommendation that conduct of country specific study due to peculiarities of economies would reveal more useful information.

Hodge (2005) 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 (2005), 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 (2005) would have estimated a threshold at which authorities needed to take measures to ensure inflation does not hamper economic growth.

Fabayo and Ajilore (2006) in their paper titled "inflation – How Much is too Much for Economic Growth in Nigeria" using annual data from 1970-2003 suggested the existence of threshold inflation level of 6 per cent for Nigeria. They explained that above this threshold, inflation retards growth performance of the economy while below it, the inflation-growth relationship is significantly positive. They suggested that the goal of macroeconomic management in Nigeria should be to bring down inflation to a moderate single digit of 6 per cent (optimal inflation target policy).

Also, Chimobi (2010) used Nigerian data on CPI and GDP for the period 1970-2005 to examine the existence or not, of a relationship between inflation and economic growth and its causality. He adopted the Johansen-Juselius co-integration technique and Engle-Granger causality test. A stationarity test was carried out using Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests and stationarity was found at both 1 and 5 per cent level of significance. After testing for causality at two different lag periods (lag 2 and lag 4), he found the result suggesting unidirectional causality running from inflation to economic growth. Thus, the study maintained that the unidirectional causality found is an indication that inflation indeed impacts on economic growth. However, this study did not estimate or suggest any threshold level at which the impact could be positive or negative, significant or not, in the long run or short run. Thus, a study that attempt to estimate the inflation

threshold level would have added to the debate especially that most economies are turning towards adopting inflation.

Frimpong and Oteng-Abayie (2010) attempted to find out whether inflation is harmful or not; and if it is at what level does it become harmful to economic growth in Ghana. They adopted a threshold regression model designed to estimate the inflation thresholds instead of imposing them, using annual data on CPI and GDP covering 1960-2008. They found evidence of threshold effect of inflation on economic growth, which was estimated at 11 per cent. Below this level, inflation is likely to have mild effect on economic growth, while above it inflation would significantly hurt economic growth. They concluded that the current medium term inflation target of 6-9 per cent annual average set by the Bank of Ghana and the Government is in the right direction as it is below the estimated 11 per cent threshold.

To summarize the findings of the above studies it can be safely noted that there is relationship between inflation and economic growth, which is often non-linear in nature. Under a certain level of inflation, the relationship is positive and beyond that level of inflation, the relationship is negative. Simple implication of this kind of relationship between inflation and economic growth is that modest increase in the rate of inflation would not be harmful for the long-run real economic growth for the economies with initially low rates of inflation. But for economies with initially high rates of inflation, further increase in the inflation rate would have adverse effects on real economic growth.

