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AN ECONOMETRIC ANALYSIS OF THE IMPACT OF INFLATION ON ECONOMIC GROWTH IN GHANA (1965-2007)

BY

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CHAPTER ONE

INTRODUCTION

1.0. The Background

Inflation – which measures the persistent increase in prices of goods and services – in Ghana has been a major economic phenomenon of great concern to all players of the economy since the nation's exit from West African Currency Board (WACB) in 1957. Hitherto, the situation was calm as far as inflation developments in Ghana were concerned because of the existence of the currency board. Ghana experienced its first inflation episode shortly after the exit of the country from WACB and lasted until 1966 when Kwame Nkrumah was overthrown.

The WACB which was established in 1912 issued its first notes and coins in 1946. These notes and coins remained legal tender in the four British colonies of West Africa (Ghana, Nigeria, Sierra-Leone, and The Gambia) until Ghana opted out in 1957. As a result market forces determined money supply in Ghana and the other three West African countries. Consequently, the main means by which Ghanaian government financed its spending were by taxing or borrowing and not by printing money which usually fueled inflation. However, after Ghana bowed out of the currency board, the economic historical records show that all efforts by successive governments to tame inflation at lower rates appear to have been elusive.

Inflation rates were in single digits during the currency board years. Indeed, inflation rates were typically estimated at less than 1 per cent during the currency board years (Sowa, 1994). However, inflation rates more than quadrupled few years after exiting from the currency board. The Nkrumah administration, in its bid to transform the Ghanaian economy into the rank of the first world economies in the shortest possible time, embarked upon a massive industrialization drive (that is, import-substitution industrialization).

This together with a broad and far-reaching social welfare benefits such as provision of highly subsidized social services in education, health, and housing necessitated the adoption of expansionary fiscal and monetary policies. This was made possible because the structure offered by the erstwhile West African Currency Board which prevented excess supply of money floating in the system was no longer in place. The combined effect of the expansionary fiscal and monetary policies led to an average of 8% inflation rate between 1960 and 1963. This figure more than doubled to 23% per annum between 1964 and 1966 (Ocran, 2003).

The military government, National Liberation Council (1966-1969), which overthrew Nkrumah administration in 1966 and the civilian government, Progress Party (1969-1971) led by Dr Busia, which succeeded it arranged with and entered into IMF/World Bank sponsored Structural Adjustment Programme. The various economic policies which were mostly

characterized by tight fiscal and monetary policies implemented during this era were able to contain inflation. This was possible mainly as a result of a combination of domestic output growth and improved import supplies under a cocoa boom and liberalized external trade. The inflation rates were 6.5%, 3%, and 8.8% in 1969, 1970, and 1971 respectively.

The National Redemption Council led by General Acheampong overthrew the Busia administration in January 1972 and it was during the reign of Acheampong that economic policy direction was reversed, putting the country through many economic woes. The rates of inflation were always in double digits. The period saw the most expansionary phase of economic management in the country's history. Inflation hit a high point of 116.5% in 1977. The in-house coup that brought General Akufo to power used extensive price controls as a tool for controlling inflation leading to a drop in the relatively high rates of inflation to 73.7% in 1978. However, as a result of the price control policy there was economic stagnation and severe shortages of goods with upward pressure on prices, smuggling, parallel market activities in goods and foreign currencies and corruption (Ocran, 2004).

In 1979, Rawlings toppled over the Akufo administration and after general election in three months time handed over power to Liman-led administration of People's National Convention. The Liman

administration embarked on expansionary economic policies. Notable among them are the increase in public sector wages in three-fold whilst the producer price of cocoa was also doubled. The inconsistencies in policies brought Rawlings, in a second military coup, back into power in December 1981. In sum, the inflationary experience in most of the period between 1972 and 1982 was largely due to expansionary fiscal and loose monetary policies. The bad economic policies coupled with external shocks such as the drought with its ensuing widespread bush-fires and the influx of over one million Ghanaian illegal immigrants in Nigeria culminated into an unprecedented inflation rate of approximately123% in 1983.

In an attempt to arrest the run-away rate of inflation, among other objectives, the PNDC government launched the Economic Recovery Programme (ERP) in 1983 and the Structural Adjustment Programme (SAP) in 1986. Over the entire period of the reforms, 1983-2000, the inflation rate averaged 34% per annum. Even though there were occasions when inflation was brought down (to as low as 10% in 1985 and 1992), these could not be sustained. The inflation rates recorded during the reform period were consistently above the targets indicating an unsuccessful management of inflation.

When the Kuffour administration assumed office in 2001, one of the objectives of its economic policies was to bring down inflation which was

hovering around 25.2% in 2000. In the year 2002, the country had a brief relief when the inflation rate dipped to 14.5%. But the relief was short-lived because in 2003 the rate climbed up to 26.7%. In 2004, the inflation rate dropped by over 50% to 13%. Thinking that we were out of the wilderness, in 2005, the inflation rate rose to 15.1% before settling at 10.9% in 2006 and further marginally dipped to 10.7% in 2007 (Daily Graphic, 21.12.07).

1.1. The Statement of the Problem/Research Questions

Like many countries, industrialized and developing, one of the most fundamental objectives of macroeconomic policies in Ghana is to sustain high economic growth together with low inflation. However, existing theoretical and empirical studies give diverse perceptions regarding the direction of impact of inflation on economic growth. Many economists consider price stability as beneficial to resource allocation and the efficiency of the economy. The implication is that inflation imposes negative externalities on the economy by interfering with the economy's efficiency (Ocran, 2003).

Inflation can lead to uncertainty about the future profitability of investment projects (especially when high inflation is associated with increased price variability). This leads to more conservative investment strategies than would otherwise be the case, ultimately leading to lower levels of investment and economic growth. Inflation may also reduce a

country's international competitiveness, by making its exports relatively more expensive, thus impacting on the balance of payment. Moreover, inflation can interact with the tax system to distort borrowing and lending decisions, raise the cost of capital, so discouraging investment and hence growth (Feldstein, 1982). These theories point to the negative effects of inflation on economic growth.

Empirically, Barro *et al* (1991), using data for around 100 countries from 1960 to 1990 to assess the effects of inflation on economic performance, explains that on the average an increase in inflation by 10 percentage per year would cause a reduction of the growth rate of real GDP per capita by 0.2-0.3 percentage points per year and a decrease in the ratio of investment to GDP by 0.4-0.6 percentage points. Obviously, this empirical study confirms the negative correlation between inflation and economic growth.

The Keynesian theoretical literature, however, tends to support the opposite conclusion. For instance, the standard Phillips curve postulates that higher inflation is correlated with reduced levels of unemployment and thus higher levels of economic activity. According to this view, changes to the rate of inflation should impact positively on growth.

This assertion is collaborated by neo-classical economic theory, led by Mundell (1965) and Tobin (1965), which argues that an increase in

inflation or inflation expectations 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.

It is in the light of this seemingly waging debate as to the direction of the effect of inflation on economic growth that the study seeks to ascertain using evidence from Ghana for over 40 years. The study will also attempt to investigate whether there is an existence of a threshold level of inflation above which inflation significantly reduces growth. Alternatively, the research study seeks to answer the following two questions:

- What impact does inflation have on the economic growth of Ghana?
- What is the threshold level of inflation for Ghana?

1.2. Objectives of the Study

The main objective of this study is to provide an analysis of Ghana's inflation for the period 1965-2007 and its effects on economic growth. The study has the following other objectives:

- To assess the impact of inflation on economic growth in Ghana
- To estimate the threshold level of inflation rate beyond which inflation can be harmful to economic growth in Ghana

- To analyze and discuss the empirical results of the study to draw policy implications for macroeconomic management

1.3. The Hypotheses of the Study

The study intends to test the following main hypotheses:

- H_1: Inflation rate negatively affects economic growth in Ghana
- H_2: Domestic investment growth impacts positively on economic growth in Ghana
- H_3: Inflation rate beyond 11% is harmful to economic growth in Ghana

1.4. Significance of the Study

The analysis of the impact of inflation on economic growth in Ghana will improve policy design and macroeconomic management of the nation's economy.

The study will also add to the existing literature and provide current analysis of the impact of inflation on economic growth in Ghana. The limited studies done by Sowa (1994) and Ocran (2003) did not focus on estimating the threshold effect of inflation on economic growth. This study intends to fill that vacuum.

The study would also be a good source of information to both the private sector and the public sector (particularly the Economic Management Team) that use inflation as an important input in their decisions.

The study would also provide additional information on inflation in an attempt to fight high and unstable inflation and pave way for economic growth.

1.5. Research Methods

The study intends to review all relevant theoretical and empirical literatures to provide the basis on which a suitable economic model could be specified for practical analysis of the study. In the interim, the model specification would take economic growth rate (represented by real GDP growth rate) as the dependent variable and inflation rate (represented by the growth rate of CPI) as one of the explanatory variables. Other variables being considered to be included in the model are Gross Domestic Investment growth rate, growth rate in labour force, gross domestic savings growth rate, real deposit rate, real wage rate, government expenditure growth, money supply (M2), and terms of trade.

The study will make use of secondary data extracted from official publication sources including Ghana Statistical Service (GSS), Bank of Ghana, Institute of Statistical, Social, and Economic Research (ISSER,

Legon), International Monetary Fund (IMF), World Bank, and International Statistical Yearbooks.

Due to non-stationarity of most of the aforementioned time series variables that would be used, the study intends to use cointegration method in its data analysis.

The regression of the model will be run using Eview 5.0 version, Gretl, and Microfit 4.0 statistical software. The results obtained from the regression are then analyzed to ascertain their implications and how they actually affect the economic growth of Ghana.

1.6. The Organization of the Study

The research study is organized as follows. The chapter 1 presents the introduction of the study which provides the overview of the entire study. Chapter 2 reviews theoretical literature and some empirical evidence on the relationship between inflation and economic growth as well as the inflation threshold. The chapter 3 presents some stylized facts and graphical representation of the relationship between inflation and economic growth in Ghana. The chapter 4 describes the data and presents the methodology to be used to analyze the data. Chapter 5 performs some estimation and applies some econometric techniques to uncover the direction and nature of the inflation-growth relationship and to attempt to find the threshold level of inflation. Finally, the chapter 6

offers some concluding remarks, provides a summary of the study, and also proposes future research on the topic.

1.7. Limitations of the Study

The major limitations encountered, during the data collection and writing of this study, are time constraints, inadequate funds, and non-availability of some data. However, measures were taken to minimize the impact of these limitations on the results of this study.

CHAPTER TWO

THEORETICAL AND EMPIRICAL LITERATURE REVIEW

2.0. Introduction

This chapter reviews the theoretical and empirical literature on the impact of inflation on economic growth. First, the basic concepts of inflation and economic growth are explained. In addition, the theoretical and empirical literature review on inflation-economic growth relationship is carried out. Further, the chapter examines the nonlinearity of the inflation-growth relationship (or the threshold level of inflation) at both the theoretical and empirical fronts.

2.1. Basic Concepts of Economic Growth and Inflation

Inflation refers to sustained increase in the general price level. In other words, inflation is a rise in the general prices of goods and services in an economy over a period of time. Inflation can also be described as a decline in the real value of money – a loss of purchasing power in the medium of exchange which is also a monetary unit of account.

