

Olowofeso, Olorunsola E. et al.

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Threshold effect of inflation on economic growth in the West African Monetary Zone

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**THRESHOLD EFFECT OF INFLATION ON ECONOMIC GROWTH IN
THE WEST AFRICAN MONETARY ZONE¹**

WAMI OCCASSIONAL PAPER SERIES NO. 26

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Abstract

While previous studies have explored the relationship between inflation and economic growth, the existing literature on threshold effect of inflation on economic growth in the West African Monetary Zone (WAMZ) predominantly assumes a linear association, neglecting the possibility of nonlinearity. This study aims to fill the gap in the empirical literature by exploiting the variation in inflation rates across countries and over time to identify endogenously the threshold inflation level that affects economic growth in WAMZ countries over the period 2001-2019. The paper applies a Panel Smooth Transition Regression (PSTR) model, considering the heterogeneity in inflation rates across countries and over time and nonlinearities in the inflation-growth nexus. Results reveal an inflation threshold of 10.3 per cent per annum for WAMZ countries, showing that achieving moderate inflation below this threshold will stimulate economic growth while high inflation above the threshold is detrimental to growth. The result provides strong empirical support for the policy stance of WAMZ countries regarding the convergence criterion to contain inflation to a single-digit level. This finding highlights the importance of adopting moderate inflation target below the identified threshold of 10.3 percent to foster sustainable economic growth. It underscores the need for central banks to adopt more proactive approach to monetary policy by closely monitoring inflation levels and taking appropriate actions to keep inflation within this desired range. Indeed, the evidence of such a nonlinear relationship implies that central banks should pay close attention to managing inflation expectations, through measures including clear and effective communication of monetary policy actions, which would help anchor inflation expectations to ensure a favourable inflation environment that supports economic growth and improve credibility of monetary policy in the region.

Key Words: Inflation; Growth; Threshold Effects; West Africa

JEL Classification : E31, O47, C34.

1.0 Introduction

One of the key macroeconomic policy objectives in most countries of the world is to maintain price stability that is conducive for economic growth. It is fundamental for countries to ensure delivery of high economic growth that brings about low inflation. Despite the continued policy focus of this objective, inflation experience in many countries of the West African Monetary Zone (WAMZ) has gone through several episodes of creeping to moderate and from high to galloping levels. Many of the countries in the zone only achieved single digit inflation rate a few times in the last decades and in the other years, inflation was double digit, and has generated a lot of attention in the literature. Despite the existence of growing literature on the effects of inflation on economic growth, theoretical and empirical studies on the subject are yet to produce a consensus, some studies demonstrate the existence of either a positive (Bruno and Easterly 1995; Mallik and Chowdhury, 2001) or negative (Khan and Senhadji, 2001; Munir et al, 2009; Ndoricimpa, 2017).

Three major strands are prominent in the literature. Some argue that there are trade-

offs between growth and inflation and conclude that high inflation has negative effects on economic growth. They opine that high inflation inflicts welfare costs on the general populace and obstructs efficient allocation of resources. It confuses the indicating roles of relative price changes, restrains developments in the financial markets as intermediation role becomes more costly. This affects the poor overly as they do not have resources which could serve as hedge against inflation, and the most worrisome effect is that it frustrates long-term economic growth (López-Villavicencio and Mignon, 2011). The other strand of the literature argues in the opposite direction and contends that moderate inflation is required to spur economic growth² and advocates for expansionary macroeconomic policies especially in developing economies where the engine of growth is through productive government expenditure (Bruno and Easterly, 1995; Mallik and Chowdhury, 2001). The third strand of the literature hypothesis that inflation does not have direct influence on economic growth, particularly in the long run. This view is in line with the super-neutrality concept of money in the long run (Faria and Carneiro, 2001). It is,

² This school of thought is of the opinion that (low) rate of inflation will make capital more attractive to hold relatively to money and this will lead to capital intensity

and thus high productivity which will lead to economic growth.

therefore, not surprising that central banks, policymakers, and researchers have devoted considerable time and resources to studying the dynamics of inflation to determine the optimal rate that would be consistent with sustainable economic growth as well as transmission channels through which high levels of inflation above the established threshold can exhibit adverse effects on economic growth.

Single digit inflation is one of the primary convergence criteria for attaining a common currency among member states of the WAMZ³. Over the years, it appears meeting this objective may be a difficult challenge for countries in the zone, as the countries are constantly experiencing different shocks (both internal and external) which have worsened their inflationary pressure. Thus, the questions practitioners and policymakers seek to answer are: does the single digit inflation convergence criterion support economic growth in the WAMZ? Then, what rate of inflation should West African Monetary Institute (WAMI) advise member states to aim for? What is the inflection point for inflation in the Zone?

While there is substantial body of literature on the inflation-growth nexus,

previous studies in the WAMZ predominantly assume a linear relationship, neglecting the possibility of nonlinearity. A few exceptions (Tarawalie, Sissoho, Conte and Ahorator, 2012; WAMA, 2018) that have documented different optimal inflation rates that can propel economic growth in the Economic Community of West African States (ECOWAS) region, employed estimation techniques that exogenously determined the optimal inflation beyond which high inflation could possibly exert a dampening effect on economic growth. However, these studies have not taken into consideration the heterogeneity in inflation rates across countries and over time to explore how such variations in inflation rates could possibly influence the inflation-growth relationship within the region. WAMZ countries have experienced significant variations in inflation rates over time due to disparities in economic structures, monetary and fiscal policies, and external factors. Consequently, it is crucial to consider the heterogeneity in inflation rates across countries over time to capture the diverse dynamics in the inflation-growth nexus. This study, therefore, seeks to determine the optimal inflation rate consistent with sustainable

³ The Member States of WAMZ include: The Gambia, Guinea, Ghana, Liberia, Nigeria, and Sierra Leone.

economic growth in the WAMZ. Exploring this issue is extremely important in the WAMZ, given the different nature of economic conditions in these countries and varying degree of resilience to shocks. However, both theoretical and empirical literature that investigates the adverse effects of high inflation on growth remains sparse. Eggoh and Khan (2014) stress that the negative impact of inflation on growth above a certain threshold could be induced by macroeconomic conditions such as the level of financial deepening, physical capital accumulation, trade openness, and public expenditures. By extension, these conditions tend to vary significantly across countries and can potentially explain the nonlinear effects of inflation on growth. Building on these insights, this paper contributes to the policy debate and empirical literature on the inflation-growth relationship by exploiting the variation in inflation rates across countries to identify endogenously the threshold inflation level that affects economic growth in WAMZ countries over the period 2001-2019.

To achieve these objectives, this paper utilizes a Panel Smooth Transition Regression (PSTR) model to explore the heterogeneity in inflation rates and nonlinearities in the inflation-growth nexus. The results reveal a threshold level of inflation rate of 10.3 per cent

per annum for the WAMZ, showing that achieving moderate inflation below this threshold will stimulate economic growth while high inflation above the threshold is detrimental to growth. This finding will provide valuable insights into the threshold level of inflation that affects economic growth, allowing policymakers to implement targeted measures to contain inflation. The study will inform policy decisions of central banks that aim to anchor inflation expectations, keeping inflation within the desired range to ensure a favourable inflation environment that supports economic growth in the region.

The paper is structured as follows. Section 1 introduces the study, while section 2 dwells on the stylized facts on the nexus between inflation and economic growth in the WAMZ. Section 3 provides a brief review of literature at theoretical and empirical levels. Section 4 addresses the methodology of the study while section 5 presents and discusses the empirical results. Section 6 concludes, with some policy recommendations.

2.0 Stylized Facts on Inflation and Economic Growth in the WAMZ

The recent heightened global concern for inflation as a result of unprecedented high and increasing global inflation, especially in the developed countries, which is spilling over to

the developing countries has increased global attention to inflation-growth nexus (Zhang, 2022). Hence, both fiscal and monetary policymakers as well as researchers have recently increased their focus on different channels of explaining the intensity of inflation-growth nexus (Zhang, 2022; Olugbenga and Oluwabunmi, 2020). This is so because, among other things, inflation impacts the economic well-being of the people through several channels as well as different economic activities (Joseph, 2014). It has also been a subject of interest, especially in determining the appropriate fiscal and monetary policy mix (Foluso and Nicholas, 2017). In fact, one of the primary objectives of most central banks is price stability to contain inflation to the desired minimum level because the welfare cost of inflation is so important that most monetary policy implementation is based on targeting

inflation among other monetary aggregates (Gillman, 2018).

Table 1 shows the trend analysis of economic growth and inflation in the WAMZ member countries during the periods 2000-2019. Based on the 5-year average analysis, global developments such as global financial crisis, global commodity prices alongside other domestic specific factors have largely influenced inflation and economic growth in the region. Many countries have largely experienced mixed performance. For instance, it is only Guinea experienced higher real economic growth in the WAMZ in the last decade-between 2010 and 2019, based on 5-year average. All other countries within the zone experienced decline in real economic growth. The table below shows that all the countries excluding Liberia and Sierra Leone experienced real economic growth during the period 2015-2019.

Table 1: Average GDP and Inflation Growth Rates in WAMZ

RGDP Growth (%)				
Country/Year	2000-04	2005-09	2010-14	2015-19
The Gambia	4.4	2.6	0.9	4.8
Ghana	4.5	6.1	8.1	5.3
Guinea	3.0	2.9	4.7	7.4
Liberia	-4.5	7.7	6.4	-0.1
Nigeria	9.3	7.3	6.4	1.2
Sierra Leone	12.9	5.1	10.4	-0.3
Inflation Rates in WAMZ				
Country/Year	2000-04	2005-09	2010-14	2015-19
The Gambia	9.1	4.3	5.2	7.1
Ghana	22.4	13.4	9.7	12.8
Guinea	8.7	22.4	14.7	8.9
Liberia	9.1	10.6	8.0	15.9

Nigeria	13.5	11.1	10.7	12.9
Sierra Leone	3.7	11.4	6.1	13.3

Sources: WAMI Database

The Gambia

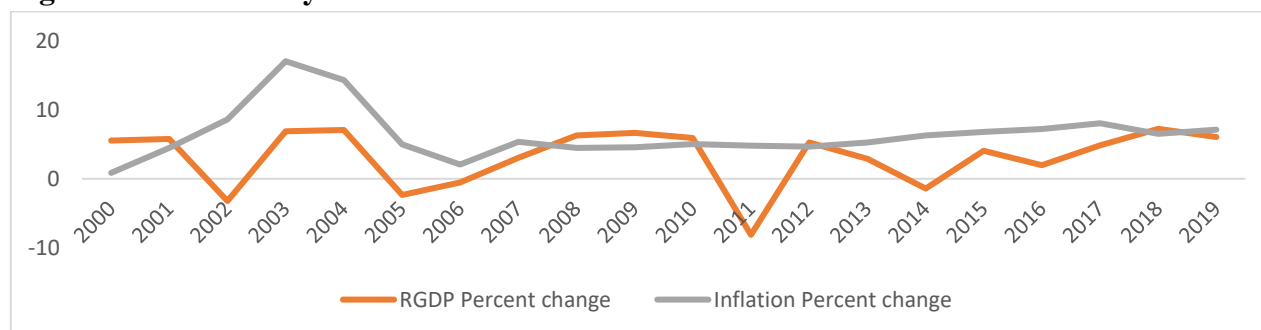
The inflation-growth relationship in the Gambian economy showed a mixed performance during the period under review. During 2000-04, the economy recovered in 2002 from a drought-induced decline in economic growth, as good rains boosted the production of agricultural output. Furthermore, the economy improved premised on registered successes under the macroeconomic and structural policy reforms.

In 2000-04, The Gambia's inflation rate averaged around 9.1 percent due to depreciation of the dalasi and an increase in

domestic pump prices, with a corresponding average GDP growth rate of 4.4 percent. Between 2005 and 2009, the central bank's slowdown in broad money growth indeed lowered inflation to a low single-digit level less than the Bank's medium-term target of 5.0 percent.

