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**Research Report**

## Inflation and growth in the WAMZ: Evidence from a threshold analysis

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**WEST AFRICAN  
MONETARY INSTITUTE (WAMI)**

**INSTITUT MONETAIRE DE  
L'AFRIQUE DE L'OUEST (IMAO)**



**WAMI OCCASIONAL PAPER SERIES  
NO. 1**

**INFLATION AND GROWTH IN THE WAMZ:  
EVIDENCE FROM A THRESHOLD ANALYSIS**

**ACCRA, GHANA  
JUNE, 2012**

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# INFLATION AND GROWTH IN THE WAMZ: EVIDENCE FROM A THRESHOLD ANALYSIS

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June 2012

Abstract

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*The focus of this paper was to empirically estimate the threshold levels of inflation in the WAMZ, using the conditional least square technique. The study also identified the determinants of growth in the WAMZ. The empirical analysis uses annual data from 1970-2010 for Ghana, Nigeria and Sierra Leone, and 1980-2010 for the Gambia and Guinea. The results showed that there exists a statistically significant long-run negative relationship between inflation and economic growth for the WAMZ countries. Furthermore, the empirical results strongly suggest the existence of threshold level of inflation for the WAMZ countries, beyond which inflation exert a negative effect on growth. The results revealed an inflation rate of 9 percent as the optimal rate of inflation for the WAMZ countries. The results showed that WAMZ countries threshold inflation rates lie within the convergence criterion of maintaining an inflation rate not exceeding 10 percent. The results are useful for policy makers in providing some clue in setting an optimal inflation target. Policy makers should implement policies aimed at achieving the threshold inflation rate that is consistent with higher economic growth. Thus, it is desirable to keep inflation rate at least within the threshold level in member countries, as it may help maintain sustainable growth. A sustainable increase in growth can be achieved by directing monetary policy towards maintaining price stability.*

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**Key Words:** *Inflation rate, Real GDP, threshold effect, WAMZ countries, Conditional least square*

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## 1.0 INTRODUCTION

The conventional view in macroeconomics holds that low inflation is a necessary condition for fostering economic growth. Over the years, the existence of a link between these two variables has become the subject of considerable interest and debate. It is widely believed that moderate and stable inflation rates promote the development process of a country, and hence economic growth. Low inflation levels promote economic growth by making prices and wages more flexible (Lucas, 1973). On the other hand, high price level may create uncertainty and hamper economic performance. Inflation may also reduce a country's international competitiveness, by making its exports relatively more expensive, thus negatively impacting on the balance of payments. Moreover, inflation can interact with the tax system to distort borrowing and lending decisions. High inflation hampers economic growth due to the adverse impact on efficient distribution of resources by changing relative prices (Fisher, 1993). If high inflation is detrimental to the economy and low inflation is beneficial, then it is natural to ask what the optimal level of inflation for an economy is. This debate raises an interesting policy issue of how much of inflation is too much; that is, how much inflation impedes economic growth. What level of inflation rate is required to propel growth in the West African Monetary Zone (WAMZ)<sup>2</sup> member countries?

Single digit inflation remains one of the primary convergence criteria required for the formation of a monetary union among member states of the WAMZ. But over the years, this objective has become nearly elusive simply because apart from internal country specific economic difficulties that besiege individual countries, external shocks like hikes in oil prices, negative terms of trade, exchange rate depreciation, among others, have invariably worsen the inflation pressure in these countries. The question practitioners and policy makers seek to find answers to is whether should we have individual specific inflation targets based

on specific economic structure of member states instead of single digit inflation for all member states? If so, what rate of inflation should the West African Monetary Institute (WAMI) advise member states to aim at? More generally, at what level of inflation does the relationship between inflation and economic growth become negative?

Although the relationship between inflation and economic growth remains controversial or somewhat inconclusive, several empirical studies confirm the existence of either a positive or negative relationship between these two major macroeconomic variables. Mundell (1965) and Tobin (1965) found a positive relationship between the rate of inflation and the rate of capital accumulation, which in turn, implies a positive relationship to the rate of economic growth. They argued that since money and capital are substitutable, an increase in the rate of inflation increases capital accumulation by shifting portfolio from money to capital, and thereby, stimulating a higher rate of economic growth (Gregorio, 1996). Conversely, Fischer and Modigliani (1978) suggest a negative and nonlinear relationship between the rate of inflation and economic growth through the new growth theory mechanisms (Malla, 1997).

A number of studies attempts to identify threshold levels in the inflation-growth relationship. For instance, Khan and Senhadji (2001) found a 1% threshold level of inflation for industrialized countries, that is, an inflation rate beyond 1% would have negative effects on growth. Using the same countries, Burdekin (2000) found a threshold level of 8%. This result is consistent with the findings of Sarel (1996) which tested for structural break and found that inflation is negatively related to growth after 8% for industrialized countries. Furthermore, while, Ghosh and Phillips (1998) obtained a 2.2% threshold level of inflation for industrialized countries, the results of Judson and Orphanides (1996) showed a 10% threshold level.

While some researchers found a positive relationship between inflation and growth, e.g. Gillman et al (2002), Sweidan (2004), Thirlwall

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<sup>2</sup> The member states of WAMZ include: The Gambia, Guinea, Ghana, Liberia, Nigeria and Sierra Leone.

and Barton (1971), Mallik and Chowdhury (2001), others such as Motely (1994), Andres and Hernando (1997), De Gregoria (1991), found a negative relationship. In view of these conflicting results, it is apparent that the impact of inflation on real output growth is an unresolved issue in the empirical literature.

The purpose of this study is to empirically estimate the threshold (optimal) level of inflation that is conducive for economic growth in the countries of the WAMZ. This paper is an attempt to contribute to the empirical debate vis-à-vis inflation and economic growth nexus. The study employed both time series and panel data techniques in estimating the desirable threshold inflation rate for countries

of the WAMZ, which are characterised by inflationary pressures. The study also attempts to identify the determinants of growth in the WAMZ.

Following the introduction, the rest of the paper is structured as follows. Section two discusses the development and trends in inflation and economic growth in the WAMZ countries. Section three provides the literature on inflation and economic growth including the theoretical and empirical literature. Section four addresses the theoretical framework and methodology, including the model specification, while section five presents the empirical results. The conclusion and policy implications of the study are presented in section six.

## 2.0 INFLATION AND ECONOMIC GROWTH IN THE WAMZ

With the adoption of the convergence criterion aimed at ensuring macroeconomic stability to underpin the strength of the common currency, price development is being tackled with renewed vigor across the WAMZ countries. From a theoretical standpoint, price stability is seen as a recipe for fostering strong economic growth. The WAMZ countries are on the verge of forming a monetary union with a single currency and a common Central Bank, and the attainment of single

digit inflation is considered as one of the convergence criteria for member countries to achieve. The WAMZ economies have experienced accelerated economic growth between 2001 and 2008, compared with the 1990s. In addition, inflationary pressures have also decelerated for most of the countries in the zone during this period. The sub-section provides trend analysis of inflation and real GDP growth for countries of the WAMZ.

### 2.1 The Gambia

In the early 1980s The Gambian economy was beset by series of adverse external and internal shocks that resulted in a decline in economic activities and rising inflation. The country experienced double digit inflation rate, which rose

from an average of 11.3 percent during 1980-84 to 23.7 percent between 1985 and 1989, while real GDP growth declined from an average of 4.6 percent to 3.2 percent during the same period (see Tables 1 & 2).

**Table 1: Inflation rates in the WAMZ**

Country/Year	1980-84	1985-89	1990-94	1995-99	2000-04	2005-10
Gambia	11.3	23.7	7.7	3.7	9.0	4.4
Ghana	70.3	26.3	23.0	32.2	22.4	13.4
Guinea	32.2	35.2	1.3	4.4	11.8	20.6
Liberia	3.3	4.0	3.3	0.7	8.1	8.9
Nigeria	15.9	25.9	35.8	25.4	13.5	11.3
Sierra Leone	39.7	86.2	65.1	26.7	4.0	12.8

Sources: WAMI data base and IFS CD-ROM 2011

**Table 2: Real GDP Growth Rates in the WAMZ**

Country/Year	1980-84	1985-89	1990-94	1995-99	2000-04	2005-10
Gambia	4.6	3.2	2.6	3.6	5.3	6.6
Ghana	-1.2	5.2	4.1	4.4	4.6	6.5
Guinea	1.5	4.3	3.8	4.8	2.7	2.3
Liberia	-2.5	-6.4	-31.0	15.1	0.7	6.6
Nigeria	-3.9	5.7	3.6	2.5	6.2	6.7
Sierra Leone	2.9	-0.6	-2.8	-5.9	14.3	5.9

Sources: WAMI data base and IFS CD-ROM 2011

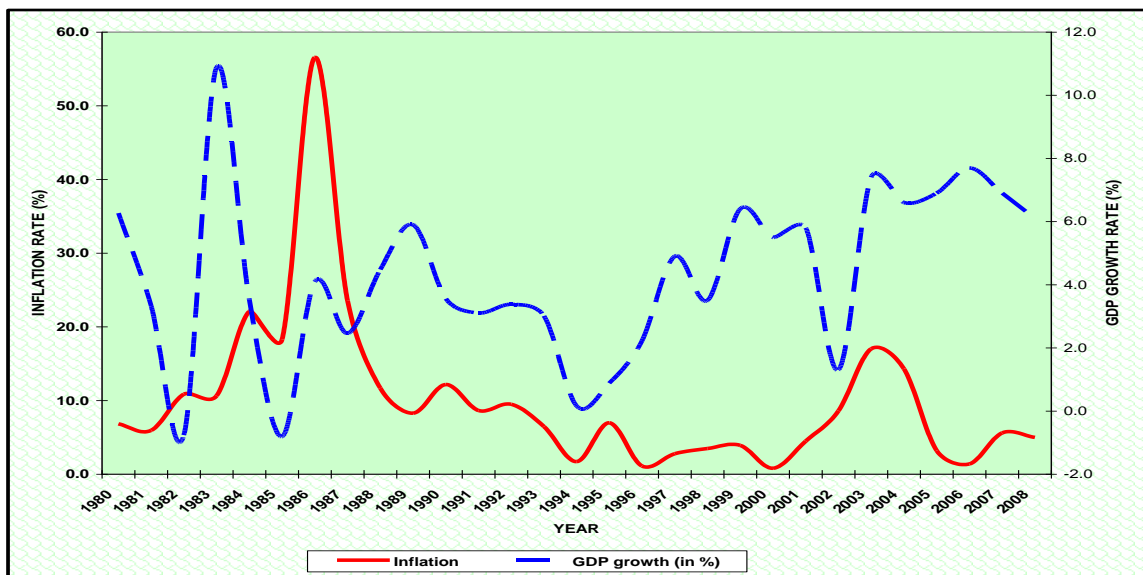
Despite the introduction of the Structural Adjustment Programme (SAP) in 1986 which was aimed at reversing the economic down-turn of the early 1980s and setting the stage for a more stable macroeconomic environment, real GDP growth

remained low in the early 1990s, averaging 2.6 percent during 1990-94. The decline was partly due to slower growth in agricultural output and tourism as well as the Military Coup in 1994, which led to disruption in economic activities in the tourism

sector and suspension of cooperation from donor countries. However, inflation declined significantly during this period. Since 1995, the country has experienced accelerated economic growth, as real GDP growth increased from an average of 3.6 percent during 1995-99 to 6.9 percent between 2005 and 2008, arising from improved agricultural output, increased tourist activities and favourable external sector development, among others. In the

same vein, price stability was also restored, attaining single digit inflation rate between 1995 and 2008. Critical investigation of Figure 1 revealed that for lower levels of inflation rate, there is some element of positive relationship between inflation and real GDP growth, while at higher levels of inflation, an inverse relationship was evident.

**Figure 1: Inflation and Real GDP Growth Rates in the Gambia**



Sources: WAMZ database and IFS year Book

## 2.2 Ghana

Ghana's macroeconomic performance in the early 1980s was sluggish, characterised by high inflationary pressure amidst declining growth. Inflation rate averaged 70.3 percent between 1980 and 1984, largely informed by increased money growth for government deficit financing. To curb the high inflationary pressure, the government instituted price control mechanisms, which subsequently distorted relative prices, caused economic stagnation and severe shortage of goods and consequently resulted in a decline in real GDP growth by -1.2 percent during the period.

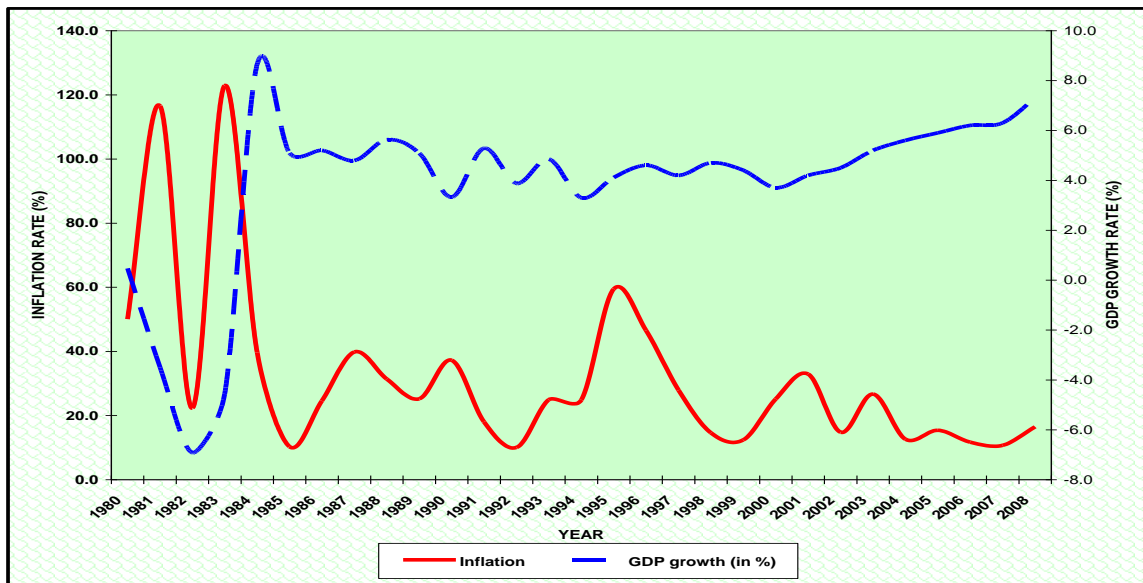
However, the Economic Recovery Programme (ERP) adopted by Ghana in the early 1980s sought to minimize both external and internal imbalances and placed the economy on a path of sustainable growth. Hence between the period 1985 and 1989, the Ghanaian economy grew by 5.2 percent, while inflation decelerated to 26.3 percent. Furthermore, between 1990 and 2008, real GDP growth remained positive, averaging above 4.0 percent. Increased government expenditure on infrastructure, as well as increased economic activities in the agriculture, services, and mining sectors, among others contributed to the positive growth rate during the period. During the period



1990 and 2004, inflation rate remained high averaging above 20.0 percent, largely explained by excessive demand pressure sustained by excessive fiscal expansion and accommodating monetary

growth. The relationship between inflation and real GDP growth seems ambiguous as evident from Figure 2. However the figure showed some inverse relationship with higher levels of inflation rate.

