Policy Research Working Paper 9405

Inflation Threshold Levels and Economic Growth in the Franc Zone Countries

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WORLD BANK GROUP
Macroeconomics, Trade and Investment Global Practice
September 2020

Policy Research Working Paper 9405

Abstract

This paper examines the growth-inflation nexus in Franc zone currency unions. It aims at estimating the inflation threshold above which additional inflationary pressures adversely affect economic expansion. It uses cointegration methods that are applied to data from 14 African countries from the Franc zone over 1970–2018. Based on country-level data, the results indicate that it is possible to increase the threshold levels used by regional central banks to 5.4 –5.6 percent in the Central African Monetary Union and 4.3 – 4.5 percent in the West African Monetary Union. Homogeneous cointegration panel data analyses confirm the need to increase the threshold in Central African Monetary Union countries but do not in the West African Monetary Union countries.

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Keywords: Inflation; growth; WAEMU; CEMAC; cointegration.

JEL classifications: E31 ; E23 ; E52 ; C33 ; C82; C22

Acknowledgements: We are thankful to colleagues for their comments but remain responsible for residual errors or omissions. We acknowledge comments received from Andrea Coppola, Theo David Thomas, Ernest John Sergenti, Alexa Tiemann, Ferdinand Owoundi Fouda and Raju Singh.

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The views expressed in this paper are personal to the authors and do not necessarily represent those of the United Nations Educational, Scientific, and Cultural Organization, the World Bank Group management and Board, or their subsidiary institutions.

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1. Introduction

In a context of increased globalization, integration remains a powerful means for economic and social development, especially for low-income countries. The classical theory of regional integration points out that integration can take many different forms, depending on the degree of political and economic commitment of potential participating member countries. The arrangements, which are to be made, can range from a simple operation consisting of a reduction of customs duties to a more ambitious form of economic integration, with provisions for a common monetary and fiscal policy. Balassa (1961) identifies five different degrees of integration from the lowest to the highest: free trade area, customs union, common market, economic union, and total economic integration. This last degree, or final phase, of the process requires the creation of a common entity, which will take decisions on several domains—mainly economic, political and social—on behalf of the integrated entity and in compliance with modalities agreed upon beforehand. Following Balassa (1961), total economic integration is therefore the outcome of a process for unifying economic policies between the various states, which necessarily entails establishing a monetary union between member countries, complete removal of obstacles to cross-border economic activities relating to trade, free movement of labor and services, as well as of capital (ECA, 2004; ECA, 2012).

However, this economic integration process is not always the outcome of the achievement of the initial stages of the Balassa framework. Among the four major currency unions in the world, the Eurozone seems to be one where Balassa's principles have been applied to some extent. The Franc zone, which includes the West African Monetary Union (WAMU) and the Central African Monetary Union (CAMU), was created on the basis of special and historical considerations that brought countries to agree, among others, to meet a set of convergence criteria.[1] Among those criteria, maintaining an annual inflation rate below 3 percent is a major one that is managed by

[1] The Central African Monetary Union (CAMU) is integrated in CEMAC (Communauté Economique et Monétaire d'Afrique Centrale) – Economic and Monetary Community of Central Africa. The WAMU is integrated in the West African Economic and Monetary Union (WAEMU). Both monetary unions remain the legal entities for monetary issues within both currency unions. Thus, these expressions will be used hereafter in this document.

the two regional central banks of these monetary zones. This level intuitively defines the central banks' objective of internal price stability.

While high and unpredictable inflation rates are generally considered as harmful for economies for several reasons, namely inefficiencies in different markets of the economy, there is a debate on the nature of the inflation-growth nexus. This research fits into the category of theoretical and empirical studies that argue for a positive inflation-growth relationship for low levels of inflation and a negative one for high levels. There has also been a debate on the threshold set within the currency unions as one may argue that a low inflation threshold can result in a hawkish monetary policy that depresses economic expansion. This question would be particularly important in the ongoing context of the implementation of recovery macroeconomic policies in the post-coronavirus disease (COVID-19) period, or the normalization of monetary policy after the adoption of exceptional measures. It also is a relevant long-term policy question that could be considered by policy makers as countries are structurally different, and they are subject to asymmetric shocks while regional integration is not yet sufficiently advanced to allow them to benefit from market adjustments or compensation mechanisms (when such shocks occur).