In 2011, real GDP was negative 8.13 percent predicated on the severe crop failure caused by drought in the reviewed year. Crop production improved by 30.0 percent in 2012 after a contraction of 60.0 percent in 2011 (IMF May 2013).

Figure 1: Trend Analysis of Economic Growth and Inflation in The Gambia



Source: WAMI Database

However, the Gambia's economic performance was hampered by the contagion effect of the Ebola outbreak on tourism, and erratic rainfall leading to a deterioration in economic growth to 0.9 percent between 2010-14 compared with an average of 2.6 percent between 2005-09. The growth rate resurgence

to an average of 4.8 percent between 2015-19 was due to the authority's economic programs; strong 2015 budget, structural and policy reforms, and efforts to secure donor support. Recovery from the effects of delayed rains also improved agriculture and tourism incomes that inter alia affected by the Ebola outbreak in the

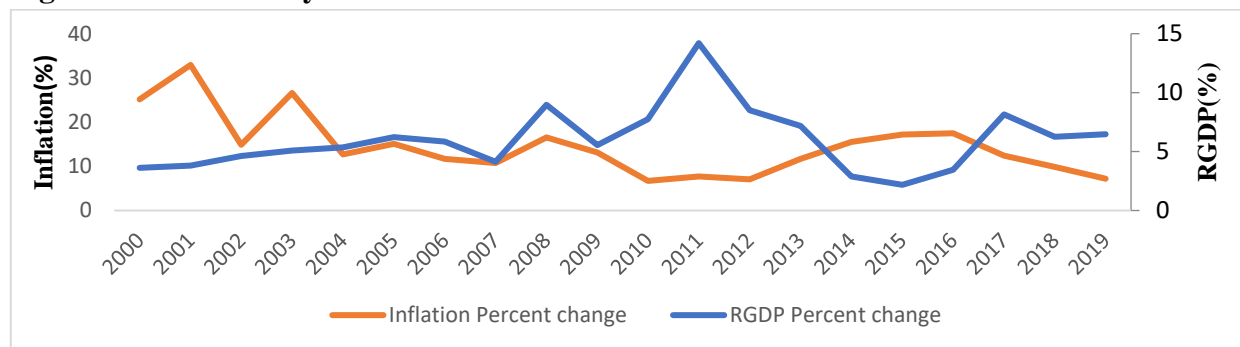
region. Notwithstanding these positive developments, inflation accelerated to 7.1 percent from 5.2 percent due to the depreciation of the dalasi and increased global oil prices.

Ghana

The Ghanaian economy had improved since 2000 underpinned by better macroeconomic management, increased agricultural output, services, and a prudent monetary policy stance. Real GDP growth remained strong during 2007 and 2008. Inflation on the other hand accelerated to a double-digit on account of the

contagion effects of the global financial crises and commodity price shocks. The economy remained fragile, weak macroeconomic balance and a vulnerable external position during the same periods (IMF Article IV, October 2008). Both indicators at times move in the same direction thus deviating from theoretical underpinning. Irrespective of the fall in inflation to 22.4 percent in 2000-04, real GDP growth also dropped by 0.4 percentage points to 4.5 percent in the same period (Table 1).

Figure 2: Trend Analysis of Economic Growth and Inflation in Ghana



Source: WAMI Database

The average inflation rate decelerated to 13.4 percent and 9.7 percent in the period 2005-09 and 2010-14 explaining the significant increase in the GDP growth from 4.5 percent to 6.1 percent and 8.1 percent in the same periods, respectively. However, average GDP growth subdued to a record low of 5.3 in 2015-19 indicating the impact of the increased inflation rate. In the fiscal year 2020, inflation

stood at 10.59 percent whilst real GDP growth declined significantly to 0.92 percent due largely to the fiscal and monetary policies in the containment of the coronavirus pandemic.

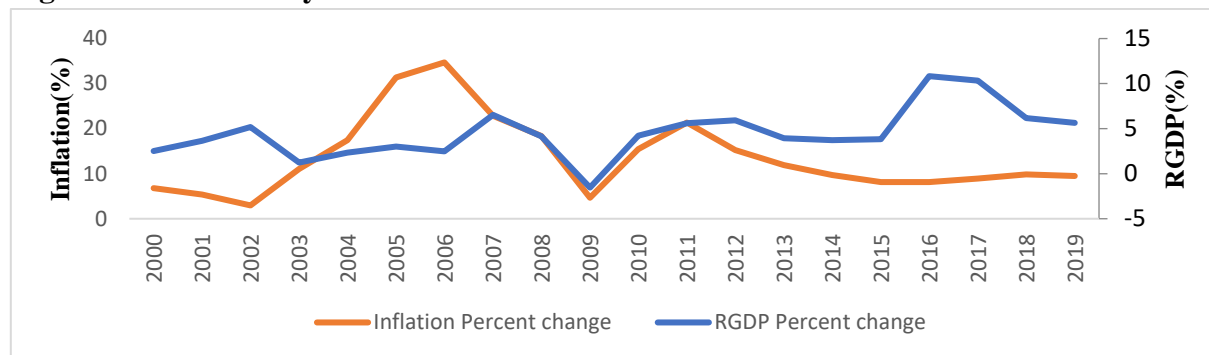
Guinea

Inflation in Guinea was relatively high during the periods under investigation. Inflationary pressure accelerated from 8.7 percent in 2000-2004 to 22.4 percent in the period 2005-2009,

driven partly by the global recession, socio-political crisis, a political sanction. These challenges beset the economy with hardship in respect of rising non-food prices, and exchange rate depreciation (BCRG, Annual Report

2009). The average real GDP growth declined from 3.0 percent recorded in 2000-2004 to 2.9 percent for the later period mentioned above due to the poor macroeconomic conditions and weak structural performance.

Figure 3: Trend Analysis of Economic Growth and Inflation in Guinea



Source: WAMI Database

Encouragingly, in 2010-2014 and 2015-19, average economic growth improved to 4.7 percent and 7.4 percent, respectively due to recovery from setbacks in the real sector and external sector positions. The inflation rate, therefore, fell from 22.4 percent to 14.7 percent and 8.9 percent in 2010-14 and 2015-19, respectively.

The growth momentum from 2010 to 2019 was due to increased economic activities in the mining, agricultural and services sectors as well as improved fiscal conditions and stable exchange rate. Figure 3 revealed some evidence of an inverse relationship between inflation and economic growth in Guinea. If inflation decelerates, economic growth improves.

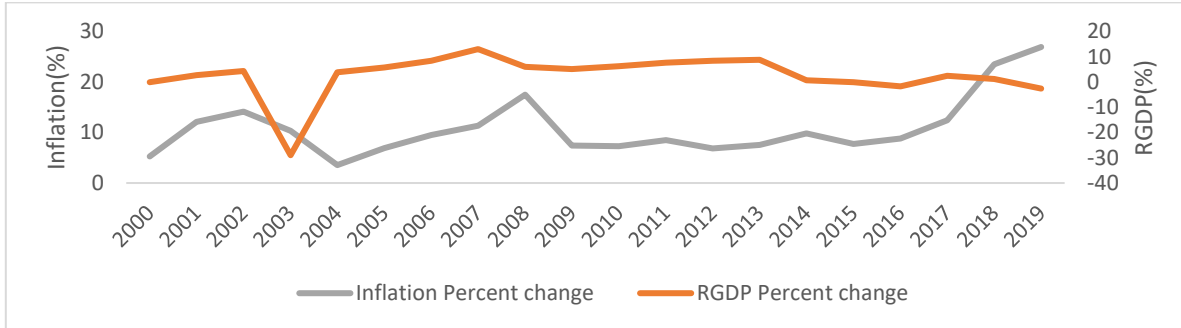
Liberia

The Liberian economy was in a dire state and was affected by shocks, including a fall in revenue, increased prices of basic commodities, minuscule production activities, especially in the timber industry, and historical effects of the 1989 to 1997 civil war. The relationship between economic growth and inflation manifested both negative and positive trends.

Between 2000-2004, GDP growth rate stood at a negative 4.5 percent with a corresponding inflation rate of 9.1 percent. This condition was explained by the government’s inability to implement macroeconomic programs coupled with displacement of people across the country. The real sector suffered a significant

setback as reflected in low production activities during the civil war.

Figure 4: Trend Analysis of Economic Growth and Inflation in Liberia



Source: WAMI Database

However, real GDP growth recovered to 7.7 percent premised on improved economic and social policies, improved revenue collections, increased peace missions, donor activities, and reconstruction activities. These factors remarkably increased economic activities thus imposing upward pressure on pump prices with the ultimate effect of setting the inflation rate to 10.6 percent. It was only during this period between 2015 and 2019 that inflation was negatively connected to economic growth as shown in Figure 4. The relationship appeared to be more tilted towards a positive than a negative relationship.

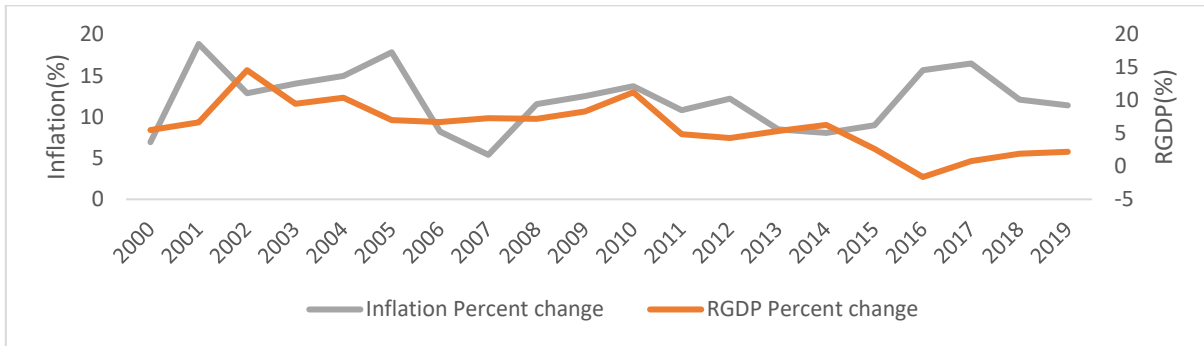
Nigeria

Developments in the global economy adversely impacted the Nigerian economy, accounting for the impinging effects on oil prices, exchange rate, and current account balance (AfDB Group report 2015). During the

period under study, growth increased but remains dull. However, in the second and third quarters of 2017, economic activity improved by 0.8 percent and 1.4 percent respectively predicated on recovery in agriculture and oil production.

However, real GDP growth improved in 2003 explained by strong economic performance in the non-oil subsectors and declining inflation on food and utility items. On the policy front, authorities implemented fiscal consolidation and tight monetary policies to stabilise the macroeconomic conditions (IMF Article 4, April 2014). Real GDP growth decreased from an average of 9.3 percent in 2000-04 to 7.3 percent, 6.4 percent, and 1.2 percent in 2005-09, 2010-14, and 2015-19, respectively. Over the same period, average inflation also decelerated from 13.5 percent to 11.1 percent, 10.7 percent, and in 2015-19, increased to 12.9 percent, respectively.