CHAPTER THREE

3. Descriptive Analysis

3. 1 Historical Overview of Inflation and Economic Growth in Ethiopia

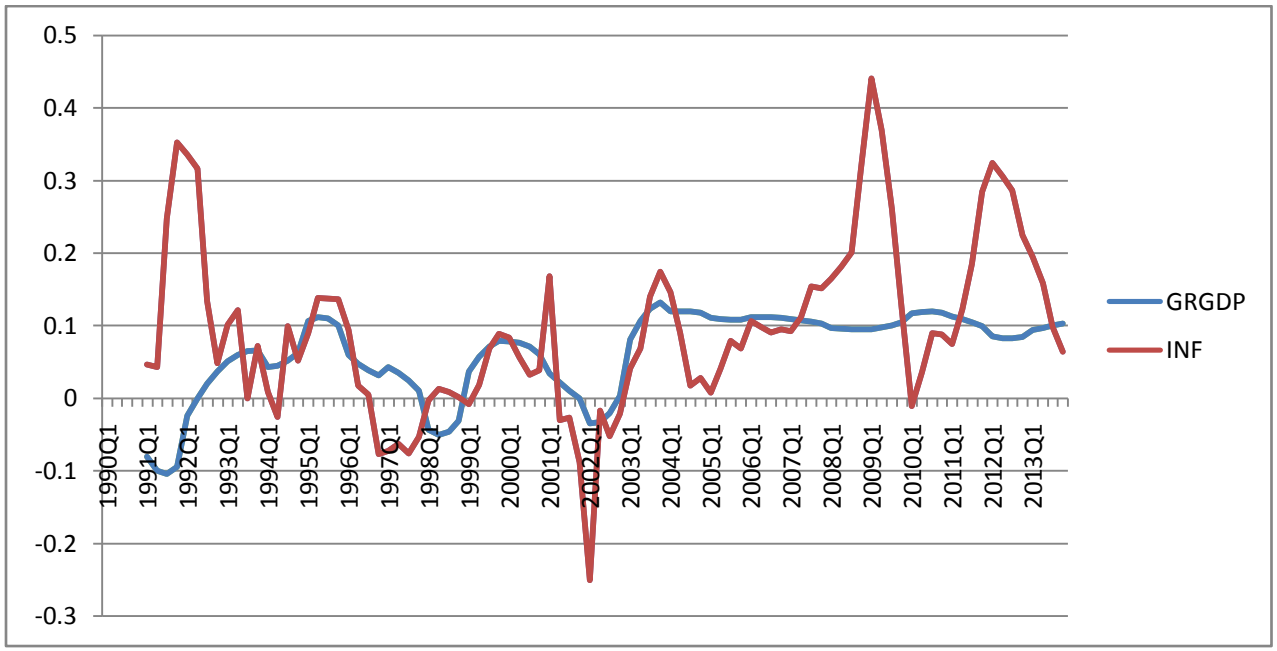
Historical inflation data indicated that the country has experienced two major episodes of high inflation in excess of 30 per cent since 1991. The first event occurred from the last quarter 1991 till the second quarter of 1992; it recorded 35.21, 33.50 and 31.60 in 1991Q4 till 1992Q2 respectively. The sharp increase in inflation rate within the mentioned period was attributed to the transition of the government and the poor agricultural performance. The other episodes have occurred in the last decade since 2002. Inflation rate has continuously risen up ward while the growth performance has been stable. This event was credited to excess money supply and high devaluation of a birr in recent period.

However inflation rate has been decreasing since the second quarter of 2012 and reaches the 6 percent inflation rate, which is a single digit as per planned in Growth and transformation plan (GTP). This mainly because of the tight policy has been taken by the government.

As shown in the graph below, inflation and output growth has moved in opposite direction in the first six quarters and then after 1992 second quarter till the last quarter of 2002 they tend to move together with a closer relationship. However in recent period the inflation accelerates with stable economic growth performance. It has been raised a concern by many that the current growth performance cannot be sustained in the face of high inflation. It can be noted from the graph below that the relationship between inflation and economic growth

is difficult to deicide. So far, to understand the long run relationship between inflation and economic growth in Ethiopia, the paper attempt forward using granger causality and threshold analysis introduced by khan and senhadji (2001

Figure 3.1 Growth and inflation relationship in Ethiopia (1991 Q1 till 2013 Q4)



The basic statistics on real GDP growth and inflation rate was examined. The table below shows that the relationship between average inflation and average economic growth within the given range.

Table 3.1 Average inflation and Average growth relationship

Inflation Range	Average INF	Average growth
<0	-5.5	1.53
0-3	1.12	4.28
3.01-5	3.75	8.81
5.01-10	7.96	9.92
>10.01	19.76	7.34

The recorded data shows that when the rates of inflation are negative the corresponding average economic growth is near zero around 1.5 percent, which is not good enough for the country like Ethiopia. This indicates that deflation is not desirable for economic growth. It is also seen that from the table that when inflation rates in between of zero to three the average growth is slightly increased to 4.28 percent. Similarly when inflation rates stuck between three and five and in between of five to 10 the related average economic growth are increased 8.81 and 9.92 percent respectively. Among the considered range inflation the high economic growth was recorded when the inflation rates are in between of five to ten percent, which shows that the desirable range for economic growth. Up to the range inflation rate become ten percent, Average inflation and average economic growth has a positive relationship.

However, when inflation rates goes above 10 the average economic growth is become 7.34 that is less than the average economic growth obtained in range five to ten percent inflation rates . The relation between the two variables is also become negative. Thus the above bivariate relationship between average inflation and average GDP growth indicates some sort of non-linearity with a structural break or turning point when the relationship between inflation and GDP growth switched.