The term 'inflation' is usually used to refer to a measured rise in a broad price index that represents the overall level of prices in goods and services in the economy. The Consumer Price Index, Producer Price Index, and GDP deflator are examples of broad price indices which can

be used to calculate inflation rate in an economy. Inflation is measured by calculating the inflation rate of the broad price index, usually the Consumer Price Index (CPI). The CPI measures prices of a selection of goods and services purchased by a 'typical consumer'. The inflation rate is the percentage rate of change of the price of a 'consumer basket' of the typical consumer. The inflation rate can be measured on a monthly, quarterly, or yearly basis.

The CPI, which is used to calculate various inflations in Ghana, is collated by Ghana Statistical Service (GSS). The consumer basket in Ghana comprises of 242 items (including food, beverage, clothing, furniture, health, education, transport, hair-cut, etc) collected from 40 marketing centres throughout the country every month. The base year for the index is 2002, which the GSS shifted from 1997 to allow the GSS to update the various weights of consumption basket from the 1992 ones and also to reflect the current world trends of measurement (www.statsghana.gov.gh).

Inflation rate is termed as 'creeping' when the annual rate is 6% or less. When the rate of increase is between 15% and 30% from year to year, it is termed as 'trotting' inflation. Both types of inflation can be distinguished from 'galloping' or 'hyper' inflation, which exists when prices are rising at an annual rate of 50%, 100%, or even more (Brooman, 1993).

The threshold level of inflation is an inflection point or the level of inflation beyond which inflation adversely affects real economic activity. Recently, a general consensus has evolved among economists that low and stable inflation promotes growth whilst high and unstable inflation impacts negatively on economic growth. This suggests that there exists a critical point of inflation beyond which inflation starts to adversely affect economic growth. In other words, the economy experiences structural break when the economy's rate of inflation reaches its critical point. This critical point of inflation is known as the threshold level of inflation.

Economic growth is usually defined as the growth rate of real Gross Domestic Product (GDP). Economic growth is the increase in the amount of goods and services produced by an economy over time. It is conventionally measured as the percentage rate of increase in real GDP. Growth is usually calculated in real terms, that is, inflation-adjusted terms, in order to net out the effect of inflation on the price of goods and services produced.

GDP per capita is the gross domestic product divided by midyear population. GDP is the sum of gross value added of products by all resident producers in the economy minus any product taxes plus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of assets or for depletion and degradation of natural resources.

2.2. Theoretical Evidence of Growth-Inflation Relationship

Economic theories reach a variety of conclusions about the impact of inflation on economic (output) growth. The following sub-sections will discuss the major economic theories including Classical, Neo-Classical, Keynesian, Neo-Keynesian, Monetarist, Endogenous growth theories, and other theories such as those propounded by the structuralists. The theories are discussed with their respective contribution to the inflation-growth relationship.

2.2.1. Classical Theory

Classical theorists laid the foundation for a number of growth theories. The foundation for classical growth model was laid by Adam Smith who postulated a supply side driven model of growth. Like other classical economists, Adam Smith held the view that total output (Y) depended on the size of the labour force (L), the supply of land (N), the stock of capital (K), the proportions in which these factors of production are combined and the level of technology (T). The classical production function can therefore be expressed as:

$$Y = f(L, N, K, T) \qquad (2.1)$$

He also posited that profit levels decline – not as a result of decreasing marginal productivity, but rather as a result of the competition among capitalists for workers will bid wages up.

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

2.2.2. Neo-Classical Theory

Solow (1956) and Swan (1956) pioneered one of the earliest neoclassical models. The model exhibited diminishing returns to labour and capital separately and constant returns to both jointly. Technological change replaced growth of capital (investment) 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 first neoclassical economists to enunciate a mechanism relating inflation and growth. According to Mundell's model, an increase in inflation or inflation expectations immediately reduces people's wealth. This works on the premise the rate of return on

individual's real money balances falls. To accumulate the desired wealth, people save more by switching to assets, increasing the price of assets, thus driving down the real interest rate. Greater savings means greater capital accumulation and thus faster output growth. In effect, inflation exhibits a positive correlation to economic growth.

Another neoclassical economist, Tobin (1965), developed the Mundell's model further by following Solow (1956) and Swan (1956) in making money a store of value in the economy. Individuals in the model substitute current consumption for future consumption by either holding money or acquiring capital. Individuals maintain precautionary balances in spite of capital offering a higher rate of return. Individuals thus hold two financial portfolios.

In times of increases in the rate of inflation, the return to money falls. According to Tobin's portfolio mechanism, the inflation will cause individuals to substitute out of money and into interest earning assets, which leads to greater capital intensity and promotes economic growth. In effect, inflation-growth relationship is positive.

Sidrauski (1967), another neoclassical economist, explaining the role of money in neoclassical economy proposed the next major development. With his work which assumes that money in the long-run is 'superneutral', Sidrauski suggests that an increase in inflation rate does not affect the steady state capital stock. As such, neither output nor

economic growth is affected by an increase in inflation rate in the long-run.

Stockman (1981) developed a model in which an increase in inflation rate results in a lower steady state level of output and welfare of people. In stockman's model, money is a complement to capital. Stockman's model works on the premise that firms put up some cash in financing their investment projects. Since inflation erodes the purchasing power of money balances, firms reduce their capital purchases when the inflation rate rises. As a result, the steady-state level of output falls in response to an increase in the inflation rate.

This theoretical review demonstrates that models in the neoclassical framework can yield a variety of results with regard to inflation-growth relationship. An increase in inflation can result in higher output (Tobin-Mundell Effect) or lower output (Stockman Effect) or no change in output (Sidrauski Effect) {Tobin 1965; Mundell 1963; Stockman 1981; Sidrauski 1967}.

2.2.3. Keynesian Theory

The traditional Keynesian model comprises of the Aggregate Demand (AD) and Aggregate Supply (AS) curves, which fittingly illustrates the inflation-growth relationship. The key feature of the Keynesian model is that in the short-run, the AS curve is upward sloping rather than

vertical. If 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 both prices and output (Dornbusch *et al.*, 1996). This holds with the fact that many factors drive inflation rate and level of output in the short-run. These include changes in: expectations, labour force, prices of other factors of production, and fiscal or monetary policy.

In moving from the short-run to the hypothetical long-run, the above-mentioned factors, and its 'shock' on the steady-state of the economy are assumed to balance out. However, the dynamic adjustment of the short-run AD and AS curves into the long-run yields an adjustment path which exhibits an initial positive relationship between inflation and growth. The model works on the premise that when prices increase, producers feel that only the prices of their products have increased while the other producers are operating at the same price level. Thus, the producer continues to produce more and output continues to rise. However, in reality, overall prices have risen.

Blanchard and Kiyotaki (1987) also believe that the positive relationship can be due to agreements by some firms to supply goods at an agreed-upon later date at an agreed price. Therefore, even if the prices of the 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.

Thus, under the Keynesian theoretical model, there is a short-run positive relationship between output and inflation. For inflation to be held steady at any level, output must equal the natural rate. This positive inflation-output relationship is collaborated by the standard Phillips curve which postulates that higher inflation is correlated with reduced levels of unemployment and higher levels of economic activity. According to this view, changes to the rate of inflation should impact positively on growth (Phillips, 1958).

2.2.4. Neo-Keynesian Theory

The Neo-Keynesian theory which initially emerged from the ideas of Keynesian theory has its central theme the concept of 'potential output' which is sometimes referred to as natural output or full-employment output. This is the level of output at which the economy's resources are fully employed. This level of output also corresponds to the natural rate of unemployment or what is referred to as non-accelerating inflation rate of unemployment (NAIRU). NAIRU is the unemployment rate at which inflation is neither rising nor falling. In this particular framework, inflation rate is endogenously determined by the normal workings of the economy. According to this theory, inflation is determined by the difference between the level of actual output (GDP) and potential output.

If GDP exceeds its potential level and unemployment is below the natural rate of unemployment, holding all other factors constant, inflation will accelerate as suppliers increase their prices and 'built-in inflation' worsens. On the other hand, if GDP falls below its potential level and unemployment is above the natural rate of unemployment, all else equal, inflation will decelerate as suppliers attempt to fill excess capacity, reducing prices, and undermining built-in inflation leading to disinflation.

However, if GDP is equal to its potential level and the unemployment rate is equal to NAIRU, and then inflation will not change as long as there are no supply shocks. In the long-run, the Neo-Keynesians believe that the Phillips curve is vertical. That is, the unemployment rate is given and equal to the natural rate of unemployment, while there are a large number of possible inflation rates that can prevail at that unemployment rate. In effect, output growth in the long-run is unresponsive to inflation.

2.2.5. Money and Monetarism Theory

Milton Friedman (1968), 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 links inflation and economic growth by simply equating the total amount of spending in the economy to the total amount of money in

existence. According to Friedman, inflation is a product of an increase in the supply or velocity of money at a rate greater than the rate of output growth in the economy.

Monetarism model postulates that when the cost of everything doubles, individuals' purchase of goods and services does not change because their wages are also twice as large. Individuals (economic agents) anticipate the rate of future inflation and incorporate its effects into their behaviour. As such, the level of output and employment is not affected. This is referred to as the neutrality of money concept. 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. 'Superneutrality' holds when real variables – including the rate of growth of GDP – are independent of the rate of growth in money supply in the long-run.

In the nutshell, 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.

2.2.6. Endogenous Growth Theory

Endogenous growth theories describe economic growth as being generated by factors within the production process (such as economies of

scale, increasing returns, or induced technological change) as opposed to exogenous factors as increases in population. In endogenous growth theory, the growth rate has depended on one variable: the rate of return on capital (Gillman, Harris, and Matyas, 2002). Thus, variables, like inflation, that decrease the rate of return on capital in turn reduce capital accumulation and decrease the growth rate. This is an indicative of an inverse inflation-growth relationship.

Endogenous models that explain growth further with human capital develop growth theory by implying that the growth rate also depends on the rate of return to human capital. The rate of return on all forms of capital must be equal in the balanced growth equilibrium. A tax on either form of capital induces a lower return. A tax (in the form inflation) on capital income directly reduces growth rate, while a tax on human capital would cause substitution of labour for leisure that lowers the rate of return on human capital and can also lower growth rate (Greenwood and Huffman, 1987).

2.2.7. The Structuralists' View

Some economists (structuralists) argue that in times of mild inflation wages lag behind the rise in general price level and thus creating higher profit margins for industrialists. According to Tobin (1972), these industrialists who receive profits as income belong to the upper income

brackets whose marginal propensity to save is higher as compared to the workers. As a result, savings go up which ensures higher rate of investment. With greater rate of investment more accumulation of capital is made possible. More rapid capital accumulation generates a higher rate of economic growth (Tobin, 1965).

Moreover, inflation may be growth-promoting as a result of the operation of the so-called 'inflation tax hypothesis'. According to Feldstein (1979), inflation acts as a tax on money holding by the public. This is because inflation continuously erodes the real value of money holding by the public. The higher the money holding, the higher the tax burden would be. Thus, in periods of moderate inflation, people are encouraged to save out of their income in order to avoid the reduction of their real money holding and hence their tax burden. In the process, as Mundell (1965) explains, resources are transferred from the public to the government and the banks. It follows that if the government, the banks, and their borrowers carry out productive investments with the resources transferred, economic growth will be promoted.

As noted by Azariadis and Smith (1996), inflation promotes growth in the way discussed above only if the inflation rates are at sufficiently low levels. However, the safe level of inflation will vary from country to country.