**Figure 2: Inflation and Real GDP Growth Rates in Ghana**



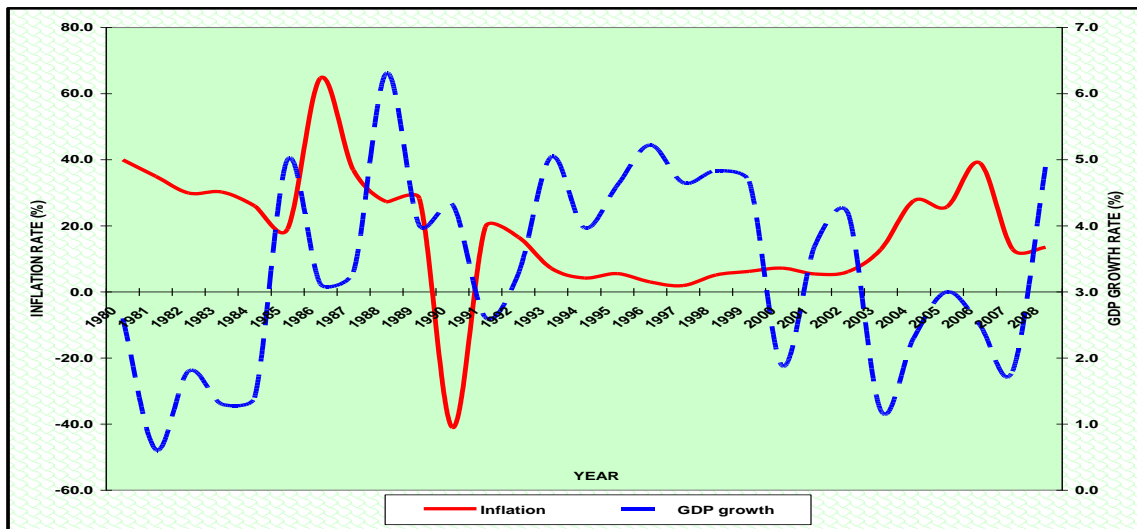
Sources: WAMZ database and IFS year Book

### 2.3 Guinea

Inflation in Guinea was relatively high in the 1980s, increasing from 32.2 percent between 1980 and 1984 to 35.2 percent during 1985 to 1989. The high inflation rate during this period was partly attributed to increased money growth for financing government fiscal deficit, as well as the energy crisis and the persistent depreciation of the Guinean franc. However, inflation decelerated significantly during the 1990s, arising from fiscal and monetary reforms, increased agricultural output and food production, relative stability of the exchange rate and decline in imported prices. Inflationary pressure accelerated between 2000 and 2008, as average inflation increased from 11.8 percent during 2000 and 2004 to 22.8 percent between 2005 and 2008, driven mostly by a rise in non-food prices, exchange rate depreciation and increased money growth.

Despite the hike in inflation rate, the Guinean economy maintained positive growth during the review period, with real GDP growth accelerating from 1.5 percent between 1980 and 1984 to 4.8 percent during 1995 and 1999, arising from increased private sector investment as well as growth in the mining and agricultural sectors. Real GDP growth also increased from 2.7 percent between 2000 and 2004 to 3.1 percent during 2005 and 2008. The growth momentum during the 2000s was due to increased economic activities in the mining, agricultural and services sectors. A critical analysis of Figure 3, revealed some evidence of an inverse relationship between inflation and economic growth in Guinea.

**Figure 3: Inflation and Real GDP Growth Rate in Guinea**



Sources: WAMZ database and IFS year Book

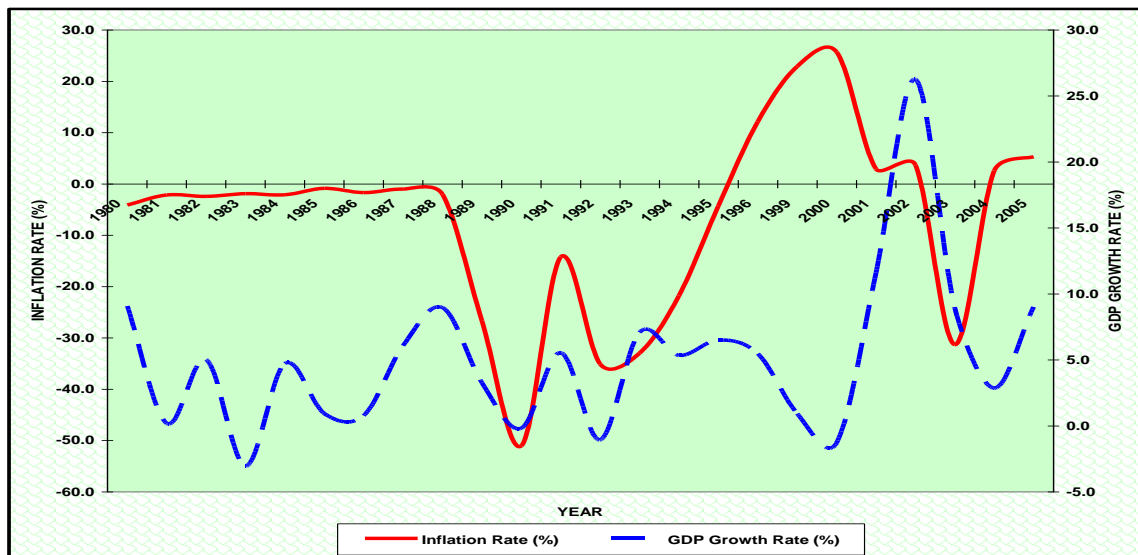
## 2.4 Liberia

Generally, since 1980 the Liberian economy has witnessed low inflationary trend except in 1998 when inflation rate stood above 20.0 percent (see Figure 4). The real GDP growth rate had been in the negative since 1980. The deterioration in the economy was worsened by the first civil war as 5-year average real GDP growth rate declined from -2.5 percent in 1980-84 to -6.4 percent in 1985-89 (the onset of the first civil war) and further down to -31.0 percent during 1990-94. However, the country experienced positive growth between 1995 and 2004. The high growth rates recorded during this period were due to the economic resuscitation and relative peace experienced after the first civil war. Not long, the second civil war (1999-2003) eroded all the economic gains made after the first civil war, and thereby pushing the economy once again into a quagmire. As at end-2003, the economic decay was huge as real GDP growth rate stood at -31.3 percent. The growth rate assumed an upward trajectory (between 2 percent and 8 percent

growth rates) after the second civil war but this was far lower than the growth trajectory after the first civil war (Figure 4).

For Liberia, the relationship between inflation and real GDP growth was not clear in the 1980s and early 1990s as can be seen in Figure 4. Of course, the war period, especially the first civil war, also distorted this relationship greatly. The relationship appeared to be more tilted towards a positive than a negative relationship. During the late 1980s and early 2000s, it appeared there was a negative relationship between inflation and real GDP growth as can be seen from Figure 4. While real GDP growth rate increased after the first civil war, inflation rate declined. During the second civil war, real GDP growth rate decreased, while inflation rate rose to double-digit level. The second post-war period witnessed a blurred relationship between inflation and economic growth.

**Figure 4: Inflation and Real GDP Growth Rates in Liberia**



Sources: WAMZ database and IFS year Book,

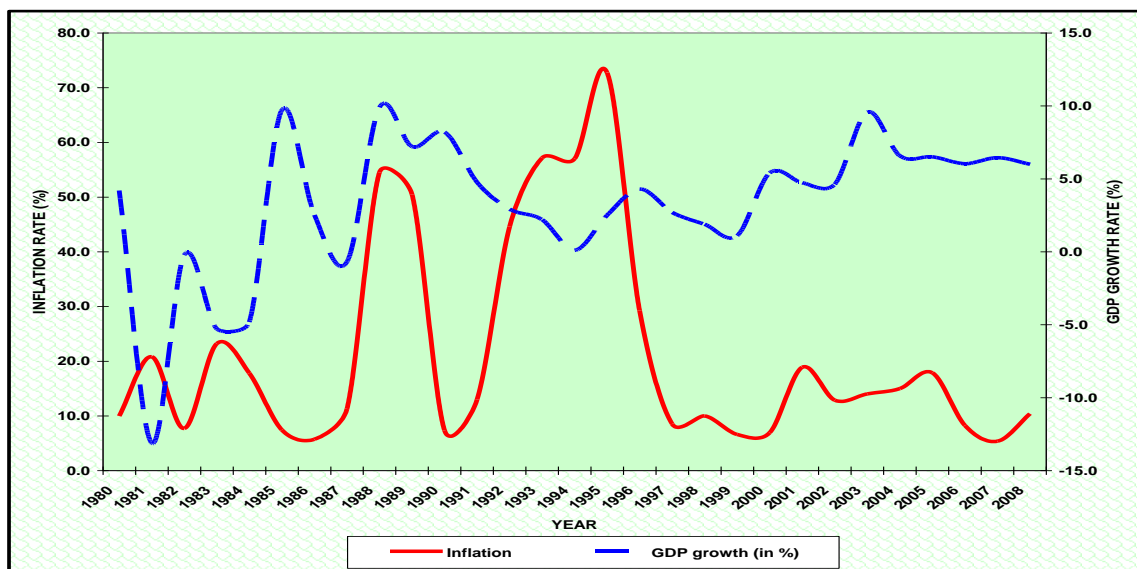
## 2.5 Nigeria

Since the 1980s, the Nigerian economy had experienced episodes of high inflation. From Table 1, inflation rate increased from an average of 15.9 percent between 1980 and 1984 to peak at an average rate of 35.8 percent during 1990 and 1994. The surge in inflation during the 1980s was partly due to collapse in the world oil market, import restrictions, foreign exchange constraints, among others, whilst excess money supply, severe shortage in commodity supply and continuous labour and political unrest following the annulment

of the June 1993 election accounted for the rise in inflation rate in the 1990s.

Real GDP growth which remained negative in the early 1980s, increased to an average of 5.7 percent in the late 1980s, following the adoption of the Structural Adjustment Programme. Real GDP growth remained positive between 1985 and 2008, largely informed by growth in both the oil and non-oil sectors of the economy. An assessment of Figure 5 showed an inverse relationship between inflation and real GDP growth.

**Figure 5: Inflation and Real GDP Growth Rates in Nigeria**



Sources: WAMZ database and IFS year Book, 2008

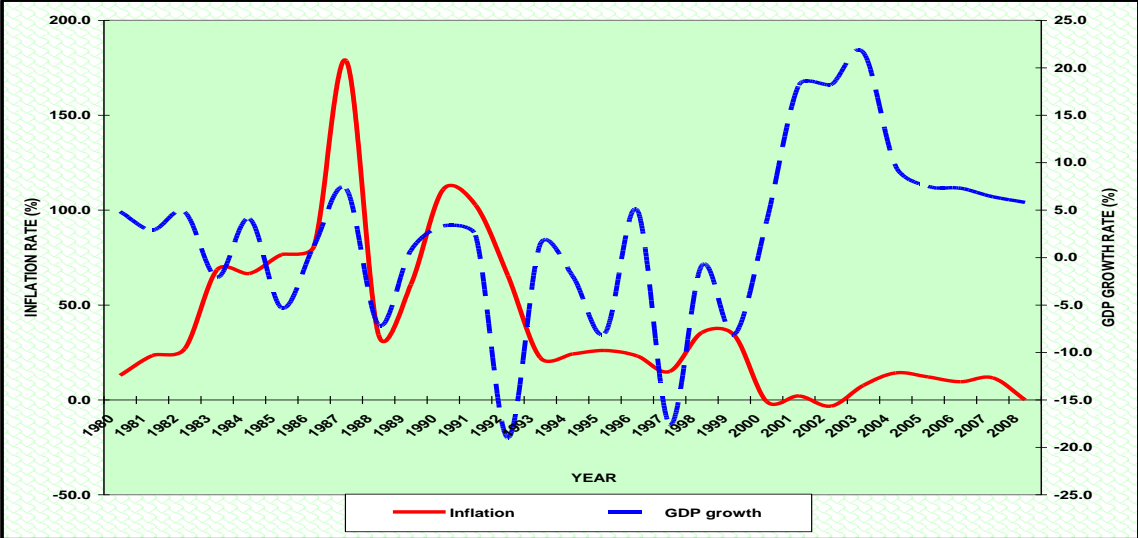
## 2.6 Sierra Leone

Sierra Leone experienced series of inflationary episodes in the 1980s and 1990s. Inflation rate increased from an average of 39.7 percent between 1980 and 1984 to 86.2 percent during 1985 and 1989 (Table 1). Monetization of government fiscal deficit, removal of subsidy following the adoption of SAP as well as the persistent depreciation of the leone accounted for the surge in inflationary pressure in the 1980s. Despite being high, inflationary pressure eased in the 1990s, as average inflation rate decelerated from 65.1 percent between 1990 and 1994 to 26.7 percent between 1995 and 1999. The decline in inflation during the 1990s was partly due to a fall in local demand as factories and businesses scaled down, whilst most banks closed operations to the public. The civil war which officially ended in 2002 ushered in a climate of relative peace and stability. During the period 2000-2008, average inflation dropped significantly, due to increased business and consumer confidence following the restoration of peace and stability.

The country's growth trajectory remained robust in the early 1980s as real GDP growth rate increased

by an average of 2.9 percent between 1980 and 1984, arising from increased economic activities in the mining and industrial sectors, as well as increased private sector investment. However, the positive real GDP growth was short lived as it declined significantly between 1985 and 1999, from -0.6 percent during 1985-89 to -5.9 percent between 1995 and 1999. The average negative real GDP during the 1990s was due to the combined effects of the civil conflict and military coup d'états in April 1992 and May 1997 that led to the disruption of agriculture and mining, and the collapse of public service, health and education. However, despite the negative average real GDP during the 1990s, GDP growth rate was positive in 1992 (1.3%), 1993 (3.0%) and 1996 (5.0%). There was a resurgence of growth in the 2000s with real GDP growth rate averaging 14.3 percent and 6.8 percent, respectively between 2000-2004 and 2005-2008. Whilst an inverse relationship was maintained for most of the period between inflation and real GDP growth, a positive relationship remained prominent since 2004.