Figure 3.2 Average Inflation and Economic Growth relationship

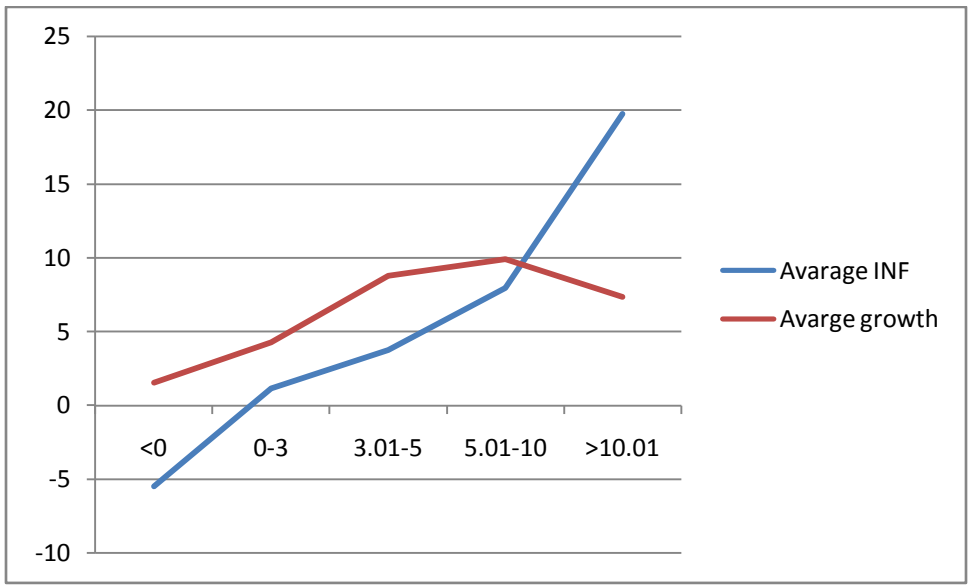


Figure 3.2 shows that Average output growth average inflation have a positive relationship up to 10 percent inflation rates, and beyond that level there is negative relationship. This suggest that the threshold level roughly around 10 percent, which the rate beyond that may affect economic growth.

Moreover, when inflation rates go down to zero and become negatives the corresponding average economic growth is turning out to be low, which is not desirable for economic growth. Due to this reason it would be important to computes the optimal lowest inflation rate, but the study is limited in the sense that it does not estimate the lower level inflation favorable for economic growth.

CHAPTER FOUR

3 Model Specification and Data Analysis

3.1 The Model

The threshold regression model was developed by Khan and Senhadji (2001) for the analysis of threshold level of inflation for both industrial and developing countries. The model was also applied by Mubarik (2005) and Hussain (2005) in computing the threshold inflation rate for Pakistan, and Frimpong and Oteng- Abayie (2010) for Ghana.

This study applies the model to estimate the threshold level of inflation above which inflation may affect economic growth in Ethiopia.

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

$Grow_t = B_0 + B_1 Inf + B_2 D_t (Inf - K^*) + B_3 GGCA + u_t$ .....Equation 1

Where economic growth and inflation are computed as:

Growth = ΔLN (RGDP) , Inflation =ΔLN (CPI) and

Growth of Gross Capital formation= ΔLN (GGCA)

RGDP - real gross domestic product

GGCA- Growth of Gross Capital formation

CPI -consumer price index

K^*- Threshold level of Inflation U_t- random error term

The quarterly growth rates of RGDP and inflation used in the analysis were computed by taking the first difference of the current and the corresponding quarter values of RGDP and CPI i.e. current quarter value of the current year less the corresponding quarter value of the previous year. This is mathematically presented as Yt–Yt-4 where Yt is the current quarter and Yt-4 is the corresponding quarter value. The growth rate of gross domestic investment (INV), considered to be an important determinant of economic growth, was the only variable included as a control variable in the main threshold regression model.

The dummy variable D_t is defined as:

$$D_t = 1: 100*DlogPt > k$$
$$0: 100*DlogPt \leq k$$

D_t is a dummy variable that takes a value of 1 for inflation levels greater than K^* percent and 0 otherwise.The parameter K^* represents the threshold inflation level with the property that the relationship between output growth and inflation is given by: (i) β1 representing low inflation; (ii) β1 + β2 representing high inflation. The high inflation means that when β2 is significant, then both (β1 + β2) would be added to see their impact on economic growth and that would be the threshold level of inflation.