In summary, at the theoretical front, inflation affects economic growth through its effects on the determinants of growth such as human capital, physical capital, or investment in R+D. This channel of influence is referred to as the capital *accumulation or investment effects* of inflation on growth. Above these effects is that inflation worsens the long-run macroeconomic performance of market economies by reducing total factor productivity (TFP). This channel via which inflation affects economic growth is known as the *efficiency channel*.

2.3. Some Empirical Evidence on Growth-Inflation Relationship

In both developed and developing countries contexts, there have been empirical studies that attempt to focus on the relationship between inflation and economic growth. This section presents a review of some of those empirical studies.

Barro (1995) explores the inflation-economic growth relationship using a large cross-country sample covering more than 100 countries including Ghana from 1960 to 1990. His empirical findings indicate the existence of a statistically significant negative relationship between inflation and economic growth if a certain number of the country characteristics (like fertility rate, education, and so on) are held constant. Using different instrumental variables (IV), he obtained a robust estimation result showing that an increase in average inflation by 10 percentage points per

year would slow the growth rate of the real per capita GDP by 0.2-0.3 percentage points per year.

In other words, his empirical analysis suggests that the estimated relationship between inflation and economic growth is negative when some reasonable instruments are considered in the statistical process. He argued that although the adverse influence of inflation on growth appeared small, the long-term effects on standards of living were actually substantial.

Malla (1997) conducts an empirical analysis using a small sample of Asian countries and countries belonging to the Organization for Economic Cooperation and Development (OECD) separately. After controlling for labour and capital inputs, the estimated results suggest that for the OECD countries there exists a statistically significant negative relationship between economic growth and inflation including its first difference. However, the relationship is not statistically significant for the developing countries in Asia.

This crucial finding of the empirical analysis suggests that the cross-country relationship between inflation and long-term economic growth experiences some fundamental problems like adjustment in country sample and the time period. Therefore, inconclusive relationship between inflation and economic growth can be drawn from comparing cross-country time-series regressions with different regions and time periods.

Mallik and Chowdhury (2001) examine the short-run and long-run dynamics of the relationship between inflation and economic growth for four South Asian economies: Bangladesh, India, Pakistan, and Sri Lankan. They applied co-integration and error correction models to the annual data retrieved from the International Monetary Fund (IMF) and International Financial Statistics (IFS). With the assumption that both time series are integrated of the same order, they proceeded to estimate for the following co-integration regression:

$$Y_t = a + bP_t + \mu_t$$

$$p_t = a + bY_t +_t \xi$$

Where Y_t = economic growth rate at time t, P_t = inflation rate at time t, and μ_t and ξ_t are random error terms. Economic growth rates Y_t are calculated from the difference of log of real GDP (at 1990 prices). Likewise, inflation rates (P_t) are calculated from the difference of log of CPI (1990=100) for all the four countries. They find two interesting results.

First, the relationship between inflation and economic growth is positive and statistically significant for all four countries. Second, the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates. The results present important policy

implications, that is, although moderate inflation promotes economic growth, faster economic growth absorbs into inflation by overheating the economy.

Faria and Carneiro (2001) investigate the relationship between inflation and economic growth in the context of Brazil which until recently has been experiencing persistent high inflation. The data used in this paper, consists of the monthly inflation rate and real output for the period January 1980 to July 1995. The authors sourced the data from the Brazilian Institute of Economics and Geography.

Analyzing a bivariate time series model (that is, vector autoregression), they find that although there exists a negative relationship between inflation and economic growth in the short-run, inflation does not affect economic growth in the long-run. Their empirical results support the superneutrality concept of money in the long run. This provides empirical evidence against the view that inflation affects economic growth in the long run.

Ahmed and Mortaza (2005) investigate the impact of inflation on economic growth in the context of Bangadesh using annual data set on real GDP and CPI for the period of 1980-2005. The empirical evidence which is acquired through the co-integration and error correction models demonstrates that there exists a statistically significant long-run negative relationship between inflation and economic growth. Further,

the estimated threshold model suggests 6-percent as threshold level (that is, structural break point) of inflation above which inflation adversely affects economic growth.

2.4 Theoretical Literature Review on Inflation Threshold

The issue of nonlinearity relationship between inflation and growth is not well explained in standard macroeconomic models. However, recent studies provide some interesting insights into this relationship. Recent economic theory on the nonlinearity of the inflation-growth relationship explains how predictable changes in the rate of inflation affect the financial system in a nonlinear way and thus explain the nonlinearity in the relationship between the two variables as explained in the following few paragraphs.

In a typical economy, the fundamental role of the financial system is to channel funds from 'natural lenders' (that is, people who have funds available to invest, but lack projects) to 'natural borrowers' (that is, people who have access to projects that efficiently converts current resources into future capital, but lack available funds), (Azariads and Smith, 1996).

Since higher rates of inflation act like a tax on real balances or bank reserves (Feldstein, 1979), an increase in the rate of inflation drives down the real rate of return not just on money, but on assets in general. In

particular, higher rates of inflation reduce savers' real rates of return and lower the real rates of interest that borrowers pay. This effect makes more people want to be borrowers and fewer people to be savers (Min, 2006).

The financial system will be unwilling to make loans to lower quality borrowers (that is, natural lenders who have become borrowers) and therefore must ration credit via increasing the lending rate, which raises cost of production and thus leads to higher inflation. Since the credit rationing limits the availability of investment capital, the financial system makes fewer loans, resource allocation is less efficient, and financial intermediary activity diminishes. Consequently, long-term economic growth declines as the rate of inflation increases (Boyd, Choi and Smith, 1997).

However, if the rate of inflation is sufficiently low, and if real rates of return on savings are sufficiently high, credit rationing will not be required to induce natural lenders to continue to lend rather than borrow. If this situation exists, then at low enough rates of inflation, the model generates a Mundell-Tobin effect, and the following would occur: an increase in the rate of inflation causes individuals to substitute away from cash into investment in physical and\or human capital. As a result, long-run growth is stimulated. But, once the rate of inflation exceeds a 'threshold' level, further increases in inflation will lead to credit rationing

with its negative impact on economic growth as described in the preceding paragraph.

Thus, a critical rate of inflation exists. Below this rate, modest increases in inflation can stimulate real activity and promote real economic growth. Above this critical rate (threshold level), increases in the rate of inflation interfere with the efficient allocation of investment and capital and consequently have negative growth effects (Azariadis and Smith, 1996).

2.5. Empirical Evidence on Inflation Threshold

Recently, some economists have focused on inflation threshold or the nonlinear view with respect to the inflation-growth relationship not only due to its ability to clearly explain the empirical finding but also for its strong policy implications: keep inflation below the threshold level. Some economists have been trying to estimate the exact threshold level.

Fischer (1983) is among the economists who first identified the possibility of the existence of a threshold level of inflation and notes that though there is a negative correlation between inflation and output growth, at some low levels of inflation there is a positive correlation between the two variables. This proposition stimulated a number of studies of which all focus on finding the *threshold level of inflation* at which the effect of inflation on output growth changes from positive to

negative. Some of those studies are reviewed in the succeeding paragraphs.

Bruno and Easterly (1995) examine the determinants of economic growth using annual CPI inflation of 26 countries which experienced inflation crises during the period between 1961 and 1992. The empirical findings of the study indicate the existence of threshold level of inflation rate of 40 percent. Thus, inflation rate of 40 percent and over is considered as the threshold level for an inflation crisis. They find inconclusive relationship between inflation and economic growth below this threshold level when countries with high inflation crisis are excluded from the sample. In addition, the empirical analysis suggests that there exists a temporal negative relationship between inflation and economic growth beyond this threshold level. The robustness of the empirical results is examined by controlling for other factors such as shocks (examples are political crises, wars, and terms of trade).

They also find that countries that have crossed the threshold into high inflation (and a negative effect on economic growth) experience a surprisingly strong recovery in growth once inflation falls back below the threshold. This suggests that there is no permanent damage to economic growth due to discrete high inflation crises.

Boyd *et al.* (2001) examine five-year average data on bank credit extension to the private sector, the volume of bank liabilities

outstanding, stock market capitalization, and trading volume (all as ratios to GDP), and inflation for a cross-sectional sample over 1960-1995. Boyd *et al.* (2001) finds that, at low-to-moderate rates of inflation, increases in the rate of inflation lead to markedly lower volumes of bank lending to the private sector, lower levels of bank liabilities outstanding, and significantly reduced levels of stock market capitalization and trading volume.

In addition, Boyd *et al.* (2001) finds that the relationship between inflation and financial development is nonlinear. That is, a given percentage-point increase in the rate of inflation has a much larger effect on financial development at low than at high rates of inflation. However, Boyd *et al.* (2001) did not estimate the exact threshold level. They experimented with critical values ranging from a 7.5 percent to 40 percent inflation rate and then chose a 15 percent inflation rate as representative.

Sarel (1995) makes use of data on population, GDP, consumer price indices, terms of trade, real exchange rates, government expenditures, and investment rates. A joint panel database was produced combining continuous annual data from 87 countries, during the period from 1970 to 1990. The empirical findings give evidence of the existence of a structural break that is significant. The break is estimated to occur when the inflation rate is 8 percent. Below that rate, inflation does not have

any effect on growth or it may even have slightly positive effect. However, when the inflation is above 8 percent, inflation effect on growth is estimated to be significantly negative and robust. The results suggest a specific numerical policy target: keep inflation below the 8 percent.

Khan and Senhadji (2001) examine the issue of existence of threshold effects in the relationship between inflation and growth, using econometric techniques originally developed by Chan and Tsay (1998) and Hansen (1999, 2000). They used data set from 140 countries (comprising both industrialized and developing countries) and generally covered the period from 1960 to 1998. Due to non-availability of some data for some developing countries, the analysis was conducted by them using 'unbalanced panel'.

The empirical results suggest the existence of threshold beyond which inflation-growth relationship becomes negative. Inflation levels below the threshold level have no effect on growth, while inflation rates above the threshold have significant negative effect on growth. The empirical results estimate threshold levels of 1-3 percent and 7-11 percent for industrialized and developing countries respectively. The results clearly suggest that the threshold level of inflation for developing countries like Ghana hovers around 7 to 11 percent.

Kremer *et al.* (2008) provides new evidence on the effect of inflation on long-term economic growth for a panel of 63 industrial and non-

industrial countries. The empirical results show that inflation impedes growth if it exceeds thresholds of 2% for industrial and 12% for non-industrial countries, respectively. The study, however, indicates that below these thresholds, the effects of inflation on growth are significantly positive.

Sargsyan (2005) is one of the pioneering empirical studies which employ the threshold model using time series data for a specific country rather than the cross-section and panel data models used in earlier studies. The study examines the threshold level of inflation at which the effect of inflation on growth changes from negative to positive. The empirical results of the study estimate 4.5 percent as an 'optimal' or threshold level of inflation for the economy of Armenia.

Kheir-El-Din and Abou-Ali (2008) investigates the existence of threshold level in addressing the relationship between inflation and growth. Using specific country time series data model for Egypt, the paper estimates 15 percent as the threshold level. However, the study proposed to the central bank of Egypt to target inflation rate range of between 9 and 12 percent since that range corresponds to the lower bound of the estimated threshold interval.

