

Olowofeso, Olorunsola E. et al.

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Optimal inflation-growth threshold: A case of the WAMZ member states

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Optimal Inflation-Growth Threshold: A Case of the WAMZ Member States¹

WAMI OCCASSIONAL PAPER SERIES NO. 30

Prepared by: Olorunsola E. Olowofeso (Ph.D.), Maimuna John-Sowe, Adegoke I. Adeleke (Ph.D.), Santigie M. Kargbo (Ph.D.), Joseph R. Yengbe Jr., and Yaya Cham

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¹ The views expressed in this paper are those of the authors and do not necessarily reflect the official position of the West African Monetary Institute (WAMI). Corresponding authors: Adegoke I. Adeleke (adelekeibrahim2004@yahoo.com) and Joseph Rabester Yengbe Jr (jorabester95@yahoo.com).

Table of Contents

Abstract.....	4
1.0 Introduction.....	5
2.0 Review of Theoretical and Empirical Literature	8
3.0 Methodology and Empirical Framework	14
3.1 Estimation Technique.....	14
3.2 Model Specification.....	15
3.3 Description of Data	17
4.0 Results Presentation and Discussion	18
4.1 Unit Root Test	19
4.2 Descriptive Statistics.....	19
4.3 Linearity and Remaining Nonlinearity Tests	20
4.4 LSTR Model Estimation.....	20
4.4.1 The Gambia	21
4.4.2 Ghana	23
4.4.3 Guinea	24
4.4.4 Liberia.....	26
4.4.5 Nigeria.....	28
4.4.6 Sierra Leone	30
4.5 Robustness Analysis.....	33
5.0 Summary, Conclusion and Policy Recommendations	33
References.....	36
Appendix.....	42
Appendix 1: Description of variables and sources.....	42
Appendix II: Unit Root Tests: Available on Request.	42
Appendix III: Descriptive Statistics of the variables used in the regression during 1996-2021 for each WAMZ Country	42

List of Tables

Table 1: Summarized Literature Review.....	11
Table 2: Smooth Transition Inflation Threshold for The Gambia.....	21
Table 3: Smooth Transition Inflation Threshold for Ghana	23
Table 4: Smooth Transition Inflation Threshold for Guinea.....	25
Table 5: Smooth Transition Inflation Threshold for Liberia	27
Table 6: Smooth Transition Inflation Threshold for Nigeria	29
Table 7: Smooth Transition Inflation Threshold for Sierra Leone	31

List of Figures

Figure 1: Smooth Transition Function for the Gambia's Inflation Threshold	22
Figure 2: Smooth Transition Function for Ghana's Inflation Threshold.....	24
Figure 3: Smooth Transition Function for Guinea's Inflation Threshold.....	26
Figure 4: Smooth Transition Function for Liberia's Inflation Threshold.....	28
Figure 5: Smooth Transition Function for Nigeria's Inflation Threshold.....	30
Figure 6: Smooth Transition Function for Sierra Leone's Inflation Threshold	32

Abstract

This study provides country-specific empirical evidence on the optimal inflation-growth threshold in the WAMZ over the period 1996-2021. Although there is large empirical literature on this subject, however, previous studies on the WAMZ economies generally focused on exogenous approaches of determining optimal inflation which impose a sharp and most often linear behaviour on the threshold level of inflation. This paper contributes to the policy debate on the inflation-growth nexus by endogenously determining the individual country inflation threshold for six WAMZ countries. The results from the study show optimal inflation rates of 10.2 percent for Ghana, 10.8 percent for Guinea, 8.7 percent for Liberia, 10.8 percent for Nigeria and 7.4 percent for Sierra Leone, at 5 percent significant level. The Gambia, however, has 6.6 percent inflation threshold but was found statistically insignificant and thus, inconclusive. Also, most of the countries in the WAMZ have inflation in the low regime to be positive and statistically significant while the high inflation regime is strongly negative, suggesting adverse effects of high inflation on growth. This finding is consistent with the theoretical proposition. It is remarkable to note that inflation threshold for the three “relatively large” economies (Nigeria, Ghana, and Guinea) in the WAMZ hovers around 10.0 percent, in line with initial WAMZ inflation convergence criteria (10 percent) as well as WAMI (2022) study of 10.3 percent. The relatively lower inflation thresholds for The Gambia, Liberia, and Sierra Leone suggests a potential difference in inflation tolerance levels relative to the size of the economies. Overall, the findings provide strong empirical support for the policy stance of WAMZ convergence criterion to contain inflation to an “upper” single-digit level. Thus, Central Banks are encouraged to continue to pursue appropriate monetary policy measures to lower inflation to the desirable single-digit level.

Key Words: Inflation; Growth; Threshold Effects; Smooth Transition Regression; West Africa

JEL Classification : E31, O47, C22.

1.0 Introduction

Understanding the interrelationship between inflation and economic growth is an important subject of interest in macroeconomics and monetary policy management. One of the major macroeconomic policy goals of many countries is to sustain price stability that is conducive for economic growth. Hence, all economies in the world strive to attain high economic growth that is consistent with low and stable inflation. Despite the continued policy focus of this goal, countries of the West African Monetary Zone (WAMZ) have gone through different inflationary episodes. To address this issue, the Economic Community of West African States (ECOWAS) Authority of Governments and Heads of State in 2019, endorsed the adoption of inflation targeting as the framework for the conduct of monetary policy in the Member States to tame high and rising inflation within the region.

Over the years, this issue has been extensively studied, however, the correct channels and specific country threshold level is still a subject of debate. Hence, empirical findings vary on the subject and different studies have utilized different proxies and methodologies in measuring the correlation between inflation and economic growth across different economies and regional cooperations (Akinsola & Odhiambo, 2017). Often, findings and policy recommendations vary and most times conflict and remain inconclusive in respect of proffering any policy recommendations applicable to many countries. These could be owing to many factors including data quality, changing country's macroeconomic conditions and diverse methodologies employed. In recent time, there is renewed interest by policymakers in the WAMZ to understand this interrelationship, due to pass-through effects of demand and supply shocks to domestic prices mainly emanating from lingering effects of the ongoing Russia-Ukraine war² and COVID-19 pandemic including supply chain disruptions.

Thus, the questions of interest to policymakers in the WAMZ are: Is lower single digit inflation (5 percent) still appropriate as one of the primary convergence criteria for attaining a common currency among WAMZ member states? At what level does inflation exhibit a negative influence on economic growth in each of the WAMZ countries? What is the inflation-growth inflection point for each WAMZ member state? Are there too many differences in the threshold

² Both Russia and Ukraine are major suppliers of commodities including wheat, titanium, palladium, corn, and crude oil. The war led to disruptions of supplies of these commodities and a surge in their prices including energy. Consequently, the war led to global economic downturn and higher inflation.

level of inflation among the WAMZ member states? These among other research questions are the focus of this study. Although some studies have attempted to identify optimal inflation rates that can propel economic growth in the ECOWAS region (WAMI, 2022; Nwosu, 2018; Barcola & Kebalo, 2018; Dada, 2018; WAMA, 2018; Ndoricimpa, 2017; WAMI, 2012;), these studies assumed exogenously the inflation threshold and empirically tested for optimal inflation rate.

To address this important subject matter, West African Monetary Institute (WAMI) has carried out four (4) related empirical studies to analyse different aspect of inflation-growth nexus in the WAMZ (see: WAMI, 2012; 2020; 2021; 2022). The initial effort was WAMI (2012), the study analysed country-specific threshold levels of inflation in the WAMZ using the conditional least square technique. The study identified the determinants of growth in the WAMZ with the aid of annual data that spans 1970-2010 for Ghana, Nigeria, and Sierra Leone, and 1980-2010 for the Gambia and Guinea. The results showed that there exists a statistically significant relationship between inflation and economic growth. The results further indicated that there exists a threshold level of 9.0 percent, beyond which inflation exerts negative effects on growth.

The second attempt was WAMI (2020), the study analysed the interrelationship between inflation and relative price variability (RPV) at a panel level. The study determined the inflation threshold level and examined whether RVP responds differently to different inflation regimes across the ECOWAS region, using the panel Smooth transition regression (PSTR) model over the period 2008 to 2019. The results showed that ECOWAS countries can achieve RPV in the moderate/intermediate inflation regime where the undesirable effect of expected inflation on RPV fades out. The study also revealed that inflation targets below the thresholds of 5.5 percent and 8.3 percent per annum are desirable in the WAEMU and WAMZ, respectively. Furthermore, in another related study, WAMI (2021) investigated the nonlinearities and country-heterogeneity in the inflation-growth nexus using PSTR model over the period 2001 to 2019. The results showed threshold level of inflation at 10.3 percent per annum, suggesting that achieving relatively low to moderate inflation of at most 10.3 percent per annum will be beneficial to growth and raising it above this threshold would constrain growth in the WAMZ.

In a similar vein, WAMI (2022) explored different transmission mechanisms in which the negative effects of inflation could impact economic growth in the WAMZ region, focusing specifically on the fiscal policy channel of inflation. This is premised on the role fiscal policy, through the government expenditure channel, plays in the transmission of inflation shocks to

economic growth within the WAMZ region. The results of the study showed strong evidence that identifies the existence of government spending threshold, suggesting that countries with government consumption expenditure to GDP ratio above the threshold of 7.7 percent of GDP would be affected more severely by inflation than their counterparts with low level of government expenditures in the WAMZ. The findings point to the importance of discretionary fiscal policy in amplifying inflation through excess demand. This suggests that policymakers should consider the possibility of adopting more forward-looking measures to curtail discretionary fiscal policies and ensure a more disciplined macroeconomic environment for the sustainable adoption of fiscal policy and promoting growth in the WAMZ.

The objective of this study is to provide country-specific empirical evidence on the optimal inflation-growth threshold in the WAMZ. Determining the inflation-growth threshold below which moderate inflation spurs growth, but above which inflation is detrimental to growth is very important for monetary policy actions in the region to curb high inflation and thus mitigate the effects of distortionary policy on the economy.

The present study, therefore, contributes to this policy debate in three ways (i) it analyses inflation-growth nexus at individual country-specific level. This is premised on the fact that to the best of our knowledge and extensive literature search, threshold studies for some of the WAMZ countries (the Gambia, Guinea, and Liberia) have not been previously empirically established. Hence, using policy prescription (such as WAMZ inflation convergence criteria) that is based on generalised panel data results for the entire WAMZ countries, for such economies, without country-specific studies could be misleading and some-how inappropriate; (ii) it utilises a recent methodology³ that allows us to smoothly and endogenously determine the threshold inflation-economic growth for each WAMZ member states and (iii) the study focuses on the recent period 1996-2021, hence, making the results of the study more policy relevant, based on recent macroeconomic shocks experienced by the countries. Indeed, this study explores the nonlinearity in inflation-growth smoothly and endogenously, by determining the threshold level of inflation on

³ It applied the smooth transition regression (STR) model which allows us to explore nonlinearities in the inflation-growth nexus and endogenously determine the threshold level of inflation. The attraction of this model is that unlike other threshold regressions, which impose a sharp nonlinear behaviour, the smooth-transition alternative allows for gradual shifts among high and low inflation regimes.

economic growth for each WAMZ member states over the period 1996-2021, by revisiting and extending the recent studies conducted by WAMI (2012; 2020; 2021; 2022).