**Figure 6: Inflation and Real GDP Growth Rates in Sierra Leone**



Sources: WAMZ data base and IFS year Book, 2008

## 3.0 INFLATION THRESHOLD AND ECONOMIC GROWTH: THEORY AND EVIDENCE

### 3.1 Theoretical Review

Theoretical literature on the relationship between inflation and economic growth reach a variety of conclusions about the responsiveness of output growth to inflation. This paper examines several different economic theories and empirical studies on the inflation-economic growth nexus. A review of the theoretical literature is pursued:

#### *Classical Growth Theory*

The Classicalists, championed by the works of Adam Smith, David Ricardo, and Karl Marx among others, presumed a supply-side driven growth model. Supply is specified as a function of land, labour, and capital. Consequently, output growth is driven by population growth, investment growth, and land growth<sup>3</sup>, as well as the increase in the overall productivity. Smith assumed a self-reinforcing growth (increasing return to scale) and that savings creates investment, hence growth. Further assumption in this postulate is that income distribution, fast or slow, determines the rate at which the economy grows. Profit declines, not necessarily because of decreasing marginal product of labour, but because competition for labour drives wages up. Implicit assumption here is the suggestion of a negative relationship between inflation and growth through higher wage cost.<sup>4</sup>

#### *Keynesian Theory*

Keynesians' explanation of the long run economic growth path is implicitly captured in the business cycle concept (a short run phenomenon) developed

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<sup>3</sup> *Cultivating more of the land will bring about growth. Ricardo later positioned the feature of land input being variable in quality and fixed in quantity. But, in the assumption of Adam Smith, more land could be conquered or annexed. This suggests that Adam Smith, by implication, preached colonialism.*

<sup>4</sup> *To the extent that inflation is seen as a tax on profit*

within the aggregate demand (AD) and aggregate supply (AS) framework. According to this model, AS is assumed to be upward sloping in the short run and changes in the demand side of the economy affect both prices and output, arising from changes in expectations, labour force, fiscal and monetary policy, among others. They therefore advocated that there exist a positive relationship between inflation and output, such that even if there is an increase in prices of goods in the economy, output would not decline because producers have to satisfy the demand requirements of consumers.

#### *Endogenous Growth Theory*

According to this theory, economic growth depends on the rate of return on capital, which is inversely related to inflation. Inflation decreases the rate of return and this in turn reduces capital accumulation and hence reduces growth rate. Alternative models examine how inflation directly affects capital accumulation and hence output growth. High inflation drives down the return to deposits, resulting in slower rate of deposits accumulation. Given that capital is a fraction of deposits, decline in deposit rates will result in slow capital accumulation and hence lower output growth.

#### *Neo-Classical Theory*

The Neo-classical theory dates back to the works of Solow (1956), Swan (1956) and Mundell (1963). The theoretical review in the neoclassical model produces different results in the inflation-growth nexus. According to Mundell's model, an increase in inflation reduces people's wealth, arising from a fall in the rate of return on individual's real money balances. People save more by switching to financial assets in order to accumulate the desired wealth, thereby increasing asset prices, resulting in a decline in the real interest rate. Increased savings result to greater capital accumulation and hence faster output growth. The Tobin's (1965) framework also revealed a positive relationship

between inflation and economic growth. It showed that higher inflation increases output growth although temporarily. Tobin's model suggests that individual's hold their asset in interest earning assets during inflationary period. This leads to greater capital intensity and hence promotes economic growth.

A variant of the neo-classical theory pioneered by Stockman (1981) found a negative relationship between inflation and economic growth. According to the Stockman model, increase in the inflation rate results in a lower steady state level of output. High inflation reduces the purchasing power of money, thereby forcing people to reduce their purchases of both cash goods and capital, resulting in a fall in the steady-state level of output.

## 3.2 Empirical Review

### *Inflation-Growth Relationships*

While the controversies over inflation-economic growth linkage is yet unsettled, an appreciable consensus has been established. As Bruno and Easterly's (1995) summary review of inflation-growth suggest, theories on the subject can be classified into three segments across the decades of their emergence. First, is the traditional 1960s view of high growth-low inflation Phillips curve era, when inflation was believed to be positively correlated with economic growth in the short run, and to some degree, the long run. Second are the 1970s and the 1980s inflationary experiential era, which focused mainly on the short run behaviour. During this period, the consensus as restated by Bruno-Easterly (1995) was that "stabilisation of hyperinflation had little output costs, whereas sterilisation of mere high inflation was indeed costly." The presumption of the 1980s was a positive short-run relationship between growth and inflation. The third wave was the 1990s and the new-growth theorist postulating an inverse relationship in the inflation-growth nexus. This is especially so, because the new-growth theorists are more concerned with long run relationship. Not only will persistent inflation reduces the level and/or growth rate of GDP in the long run (Barro, 1991; Cozier and Selody, 1992 and Fisher, 1993),

in the face of a tax system not fully indexed, even a relatively low inflation imposes significant deadweight losses on the economy (Feldstein, 1996).

Barro (1997) used a panel data for 100 countries over the period 1960-1990 and estimated growth regression using Instrumental Variables (IV) technique. He found a negative relationship between inflation and economic growth. The result showed that a 10 percent inflation rate reduces real GDP per capita by 0.2% per year. Similarly, Bruno and Easterly (1995) studied inflation-growth relationship for 26 countries over the 1961- 1992 period. They found a negative relationship between inflation and growth when level of inflation exceeds some threshold. At the same time they showed that impact of low and moderate inflation on growth is quite ambiguous.

Fischer (1993) used cross-sectional data covering 93 countries to investigate the non-linear relationship between inflation and growth, using the growth accounting framework in order to detect the channels through which inflation impacts on growth. He found that inflation influences growth by decreasing productivity growth and investment. The result also showed that the effect of inflation is non-linear with breaks at 15 and 40 percent. In a related study, Sarrel (1995) used a panel data sample of 87 countries over 21 years (1970-1990) to investigate the relationship between inflation and growth with a fixed effect technique framework. He found evidence of structural break in interaction between inflation and growth. However, the main findings of his study was that the estimated threshold level was 8 percent, and an inflation rate exceeding this threshold would lead to negative, powerful and robust impact of inflation on growth.

Khan and Senhadji (2001) investigated the inflation-growth interaction using a panel data set on 140 countries (both industrial and developing) over the period 1960-1998. They employed the method of non-linear least squares to deal with non-linearity and non-differentiability of the inflation threshold level in growth regression. Their results showed an inverse relationship between inflation and growth, with estimates of the inflation

threshold levels of 1-3 percent for developed and 11-12 percent for developing countries. Mallik and Chowdhury (2001) also examined 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 Lanka, using co-integration and error correction techniques. Their results showed that the relationship between inflation and economic growth was positive and statistically significant for all four countries. They also found that the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates.

Lee and Wong (2005) estimated the threshold levels of inflation for Taiwan and Japan using quarterly data set from the period 1965–2002 for Taiwan and 1970–2001 for Japan. Their estimation of the threshold models suggests that an inflation rate beyond 7.25 per cent is detrimental for the economic growth of Taiwan. On the other hand, they found two threshold levels for Japan, which are 2.52 per cent and 9.66 per cent. This suggests that inflation rate below the estimated level of 9.66 per cent is favorable to economic growth and beyond this threshold value it is harmful for the economic growth.

Mubarik (2005) estimated the threshold level of inflation for Pakistan using an annual data set from the period between 1973 and 2000. He employed the Granger Causality test as an application of the threshold model and the relevant sensitivity analysis of the model. His estimation of the threshold model suggests that an inflation rate beyond 9 percent is detrimental for the economic growth of Pakistan. This in turn, suggests that inflation rate below the estimated level of 9 percent is favorable for economic growth. In the same spirit, Ahmed and Mortaza (2005) explored

Bangladesh annual data to investigate its experience regarding inflation-economic growth relationship. The paper employed Engle and Granger (1987) co-integration procedure and error correction model to evaluate the short-run and long-run features in inflation-growth relationship; subsequently, it adopts Khan and Senhadji (2001) model to estimate the threshold level for inflation rate. The finding is consistent with the consensus of a long-run (strong) negative relationship. The study posited a 6 percent threshold level of inflation, above which inflation adversely affects economic growth. Faria and Carneiro (2001) also investigated the relationship between inflation and economic growth in the context of Brazil, a country that had experienced persistent high inflation. Analyzing a bivariate time series model (i.e., vector auto regression) with annual data for the period between 1980 and 1995, they found a negative relationship between inflation and economic growth in the short run. However, their result showed that inflation does not affect economic growth in the long run. Their empirical results also support the *super-neutrality* concept of money in the long run

The review of literature indicates a prevalence of significant differences among the results of empirical studies, as the effects of inflation on growth are quite different across countries. Such divergences of results were quite wide in cases of empirical studies which concentrated on estimation of threshold rate of inflation for individual countries. These studies generally found that for economies with initially low rates of inflation, modest increases in the rate of inflation do not affect long-run rates of real economic growth. But for economies with initially high rates of inflation, further increases in the inflation rate have adverse effects on real economic growth.



## 4.0 THEORETICAL FRAMEWORK AND METHODOLOGY

This study adopts the Keynesian Aggregate Demand (*AD*) and Aggregate Supply (*AS*) framework to explain the inflation – growth relationship. The rationale for this framework is based on the fact that prices and output are significantly determined by *AD* and *AS*. The *AD* is derived from an open-economy IS-LM framework where the aggregate demand curve is a locus of points showing the price-output combinations that ensure internal and external equilibrium in the economy. The internal equilibrium is obtained when the goods and the money markets are in simultaneous equilibrium. The external equilibrium is derived from the Balance of Payments (*BOP*)

equilibrium. Unlike the classical school of thought that holds that the economy is always in full equilibrium (implying vertical Aggregate Supply curve), this Keynesian framework postulates that the economy can be below full employment level, at least in the short run, implying upward sloping Aggregate Supply curve. The *AS* curve is derived from labour market conditions using the price-setting and Phillips' curve relationships together with the Okun's Law. Algebraically, the relationship between price (inflation) and output (growth) can be derived through the *AD* and *AS* formulations as outlined below.

### 4.1 Derivation of Price-Output Relationship in Aggregate Demand Framework

Suppose the open-economy flexible price IS-LM-BP framework is illustrated by the following equilibrium relationships:

$$IS: \quad r = A + \alpha_1 (E/P) - \alpha_2 (Y/P), \quad \alpha_1, \alpha_2 > 0 \quad (\text{Product market}) \quad (1)$$

$$LM: \quad r = \beta_1 (D/P) + \beta_2 (R/P) + \beta_3 (Y/P), \quad \beta_1, \beta_2, \beta_3 > 0 \quad (\text{Money market}) \quad (2)$$

$$BP: \quad R/P = B + \delta_1 (E/P) - \delta_2 (Y/P), \quad \delta_1 > 0; 0 < \delta_2 < 1 \quad (\text{External Sector}) \quad (3)$$

Where

$r$  = Real interest rate

$E/P$  = Real exchange rate

$Y/P$  = Real output

$D/P$  = Real domestic credit

$R/P$  = Real foreign reserves

$P$  = Price level

$A, B$  = A set of autonomous or exogenous variables

It must be noted that the external sector equilibrium condition is derived on assumption that there is perfect capital mobility across countries; hence, the international interest rate equals the

domestic interest rate. Thus, the balance of payments equilibrium is determined solely by the current account (trade) balance.

Substituting equation 3 into 2 gives:

$$LM: \quad r = \beta_1 (D/P) + \beta_2 [B + \delta_1 (E/P) - \delta_2 (Y/P)] + \beta_3 (Y/P) \quad (4)$$

Re-arranging equation 4 yields:

$$LM: r = U + \gamma_1(D/P) + \gamma_2(E/P) + \gamma_3(Y/P) \quad (5)$$

Where

$$U = \beta_2 B, \quad \gamma_1 = \beta_1, \quad \gamma_2 = \beta_2 \delta_1, \quad \gamma_3 = \beta_3 - \beta_2 \delta_2$$

Solving equations 1 and 5 simultaneously gives:

$$Y/P = V + \phi_1(E/P) - \phi_2(D/P) \quad (6)$$

Where  $V$  is a set of autonomous or exogenous variables  $(A - U)/(\gamma_3 + \alpha_2)$ ,

$$\phi_1 = (\alpha_1 - \gamma_2)/(\gamma_3 + \alpha_2),$$

$$\phi_2 = -\gamma_1/(\gamma_3 + \alpha_2)$$

Assuming that each term, apart from  $V$ , is time dependent, equation 6 can be written in growth terms (after taking the logarithmic form and differentiating each term with respect to time) as:

$$y - \pi = \phi_1(e - \pi) - \phi_2(d - \pi) \quad (7)$$

$$\text{Where } y = \frac{1}{Y} * \frac{\partial Y}{\partial t}; \quad \pi = \frac{1}{P} * \frac{\partial P}{\partial t};$$

$$e = \frac{1}{E} * \frac{\partial E}{\partial t}; \quad d = \frac{1}{D} * \frac{\partial D}{\partial t};$$

Re-arranging equation 7 gives:

$$y = \phi_1 e - \phi_2 d + (1 - \phi_1 + \phi_2) \pi \quad (8)$$

If  $\phi_1 > 1 + \phi_2$ , according to equation 8, the relationship between output growth and inflation rate in the aggregate demand framework will be negative. Otherwise, the relationship between output growth and inflation will be positive.

## 4.2 Derivation of Price-Output Relationship in Aggregate Supply Framework

The labour market developments give rise to wage and price settings. These in turn determine the short-run aggregate supply in the product market. The key assumption here is that in the long-run, the aggregate supply function is perfectly inelastic.