Fabayo and Ajilore (2006) follow the methodology of Khan and Senhadji (2001) to examine the existence of threshold effects in inflation-growth relationship using Nigeria data for the period 1970 to 2003. The results

suggest the existence of inflation threshold level of 6 percent. Below this level, there exists significantly positive relationship between inflation and economic growth, while above this threshold level, inflation retards growth performance. Sensitivity analyses conducted confirmed the robustness of these results. This finding suggests that bringing inflation down to single digits should be the goal of macroeconomic management in Nigeria while the optimal inflation target for policy in Nigeria is 6 percent.

CHAPTER THREE

ECONOMIC GROWTH AND INFLATION IN GHANA

3.0. Introduction

This chapter reviews the developments of economic growth and inflation in Ghana, spanning from 1965 to 2007. Section 3.1 presents the historical trends of economic growth and inflation in Ghana. Section 3.2 provides graphical presentation of the relationship between inflation and economic growth in Ghana since 1965. Finally, section 3.3 provides simple statistical description about growth and inflation developments in Ghana.

3.1. Historical Trends of Inflation and Economic Growth in Ghana

The first seven years after Ghana attained self-rule, 1957-1964, saw a comparatively stable macroeconomic environment as inflation hovered around a single-digit figure. However, the 1970s and early 1980s recorded an unprecedented macroeconomic instability and very unstably high inflation episodes. In fact, between 1975 and 1983, inflation exceeded 100% on three occasions (that is in 1977, 1981, and 1983). The impact of this development on the performance of the economy is that the country recorded a negative average annual growth rate of over 2% for nine years, period of 1975-1983.

In an attempt to arrest the run-away inflation rate, among other objectives, Ghana under the aegis of the Bretton-Wood Institutions embarked on stabilization policy in 1983. The stabilization policies span from 1983 to 2000. These stabilization policies involved the Economic Reform Programme (1983-1986), the Structural Adjustment Programme (1987-1990), and the third phase of Accelerated Growth (1991-2000).

However, the economic reforms appeared to have done little to resolve the persistent high inflation. Over the entire period of the reforms, 1983-2000, inflation averaged 33.1% per annum. Even though there were occasions when inflation was brought down (to as low as 10% in 1985 and 1992), these could not be sustained, indicating an unsuccessful management of inflation during the reform period. Sowa (1994), after ten years of economic reforms, asserted that, among other factors, inflation has been a major hindrance of the economic reform programme for which an antidote is yet to be found. Again, a study by Catoa and Terrones (2003) cited Ghana as one of the top 25 countries in the world with high inflation levels.

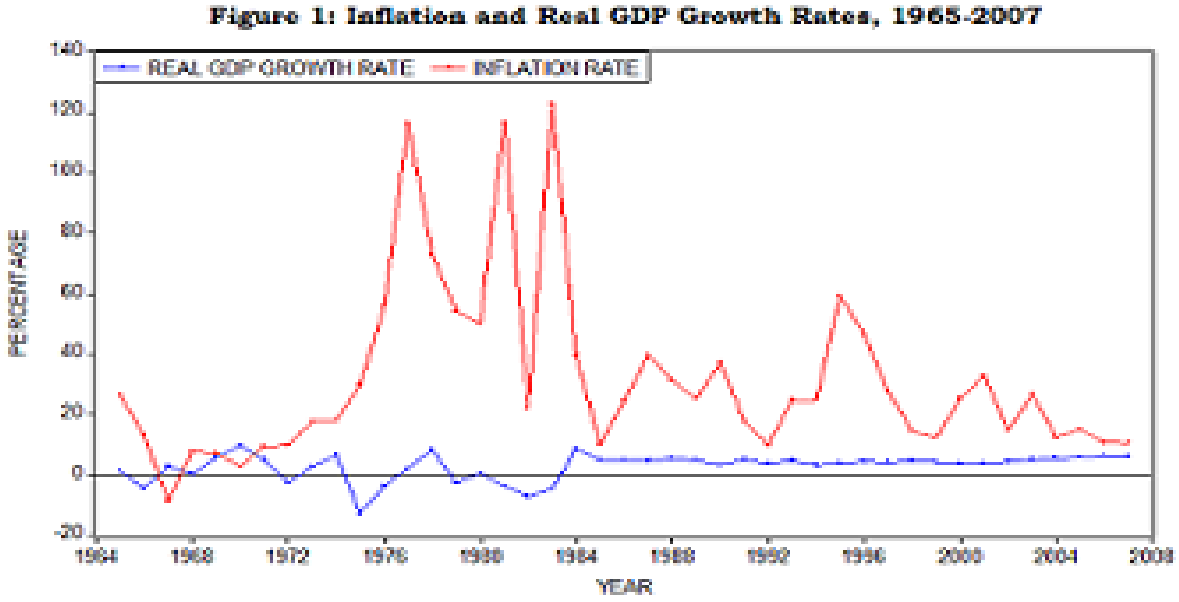
Real GDP growth performance from 1960 to pre-reform period (prior to 1983) portrayed significant ups and downs, with the country recording negative growth rates in eight instances (1966, 1972, 1975, 1976, 1979, 1981, 1982, and 1983). However, the period of reforms saw stability of economic growth consistently for more than 20 years (see Figure 1). The

absurdity of Ghana's economic growth, however, is that during the period of growth, inflation largely remained persistent and relatively high in most years and at best moderate.

3.2. The Graphical Presentation of the Inflation-Growth Relationship

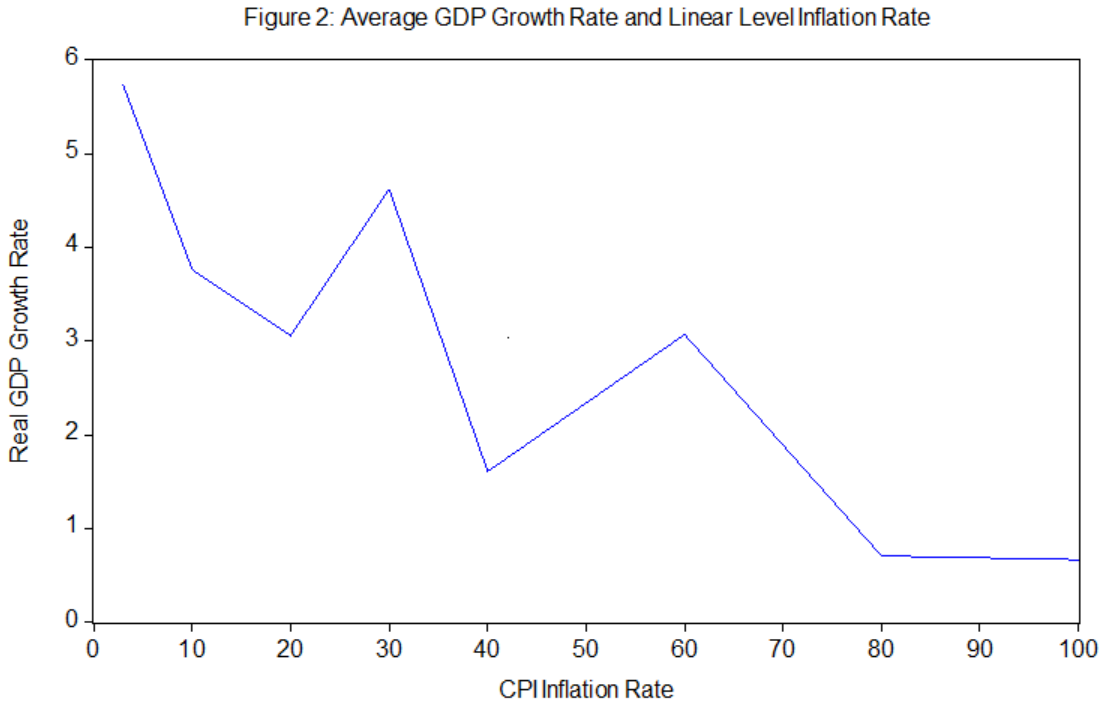
As a motivation, it is important to observe the relationship between inflation and economic growth through visual examination. Figure 1 illustrates the trend in inflation and real GDP growth rates of Ghana from 1965 to 2007. Though no significant analysis or conclusion can be made from the visual trend of inflation and real GDP growth rates, the Figure 1 portrays an inverse relationship between the two macroeconomic variables. As illustrated, growth rates remained generally low, and some instances negative, in the late 1970s and early 1980s when the inflation rates were very high. However, economic growth has consistently remained steady and relatively high with an annual average rate of 4.5 per cent from 1983 through 2000, but accelerated to 5.8 per cent in 2004 and 6.2 per cent in 2006, when inflation rates are relatively moderate.

Figure 1: Inflation and Real GDP Growth Rate, 1965-2007



To understand the historical nature of the relationship between inflation and economic growth in Ghana more accurately, the study follows the analysis approach adopted by Mubarik (2005). With this approach, the whole sample covering 1965 to 2007 is grouped into 8 observations. First of all, a range of inflation is chosen from the sample minimum and maximum levels of inflation rates. For example, if inflation is 5-percent or less, it is associated at level 5. In much the same way, if inflation rate is more than 5-percent but less than or equal to 10-percent, it is assigned level 10, and so on. Within each band (range) of inflation, average real GDP growth rates are calculated against each linear level of inflation. For illustration, the range of inflation rate of 5-percent or less, which is assigned level 5, has an average real GDP growth rate of 5.73

Figure 2: Average GDP Growth Rate and Linear inflation rate



percent during the period of 1965 to 2007. In this context, Figure 2 illustrates largely a negative relationship between inflation and real GDP growth. This simple analysis suggests that inflation has a negative effect on economic growth.

3.3 Statistical Description of GDP Growth and Inflation

Data for Ghana during the period of the study, as given in the World Development Indicators, indicate that the annual real GDP growth rate averaged 2.91 percent. There is a high variability around this average

Table 1: Statistical Description of GDP Growth and Inflation (1965-2007)

Statistic	GDP Growth Rate	Inflation Rate
Mean	2.911709	31.22367
Median	4.400000	24.87030
Maximum	9.723400	122.8745
Minimum	-12.43160	-8.422500
Std. Dev.	4.455094	29.36799
Skewness	-1.419272	1.842367
Kurtosis	5.010742	6.106357
Observations	43	43

rate with values ranging between a minimum of minus 12.43 percent in 1975 and a maximum of 9.56 percent in 1971 with a standard deviation of 4.46 percent (see table 1). Comparing this total period average of 2.91 percent to the post-economic reform average of 4.95 percent shows a significant improvement in the economy for the last 24 years, 1984-2007.

Inflation rates, measured by the annual change in Consumer Price Index, over the entire period, also show a sharp variability as reflected in a large standard deviation of 29.37 percent around an average of 31.22 percent, within a range of a minimum of minus 8.42 percent in 1967 and a maximum of 122.87 percent in 1983.

CHAPTER FOUR

THE MODEL AND METHODOLOGY

4.0. Introduction

This chapter presents the analytical models and the econometric framework for the empirical analysis of the study. Two models are specified under section 4.1 for the analytical framework. Section 4.2 presents the econometric methodology of the recently developed ARDL cointegration procedure to be used to estimate the model.

4.1. Specification of Analytical Framework Models

In this section, two economic models are specified. Model I is used to test the effect of inflation on economic growth. Model II is used to determine the inflation threshold.