The paper is structured as follows. Section 1 introduces the study, and section 2, dwells on the review of literature at both theoretical and empirical levels. Section 3 provides the methodology and estimation procedure of the study, while section 4 presents and discusses the empirical results. Section 5 presents conclusion and policy recommendations.

2.0 Review of Theoretical and Empirical Literature

Classical growth theory described implicitly the negative relationship between inflation and growth by explaining that profits decline because of competition for labour driving wages upward rather than decreasing marginal product of labour, hence the classical growth model is supply-side driven. Keynesian theory on the other hand explains that it is the changes in the demand side arising from changes in expectations such as employment expectations, fiscal expectations, monetary expectations among others that affect both prices and output. If prices increase, producers will up production to meet consumers demand, hence, there is a positive relationship between inflation and growth. There is also the endogenous growth theory which states that growth depends on the return on capital (ROC). ROC has an inverse relationship to inflation. The theory explains how higher inflation affects real return on deposit, resulting to slower deposits accumulation. Given that deposits are a fraction of capital, slower capital accumulation leads to lower output growth. The Tobin's effect suggested that inflation impedes real interest rate and therefore the opportunity cost of investment, however promoting physical capital accumulation and stimulating growth (Vaoni, 2012), but above a certain threshold the reverse Tobin-effect surfaces, and its effect on growth is disruptive. Khan (2014), further explains the reverse Tobin-effect phenomenon, stating how high inflation distorts relative prices and is also responsible for the misallocation of resources and has the propensity to hamper physical capital accumulation and subsequently impedes economic growth.

A significant amount of empirical literature has focused on the relationship between inflation and economic growth, most of which concentrates on the linearity as well as its relationship being negative or positive. There have also been numerous studies focusing on the threshold effect of inflation on economic growth (Mohtar et. al. 2021). Notwithstanding 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. There are different schools of

thought on inflation-growth nexus in the literature. Some assert that inflation slows and adversely affects growth (Stockman 1981, Fisher, 1983, Khan & Senhadji, 2001; Valdovinos 2003; Munir et al, 2009; Ndoricimpa, 2017) whilst other studies indicate that inflation promotes and positively impacts economic growth at a given threshold (Bruno & Easterly, 1995; Ghosh & Phillips, 1998; Bruno & Easterly, 1998; Mallik & Chowdhury, 2001; Aydin et al, 2016; Vinayathan, 2013). Some other earlier studies emphasized nonlinear relationship that exist between inflation and growth; they opined that inflation has no bearing on growth unless it exceeds a certain threshold (Fisher, 1993; Bruno & Easterly, 1998).

The strand of literature on negative inflation-growth effects stresses that high inflation inflicts welfare costs on the general populace and obstructs efficient allocation of resources. As inflation disproportionately impact relative price variability, restraining developments in the financial markets as intermediation role becomes more costly. This affects the poor overly as they do not have enough resources to hedge against inflation, and the most worrisome effect is that it frustrates long-term economic growth (López-Villavicencio & Mignon, 2011). The other strand of the literature however argues that moderate inflation is required to spur economic growth, and advocates for expansionary macroeconomic policies especially in developing economies where the engine of growth is through productive government expenditure (Bruno & Easterly, 1995; Mallik & Chowdhury, 2001). Other empirical literature provides strong support for the nonlinear effects of inflation on economic growth, pointing to the differential impact of inflation on growth across countries as the level of inflation varies. Findings suggest that inflation may not have any effect or could exert a positive influence on growth below a certain threshold but detrimental to growth above the threshold level (Khan and Senhadji, 2001; Lopez-Villavicencio & Mignon, 2011; Seleteng, Bittencourt, & Eyden, 2013; Eggoh & Khan, 2014; Thanh, 2015).

In recent years, there have also been some empirical studies carried out in the WAMZ member state, investigating the relationship between inflation and growth, but most importantly to establish the threshold level conducive for economic growth. Tarawalie (2022) analyses the relationship between inflation and growth in Sierra Leone, over the sample period 1980-2020, employed the ordinary least squared method of estimation technique. Results showed that ≤ 10.3 percent inflation was the optimal level conducive for growth enhancement, above this level, inflation was expected to have an adverse effect on growth. Additionally, trade openness, investment and a dummy variable for war were found to have statistically significant coefficient,

with openness and investment showing a positive relationship to growth while the dummy variable for war was negative. A study conducted by Bawa and Ismaila (2021) for the sample period 1980-2009, using the threshold regression model established the threshold level of inflation of 13 percent as favourable for growth in Nigeria. The result also revealed that below the threshold level, inflation has a less negative impact on growth, above it, the impact is negative and significantly higher. Table 1 below shows the detailed summary of the literature, both at the theoretical and empirical level. Generally, the literature maintains that high and unexpected inflation is considered detrimental to economic growth with several reasons explaining how inflation undermines economic efficiency, leaving both producers and consumers affected. Lower level of inflation has proven favourable for economic growth but beyond a certain level, it starts to have an adverse impact on economic growth.(Tarawalie A. B., 2022; Mohtar R., Anita K. & Putu A. P. P., 2021; Khoza K., Thebe R. & Phiri A., 2016; Jean-Baptiste Nkume J. B. & Ngalawa H., 2014).

Table 1: Summarized Literature Review

S/NO	Studies	Sample/Scope	Theoretical Framework	Methodology		Empirical Results
				Estimation Methods	Variable	
1	WAMI, 2012	WAMZ Member States, 1970-2010	Inflation growth threshold analysis	Conditional least square	real interest rate, real exchange rate, real GDP, price level, real domestic credit, real foreign reserves	Result revealed an optimal inflation rate of 9 percent for the WAMZ
2	Bawa S. and Ismaila S. A., 2021	Nigeria, 1980-2009	Inflation growth threshold analysis	Threshold regression model	Real GDP, CPI, total investment proxied by gross fixed capital formation	Result revealed threshold level inflation of 13 percent for Nigeria below which inflation impact is insignificant on growth, above there's increasing negative effect on Growth
3	Sanga D. and Gui-Diby S. L., 2020	Franc Zone Countries, 1970-2018	Inflation growth threshold analysis	Co-integration method	GDP, CPI, Investment Terms of Trade, Population growth, Reserves	Result shows that inflation threshold level can be adjusted between 5.4-5.6 percent for CAMU and 4.3-4.5 percent for WAMU above which inflation adversely affect Growth
4	Khoza K., Thebe R., and Phiri A., 2016	South Africa, 1994-2016	Inflation growth threshold analysis	Smooth Transition regression (STR)	GDP, inflation, investment, broad money, REER, government spending	Results revealed that up to the threshold of 5.4 percent inflation impact on Growth is positive, above the threshold, inflation impact is negative. Also, between 3-6 percent was seen as the optimal inflation level
5	Mohtar R., Anita K., and Putu A. P. P., 2021	Indonesia, 1969-2017	Inflation growth threshold analysis	Threshold regression model	Inflation rate, economic growth, Investment, population	Results explain that inflation up to the threshold of 7 to 8 percent was safe for economic growth. Additionally, 3 percent inflation was the optimal level for growth.

6	Tarawalie A. B., 2022	Sierra Leone, 1980-2020	Inflation growth nexus and threshold level analysis	Ordinary Least Square	Inflation rate, exchange rate, investment, trade openness, terms of trade	Result shows that the threshold level favourable for economic growth was ≤ 10.3 percent. Above this level it's unfavourable for growth
7	Tenaw D. and Demeke H., 2020	Ethiopia, 1975-2018	Threshold effect, Inflation growth nexus	Threshold Autoregressive (TAR) model	Inflation (food & non-food), government expenditure, real GDP, trade openness, broad money, labor force	Results revealed that the inflation threshold level for which growth is threaten is above 1-3 percent for industrial countries and 7-11 percent for developing countries.
8	Kusumatriisna A. L., Sugema K. I., and Pasaribu S. H. 2022	Indonesia, 1994-2019	Threshold effect, Inflation growth nexus	Conditional Least square	Inflation, population, investment, trade openness, government spending	Results explain that for the linear model, inflation has a significant negative effect on growth, moreover, the non-linear model revealed that only after the 9.59 percent inflation threshold growth is negatively affected. Furthermore, the result showed that inflation threshold varied for the two regions (eastern and western)
9	Jean-Baptiste Nkume J. B. and Ngalawa H., 2014	Malawi, 1980-2013	Optimal Inflation threshold for growth	Conditional Least Square	GDP, inflation, population, investment, trade openness	The study revealed that the optimal inflation was 17 percent, below which GDP gains are greater than above the threshold level.
10	Khan and Senhadji, 2001	140 industrial and developing countries, 1960-1998	Threshold effect, Inflation growth nexus	Generalized Least Square	GDP, Inflation, Real Income per capita in PPP	Results showed that above the estimated inflation threshold level of 1-3 percent for industrial countries and 7-11 percent for developing countries, inflation significantly slow growth.
11	WAMA, 2018	ECOWAS members countries 1970-2014	Optimal Inflation threshold	Khan and Sanhadji (2001) non-linear	GDP growth, inflation rate, investment growth, labor force growth, terms of trade, trade openness,	Results showed that the optimal inflation rate for the ECOWAS region was 6 percent with 3 percent for UEMOA and 9 percent for the WAMZ

				regression technique	real exchange rate depreciation	
12	Espinoza R., Leon H., and Prasad A. 2010	165 countries 1960-2007	Inflation growth Threshold analysis	Smooth transition model	GDP, investment, inflation rate, population growth, terms of trade	Results revealed that apart from advance economies, inflation quickly become harmful above 10 percent for all economies.

Source: WAMI's Staff Compilations

3.0 Methodology and Empirical Framework

3.1 Estimation Technique

This section explains how the Smooth-Transition Regression (STR) estimation technique is utilised to estimate the threshold effects of inflation on economic growth in each of the WAMZ member states. The attraction of this estimation technique is that unlike the conventional threshold regressions, which imposes a sharp nonlinear behaviour contingent on whether the threshold variable is below or above the threshold value, the smooth-transition alternative makes available the gradual shifts among regimes and can accommodate two types of variation. The first variation is where the parameters of the model adjust conditional on whether the transition variables are below or above the transition value. The second is where the parameters of the model adjust conditional on the distance between the transition variable and the transition value. Hence, it allows for estimation of two-regime with unknown parameters for the shape and location of the smooth threshold, as the regime switching occurs smoothly whenever an observed variable crosses the unobserved thresholds. Based on this smooth response, STR models regularly have more “accurate” dynamics than their other threshold regression variants. They are locally linear but globally nonlinear, therefore, it is theoretically and empirically more appealing than the conventional threshold regressions which impart a sudden shift in parameter values. The STR models have been widely applied in empirical research to investigate possible nonlinear relationships because of its appealing features (Fouquau et al., 2008; Kilic, 2016; Anderl & Caporale, 2022; Abir & Nefzi, 2022).