Labour Cost Function:

$$w = \pi^* - \alpha_1(u - u^*) + \alpha_2 \eta, \quad \alpha_1 > 0, \quad 0 \leq \alpha_2 \leq 1 \quad (9)$$

$$\text{Mark-up Price Function: } \pi = w - \eta \quad (10)$$

Where  $w$  = wage rate,  $\pi$  = the rate of inflation,  $\pi^*$  = expected rate of inflation,  $u$  = actual rate of unemployment,  $u^*$  = natural rate of unemployment,  $\eta$  = growth rate of labour productivity,  $y$  = growth rate of output, and  $y^*$  = potential (optimal) growth rate of output.

$$\text{Aggregate Supply Function: } \pi = \pi^* + \alpha_1 \beta (y - y^*) \quad (13)$$

From equations 9 and 10, the Phillips Curve can be derived by substituting equation 9 into equation 10 to obtain equation 11:

Phillips Curve:

$$\pi = \pi^* - \alpha_1(u - u^*) - (1 - \alpha_2)\eta \quad (11)$$

Okun's Law:

$$u - u^* = -\beta(y - y^*), \quad \beta > 0 \quad (12)$$

By substituting equation 12 into equation 11, and assuming labour productivity growth is zero, we derive the short-run aggregate supply function which is given as:

Making  $Y$  the subject of equation 13 gives

$$y = y^* + (1/\alpha_1\beta)(\pi - \pi^*) \quad (14)$$

If expected inflation rate is assumed to be the optimal inflation rate, then equation 14 does not only establish a positive relationship between output growth and inflation but also highlights the fact that when realised inflation rate is below the optimal rate, there would be a negative relationship between output growth and optimal inflation differential, and vice versa. Thus, within the

aggregate supply framework, it is clear that inflation rate has a positive relationship with output and, more importantly, there is a threshold within which inflation rate will have a positive impact on growth rate of output, and beyond which inflation rate will have a negative impact on output growth rate.

Re-stating the full employment output (potential output) as a function of factor inputs (since at full employment all factor inputs are assumed to be fully employed), equation 12 can be re-specified as

$$y = y(k^*, l^*) + (1/\alpha_1\beta)(\pi - \pi^*) \quad (15)$$

Where  $k^*$  and  $l^*$  are full employment (steady state) growth rates of capital and labour respectively.

The model for the study is adopted from the model developed by Khan and Senhadji (2001) which is based on the AD-AS framework and has been widely used in the literature (E.g. Ahmed and Mortaza, 2005; Mubarik, 2005; Seleteng, 2005) to estimate optimal inflation for both developed and developing economies. However, some modifications were made to the existing model

taking into consideration the consistency in the theoretical framework as well as the structure of the WAMZ economies. These modifications relate essentially to the openness of the WAMZ economies as well as their political and economic developments. The general empirical threshold model is specified as follows:

$$GROWTH_t = \alpha_0 + \alpha_1 INF_{t-s} + \alpha_2 D_2(DINF_t) + X\beta + \varepsilon_t \quad (16)$$

Where

$$GROWTH = \Delta LN(RGDP) \equiv \text{Real GDP growth rate}$$

$$INF = \Delta LN(CPI) \equiv \text{Domestic inflation rate, current and lagged values}$$

$DINF = \Delta LN(CPI) - K \equiv$  The differential between observed inflation rate ( $\Delta LN(CPI)$ ) and the assumed optimal inflation rate ( $K$ )

$$D_2 = \begin{cases} 1 & \text{If } \Delta LN(CPI) > K \\ 0 & \text{otherwise} \end{cases}$$

$X = \{GROWTH_{t-p}, INV_{t-s}, APOP_{t-s}, REX_{t-s}, TOT_{t-s}, OPEN_{t-s}, GEXP_{t-s}, OIL_{t-s}\} \equiv$  A row vector of other explanatory variables such as the lags of  $GROWTH$ ,

$$INV = \Delta LN(INVESTMENT) \equiv \text{Growth rate of real investment}$$

$APOPN = \Delta LN(POPULATION) \equiv$  Active population growth rate

$REX = \Delta LN(EXCHANGERATE) \equiv$  Real rate of exchange rate appreciation/ depreciation,

$TOT = EXPORT\ VALUE\ INDEX / IMPORT\ VALUE\ INDEX \equiv$  Terms of trade

$OPEN = (EXPORT + IMPORT) / GDP \equiv$  Openness index

$GEXP = \Delta LN(GOVEXPENDITURE) \equiv$  Growth rate of government expenditure

$OIL = \Delta LN(OILREVENUE) \equiv$  Growth rate of oil revenue in real terms

$\beta \equiv$  A column vector of coefficients

$t \equiv$  Time indicator;  $p = 1, 2, \dots, n$ ;  $s = 0, 1, 2, \dots, n$ ; and  $\varepsilon =$  Error term

### 4.3 A Priori Expectations

Theoretically, the following relationships are expected to emerge:

- Inflation is expected to have a positive impact on real GDP growth at low levels. However, if inflation rate exceeds the optimal rate needed for growth, it will begin to have a negative impact on real GDP growth. Hence, the expected signs of the relevant coefficients are  $\alpha_1 > 0$ ,  $\alpha_2 < 0$ .
- Lags of real GDP growth will have positive impact on current level of real GDP growth.
- Investment growth is expected to have a positive impact on real GDP growth, though some of its lags may have negative coefficients.
- Population growth is also expected have positive impact on real GDP growth, though some of its lags may have negative coefficients.
- Exchange rate depreciation is expected to improve real GDP growth. However, excessive depreciation may also be harmful to growth or the J-curve theory may apply. Hence, the sign of real exchange rate depreciation may be indeterminate.
- Terms of trade and openness index are expected to have positive impact on real GDP

growth, though some of their lags may have negative coefficients.

- Government expenditure is expected to promote real GDP growth, though some of its lags may have negative coefficients.
- Oil revenue growth (applicable only in the case of Nigeria as at now) is expected improve real GDP growth, but the Dutch Disease problem may surface. Hence, the sign of the relevant coefficient is indeterminate *a priori*.

### 4.4 Data Description and Transformation

Data were sourced from WDI CD-ROM (2007), IFS CD-ROM (2007), ADI CD-ROM (2009) and World Economic Outlook Database. Based on the availability of data, the study utilized annual data ranging from 1970-2010 for Ghana, Nigeria and Sierra Leone and 1980-2010 for the Gambia, Guinea and Liberia. Apart from variables which are ratios, all the variables undergo logarithmic transformation and definition. Nominal values are transformed into real values. US producer price index is used to compute the bilateral real exchange rates for the various countries.

## 4.5 Estimation Techniques

To estimate the threshold level of inflation, the study employed the conditional least square technique. The idea is to minimize the sum of squared residuals or maximize the coefficient of determination in the growth regression (equation

16), conditional on a particular threshold level, repeating the procedure for different threshold values from 1 percent to 20 percent. Stationarity tests are conducted on the model variables using Augmented Dickey-Fuller (ADF) unit root test techniques. The estimations are carried out using Eviews version 6.

## 5.0 PRESENTATION AND ANALYSIS OF RESULTS

In this section, empirical results of unit root tests, granger causality tests and the optimal inflation estimation are presented and analyzed. The estimation was carried out for each of the six member countries of the WAMZ.

### 5.1 Unit Root Test Results

The unit root test results are presented in Appendix 1. For the Gambia, all the model variables were found to be stationary at levels. In the model for Ghana, all the variables were found to be stationary at levels except the terms of trade which was found to be integrated of order-one. Apart from active population growth, inflation rate and openness index which were integrated of order one, all the variables in the Guinean model were stationary at levels. The variables in the Liberian model have no unit roots except active population growth which was integrated of order-one. For Nigeria, all the variables were found to be stationary at levels, except terms of trade which was integrated of order-one. None of the variables in the Sierra-Leonean model has a unit root.

### 5.2 Optimal Inflation Estimation Results for the WAMZ countries

#### 5.2.1 The Gambia

The results revealed that, apart from real investment growth, all the variables had significant impact on real GDP growth in the Gambia over the period (Table 3). Inflation rate had positive impact on real GDP growth. However, optimal inflation differential had a negative impact on real GDP growth. The estimated model satisfied all the diagnostic tests except the residual normality test. The model had an explanatory power (coefficient of determination) of 85.2 percent at the least assumed optimal inflation rate of 1 percent. After varying the assumed optimal inflation rate, the explanatory power of the model increased until it reached a peak of 86.7 percent (while residual sum of squares attained its minimum of 0.002348) at the assumed optimal rate of 9 percent. Further increases in the assumed optimal rate led to a decline in the coefficient of determination and a rise in the residual sum of squares. This result is consistent with the findings of Mubarak (2005) for Pakistan. The estimation results therefore suggest that the optimal inflation rate for the Gambia based on the 1980-2006 data is 9 percent.

**Table 3: Optimal Inflation Results for the Gambia (Dependent Variable: RGDP)**

Assumed Optimal Inflation	Explanatory Variables	Coefficients	Probability of Significance	Explanatory Power/ RSS
5%	C	0.139853	0.0130	<b>R<sup>2</sup>: 0.858542</b>
	DCPI(-2)	0.123502	0.0440	<b>RSS: 0.002495</b>
	D5*(OPINF5-DCPI)	-0.060428	0.3014	
	DAPOP	-44.25053	0.0069	
	DAPOP(-1)	73.96820	0.0069	
	DAPOP(-2)	-37.94490	0.0052	
	DREX	0.060005	0.0207	
	DREX(-1)	0.041808	0.1130	
	TOT	0.121154	0.0117	
	OPEN(-1)	0.142250	0.0001	
	OPEN(-2)	-0.095667	0.0045	
	DRINV	0.012542	0.6308	

<b>8%</b>				
	C	0.132697	0.0145	<b>R<sup>2</sup>: 0.865794</b>
	DCPI(-2)	0.133155	0.0326	<b>RSS: 0.002367</b>
	D8*(OPINF8-DCPI)	-0.087916	0.1957	
	DAPOPN	-45.64580	0.0048	
	DAPOPN(-1)	74.81826	0.0054	
	DAPOPN(-2)	-37.40990	0.0046	
	DREX	0.057781	0.0196	
	DREX(-1)	0.041666	0.1029	
	TOT	0.123101	0.0094	
	OPEN(-1)	0.144752	0.0001	
	OPEN(-2)	-0.094485	0.0039	
	DRINV	0.016832	0.5528	
<b>9%</b>				
	C	0.131313	0.0154	<b>R<sup>2</sup>: 0.866854</b>
	DCPI(-2)	0.136709	0.0295	<b>RSS: 0.002348</b>
	D9*(OPINF9-DCPI)	-0.093460	0.1839	
	DAPOPN	-45.48218	0.0046	
	DAPOPN(-1)	74.30529	0.0053	
	DAPOPN(-2)	-37.05276	0.0048	
	DREX	0.057905	0.0185	
	DREX(-1)	0.042854	0.0927	
	TOT	0.123470	0.0090	
	OPEN(-1)	0.145628	0.0000	
	OPEN(-2)	-0.094917	0.0037	
	DRINV	0.017319	0.5404	
<b>10%</b>				
	C	0.132102	0.0148	<b>R<sup>2</sup>: 0.866356</b>
	DCPI(-2)	0.138790	0.0287	<b>RSS: 0.002357</b>
	D10*(OPINF10-DCPI)	-0.094799	0.1894	
	DAPOPN	-45.17413	0.0048	
	DAPOPN(-1)	73.88947	0.0055	
	DAPOPN(-2)	-36.96670	0.0049	
	DREX	0.058466	0.0172	
	DREX(-1)	0.043848	0.0865	
	TOT	0.123629	0.0091	
	OPEN(-1)	0.146095	0.0001	
	OPEN(-2)	-0.095457	0.0036	
	DRINV	0.017658	0.5340	

Source: WAMI Staff Computations

The results further indicate that the determinants of real GDP growth, in the Gambia over the period 1980-2010 were inflation, active population growth rate, real exchange rate, terms of trade and openness index. Current active population growth rate had a negative impact on real GDP growth, while in dynamic terms; active population had a

positive impact on real GDP growth. However, the overall combined growth effect of active population growth on real GDP growth was negative. This implies that the active population growth rate was above what was required to propel growth in the Gambian economy.

Real exchange rate depreciation had a positive impact on real GDP growth rate over the study period. Increasing (favourable) terms of trade also had a positive impact on real GDP growth in the Gambia. In static terms, openness index had a positive impact on real GDP, while in dynamic terms; it had a negative impact on real GDP growth. However, the overall combined effect of openness on real GDP was found to be positive. These results suggest that openness of the Gambian economy to the rest of the world is relevant for stimulating economic growth

## 5.2.2 Ghana

In the case of Ghana, the results showed that apart from real investment growth, the coefficients of all other variables were statistically significant at the conventional level (Table 4). While in dynamic terms, the coefficient of inflation rate was found to be positive validating related previous results by Adenutsi (2011), optimal inflation differential had a negative impact on real GDP growth. The estimated model was consistent with economic theory and also satisfied all the diagnostic tests. The result also showed that 90.1 percent of the variations in real GDP growth in Ghana at the least

assumed optimal inflation rate of 1 percent is accounted for by the explanatory variables. After varying the assumed optimal inflation rate, the explanatory power of the model rose, reaching a peak of 90.7 percent at the assumed optimal rate of 10 percent, while the residual sum of squares declined to its minimum of 0.006239. Further increases in the assumed optimal rate beyond 10 percent led to declines in the explanatory power and an increase in the residual sum of squares. A similar result was obtained by Seleteng (2005) for Lesotho. Thus, the optimal inflation rate for Ghana based on the 1970-2006 data is 10 percent.

In addition to inflation rate, the key determinants of real GDP growth rate in Ghana over the study period were active population growth rate, terms of trade, the real exchange rate and the dynamics of real GDP growth. Past level of real GDP growth had significant impact on current level of real GDP growth. This suggests that boosting economic growth in the current period; it will have ripple effect on economic growth in future. Active population growth had a negative impact on real GDP growth rate in static terms but a positive impact in dynamic terms. Overall economic growth impact of active population growth was positive.