4.1.0. Model I: Growth-Inflation Equation Specification

The model specification for the examination of the impact of inflation on economic growth is based on the standard neoclassical growth model pioneered by Solow (1956) and Swan (1956). The neoclassical growth model is used extensively in empirical studies to estimate the effect of inflation, and other explanatory variables, on economic growth. Besides the conventional inputs of capital and labour which are traditionally used to explain output growth, the standard neoclassical growth model

makes allowance for other 'unconventional' factors such as inflation to be included in the model to examine their impact on economic growth.

Following the works of Fischer (1993), Barro *et al* (1995), Levine and Renelt (1992), Frimpong and Oteng-Abayie (2006), and Harvie and Pahlavani (2006) with slight modification[1], the standard neoclassical production function to be estimated is represented as:

$$Y_t = f(A_t, K_t, L_t, \mu) = A_t L_t^{\alpha} K_t^{\beta}, \mu^{1-\alpha-\beta} \quad (4.1)$$

Where Y_t is real output, K_t is capital stock, L_t is raw labour input, A_t is the efficiency of production, μ is the externality generated by depreciation rate (discount factor), α and β are the capital stock and labour shares, respectively. It is assumed that α and β are less than one, such that there are diminishing returns to the labour and capital inputs.

The externality, μ, can be represented by a Cobb–Douglas function of the form:

$$\mu = f(K_t, L_t, P_t^{\delta})^{\lambda} \quad (4.2)$$

Where, P_t is the rate of depreciation or discount factor measured here by inflation rate, δ is the elasticity of capital stock with respect to inflation and λ is the intertemporal elasticity between capital stock and inflation.

[1] A variant of this model has been used by previous researchers such as Akinlo, 2005; Adam and Frimpong, 2010

Let $\delta < 0$ such that an increase in inflation yield negative externality to total production or output. If $\lambda > 0$ increase in inflation reduces the present value of the capital stock overtime and diminish the growth potential of the economy and, if $\lambda < 0$, increase in inflation yield positive effect on the economy. This model specification is consistent with standard perpetual inventory model of generating capital stock:

$$K_t = K_{t-1} + I_t - \phi K_{t-1} \quad (4.3)$$

Where I_t is flow of gross investment at period t and ϕ is the rate at which capital depreciate in period $t-1$.

If we combine equations (4.1) and (4.2), we obtain:

$$Y_t = A_t L_t^{\alpha} K_t^{\beta} [(L_t K_t P_t^{\delta})^{\lambda}]^{1-\alpha-\beta} \quad (4.4)$$

Factoring out in equation (4.3) gives

$$Y_t = A_t L_t^{\alpha+\lambda(1-\alpha-\beta)} K_t^{\beta+\lambda(1-\alpha-\beta)} P_t^{\delta\lambda(1-\alpha-\beta)} \quad (4.5)$$

If we take natural logarithm of equation (4.5), we obtain

$$\ln Y_t = \ln A_t + [\alpha + \lambda(1-\alpha-\beta)] \ln L_t + [\beta + \lambda(1-\alpha-\beta)] \ln K_t + [\delta\lambda(1-\alpha-\beta)] \ln P_t \quad (4.6)$$

Equation (4.6) assumes no policy intervention but most government tries to design monetary policies to insulate total output from inflation movement. Neglecting the behaviour of policy variables may distort the true consequences of inflation variations on output. By including policy variables, the observed relationship between output and inflation rates

would take into account the monetary policy behaviour rather than the direct influence of inflation on output. We include money supply as a percentage of GDP ($M2$), Mt, taking care of government intervention. The $M2$ has two distinct features (i.e. monetary policy instrument and measure of financial development) which makes it more preferable. We also control for term of trade (T_t) to account total transfer of technology and source of foreign exchange to augment the financial base of the local industries.

Hence, the equation to be estimated in this study takes the form:

$$\ln Y = c + \psi_1 \ln K_t + \psi_2 \ln L_t + \psi_3 \ln P_t + \psi_4 \ln T_t + \psi_5 \ln M_t + \varepsilon_t \qquad (4.7)$$

where all the variables are as defined previously; the coefficients ψ_i, $i = 1,2,...5$ are the partial constant elasticities of output with respect to capital, labour, inflation, terms of trade, and money supply respectively; c and ε_t are the constant parameter and the error term respectively, and t stands for time subscript. Equation (4.7) represents the long-run equilibrium relationship.

4.1.1. Justification of the Variables and their Measurement

The reason for choosing the above-used variables is their authenticity in empirical literature on growth. Solow (1965), Swan (1965), Mankiw *et al.* (1992), Fischer (1993), Barro *et al.* (1995), Harrison (1996), Khan and Senhadji (2001), Kormendi and Meguire (1985), Mubarik (2005), and

Harvie and Pahlavani (2006), all made use of one or more of these variables in their growth models as exogenous variables.

The dependent variable, Y_t, is taken as economic growth and is measured as growth rate in real GDP. Capital (K_t) is measured as a gross domestic investment as a proportion of GDP. As described in Sala-i-Martin (2002), gross domestic investment is one of the major significant factors that correlate positively with economic growth. *A priori* economic criteria suggest that there is a positive relationship between economic growth and gross domestic investment. Thus the coefficient of K_t is expected to be positive, that is $\psi_1 > 0$

The labour input (L_t) is measured as aggregate labour force in Ghana. An increase in the labour force is expected to increase labour supply which in turn is expected to improve economic growth. Thus, the coefficient of labour is expected to be positive, that is $\psi_2 > 0$.

Inflation (P_t) is measured as the growth rates in Consumer Price Index (CPI). Inflation is expected to impact negatively on economic growth in line with Stockman's (1980) model. The expectation of the inverse growth-inflation relationship is based on the fact that inflation rates in Ghana, for the period under review, on the average are high. Therefore, the coefficient of inflation is expected to be negative, that is $\psi_3 < 0$.

The terms of trade (T_t), the rate at which units of one product from Ghana can be exchanged for units of product from a foreign country, is measured as the export price index divided by import price index. The nation's ability to import raw materials to feed our local industries depends on the availability of foreign exchange which in turn depends on the terms of trade. Thus, improvement in the country's terms of trade brings about adequate foreign exchange necessary to ensure efficient functioning of our industries leading to growth in output. The coefficient for the terms of trade variable is therefore expected to be positive, that is $\psi_4 > 0$.

Money supply (M_t) is measured as the ratio of M2 to GDP. Money supply (M2) is double used as a proxy for government monetary policy direction which tries to insulate output from inflation and financial development. Financial development stimulates economic growth by widening the provision of financial services by financial intermediaries such as savings mobilization, project evaluation, and risk management. Therefore, the coefficient of money supply is expected to be positive, that is $\psi_5 > 0$.

4.1.2. Model II: Threshold Model Specification

The model is developed by Khan and Senhadji (2001) for the analysis of the threshold level of inflation for developed and developing countries. The study utilizes this seminal work to estimate the threshold level of

inflation above which inflation adversely affects economic growth for Ghana. The equation to estimate the threshold level of inflation is represented in the following conditional form:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta P_t + \beta_2 D_t (\Delta P_t - k) + \beta_{2+i} X_{it} + \mu_t \quad (4.8)$$

Economic growth and inflation are computed as:

$$\dot{Y}_t = \Delta Y_t = \Delta Log(Y_t) \quad (4.9)$$

$$\dot{P}_t = \Delta P_t = \Delta Log(P_t) \quad (4.10)$$

Where Y_t is real GDP, ΔY_t is the growth rate of real GDP, P_t is the consumer price index, ΔP_t is the inflation, k is the threshold level of inflation, and μ_t is the random term which represents measurement error in the explanatory variables. The variable X_{it} is a vector of control variables which include the growth rate of gross domestic investment as a proportion of GDP (ΔK_t), growth rate of aggregate labour force (ΔL_t), the growth rate of terms of trade (ΔT_t), and the growth rate of money supply (ΔM_t). The growth rates of all these explanatory variables are computed using similar method as ΔY_t and ΔP_t as shown in equations (4.9) and (4.10) respectively.

The dummy variable D_t is defined in the following way:

$$D_t = \begin{cases} 1: & if \quad P > K \\ 0: & if \quad P \leq K \end{cases} \qquad (4.11)$$

The parameter K (that is the threshold inflation level) has a property that the relationship between output growth and inflation is given by:

(i) β_1 represents low inflation; (ii) $\beta_1 + \beta_2$ represents high inflation. The high inflation means that when the long-run inflation estimate is significant then both coefficients ($\beta_1 + \beta_2$) would be added to see their impact on growth and that would be the threshold level of inflation.

By estimating regressions for different values of K which is chosen in an ascending order (that is 1, 2, 3, and so on), the optimal value of K is obtained by finding the value that maximizes the R^2 from the respective regressions. In other words, the optimal threshold level (k) is that which minimizes the residual sum of squares (RSS). Though this process is tedious since several regressions have to be estimated, the procedure is widely accepted in the empirical literature on this topic.

4.2. Econometric Methodology

This section focuses on time series properties of the variables used in this study, the basis for the adoption of the bounds testing (or autoregressive distributed lag (ARDL)) cointegration procedure to

estimate the model, and the steps (methods) involved in the application of the ARDL methodology.

4.2.0. Time Series Properties

Empirical studies show that most of the time series are not stationary. Indeed, the visual inspection of all the variables intended to be used in this study in their levels suggests that they are trending and therefore non-stationary. That is, their mean and variances depend on time. As econometric theory shows, when the variables are non-stationary, the standard ordinary least squares cannot be applied because there might be a spurious regression which affects forecasting performance.

A number of methods are suggested to solve this problem. One of them is taking the differences of the series and then putting them into regressions. However, in this case we are confronted with a new problem. This method leads to the loss of information that is important for the long-run equilibrium. As long as the first differences of the variables are used, determining a potential long-run relationship between these variables becomes impossible. This is the point of origin of cointegration analysis.

The cointegration approach developed by Engle and Granger (1987) overcame this problem. According to this approach, time series which are not stationary at levels but stationary in the first difference can be

modeled with their level states. In this way, loss of information in the long run can be prevented. However, this approach becomes invalid if there are more than one cointegration vectors. Moving from this point, with the help of the approach developed by Johansen (1988), it is possible to test how many cointegration vectors there are among the variables by using the VAR model in which all the variables are accepted as endogenous. Therefore, unlike the Engle-Granger method, a more realistic examination is provided without limiting the test in one cointegration vector expectation.

However, in order to perform these tests developed by Engle and Granger (1987), Johansen (1988), and Johansen and Juselius (1990), the condition must be met that all series should be not stationary at the levels and they should become stationary when the same differences are taken. If one or more of the series are stationary at levels, that is to say $I(0)$, the cointegration relationship cannot be examined with these tests. Due to this limitation, the study employs the bounds testing approach to cointegration, which has become increasingly popular in recent times.

4.2.1. The ARDL Cointegration Approach

To search for possible valid dynamic long-run relationships amongst the variables of interest, the study adopts the recently developed autoregressive distributed lag (ARDL). This new version of the

cointegration techniques for determining long-run relationships among the variables in this study was developed by Pesaran and Shin (1995, 1999), Pesaran *et al.* (1996), and Pesaran (1997). There are a number of advantages of using this cointegration approach over other alternatives like the conventional Johansen (1998) and Johansen and Juselius (1990).