To explore the threshold effects of inflation on economic growth in each of the WAMZ member states, we adopted the STR model developed by Terasvirta (1994). This model allows us to exploit the heterogeneity in inflation rate 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 STR 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. Evidence shows that the STR model can mitigate potential endogeneity biases (Fouquau et al., 2008). This occurs through the smooth change in the coefficients from one regime to another depending on the threshold variable. The standard representation of the model is as specified in equation (1):

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-1} \cdot G(z_{t-d}, \gamma, c) + \varepsilon_t \quad (1)$$

Where β_1 and β_2 are the parameter vectors of the linear and nonlinear components, respectively, y_t is a vector of endogenous variables, including the inflation threshold and ε_t is a vector of stochastic white noise disturbances. $G(z_{t-d}, \gamma, c)$ is the transition function which is a continuous function of the inflation threshold variable and normalized to be bounded between 0 and 1 and depends on the transition variable z_{t-d} , the slope parameter γ , which determines the smoothness of the transition function and the location or threshold parameter c , which determines the threshold value. The transition variable z_{t-d} is an exogenous variable with a delay parameter d . The transition regimes are established based on equation (2) below:

$$y_t = \begin{cases} \beta_{10} + \beta_{20}y_{t-1} + \varepsilon_{1t} & \text{if } z_{t-d} \leq c \\ \beta_{11} + \beta_{21}y_{t-1} + \varepsilon_{2t} & \text{if } z_{t-d} > c \end{cases} \quad (2)$$

STR allows the transition to occur smoothly as a function of transition variable z_{t-d} and the subsequent transition function can either be exponential or logistic (Escribano & Jordá, 2001). The logistic transition function is of the form:

$$G(z_{t-d}, \gamma, c) = \frac{1}{(1 + \exp\{-\gamma(z_{t-d} - c)\})} \quad (3)$$

where the parameter c represents the threshold between two regimes $G(z_{t-d}, \gamma, c) = 0$ and $G(z_{t-d}, \gamma, c) = 1$. For values of the inflation transition variable around the threshold parameter c , the logistic transition function takes the value of 0.5; instead, for large negative values of the inflation transition variable it approaches zero. For $\gamma \rightarrow \infty$, the transition occurs discontinuously, and the model becomes a threshold model. Hence, the logistic function changes monotonically and can depicts an asymmetric behaviour between negative and positive deviations of z_{t-d} from c . Therefore, the logistic model specifically accounts for asymmetries in the inflation resulting from an increase or decrease in threshold inflation-growth (Kilic, 2016; Anderl & Caporale, 2022).

3.2 Model Specification

The empirical literature review proposes that in investigating the relationship between inflation and growth, it is important to analyse both the linear and nonlinear components of the data overtime. Following the existing empirical literature and the growth in methodological approaches of estimating nonlinear models, we examine the effects of inflation on growth in each of the six (6) WAMZ countries by estimating the STR models over the period 1996-2021:

$$\Delta g_t = \alpha_0 + \delta_1 \Delta g_{t-1} + \varphi_1 \Delta p_t + \theta_1 \Delta q_t + \omega_1 \Delta n_t + \gamma_1 \Delta s_t + \mu_1 \Delta b_t + \pi_1 \Delta r_t + [\alpha_0 + \delta_1 \Delta g_{t-1} + \varphi_1 \Delta p_t + \theta_1 \Delta q_t + \omega_1 \Delta n_t + \gamma_1 \Delta s_t + \mu_1 \Delta b_t + \pi_1 \Delta r_t]. G_t + \varepsilon_t \quad (4)$$

where g_t is growth rate of real GDP, $t = 1, \dots, T$, the time dimension (1996-2021), the main variable of interest is p_t which stands for changes in domestic consumer prices (inflation rates), we also consider other control variables used in the standard growth literature such as the initial level of growth rate of real GDP g_{t-1} , growth rate of gross fixed capital formation (investment) q_t , growth rate of terms of trade n_t , growth rate of nominal exchange rate (variation in exchange rate) s_t , growth rate of oil price (Brent crude) which is a proxy for oil price shock b_t , population growth r_t and ε_t is the disturbance (error) term.

Looking at equation (1), it predicts that inflation can spur economic growth in the low inflation regime below the threshold parameter c , associated with the coefficient on inflation of β_1 but inimical to growth if inflation exceeds the threshold c (high inflation regime) with a combined parameter of $(\beta_1 + \beta_2)$. 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 growth rate of gross fixed capital formation 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.

From the Neoclassical growth literature, the coefficient on initial income is expected to be negative, reflecting the hypothesis of conditional convergence. Further, to test the robustness of the results, additional control variables such as dynamics of population growth is included to capture its effect on growth, which on *a priori* is expected to be positive. 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, & Simone, 2021). In addition, different measures of exchange rate are used alternatively to assess the sensitivity of the results to changes in this variable. For instance, 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, & Mignon, 2009).

We perform a test for linearity between inflation and economic growth against the alternative hypothesis of the STR 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 STR model.⁴ This test entails testing a linear model ($r = 0$) against the STR 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. To test the robustness of the results, alternative models of the STR are estimated to determine whether the results of nonlinearity the growth effects of inflation are sensitive to the choice of control variables.

3.3 Description of Data

This study uses time series approach covering all the six WAMZ countries (The Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone) using annual data during 1996 - 2021. 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 was measured as the first difference of the logarithm of real GDP obtained from the Penn World Table, version 10.0 (Feenstra, Inklaar & Timmer, 2015) and World Development

⁴ To conduct the test, an auxiliary regression is derived from equation (1) by replacing the transition with a first-order Taylor expression around $\gamma = 0$.

Indicators (WDI). The threshold variable, inflation rate was computed as the annual percent change of the CPI and sourced from the World Development Indicators (WDI) dataset. The control variables are investment to GDP ratio, growth rate of terms of trade, nominal exchange rate changes, initial income, growth rate of oil price (Brent crude), which is a proxy for oil price shock and population growth. 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 was 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. Data on nominal exchange rates was obtained from the WEO database and 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. Data on the oil price change is obtained from the IMF's WEO database and it is measured as first difference of the logarithm of Brent Crude Oil Price. Population growth is measured as first difference of the logarithm of total population, and it is obtained from the PWT, version 10.0 and World Development Indicators (WDI).

4.0 Results Presentation and Discussion

This section presents and discusses the empirical findings on the possible existence of inflation threshold in Member States of the WAMZ. The STR model was at the country level of member states in the zone covering the period of 1996-2021. The analysis is an extension of a recent policy study (WAMI, 2022) which uses the panel smooth transition regression (PSTR) model to analyse the inflation-growth nonlinearity relationship in the WAMZ over the period 1996-2019.

A useful starting point is to consider the time series properties of all the variables used to estimate the STR model since this approach requires that all the variables are stationary. In trying to fulfil this requirement, we estimated the model using the growth rate of the variables as shown in equation (4). This empirical specification is consistent with recent empirical studies that have applied the STR model (Fouquau et al., 2008; Kilic, 2016; Anderl & Caporale, 2022). In this study, we have not extended the study period to pre-1996 because of data unavailability for key variables of interest for some Member States.

4.1 Unit Root Test

There is a growing consensus among scholars that the traditional tests used in empirical research to test for the existence of non-stationary series (presence of unit roots) such as the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests have low power especially in the presence of structural breaks in nonlinear time series. Given this argument, it is helpful to analyse the time series properties of the variables taking into consideration the second-generation tests such as Zivot & Andrews (1992), Elliott, Rothenberg, and Stock (1996), Kwiatkowski, Phillips, Schmidt, & Shin (1992), Ng & Perron (2001).

The results of the unit root tests for nonlinear time series by applying the test proposed by Kwiatkowski, Phillips, Schmidt, and Shin (1992) was carried out but we could not present them due to avoidance of clumsiness of the results. Also, there is limited number of data points used (25 observations), hence, problem of unit root is not very critical in such situation. Nonetheless, we considered all options, intercept only, intercept and trend, and the appropriate lag length, the results indicate that all the variables expressed in growth rates are stationary or integrated of order zero ($I(0)$) at 1 and 5 percent significance levels for all six (6) countries. The stationarity of the series implies that the STR model is a suitable estimation technique to determine the possible existence of the threshold effects of inflation on economic growth in these countries.

4.2 Descriptive Statistics

The descriptive statistics for the variables used in the regression during 1996-2021 is presented in the appendix III. The statistics show significant variations in the variables of interest (growth in real GDP, inflation rate and other control variables) for the six WAMZ countries over time. The mean of Growth in real GDP varies from 0.03 percent in the Gambia to 0.089 percent in Liberia over the review period. Further, the statistics reveal substantial variation in growth in real GDP across WAMZ countries. The data also shows significant heterogeneity in levels of average annual inflation rate over time, which ranges from 5.8 percent in the Gambia to 14.5 percent in Ghana over the study period. Similarly, other control variables vary substantially across countries and overtime. It points to a potential nonlinear association between inflation and economic growth in the WAMZ. As revealed in the results, 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 rate, gross fixed capital formation,

terms of trade, nominal exchange rate and growth rate of population over time. These are interesting features of the dataset that reinforce our view of the suitability of the STR model to exploit such heterogeneity and explore the possible nonlinearities in the relationship between inflation and economic growth in each of the WAMZ countries.

4.3 Linearity and Remaining Nonlinearity Tests

To obtain the inflation threshold value, it is useful to determine the existence or otherwise of a nonlinear relationship between inflation and economic growth in each Member State. All the results Tables (2 to 7) display the linearity tests against the STR alternatives. For brevity of presentation, we could not present other alternative results of these tests for all Member States. The test results show strong rejection of the null hypothesis of linearity at the 5 percent level across all countries. This finding indicates the existence of a nonlinear relationship between inflation and economic growth in all the countries under investigation. The outcome is consistent with the findings from the policy study conducted by WAMI (2022) which illustrates strong nonlinear inflation-growth relationship by applying the PSTR model across the WAMZ countries. Indeed, the PSTR model allows for cross-country heterogeneity and nonlinearities to endogenously determine the inflation threshold beyond which inflation is detrimental to growth.

We performed further test of any remaining nonlinearity in the data using the additive nonlinearity tests. Considering the decision rule for estimation of the STR model using the Terasvirta Sequential and Escribano-Jorda tests, our results strongly indicate that a first-order logistic smooth transition regression (LSTR) model should be estimated to capture the nonlinear relationship in the inflation-growth nexus for each country.

4.4 LSTR Model Estimation

Following the determination of the suitability of the estimation of the LSTR model, equation (3) is estimated using the LSTR model by applying the nonlinear least squares to analyse the inflation-growth nonlinearity in each country. The estimation of the LSTR allows us to determine the inflation threshold (location parameter), analyse the behaviour of inflation in both low inflation regime below the threshold and above the threshold in the high inflation regime. The estimation produces the value for the slope parameter (γ), which shows the extent to which inflation above the threshold can become harmful to growth. In estimating the LSTR model, the threshold value and slope coefficient were determined by a grid search. We utilised

the Broyden, Fletcher, Goldfarb and Shanno (BFGS) iteration process in the estimation allowing the default of 500 iterations (see EViews 13 manual for details).

4.4.1 The Gambia

Table 2 presents the parameters from the nonlinear estimation of the LSTR model with one threshold level of inflation. The results displayed are divided into two components, comprising the linear and nonlinear parts with the estimated inflation threshold, slope parameter (γ) and relevant regression statistics over the period of 1996-2021.