Figure 5: Trend Analysis of Economic Growth and Inflation in Nigeria



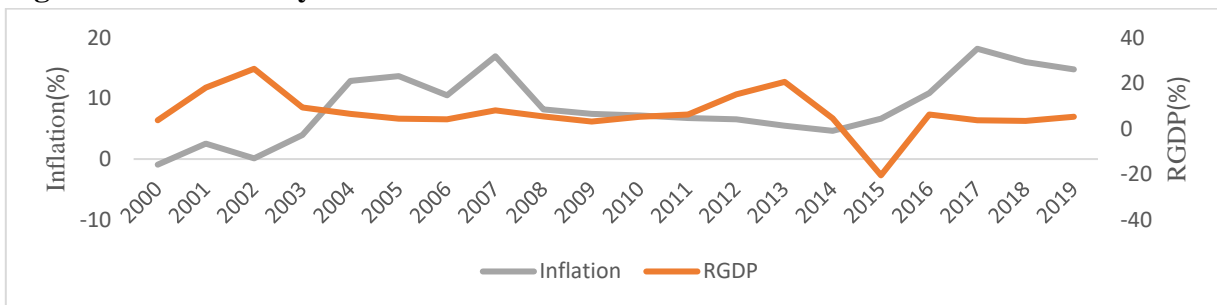
Source: WAMI Database

Sierra Leone

In Sierra Leone, economic growth was broad-based. Despite the increase in the rate of inflation to double digits, there was a recovery in growth in 2000-04 with the real GDP growth rate averaging 12.9 percent premised on improvements in the country’s real sector.

However, growth slowed to an average of 5.1 percent in 2005-09 with a corresponding increase in inflation to 11.4 percent in the same period from 3.7 percent in the preceding period due to a sustained increase in general price levels throughout 2008 because of the global financial crisis.

Figure 6: Trend Analysis of Economic Growth and Inflation in Sierra Leone



Source: WAMI Database

With the impact of the Ebola Virus in the region especially in Sierra Leone, economic growth was curbed to a negative 0.3 percent whilst inflation accelerated to 13.3 percent in 2015-19. Agriculture, being the mainstay of the populace was disrupted during the restrictions to contain the virus, especially

in the major crop-producing regions thereby causing a food price increase of about 30.0 percent (Olusegun, 2014). The inflation-growth relationship in Sierra Leone exhibited an inverse relationship for most of the period as indicated in Figure 6.

3.0 Literature Review

3.1 Theoretical Literature Review

Theories on the relationships between inflation and economic growth are copious and this largely account for the attendant conflicting views on the issue. Prominent among these theories are the classical growth theory, Keynesian theory of aggregate demand (AD) and aggregate supply (AS) framework, Monetarism, neo-classical growth theory and endogenous growth theory. Each of these theories will be discussed in turn.

The **classical growth theory** laid out by Adam Smith was created based on the theory of supply side economics. This growth theory did not explicitly state the relationship between inflation and growth but rather implicitly suggested it to be negative. The **Keynesian theory** on the other hand considers both the aggregate demand (AD) and aggregate supply (AS) curves. It shows that in the short run, the AS curve is upward sloping but vertical in the long run. The upward slope of the AS curve implies that prices and output are affected by changes in AD and vertical AS curve implies that only prices are affected by changes in AD. Moreover, factors including expectations, labour forces, fiscal and monetary policies, prices of other products affect prices and output in the short run (Dornbusch et al., 1996). The theory suggests

that dynamic adjustments in the short run aggregate demand and aggregate supply curves give rise to an adjustment path that exhibits an initial positive relationship between inflation and growth because of the concept of time inconsistency but turn negative towards the end of the adjustment path. The positive relationship can also be due to standing trade or sales arrangements. Hence even with price changes, output is not affected. In conclusion this model postulate that there exists a trade-off in the short run but not a permanent trade-off between inflation and output.

Diving into the Keynesian theoretical framework, it was pointed out that aggregate demand could be induce through government spending (capital/investment or recurrent expenditure) and or through other fiscal measures such as tax cuts. In theory an increase in government spending indicates a shift in the aggregate demand curve to the left. With the aggregate supply curve sloping upwards, the curve will reveal increases in both the output and price level. On one hand government spending could lead to excess demand, aggregate demand exceeding aggregate supply. Subsequently, the domestic economy could experience increases in the general price level "Demand pull inflation". If the economy is operating at full employment inflationary pressure could persist. On the other hand, when

output increase along with the price level, real money demand will similarly increase. With money supply remaining fix, interest rate will rise conversely affecting Consumption and investment and consequently output. A sheer scale borrowing by government under such condition can lead to substantial increase in the real interest rate consequently absorbing the lending capacity of the domestic economy as well as discouraging capital investment by private enterprises.

In another vein, **Monetarist theory**, led by Milton Friedman, is based on the concept of money neutrality. It opined that the increase in money supply leads to increases in the cost of everything, therefore the real economy is not affected. It assumed that an increase in steady growth rate of the money stock will lead to a corresponding rise in the steady growth rate of prices in the long run. Hence, the super-neutrality of money assumes that economic activity is not dependent on money growth in the long run. In sum, if inflation works in this way, then it is not harmful to economic growth. In the same vein, **Sidrauski in 1967** developed the super-neutrality theory of money. The theory is based on the concept that growth rate of output is independent of the growth rate of money supply in the long run. It suggested that the steady state capital stock is not influenced by

the increase in the rate of inflation because the representative individual's real discount rate is unaffected by inflation. Implying that both output and economic growth are not affected by inflation in the long run.

The **Neo-classical growth theory** considers productivity, capital accumulation, population growth and technological advancement to explain long run economic growth. It was initially developed by Robert Solow and Trevor Swan in 1956. The theory states that capital accumulation and its efficiency is important for economic growth and the relationship between capital and labour determines an economy's output. Technology is thought to boost labour productivity and expand output capabilities of labour. There are several models under the Neo-classical growth theory that relate inflation to output growth, most of which believe inflation either have positive or at most neutral effects on economic growth but not negative effects. For instance, **Mundell (1963) model** suggested that an increase in inflation or its expectation immediately reduces people's wealth, by reducing the rate of return on individual real money balances. Hence, people must save more to acquire assets in order to attain desire wealth. Higher demand for assets will increase asset prices but a decrease in real interest rate. If people are saving more by switching to

assets, it means that there is greater accumulation and thus faster output growth. This implies that inflation may have initial negative effect on economic agents, but it generates higher economic growth in the long run. The **Tobin effect** is a modification of Mundell's model, developed by Tobin in 1965. The model was developed based on Solow-Swan growth model, noting that people sacrifice current consumption for future consumption (precautionary motive), not wanting to acquire capital despite higher rate of return. Tobin suggest that inflation will see people wanting to acquire capital and not wanting to hold money because inflation reduces return to money. Tobin further explains that higher inflation rate permanently raises output level but the effect on output is temporary occurring during the transition from one steady state capital stock to a new steady state capital stock. Inflation effect on growth is said to be positive in that it induces greater capital accumulation and higher growth. Even when return to capital begin to fall, higher investment falls but steady state growth will continue.

In another vein, **Stockman in 1981** developed a model which suggested that inflation has a negative impact on economic growth. His argument is based on cash in advance constraint model, stating that an

individual or firm must have sufficient cash available before they can spend on goods or services. Making a case for the negative relationship, he explained that funds for investment(s) is held at some point and if inflation is high during that time, real return on investment or purchasing power on other goods is lower. Hence, the rise in the rate of inflation will result in a lower steady state level of output. In a similar vein, **Endogenous growth theory** focuses on endogenous factors which include economies of scale, technological change, increased returns to scale, during production processes. The theory suggest that economic growth depends on the rate of return on capital accumulation, both human and physical capital. Inflation is assumed to act as tax, affecting the return on all capital, directly reducing the growth rate and indirectly reducing the return on human capital through substituting labour for leisure. Haslag (1995) pointed out that inflation might directly affect capital accumulation and consequently affect output growth. He explained that an increase in the rate of inflation reduces the return on deposits resulting in a slower rate of capital accumulation. It assumed that capital is a fraction of deposits and holding deposits as reserve requirements during inflation will

lower capital accumulation and therefore economic growth will be negatively affected.

To put these theories in perspectives, we categorised them based on their major conclusions on the effects of inflation on economic growth. Broadly, there are two types of theoretical expectations concerning the effect of changes in average inflation level on output growth. There are theories that support the notion of *inflation has no effect on growth* and others that oppose this belief and argue that *inflation has real effects on economic growth*. The latter group are also divided into those that support positive relationship and others who advocate negative linkages between inflation and growth.

The first expectation is based on the exogenous growth and monetarists' theories which proposed that inflation rate will have no effect on the growth rate as well as the level of output. This was premised on the argument that individuals usually anticipate the rate of future inflation and incorporate its effects into their behaviour, as such, employment and output are not affected. This concept is known as neutrality of money. Another related theory is the quantity theory of money which links inflation and economic growth by simply equating the total amount of spending in the economy to the total amount of money in existence. The theory contends that inflation is

the product of an increase in money supply or velocity of money at a rate greater than the rate of growth in the economy. This suggests that in the long run, prices are mainly affected by the growth rate in money while having no real effect on economic growth.

As opposed to this, the Keynesian, neo-classical and endogenous growth theories emphasise that money and inflation do affect the growth rate of output, although with divergent conclusion. For those that support positive relationship, there are different channels for such an effect. One argument is known as the Mundell-Tobin effect in which a more inflationary policy enhances growth as investors move out of money and into growth enhancing capital investment. This is because a rise 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 in greater capital accumulation and hence faster output growth. Similarly, the structuralists emphasise that inflation promotes real growth. These can be justified with two possible schools of thoughts: (i) in Keynesian economies under fixed prices, inflation can stimulate growth by

redistributing profits from workers with low savings propensities to entrepreneurs with high propensities to save and invest, and by increasing the nominal rates of return relative to the cost; and (ii) in economies with flexible prices, inflation can redistribute money from holders of money balance to the monetary authorities, a phenomenon also known as inflation tax that helps governments to expand their investment programmes and thereby increase growth.

Contrary to this view, other schools of thought argue that inflation retards economic growth. The arguments supporting this view are that: (i) high inflation rates raise the cost and risk of productive capital and may lead to misallocation of funds to less productive investments that act as a hedge against inflation; and (ii) high inflation rates along with managed exchange rates lead to trade imbalances and speculative capital outflows affecting an economy's growth. This school generally declares that high inflation inflicts welfare costs on the society, hinders efficient resource allocation by obscuring the signalling role of relative price changes, inhibits financial development by making intermediation more costly, hits the poor disproportionately because

they do not hold financial assets that provide a hedge against inflation and usually, obstructs long-term economic growth.

The aforementioned theories capture the roles of inflation in the growth models.⁴ Generally, economic theories have established that at least in the short run, inflation induces growth, to the extent that it is positively correlated with growth but in the long run if it persists, it becomes inimical to growth.

3.2 Empirical Literature Review

To date, the relationship between inflation and economic growth remains controversial and/or inconclusive; many empirical studies demonstrate the existence of either a positive (such as Bruno and Easterly 1995; Mallik and Chowdhury, 2001) or negative (Khan and Senhadji, 2001; Munir et al, 2009 among others) relationship between these two major macroeconomic variables. Moreover, in recent years, a number of studies have revealed that low and stable inflation promotes economic growth and vice versa (Mubarik, 2005). Bruno and Easterly (1995) summarised the theories on the subject and classified them into three segments across the decades. First, is the traditional 1960s view of

⁴ It must be noted that studies refer to above is far from being exhaustive debate or contributions of the economic theories on inflation- growth nexus.

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, in the long run. The second, are the 1970s and 1980s inflationary experiential era which focused mainly on the short run behaviour. During this period, the consensus was reached 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 theorists 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 reduce the level and/or growth rate of GDP in the long run (Barro, 1995; Fischer, 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).

This has prompted empirical studies that captured this relationship. 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. It finds that inflation influences growth by decreasing productivity growth and investment. The result also shows that the effect of inflation is non-linear with breaks at 15 and 40 per cent. Barro (1995) used a panel data for 100 countries from 1960 to 1990 and estimated growth regression using Instrumental Variables (IV) technique. The study finds a negative relationship between inflation and economic growth. The result reveals that a ten per cent inflation rate reduces real GDP per capita by 0.2 per cent per year. Similarly, Sarel (1996) used a panel data sample of 87 countries over 21 years (1970 to 1990) to investigate the relationship between inflation and growth with a fixed effect technique framework. The study shows evidence of structural break in interaction between inflation and growth. The main finding of the study is that the estimated threshold level is eight per cent, and an inflation rate exceeding this threshold would lead to negative, significant and robust impact of inflation on growth. Table 2 below presents the tabular representation and summary of the recent relevant empirical literature.