Selected empirical studies attempt to address this issue for countries in the CAMU and WAMU regions. Recently, by assuming the existence of a non-linear relationship between inflation and growth, Combey and Nubukpo (2010) estimate an 8.1 percent threshold level, Fiodendji, Kamgnia and Tanimoune (2014) find a 6.27 percent threshold, and Sall (2020) find a 3.9 percent threshold above which inflation becomes detrimental to economic growth in the WAMU region. AMOA (2016) confirms the 3 percent level for WAMU member states. In the CAMU region, the literature on this issue is nascent but there are some studies which provide initial ideas on the potential inflation rate threshold level like: Mvondo (2015) who identifies a potential inflation target (for the central bank) that could average 3.6 percent, or Mvondo (2018) who refers to a threshold at 6 or 5 percent. However, those papers present one common caveat, which is related to the integration of the existence of potential cointegration relationships between variables that are used to estimate the indicative inflation rate thresholds. The second caveat is the assumption of

a homogeneous behavior of countries while CAMU and WAMU countries are subject to asymmetric shocks due to differences in their economic structure.

While recent studies mainly use the panel smooth transition regression (PSTR) method (Kremer, Bick, & Nautz, 2013; Ibarra & Trupkin, 2016; Ndoricimpa, 2017), this paper fills this analytical gap through the analysis of cointegration relationships at the regional and country levels by using panel and country data sets. In this paper, we investigate, through non-linear models combined with cointegration relationship, the threshold level of inflation above which inflation becomes harmful to economic growth for member states of the WAMU and CAMU regions. Models are based on results from Khan and Senhadji (2001) on thresholds, and Faria and Carneiro (2001) on cointegration relationships in the growth-inflation nexus. At the regional level and in each monetary union, we use panel data to analyze a homogeneous cointegration relationship between macroeconomic variables, and the Kao & Chiang (2000) cointegration approach is used to perform this analysis. To show the heterogeneity of this relationship, we use the Stock & Watson (1993) cointegration approach at the country level, and we derive an aggregate regional inflation threshold. We also use ARDL models to check the robustness of the analyses. Results from this study are expected to inform policy makers in CAMU and WAMU countries on the appropriate level of inflation and shed light on the suitability of the 3 percent inflation rate criterion within unions.

Overall, these results show that based on the current inflation thresholds, there are opportunities to increase the current thresholds that are used by the regional central bank in each currency union. By considering a homogeneous cointegration relationship, the inflation threshold above which price increases negatively affect growth would be 5 percent in the CAMU and 2 percent in the WAMU. However, based on the country-level analyses, it could be concluded that it is possible to increase the threshold levels used by both regional central banks: 5.4-5.6 percent in the CAMU, well above the 3 percent adopted in this currency union, and 4.3-4.5 percent in the WAMU, well above the conservative 2 percent being used by the regional central bank of this currency union.

For this purpose, the paper is organized as follows. A literature review is summarized in Section 2 while Section 3 discusses general facts related to inflation, economic growth and the monetary policy within the CAMU and WAMU regions. Section 4 presents the econometric model specification while Section 5 presents data sources, the correlation matrix and selected descriptive statistics of the variables of interest. Section 6 presents an analysis of the results while Section 7 concludes and provides a few policy recommendations.

2. Literature Review

Theoretical considerations

High and unpredictable inflation rates are generally considered as harmful for economies for several reasons, namely inefficiencies in different markets of the economy. These include challenges related to long-term budgeting and planning for different economic agents and adjustment and transaction costs related to the changes in prices. Most important is the effect of inflation on the overall growth of the economy through various mechanisms. Economists and policy makers have had and continue to have different views on the relationships between inflation and economic growth on both theoretical and empirical grounds.