**Table 4: Optimal Inflation Results for Ghana: (Dependent Variable: RGDP)**

Assumed Optimal Inflation	Explanatory Variables	Coefficients	Probability of Significance	Explanatory Power/ RSS
5%	C	-0.215927	0.0000	<b>R<sup>2</sup>: 0.901316</b>
	DRGDP(-1)	0.512606	0.0000	<b>RSS: 0.006632</b>
	DCPI	3.978730	0.0000	
	D5*(DCPI-OPINF5)	-0.039671	0.0000	
	DAPOP(-1)	11.11371	0.0000	
	DAPOP	-10.05160	0.0000	
	DRINV(-3)	0.029343	0.1644	
	DTOT(-1)	0.067691	0.0016	
	DREX(-3)	-0.049632	0.0022	
	DUM2	0.014480	0.0240	
AR(1)	-0.442080	0.0611		
9%	C	-0.215927	0.0000	<b>R<sup>2</sup>: 0.901316</b>
	DRGDP(-1)	0.512606	0.0000	<b>RSS: 0.006632</b>
	DCPI	2.215592	0.0000	
	D9*(DCPI-OPINF9)	-0.022039	0.0000	
	DAPOP(-1)	11.11371	0.0000	
	DAPOP	-10.05160	0.0000	
	DRINV(-3)	0.029343	0.1644	



	DTOT(-1)	0.067691	0.0016	
	DREX(-3)	-0.049632	0.0022	
	DUM2	0.014480	0.0240	
	AR(1)	-0.442079	0.0611	
<b>10%</b>	C	-0.216431	0.0000	<b>R<sup>2</sup>: 0.907165</b>
	DRGDP(-1)	0.512216	0.0000	<b>RSS: 0.006239</b>
	DCPI	2.005379	0.0000	
	D10*(DCPI-OPINF10)	-0.019961	0.0000	
	DAPOP(-1)	11.18074	0.0000	
	DAPOP	-10.11588	0.0000	
	DRINV(-3)	0.029593	0.1512	
	DTOT(-1)	0.067483	0.0014	
	DREX(-3)	-0.051531	0.0012	
	DUM2	0.016081	0.0107	
	AR(1)	-0.435518	0.0673	
<b>11%</b>	C	-0.211652	0.0000	<b>R<sup>2</sup>: 0.906874</b>
	DRGDP(-1)	0.524072	0.0000	<b>RSS: 0.006258</b>
	DCPI	1.775747	0.0000	
	D11*(DCPI-OPINF11)	-0.017719	0.0000	
	DAPOP(-1)	11.35129	0.0000	
	DAPOP	-10.23745	0.0000	
	DRINV(-3)	0.033163	0.1146	
	DTOT(-1)	0.064493	0.0017	
	DREX(-3)	-0.058770	0.0003	
	DUM2	0.019481	0.0033	
	AR(1)	-0.382448	0.1233	

Source: WAMI Staff Computations

The coefficient of terms of trade was positive as expected, but the lag of the real exchange rate had a negative impact on economic growth, implying that in dynamic terms real exchange rate depreciation was depressed economic growth in Ghana. The dummy variable had a significant positive impact on real GDP growth. This suggests that the reforms in the 1980s and 1990s had significant impact on economic growth in the Ghanaian economy. Overall, the Ghanaian economy could benefit greatly from improvement in the terms of trade but effort must be made to check the negative impact of trade openness and the pass-through effects of real exchange rate depreciation.

### 5.2.3 Guinea

In Guinea, the results showed that the coefficients of the explanatory variables significantly explained

variations in real GDP growth in Guinea (Table 5). Inflation rate had positive impact on real GDP growth. However, optimal inflation differential had a negative impact on real GDP growth. The estimated model passed all the diagnostic tests except the serial correlation test. Correlation-robust model was, therefore, estimated to take account of the serial correlation. The diagnostic test indicates that 84.0 percent of the variation in the dependent variable (with residual sum of squares of 0.000506) at the least assumed optimal inflation rate of 1 percent is accounted for by the explanatory variables. Increasing the assumed optimal inflation rate led to an increase in the explanatory power of the model until it reached a peak of 84.1 percent (with the residual sum squares reaching a minimum of 0.000503) at the assumed optimal rate of 5 percent. Further increases in the assumed optimal rate led to declines in the coefficient of determination, and an increase in the residual sum squares.. Hence, the empirical estimates point to an optimal inflation rate of 5 percent for Guinea.

The other determinants of real GDP growth rate in Guinea were active population growth rate, real investment growth rate, real exchange rate and terms of trade. Active population growth rate had a positive impact on real GDP growth in dynamic terms. Real investment growth rate also had a positive effect on real GDP growth rate in dynamic

terms. While real exchange rate depreciation had an overall combined positive impact on real GDP growth, the terms of trade had both positive and negative influences in dynamic and static terms respectively. However, the overall effect of terms of trade on real GDP growth was found to be negative.

**Table 5: Optimal Inflation Results for Guinea: (Dependent Variable: RGDP)**

Assumed Optimal Inflation	Explanatory Variables	Coefficients	Probability of Significance	Explanatory Power/ RSS
<b>3%</b>	C	0.082121	0.0001	<b>R<sup>2</sup>: 0.840755</b>
	D(DAPOP(-1))	1.088955	0.0646	<b>RSS: 0.000504</b>
	D(DCPI(-1))	0.067091	0.0226	
	D2*(DCPI- OPINF2)	-0.065849	0.0012	
	DREX	0.016928	0.0005	
	DREX(-1)	-0.014205	0.0127	
	DRINV(-2)	0.052430	0.0001	
	TOT	-0.132035	0.0001	
	TOT(-2)	0.080633	0.0014	
	AR(1)	-0.627755	0.0185	
<b>4%</b>	C	0.081605	0.0001	<b>R<sup>2</sup>: 0.841220</b>
	D(DAPOP(-1))	1.095961	0.0639	<b>RSS: 0.000503</b>
	D(DCPI(-1))	0.068986	0.0206	
	D3*(DCPI- OPINF3)	-0.068314	0.0012	
	DREX	0.017239	0.0005	
	DREX(-1)	-0.014543	0.0115	
	DRINV(-2)	0.052970	0.0001	
	TOT	-0.133706	0.0001	
	TOT(-2)	0.082496	0.0013	
	AR(1)	-0.620525	0.0203	
<b>5%</b>	C	0.081386	0.0001	<b>R<sup>2</sup>: 0.841221</b>
	D(DAPOP(-1))	1.093525	0.0648	<b>RSS: 0.000503</b>
	D(DCPI(-1))	0.070228	0.0195	
	D4*(DCPI- OPINF4)	-0.070950	0.0012	
	DREX	0.017601	0.0005	
	DREX(-1)	-0.014771	0.0107	
	DRINV(-2)	0.053424	0.0001	
	TOT	-0.134836	0.0001	
	TOT(-2)	0.083541	0.0012	
	AR(1)	-0.616949	0.0212	
<b>6%</b>	C	0.081398	0.0001	<b>R<sup>2</sup>: 0.840775</b>
	D(DAPOP(-1))	1.085710	0.0665	<b>RSS: 0.000504</b>
	D(DCPI(-1))	0.071279	0.0189	
	D5*(DCPI- OPINF5)	-0.073758	0.0013	
	DREX	0.018030	0.0004	

	DREX(-1)	-0.014966	0.0101	
	DRINV(-2)	0.053945	0.0000	
	TOT	-0.135560	0.0001	
	TOT(-2)	0.083923	0.0012	
	AR(1)	-0.617508	0.0208	

Source: WAMI Staff Computations

## 5.2.4 Liberia

The explanatory variables included in the empirical model for Liberia are inflation rate, active population growth, real exchange rate changes and a dummy variable that captures the war period. Variables such as real investment growth, openness index and terms of trade were excluded from the model due to unavailability of data. The results revealed that all the variables, except lag of inflation, had significant impact on real GDP growth in Liberia (Table 6). While the current level of inflation and the second lag of inflation had positive impact on growth, the first lag of inflation had a negative impact; with the Overall effect of inflation rate on real GDP growth being positive in dynamic terms. Optimal inflation differential was found to have a negative impact on real GDP growth. The diagnostic tests of the model were satisfactory, with the independent variables explaining 72.4 percent of the variations in real GDP growth at the least assumed optimal inflation rate of 1 percent. After varying the assumed optimal inflation rate, the explanatory power of the model increased until it reached a peak of 73.2 percent (with minimum residual sum of squares of

0.476691) at the assumed optimal rate of 7 percent. Further increases in the assumed optimal rate led to declines in the coefficient of determination and an increase in the residual sum square. A similar result was obtained by Lee and Wong (2005) for Taiwan and Japan. The empirical results therefore suggest that the optimal inflation rate for Liberia is 7 percent.

The results further revealed that active population growth, real exchange rate and real GDP growth dynamics had significant impact on real GDP growth. The past level of real GDP growth impacted positively on the current level of real GDP growth, implying that increasing economic activities in the current period will positively propel growth in the future. Active population growth had a dynamic positive impact on real GDP growth. The first and second lags of real exchange rate had negative and positive impacts respectively on real GDP growth rate; however the combined effect of real exchange rate depreciation on economic growth was negative. Thus, to propel growth in the Liberian economy, there is the need to work on both supply- and demand-side variables.

**Table 6: Optimal Inflation Results for Liberia: (Dependent Variable: RGDP)**

Assumed Inflation	Optimal	Explanatory Variables	Coefficients	Probability of Significance	Explanatory Power/ RSS
5%		C	0.095330	0.0934	<b>R<sup>2</sup>: 0.730306</b>
		DUM	-0.298497	0.0013	<b>RSS: 0.479567</b>
		DRGDP(-2)	0.569238	0.0003	
		DREX(-1)	-3.189415	0.0014	
		DREX(-2)	1.894427	0.0643	
		D(DAPOP(-1))	14.23234	0.0001	
		DCPI(-1)	-2.278852	0.0062	
		DCPI(-2)	0.743432	0.2427	
		DUM*DCPI	2.925544	0.0041	
		D5*(OPINF5-DCPI)	-1.003297	0.2691	
6%		C	0.097854	0.0810	<b>R<sup>2</sup>: 0.730996</b>
		DUM	-0.297563	0.0013	<b>RSS: 0.478340</b>

	DRGDP(-2)	0.566877	0.0003	
	DREX(-1)	-3.200631	0.0014	
	DREX(-2)	1.882614	0.0636	
	D(DAPOP(-1))	14.21382	0.0001	
	DCPI(-1)	-2.290642	0.0060	
	DCPI(-2)	0.744975	0.2405	
	DUM*DCPI	2.932300	0.0038	
	D6*(OPINF6-DCPI)	-1.088852	0.2586	
<b>7%</b>	<b>C</b>	0.100562	0.0695	<b>R<sup>2</sup>: 0.731924</b>
	DUM	-0.298306	0.0012	<b>RSS: 0.476691</b>
	DRGDP(-2)	0.565509	0.0003	
	DREX(-1)	-3.201762	0.0013	
	DREX(-2)	1.863325	0.0631	
	D(DAPOP(-1))	14.11742	0.0001	
	DCPI(-1)	-2.291958	0.0057	
	DCPI(-2)	0.745862	0.2382	
	DUM*DCPI	2.931693	0.0037	
	D7*(OPINF7-DCPI)	-1.180628	0.2452	
<b>8%</b>	<b>C</b>	0.104805	0.0580	<b>R<sup>2</sup>: 0.729103</b>
	DUM	-0.303250	0.0010	<b>RSS: 0.481706</b>
	DRGDP(-2)	0.565480	0.0003	
	DREX(-1)	-3.155313	0.0015	
	DREX(-2)	1.793614	0.0711	
	D(DAPOP(-1))	13.89561	0.0001	
	DCPI(-1)	-2.236368	0.0065	
	DCPI(-2)	0.719771	0.2555	
	DUM*DCPI	2.971757	0.0034	
	D8*(OPINF8-DCPI)	-1.131760	0.2887	

Source: WAMI Staff Computations

### 5.2.5 Nigeria

The empirical results for Nigeria revealed that, apart from openness index, all the variables had significant explanation for real GDP growth in Nigeria (Table 7). Inflation rate had an overall positive impact on real GDP growth in dynamic terms. However, optimal inflation differential had a negative impact on real GDP growth. The estimated model passed all the diagnostic tests and returned explanatory power of 88.0 percent at the least assumed optimal inflation rate of 1 percent. When the assumed optimal inflation rate was increased, the explanatory power of the model increased, reaching a peak of 88.2 percent (with minimum residual sum of squares of 0.010737) at the assumed optimal rate of 13 percent. Inflation rates beyond 13 percent reduced the explanatory

power as the residual sum of squares increased. Thus, the empirical results point to an optimal inflation rate of 13 percent for Nigeria.

Economic growth determinants in Nigeria apart from domestic inflation rate over the period 1970-2010 were dynamics of real GDP growth, terms of trade, openness index, active population growth rate and the growth rate of oil revenue. The third and first lags of real GDP growth had positive and negative impacts on current real GDP growth rate. The combined impact was, however, positive, indicating that real GDP growth in Nigeria was driven partly by its own dynamics. While the terms of trade had significant dynamic positive impact on real GDP growth, the openness index had not. The

oil revenue growth also had a significant positive impact on real GDP growth in Nigeria which is consistent with the related *a priori* expectation. Active population growth rate had static positive and dynamic negative impacts on real GDP growth rate but with an overall-combined negative growth impact. This may be explained by the high level of unemployment in Nigeria. A dummy variable

capturing economic developments in the late 1990s and 2000s had a significant negative impact, suggesting that real GDP growth had slowed down due to economic developments (both internal and external) in recent years. Overall, working on the supply- and demand-side factors could improve economic growth in Nigeria.