As previously mentioned, the objective is to analyse the threshold effect of inflation on growth and associated slope parameter, which allows us to determine the smoothness of the transitions from the lower to upper inflation regimes with a view to evaluating the speed at which the level of inflation above estimated threshold becomes detrimental to growth. Given this objective, the analysis focuses largely on the estimated inflation threshold, the direction of the coefficient of inflation in both the lower and upper inflation regimes in assessing the possible existence of a nonlinear effect of inflation on growth and the value of the slope parameter. The results of the LSTR model indicate an inflation threshold of 6.6 percent. However, the threshold effects of inflation on growth were not statistically significant at the conventional 5 percent level. Looking at the coefficient of inflation, the result appears to be counterintuitive. Inflation exhibits a negative effect on growth in the low inflation regime below the threshold associated with the linear component of the regression and a positive effect on growth in the high inflation regime above the threshold. However, the other regression statistics were not interpreted since the inflation threshold and overall regression were not significant. This outcome suggests the need for further consideration of the model to determine country-specific drivers of the inflation-growth dynamics in The Gambia.

Table 2: Smooth Transition Inflation Threshold for The Gambia

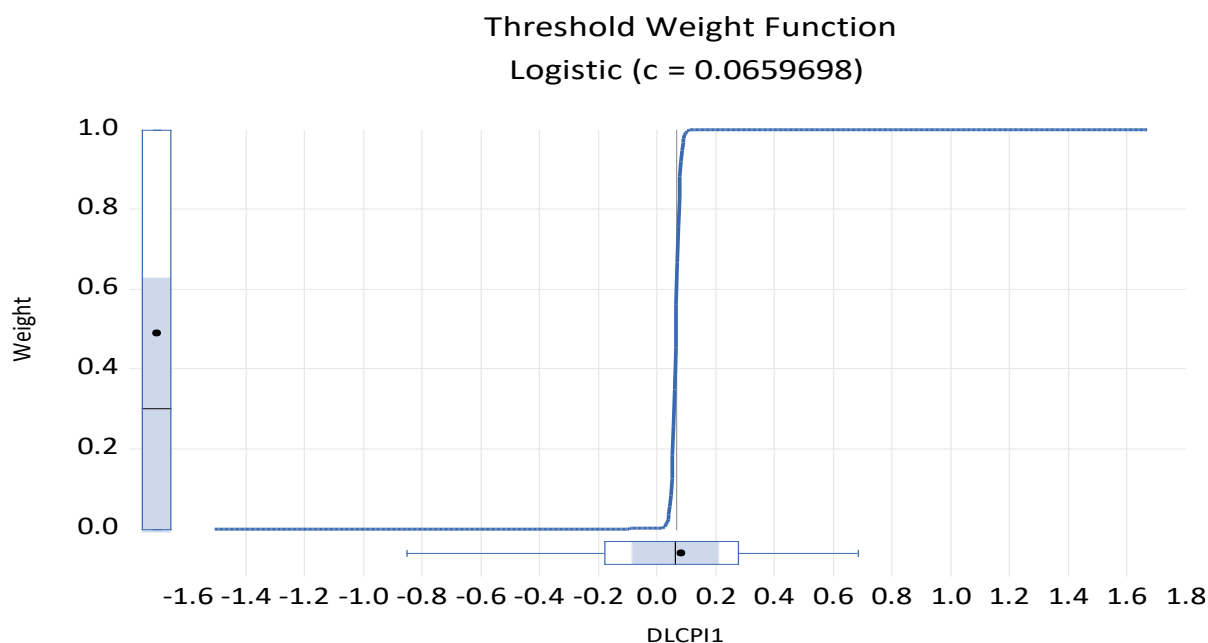
		90% Confidence Interval		95% Confidence Interval		99% Confidence Interval	
Variable	Coef.	Low	High	Low	High	Low	High
Linear Part							
DLRGDP(-1)	-0.4551	-1.5929	0.6827	-2.1316	1.2215	-4.3224	3.4123
DLRGDP(-2)	-1.9703**	-2.9288	-1.0119	-3.3827	-0.5580	-5.2281	1.2875
DLCPI	-0.0694*	-0.1209	-0.0180	-0.1452	0.0064	-0.2443	0.1054
GGFCF	0.0210	-0.2805	0.3226	-0.4232	0.4653	-1.0037	1.0458
DLTOT	-0.8895	-2.5249	0.7460	-3.2994	1.5204	-6.4483	4.6693
DLTOT(-1)	0.0469	-1.1608	1.2546	-1.7327	1.8264	-4.0580	4.1517
GLNEXC	0.0454	-0.2457	0.3365	-0.3835	0.4743	-0.9440	1.0348
DLOIL_BR	-0.0710	-0.3471	0.2052	-0.4779	0.3360	-1.0097	0.8678

DLPOP	-58.0448*	-98.1044	-17.9852	-117.073	0.9838	-194.2048	78.1152
Non-Linear Part							
DLRGDP(-1)	1.0235	-1.9986	4.0456	-3.4296	5.4766	-9.2483	11.2953
DLRGDP(-2)	2.3736**	1.2101	3.5371	0.6591	4.0880	-1.5811	6.3283
DLCPI	0.2398*	0.0467	0.4329	-0.0447	0.5244	-0.4165	0.8962
GGFCF	-0.1167	-0.4387	0.2054	-0.5912	0.3578	-1.2112	0.9779
DLTOT	-0.0575	-1.7883	1.6733	-2.6079	2.4929	-5.9404	5.8254
DLTOT(-1)	0.6514	-2.4098	3.7126	-3.8593	5.1621	-9.7533	11.0561
GLNEXC	0.3266	-0.1934	0.8467	-0.4396	1.0929	-1.4409	2.0942
DLOIL_BR	-0.0092	-0.2982	0.2798	-0.4351	0.4167	-0.9915	0.9731
DLPOP	-6.4353	-13.7528	0.8822	-17.2178	4.3472	-31.3070	18.4365
Threshold Part							
C	1.8532**	0.6943	3.0121	0.1455	3.5609	-2.0860	5.7924
SLOPE	138.1346	-3781.09	4057.36	-5636.92	5913.19	-13183.06	13459.33
THRESHOLD	0.0660	-0.1097	0.2416	-0.1928	0.3248	-0.5310	0.6629
CONFIDENCE LEVEL		0.0660±0.1756		0.0660±0.2588		0.0660±0.5969	
R-squared	0.9822						
Adj. R-squared	0.8047						

Note: ***, ** and * denote 1%, 5% and 10 %, respectively. Dependent variable-- Growth in real GDP.

Source: Authors' estimates using EViews 13

Figure 1: Smooth Transition Function for the Gambia's Inflation Threshold



4.4.2 Ghana

Turning to Ghana, the results reveal a threshold value of inflation of 10.2 percent which is statistically significant at the 1 percent significance level. This finding suggests that implementing a mix of policies that would ensure that inflation is attained below the threshold of 10.2 percent would support economic growth. Above this threshold, inflation would be harmful to growth. This outcome is reflected in the direction of inflation effects on growth, which is consistent with the predictions on the inflation-growth nonlinear relationship. The coefficient of inflation in the low inflation regime is (0.4211) and below this threshold is associated with the linear aspect of the estimation, which is positive but not statistically significant. Above the threshold associated with the nonlinear component of the estimation, the effect on growth is negative (-0.399), reflecting detrimental growth effect of inflation although not statistically significant. The insignificant effect of inflation in both the low and high inflation regimes could be partly attributed to the limited number of observations used in the estimation, considering the relatively short study period which is divided into low and high inflation regimes associated with the linear and nonlinear components of the estimation.

Table 3 reports the inflation threshold value, smoothening slope parameter (γ) associated with the inflation threshold and corresponding confidence intervals of both the threshold level of inflation and the slope parameter at the confidence intervals of 90 percent, 95 percent, and 99 percent, respectively. The inflation threshold at the 95 percent confidence level is estimated to be 10.2 ± 1.30 . While the slope coefficient is not statistically significant, the magnitude of the parameter suggests a steep transition function (see Figure 2). The shape of the transition function implies that inflation quickly becomes harmful to growth when it exceeds the threshold of 10.2 percent.

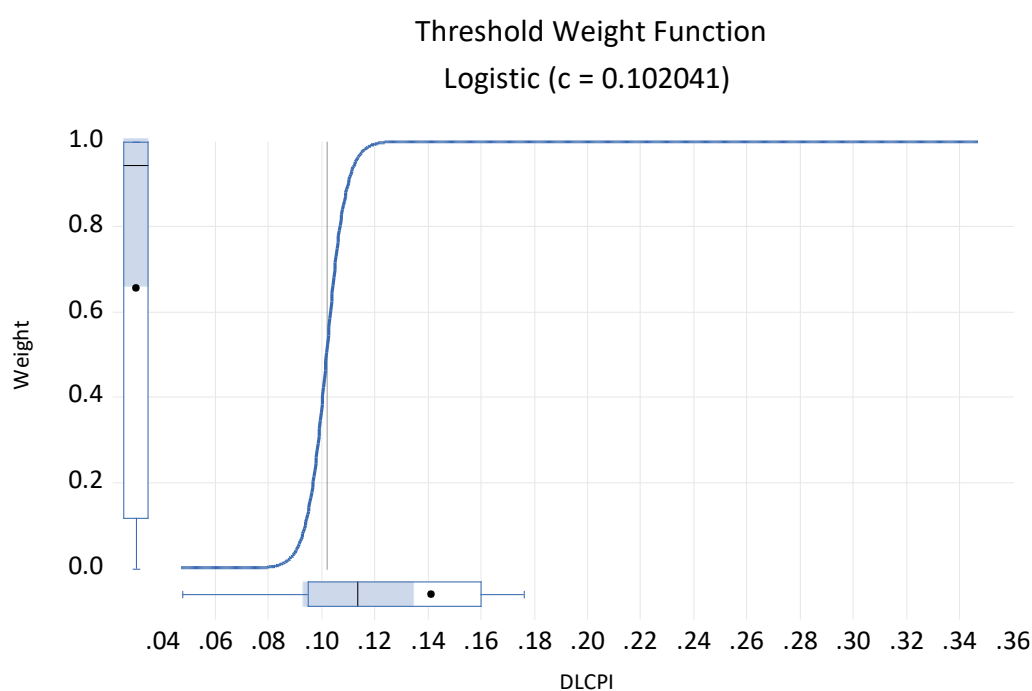
Table 3: Smooth Transition Inflation Threshold for Ghana

		90% Confidence Interval		95% Confidence Interval		99% Confidence Interval	
Variable	Coef.	Low	High	Low	High	Low	High
Linear Part							
DLCPI(-1)	0.4211	-0.0073	0.8495	-0.1136	0.9558	-0.3702	1.2124
GGFCF	0.0835	-0.1096	0.2766	-0.1575	0.3245	-0.2732	0.4402
DLTOT	-0.6838**	-1.1683	-0.1993	-1.2885	-0.0791	-1.5787	0.2111
GLNEXC	0.7819	-0.0286	1.5924	-0.2297	1.7935	-0.7152	2.2790
DLOIL_BR	0.0667**	0.0162	0.1173	0.0037	0.1298	-0.0265	0.1600
DLPOP	0.9275	-9.4956	11.3506	-12.0815	13.9366	-18.3250	20.1801
IT_DUM	0.1043**	0.0433	0.1654	0.0281	0.1805	-0.0085	0.2171