On one hand, some economists predict a positive relationship between inflation and growth. They argue that since money and capital are substitutes, an increase in capital accumulation by shifting portfolio from money to capital is favorable to economic growth (Mundell, 1965; Tobin, 1965; and Gregorio, 1996). On the other hand, other economists argued for a negative relationship between inflation and growth. In the AK model, inflation reduces the level of capital return, and the reduction in capital return depresses economic expansion by being a disincentive to investment. This negative impact of inflation on growth is similar to the ones discussed by Huybens & Smith (1999) in a formal model, which studies the interactions between inflation,

financial market and real activity. In a combined endogenous and neo-Keynesian model, Vaona (2012) shows that high inflation also negatively affects economic output by reducing real wages, and marginal product of capital. Romer (2001) finds that high inflation discourages long-term investments and distorts tax systems, all of them hindering economic growth.

Between the two views, some theoretical and empirical studies argue that depending on the level of inflation, the latter can either reinforce or harm economic growth. Lucas (1973) explains that low inflation allows overcoming rigidity of nominal prices and wages, thereby contributing to boost economic growth. Akerlof et al. (2000) establish a relationship between the inflation threshold to natural unemployment rate, and suggest that beyond a specific inflation level, the increase in inflation results in higher unemployment, with the rate moving towards the natural unemployment rate.

Finally, there is also the super-neutrality hypothesis which is supported by Sidrauski (1967). He shows that an increase in money supply, equally translated into price increase, negatively weighs on the stock of real cash but does not affect the steady-state consumption in the long-run, thus it does not modify output growth in the long run. In the short run, it can affect growth through the decline in the rate of capital accumulation.

The relationship between inflation and growth is one of the most controversial subjects in macroeconomics as demonstrated by different views in both theoretical and empirical studies. Three main streams of opinions emerge from different studies on the subject but there are limited empirical studies on the positive relationship between inflation and economic growth. Most studies find a negative relationship between the two variables or establish a non-linear relationship between growth and inflation. Selected empirical studies, leading to the above conclusions, are presented below.

Negative and neutral relationships between inflation and growth

Barro and Sala-i-Martin (1995), among others, based on a neoclassical growth model find a statistically significant negative relationship between inflation and economic growth. Based on large sample data from more than 100 economies covering the period 1960 to 1990, Barro (1995) finds that there is a statistically significant negative relationship between inflation and economic growth. He concluded that an increase in the average annual inflation by 10 percent per year lowers real GDP growth by 0.2 to 0.3 percent.

Faria and Carneiro (2001) find that the long-run relationship between inflation and growth is not significant and they conclude that Sidrauski's super-neutrality of money cannot be rejected. Based on data from Brazil covering the period 1980 to 1995, Faria and Carneiro (2001) test the hypothesis that inflation has long run impact on output and concluded that inflation has no real effect on output and productivity in the long run. It only negatively affects output in the short run.

Existence of a non-linear relationship between inflation and growth

Broad analyses on the existence of a non-linear relationship

The level of inflation matters as demonstrated by the results of Bruno and Easterly (1995) who found no evidence of any consistent relationship between inflation and growth up to a certain level of inflation. Moreover, their empirical analysis showed a temporal negative relationship between these two variables beyond a 40 percent threshold level, leading to their concluding to the lack of permanent damage to economic growth due to discrete high inflation crisis.

The fact that inflation level does influence its relationship with economic growth led to a series of studies looking at the level of inflation at which such a structural break in growth can occur. Ghosh and Phillips (1998) find that starting from lower inflation rates, a rapid disinflation is associated with a fall in growth based on a large panel data analysis on International Monetary Fund's (IMF) member countries covering the period 1960-1996. Ghosh and Phillips (1998) notice

that at very low inflation rates (less than 3 percent a year), inflation and growth are positively correlated while they are negatively correlated above that level. They also found out that the negative relationship is convex meaning that the decline in growth is larger at low inflation rates than higher ones.

The above empirical findings on the relationships between inflation and growth have been confirmed on both developing and developed countries' economies. In a study covering Bangladesh, India, Pakistan and Sri Lanka, Malik and Chowdhury (2001) demonstrate that moderate inflation is helpful to growth and faster economic growth feeds back into inflation. They therefore recommended moderate inflation for growth of these economies. Using Vector Auto Regressive (VAR) techniques, Nell (2000) examines the relationship between inflation and growth in South Africa covering the period 1960-1999 and found out that inflation within the single-digit zone may be beneficial to growth, while inflation in the double-digit zone appeared to be detrimental.