**Table 7: Optimal Inflation Results for Nigeria: (Dependent Variable: RGDP)**

Assumed Optimal Inflation	Explanatory Variables	Coefficients	Probability of Significance	Explanatory Power/ RSS
5%	C	0.103688	0.2279	<b>R<sup>2</sup>: 0.880061</b>
	DUM	-0.098200	0.0004	<b>RSS: 0.010894</b>
	DRGDP(-3)	0.811443	0.0000	
	DRGDP(-1)	-0.362084	0.0024	
	DCPI(-4)	-0.166125	0.0005	
	DUM*DCPI(-1)	0.258641	0.0009	
	D5*(DCPI-OPINF5)	-0.161564	0.0003	
	DTOT(-1)	0.115520	0.0000	
	DTOT(-2)	0.058806	0.0170	
	OPEN(-1)	0.015050	0.6568	
	DAPOP	9.442859	0.0073	
	DAPOP(-2)	-10.17496	0.0087	
	DOIL	0.016508	0.0331	
12%	C	0.112547	0.1931	<b>R<sup>2</sup>: 0.880702</b>
	DUM	-0.102320	0.0003	<b>RSS: 0.010836</b>
	DRGDP(-3)	0.831059	0.0000	
	DRGDP(-1)	-0.368314	0.0021	
	DCPI(-4)	-0.157608	0.0008	
	DUM*DCPI(-1)	0.274106	0.0005	
	D12*(DCPI-OPINF12)	-0.183289	0.0003	
	DTOT(-1)	0.118721	0.0000	
	DTOT(-2)	0.063447	0.0110	
	OPEN(-1)	0.016849	0.6174	
	DAPOP	9.389585	0.0074	
	DAPOP(-2)	-10.79287	0.0059	
	DOIL	0.015248	0.0492	
13%	C	0.112423	0.1915	<b>R<sup>2</sup>: 0.881786</b>
	DUM	-0.102154	0.0003	<b>RSS: 0.010737</b>
	DRGDP(-3)	0.837087	0.0000	
	DRGDP(-1)	-0.373734	0.0018	
	DCPI(-4)	-0.155851	0.0008	
	DUM*DCPI(-1)	0.275399	0.0005	
	D13*(DCPI-OPINF13)	-0.190409	0.0003	
	DTOT(-1)	0.119830	0.0000	
	DTOT(-2)	0.064818	0.0095	
	OPEN(-1)	0.016053	0.6327	
	DAPOP	9.371945	0.0073	

	DAPOPN(-2)	-10.77650	0.0058	
	DOIL	0.014955	0.0529	
14%	C	0.112009	0.1933	<b>R<sup>2</sup>: 0.881603</b>
	DUM	-0.101763	0.0003	<b>RSS: 0.010754</b>
	DRGDP(-3)	0.842909	0.0000	
	DRGDP(-1)	-0.380106	0.0016	
	DCPI(-4)	-0.154878	0.0009	
	DUM*DCPI(-1)	0.275400	0.0005	
	D14*(DCPI-OPINF14)	-0.197379	0.0003	
	DTOT(-1)	0.120622	0.0000	
	DTOT(-2)	0.066155	0.0085	
	OPEN(-1)	0.014815	0.6598	
	DAPOPN	9.334410	0.0075	
	DAPOPN(-2)	-10.70854	0.0060	
	DOIL	0.014787	0.0559	

Source: WAMI Staff Computations

## 5.2.6 Sierra Leone

The results as shown in Table 8 indicated that, all the variables, except the dummy variable, had significant explanation for real GDP growth in Sierra Leone over the study period. Inflation rate had overall negative dynamic impact on real GDP growth. The optimal inflation differential also had a negative impact on real GDP growth. The estimated model passed all the diagnostic tests except for serial correlation. This was corrected and the model returned explanatory power of 88.1 percent at the least assumed optimal inflation rate of 1 percent. Increasing the assumed optimal inflation rate moved the explanatory power to a peak of 88.1 percent at the assumed optimal rate of 10%. This results is not at variant with that obtained by Seleteng (2005) for Lesotho. Beyond this level, the explanatory power of the model began to fall. Thus, for Sierra Leone, the optimal inflation rate is 10 percent.

Further, the empirical results indicate that, apart from domestic inflation rate, the principal determinants of real GDP growth in Sierra Leone over the period 1970-2010 were active population growth rate, real investment growth rate and real exchange rate. Active population growth had static positive and dynamic negative impacts on economic growth. The combined growth impact of active population growth was positive as expected *a priori*. The real investment growth had positive impact on real GDP growth in static and dynamic terms. Thus, supply-side factors contributed immensely to real GDP growth in Sierra Leone over the study period. The fourth lag of the real exchange rate positive impact on real GDP growth, implying that real exchange rate depreciation had dynamic positive influence on economic growth. However, the poor performance of openness index and terms of trade suggest the external sector contributed very little to economic growth in Sierra Leone over the period under study. The coefficient of the war dummy variable was not statistically significant but shows a tendency of depressing real GDP growth.

**Table 8: Optimal Inflation Results for Sierra Leone: (Dependent Variable: RGDP)**

Assumed Inflation	Optimal	Explanatory Variables	Coefficients	Probability of Significance	Explanatory Power/RSS
5%	C		-0.098282	0.0006	R <sup>2</sup> : 0.881295
	DUM1		-0.003779	0.9391	RSS: 0.020649
	DRGDP(-1)*DUM1		-0.440198	0.0789	
	DCPI(-4)		0.085984	0.0290	
	DCPI*DUM1		-0.134429	0.2269	
	D5*(DCPI-OPINF5)		-0.017021	0.6254	
	DAOPN		12.61468	0.0004	
	DAOPN(-1)		-14.34937	0.0008	
	DAOPN(-3)		7.059281	0.0002	
	DREX(-4)		0.090835	0.0789	
	DRINV		0.095688	0.0085	
	DRINV(-1)		0.106283	0.0043	
	DRINV(-2)		0.083180	0.0334	
	AR(1)		-0.608337	0.0366	
	9%	C		-0.098414	0.0005
DUM1			-0.005299	0.9167	RSS: 0.020622
DRGDP(-1)*DUM1			-0.440480	0.0783	
DCPI(-4)			0.086509	0.0288	
DCPI*DUM1			-0.131333	0.2464	
D9*(DCPI-OPINF9)			-0.018637	0.6120	
DAOPN			12.68245	0.0004	
DAOPN(-1)			-14.43042	0.0008	
DAOPN(-3)			7.073308	0.0002	
DREX(-4)			0.091373	0.0781	
DRINV			0.095405	0.0086	
DRINV(-1)			0.106145	0.0042	
DRINV(-2)			0.083033	0.0336	
AR(1)			-0.607670	0.0367	
10%		C		-0.098519	0.0005
	DUM1		-0.005470	0.9143	RSS: 0.020620
	DRGDP(-1)*DUM1		-0.440471	0.0782	
	DCPI(-4)		0.086515	0.0288	
	DCPI*DUM1		-0.130957	0.2493	
	D10*(DCPI-OPINF10)		-0.018932	0.6114	
	DAOPN		12.69490	0.0004	
	DAOPN(-1)		-14.44596	0.0008	
	DAOPN(-3)		7.079424	0.0002	
	DREX(-4)		0.091387	0.0780	
	DRINV		0.095448	0.0085	
	DRINV(-1)		0.106148	0.0042	
	DRINV(-2)		0.082969	0.0338	
	AR(1)		-0.607746	0.0366	
	11%	C		-0.098638	0.0005
DUM1			-0.005597	0.9126	RSS: 0.020621
DRGDP(-1)*DUM1			-0.440487	0.0782	
DCPI(-4)			0.086494	0.0288	
DCPI*DUM1			-0.130678	0.2518	

	D11*(DCPI-OPINF11)	-0.019192	0.6116	
	DAPOPN	12.70634	0.0005	
	DAPOPN(-1)	-14.46064	0.0008	
	DAPOPN(-3)	7.086072	0.0002	
	DREX(-4)	0.091383	0.0780	
	DRINV	0.095512	0.0084	
	DRINV(-1)	0.106165	0.0042	
	DRINV(-2)	0.082906	0.0340	
	AR(1)	-0.607809	0.0366	

Source: WAMI Staff Computations

### 5.3 Optimal Inflation for the WAMZ

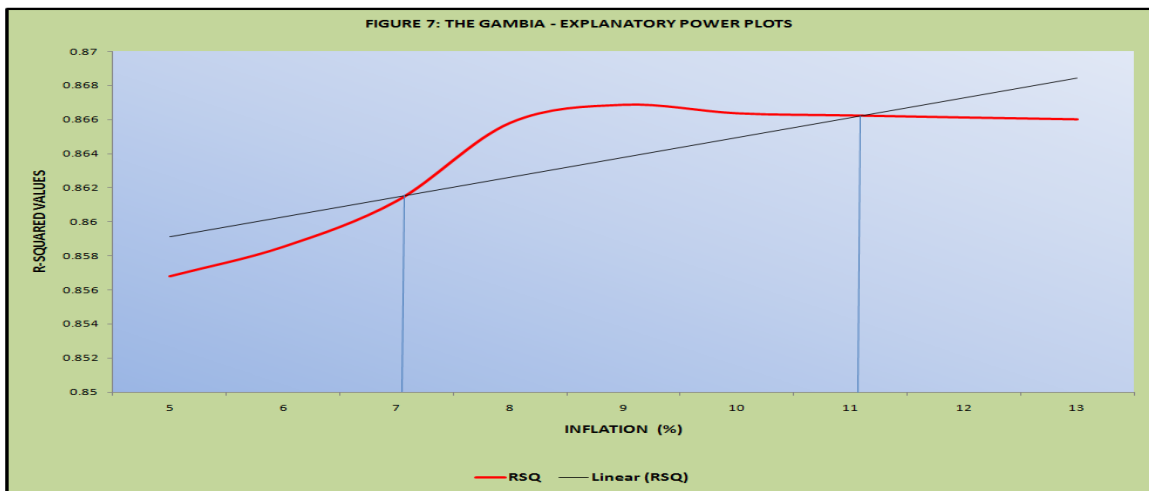
There is the need to determine the optimal inflation rate for the WAMZ as a whole. Two different methodologies were used in this regard. The first approach uses the estimates of inflation thresholds in the member countries as established in the previous section to arrive at an optimal level of inflation for the Zone, while the second methodology employs panel data model estimation techniques.

#### 5.3.1 Optimal Inflation for the WAMZ: Country-Specific Model Estimations

The optimal inflation for the Zone was obtained from the country-specific inflation threshold estimations. This is done by first working out the ranges within which inflation in the individual

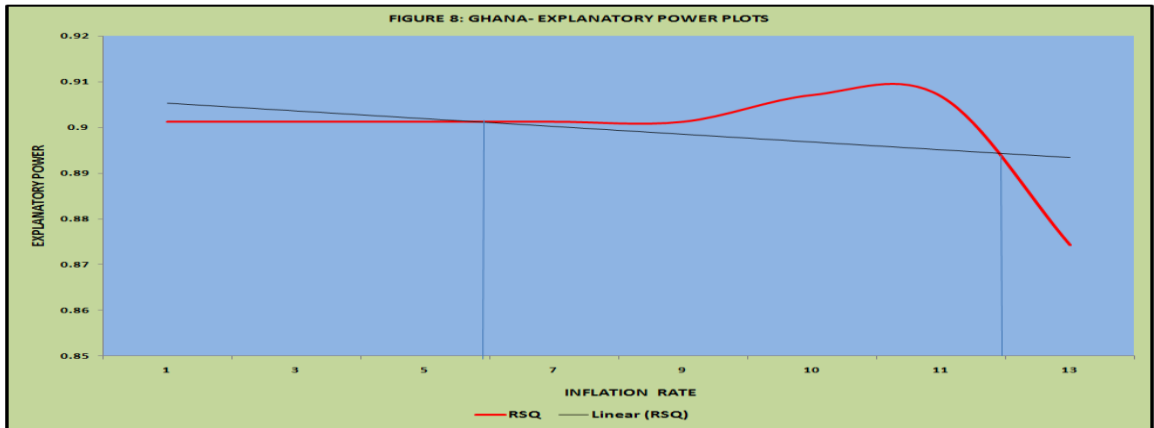
countries is pro-growth. The intersection of these ranges gives the optimal inflation rate for the Zone.

This approach, which is the most common in the literature (Seleteng, 2005), tries to establish the range within which the inflationary effect is significant. Under this approach, a trend line is constructed for the explanatory powers of a given model. The points of intersection of the trend line and the explanatory power plot give the pro-growth inflation range in each member country. From Figures 7 - 12, the ranges are as follows: The Gambia, 7-11%; Ghana, 6-12%; Guinea, 3-9%; Liberia, 3-9%; Nigeria, 9-14%; and Sierra Leone, 7-12%. The intersections of these ranges are depicted in Figure 13. The optimal inflation rate for the WAMZ, according to Figure 13 is 9%. However, a deviation of  $\pm 2\%$  could be maintained, giving a pro-growth inflation range for the Zone as 7-11%.