Nonlinear Part							
DLCPI(-1)	-0.3990	-0.8559	0.0579	-0.9692	0.1713	-1.2429	0.4449
GGFCF	-0.0955	-0.3058	0.1148	-0.3579	0.1670	-0.4839	0.2930
DLTOT	0.7360**	0.2016	1.2705	0.0689	1.4031	-0.2512	1.7233
GLNEXC	-0.8206*	-1.6340	-0.0073	-1.8358	0.1945	-2.3230	0.6817
DLOIL_BR	-0.0226	-0.0871	0.0420	-0.1031	0.0580	-0.1418	0.0966
DLPOP	7.8182*	0.5033	15.1330	-1.3115	16.9478	-5.6931	21.3295
IT_DUM	-0.0798*	-0.1442	-0.0154	-0.1601	0.0005	-0.1987	0.0391
Threshold Part							
C	-0.1672*	-0.3295	-0.0049	-0.3698	0.0354	-0.4670	0.1326
SLOPE	273.1320	-83.2642	629.5281	-171.69	717.95	-385.17	931.43
THRESHOLD	0.1020**	0.0916	0.1125	0.0890	0.1151	0.0828	0.1213
CONFIDENCE LEVEL		0.1020±0.0104		0.1020±0.0130		0.1020±0.0193	
R-squared	0.9059						
Adj. R-squared	0.6908						

Note: ***, ** and * denote 1%, 5% and 10 %, respectively. Dependent variable-- Growth in real GDP.
IT_DUM – Inflation Targeting (IT) Monetary Policy Framework Dummy Variable for Ghana
Source: Authors' estimates using EViews 13

Figure 2: Smooth Transition Function for Ghana's Inflation Threshold



4.4.3 Guinea

As can be seen from Table 4, the estimation of the LSTR model establishes an optimal inflation threshold of 10.8 percent which is statistically significant at the 1 percent level of

significance. The coefficient of inflation in the lower inflation regime is 0.0673, below which the threshold is positive and statistically significant at the 1 percent level. The result suggests that achieving inflation below this threshold will be beneficial to growth in Guinea. The finding 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, promoting physical capital accumulation and stimulating growth (Vaoni, 2012). As expected, the coefficient of inflation above the threshold in the upper regime associated with the nonlinear component of the estimation (-0.0416) turns out to be negative and statistically significant, although at the 10 percent level. This prediction ties with the reverse Tobin-effect phenomenon since high inflation would create distortions to relative prices and misallocation of resources which potentially impede physical capital accumulation and growth (Khan, 2014).

Table 4 reports the inflation threshold and slope parameter (γ) associated with associated the threshold level of inflation at the confidence intervals of 90 percent, 95 percent, and 99 percent, respectively. Results show the estimated inflation threshold at the 95 percent confidence level at 10.84 ± 2.21 . The estimated slope parameter of the transition function ($\gamma = 171.42$) is large, reflecting a sharper transitioning from the lower to higher inflation regime. The size of the transition function suggests that inflation quickly impedes growth when the level of inflation is attained beyond the threshold of 10.8 percent.

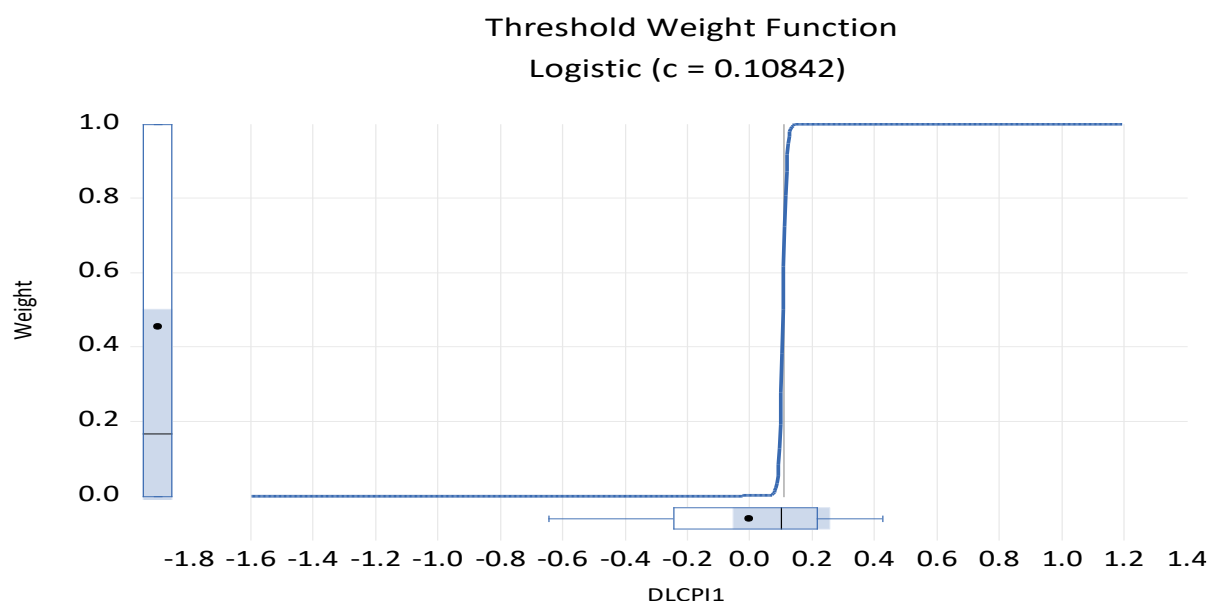
Table 4: Smooth Transition Inflation Threshold for Guinea

		90% Confidence Interval		95% Confidence Interval		99% Confidence Interval	
Variable	Coef.	Low	High	Low	High	Low	High
Linear Part							
DLRGDP(-1)	0.0336	-0.0467	0.1140	-0.1281	0.1953	-0.7765	0.8438
DLRGDP(-2)	-0.6977**	-0.7498	-0.6456	-0.8025	-0.5929	-1.2227	-0.1726
DLRGDP(-3)	-0.4598**	-0.5338	-0.3858	-0.6087	-0.3109	-1.2057	0.2860
DLCPI	0.0673**	0.0604	0.0742	0.0535	0.0812	-0.0022	0.1368
GGFCF	0.0293**	0.0263	0.0324	0.0232	0.0355	-0.0015	0.0601
DLTOT	0.1274**	0.1000	0.1549	0.0721	0.1827	-0.1495	0.4044
GLNEXC	-0.2143**	-0.2422	-0.1863	-0.2704	-0.1581	-0.4958	0.0673
DLOIL_BR	-0.0767**	-0.0954	-0.0580	-0.1143	-0.0390	-0.2652	0.1119
DLPOP	9.1021**	8.3122	9.8920	7.5124	10.6918	1.1377	17.0665
Non-linear Part							
DLRGDP(-1)	-0.2947	-1.4799	0.8905	-2.6798	2.0905	-12.2439	11.6546
DLRGDP(-2)	0.3749	-0.1630	0.9128	-0.7077	1.4575	-5.0487	5.7985
DLRGDP(-3)	0.0003	-1.5951	1.5958	-3.2105	3.2112	-16.0856	16.0863
DLCPI	-0.0416*	-0.0806	-0.0027	-0.1200	0.0367	-0.4342	0.3510

GGFCF	0.0171	-0.0424	0.0765	-0.1025	0.1367	-0.5821	0.6163
DLTOT	0.0309	-0.2430	0.3047	-0.5202	0.5820	-2.7301	2.7918
GLNEXC	0.2380**	0.2139	0.2621	0.1895	0.2865	-0.0049	0.4810
DLOIL_BR	0.0757**	0.0594	0.0920	0.0429	0.1085	-0.0887	0.2401
DLPOP	-2.6230	-9.2802	4.0342	-16.0204	10.7744	-69.7426	64.4966
Threshold Part							
C	-0.0880**	-0.1006	-0.0755	-0.1134	-0.0627	-0.2150	0.0389
SLOPE	171.4230**	86.2514	256.5946	0.0182	342.8278	-687.2971	1030.1430
THRESHOLD	0.1084*	0.0975	0.1194	0.0864	0.1305	-0.0021	0.2189
CONFIDENCE LEVEL		0.1084±0.0110		0.1084±0.0221		0.1084±0.1105	
R-squared	0.9990						
Adj. R-squared	0.9979						

Note: ***, ** and * denote 1%, 5% and 10 %, respectively. Dependent variable-- Growth in real GDP.
Source: Authors' estimates using EViews 13

Figure 3: Smooth Transition Function for Guinea's Inflation Threshold



4.4.4 Liberia

The LSTR estimation results reported in Table 5 reveal that the inflation threshold of 8.73 percent is statistically significant at the 1 percent significance level. Turning to the inflation variable of interest, the coefficient (1.5859) shows that achieving inflation below the threshold of 8.73 percent would positively impact growth in the lower regime, however, the effect on growth is not significant. At the higher regime (nonlinear part), the coefficient of inflation (-4.40) points to growth-retarding effect of inflation above the threshold, although it is not statistically significant.

Table 5 displays the inflation threshold value and the slope parameter (γ) associated with the inflation threshold at the confidence intervals of 90 percent, 95 percent, and 99 percent, respectively. The results show the estimated inflation threshold at the 90 percent confidence level at 8.73 ± 2.35 . The size of the estimated slope coefficient (130.80) reflects a sharp change in the growth effect of inflation when transitioning from the lower to the upper inflation regimes. This finding suggests that obtaining a level of inflation above the threshold is inimical to growth.