Estimated inflation thresholds

In the quest to explore the relationships between inflation and growth, several studies went further to establish a threshold level of inflation that constitutes a spot sign above which inflation becomes harmful to the economy. This category of papers is based on pooled data ordinary (OLS), generalized least square (GLS) or non-linear least squares estimators, within-between panel specific estimators, and panel smooth transition (PSTR) estimators.

Based on pooled data of 87 countries covering the period 1970-1990 and GLS estimators, Sarel (1996) finds a significant structural break at 8 percent of annual average inflation rate based on a panel data. The determination of the threshold is based on the minimization of the sum of squared residuals, and it allows the author to conclude that below 8 percent inflation rate, inflation has a slightly positive effect on growth but powerful negative effect on growth above that threshold. Along these lines, Khan and Senhadji (2001) examine the issue based on a data

set of 140 industrial and developing countries for each group. Using a non-linear least squares model, they establish a threshold beyond which inflation exerts a statistically significant negative effect on growth standing at 1-2 percent and 11-12 percent inflation levels for industrialized and developing countries respectively. Following the methods used by Khan and Senhadji (2001) and Sarel (1996), Ahmed and Mortaza (2005) established a statistically significant long run negative relationship between inflation and growth at a threshold of 6 percent of inflation for the economy of Bangladesh. Mubarik (2005) suggested a 9 percent threshold level of inflation for the economy of Pakistan following Khan and Senhadji's methodology covering the period 1973-2000. By creating intervals of inflation rates, (Fischer, 1993) shows that inflation has a negative impact on growth but the impact declines as inflation rises.

By using within estimators and minimizing the sum of squared residuals, Combey and Nubukpo (2010) establish evidence of a non-linear relationship between inflation and economic growth in the WAEMU region and found a threshold of 8.1 percent above which inflation becomes detrimental to economic growth. Their estimation is based on the Drukker et al. (2005) model depicting the relationship between inflation and growth on 138 countries covering the period 1950-2000 to which they have added a threshold. They consider the following variables: investment to GDP ratio, total exports and imports to GDP ratio, and government expenditures to GDP ratio. Fiodendji, Kamgnia, Tanimoune (2014) examine the relationship between inflation and economic performance in the CFA franc zone over the period 1991-2009 and studied the mechanism through which inflation affects long-term economic growth using a threshold model. These authors find a 6.27 percent threshold, which is below the 8.1 percent found by Combey and Nubukpo (2010) but still above the 3 percent convergence criteria set by the WAEMU. However, (AMOA, 2016) still finds a 3 percent threshold for WAMU countries by using GLS estimators. Yabu and Kessy (2015), on the basis of random effects GLS estimators and seemingly unrelated regressions (SUR), estimate the threshold level of inflation, which is conducive for economic growth in the three founding East African Community (EAC) countries (Kenya, Tanzania and Uganda) using a panel data set for the period 1970-2013. Based on the estimation of a non-linear quadratic model, they found that an average rate of inflation beyond 8.5 percent has

negative and significant impact on economic growth in the EAC region. The threshold levels beyond which inflation starts exerting cost on economic growth for individual countries are 6.8 percent, 8.8 percent and 8.4 percent for Kenya, Tanzania and Uganda respectively.

Recent studies mainly use the PSTR approach developed by Hansen (1999), Hansen (2000), and González, Teräsvirta, & van Dijk (2005). By using the PSTR with the González, Teräsvirta, & van Dijk (2005) approach on a panel of the WAMU countries observed during the period 1980-2016, Sall (2020) finds a threshold level of 3.9 percent, and the threshold can range between 2.7 percent and 4.1 percent. Using the PSTR Hansen (1999) approach on African countries, Ndoricimpa (2017) finds a level of 6.7 percent for the continent, 9 percent for low-income countries and 6.5 percent for middle-income countries. From its analysis, Ndoricimpa (2017) also concludes that low inflation spurs growth in middle-income countries but it does not have a significant impact on growth in low-income countries. Like Ndoricimpa (2017), Kremer, Bick, & Nautz (2013) find that 2 percent is an adequate level for industrialized countries and 17 percent is the threshold for non-industrialized countries.