If the threshold were known a priori, the model could be estimated by ordinary least square (OLS) Since K^* is unknown, it has to be estimated along with the other regression parameters. The appropriate estimation method in this case is nonlinear least square. Instead, estimation has to be carried out with method called conditional least square which can describe as follows. While the value of K^* is given arbitrarily for the estimation, the optimal K^* is obtained by finding that value that minimizes the residual sum of squares

(RSS). Thus, the optimal threshold level is that which minimizes the sequence of residual sum of square (RSS).

3.2 DATA SPECIFICATION

The study has sought to target optimal inflation rate for economic growth. Since the different regime has followed varies economic approaches. So far, this paper has focused on the current Ethiopian government regime period. To do so, the annual time series data is not long enough to carry out robust and sensible econometric analysis. For this matter, this paper uses the quarterly time-series data for the period 1991 to 2013, but the data for most of the variables listed above is on annual basis. Only inflation is available on quarterly basis. As a consequence, in order to have a longer time-series data, Eviews software was used in order to carry out a cubic interpolation of the quarterly time-series. However, the methodological technicalities and underpinnings behind the interpolation technique adopted are beyond the scope of this paper.

After the interpolation procedure, the data covering 1993 QI to 2013 QIV was used and this yielded 94 observations. The variables were further transformed into logarithm form due to the following advantages as suggested by Sarel (1996) and, Ghosh and Phillips (1998): The log transformation provides the best fit. That is to say, the log transformation also, to some extent, smoothes time trend in the dataset. The log transformation can be justified by the fact that its implications are more plausible than those of a linear model.

Data on Ethiopian macroeconomic variables differs between sources. The data from national sources such as MoFED and NBE are different from those from IMF and World Bank. For data consistency attempts have been made to rely on national sources. Accordingly, GDP and Gross Capital accumulation data acquired from MoFED while the quarterly Consumer price index from NBE.

3.3 DATA ANALYSIS

The classical time series regression model is based on the assumption that the data generating processes are stationary, i.e., the moments of the variables under consideration are time invariant. However, as the economy grows and evolves over time, most macroeconomic variables are likely to grow over time rendering them non-stationary (Granger and Newbold, 1974). Regression using non-stationary variables will only reflect a relationship that is not real, and accordingly such regression is termed as "spurious regression". In this case, as the sample size Increases, the coefficient variance doesn't tend to be constant and the consistency property of OLS estimators breaks down. The sampling distribution of the estimators will be non-standard and the usual statistics (*t* and *F*) based on normal become invalid (Maddala, 1992). Nelson and Plosser (1982) distinguish between two types of stationary series: trend stationary processes (TSP) and difference stationary processes (DSP). These two distinctions derive from the two widely used techniques of converting non stationary series into stationary series: de-trending and differencing. Though both techniques may lead to stationary series, caution is needed in choosing between the two as de-trending a DSP series or differencing a TSP series may lead to spurious autocorrelation (Nelson and Kang, 1984). Nelson and Plosser (1982) indicate that in most economic time series DSP is more appropriate and the TSP should be applied only if we assume the residuals exhibit strong autocorrelation.

For testing the stationary/non-stationary (i.e., to test for the existence of unit roots) of the variables used in this study Dickey-Fuller (DF)/Augmented Dickey- Fuller (ADF) and Phillips Perron (PP) tests are used. ADF test is biased towards accepting the null hypothesis of unit root in the series if the series exhibits significant structural break (Badawi, 2007; Kim, 1990 cited in Maddala, 1992). In the presence of structural breaks, the Phillips-Perron test (Phillips and Perron, 1988) gives more robust estimates. Before estimating the model; Granger-Causality test is applied to measure the linear causation between inflation and economic growth.

CHAPTER FIVE

5. Estimation and Interpretation of Result

5.1 Unit Root Test

One of the major problems encountered in studying economic relationships is the likelihood of spurious regression (seemingly related variables). To deal with this problem it is crucial to study the long run relationship of the variables. This is often done by checking if the variables are co integrated. The first step in co integration analysis is studying the order of integration of the variables under consideration. The order of integration of the variables in this study is determined using unit root tests.