Table 2: Summary of Literature Review on Inflation and Economic Growth

S/NO	Studies	Sample/Scope	Theoretical Framework	Methodology		Empirical Results
				Estimation Methods	Variables	
Inflation-Growth Studies						
1	Okoroafor et al, (2018)	Nigeria, 1961-2016	Parametric linear causality	Traditional ARDL Method, VAR & ARMA	Inflation rate, Real GDP growth rate, Real GDP weighted by broad money supply (level of financial deepening)	Result finds that attaining an inflation threshold of 14% would boost the economy and bring it to a steady path of growth.
2	Ahortor et al, (2012)	WAMZ Countries	Keynesian Aggregate demand & Aggregate supply Framework	Conditional Least square technique, Panel data model	Real GDP growth rate, Domestic Inflation (Current & Lagged), Real Investment growth rate, population growth rate, Real exchange rate appreciation/depreciation, Terms of trade, trade openness, growth rate of gov. exp., growth rate of OIL revenue in real terms	Results showed that there exists a statistically significant long-run negative relationship between inflation and economic growth for the WAMZ countries. The results also showed that WAMZ countries threshold inflation rates lie within the convergence criteria of maintaining an inflation rate not exceeding 10 percent.
3	Lopez-Villavicencio and Mignon (2011)	44 Countries (both industrialized & emerging economies) 1961-2007	Level of Inflation and its effect on growth	Panel Smooth transition Regression (PSTR) & Dynamic GMM Models for panel data	trade openness (% GDP), Gov. consumption (% of GDP), GDI (% of GDP), population growth, inflation rate (growth rate of CPI), Growth rate GDP per capital in constant 2000 USD prices	Results show strong evidence that inflation non-linearly impacts growth and that there exists a threshold beyond which inflation exerts a negative effect on growth and below

						which it is growth enhancing for advance economies
4	Thanh (2015)	Asian-5 countries, 1980-2011	Non-linearity between inflation & Growth	Panel smooth transition regression approach (PSTR)	GDP PC, Initial output level, Employment growth rate, investment growth rate, terms of trade growth rate, SD terms of trade, government spending growth rate, inflation rate and semi-log transformation of CPI	Results shows that there is a statistically significant negative relationship between inflation & growth for inflation rate above the threshold of 7.84%
5	Baharumshah et al., (2016)	9-4 emerging and developing countries, 1976-2010	Effect of Inflation & Inflation Uncertainty on growth	GMM model for Panel data	Initial income (log), Population growth, investment ratio, schooling, inflation rate, inflation above threshold, inflation uncertainty, inflation uncertainty above the inflation threshold	Results shows that Inflation harms growth, while inflation uncertainty promotes growth in non-inflation crisis countries. There are more negatives of not keeping growth in check than positives. There is a positive effect of uncertainty about the inflation rate on growth when inflation reaches a moderate range of 5.6% -15.9%
6	Eggoh and Khan, (2014)	102 Developed & Developing Countries 1960-2009	Non-linearity between inflation & Economic Growth	PSTR and dynamic GMM models	Inflation growth rate of CPI, GDP PC in constant 2000 USD prices, trade openness measure as the ratio of plus exports to GDP, gov exp to GDP, investment at a ratio to GDP, fix capital formation to GDP, liquid liability to GDP and population growth	Result Shows a non-linear relationship b/w inflation and growth and that threshold estimates decrease with the level of income. This systematic inverse relationship illustrates

						the fact that inflation indexation and inflation tolerance are higher in developing economies than in developed economies
7	Ndjokou, & Tsopmo, (2017)	BEAC Zone, 1985-2013	Threshold Effect, Inflation on Growth	PSTR Model, (GMM Method)	Real GDP growth rate, CPI growth rate, export GDP ratio, import GDP ratio, Population growth, gross fix capital to GDP ratio, public expenditure to GDP ratio, export price index to import price index ratio	Result show below the established threshold of around 4.3% a 1% increase in inflation positively affects growth by 0.28%, while above the threshold a 1% increase in inflation negatively affects growth by 0.26%
Inflation-Growth Transmission Channels Studies						
1	Morvillier, (2019)	62 Countries (18 advanced economies, 22 emerging economies and 22 developing economies), 1980-2015	Currency undervaluation impact on Inflation-Growth relation	Bayesian Model Averaging (BMA) to select relevant growth determinants & Behavioral Equilibrium Exchange Rate to investigate if undervaluation level matters for the inflation-growth nexus.	Inflation, Gross fixed capital, Gov. Consumption, Real Initial GDP Per Capital, Fertility, terms of trade, Human capital	Results find a negative inflation-growth nexus for emerging countries, while inflation does not hamper growth for developing economies. Moreover, it shows that the higher the undervaluation, the higher the negative impact of inflation on growth

2	Keith Blackburn & Jonathan Powel, (2011)	Empirical observation	Relationship between Corruption (bureaucratic), inflation and economic growth	Dynamic general equilibrium model	Inflation growth rate of CPI, GDP, Gov. Expenditure, Consumption, income level, real interest rate	Corruption impedes real economic growth by forcing the government to rely more on inflationary finance which reduces capital accumulation through the tax that it imposes on investment.
3	Dimitrios Varvarigos, (2010)	12 Sub-Sahara African Countries, 1950-2007	Correlation between output growth & Average inflation and inflation variability & policy volatility and social welfare	Dynamic general equilibrium model	Inflation growth rate, real GDP growth rate, Gov Expenditure, Money supply rate of change, Leisure time, Consumption	Result shows a negative correlation between policy volatility and growth. It also provides a theoretical justification for the simultaneous negative correlation of long run growth with both average inflation and inflation variability. The model also supports the view that policy volatility reduces social welfare

4	Ibarra,R, & Trupkin,D.R, (2015)	138 Developed & Developing countries, 1950-2009	Nexus between inflation & economic growth taking into account institution quality	Panel smooth transition regression approach (PSTR)	Inflation, GDP, Initial pc income, population growth, investment output ratio, trade openness, SD of terms of trade	Result Shows a non-linear relationship between inflation and growth. Also, the threshold level of inflation above which economic growth is negative is 19.1% for non-industrialized economies and 4.5% for industrialized economies. Results also show that the cost of inflation increases with quality of institutions. The inflation threshold falls when reduced groups that exceed certain level of institution quality are considered
5	Nguyen, (2018)	India, China & Indonesia, 1970-2010	Government Spending & Inflation, long run, short run relationship	Co-integration & Vector error correction model	GDP per capital, Nominal exchange rate, public expenditure as a share of Nominal GDP, CPI growth rate, unemployment rate	A casual long run relationship between government spending and inflation was revealed among the three sample countries, implying that institutional structure is not of major significance.

6	Itchoko Motande Mondjeli mwa Ndjokou, (2015)	WAEMU Countries (7 Countries), 1985-2012	Public Expenditure, Economic Growth (threshold effect)	PSTR Model	Public expenditure, private Investment, population, GDP, Taxes, External Public Debt	Results revealed the below the established public expenditure threshold of 15.14%, public expenditure impact on growth is insignificant. However, above the threshold it is unfavourable to growth.
7	Tomasz Łyziak & Joanna Mackiewicz-Łyziak, (2020)	22 European Union (EU) Countries,	Inflation expectation, public debt & Fiscal sustainability Nexus	Fixed effect model & VAR model	Lagged Inflation, Output gap, Real interest rate, Exchange Rate, Oil price, public debt	Result shows that fiscal policy is only significantly influential towards inflation in countries with sustainable fiscal measures
8	Onuoba & Okorie, (2020)	Eleven (11) African Countries, 1990-2019	Disaggregated Public Expenditure, Inflation rate Nexus	Panel Fully Modified OLS & Panel Dynamic OLS	Disaggregated expenditure as a percentage of GDP, Inflation Rate,	Findings among the Countries showed that changes in both capital and defence expenditure above 1% will have an incremental change in inflation. Also, expenditure on Education and health was seen to have respective positive and inverse relationship with inflation but was however insignificant.

9	Attari & Javed, (2013)	Pakistan, 1980-2010	Inflation, Growth, Government Expenditure Nexus	ADF unit root test, ARDL, Johansen Co- integration & Granger-causality test	Government Expenditure, GDP, Inflation rate	Result shows that Inflation above the threshold adversely affects growth. Development expenditure was a strong link to growth relationship
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Source: Compiled by the Authors

Ghosh and Phillips (1998) used a data set of 3,603 annual observations on real per capita GDP growth and the period average of consumer price inflation, corresponding to 145 IMF member countries, over the period 1960 to 1996. The objective of the study is to determine whether inflation-growth correlation is robust. Further, it also checked for non-linearity of the relationship. The results reveal that there is a negative relationship between inflation and growth and observed that, at very low rates (two to three per cent a year or lower), inflation and growth are positively correlated. Otherwise, inflation and growth are negatively correlated but the relationship is convex. The study also notes a threshold of 2.5 percent and a significant negative effect above this level.

Khan and Senhadji (2001) investigated the inflation-growth interaction using a panel data set of 140 countries (both industrial and developing) from 1960 to 1998. The study employed the method of non-linear least squares to deal with non-linearity and non-differentiability of the inflation threshold level in growth regression. The results show an inverse relationship between inflation and growth, with estimates of the inflation threshold levels of one to three per cent for developed and 11 to 12 per cent 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. The results show that the relationship between inflation and economic growth is positive and statistically significant for all four countries. The study also observes that the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates.

Many of the recent literature generally believe that there is nonlinearity in the inflation-growth nexus and that this relationship is largely negative, particularly in a low-inflation environment (López-Villavicencio and Mignon, 2011). This is likely to influence its dynamic through several channels (see Temple, 2000; Gillman and Kejak, 2005; for surveys of literature). For example, considering a model of optimal growth, Gylfason and Herbertsson (2001) show that higher inflation reduces capital efficiency which affects output negatively. Higher rates of inflation also lead to a lower return on loans and lower steady-state capital stock (Huybens and Smith, 1999). This inflation-growth nexus is likely to be influenced by real undervaluation as an

undervalued currency is associated with supplementary inflation pressures (Calvo et al., 1995; Haddad and Pancaro, 2010; Chen, 2017; Grekou, 2018a; Morvillier, Florian, 2019) through economy overheating and an imported inflation mechanism. Thus, higher inflation rates, associated with an uncertain economic environment reduces investment which can hamper growth significantly (Temple, 2000).

There are some other recent studies that attempt to trace the channels through which negative inflation tends to hamper (transmit) economic growth through several **institutional factor** (Ibarra, Raul; Trupkin, Danilo R. 2015). Results from this study shows that inflation threshold in developing economies falls as there are improvement in some levels of institutional quality. Hence, the quality of institutions matters for the nexus between inflation and growth and that cost of inflation increases with the quality of institution. Eggoh and Khan, (2014); Dimitrios, 2010) examined the channels through **efficiency of public spending and debts** and found negative correlation between output growth and inflation and that both the mean and the variance of the inflation rate are elevated by fluctuations in public spending. Several other empirical studies have been conducted to explore the

link between Public Expenditure, Inflation and Growth. However, the significance or degree of the impact public spending could have on inflation as well as growth may varies, depending on the direction of public spending, the level of fiscal sustainability as well as the fiscal measures employ. Motande, (2015), using data set from 1985- 2012 for the WAEMU countries, while relying on the PSTR model, found that below the established public expenditure threshold of 15.14%, public expenditure impact on growth is insignificant for the region. However, above the threshold it was found to be unfavourable to growth. Onuoba & Okorie, (2020), examine eleven (11) African countries data from 1990-2019 to determine the effect of public expenditure on inflation. After disaggregating public expenditure, using the Panel Fully Modified OLS & Panel Dynamic OLS they found that there exists a long run equilibrium relationship among the variables. Findings among the Countries showed that changes in both capital and defence expenditure above 1% will respectively lead to around 0.55% and 0.27% incremental change in inflation. Expenditure on education and health was seen to have respective positive and inverse relationship with inflation but was however insignificant. Short run and long run relationship between

government spending and inflation was also looked into by Nguyen, (2016) while using the datasets for India, China & Indonesia, from 1970-2010. Using Co-integration & Vector error correction model a casual long run relationship between government spending and inflation was revealed among the three sample countries, implying that institutional structure is not of major significance to the relationship of the variables. Łyziak and Mackiewicz-Łyziak, (2020), in a study of twenty-two (22) EU economies in relations to Inflation expectation, public debt & Fiscal sustainability Nexus. Results from the study showed that fiscal policy is only significantly influential towards inflation in countries with sustainable fiscal measures. Attari & Javed, (2013), while studying the economy of Pakistan (1980-2010) to assess the government expenditure, inflation- growth relationship revealed the following: inflation above the threshold adversely affects growth pointing out a negatively strong relationship. Also, disaggregated public spending revealed that government development expenditure was a strong transmission channel to the inflation-growth relationship, while the current expenditure link was seen to be statistically weak or insignificant.