The above literature review clearly points to the lack of integration of the long and short run dynamics in the analysis of the growth-inflation nexus. This paper intends thus to shed some light on this issue.

3. Stylized Facts on Growth and Inflation in CAMU and WAMU

In both groups of countries, there is a price surge in 1994-1995, which is explained by the devaluation of the CFA franc (Figure 1 and Figure 2). While there have been some episodes of high inflation rates in the 1970s and 1980s in respectively WAMU and CAMU, and inflation rates remain broadly below 5 percent after the devaluation in both unions. During the period 2015-2018, inflation has been broadly above GDP growth rate in CAMU as this region was hard hit by the negative oil price shock, which occurred in 2014. Figure 3 and Figure 4 suggest that, for some countries, inflation rates above the current threshold did not impede economic expansion.

Figure 1: Trends Growth and Inflation Rates in CAMU Countries, 1981-2018

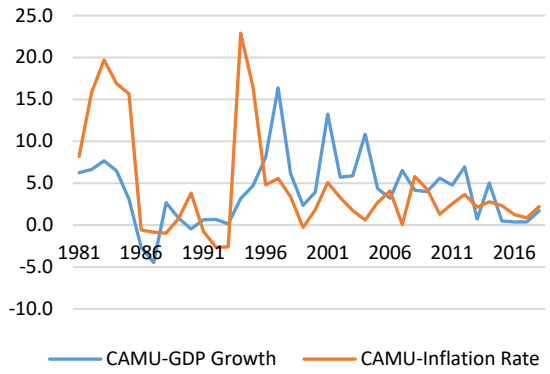


Figure 2: Trends Growth and Inflation Rates in WAMU Countries, 1971-2018

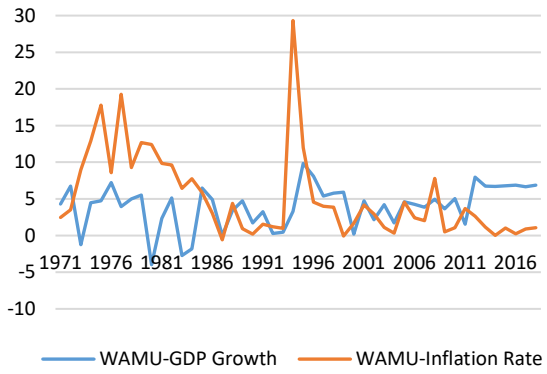


Figure 3: Comparison of Median Growth and Inflation Rates of CAMU Countries, 1981-2018

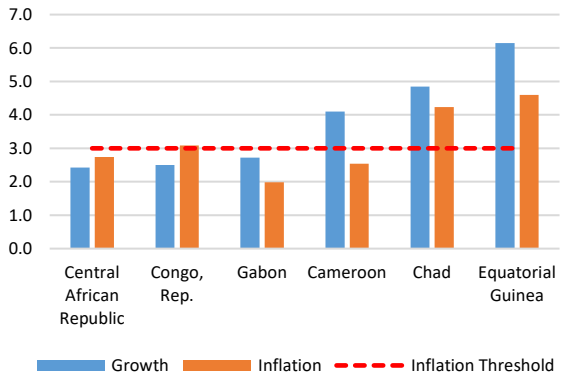
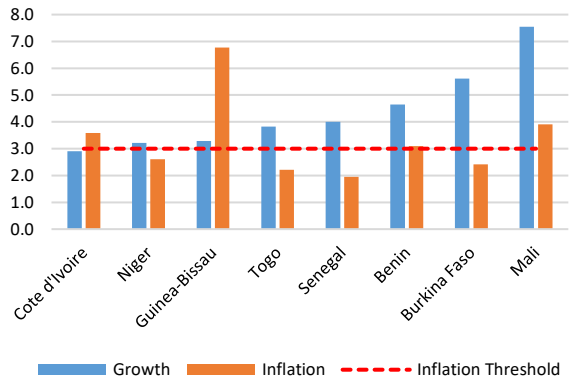


Figure 4: Comparison of Median Growth and Inflation Rates of WAMU Countries, 1981-2018



Source: UNSD, WDI and ECOWAS database.