An important exercise in time series analysis is the test of whether the macro economic variables in the modeling exercise are stationary or not. Augmented dickey fuller test for unit root is conducted on the variables to be included in inflation threshold estimation model. The result of ADF is shown below in table 5.1

Table 5.1 Unit Root Test

Variables	Test Equation				Order of Integration
	Test Statics Intercept	Critical Value at 5% significance level	Test Statistics Trend and Intercept	Critical Value at 5% significance level	
D(GRGDP)	-4.120658	-2.895512	-4.098524	-3.462912	I(1)
D(INF)	-6.835822	-2.896779	-6.860782	-3.464865	I(1)
D(GGCA)	-4.368862	-2.897223	-4.362667	-3.465548	I(1)

The unit root tests conducted revealed all variables have unit root in their level, thus have to be differenced to achieve stationary. Unit root tests revealed that all variables used in this study are I (1), which all variable are stationary at difference. Thus, the determination of co integrating relationships doesn't suffer from mixed order of integration.

5.2 Causality Test

Before estimating the optimal level of inflation which is desirable for long run economic growth in Ethiopia, Granger causality test has been taken to determine the causation between inflation and economic growth. The log differenced of CPI and output growth to compute inflation and growth for reasons discussed previously. The existence of Granger Causality between inflation and growth also implies that there is a long-run relationship between the two variables, and hence the variables are co integrated. See table 4.2.

Table 5.2 depict the results of Granger causality between Inflation and Growth

Sample: 1990Q1 2013Q4
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
INF does not Granger Cause GRGDP	86	2.75978	0.0179
GRGDP does not Granger Cause INF		1.45882	0.2044

Test statistics in table 5.2 show that the null hypothesis inflation does not granger cause output growth is rejected at 5% significance level. However, the null hypothesis output growth does not granger cause inflation unable to reject with given period at 5% significance level. This proves that there is no feedback from output growth to inflation. This result also helps in choice of dependent and independent variable for threshold model specification.

5.3 Linear Regression

Simple linear regression is estimated on the long run relationship between output growth and inflation before inflation threshold estimation. In the Granger- Causality test depicted in table 4.2, inflation rate was found to be Granger-Causing economic growth at a lag of Six (lag = 6) for the given period of 1991 QI to 2013 QIV; therefore inflation is kept at lag six in the estimate.

Table 5.3 Shows OLS estimation of Inflation and Economic Growth: without Threshold

Dependent
Variable: GRGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.058241	0.006900	8.440257	0.0000
INF(-6)	0.048972	0.045504	1.076202	0.2850
GGCA	0.081010	0.043565	1.859516	0.0665

The result revealed in the above table indicates that inflation has a positive effect on long run growth. This is different from theory has proposed the relationship between the two is

negative and most recent studies also confirmed. However, this positive result of long run relationship between inflation and economic growth in Ethiopia is consistent with some similar studies. For example, Arai et al (2002) found a positive and significant relationship between average inflation and average growth for OECD countries. One a basic reasoning behind it is when inflation is high; wealth could be allocated away from money and into physical assets which are related to investment.

Similar to Ethiopian economy, positive long run relationship between inflation and economic growth was obtained by Seleteng (nd) on the case of Lesotho. He reasoned out for economies with initially low rates of inflation, modest increase in the rate of inflation don't affect long run rates of real economic growth. This explanation may work for the Ethiopian case as well since it is low level of average inflation for the period covered.

Although high inflation rate was observed to stimulate economic growth in some countries, many studies advise that the inflation rate should be kept as low as possible since high inflation is inherently unstable due to inflation inertia.

5.4 Estimation of the Threshold Inflation Level

The study hypothesis that high inflation in Ethiopia has an adverse effect on economic growth after it exceeds a certain limit. Khan and Senhadji (2001) estimated the threshold level of inflation above which inflation significantly slows growth at 11 per cent for developing countries. The estimation of equation (1) gives a specific value of the threshold inflation level and also measure the impact of that level on economic growth. The equation

was estimated and residual sum of square and the adjusted coefficient of determination (R2) from 5 percent to 15 percent threshold level of inflation was computed. The optimal threshold level is the one minimize residual sum of square (RSS) or that maximizes the adjusted coefficient of determination (R2). In Granger Causality analysis, inflation is causing growth at lag six (lag = 6) for the given period of 1991 Q 1-2013 Q4; therefore, inflation is kept at lag six in the estimate.