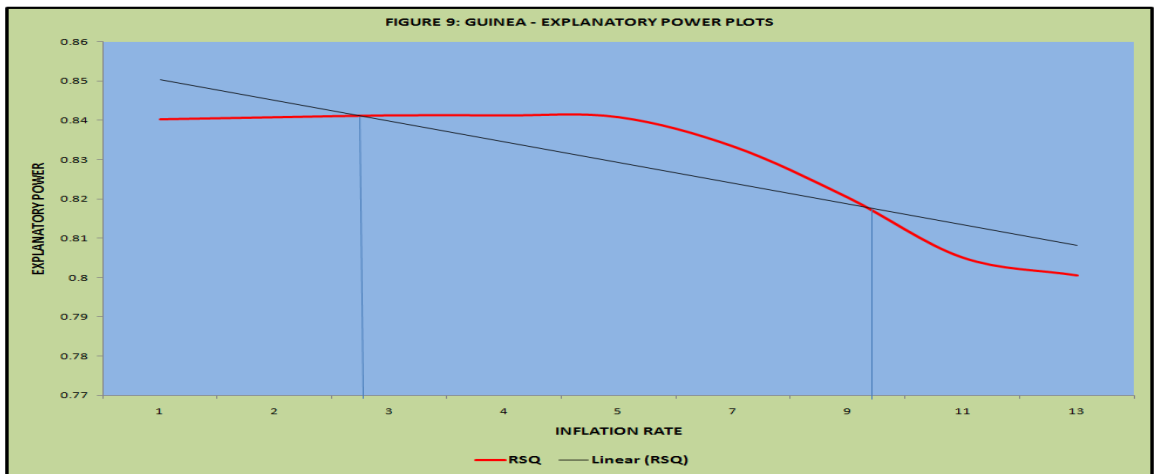


Source: Authors' calculation

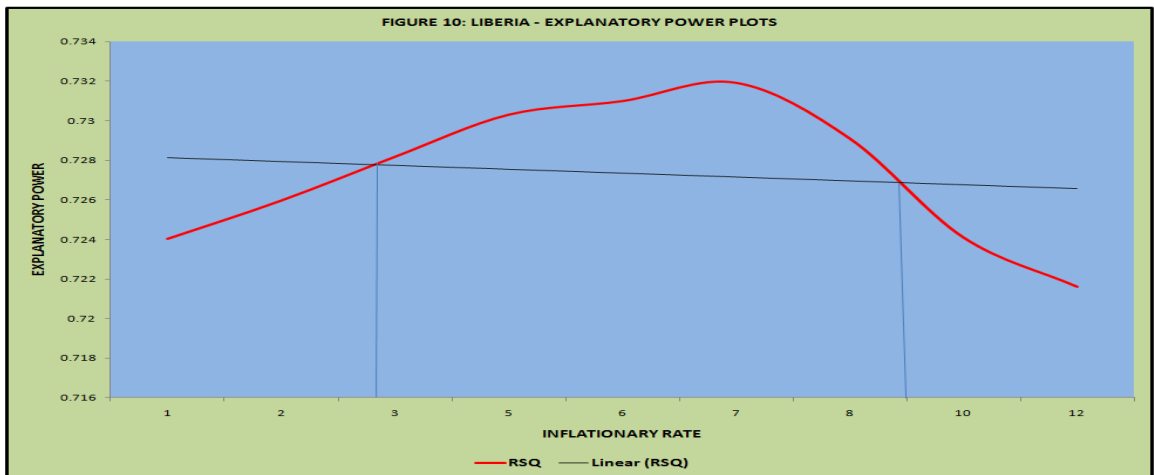




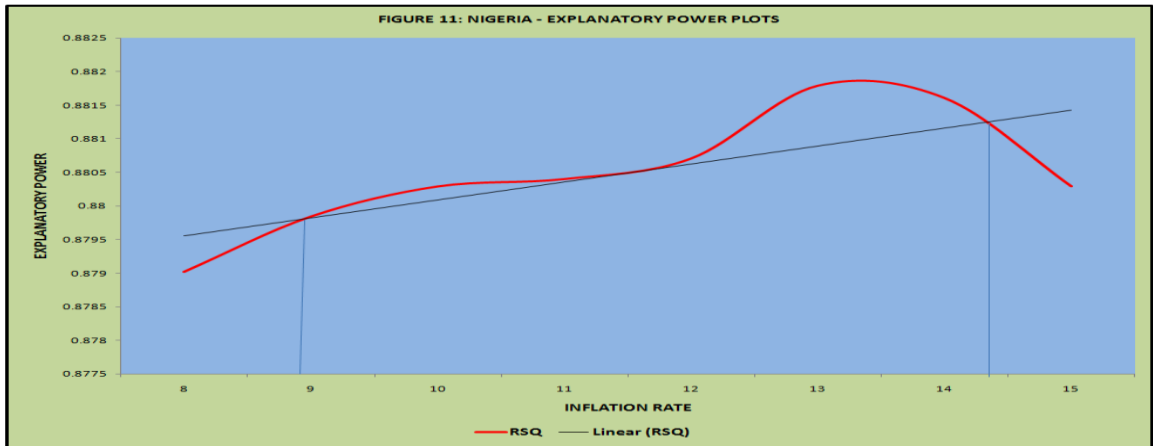
Source: Authors' calculation



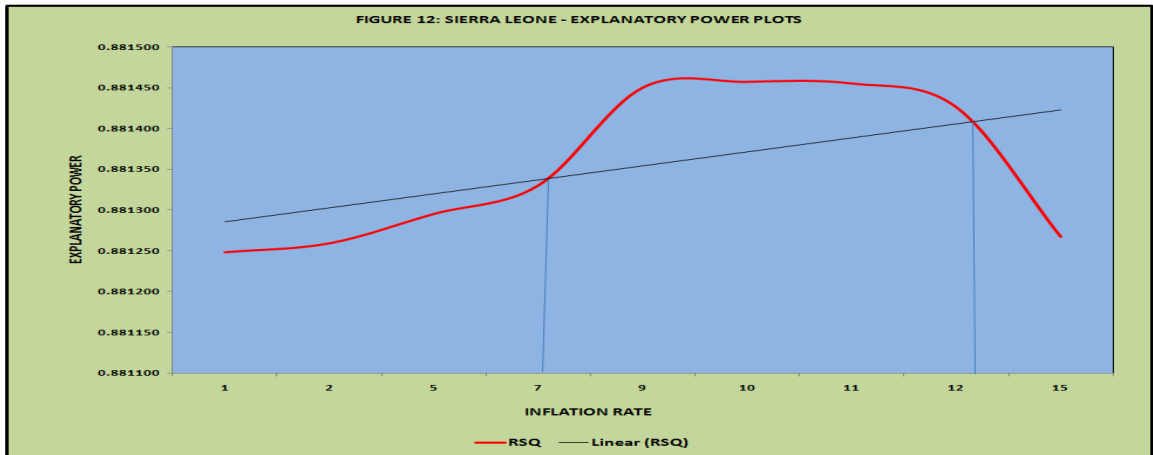
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Source: Authors' calculation



Source: Authors' calculation



Source: Authors' calculation

Figure 13: Range of Pro-Growth Inflation Rates in WAMZ Countries

Country	Pro-Growth Inflation Rate (%)												Range (%)	
	3	4	5	6	7	8	9	10	11	12	13	14		
NIGERIA														6
SIERRA LEONE														6
GHANA														7
GAMBIA														5
LIBERIA														7
GUINEA														7
WAMZ (Average)														-

Source: Author's calculation based on Figures 7-12

As far as individual country analysis is concerned, from Figure 13, it is quite apparent that there is only one common pro-growth optimal inflation rate for the WAMZ member countries. This is the annual point optimal inflation rate of 9%. Below or beyond the annual optimal inflation rate of 9%, the impact of inflation on economic growth will be mixed across countries although a  $\pm 2\%$  (implying 7%-11%) will not harm majority of the WAMZ member countries (see Figure 13). For instance, a rate of inflation in excess of the optimal 9% but within a margin of 2 (i.e. 9-11), will make Liberia and Guinea worse-off, as these countries will be forced to the downside of their 'Laffer curve', although the rest of the WAMZ countries, viz. Nigeria, Sierra Leone, Ghana and the Gambia will still be within the 'good side' of their respective 'Laffer curves'. Similarly, with the exception of Nigeria, none of the countries will suffer unfavourable impact of inflation on economic growth if the rate of inflation falls below the optimal rate but ranges between 7 and 9. Also striking to note is the fact the Gambia has the narrowest survival range of 5, whilst the mode of the survival range of 7 is associated with Ghana, Liberia and Guinea. These differences could be attributed to a myriad of reasons including differences in macroeconomic fundamentals including differences in absorption capacity, prudent management, the degree of trade openness and import dependency.

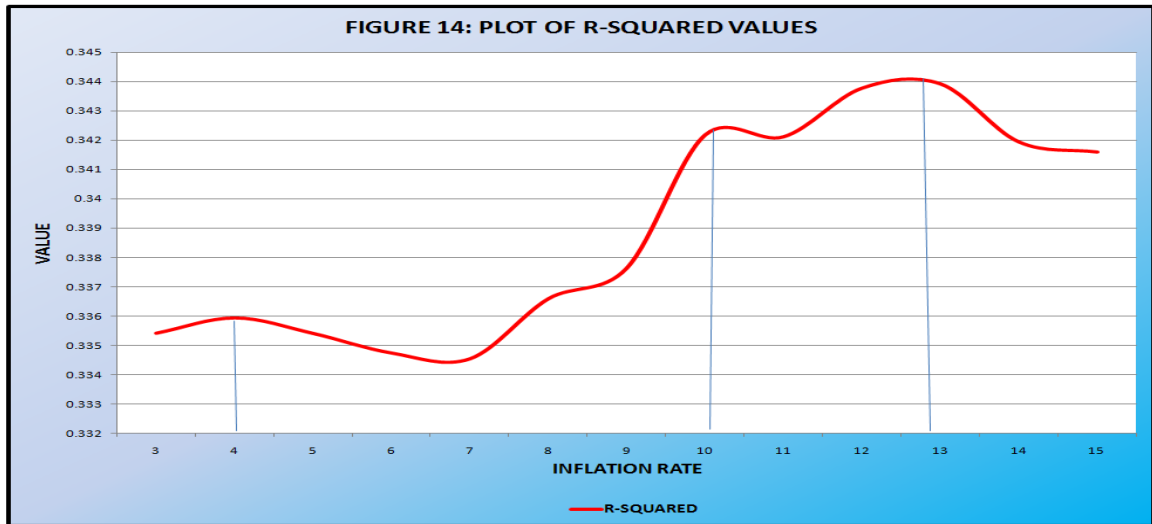
### **5.3.2 Optimal Inflation for the WAMZ: Panel-Data Model Estimations**

A panel data model was also estimated to determine the optimal inflation model for the WAMZ. Cross-section fixed effects estimation technique was applied. The results are reported in Table 8 and graphically depicted in Figure 14. The detailed estimation results are presented in Appendix II.

From the results the values of the R-squared have been oscillating. The following ranges of values for the R-squared emerge with turning points: 3-7%, 8-11% and 12-15% with optimal inflations of 4, 10 and 13 percent respectively. For each of the ranges, one R-squared value is obtained for the countries. The panel data estimation results reflect substantially the results of the country-specific model estimations. Thus, judging from the individual country estimates, Range I may be too low for at least three countries in the Zone, while Range 3 may be too high for at least two countries in the Zone. Thus, Range II becomes the most desirable range with an optimal inflation rate of 10%. The entire Range II (8-11% inflation rate) could be appropriate for policymaking within the Zone. This result is consistent with the result obtained by Khan and Senhadji (2005) for Developing countries. Both methodologies have, therefore, delivered similar ranges of pro-growth inflation rates.

**Table 8: Optimal Inflation Results for the WAMZ – Panel Data Estimates**

RANGE	R-SQUARED	OPTIMAL INFLATION
<b>RANGE I (3-7%)</b>		
3	0.335419	
4	0.335942	<b>4%</b>
5	0.335412	
6	0.334744	
7	0.334547	
<b>RANGE II (8-11%)</b>		
8	0.336595	
9	0.337639	
10	0.342185	<b>10%</b>
11	0.342121	
<b>RANGE III (12-15%)</b>		
12	0.343780	
13	0.343925	<b>13%</b>
14	0.341943	
15	0.341600	



Source: Authors' calculation

## 6.0 CONCLUSION

The focus of this paper was to empirically estimate the threshold levels of inflation in the WAMZ. An assessment of the empirical results had been acquired through the conditional least square technique. The study also identified the determinants of growth in the WAMZ. The results showed that there exists a statistically significant long-run negative relationship between inflation and economic growth for the WAMZ countries. These results are consistent with the findings of Barro (1997), Khan and Senhadji (2001), Faria and Carneiro (2001), Adenutsi (2011), among others. Furthermore, the empirical results strongly suggest the existence of threshold levels for all the countries, beyond which inflation exert a negative effect on growth. The results revealed the following ranges for the threshold inflation rates of the WAMZ countries; Gambia (7-11 percent), Ghana (6-12 percent), Guinea (3-9 percent), Liberia (3-9 percent), Nigeria (9-14 percent) and Sierra Leone (7-12 percent).

The results showed that WAMZ countries threshold inflation rates lie within the convergence

criteria of maintaining an inflation rate not exceeding 10 percent. The results are useful for policy makers in providing some clue in setting an optimal inflation target. Policy makers should implement policies aimed at achieving the threshold inflation rate that is consistent with higher economic growth. Thus, it is desirable to keep inflation rate at least within the threshold level in member countries, as it may help maintain sustainable growth. A sustainable increase in growth can be achieved by directing monetary policy towards maintaining price stability.

It is important to caution that in relying on the findings and conclusions of this study, it must be noted that a common sample data range was not used in this due to the traditional problems of data availability. Thus, whilst the results of Ghana, Nigeria and Sierra Leone were based on the annual data ranging 1970-2010, those obtained for the Gambia, Guinea and Liberia were based on 1980-2010 available figures.

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## APPENDIX I

**Table A1: Unit Root Test Results for the Gambia**

VARIABLE	ADF STATISTIC AT LEVEL	ADF STATISTIC AT 1 <sup>ST</sup> DIFF	REMARKS
DAPOP	-4.225130* (-3.658446)*	....	I(0)
DCPI	-1.716743* (-1.609070)*	.....	I(0)
DREX	-4.724121** (-4.394309)**	.....	I(0)
DRGDP	-5.681399** (-4.374307)**	.....	I(0)
DRINV	-3.549249** (-3.012363)**	.....	I(0)
OPEN	-5.605473** (-4.416345)**	.....	I(0)
TOT	-5.032072** (-4.416345)**	.....	I(0)

(..) MacKinnon Critical Values; \*\* 1% significance level; \*1% significance level

**Table A2: Unit Root Test Results for Ghana**

VARIABLE	ADF STATISTIC AT LEVEL	ADF STATISTIC AT 1 <sup>ST</sup> DIFF	REMARKS
DAPOP	-4.121601** (-3.670170)**	....	I(0)
DCPI	-4.812394** (-3.632900)**	.....	I(0)
DREX	-3.519626* (-2.948404)*	.....	I(0)
DRGDP	-5.283306** (-4.243644)**		I(0)
DRINV	-4.952860** (-3.632900)**	.....	I(0)
OPEN	-2.364372 (-3.626784)**	-5.201928** -3.632900)**	I(1)
TOT	-3.074801 (-4.234972)**	-6.441774** (-3.639407)**	I(1)

(..) MacKinnon Critical Values; \*\* 1% significance level; \*1% significance level

**Table A3: Unit Root Test Results for Guinea**

VARIABLE	ADF STATISTIC AT LEVEL	ADF STATISTIC AT 1 <sup>ST</sup> DIFF	REMARKS
DAPOP	-1.363065 (-3.752946)**	-3.155884* (-2.998064)*	I(1)
DCPI	-2.422540 (-3.724070)**	-6.751066** (-3.737853)**	I(1)
DREX	-5.172280** (-3.724070)**	.....	I(0)
DRGDP	-3.703733* (-2.986225)*	.....	I(0)
DRINV	-3.343143* (-2.986225)*	.....	I(0)
OPEN	-1.836370 (-3.711457)**	-5.008328** (-3.724070)**	I(1)



TOT	-4.379535** (-4.356068)**	.....	I(0)
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(..) MacKinnon Critical Values; \*\* 1% significance level; \*1% significance level

**Table A4: Unit Root Test Results for Liberia**

VARIABLE	ADF STATISTIC AT LEVEL	ADF STATISTIC AT 1 <sup>ST</sup> DIFF	REMARKS
DAPOP	-2.112337 (-3.661661)**	....	I(1)
DCPI	-4.490310** (-4.262735)**	.....	I(0)
DREX	-4.971113** (-4.262735)**	.....	I(0)
DRGDP	-3.199677* (-2.954021)*	.....	I(0)

(..) MacKinnon Critical Values; \*\* 1% significance level; \*1% significance level

**Table A5: Unit Root Test Results for Nigeria**

VARIABLE	ADF STATISTIC AT LEVEL	ADF STATISTIC AT 1 <sup>ST</sup> DIFF	REMARKS
DAPOP	-3.704350* (-3.580623)*	....	I(0)
DCPI	-3.010780* (-2.948404)*	.....	I(0)
DREX	-4.621243** (-4.243644)**	.....	I(0)
DRGDP	-4.126648* (-3.587527)*	.....	I(0)
DRINV	-4.324106** (-4.243644)**	.....	I(0)
OPEN	-4.573488** (-4.273277)**	.....	I(0)
TOT	-2.012849 (-3.626784)**	-5.864820** (-3.632900)**	I(1)
DOIL	-5.893814** (-4.243644)**		I(0)