Firstly, the Johansen conventional cointegration method estimates the long-run relationship under the restrictive assumption that all the model's variables are integrated of order 1, that is I(1). However, and as shown at Pesaran and Shin (1995) and Pesaran *et al.* (2001), the ARDL models yield consistent estimates of the long run coefficients that are asymptotically normal irrespective of whether the underlying regressors are purely $I(0)$, purely $I(1)$, or mixture of both. This implies that, unlike the standard cointegration approach, the ARDL avoids the pre-testing of variables to identify the order of integration of the underlying variables.

Secondly, the ARDL method avoids the larger number of specification to be made in the standard cointegration test. These include decisions regarding the number of endogenous and exogenous variables (if any) to be included, the treatment of deterministic elements, as well as the optimal of lags to be specified. The estimation procedures are generally very sensitive to the method used to make these choices and decisions (Pesaran and Smith, 1998). With the ARDL methodology, it is possible

that different variables have different optimal lags, which is impossible with the conventional cointegration test.

Furthermore, the ARDL methodology provides unbiased estimates of the long-run model and valid t-statistics by the inclusion of dynamics in the model, even when some of the regressors are endogenous (Inter, 1993). This is particularly important in this study because of potential endogeneity of some of the regressors (particularly inflation).

Lastly, when compared to other alternative techniques, the ARDL methodology performs better with small sample data which according to Nayaran (2004) should be between 30 and 80 observations like the one in this study.

4.2.2. The ARDL Model Specification

According to Pesaran and Pesaran (1997), there are two steps for implementing the ARDL approach to cointegration procedure. First, the existence of the long-run relationship between the variables in the system is tested using an F-test. Secondly, the error correction representation and long-run model are estimated after the lag orders of the variables are chosen using Akaike Information Criterion (AIC). Then the stability tests, namely Cummulative Sum of Recursive Squares (CUSUM) and Cummulative Sum of Square of Recursive Residuals (CUSUMQ) tests are conducted.

To conduct the bounds test, the growth equation (4.7) is converted into an unrestricted error correction model (UECM) form as follows:

$$\Delta \ln Y_t = c_o + \delta_1 \ln Y_{t-1} + \delta_2 \ln K_{t-1} + \delta_3 \ln L_{t-1} + \delta_4 \ln P_{t-1} + \delta_5 \ln T_{t-1} + \delta_6 \ln M_{t-1} + \sum_{i=1}^{n} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{n} \rho_i \Delta \ln K_{t-i} + \sum_{i=0}^{n} \alpha_i \Delta \ln L_{t-i} + \sum_{i=0}^{n} \phi_i \Delta \ln P_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta \ln T_{t-i} + \sum_{i=0}^{n} \psi_i \Delta \ln M_{t-i} + \varepsilon_t \quad (4.12)$$

Where, Δ is the first difference operator. The parameters $\beta, \rho, \alpha, \phi, \gamma$, and ψ represents the short-run dynamics of the model to be estimated through the error correction framework, δ_i are the long run multipliers, c_o is the drift (constant term), and ε_t are white noise errors.

4.2.3. Bounds Testing Procedure

The first step, as mentioned earlier, in the ARDL bounds testing approach is to estimate equation (3.9) using ordinary least squares (OLS) to trace the presence of cointegration (that is, the long-run relationship among the variables) by restricting all estimated coefficients of lagged level variables equal to zero. That is, the null hypothesis of no cointegration (Ho: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$) is tested against the alternative (H1: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$) by means of an F-test with an asymptotic non-standard distribution. We denote the test which normalizes on Y by F_Y (Y/K, L, P, T, M). Two asymptotic critical value

bounds provide a test for cointegration when the independent variables are $I(d)$ with $0 \leq d \leq 1$. The lower bound assumes that all the regressors are $I(0)$, and the upper bound assumes that they are I(1). If the computed F-statistics lies above the upper level of the band, the null hypothesis is rejected, indicating cointegration. If the computed F-statistic lies below the lower level band, the null hypothesis cannot be rejected, supporting the absence of cointegration. If the F-statistic falls within the two bands, the result would be inconclusive. The critical values for the F-test are obtained from Pesaran *et al* (2001: pp 300).

In the second step, after the confirmation of the existence of a long-run relationship between the variables in the model, the conditional ARDL (p, q_1, q_2, q_3, q_4, q_5,) long-run model for Y_t can be estimated as follows:

$$\ln Y_t = c_o + \sum_{i=1}^{p} \delta_1 \ln Y_{t-i} + \sum_{i=0}^{q_1} \delta_2 \ln K_{t-i} + \sum_{i=0}^{q_2} \delta_3 \ln L_{t-i} + \sum_{i=0}^{q_3} \delta_4 \ln P_{t-i} + \sum_{i=0}^{q_4} \delta_5 \ln T_{t-i} + \sum_{i=0}^{q_5} \delta_6 \ln M_{t-i} + \varepsilon_t \quad (4.13)$$

Where, all the variables are as defined previously. The estimation of equation (4.13) involves selecting of the orders of lags of the ARDL (p, q_1, q_2, q_3, q_4, q_5,) long-run model using Akaike Information Criteria (AIC).

In the third and final step, the ARDL specification of the short-run dynamics can be derived by constructing an error correction model (ECM) of the following form:

$$\Delta \ln Y_t = c_o + \sum_{i=1}^{n} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{n} \rho_i \Delta \ln K_{t-i} + \sum_{i=0}^{n} \alpha_i \Delta \ln L_{t-i} + \sum_{i=0}^{n} \phi_i \Delta \ln P_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta \ln T_{t-i} + \sum_{i=0}^{n} \psi_i \Delta \ln M_{t-i} + \xi ECM_{t-1} + \mu_t \quad (4.14)$$

Where ECM_t, the error correction term, is defined as:

$$ECM_t = \ln Y_t - c_o - \sum_{i=1}^{p} \delta_1 \ln Y_{t-i} - \sum_{i=0}^{q_1} \delta_2 \ln K_{t-i} - \sum_{i=0}^{q_2} \delta_3 \ln L_{t-i} - \sum_{i=0}^{q_3} \delta_4 \ln P_{t-i} - \sum_{i=0}^{q_4} \delta_5 \ln T_{t-i} - \sum_{i=0}^{q_5} \delta_6 \ln M_{t-i} \quad (4.15)$$

Where all the coefficients of the short-run equation (4.14) are coefficients relating to the short-run dynamics of the model's convergence to equilibrium and ξ represents the speed of adjustment.

4.3. Unit Root Test

As stated earlier, the ARDL approach to cointegration does not require the pre-testing of the variables, included in the model, for unit root unlike other techniques such as the Johansen approach (Pesaran *et al.*, 2001). However, Ouattara (2004a) argues that in the presence of I(2) variables, the computed F-statistics provided by Pesaran *et al.* (2001) are

no more valid because they are based on the assumption that the variables are I(0) or I(1). Therefore the implementation of unit root tests is carried out in order to ensure that none of the variables is integrated of order 2 or beyond.

Traditionally, tests such as the Augmented Dickey-Fuller (AD) and the Phillips-Perron (PP) proposed by Dickey and Fuller (1979) and Phillips and Perron (1999) respectively, are often used to test for the order of integration. However, it has recently been documented that such tests perform badly in the presence of small samples such as ones being used in this study. They often tend to over-reject the null hypothesis when it is true and under-reject it when it is false (Dejong *et al.*, 1992; Harris, 2003).

To address these shortcomings, a new test has been proposed recently: the Dickey-Fuller generalized least square (DFGLS) de-trending test proposed by Elliot *et al.* (1996):

$$\Delta y_t^d = \theta y_{t-1}^d + \gamma_1 \Delta y_{t-1}^d + ... + \gamma_p y_{t-p}^d + \varepsilon_t \qquad (4.16)$$

Where y_t^d GLS is *detrended data*

This is a simple alteration of the conventional augmented Dickey-Fuller (ADF) t-test:

$$\Delta y_t = \mu + \theta y_{t-1} + \delta t + \sum_{i=1}^{p} \theta_i \Delta y_{t-i} + \varepsilon_t \qquad (4.17)$$

where δt is time trend and ε_t is error term

It employs generalized least squares (GLS) before running the ADF test regression. Compared to the ADF, it performs better in terms of sample size and power. This study intends to employ this econometric tool to test for unit roots in the variables.

4.4. Data Sources

The empirical models of this study make use of secondary sources of annual data set for the period of 1965 to 2007 for which data were available. The data are drawn from the World Bank's World Development Indicators (2009) on its website, Quarterly Digest of Statistics of Bank of Ghana and Ghana Statistical Services Department.

CHAPTER FIVE

ESTIMATION RESULTS AND ANALYSIS

5.0. Introduction

This chapter presents the analysis and discussions of the estimation results. First, the unit root tests results of the variables are presented in section 5.1. The cointegration test results as well as the long-run and short-run coefficient results among the variables are provided in section 5.2. Finally, section 5.3 examines the existence of threshold level of inflation for Ghana. Sensitivity analysis of the threshold is carried out to check the robustness of the threshold results.

5.1. Unit Root Tests

Though the ARDL approach to cointegration does not require the pre-testing of the variables included in the model for unit root, the computed F-statistics provided by Pesaran *et al* (2001) are no more valid in the presence of I(2) or beyond variables because they are based on the assumption that the variables are either I(0) or I(1). It is therefore important to carry out the implementation of the unit root tests to ensure that none of the variables is integrated of order 2 or beyond. To determine the order of integration of the variables, the study employs a more efficient Dickey-Fuller generalized least square (DF-GLS) detrending test proposed by Elliot *et al* (1996). The results of the DF-GLS unit root

Table 2: Results of DF-GLS Unit Root Tests on Variables

Variable in Log Level			1st Difference Variable			I(d)
Variable	Lag	DF-GLS Stats	Variable	Lag	DF-GLS Stats	
$\log Y_t$	1	-1.9562	$\log Y_t$	0	-6.3280***	I(1)
$\log K_t$	0	-1.1576	$\log K_t$	0	-5.4925***	I(1)
$\log L_t$	2	-0.0448	$\log L_t$	0	-4.6754***	I(1)
$\log P_t$	2	-0.6781	$\log P_t$	1	-2.2410**	I(1)
T_t	0	-0.3924	T_t	0	-5.8368***	I(1)
$\log M_t$	3	-0.8434	$\log M_t$	0	-5.5691***	I(1)

*** (**) denotes the rejection of the null hypotheses at 1 %(5%) significance level.

tests as reported in table 2 which are obtained from E-Views 5.1 indicate that all the time series variables are I(1).

5.2. Cointegration Test

The results of the unit root tests indicate that the ARDL model for $\log Y_t$ can be implemented using upper bound critical values reported in Pesaran *et al* (2001) for determination of cointegration. From table 3, the calculated F-statistics $F_Y(Y_t / K_t, L_t, P_t, T_t, M_t)$ = 12.57530 for ARDL (1,1,1,3,1,1) is higher than the upper bound critical value of 4.18 at 1% significance level. This implies that the null hypothesis of no cointegration relationship among the variables is rejected at 1% significance level in favour of the alternative hypothesis of the existence

Table 3: Results of ARDL Bounds Test for the Existence of Cointegration

Computed F-statistics	k*	Critical Values**					
		10%		5%		1%	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
12.57530***	5	2.26	3.35	2.62	3.79	2.96	4.18

*** Significance at 1% level. **Critical values were obtained from table CI(iii): Unrestricted intercept and no trend Pesaran *et al* (2001:pp 300). * k represents the number of independent variables in the model.

of cointegration relationship among the variables. In other words, the results prove that real output, capital stock, labour stock, money supply (M2) as percentage of GDP, inflation, and terms of trade have long-run relationship when real output is made the dependent variable.