Table 5.4 OLS Estimation on the threshold level of inflation K*=10

Dependent Variable GRGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.050176	0.007024	7.143431	0.0000
INF(-6)	0.131037	0.050318	2.604200	0.0109
DT*(INF(-6)-0.10)	-0.269845	0.084862	-3.179826	0.0021
GGCA	0.078726	0.041360	1.903422	0.0605
Adjusted R^2	.156			
Sum of Squared residual	0.148048			

Table 4.4 shows that the OLS estimation of the model on optimal inflation rate. An estimation result for different level of inflation is provided in Annex 1. For inflation level below the threshold, the significance and size of high coefficient of high inflation is increasing as we approach the threshold level. However, above the threshold level, as inflation increases, there is a general trend of declining significance and magnitude of the inflation coefficient.

Figure 5.1 value of threshold k versus Residual sum of Square

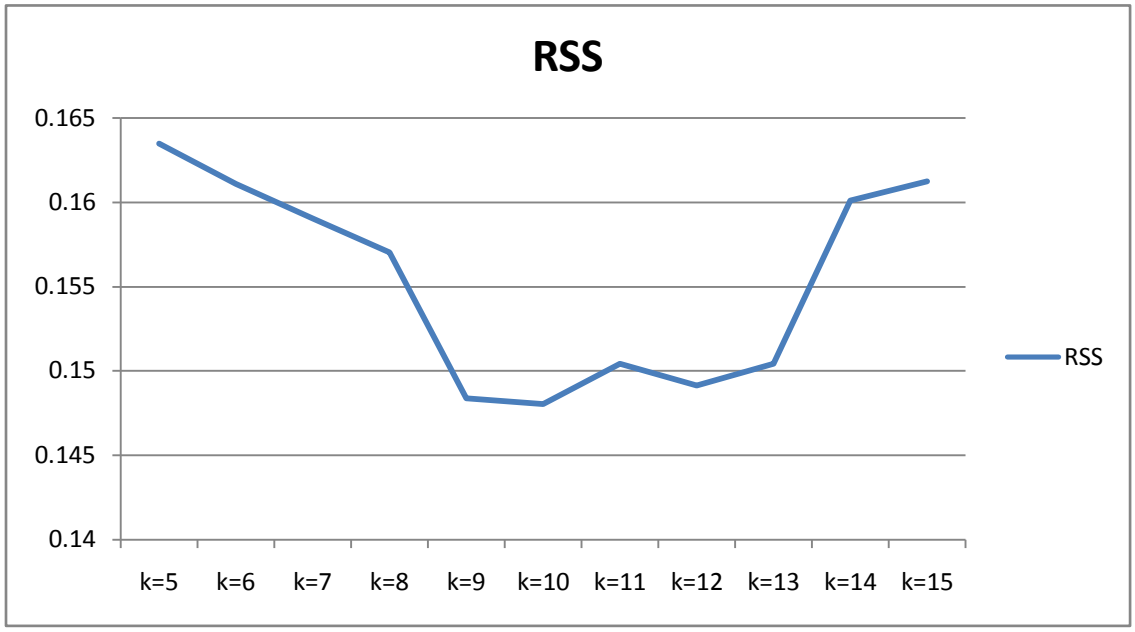


Figure 5.1 demonstrate the level of inflation, which is conducive for economic growth, and this found to be 10 percent and this is line with finding khan and Senhadaji (2001)

CHAPTER SIX

6. Conclusion and Recommendation

6.1 Conclusion

Governments and central banks worldwide want to achieve price stability for several reasons, with the most compelling being the potential for long-term growth. The objective of this study is to determine the threshold level of inflation for economic growth. In doing so, this study uses various tables and graphs. Causality analysis test was done to set up the dependent and independent variables. Finally the threshold regression model developed by khan and sendahji (2001) was estimated by OLS quarterly time series data covering the sample period 1991Q1 to 2013 Q4.

Historical data as depicted in several tables and graphs show that the average economic growth reaches its peak when inflation rates in between 5-10 in and turn down when inflation rates goes above 10 percent. Besides, the estimate of granger causality test defines causality direction from inflation to economic growth but not vice versa. Granger Causality test so far confirms that the causality runs from inflation to growth allowing a regression analysis to see the threshold effect of inflation on economic growth.

Based on the approach adopted, it is found some evidence that inflation has a threshold effect on economic growth. Estimated threshold model indicate that there is non-linear

relationship between economic growth and inflation in the Ethiopian economy and the threshold level of inflation for GDP growth is **10 percent**.