Another prominent channel of inflation to economic growth is through **corruption** (Keith and Powell 2011) and it shows that embezzlement of tax revenues by public officials makes the government to rely more on seigniorage to finance its expenditures and this raises inflation which eventually depresses investment and growth via a cash-in-advance constraint. That is, loss of tax revenues leads to the printing of more money and higher inflation.

In a nutshell, the literature review indicates prevalence of significant differences among the results of empirical studies, as the optimal levels of inflation and its transmission channels on economic growth are quite different across countries. Such divergences are wide in cases of empirical studies which concentrated on estimation of threshold rate of inflation for panel of countries in both developed and developing economies. These studies generally note 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 have adverse effects on real economic growth.

4.0 Methodology

4.1 Model Specification and Estimation Technique

This section describes the PSTR estimation technique used to explore the threshold effects of inflation on economic growth in the WAMZ. The literature review suggests that in analysing the inflation-growth relationship in a panel data setting, an appropriate estimation technique should capture nonlinearities and heterogeneity in the growth effects of inflation across countries over time. Drawing from the vast empirical literature on the determinants and the nonlinear effects of inflation on economic growth (e.g. Barro, 1996; Khan and Senhadji, 2001; Ahortor et al, 2011; Lopez-Villavicencio and Mignon, 2011; Kremer, Bick, and Nautz, 2013; Seleteng, Bittencourt, and Eyden, 2013; Eggoh and Khan, 2014; Thanh, 2015; Espinoza, Leon, and Prasad, 2016; Nduricimpa, 2017), we examine the effects of inflation on growth by estimating the following relationship over the period 2001-2019:

$$g_{it} = \alpha_0 + \alpha_1'x_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where g_{it} is growth rate of real GDP per capita, $i = 1, \dots, N$ represents the individual

country/six (6) cross-sectional units (The Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone), $t = 1, \dots, T$, the time dimension (2001-2019). x_{it} is the vector of explanatory variables, comprising the independent variable of interest (inflation rate) and control variables used in the standard growth literature such as the initial level of real GDP per capita, investment to GDP ratio, trade openness, public debt to GDP ratio, government spending, nominal exchange rate changes, growth rate of terms of trade, and institutional quality proxied by control of corruption index⁵. μ_i is the country fixed effects and ε_{it} is the error term.

To explore the threshold effects of inflation on economic growth, we adopted the PSTR model developed by Gonzalez, Terasvirta and Dijk (2005) as specified in equation (2). The PSTR model is a generalisation of the fixed effects panel threshold model proposed by Hansen (1999). The PSTR model has been widely applied in empirical research to investigate possible nonlinear relationships because of its appealing features. While both the panel threshold model of Hansen (1999) and the PSTR model developed by Gonzalez et al.

5 The plausible effects of inflation and control variables on growth under the different inflation

regimes are explained in the nonlinear model of the subsequent specification.

(2005) are static models, unlike Hansen's model, the PSTR model allows for smooth transition or gradual change in the regression coefficients from one regime to another depending on the threshold variable (Gonzalez et al. 2005; Seo and Shin, 2016). In doing so, the PSTR model allows us to exploit the heterogeneity in inflation rates across countries and detect possible nonlinearity through the variations in the effect of inflation on growth overtime. By allowing for such variations in the parameter estimates, the PSTR model offers a suitable framework to tackle the problem of structural breaks. It ensures the endogenous determination of the inflation threshold parameter that will support growth above which high inflation can possibly be detrimental to growth. By extension, the PSTR is applied to identify possible transmission channels of the inflation-growth nonlinearity.

Seo and Shin (2016) extended the static panel threshold models of Hansen (1999) and the PSTR by introducing the dynamic panel threshold model, which is applied by Seo et al. (2019). This model employs the first-difference generalised method of moments (GMM) estimator and allows for endogeneity of the threshold variable and some of the regressors. In this

paper, however, the dynamic panel threshold model was not used since this estimator requires a large number of cross-sectional units to obtain reliable results. Considering the relatively small cross-sectional units (six WAMZ countries), the application of the dynamic panel threshold model would not yield consistent estimates of the parameters due to lack of variation in the data. This is because the GMM estimator relies on instrumental variables to identify the parameters, and in small sample sizes, these instruments may not be valid, leading to unreliable results. Thus, our analysis relies upon the results from the estimation of the PSTR model, which works well with small cross-sectional units because it does not rely on instrumental variables. Evidence shows that the PSTR model can mitigate potential endogeneity biases through the smooth change in the coefficients from one regime to another depending on the threshold variable (Fouquau et al., 2008).

To examine this nonlinear relationship, we consider a PSTR model associated with one threshold parameter or two regimes of inflation, reflecting the low and high inflation regimes with a single transition function as specified as in equation (2):

$$g_{it} = \alpha_i + \beta_0' x_{it} + \beta_1' x_{it} \varphi(q_{it}; \gamma, \vartheta) + \varepsilon_{it} \quad (2)$$

where x_{it} is a vector of time varying explanatory variables including inflation threshold variable (q_{it}) as described in equation (1). In line with Gonzalez et al. (2005), we allow for one period lag of the potentially endogenous explanatory variables in the vector x_{it} including the inflation threshold variable (q_{it}). The endogeneity problem may be created through potential correlation between the error term ε_{it} and some of the explanatory variables in the vector x_{it} . For instance, inflation is endogenous to growth, which may be driven by government policies or shocks that simultaneously affect inflation and economic growth. The transition function $\varphi(q_{i,t}; \gamma, \vartheta)$ is a continuous function of the inflation threshold variable ($q_{i,t}$), normalized to be bounded between 0 and 1 and the extreme values are associated with the parameters β_0 and $\beta_0 + \beta_1$. γ is a slope parameter, which determines the smoothness of the transition function and ϑ is a location or inflation threshold parameter.

Looking at equation (2), theory predicts that inflation can spur economic growth in the low inflation regime below the threshold parameter ϑ , associated with the

coefficient on inflation of β_0 but inimical to growth if inflation exceeds the threshold ϑ (high inflation regime) with a combined parameter of $(\beta_0 + \beta_1)$. The direction of the inflation effects below the threshold is consistent with the prediction on the Tobin's effect, which suggests that inflation lowers the real interest rate and by extension, the opportunity cost of investment, thus promoting physical capital accumulation and stimulating growth (Vaoni, 2012). Above the threshold, the effect on growth will be negative, reflecting the detrimental growth effect of inflation due to decreasing capital stock induced by higher inflation. This prediction ties with the reverse Tobin-effect phenomenon since high inflation would create distortions to relative prices and misallocation of resources which potentially hinders physical capital accumulation and impedes growth (Khan, 2014).

The effects of the control variables on growth in both the low and high inflation regimes are noteworthy. In line with the predicted Tobin's effect, the coefficient of the ratio of investment to GDP is expected to be positive in the low inflation regime, implying that low levels of inflation can enhance economic growth. On the other hand, it is anticipated that the reverse-Tobin effect will set in above the threshold, which

suggests a negative impact of physical capital accumulation on growth in the high inflation regime.

Leveraging the theories of international trade and endogenous growth, trade openness can stimulate growth through rising productivity, relative price competitiveness, and encouraging technological imitation (Edwards, 1997). Thus, the coefficient on this variable is expected to be positive in the low inflation regime. On the contrary, high inflation may erode price competitiveness and exacerbate the adverse effects of external shocks on economic growth. Thus, trade openness should exert a negative impact on growth in the high inflation regime.

Government consumption is included as a control variable in the model to explore the growth effects of inflation through the public expenditures channel. Below the inflation threshold, public expenditures can stimulate growth if directed towards more productive spending in the economy. Above the inflation threshold, increased public expenditures may be detrimental for growth since inflation aggravates public expenditures through cost escalation (see Eggoh and Khan, 2014). The resulting increases in spending may not be channelled

into growth-promoting activities. We further control for the effects of fiscal policy on growth through the inclusion of public debt to GDP ratio as proxy for government burden. The literature suggests that public debt can promote growth if these resources are channelled into productive investments. However, several scholars have demonstrated that public debt can be inimical to economic growth beyond a certain threshold (see e.g., Reinhart and Rogoff, 2010; Cecchetti et al., 2011; Minea and Parent, 2012; Djiogap, 2016). Along this line, elevated levels of public debt can exert damaging effects on growth as higher inflation amplifies fiscal risks through increases in government expenditures. The resulting increases in spending through increased public debt may be used to finance unproductive expenditures, which could aggravate the crowding out effect of the private sector through the public debt accumulation channel.

From the Neoclassical growth literature, the coefficient on initial income is expected to be negative, reflecting the hypothesis of conditional convergence. Growth in terms of trade captures the effects of external shocks on economic growth. The nominal exchange rate changes variable controls for possible pass-through effects of exchange rate

fluctuation (Nguyen, 2018; Arisen, Managuinhane, and Simone, 2021). We included control of corruption index to capture the effects of institutional quality on growth. To test the robustness of the results, additional control variables are included such as population growth to capture population dynamics effect on growth. In addition, different measures of exchange rate are used alternatively to assess the sensitivity of the results to changes in this variable. For instance, exchange rate volatility is included to capture the effect of exchange rate instability on economic growth. Alternatively, the real exchange rate misalignments variable is used to capture possible negative effects of persistent misalignments on growth through distortions to relative prices of traded to non-traded goods that affect the decisions of economic agents which may generate instability (Bereau, Villavicencio, and Mignon, 2009).

Gonzalez et al. (2005) utilize a logistic transition function, which is generally specified as:

$$\varphi(q_{i,t}; \gamma, \vartheta) = \frac{1}{(1 + \exp(-\gamma \prod_{j=1}^m (q_{i,t}; \gamma, \vartheta_j)))}, \gamma > 0 \quad (3)$$

Where $\vartheta_1 \leq \vartheta_2 \leq \dots \leq \vartheta_m$ and $\vartheta = (\vartheta_1, \dots, \vartheta_m)'$ is an m-dimensional vector of

threshold parameters. They stress that it is appropriate to consider a model with $m = 1$ (logistic function) or $m = 2$ (exponential function), since these functions allow for more commonly encountered types of variation in the parameters. Following this approach, we estimated the PSTR model by adopting the logistic function ($m = 1$) as in equation (4). Considering $m = 1$, the PSTR model has two extreme regimes associated with low and high values of inflation and assuming one transition function, the logistic transition function takes the form:

$$\varphi(q_{i,t}; \gamma, \vartheta) = \frac{1}{(1 + \exp(-\gamma(q_{i,t}; \gamma, \vartheta)))}, \gamma > 0 \quad (4)$$

In line with the estimation procedures proposed by Gonzalez et al. (2005), we perform a test for linearity between inflation and economic growth against the alternative hypothesis of the PSTR model. This test allows us to ascertain whether there is a nonlinear relationship between inflation and economic growth in the WAMZ. To determine the presence of nonlinearities in the inflation-growth relationship, the null hypothesis of homogeneity, $H_0: \gamma = 0$ or $H_0: \beta_0 = \beta_1$, is tested against the alternative

of the PSTR model from equation (6).⁶ This test entails testing a linear model ($r = 0$) against the PSTR model with one transition function ($H_0: r = 1$) or two extreme regimes. The test is evaluated based on the probability values of the Wald, Fisher and Likelihood ratio test statistics. The rejection of the null hypothesis of linearity implies that the relationship is nonlinear, requiring further testing of the remaining heterogeneity to determine the number of location parameters and transition functions. Further tests are performed to ensure that there are no remaining nonlinearities in the underlying relationship. This decision is determined by the outcome of the probability values of the three tests to the extent that all fail to reject the null hypothesis.