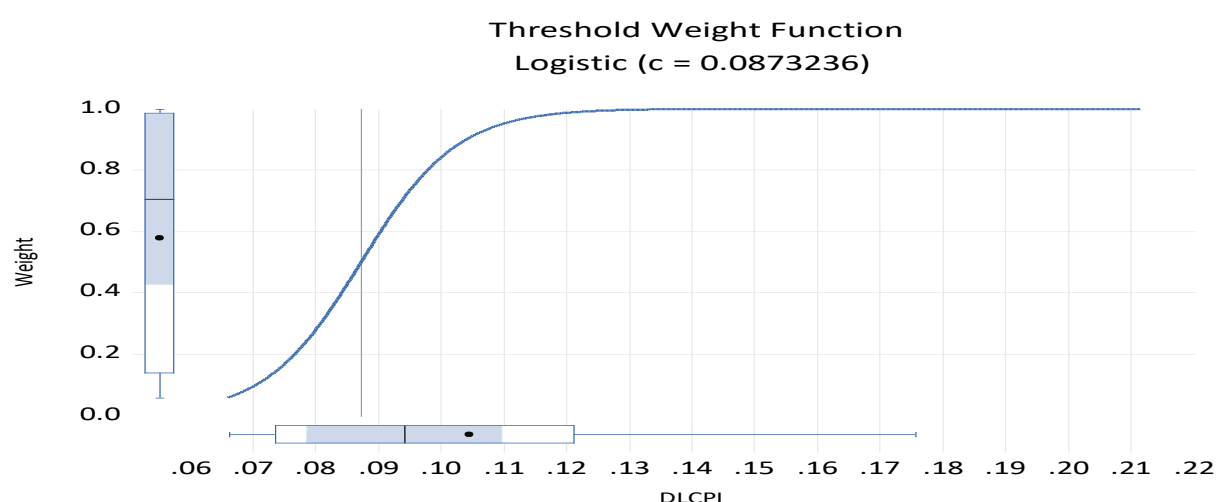
Table 5: Smooth Transition Inflation Threshold for Liberia

		90% Confidence Interval		95% Confidence Interval		99% Confidence Interval	
Variable	Coef.	Low	High	Low	High	Low	High
Linear Part							
DLRGDP(-1)	0.3617*	0.0012	0.7223	-0.1079	0.8313	-0.4170	1.1405
DLRGDP(-2)	-0.7628*	-1.5100	-0.0157	-1.7359	0.2102	-2.3764	0.8508
DLCPI(-1)	1.5859	-1.0689	4.2407	-1.8716	5.0434	-4.1476	7.3194
GGFCF	-0.0782	-0.3773	0.2209	-0.4677	0.3113	-0.7241	0.5677
DLTOT	0.4153	-0.7571	1.5878	-1.1116	1.9423	-2.1168	2.9474
GLNEXC	-1.2641**	-1.9402	-0.5879	-2.1446	-0.3835	-2.7243	0.1961
DLOIL_BR	-0.1064	-0.4894	0.2767	-0.6052	0.3925	-0.9336	0.7208
DLPOP	8.0868*	0.9758	15.1979	-1.1744	17.3480	-7.2707	23.4444
Non-linear Part							
DLRGDP(-1)	-0.6566**	-1.1540	-0.1591	-1.3045	-0.0087	-1.7309	0.4177
DLRGDP(-2)	0.4770	-0.4253	1.3794	-0.6982	1.6522	-1.4718	2.4258
DLCPI(-1)	-4.4005	-8.9466	0.1457	-10.3212	1.5203	-14.2187	5.4178
GGFCF	0.1678	-0.1914	0.5270	-0.3000	0.6356	-0.6080	0.9436
DLTOT	-1.5179	-3.1450	0.1093	-3.6370	0.6013	-5.0320	1.9963
GLNEXC	1.5549*	0.2490	2.8607	-0.1458	3.2556	-1.2653	4.3751
DLOIL_BR	0.1656	-0.4185	0.7496	-0.5951	0.9262	-1.0958	1.4269
DLPOP	10.6078**	2.6596	18.5560	0.2563	20.9593	-6.5578	27.7734
Threshold Part							
C	-0.2089*	-0.3895	-0.0283	-0.4441	0.0263	-0.5989	0.1812
SLOPE	130.80	-192.98	454.58	-290.88	552.48	-568.45	830.05
THRESHOLD	0.0873**	0.0638	0.1109	0.0567	0.1180	0.0365	0.1381
CONFIDENCE LEVEL		0.0873±0.0235		0.0873±0.0306		0.0873±0.0508	
R-squared	0.9887						
Adj. R-squared	0.9378						

Note: ***, ** and * denote 1%, 5% and 10 %, respectively. Dependent variable-- Growth in real GDP.

Source: Authors' estimates using EViews 13

Figure 4: Smooth Transition Function for Liberia's Inflation Threshold



4.4.5 Nigeria

Table 6 presents the estimated results of the LSTR model, displaying a threshold level of inflation of 10.76 percent which is statistically significant at the 1 percent level. By allowing for one period lag in inflation, the results of the Wald test for the joint significance indicate that the combined coefficient of inflation in the low inflation regime are statistically significant. The evidence intuitively indicates that inflation spurs growth in this regime below the threshold level. The result implies that moderate inflation will be beneficial to growth in Nigeria if maintained at levels below the threshold. The combined coefficient turns out to be negative although not statistically significant in the upper regime above the threshold, pointing to the detrimental impact of inflation on growth above the threshold value.

In addition, the Table presents the inflation threshold value and the slope parameter (γ) associated with the inflation threshold at the confidence intervals of 90 percent, 95 percent, and 99 percent, respectively. The results reveal the estimated threshold inflation rate of 10.76 ± 4.10 at the 95 percent confidence level. The estimated slope parameter (43.08) reveals a relatively sharp transition function, although the size of the slope is smaller compared to slope parameters of other WAMZ countries. This evidence suggests that the transmission of the undesirable effects of inflation to growth above the threshold occurs at a relative lower speed compared to other Member States. The outcome could be associated with recent policy gains induced by the Central Bank interventions to address some of the supply-side constraints especially boosting domestic food production.

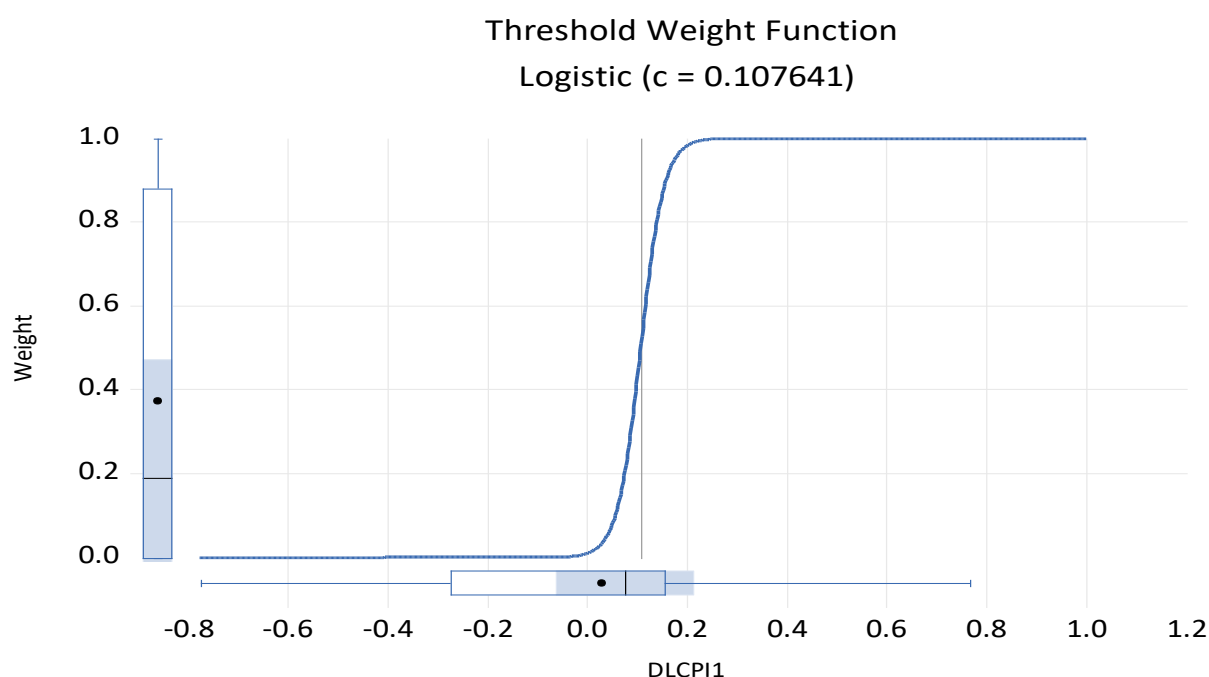
Table 6: Smooth Transition Inflation Threshold for Nigeria

		90% Confidence Interval		95% Confidence Interval		99% Confidence Interval	
Variable	Coef.	Low	High	Low	High	Low	High
Linear Part							
DLRGDP(-1)	0.6374**	0.1489	1.1259	0.0142	1.2606	-0.3402	1.6149
DLCPI	0.0043	-0.0446	0.0531	-0.0581	0.0666	-0.0936	0.1021
DLCPI(-1)	0.0329**	0.0101	0.0556	0.0038	0.0619	-0.0127	0.0784
GGFCF	-0.1032**	-0.1815	-0.0250	-0.2031	-0.0034	-0.2599	0.0534
DLTOT	0.1309	-0.1627	0.4245	-0.2436	0.5055	-0.4566	0.7184
GLNEXC	-0.0417*	-0.0753	-0.0081	-0.0846	0.0012	-0.1090	0.0256
DLOIL_BR	-0.0990*	-0.1788	-0.0193	-0.2007	0.0027	-0.2586	0.0606
DLPOP	-24.8366**	-41.0515	-8.6217	-45.5218	-4.1514	-57.2828	7.6096
Non-linear Part							
DLRGDP(-1)	-1.0441	-2.3802	0.2919	-2.7486	0.6603	-3.7177	1.6294
DLCPI	-0.0071	-0.0843	0.0702	-0.1056	0.0915	-0.1616	0.1475
DLCPI(-1)	-0.0418	-0.1233	0.0397	-0.1457	0.0622	-0.2048	0.1212
GGFCF	-0.2436	-0.8534	0.3661	-1.0215	0.5342	-1.4638	0.9765
DLTOT	-0.1885	-0.9101	0.5331	-1.1090	0.7320	-1.6324	1.2554
GLNEXC	-0.0508	-0.3741	0.2725	-0.4632	0.3617	-0.6977	0.5962
DLOIL_BR	0.1956*	0.0210	0.3701	-0.0271	0.4182	-0.1537	0.5448
DLPOP	-0.2003	-3.6940	3.2934	-4.6572	4.2566	-7.1913	6.7907
Threshold Part							
C	0.6932**	0.2731	1.1133	0.1573	1.2291	-0.1475	1.5339
SLOPE	43.09	-1.57	87.75	-13.89	100.06	-46.28	132.45
THRESHOLD	0.1076**	0.0755	0.1398	0.0666	0.1487	0.0433	0.1720
CONFIDENCE LEVEL		0.1076±0.0322		0.1076±0.0410		0.1076±0.0643	
R-squared	0.9583						
Adj. R-squared	0.8081						

Note: ***, ** and * denote 1%, 5% and 10 %, respectively. Dependent variable-- Growth in real GDP.

Source: Authors' estimates using EViews 13

Figure 5: Smooth Transition Function for Nigeria's Inflation Threshold



4.4.6 Sierra Leone

As reported in Table 7, the estimation of the LSTR model shows an inflation threshold of 7.42 percent that is statistically significant at the 1 percent level of significance. Consistent with the literature on the inflation-growth nonlinearity, the coefficient of inflation in the lower inflation regime (6.0713) below this threshold is positive and statistically significant at the 1 percent level. This evidence shows the growth-promoting effects when moderate levels of inflation are achieved below the inflation threshold. Moving from the lower inflation regime to the upper regime above the threshold, the coefficient of inflation (-5.3047) turns out to be negative and statistically significant, reflecting the growth-retarding effect of inflation above the threshold.

Further, the Table reports the estimated inflation threshold and slope parameter (γ) associated with the threshold level at the confidence intervals of 90 percent, 95 percent, and 99 percent, respectively. Results show the estimated inflation threshold of 7.42 ± 0.01 at the 95 percent confidence interval. The estimated slope parameter indicates a relatively higher value of the slope of transition function ($\gamma = 253.16$), reflecting a sharper transitioning from the lower to higher inflation regime. This finding implies that obtaining inflation levels above the threshold would trigger a speedy transmission of the adverse effect of inflation on growth in Sierra Leone.