6.2 Recommendation

As an inflation targeting country, this is a crucial finding as it provides a baseline study in search of the optimal level of inflation for growth. These findings are essential for monetary policy formulation by the National Bank of Ethiopia, whose primary objective is the achievement and maintenance of price stability, as it provides a guide for the Bank to choose an optimal inflation rate, which is consistent with long-term sustainable economic growth goals of the country. However, this study does not estimate that level of inflation that is too low for economic growth; indeed, this calls for further research

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Annex 1.

K	Varibale	Coeficient	Std.Error	*t-stastics*	*Propabilty*	RSS	R2
	C	0.055239	0.007331	7.535331	0		
	INF(-6)	0.130322	0.082049	1.588341	0.1161		
	DT*(INF(-6)-0.05)	-0.10697	0.089876	-1.190197	0.2374		
k=5	GGCA	0.074023	0.043851	1.68806	0.0952	0.16348	0.10066
	C	0.053441	0.00744	7.183328	0		
	INF(-6)	0.160092	0.081685	1.95986	0.0534		
	DT*(INF(-6)-0.06)	-0.14765	0.090536	-1.630868	0.1068		
K=6	GGCA	0.070047	0.043656	1.604514	0.1124	0.161079	0.113866
	C	0.052738	0.007362	7.163127	0		
	INF(-6)	0.157923	0.071989	2.1937	0.0311		
	DT*(INF(-6)-0.07)	-0.164319	0.085021	-1.932692	0.0567		
K=7	GGCA	0.0727	0.043079	1.687594	0.0953	0.159059	0.124982
	C	0.052106	0.007299	7.138562	0		
	INF(-6)	0.15823	0.066661	2.373647	0.02		
	DT*(INF(-6)-0.08)	-0.181417	0.082434	-2.200752	0.0306		
k=8	GGCA	0.063447	0.043331	1.464243	0.147	0.157029	0.136147
	C	0.050955	0.006955	7.326519	0		
	INF(-6)	0.152246	0.054296	2.804013	0.0063		
	DT*(INF(-6)-0.09)	-0.257702	0.081922	-3.145697	0.0023		
k=9	GGCA	0.062407	0.041823	1.492175	0.1395	0.148396	0.183638
	C	0.050176	0.007024	7.143431	0		
	INF(-6)	0.131037	0.050318	2.6042	0.0109		
	DT*(INF(-6)-0.10)	-0.269845	0.084862	-3.179826	0.0021		
k=10	GGCA	0.078726	0.04136	1.903422	0.0605	0.148048	0.185552
	C	0.050843	0.007066	7.195159	0		
	INF(-6)	0.124883	0.050622	2.466963	0.0157		
	DT*(INF(-6)-0.11)	-0.25551	0.086903	-2.940182	0.0043		
k=11	GGCA	0.069023	0.041886	1.647875	0.1032	0.150444	0.172374
	C	0.050211	0.007075	7.097233	0		
	INF(-6)	0.128117	0.050429	2.540535	0.013		
	DT*(INF(-6)-0.12)	-0.261494	0.085111	-3.072384	0.0029		
k=12	GGCA	0.065305	0.041819	1.561605	0.1222	0.149136	0.179568
k=13	C	0.050994	0.007047	7.235979	0	0.150426	0.172472

K	Varibale	Coeficient	Std.Error	*t-stastics*	*Propabilty*	RSS	R2
	INF(-6)	0.124013	0.050461	2.457572	0.0161		
	DT*(INF(-6)-0.13)	-0.267286	0.090851	-2.942013	0.0042		
	GGCA	0.046347	0.043318	1.069931	0.2878		
	C	0.055739	0.006955	8.014419	0		
	INF(-6)	0.077313	0.047651	1.622471	0.1085		
	DT*(INF(-6)-0.14)	-0.228117	0.128006	-1.782084	0.0784		
k=14	GGCA	0.060855	0.044467	1.368542	0.1749	0.160103	0.119235
	C	0.055634	0.007026	7.918645	0		
	INF(-6)	0.06607	0.046316	1.426511	0.1575		
	DT*(INF(-6)-0.15)	-0.216657	0.134846	-1.606691	0.112		
k=15	GGCA	0.071505	0.043559	1.641569	0.1045	0.161228	0.113046

Declaration

I, the undersigned, declare that this project paper is my original work and has not been presented for a degree in any other university, and that all sources of material used for the project paper have been duly acknowledged.

Declared by:

Name _____

Signature_____

Date_____

Confirmed by advisor:

Name_____

Signature_____

Date_____