In estimating the PSTR model, the elasticities computed are not constant but vary across countries and time depending on the value of the transition function. To derive the elasticity of growth with respect to inflation, equation (2) is further expanded as specified in equation (5) and the elasticity obtained as the weighted average of the parameters β_0 and β_1 :

$$g_{it} = \alpha_i + \beta_0\pi_{i,t} + \beta_1\pi_{i,t}\varphi(q_{i,t}; \gamma, \vartheta) + \beta'_{01}R_{i,t} + \beta'_{11}R_{i,t}\varphi(q_{i,t}; \gamma, \vartheta) + \varepsilon_{it} \quad (5)$$

⁶ To conduct the test, an auxiliary regression is derived from equation (5) by replacing the transition with a first-

$$\frac{\partial g_{i,t}}{\partial \pi_{i,t}} = \beta_0 + \beta_1 * \varphi(q_{i,t}; \gamma, \vartheta) \quad (6)$$

where $\pi_{i,t}$ is the inflation rate, $R_{i,t}$ is a vector of the control variables captured in equation (1) and $\varphi(q_{i,t}; \gamma, \vartheta)$ is the transition function defined as a function of the inflation threshold variable. To test the robustness of the results, alternative models of the PSTR are estimated to determine whether the results of nonlinearity and transmission channels of the adverse growth effects of inflation are sensitive to the choice of control variables.

4.2. Description of Data

This study uses a panel data approach covering all the six WAMZ countries (The Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone) using annual data during 2001-2019. The choice of the study period was determined by available data for all the countries. Appendix 1 presents the description of the variables. The dependent variable, growth rate of real GDP per capita was measured as the first difference of the logarithm of real GDP per capita obtained from the Penn World Table, version 10.0 (Feenstra, Inklaar and Timmer, 2015). The threshold variable, inflation rate was

order Taylor expression around $\gamma = 0$. For brevity of presentation, the auxiliary regression is not specified.

computed as the annual percent change of the CPI and sourced from the IMF's World Economic Outlook (WEO) dataset. The control variables are investment to GDP ratio, trade openness, public expenditures, public debt to GDP ratio, growth rate of terms of trade, nominal exchange rate changes, initial income, population growth, and institutional quality. Data on public debt ratio and nominal exchange rates were obtained from the WEO database. The investment ratio is measured as the ratio of gross fixed capital formation to GDP and sourced from the World Development Index (WDI) of the World Bank. The terms of trade (TOT) variable is computed as the ratio of the price level of exports to the price level of imports and growth in TOT was obtained as the first difference of the logarithm of TOT. Public expenditure is measured as the share of government consumption in GDP, which was sourced from the Penn World Table (version 10.0). Trade openness is computed as the ratio of the sum of exports and imports to GDP and obtained from the World Bank's World Development Indicators (WDI). Exchange rate movements is obtained as the annual variation of the nominal exchange rates (see Rincon-Castro and Rodriguez-Nino, 2018) i.e., $\Delta NEX_t = \ln(NEX_t) - \ln(NEX_{t-1})$ where NEX represents the

nominal exchange rate. This is defined in terms of the units of the local currency to the US dollar. Exchange rate volatility is measured as a 5-year rolling standard deviation of the logarithm of the nominal exchange rate.

Data on currency misalignments was based on the Multilateral Price Levels (MPL)-based currency misalignments series obtained from the CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) EQCHANGE database. Currency misalignments for each country is calculated as the difference between the observed real effective exchange rate of a country and its equilibrium level at each period t (Couharde et al., 2018). The authors' obtained the real effective exchange rate of each country as the weighted average of real bilateral exchange rate against each of its trading partners. Data on public debt to GDP ratio was obtained from the IMF's WEO database. The initial real GDP per capita data was obtained from the World Development Indicators (WDI), and initial income measured as the logarithm of the real GDP per capita in the first year of each five-year sub-period (Jude and Levieuge, 2015). The control of corruption index used as proxy for the quality of institutions. It ranges from -2.5 reflecting weak institutional quality to 2.5

representing stronger quality of institutions. To capture the growth effects of the index, it was normalised to 0-1 range by adding 2.5 units to each observation and dividing by 5. Data on the index was obtained from the World Bank’s governance indicators while population was obtained from the Penn World Tables.

Table 3 presents the descriptive statistics for the variables used in the regression during 2001-2019. Growth in real

GDP per capita varies from -37.6 percent in Liberia in 2003 to 27.9 percent in Liberia in 2007. Further, the statistics reveal substantial variation in growth in real GDP per capita across countries from -25.1 percent in Sierra Leone in 2015 to 27.9 percent in Liberia in 2007. The data shows significant heterogeneity in levels of average annual inflation rate over time, which ranges from 0.12 percent in Sierra Leone in 2002 to 34.7 percent in Guinea in 2006.

Table 3: Descriptive Statistics: 2001-2019

Variable	Obs	Mean	Std.Dev.	Min	Max
Growth in real GDP per capita	108	0.022	0.066	-0.376	0.279
Inflation rate	114	11.247	6.286	0.121	34.702
Government consumption to GDP ratio	114	12.421	5.951	0.521	30.797
Investment to GDP ratio	114	19.469	6.648	7.278	52.418
Public debt to GDP ratio	114	81.398	110.887	7.276	600.623
Trade to GDP ratio	114	75.260	49.828	20.723	311.354
Log of initial income	114	7.639	0.540	6.549	8.590
Growth in TOT	108	0.002	0.058	-0.182	0.204
Exchange rate changes	108	0.079	0.107	-0.204	0.485
REER Misalignment	114	0.010	0.210	-0.527	0.367
Volatility of nominal exchange rate	108	0.137	0.091	0.009	0.427
Control of corruption index	114	0.347	0.074	0.199	0.508

Source: WAMI Staff computations using STATA 16.0 Econometric package. REER-real effective exchange rate, TOT-terms of trade, and GDP-gross domestic product.

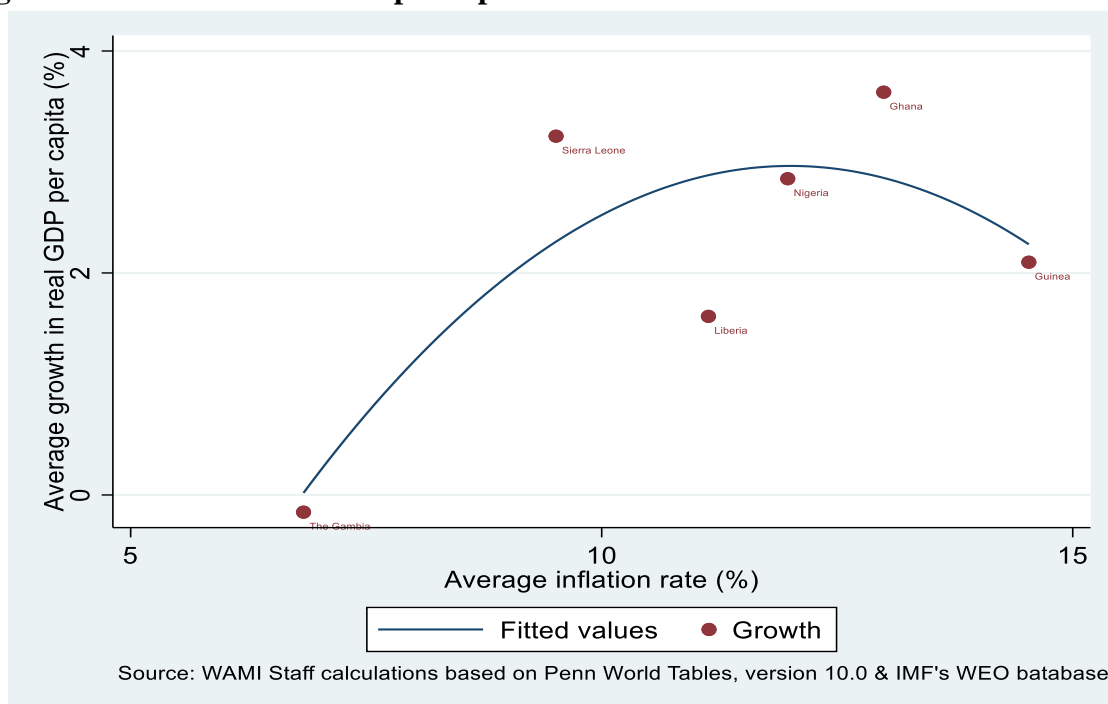
Figure 7 shows how growth in real GDP per capita and inflation rate are compared over the period 2001-2019. The figure was obtained using a quadratic plot of the average growth in real GDP per capita and inflation for each country during the period. The plot allows us to provide some

preliminary analysis of how inflation can potentially affect growth in the WAMZ countries. It points to a potential nonlinear association between inflation and economic growth in the WAMZ. As can be seen, inflation is likely to be beneficial to economic growth up to a certain threshold, above which

it can potentially dampen growth of these economies. Overall, the description of the variables of interest shows that there is significant variation in inflation rates across countries over time. This is an interesting feature of the dataset which reinforces our

view of the suitability of the PSTR model to exploit such heterogeneity and explore the possible nonlinearities in the relationship between inflation and economic growth in the WAMZ.

Figure 7: Growth in real GDP per capita and inflation in the WAMZ:2001-2019



5.0 Results Presentation and Discussion

The descriptive statistics in Table 3 show significant variations in inflation rates across countries. The plot of growth against inflation also points to potential nonlinear association between inflation and economic growth in the WAMZ. Given these features of the dataset, it is helpful to apply the PSTR model to exploit such variations and

determine empirically whether the inflation-growth relation is nonlinear in the WAMZ countries. This section is concerned with evaluating the nonlinear inflation-growth relationship to determine the inflation threshold that will support economic growth in the WAMZ.

5.1 Analysis and Results

5.1.1 Nonlinear Inflation-Growth Relationship

Prior to estimating the parameters of the PSTR model from equation (2), we performed a test for homogeneity between inflation and economic growth against the PSTR model. This implies testing to determine whether the growth effect of inflation is the same across countries or varies across countries over time. The test for nonlinearity involves testing a linear model ($r = 0$) against the PSTR model with one transition function ($H_0: r = 1$) or two extreme regimes. Table 4 reports the results of the linearity test for all three test statistics. It shows from the probability values of all

three test statistics that the null hypothesis of linearity is rejected at 1 percent level of significance. This is evidence that there exists a nonlinear relationship between inflation and economic growth in the WAMZ. The finding suggests that it is not appropriate to analyse the inflation-growth relationship in the WAMZ countries using linear panel data estimation techniques. The next step in the estimation procedures of the PSTR model is to evaluate whether there is any remaining nonlinearity in the data. This implies testing the null hypothesis of a PSTR model of one transition function ($H_0: r = 1$) or two extreme regimes model against an alternative PSTR model of at least two thresholds or three regimes model ($H_1: r = 2$).