Once the long-run (cointegration) relationship is established among the series, the ARDL model can be specified to determine long term and short term relationships. The study thus proceeds to estimate equation (4.13) and select the lag orders of the variables in the system based on Akaike Information Criterion and obtains the ARDL (1,1,1,3,1,1) specification.

The long run coefficients of the variables under consideration are reported in table 4. As expected, the results indicate that capital investment proxied by gross domestic capital formation has a positive and statistically significant impact on economic growth. At 1 per cent significant level, the results reveal that, all things being equal, a 1 per cent increase in capital investment leads to approximately 1.30 per cent

Table 4: ARDL (1, 1,1,3,1, 1) Model: Long Run Results.

Dependent Variable is Y_t

Regressors	Coefficient	Std Error	T-Statistics	T-Probability
K_t	1.2985	0.4830	3.5940***	0.0021
L_t	4.0523	3.0082	1.8011*	0.0885
P_t	-0.2492	0.2496	-1.3348	0.1986
T_t	-1.1115	0.4783	-3.1070***	0.0061
M_t	-1.2891	0.8102	-2.1271**	0.0475
C	-40.9730	44.1170	-1.2417	0.2303

***, **, and * indicate 1%, 5% and 10% significance level

increase in real GDP. This confirms the important role capital investment plays in promoting economic growth in Ghana. The coefficient of labour is also positively signed as expected and significant at approximately 9 per cent t-probability.

The long-run impact of terms of trade on economic growth is negative and significant at 1 per cent level. This is an indication of the Ghanaian industries' high dependency on the import of raw materials and other essential inputs for production. A nation's ability to import depends on the availability of foreign exchange which in turn depends on the terms of trade. Many years of worsening Ghana's terms of trade relative to our major trading partners implies limited access to foreign exchange and thus restrictions on the importation of raw materials and essential inputs. This has led to deterioration in the manufacturing and

agricultural sectors as well as physical infrastructure upon which the Ghanaian economy hinges.

The money supply variable, also has a negative sign and even significant at 9 per cent t-probability. This shows that the recent proliferation of financial institutions in the Ghanaian economy has not yet made any significant positive impact on economic growth possibly due to the existence of market failure in the financial sector. Symptoms of the market failure in the financial sector include the fact that many good projects go unfinanced because lenders are unwilling to bear the risk of lending; lenders are only willing to lend for short periods of time; and savers are only interested in holding short financial assets. These, coupled with years of financial repression and macroeconomic instability particularly in the 1970s and early 1980s, have contributed to this negative correlation between financial development and economic growth in the Ghanaian economy.

Inflation has the expected negative effect on economic growth. However, as indicated by the results reported in table 4, inflation does not impact significantly on economic growth in the long-run. This fact is supported by the short-run results reported in table 5 as the second and third lags of inflation have insignificant effect on economic growth. On the other

Table 5: Results of ARDL (1,1,1,3,1,1) Error Correction Model (ECM).

Dependent Variable: ΔY_t

Regressors	Coefficient	Std. Error	t-Statistics	Probability
ΔY_{t-1}	0.381511	0.106777	3.572965***	0.0000
ΔK_t	0.347741	0.125690	2.766655**	0.0107
ΔK_{t-1}	-1.168062	0.229874	-5.081313***	0.0000
ΔL_t	-2.386189	2.177879	-1.095648	0.2841
ΔL_{t-1}	4.929941	1.869046	2.637678**	0.0144
ΔP_t	-3.452023	0.537572	-6.421509***	0.0000
ΔP_{t-1}	-1.105774	0.611771	-1.807497*	0.0832
ΔP_{t-2}	-0.399793	0.301599	-1.325581	0.1975
ΔP_{t-3}	-2372192	0.174502	-1.539246	0.1876
ΔT_t	-0.977188	0.136704	-7.148207***	0.0000
ΔT_{t-1}	0.578451	0.156939	3.685833***	0.0012
ΔM_t	-1.458608	0.709372	-2.056197*	0.0508
ΔM_{t-1}	-1.562046	0.483805	-3.228666***	0.0036
ECM_{t-1}	-1.357253	0.211727	-6.410379***	0.0000
C	-0.002717	0.173687	-0.015642	0.9876
R^2	0.926502		SER	0.211448
$\overline{R}$	0.886690		AIC	0.017708
F-statistic	21.80717		SBIC	0.664123
Prob(F-statistic)	0.000000		DW-Statistics	2.232160

***, **, and * indicate 1%, 5% and 10% significance level respectively

hand, there is a significant impact of inflation on economic growth in the short run. At a 1 per cent significance level, inflation exerts a negative influence on economic growth. The previous year's inflation also impacts negatively on economic growth at 10 per cent significance level. Clearly there exists a negative relationship between inflation and economic growth in the short-run. However, inflation does not affect economic growth in the long-run.

The results of the short-run dynamic coefficients of the model ARDL (1,1,1,3,1,1) associated with the long-run relationships as shown in Table 5 indicates that the error correction term, ECM_{t-1}, has the right sign (negative) and is statistically significant at 1 per cent level. This is a further evidence of the existence of a long-run (cointegration) relationship among the variables in the model. The estimated value of ECM_{t-1} is -1.3370, implying that the deviations from the long-run equilibrium caused by the short-run shocks takes less than one year to be corrected.

From the result of the coefficient of determination (R^2 = 0.9265), it is clear that the overall goodness of fits of the ARDL models is very high. Moreover, the diagnostic test results (see Table 6) indicate that the short run model passes the serial correlation, functional form misspecification, non-normal errors, and heteroscedasticity test at 5%. These imply that the model is well specified without the problem of serial correlation and

Table 6: ARDL-VECM Model Diagnostic Tests

Serial Correlation F(2, 21)=0.813229[0.4569]	Functional Form F(1, 22)=0.4599[0.5047]
Heteroskedasticity F(14, 23)=1.5314[0.1767]	Normality $\chi^2(2)$=1.3985[0.4969]

Figure 3: Plot of Cumulative Sum of Recursive Residuals (CUSUM)

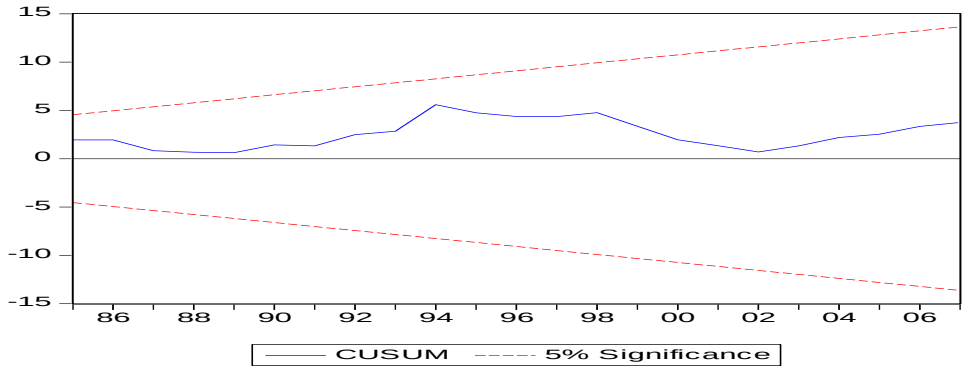
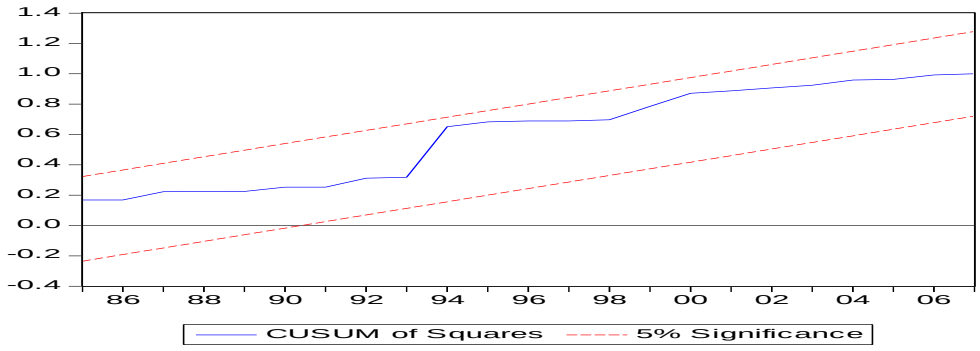


Figure 4: Plot of Cumulative Sum of Square Of Recursive Residuals (CUSUMQ)



heteroscedasticity. Thus, it can be said that the estimated short-run model performs well.

The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ), from the recursive estimation model, test the stability of the model. Figures 1 and 2 indicate the graphs of CUSUM and CUSUMQ tests respectively. From the figures, it is clear that the plots of both CUSUM and CUSUMQ are within 5% of critical bands. This implies that the estimated model is stable.

5.3. Estimation of Inflation Threshold

According to the third hypothesis of this study, inflation in the Ghanaian economy possibly has an adverse effect on growth after it exceeds a certain limit. With the prior knowledge of a similar technique adopted by Khan and Senhadji (2001) who in their seminal work found inflation threshold level of between 7 per cent and 11 per cent for developing countries, the study tests for several levels of inflation. However, the results of inflation levels between 6 per cent and 12 per cent which gave relevant results are produced in table 6.

The estimation of equation (4.8) gives a specific value of the threshold inflation level and also measures the impact of that level on economic growth. Thus, equation (4.8) is estimated and the coefficient of determination (R^2) for each threshold level of inflation ranging from K=6 to K=12 is computed. Table 7 shows the results of the estimation of the inflation threshold level.