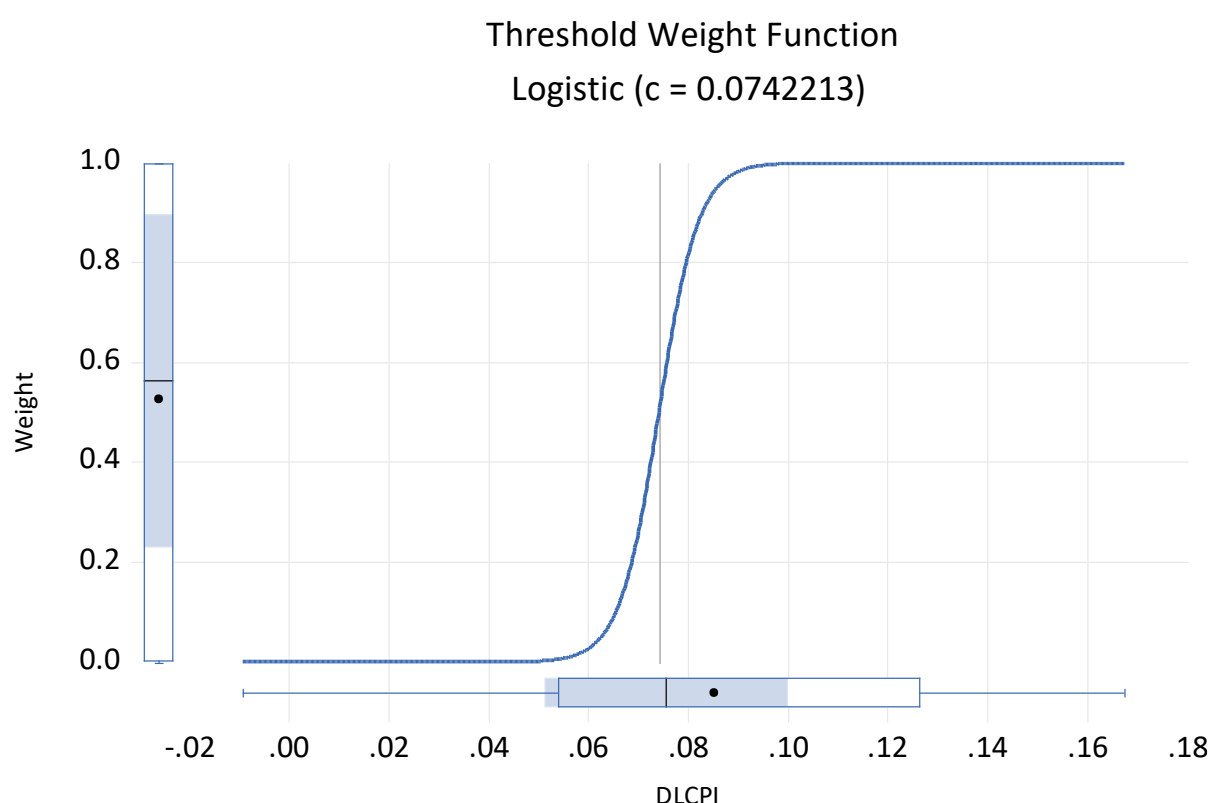
Table 7: Smooth Transition Inflation Threshold for Sierra Leone

		90% Confidence Interval		95% Confidence Interval		99% Confidence Interval	
Variable	Coef.	Low	High	Low	High	Low	High
Linear Part							
DLRGDP(-1)	1.9630**	1.7654	2.1606	1.5653	2.3607	-0.0294	3.9553
DLRGDP(-2)	-1.4091**	-1.5569	-1.2612	-1.7066	-1.1116	-2.8998	0.0816
DLRGDP(-3)	-1.7422**	-1.8807	-1.6038	-2.0209	-1.4636	-3.1382	-0.3463
DLCPI	6.0713**	5.4083	6.7344	4.7370	7.4056	-0.6134	12.7561
GGFCF	0.0448**	0.0352	0.0544	0.0255	0.0641	-0.0517	0.1413
DLTOT	2.9646**	2.4646	3.4646	1.9584	3.9708	-2.0764	8.0055
GLNEXC	0.7126**	0.4269	0.9983	0.1376	1.2876	-2.1679	3.5931
DLOIL_BR	-0.0295**	-0.0431	-0.0159	-0.0568	-0.0021	-0.1665	0.1076
DLPOP	-3.9014**	-5.0310	-2.7719	-6.1746	-1.6283	-15.2897	7.4868
Non-linear Part							
DLRGDP(-1)	-2.4690**	-2.7220	-2.2159	-2.9782	-1.9597	-5.0203	0.0823
DLRGDP(-2)	1.2994**	1.1511	1.4477	1.0009	1.5978	-0.1958	2.7946
DLRGDP(-3)	1.9727**	1.8225	2.1228	1.6705	2.2748	0.4590	3.4863
DLCPI	-5.3047**	-5.9162	-4.6932	-6.5353	-4.0740	-11.4701	0.8607
GGFCF	-0.4017**	-0.4892	-0.3143	-0.5777	-0.2258	-1.2833	0.4798
DLTOT	-3.0672**	-3.5796	-2.5549	-4.0982	-2.0363	-8.2324	2.0979
GLNEXC	-0.8226**	-1.1182	-0.5270	-1.4175	-0.2277	-3.8031	2.1580
DLOIL_BR	-0.0262*	-0.0444	-0.0079	-0.0629	0.0106	-0.2102	0.1578
DLPOP	7.8998**	6.0536	9.7461	4.1844	11.6153	-10.7141	26.5138
Threshold Part							
C	-0.1653**	-0.1938	-0.1368	-0.2226	-0.1079	-0.4526	0.1221
SLOPE	253.16**	228.16	278.16	202.86	303.47	1.12	505.20
THRESHOLD	0.0742**	0.0736	0.0748	0.0730	0.0755	0.0681	0.0804
CONFIDENCE LEVEL		0.0742±0.0006		0.0742±0.0012		0.0742±0.0062	
R-squared	0.9999						
Adj. R-squared	0.9998						

Note: ***, ** and * denote 1%, 5% and 10 %, respectively. Dependent variable-- Growth in real GDP.

Source: Authors' estimates using EViews 13

Figure 6: Smooth Transition Function for Sierra Leone's Inflation Threshold



Interestingly, the threshold for the three leading economies (Nigeria, Ghana, and Guinea) hovers around 10.0 percent. The results are consistent with recent evidence by WAMI (2022) on the detrimental effect of inflation on growth above the threshold of 10.3 for WAMZ countries using the PSTR approach. Similarly, this finding is in line with evidence from previous empirical studies (e.g., Espinoza, Leon, & Prasad, 2010). Using the STR model, their study finds that an inflation rate above the threshold of 10.0 percent quickly becomes harmful to growth in developing countries. However, Nwosu (2018) reported a higher inflation threshold of 12.86 percent in the WAMZ beyond which inflation stifles output growth. Looking at the inflation thresholds for The Gambia, Liberia, and Sierra Leone, the results indicate a relatively lower threshold associated with the 95 percent confidence level ranging from 7.42 ± 0.12 in Sierra Leone to a threshold level of 8.73 ± 3.06 in Liberia. These findings suggest a potential difference in inflation tolerance levels between relatively large and small economies in the WAMZ.

Across all Member States, the size of the slope parameter of the transition function suggests that inflation quickly retards growth above the recommended threshold. This finding has important implications for policy responses to curb inflation in WAMZ Member States.

The outcome suggests the need for prompt policy responses when the level of inflation is at or above the estimated threshold to avoid the undesirable effects on economic growth.

4.5 Robustness Analysis

To evaluate the robustness of the inflation-growth nonlinearity in each of the WAMZ countries, we considered three different alternative model specifications to verify the sensitivity of the results to the use of different combinations of control variables. In the second model, we extended the baseline specification in equation (4) by replacing growth rate of terms of trade with trade openness as a control variable to account for trade dynamics. Theories of international trade and endogenous growth have shown that trade can stimulate growth through rising productivity, relative price competitiveness, and encouraging technological imitation (Edwards, 1997). Similarly, in the third alternative model specification, nominal exchange rate changes variable was replaced with the real exchange rate. In another model specification, we estimated a model where we replaced investment to GDP ratio with the ratio of FDI inflows to GDP. This specification was motivated by the endogenous growth literature suggesting that host countries will enhance productivity gains and growth from FDI through technology transfer, diffusion, and spillovers effects (Nair-Reichert and Weinhold, 2001). At the micro level, the presence of foreign firms in host countries will increase FDI productivity spillovers by improving the productivity of domestic firms in countries that they operate (Javorick, 2004). At the aggregate level, evidence suggests that FDI promotes domestic investment through the transfer of technology from foreign affiliates to economic agents in host countries (Borensztein et al, 1998).

The results of linearity and no remaining non-linearity tests show that across all the models, results show strong rejection of the null hypothesis of linearity and confirm the estimation of a STR 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 WAMZ⁵.

5.0 Summary, Conclusion and Policy Recommendations

⁵ Due to large volume of these results for each of the six WAMZ countries for each alternative specifications and the fear of bulkiness, we could not present them, but they are available upon request.

This study seeks to provide novel country-specific empirical evidence on the optimal inflation-growth threshold in the WAMZ over the period 1996-2021. Determining the inflation-growth threshold below which moderate inflation spurs growth, but above which inflation is detrimental to growth is very important for monetary policy actions in the region to curb high inflation and thus mitigate the effects of distortionary policy on the economy. Although there is large empirical literature on this subject globally, however, previous studies especially on the WAMZ economies focused on exogenous approaches of determining optimal inflation which has been found to impose a sharp and most often linear behaviour on the threshold level of inflation. This paper contributes to the policy debate on the inflation-growth nexus in three-folds. Unlike previous studies, it endogenously determines the individual country-specific threshold level of inflation on economic growth for WAMZ countries, allowing for heterogeneous inflationary episodes over time. It uses recent methodology of smooth transition regression that allows for gradual shifts among high and low inflation regimes in determining the threshold inflation-growth nexus for each WAMZ member states, and lastly, it focuses on the recent period of 1996-2021, hence, making the results of the study more policy-relevant, by capturing recent macroeconomic shocks experienced by the countries.

Preliminary results from the study shows interesting optimal inflation rates for each of the WAMZ countries with three different confidence intervals of 90 percent, 95 percent, and 99 percent, associated with low and high inflation regimes, that is, below and above this threshold, respectively. The estimated results are divided into three components, comprising the linear, nonlinear and the estimated inflation threshold part (where most of the interpretations are focused). The estimated inflation threshold coefficients are 10.2 percent for Ghana, 10.8 percent in Guinea, 8.7 percent in Liberia, 10.8 percent for Nigeria and 7.4 percent in Sierra Leone, which are all statistically significant at the 5 percent level of significance. However, for the Gambia, we found inconclusive inflation threshold coefficient of 6.6 percent that is statistically insignificant at the conventional 5 percent level. For most of the countries in WAMZ, the linear coefficient of inflation in the low inflation regime is positive and statistically significant at the 5 percent level of significance. This finding is consistent with the theoretical proposition where there is positive effect of attaining lower levels of inflation on economic growth. On the contrary, the nonlinear coefficient of inflation in the high inflation regime is strongly negative and significant for some, suggesting an adverse effect of high inflation on growth. This implies that elevated levels of inflation above the established threshold would constrain growth in the WAMZ.