Table 4: Model 1-Homogeneity and no remaining heterogeneity tests in the WAMZ (2001-2019)

Hypothesis	Test	Statistics	P-value
$H_0: (r = 0); H_1: (r = 1)$	Wald Test (LM)	22.302	0.008
	Fisher Test (LMF)	2.689	0.008
	LRT Tests (LRT)	24.981	0.003
$H_0: (r = 1); H_1: (r = 2)$	Wald Test (LM)	16.263	0.062
	Fisher Test (LMF)	1.477	0.172
	LRT Tests (LRT)	17.627	0.040

Lagrange multiplier-Wald (LM); Lagrange multiplier -Fischer (LMF); and likelihood ratio (LR) tests.

The null hypothesis of linearity H_0 : linear model; H_1 : PSTR model with at least one threshold.

The null hypothesis of no remaining non-linearity H_0 : PSTR model with one threshold; H_1 : PSTR model with at least two thresholds.

Source: WAMI Staff estimates using MATLAB software

Table 4 shows that the Wald (LM) and Likelihood Ratio (LR) tests reject the null hypothesis of a PSTR model of one

threshold value or two extreme regimes, while the Lagrange multiplier -Fischer (LMF) suggests that we do not reject the null

hypothesis. However, Gonzalez et al. (2005) illustrated that a logistic PSTR model ($m=1$) with one threshold value is sufficient to capture the heterogeneity in the data. Accordingly, the result suggests that the inflation-growth relationship is characterised by one transition function or two extreme regimes, corresponding to the low and high episodes of inflation experienced by WAMZ countries over time. This implies that estimating a PSTR model with such characterization is sufficient to explain the nonlinear growth effects of inflation in the WAMZ countries. Table 5 displays the results of the baseline estimation associated with two extreme regimes of the PSTR model for the WAMZ countries over the period 2001-2019. As discussed earlier, the estimation of the PSTR model allows for time-varying and smooth change in the effects of the regressors on growth from the low to high inflation regimes.

The first issue of interest in analysing this relationship is to evaluate whether there are threshold effects of inflation on economic growth. Interestingly, the nonlinear growth effect of inflation is strongly evidenced in the WAMZ countries. As can be seen from Table 5, the estimation of the PSTR model establishes an optimal inflation threshold of 10.3 percent per annum for WAMZ

countries. The coefficient on inflation in the low inflation regime (0.0128) below this threshold is positive and statistically significant at the 1 percent level, implying that achieving moderate inflation below this threshold level will spur growth in this regime. The result suggests that inflation will be beneficial to growth in the WAMZ countries if maintained at levels below 10.3 percent. Above the threshold, the coefficient turns out to be negative and statistically significant at the 1 percent level of significance, suggesting that achieving a level of inflation above the threshold would be detrimental to growth. To assess the inflation effects on growth in the second regime above the threshold, the coefficient of inflation is defined as $(\beta_0 + \beta_1)$, that is $(0.0128-0.0137=-0.0009)$. As expected, the effects of inflation growth are positive and negative in low and high inflation regimes, respectively. Looking at the low inflation regime, the results imply that a 1 percent increase in inflation enhances growth by 1.28 percent, *ceteris paribus*. Above the inflation threshold, the size of the coefficient of inflation (-0.0009) implies that a 1 percent in inflation reduces growth by 0.09 percent. Thus, the magnitude of these coefficients indicates that the growth-promoting effects of moderate inflation in the low inflation

regime are stronger than the growth retarding effects beyond the inflation above the threshold.

Table 5: Model 1-PSTR Estimation of Inflation-Growth Relationship in the WAMZ (2001-2019)

	β_0	β_1
Location (threshold) parameter (ϑ)	10.3369	
Slope parameter (γ)	4.2495	
Lagged inflation rate	0.0128*** (0.0044)	-0.0137*** (0.0042)
Lagged investment to GDP ratio	0.0013 (0.0008)	-0.0019 (0.0015)
Lagged trade openness ratio	-0.0001 (0.0004)	0.0009** (0.0004)
Lagged public debt to GDP ratio	0.0004* (0.0002)	-0.0007** (0.0003)
Lagged government consumption ratio	0.1810 (0.2153)	-0.1882 (0.1969)
Variation of nominal exchange rates	-0.1922** (0.0696)	0.2542*** (0.0863)
Growth rate of terms of trade	0.1043 (0.1107)	-0.5841*** (0.1819)
Lagged log of initial level of income	-0.1098*** (0.0259)	0.0332*** (0.0086)
Lagged normalized control of corruption index	0.3535* (0.1977)	-0.4534*** (0.1232)
AIC criterion	-5.669	
Schwarz criterion	-5.172	

Note: ***, **, * denote 1%, 5% and 10 %, respectively. Dependent variable - Growth in real GDP per capita. Standard errors in parentheses are corrected for heteroscedasticity. Source: WAMI Staff estimates using MATLAB software

Nonetheless, given the nonlinear nature of the PSTR model from equation (6), the parameters β_0 and β_1 do not directly capture the direct impact of inflation on economic growth. Thus, the parameter β_0 represents the direct impact of inflation on growth only when the transition function $\varphi(q_{i,t}; \gamma, \vartheta)$ tends toward 0. At the opposite, when $\varphi(q_{i,t}; \gamma, \vartheta)$ tends toward 1, the

elasticity of growth to inflation is equal to the sum of the parameters β_0 and β_1 . Between these two extremes, there is an infinite number of elasticity parameters of growth to inflation, and the elasticity is defined as the weighted average as the weighted average of the values of the parameters β_0 and β_1 (Jude, 2010; Eggoh and Khan, 2014). Along these lines, Jude (2010) argues that the estimated

parameters β_j cannot be directly interpreted but should be based on the directions or signs of these parameters. Indeed, a positive (negative) sign of the coefficient on inflation indicates that the elasticity of growth to inflation increases (decreases) as the level of inflation increases over time.

The result supports our hypothesis of the existence of nonlinear effect of inflation on economic growth, conditional on the level of inflation. It points to the time-varying effect of inflation on growth through the smooth variation in the coefficient of inflation from a low to high inflation regime. In this first regime, the positive and statistically significant impact of inflation on growth points to the existence of the Tobin's effect in the WAMZ countries. It evidences that the growth-enhancing effect of inflation can be induced through greater physical capital accumulation. The result is consistent with economic theory which suggests that in the low inflation regime, a relatively small increase in inflation rate would reduce the real interest rate and enhance physical capital accumulation, as economic agents substitute away from holding money due to lower return. The resulting increase in physical capital accumulation would stimulate economic growth. Comparing this finding to evidences from previous empirical studies

shows that our results are similar to the findings by Ghosh and Phillips (1998), Khan and Senhadji (2001) and Mondjeli and Tsopma (2017). Their studies demonstrate evidence of the growth-enhancing effect of inflation below a certain inflation threshold but higher inflation above the established threshold is detrimental to growth. Some other studies reveal that the growth effect of inflation was not statistically significant in the low inflation regime for the SADC member countries (Seleteng et al., 2013). A similar conclusion was reached by Eggho and Khan (2014) and Ndoricimpa (2017) for low-income countries. Considering emerging and developing economies, Lopez-Villavicencio, and Mignon (2011) find an inflation threshold of 1.2 percent and 14.5 percent for developed and emerging economies, respectively. They find that inflation is growth-promoting below the threshold in developed countries but does not support growth in emerging economies. Estimating the inflation threshold at 7.84 percent, Thanh (2015) reached a similar conclusion on the insignificant but strongly negative effect of inflation in the low and high inflation regimes, respectively in the ASEAN economies.

In the second regime, the high inflation regime associated with the

parameters of the regressors above the inflation threshold, the negative and statistically significant coefficient on inflation (-0.0009) corresponds to the reverse of Tobin's effect. This implies that higher inflation above the threshold would lead to misallocation of resources which hinders physical capital accumulation and negatively impacts economic growth. Indeed, the outcome is in line with the predictions in the endogenous growth literature which suggests that higher inflation reduces the return on capital. This in turn impedes physical capital accumulation which dampens economic growth.

Comparing this result to previous findings, this threshold level is closer to the endogenously estimated value of 9.0 percent for low-income countries by Ndoricimpa (2017), and the exogenously determined values of 9.0 percent by Tarawalie, Sissoho, Conte and Ahoritor (2012) and WAMA (2018) for WAMZ countries, and 11 percent for developing countries estimated by Khan and Senhadji (2001). In contrast, the estimated threshold value of 10.3 percent for the WAMZ countries is relatively lower when compared to the value of 4.3 percent for the BEAC Zone (Bank of Central African States) estimated by Mondjeli and Tsopma (2017) and 19.5 percent by Eggoh and Khan

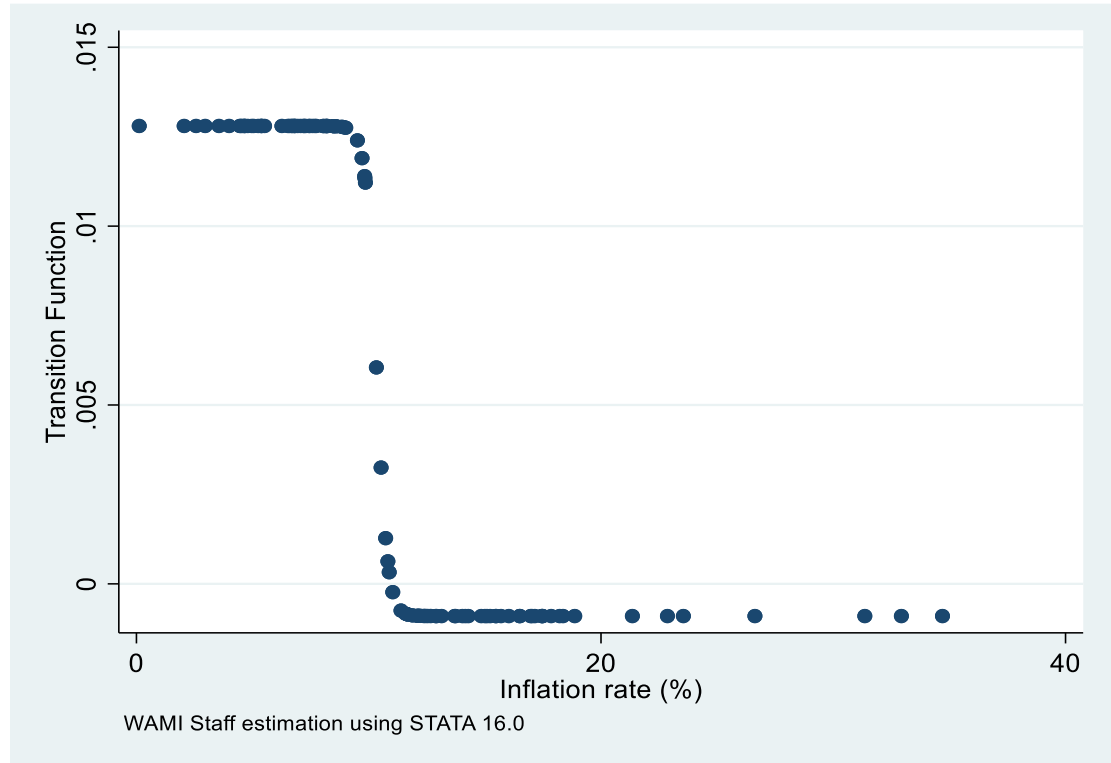
(2014) for lower income countries. Similarly, Seleteng, Bittencourt and Eyden (2013) estimated a threshold of 18.9 percent for the South African Development Community (SADC) region using the PSTR estimation. The difference in inflation thresholds in these sub-regions implies that WAMZ countries have lower inflation tolerance relative to the SADC countries and the opposite is true when compared to the BEAC Zone. It suggests that WAMZ countries would experience the adverse effects of inflation on growth at relatively low inflation level compared to their counterparts in the SADC region and high level relative to the BEAC Zone.