Note: Aggregate indicators are based on weighted averages – Weights are derived from GDP, 2010 USD constant prices.

The fact that the CFA franc is pegged to the euro has broadly helped containing inflationary pressures but also cost the independence of the regional monetary policies. In comparison with other African countries, inflationary pressures have been broadly contained in the Franc zone countries, excluding the period that followed the 1994 devaluation and outliers such as Equatorial Guinea and Guinea-Bissau. However, this result comes at the expense of the autonomy of the monetary policy as, according to the Impossible Trinity of Mundell, a country loses the autonomy of its monetary policy when it adopts a fixed exchange rate regime and it allows the free circulation of capital flows. The loss of the independence of the monetary policy can be observed by comparing the dynamics of the monetary policy rates of the regional central banks and the one of the European Central Bank (ECB) – at least until before the 2014 negative oil price shock for CAMU countries. In addition, this limited margin on the monetary policy is also

reflected in the choice of the inflation rate level to reduce the discrepancy between domestic inflation rate and inflation rates observed in the country supporting the peg (anchor country or economy – France).

4. Econometric Model Specification

As CAMU and WAMU countries are in currency unions, we perform country-level and regional analyses, and country-level results are aggregated to derive a regional threshold. While CAMU and WAMU countries share the euro peg to the CFA franc, analyses are performed for each sub-region because countries are structurally different, and the monetary policy is managed by two different regional central banks.

Baseline Model

Based on Khan and Senhadji (2001), the following models are tested:

$$y_t = \beta_0 + \beta_1 \pi_t + \beta_2 D_t + \beta_3 p_t + \beta_4 i_t + \beta Z_t + \varepsilon_t \quad [1]$$

$$y_t = \beta_0 + \gamma_1 D_t.(\pi_t - k) + \gamma_2 (1 - D_t).(\pi_t - k) + \gamma_3 p_t + \gamma_4 i_t + \beta Z_t + \varepsilon_t \quad [2]$$

Where y_t is the growth rate of real GDP, π_t the inflation growth rate, p_t the population growth rate, i_t the total investment in percentage of GDP, k the threshold level of inflation, $Z_t$is a set of additional control variables, and ε_t the random error term representing measurement error in the explanatory variables. All growth rates are computed as $x_t = 100 * \Delta log X_t$. The dummy variable D is defined as:

$$D_t = \begin{cases} 1 \; if \; \pi_t > k \\ 0 \; if \; \pi_t \leq k \end{cases} \quad [3]$$

For the purpose of this study, we are particularly interested in parameters β_1 , β_1, and k. The parameter β_1 represents the relationship between growth and low inflation while β_2 measures the effect of inflation rate on economic growth when the latter is greater than the assumed structural break level (k). Accordingly, $\beta_1 + \beta_2$ represents the annual economic growth when inflation is high. The parameter *k* is the threshold inflation level.

The population growth rate and the investment rate are used as control variables. The former reflects the effect of population growth on the wealth of a country (Solow, 1956). The latter cater for the fact that high inflation leads to reduced investment and productivity growth (Fischer, 1993). In addition to the above-mentioned control variables, to test the robustness of the analyses, we add international trade openness (OPEN) and terms and trade (TOT) as international trade can catalyze economic expansion through access to international markets, and access to innovation technologies, while negative terms of trade of shock can depress economic expansion; particularly in commodity dependent countries. Negative terms of trade shocks, for commodity exporting countries, can result from commodity busts, which would reduce the sector investment prospects. However, an increase in terms of trade also negatively affects the country's competitiveness. We also consider natural resource rent (NRES) to control the importance of natural resources in the economic expansion of the country, and this variable is particularly important for CEMAC countries as most of them heavily rely on hydrocarbon commodities. Government expenditures can positively affect growth through the fiscal multiplier or negatively weigh on growth prospects because of inefficiencies and crowding out effects (Ndoricimpa, 2017; Ibarra & Trupkin, 2016). We do not add specifically governance variables because these time series have a limited length for countries in our sample, or do not change significantly over the period of study.