(..) MacKinnon Critical Values; \*\* 1% significance level; \*1% significance level

**Table A6: Unit Root Test Results for Sierra Leone**

VARIABLE	ADF STATISTIC AT LEVEL	ADF STATISTIC AT 1 <sup>ST</sup> DIFF	REMARKS
DAPOP	-4.423968** (-3.653730)**	....	I(0)
DCPI	-3.500411* (-2.954021)*	.....	I(0)
DREX	-7.842902** (-3.653730)**	.....	I(0)
DRGDP	-5.608373** (-3.646342)**	.....	I(0)
DRINV	-8.561833** (-3.646342)**	.....	I(0)

(..) MacKinnon Critical Values; \*\* 1% significance level; \*1% significance level

## APPENDIX II

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.026753	0.017417	-1.536055	0.1270
DCPI	-0.002558	0.022593	-0.113240	0.9100
D3*(DCPI-OPINF3)	-0.044073	0.021937	-2.009103	0.0466
DRINV	0.065310	0.015943	4.096426	0.0001
DAPOPN	2.087656	0.564997	3.694989	0.0003
DREX(-4)	0.025818	0.014445	1.787306	0.0763
Fixed Effects (Cross)				
_GAM--C	-0.014645			
_GHA--C	0.003081			
_GUI--C	0.001111			
_NIG--C	0.000694			
_SIL--C	0.005936			

### Effects Specification

#### Cross-section fixed (dummy variables)

R-squared	0.335419	Mean dependent var	0.025355
Adjusted R-squared	0.288323	S.D. dependent var	0.051818
S.E. of regression	0.043714	Akaike info criterion	-3.352095
Sum squared resid	0.242689	Schwarz criterion	-3.138957
Log likelihood	239.6185	F-statistic	7.121995
Durbin-Watson stat	2.268556	Prob(F-statistic)	0.000000

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027132	0.017366	-1.562374	0.1207
DCPI	-0.002550	0.022552	-0.113068	0.9102
D4*(DCPI-OPINF4)	-0.044786	0.022012	-2.034617	0.0440
DRINV	0.065259	0.015936	4.095011	0.0001
DAPOPN	2.091097	0.564581	3.703801	0.0003
DREX(-4)	0.025749	0.014440	1.783135	0.0770
Fixed Effects (Cross)				
_GAM--C	-0.014849			
_GHA--C	0.003129			
_GUI--C	0.001173			
_NIG--C	0.000643			
_SIL--C	0.006045			

#### Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.335942	Mean dependent var	0.025355
Adjusted R-squared	0.288883	S.D. dependent var	0.051818
S.E. of regression	0.043697	Akaike info criterion	-3.352882
Sum squared resid	0.242498	Schwarz criterion	-3.139744
Log likelihood	239.6724	F-statistic	7.138712
Durbin-Watson stat	2.269950	Prob(F-statistic)	0.000000

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027431	0.017353	-1.580788	0.1164
DCPI	-0.003061	0.022506	-0.136017	0.8920
D5*(DCPI-OPINF5)	-0.044380	0.022094	-2.008724	0.0467
DRINV	0.065192	0.015942	4.089375	0.0001
DAPOPN	2.090537	0.564878	3.700862	0.0003
DREX(-4)	0.025733	0.014446	1.781327	0.0772
Fixed Effects (Cross)				
_GAM--C	-0.014725			
_GHA--C	0.003059			
_GUI--C	0.001275			
_NIG--C	0.000554			
_SIL--C	0.006053			

#### Effects Specification

#### Cross-section fixed (dummy variables)

R-squared	0.335412	Mean dependent var	0.025355
Adjusted R-squared	0.288315	S.D. dependent var	0.051818
S.E. of regression	0.043714	Akaike info criterion	-3.352083
Sum squared resid	0.242691	Schwarz criterion	-3.138946
Log likelihood	239.6177	F-statistic	7.121748
Durbin-Watson stat	2.270913	Prob(F-statistic)	0.000000

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027979	0.017322	-1.615220	0.1087
DCPI	-0.003486	0.022487	-0.155004	0.8771
D6*(DCPI-OPINF6)	-0.043774	0.022156	-1.975697	0.0504
DRINV	0.064983	0.015948	4.074706	0.0001
DAPOPN	2.096703	0.564970	3.711178	0.0003
DREX(-4)	0.025721	0.014454	1.779521	0.0775
Fixed Effects (Cross)				
_GAM--C	-0.014643			
_GHA--C	0.002980			
_GUI--C	0.001538			
_NIG--C	0.000346			
_SIL--C	0.006113			

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#### Effects Specification

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Cross-section fixed (dummy variables)

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R-squared	0.334744	Mean dependent var	0.025355
Adjusted R-squared	0.287599	S.D. dependent var	0.051818
S.E. of regression	0.043736	Akaike info criterion	-3.351078
Sum squared resid	0.242935	Schwarz criterion	-3.137941
Log likelihood	239.5489	F-statistic	7.100424
Durbin-Watson stat	2.274358	Prob(F-statistic)	0.000000

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Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.028270	0.017303	-1.633865	0.1048
DCPI	-0.003839	0.022442	-0.171047	0.8645
D7*(DCPI-OPINF7)	-0.043651	0.022204	-1.965881	0.0515
DRINV	0.064938	0.015950	4.071411	0.0001
DAPOPN	2.096011	0.565099	3.709105	0.0003
DREX(-4)	0.025753	0.014456	1.781535	0.0772
Fixed Effects (Cross)				
_GAM--C	-0.014568			
_GHA--C	0.002944			
_GUI--C	0.001643			
_NIG--C	0.000237			
_SIL--C	0.006140			

#### Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.334547	Mean dependent var	0.025355
Adjusted R-squared	0.287389	S.D. dependent var	0.051818
S.E. of regression	0.043743	Akaike info criterion	-3.350783
Sum squared resid	0.243007	Schwarz criterion	-3.137645
Log likelihood	239.5286	F-statistic	7.094155
Durbin-Watson stat	2.275368	Prob(F-statistic)	0.000000

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027948	0.017280	-1.617389	0.1083
DCPI	-0.002166	0.022565	-0.095970	0.9237
D8*(DCPI-OPINF8)	-0.046730	0.022617	-2.066106	0.0409
DRINV	0.063191	0.015934	3.965662	0.0001
DAPOP	2.065254	0.565401	3.652724	0.0004
DREX(-4)	0.025226	0.014442	1.746691	0.0831
Fixed Effects (Cross)				
_GAM--C	-0.014241			
_GHA--C	0.003398			
_GUI--C	0.002092			
_NIG--C	-0.000368			
_SIL--C	0.005747			

#### Effects Specification

Cross-section fixed (dummy variables)			
R-squared	0.336595	Mean dependent var	0.025355
Adjusted R-squared	0.289583	S.D. dependent var	0.051818
S.E. of regression	0.043676	Akaike info criterion	-3.353866
Sum squared resid	0.242259	Schwarz criterion	-3.140729
Log likelihood	239.7398	F-statistic	7.159637
Durbin-Watson stat	2.286151	Prob(F-statistic)	0.000000

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.028033	0.017250	-1.625112	0.1066
DCPI	-0.001258	0.022636	-0.055561	0.9558
D9*(DCPI-OPINF9)	-0.049225	0.023268	-2.115581	0.0363
DRINV	0.062816	0.015929	3.943547	0.0001
DAPOP	2.055252	0.565318	3.635568	0.0004
DREX(-4)	0.025613	0.014423	1.775851	0.0782
Fixed Effects (Cross)				
_GAM--C	-0.013812			
_GHA--C	0.003620			
_GUI--C	0.002219			
_NIG--C	-0.001035			
_SIL--C	0.005818			

#### Effects Specification

Cross-section fixed (dummy variables)			
R-squared	0.337639	Mean dependent var	0.025355
Adjusted R-squared	0.290700	S.D. dependent var	0.051818
S.E. of regression	0.043641	Akaike info criterion	-3.355441
Sum squared resid	0.241878	Schwarz criterion	-3.142303
Log likelihood	239.8477	F-statistic	7.193161
Durbin-Watson stat	2.291791	Prob(F-statistic)	0.000000



Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.028293	0.017141	-1.650655	0.1013
DCPI	0.003767	0.023132	0.162843	0.8709
D10*(DCPI-OPINF10)	-0.057127	0.024619	-2.320396	0.0219
DRINV	0.060505	0.015946	3.794390	0.0002
DAPOPN	2.027943	0.564125	3.594844	0.0005
DREX(-4)	0.029208	0.014411	2.026786	0.0448
Fixed Effects (Cross)				
_GAM--C	-0.013076			
_GHA--C	0.002801			
_GUI--C	0.002911			
_NIG--C	-0.001282			
_SIL--C	0.005931			

#### Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.342185	Mean dependent var	0.025355
Adjusted R-squared	0.295568	S.D. dependent var	0.051818
S.E. of regression	0.043491	Akaike info criterion	-3.362327
Sum squared resid	0.240218	Schwarz criterion	-3.149190
Log likelihood	240.3194	F-statistic	7.340383
Durbin-Watson stat	2.304029	Prob(F-statistic)	0.000000

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.028188	0.017148	-1.643800	0.1027
DCPI	0.003028	0.023006	0.131600	0.8955
D11*(DCPI-OPINF11)	-0.057380	0.024758	-2.317598	0.0221
DRINV	0.060463	0.015949	3.791009	0.0002
DAPOPN	2.019713	0.564602	3.577230	0.0005
DREX(-4)	0.029044	0.014406	2.016052	0.0459
Fixed Effects (Cross)				
_GAM--C	-0.012984			
_GHA--C	0.002670			
_GUI--C	0.003231			
_NIG--C	-0.001321			
_SIL--C	0.005821			

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Effects Specification

Cross-section fixed (dummy variables)

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R-squared	0.342121	Mean dependent var	0.025355
Adjusted R-squared	0.295499	S.D. dependent var	0.051818
S.E. of regression	0.043493	Akaike info criterion	-3.362229
Sum squared resid	0.240241	Schwarz criterion	-3.149092
Log likelihood	240.3127	F-statistic	7.338279
Durbin-Watson stat	2.303465	Prob(F-statistic)	0.000000

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Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027954	0.017131	-1.631810	0.1052
DCPI	0.003316	0.022919	0.144689	0.8852
D12*(DCPI-OPINF12)	-0.060015	0.025124	-2.388701	0.0184
DRINV	0.061125	0.015897	3.845038	0.0002
DAPOP	1.996384	0.564922	3.533909	0.0006
DREX(-4)	0.028439	0.014370	1.979021	0.0500
Fixed Effects (Cross)				
_GAM--C	-0.013418			
_GHA--C	0.002678			
_GUI--C	0.003317			
_NIG--C	-0.001276			
_SIL--C	0.006023			

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Effects Specification

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Cross-section fixed (dummy variables)

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R-squared	0.343780	Mean dependent var	0.025355
Adjusted R-squared	0.297276	S.D. dependent var	0.051818
S.E. of regression	0.043438	Akaike info criterion	-3.364754
Sum squared resid	0.239636	Schwarz criterion	-3.151617
Log likelihood	240.4857	F-statistic	7.392504
Durbin-Watson stat	2.304038	Prob(F-statistic)	0.000000

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Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.028103	0.017119	-1.641587	0.1031
DCPI	0.002898	0.022837	0.126875	0.8992
D13*(DCPI-OPINF13)	-0.060949	0.025450	-2.394871	0.0181
DRINV	0.061502	0.015882	3.872368	0.0002
DAPOPN	1.991114	0.565145	3.523195	0.0006
DREX(-4)	0.026854	0.014348	1.871671	0.0636
Fixed Effects (Cross)				
_GAM--C	-0.013148			
_GHA--C	0.002773			
_GUI--C	0.003341			
_NIG--C	-0.001645			
_SIL--C	0.006100			

#### Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.343925	Mean dependent var	0.025355
Adjusted R-squared	0.297432	S.D. dependent var	0.051818
S.E. of regression	0.043434	Akaike info criterion	-3.364976
Sum squared resid	0.239582	Schwarz criterion	-3.151839
Log likelihood	240.5009	F-statistic	7.397286
Durbin-Watson stat	2.306089	Prob(F-statistic)	0.000000

Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.029427	0.017084	-1.722469	0.0874
DCPI	0.002339	0.022902	0.102149	0.9188
D14*(DCPI-OPINF14)	-0.059288	0.025667	-2.309856	0.0225
DRINV	0.062362	0.015884	3.926049	0.0001
DAPOPN	2.018594	0.564770	3.574189	0.0005
DREX(-4)	0.026359	0.014369	1.834373	0.0689
Fixed Effects (Cross)				
_GAM--C	-0.012769			
_GHA--C	0.002094			
_GUI--C	0.003526			
_NIG--C	-0.001682			
_SIL--C	0.006457			

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#### Effects Specification

Cross-section fixed (dummy variables)

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R-squared	0.341943	Mean dependent var	0.025355
Adjusted R-squared	0.295309	S.D. dependent var	0.051818
S.E. of regression	0.043499	Akaike info criterion	-3.361959
Sum squared resid	0.240306	Schwarz criterion	-3.148821
Log likelihood	240.2942	F-statistic	7.332475
Durbin-Watson stat	2.309136	Prob(F-statistic)	0.000000

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Dependent Variable: DRGDP

Cross-sections included: 5

Total pool (unbalanced) observations: 137

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.029796	0.017073	-1.745216	0.0834
DCPI	0.001404	0.022771	0.061673	0.9509
D15*(DCPI-OPINF15)	-0.058878	0.025656	-2.294908	0.0234
DRINV	0.062288	0.015890	3.919863	0.0001
DAPOP	2.025721	0.564583	3.587995	0.0005
DREX(-4)	0.026361	0.014373	1.834084	0.0690
Fixed Effects (Cross)				
_GAM--C	-0.012678			
_GHA--C	0.001882			
_GUI--C	0.003535			
_NIG--C	-0.001613			
_SIL--C	0.006536			

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Effects Specification

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Cross-section fixed (dummy variables)

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R-squared	0.341600	Mean dependent var	0.025355
Adjusted R-squared	0.294942	S.D. dependent var	0.051818
S.E. of regression	0.043510	Akaike info criterion	-3.361438
Sum squared resid	0.240432	Schwarz criterion	-3.148301
Log likelihood	240.2585	F-statistic	7.321321
Durbin-Watson stat	2.310709	Prob(F-statistic)	0.000000

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