Table 7: OLS Estimation of Inflation Threshold Model at K=6 to K=12. Dependant Variable: $\dot{Y}$

	Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	DW
6%	$\dot{P}$	-0.382051	0.169667	-2.251766	0.0302	0.359	1.93
	$D(\dot{P}-6)$	0.353711	0.173509	2.038579	0.0485		
	$\dot{K}$	0.063082	0.028335	2.226288	0.0320		
	$\dot{T}$	2.014484	0.713268	2.824300	0.0075		
	C	7.385053	1.039306	7.105756	0.0000		
7%	$\dot{P}$	-0.375634	0.167726	-2.239566	0.0310	0.364	1.94
	$D(\dot{P}-7)$	0.348004	0.171510	2.029059	0.0495		
	$\dot{K}$	0.062878	0.028105	2.237223	0.0312		
	$\dot{T}$	2.046357	0.709454	2.884413	0.0064		
	C	7.695618	1.182321	6.508905	0.0000		
8%	$\dot{P}$	-0.379136	0.168602	-2.248702	0.0304	0.367	1.95
	$D(\dot{P}-8)$	0.352745	0.172370	2.046436	0.0477		
	$\dot{K}$	0.062552	0.027817	2.248720	0.0304		
	$\dot{T}$	2.104755	0.706163	2.980552	0.0050		
	C	8.077559	1.346518	5.998851	0.0000		
9%	$\dot{P}$	-0.380915	0.170685	-2.231692	0.0316	0.372	1.97
	$D(\dot{P}-9)$	0.356140	0.175010	2.034970	0.0489		
	$\dot{K}$	0.061958	0.027489	2.253898	0.0301		
	$\dot{T}$	2.185640	0.717153	3.047664	0.0042		
	C	8.459334	1.528385	5.534818	0.0000		
10%	$\dot{P}$	-0.382932	0.170853	-2.241293	0.0309	0.378	1.98
	$D(\dot{P}-10)$	0.359934	0.175714	2.048414	0.0475		
	$\dot{K}$	0.061312	0.027176	2.256090	0.0299		
	$\dot{T}$	2.274523	0.729499	3.117923	0.0035		
	C	8.850701	1.702164	5.199675	0.0000		
11%	$\dot{P}$	-0.388870	0.175010	-2.221983	0.0323	0.384	2.01
	$D(\dot{P}-11)$	0.368624	0.180904	2.037673	0.0486		
	$\dot{K}$	0.061678	0.027219	2.265980	0.0292		
	$\dot{T}$	2.365554	0.748628	3.159853	0.0031		
	C	9.234200	1.891106	4.882962	0.0000		
12%	$\dot{P}$	-0.011981	0.314704	-0.038071	0.9698	0.334	1.99
	$D(\dot{P}-12)$	-0.026019	0.327272	-0.079502	0.9371		
	$\dot{K}$	0.059329	0.027654	2.145397	0.0384		
	$\dot{T}$	1.618149	0.874252	1.850895	0.0720		
	C	5.061438	3.895570	1.299281	0.2017		

The result shows that 11 per cent of inflation is the threshold level. At 11 per cent threshold level of inflation, R^2 is at the maximum and also the coefficient of $D(\dot{P}-11)$ is statistically significant at 5 per cent significance level. This implies that if inflation increases beyond the 11 percent threshold level, economic growth would approximately decline by 0.023 per cent, (that is the sum of the coefficients of $\dot{P}$ and $D(\dot{P}-11)$ at the inflation threshold level of 11 per cent).

5.3.0. Sensitivity Analysis

To check the robustness and specification bias of the estimated model, the threshold model (of equation 4.8) is estimated again using the two-stage least squares (2SLS). The results of the 2SLS regression as produced in table 8 also suggest 11 per cent threshold inflation level.

The comparison of both estimated models, OLS (table 7) and 2SLS (table 8), indicate the same threshold level of inflation and close coefficients. Both models produce results that indicate an 11 per cent threshold level of inflation for economic growth of Ghana.

In estimating the threshold model, some other variables that can be found in growth literature were included in the initial model, but were dropped after producing insignificant results. These variables include

Table 8: Two-Stage Least Square Estimation (2SLS) of Inflation Threshold Model at K=6 to K=12. Dependant Variable: $\dot{Y}$

K	Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	DW
6%	$\dot{P}$	-0.405144	0.183417	-2.208873	0.0335	0.362	1.91
	$D(\dot{P}-6)$	0.378371	0.187960	2.013037	0.0514		
	$\dot{K}$	0.062826	0.028380	2.213747	0.0331		
	$\dot{T}$	2.176282	0.830254	2.621225	0.0126		
	C	7.586114	1.149282	6.600743	0.0000		
7%	$\dot{P}$	-0.398258	0.180525	-2.206108	0.0337	0.366	1.92
	$D(\dot{P}-7)$	0.372279	0.184982	2.012514	0.0515		
	$\dot{K}$	0.062590	0.028140	2.224246	0.0323		
	$\dot{T}$	2.215107	0.825598	2.683032	0.0108		
	C	7.920436	1.299549	6.094755	0.0000		
8%	$\dot{P}$	-0.402932	0.180959	-2.226648	0.0321	0.371	1.93
	$D(\dot{P}-8)$	0.378372	0.185324	2.041674	0.0484		
	$\dot{K}$	0.062219	0.027844	2.234589	0.0316		
	$\dot{T}$	2.287636	0.820716	2.787368	0.0083		
	C	8.340689	1.471670	5.667499	0.0000		
9%	$\dot{P}$	-0.407714	0.184325	-2.211932	0.0332	0.377	1.95
	$D(\dot{P}-9)$	0.385078	0.189243	2.034835	0.0491		
	$\dot{K}$	0.061556	0.027508	2.237780	0.0313		
	$\dot{T}$	2.391292	0.833225	2.869925	0.0067		
	C	8.782312	1.677906	5.234090	0.0000		
10%	$\dot{P}$	-0.412931	0.185600	-2.224843	0.0323	0.383	1.97
	$D(\dot{P}-10)$	0.392441	0.191038	2.054258	0.0471		
	$\dot{K}$	0.060823	0.027190	2.236927	0.0314		
	$\dot{T}$	2.506829	0.846021	2.963081	0.0053		
	C	9.243190	1.876839	4.924871	0.0000		
11%	$\dot{P}$	-0.423933	0.191733	-2.211065	0.0333	0.391	2.01
	$D(\dot{P}-11)$	0.406794	0.198243	2.051993	0.0473		
	$\dot{K}$	0.061182	0.027252	2.245033	0.0308		
	$\dot{T}$	2.633960	0.865823	3.042147	0.0043		
	C	9.720767	2.101825	4.624918	0.0000		
12%	$\dot{P}$	-0.025640	0.329097	-0.077911	0.9383	0.333	1.95
	$D(\dot{P}-12)$	-0.010988	0.343135	-0.032024	0.9746		
	$\dot{K}$	0.059246	0.027671	2.141056	0.0389		
	$\dot{T}$	1.730319	1.045239	1.655429	0.1063		
	C	5.261201	4.111816	1.279532	0.2087		

Instrument list: $\dot{Y}_{t-1}$ $D(\dot{P}-k)$ $\dot{P}$ $\dot{T}$ $\dot{K}$

growth rate of aggregate labour force (ΔL_t) and the growth rate of money supply (ΔM_t).

The regression of the 2SLS made use of a set of instruments which include the first lag of GDP growth ($\dot{Y}_{t-1}$), inflation ($\dot{P}$), the dummy variable [$D(\dot{P}-k)$] as well as the growth rates of capital ($\dot{K}$) and terms of trade ($\dot{T}$). These variables are used as instruments because they produce significant coefficients and are not autocorrelated with the error term in equation 4.8 at 5% significance level.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0. Introduction

This chapter provides the summary of the findings of the research study and presents the conclusions, particularly on the hypotheses put forward in the introductory chapter. In addition, some recommendations are presented for policy makers and other players in the economy and for further research in the field of growth-inflation relationship.

6.1. Summary

In chapter 1, an introduction to the study is set out, which outlines the importance and motivation for the study. The hypotheses and objectives are clearly spelt out as well as the research methodology and a brief summary of the structure of the study and the limitations of the study.

Chapter 2 presents the definitions of some basic concepts of economic growth and inflation as well as the theoretical and empirical evidence on the growth-inflation relationship. In addition, it examines the nonlinearity of the growth-inflation relationship at both the theoretical and empirical fronts.

Chapter 3 traces the historical developments of economic growth and inflation in Ghana. It also portrays graphically the relationship between

economic growth and inflation in Ghana. The graphical analysis shows an inverse relationship between economic growth and inflation.

In chapter 4, the model and methodology used in analyzing the impact of inflation on economic growth are presented. Two models – one for analyzing the impact of inflation on economic growth and the other for examining the threshold level of inflation – are provided. A recent state-of-the-art econometric methodology of Autoregressive Distributed Lag (ARDL) cointegration approach is employed to assess the growth-inflation relationship in Ghana.

Chapter 5 presents the empirical findings of the study. As expected, capital and labour impact positively on economic growth while inflation exerts negative influence on the economic growth of Ghana. Money supply and terms of trade are also found to negatively impact Ghana's growth. The threshold level of inflation is found to be at 11 per cent and an increase in inflation beyond this threshold reduces economic growth by 0.023 per cent in the long run. A sensitivity analysis conducted to examine the robustness of the threshold results confirms the 11 per cent inflation rate as the threshold level.

6.2. Conclusion

The objective of this study is to investigate the impact of inflation on economic growth of Ghana and to estimate the threshold level of inflation rate beyond which inflation can be harmful to economic growth in Ghana.

First, the unit root tests carried out on all the variables using the Dicky-Fuller generalized least square (DF-GLS) indicate that all the time series variables are I(1). This meets the requirements for the implementation of the ARDL model using the critical values reported in the Pesaran *et al* (2001) for determination of cointegration. The calculated F-statistic $[F_Y(Y_t / K_t, L_t, P_t, T_t, M_t)]$ of 12.5753 for ARDL (1,1,1,3,1,1) is higher than the upper bound critical value of 4.18 at 1 per cent significance level. The results prove that real output, capital stock, labour force, inflation, terms of trade and money supply (M2) as a percentage of GDP are cointegrated (that is, have long-run relationship) when the real output is made the dependent variable.

The empirical study provides policy-makers with an estimate of the impact of inflation, as well as other instrumental variables, on economic growth in Ghana for the period of 1965 to 2007. The main conclusion that can be drawn from the empirical results is that inflation has a

robustly estimated negative impact on GDP growth. One major policy implication that can be drawn from this analysis is that reducing the rate of inflation is one major way of promoting economic growth in Ghana. From the empirical results, inflation adversely affects economic growth such that a one-percentage point fall in inflation significantly enhances economic growth by 0.023 per cent in the short-run, and vice versa. In other words, any policy initiative that will help to reduce inflation rate by one per cent in the short-run will also promote economic growth by 0.023 per cent. However, the empirical results point out no significant long-run correlation between inflation and economic growth.

The empirical result on the threshold level of inflation is robustly estimated at 11 per cent for the Ghanaian economy. This implies that any inflation beyond the 11 per cent threshold level is inimical to economic growth. Statistically, a one-percentage point increase of inflation beyond the 11 per cent threshold would reduce economic growth by 0.023 per cent per annum.

This empirical study strongly suggests and gives credence to Bank of Ghana's pursuit to reduce inflation from the current average level which hovers around 18 per cent and 21 per cent. Thus, Bank of Ghana should pursue price stability as its major policy objective in maintaining and fostering economic growth.

6.3. Recommendation

The analysis of the composition of Consumer Price Index (CPI), which is used in the computation of inflation, reveals that food price accounts for over 60 per cent of the CPI. A fall in food production, therefore, has an upward adjustment on inflation and adverse effect on growth. This implies that a policy that boosts food production has favourable impact on growth.

From the long-run model results, the one variable that is highly associated with economic growth is the growth rate in capital stock. According to the evidence presented, a one-percentage point improvement the country's capital stock enhances economic growth by 1.29 per cent. Thus, policies that emphasize expansion of physical capital base of the economy are likely to have a significant positive impact on growth.

The study depicts a negative nexus between financial development, proxied by money supply (M2) as a percentage of GDP, and economic growth contrary to theoretical argument. This result is the product of many years of interest rate controls coupled with high inflation rates in Ghana's economic history, particularly in the 1970s and 1980s. The interest rate controls together with the high rate of inflation established a system of financial repression which weakened the development of the financial market and subjected the allocation of credit to political

patronage (Sowa and Acquaye, 1999). There is therefore the need for policies that support more liberalization of the financial sector.

The empirical results might be useful for policymakers in providing some indication in setting an optimal inflation. However, this study does not estimate that level of inflation that is too low for economic growth. This therefore calls for further research on this topic.

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