Figure 8 shows the transition function depicting the elasticity of growth with respect to inflation. The value of the slope parameter (γ) determines the smoothness of the transitions (Gonzalez et al., 2005), indicating a smooth transition between the two regimes when it is less than one. Thus, the transition between the lower inflation regime to higher regime is relatively smooth if the value of the slope parameter is very low. By opposite, the larger the size of the slope, the sharper is the transition from one regime to another. The estimated slope parameter of the transition function ($\gamma = 4.2495$) demonstrates a relatively gradual change in the growth effect

of inflation when transitioning from low to high inflation regime. Looking at the figure shows a relatively high elasticity of growth to inflation below the inflation threshold of 10.3 percent but gradually declining elasticity

when the level of inflation exceeds the threshold. Indeed, this plot reinforces our argument about the existence of a nonlinear effect of inflation on growth in the WAMZ.

Figure 8: Transition function of elasticity of growth and inflation



5.1.2 Robustness Analysis

To assess the robustness of the inflation-growth nonlinearity, we considered three alternative specifications to determine the sensitivity of the results to the use of different combinations of control variables. In model specification 2, the annual variation of nominal exchange rate variable was replaced with exchange rate volatility, and the real effective exchange rate misalignments in

model 3. The results of linearity and no remaining non-linearity tests are presented in Table 6. The results of all three test statistics show strong rejection of the null hypothesis of linearity and confirm the estimation of a PSTR model associated with one inflation threshold value or two regimes. This further supports our earlier finding on the existence of a nonlinear relationship between inflation and economic growth in the WAMZ. In both

specifications, the test of any remaining heterogeneity, which involving testing the null hypothesis of PSTR model with one threshold or two regimes against the alternative hypothesis of a PSTR model with at least two thresholds, indicates strong

rejection of the null hypothesis. However, we estimated a logistic PSTR model with one threshold value or two extreme regimes for both specifications since this model is sufficient to capture the heterogeneity in the data.

Table 6: Alternative-Homogeneity and no remaining heterogeneity tests in the WAMZ (2001-2019)

	Hypothesis	Test	Statistics	P-value
Model 2	$H_0: (r = 0); H_1: (r = 1)$	Wald Test (LM)	21.879	0.009
		Fisher Test (LMF)	2.625	0.009
		LRT Tests (LRT)	24.449	0.004
	$H_0: (r = 1); H_1: (r = 2)$	Wald Test (LM)	18.132	0.034
		Fisher Test (LMF)	1.681	0.108
		LRT Tests (LRT)	19.848	0.019
Model 3	$H_0: (r = 0); H_1: (r = 1)$	Wald Test (LM)	20.897	0.013
		Fisher Test (LMF)	2.479	0.014
		LRT Tests (LRT)	23.224	0.006
	$H_0: (r = 1); H_1: (r = 2)$	Wald Test (LM)	20.293	0.016
		Fisher Test (LMF)	1.928	0.061
		LRT Tests (LRT)	22.478	0.007

Note: The null hypothesis of linearity H_0 : linear model; H_1 : PSTR model with at least one threshold. The null hypothesis of no remaining non-linearity H_0 : PSTR model with one threshold; H_1 : PSTR model with at least two thresholds.
Source: WAMI Staff estimates using MATLAB software

The estimation results displayed in Table 6 reveal that the inflation thresholds of the alternative models (2) and (3) are close to the threshold value of 10.3 percent from the baseline Model 1, estimated at 10.7 percent and 10.9 percent, respectively. The results show remarkably strong evidence of the existence of nonlinear growth effect of inflation through the directions of the signs on the coefficient on inflation in both the low

and high inflation regimes. As expected, the growth effect of inflation differs between the low inflation regime and the high regime. In both specifications, the coefficient of inflation associated with the low regime below the inflation threshold is positive and statistically significant at the 5 percent level of significance. Thus, the growth-enhancing effect of moderate inflation rates is confirmed as in the baseline results of Model

1 in Table 4, in line with the Tobin's effect proposition. In the second regime, the estimation results confirm that high inflation above the threshold level is detrimental to growth. In Model 2, the inflation effect in the high regime is negative (0.0104-0.0112=-0.0008) or 0.08 percent. This finding further supports the existence of the reverse Tobin's effect above the threshold inflation level. Overall, our results confirm the existence of the growth-promoting effect of moderate inflation rates in the low inflation regime, while inflation retards growth in the high inflation regime. As can be seen from alternative models in (2) and (3), the nonlinear relationship between inflation and economic growth still holds after the inclusion of or the change in some of the control variables. Indeed, the results illustrate that the inflation rate is associated with one threshold value, or two regimes of low and high inflation. Compared to the baseline estimation results of Model 1, across these

specifications, the slope of the transition function is similarly low, ranging from 1.81 to 2.02. The size of the slope points to a relatively smooth change in the regression coefficients in explaining the inflation-growth nonlinearity when transitioning from low to high inflation regimes. Nonetheless, looking at the information criteria across all three models (1)-(3), the estimation results of Model 1 displayed in Table 4 exhibits the lowest values of the Akaike Information Criterion (AIC) and Schwartz Information Criterion (SBC). Thus, the optimal inflation for the WAMZ is determined to be the inflation threshold of 10.3 percent estimated using Model 1. Overall, the estimation results present convincing evidence of the nonlinear effects of inflation on economic growth, showing an inflation threshold of 10.3 percent below which, moderate inflation rates stimulate economic growth in the WAMZ and above which it retards growth.

Table 7: Alternative-PSTR Estimation of Inflation-Growth Relationship in the WAMZ (2001-2019)

Variable	Model 2		Model 3	
Location (threshold) parameter (ϑ)	10.6793		10.9340	
Slope parameter (γ)	2.0239		1.8101	
	β_0	β_1	β_0	β_1
Lagged inflation rate	0.0104** (0.0038)	-0.0112*** (0.0038)	0.0084** (0.0042)	-0.0080** (0.0039)

Lagged investment to GDP ratio	0.0022** (0.0009)	-0.0028 (0.0016)	0.0021** (0.0009)	-0.0036** (0.0015)
Lagged trade openness ratio	0.0001 (0.0003)	0.0008* (0.0004)	0.0002 (0.0003)	0.0006 (0.0004)
Lagged public debt to GDP ratio	0.0003 (0.0002)	-0.0006** (0.0002)	0.0002 (0.0001)	-0.0005** (0.0002)
Lagged government consumption to GDP ratio	0.1361 (0.2148)	-0.0982 (0.1927)	0.1266 (0.2349)	-0.0532 (0.2277)
Lagged real exchange rate volatility	-0.2265* (0.1173)	0.2643* (0.1391)		
Lagged real exchange rate misalignments			-0.0009 (0.0484)	0.0650 (0.0510)
Growth rate of terms of trade	0.1112 (0.1185)	-0.6063*** (0.2016)	0.0693 (0.1188)	-0.5613** (0.1992)
Lagged log of initial level of income	- 0.1134*** (0.0318)	0.0334*** (0.0084)	-0.1500*** (0.0300)	0.0277*** (0.0083)
Lagged normalised control of corruption index	0.3419* (0.2005)	-0.5228*** (0.1379)	0.0877 (0.2003)	-0.3400*** (0.1154)
AIC criterion	-5.634		-5.628	
Schwarz criterion	-5.137		-5.132	

Source: WAMI Staff estimates using STATA software

6.0 Summary, Conclusion and Policy Recommendations

This paper examined the possible nonlinear effect of inflation on economic growth in the WAMZ countries over the period 2001-2019. Although there is large empirical literature on the relationship between inflation and economic growth, only few studies have investigated the inflation-growth nonlinearity in WAMZ countries, exogenously determining the optimal

threshold inflation rates beyond which inflation is detrimental to growth. This paper contributes to the policy debate on the inflation-growth nexus by endogenously determining the threshold level of inflation on economic growth, considering the heterogeneity in inflation rates across countries and over time within the WAMZ.

To exploit such heterogeneity, the paper applied the PSTR model to explore nonlinearities in the inflation-growth

relationship. The results suggest that the inflation-growth relationship in the WAMZ is characterized by a threshold effect, indicating that the inflation effect on growth is nonlinear. The findings demonstrate that achieving moderate inflation will stimulate economic growth below the threshold level of 10.3 percent. However, once inflation surpasses this threshold, it exerts a strong negative impact on growth. This outcome illustrates the positive effect of attaining lower levels of inflation on economic growth in the WAMZ countries. By opposite, the coefficient of inflation in the high inflation regime is strongly negative, which points to the adverse effects of high inflation on growth above the threshold level. This implies that elevated levels of inflation above the established threshold would constrain growth in the WAMZ.

The findings have important implications for policymakers in the WAMZ. The results show that while lowering inflation below the threshold of 10.3 percent will be beneficial to growth, raising it above is detrimental to growth. This outcome provides strong empirical support for the policy stance of WAMZ countries regarding the convergence criterion to contain inflation to a single-digit level. Policymakers should be mindful of the threshold level of inflation

beyond which the negative effects on economic growth may outweigh any potential benefits of moderate inflation. Crossing the threshold could result in adverse consequences for the economy. Therefore, it is crucial for policymakers to adopt appropriate measures to ensure that inflation remains below the identified threshold. Given these findings, central banks are encouraged to adopt a forward-looking approach to contain inflation, by setting explicit inflation targets below the identified threshold level of 10.3 percent. This approach will allow central banks to formulate appropriate monetary policies to achieve and maintain price stability while supporting economic growth. Such an approach would complement the current measures being implemented by central banks to closely monitor inflation levels and keep inflation within the desired range, including adjusting monetary policy rates, implementing liquidity management tools, and monitoring macroeconomic indicators to respond promptly to inflationary pressures.

Additionally, the evidence of the existence of a nonlinear relationship between inflation and economic growth implies that central banks should pay close attention to managing inflation expectations, through measures such as the effective

communication of monetary policy actions, which would help anchor inflation expectations to ensure a favourable inflation environment that supports economic growth and improve credibility of monetary policy in the region. Lastly, this paper does not assess whether the established inflation threshold of 10.3 percent will support growth across all

key growth-promoting sectors such as agriculture, industry, manufacturing, and services sectors in the WAMZ. Future research to determine the level of inflation that will be beneficial to growth in these sectors will be relevant for policymaking in the WAMZ.

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Appendix 1: Description of variables and sources

Main Variables	Description	Sources
Growth rate of real GDP per capita	First difference of the logarithm of real GDP per capita.	Penn World Table (PWT), version 10.0 (Feenstra, Inklaar and Timmer, 2015).
Inflation rate (threshold variable)	Annual percent change of Consumer Price Index (CPI)	IMF's World Economic Outlook (WEO) and WAMI databases.
Government expenditures ratio (threshold variable)	Share of government consumption in GDP.	PWT, version 10.0
Control Variables		
Investment to GDP ratio	Share of gross fixed capital formation in GDP.	PWT, version 10.0
Public debt ratio	Ratio of public debt to GDP	IMF's WEO database
Growth in terms of trade (TOT)	TOT) is computed as the ratio of the price level of exports to the price level of imports and growth in TOT as the first difference of the logarithm of TOT.	PWT, version 10.0
Standard deviation of nominal exchange rate	A five-year rolling standard deviation of the natural logarithm of the nominal exchange rate.	Own computation. Series obtained from the WEO.
Nominal exchange rate changes	First difference of the logarithm of nominal exchange rate.	IMF's WEO database
Currency misalignments	Difference between the observed real effective exchange rate of a country and its equilibrium level at each period t.	CEPII EQCHANGE database
Trade openness	Sum of exports and imports to GDP	World Development Indicators (WDI)
Government expenditures ratio	Share of government consumption in GDP.	PWT, version 10.0
Control of corruption	Normalised index as proxy for the quality of institutions.	World Bank's governance indicators
Population growth	First difference of the logarithm of total population.	Series obtained from PWT, version 10.0