It is interesting to note that inflation threshold for the three leading economies (Nigeria, Ghana, and Guinea) in the WAMZ hovers around 10.0 percent, which is consistent with initial WAMZ inflation convergence criteria (10 percent) as well as the recent WAMI study of 10.3 percent threshold for the WAMZ countries (WAMI, 2022; Espinoza, Leon, and Prasad, 2010). For instance, examining the inflation thresholds for The Gambia, Liberia, and Sierra Leone, the results indicate a relatively lower threshold associated with the 95 percent confidence level ranging from 7.42 ± 0.06 in Sierra Leone to a threshold level of 8.73 ± 2.35 in Liberia. These findings suggest a potential difference in inflation tolerance levels between relatively large and small economies in the WAMZ. It also points the fact that there is need for prompt policy responses when the level of inflation is at or above the estimated threshold for each WAMZ countries, to avoid the undesirable effects on economic growth.

Thus, Central Banks are encouraged to continue to pursue adequate monetary policy measures to lower inflation to the desirable upper single-digit level. This will create the enabling financial environment, coupled with additional policy actions to reduce the costs of financial intermediation to promote credit extension to firms, and encourage investment in physical capital to stimulate growth.

Lastly, the limitation of this study is that it does not consider sectoral importance of inflation at the country level as well as country-specific transmission channels of inflation to growth in the WAMZ. Future research exercise to determine the level of inflation that will be beneficial to growth in these sectors as well as the country-specific transmission channels that will be relevant for policymaking in the WAMZ is proposed.

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Appendix

Appendix 1: Description of variables and sources

Main Variables	Denotation	Description	Sources
Growth rate of real GDP	DLGDP	First difference of the logarithm of real GDP.	Penn World Table (PWT), version 10.0 (Feenstra, Inklaar and Timmer, 2015) and World Development Indicators (WDI).
Inflation rate (threshold variable)	DLCPI	Annual percent change of Consumer Price Index (CPI)	IMF's World Economic Outlook (WEO), WAMI databases and World Development Indicators (WDI).
Control Variables			
Investment to GDP ratio	GGFCF	Share of gross fixed capital formation in GDP.	PWT, version 10.0 and World Development Indicators (WDI)
Growth in terms of trade (TOT)	DLTOT	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 and World Development Indicators (WDI)
Nominal exchange rate changes	GLNEXC	First difference of the logarithm of nominal exchange rate.	IMF's WEO database and World Development Indicators (WDI)
Oil Price changes	DLOIL_BR	First difference of the logarithm of Brent Crude Oil Price.	IMF's WEO database
Population growth	DLPOP	First difference of the logarithm of total population.	PWT, version 10.0 and World Development Indicators (WDI)

Appendix II: Unit Root Tests: Available on Request.

Appendix III: Descriptive Statistics of the variables used in the regression during 1996-2021 for each WAMZ Country

Descriptive Statistics for the Gambia

	DLRGDP	DLCPI	GGFCF	DLTOT	GLNEXC	DLOIL_BR	DLPOP
Mean	0.0339	0.0575	0.1137	-0.0011	0.0664	0.0495	0.0304
Median	0.0471	0.0511	0.0397	-0.0031	0.0501	0.1066	0.0303
Maximum	0.0881	0.1573	1.4488	0.0872	0.3594	0.5101	0.0320
Minimum	-0.0848	0.0085	-0.3486	-0.0948	-0.1207	-0.6357	0.0287
Std. Dev.	0.0378	0.0327	0.3655	0.0415	0.1046	0.3029	0.0009
Skewness	-1.3453	1.3975	1.9862	-0.0311	0.7450	-0.5740	0.1833
Kurtosis	4.9824	5.5857	8.1998	3.0065	4.1415	2.5220	2.3065
Jarque-Bera	11.6350	15.1021	44.6029	0.0041	3.6697	1.6108	0.6409
Probability	0.0030	0.0005	0.0000	0.9980	0.1596	0.4469	0.7258
Sum	0.8482	1.4379	2.8423	-0.0287	1.6592	1.2367	0.7591
Sum Sq. Dev.	0.0343	0.0256	3.2068	0.0413	0.2624	2.2026	0.0000
Observations	25	25	25	25	25	25	25

Descriptive Statistics for Ghana

	DLRGDP	DLCPI	GGFCF	DLTOT	GLNEXC	DLOIL_BR	DLPOP
Mean	0.0544	0.1453	0.0120	-0.0028	0.1428	0.0495	0.0239
Median	0.0507	0.1166	0.0181	0.0092	0.1010	0.1066	0.0245
Maximum	0.1314	0.3472	0.4922	0.0985	0.7147	0.5101	0.0258
Minimum	0.0051	0.0475	-0.3298	-0.0903	0.0063	-0.6357	0.0210
Std. Dev.	0.0255	0.0775	0.2020	0.0481	0.1541	0.3029	0.0015
Skewness	0.9294	1.3968	0.3025	-0.1848	2.2502	-0.5740	-0.5457
Kurtosis	4.7675	4.2424	2.7918	2.6877	8.6780	2.5220	2.0174
Jarque-Bera	6.8530	9.7378	0.4265	0.2438	54.6808	1.6108	2.2464
Probability	0.0325	0.0077	0.8079	0.8852	0.0000	0.4469	0.3252
Sum	1.3595	3.6314	0.2988	-0.0700	3.5695	1.2367	0.5973
Sum Sq. Dev.	0.0156	0.1442	0.9796	0.0556	0.5698	2.2026	0.0001
Observations	25	25	25	25	25	25	25

Descriptive Statistics for Guinea

	DLRGDP	DLCPI	GGFCF	DLTOT	GLNEXC	DLOIL_BR	DLPOP
Mean	0.0429	0.1399	0.0230	-0.0016	0.0904	0.0495	0.0237
Median	0.0387	0.1123	-0.0473	-0.0017	0.0650	0.1066	0.0229
Maximum	0.1027	0.4074	1.1869	0.0864	0.4849	0.5101	0.0283
Minimum	-0.0113	-0.0930	-0.5085	-0.1409	-0.2042	-0.6357	0.0193
Std. Dev.	0.0244	0.1153	0.2958	0.0456	0.1313	0.3029	0.0029
Skewness	0.5089	0.4863	2.3824	-0.8341	0.9688	-0.5740	0.2524
Kurtosis	4.1141	3.1770	11.0242	5.0604	5.3943	2.5220	1.8941
Jarque-Bera	2.3720	1.0180	90.7188	7.3215	9.8821	1.6108	1.5395
Probability	0.3054	0.6011	0.0000	0.0257	0.0071	0.4469	0.4631
Sum	1.0716	3.4971	0.5751	-0.0389	2.2591	1.2367	0.5924
Sum Sq. Dev.	0.0142	0.3191	2.1005	0.0499	0.4140	2.2026	0.0002
Observations	25	25	25	25	25	25	25

Descriptive Statistics for Liberia

	DLRGDP	DLCPI	GGFCF	DLTOT	GLNEXC	DLOIL_BR	DLPOP
Mean	0.0888	0.1153	0.1735	0.0065	0.0574	0.0495	0.0349
Median	0.0515	0.0979	0.0337	0.0151	0.0391	0.1066	0.0269
Maximum	0.7241	0.2712	3.1579	0.2043	0.2579	0.5101	0.0790

Minimum	-0.3588	0.0661	-0.8594	-0.1817	-0.1975	-0.6357	0.0172
Std. Dev.	0.1825	0.0539	0.7698	0.0991	0.1020	0.3029	0.0169
Skewness	1.2807	1.4101	2.4246	0.0995	0.1244	-0.5740	1.5215
Kurtosis	8.1385	4.2154	10.2482	2.8515	3.6307	2.5220	4.2418
Jarque-Bera	34.3387	9.8232	79.2200	0.0642	0.4788	1.6108	11.2519
Probability	0.0000	0.0074	0.0000	0.9684	0.7871	0.4469	0.0036
Sum	2.2208	2.8835	4.3378	0.1627	1.4345	1.2367	0.8734
Sum Sq. Dev.	0.7997	0.0697	14.2236	0.2355	0.2498	2.2026	0.0069
Observations	25	25	25	25	25	25	25

Descriptive Statistics for Nigeria

	DLRGDP	DLCPI	GGFCF	DLTOT	GLNEXC	DLOIL_BR	DLPOP
Mean	0.0468	0.1116	0.0042	-0.0066	0.1131	0.0495	0.0259
Median	0.0517	0.1142	-0.0069	-0.0052	0.0234	0.1066	0.0259
Maximum	0.1426	0.1729	0.2948	0.1096	1.4396	0.5101	0.0268
Minimum	-0.0181	0.0525	-0.2288	-0.1757	-0.0593	-0.6357	0.0249
Std. Dev.	0.0349	0.0329	0.1334	0.0609	0.2897	0.3029	0.0007
Skewness	0.3399	0.0748	0.6269	-0.4116	4.0538	-0.5740	-0.0726
Kurtosis	3.8246	2.1096	3.1310	3.9473	19.1130	2.5220	1.5269
Jarque-Bera	1.1898	0.8491	1.6554	1.6406	338.9169	1.6108	2.2826
Probability	0.5516	0.6541	0.4371	0.4403	0.0000	0.4469	0.3194
Sum	1.1689	2.7906	0.1058	-0.1641	2.8271	1.2367	0.6472
Sum Sq. Dev.	0.0292	0.0260	0.4272	0.0891	2.0138	2.2026	0.0000
Observations	25	25	25	25	25	25	25

Descriptive Statistics for Sierra Leone

	DLRGDP	DLCPI	GGFCF	DLTOT	GLNEXC	DLOIL_BR	DLPOP
Mean	0.0438	0.1044	0.3106	-0.0559	0.0971	0.0495	0.0254
Median	0.0509	0.1001	-0.0381	-0.0112	0.0871	0.1066	0.0224
Maximum	0.2344	0.3073	8.9070	0.1716	0.4657	0.5101	0.0463
Minimum	-0.2293	-0.0092	-3.1917	-0.9004	-0.0520	-0.6357	0.0052
Std. Dev.	0.0994	0.0755	2.0667	0.1987	0.1000	0.3029	0.0098
Skewness	-1.0031	1.1591	2.9209	-3.2762	1.9077	-0.5740	0.5668
Kurtosis	4.9445	4.4953	13.4841	14.4151	8.4920	2.5220	3.2099
Jarque-Bera	8.1309	7.9269	150.0440	180.4557	46.5827	1.6108	1.3845
Probability	0.0172	0.0190	0.0000	0.0000	0.0000	0.4469	0.5004

Sum	1.0956	2.6095	7.7645	-1.3972	2.4282	1.2367	0.6354
Sum Sq. Dev.	0.2369	0.1369	102.5116	0.9471	0.2400	2.2026	0.0023
Observations	25	25	25	25	25	25	25