Equation (1) estimates a linear impact of inflation on growth while Equation (2) estimates a non-linear impact of inflation on growth as tested by Khan and Senhadji (2001) and Combey and Nubukpo (2010). For the purpose of this paper, *"Basic Model"* refers to the model that aims at explaining the growth dynamic by only using investment, total population, and inflation.

"*Augmented 1"* and "*Augmented 2"* refer to the model aiming at explaining the growth dynamic by using the basic model's variables and the respective following combination of additional control variables: [OPEN, TOT] and [OPEN, TOT, NRES and/or GEXP].

Estimation Strategy

We improve the model specifications used by Khan and Senhadji (2001), Combey and Nubukpo (2010) or AMOA (2016) at the country or regional level by considering the potential existence of long-run and short-run equations. For regional-level equations, we use the panel cointegration method developed by Kao & Chiang (2000). This method is based on the dynamic ordinary least squares (DOLS) and assumes a common long-term cointegration relationship. Kao & Chiang (2000) demonstrate that DOLS estimators outperform OLS and fully modified OLS (FMOLS) estimators. The Kao & Chiang (2000) estimator is like the one developed by (Stock & Watson, 1993) to analyze cointegration within a single time series sample. For country-level equations, we use the Stock & Watson (1993) cointegration approach with residuals from the long run equations being tested for the existence of unit root. Thus, we test the existence of cointegration relationships, and we estimate the underlying long-run relationship before integrating it an error correction model (ECM) form. For robustness purposes, we estimate two versions of the models: one with a contemporary price variable and another with lagged and forwarded price variables. The model with lagged and forwarded price variables is used to correct potential endogeneity issues in the ECM form while the model with the contemporary variables assumes a strong exogeneity of the inflation rate.

Before estimating coefficients, we test the stationarity of all macroeconomic variables with the Philips-Perron unit root test at the country level (Philips-Perron, 1988), and the Fischer-type panel unit root Choi (2001). For the panel unit root tests, we also correct a potential cross-sectional dependence by demeaning time series; subtracting the panel series mean from the series. Levin, Lin, & Chu (2002) demonstrate that demeaning helps to correct cross-sectional dependence. For country level time series, based on the inclusion of several dummy variables by

AMOA (2016) in the country-level estimates, we check the impact of a potential structural break on the Zivot & Andrews (1992) unit root decision to confirm the stationarity of a time series.

For both country and regional level analyses, the methodology consists of estimating regressions for different values of *k*. The optimal value *k* is the one maximizing the R-squared (R^2) from the respective regressions or minimizing the residual sum of squares (RSS). The maximum inflation threshold level is 12 percent. Sensitivity analyses are performed to check for the robustness of the results. These are thoroughly described in the results section. In addition to minimizing the RSS, a Wald test of significance is performed to confirm the importance of this level.

5. Data Sources

The study uses annual data from the following data sources: World Development Indicators (WDI), the IMF World Economic Outlook (WEO) database, the ECOWAS database, and the statistical database of the United Nations Statistics Division (UNSD). GDP, international trade openness and total investment series come from the UNSD database. Consumer Price Indices (CPI) and terms of trade are from the WEO database, and some series have been estimated using data from the ECOWAS database; particularly for the period 1970-1979 for WAMU countries. Population data and natural resource rent data series come from the WDI database. The study covers the periods 1970-2018 for all WAMU countries, and 1980-2018 for all CAMU countries.

The growth rate of GDP, total population and CPI are transformed by using log transformation as in (1) while investment, international trade openness and natural resource rent are measured in percentage to GDP. Investment and international trade data are valued in constant prices. The log transformation is meant to eliminates, at least partially, the strong asymmetry in inflation distribution and to some to smooth time trend in the data set.

Table 1 presents the correlation matrix between all variables in CAMU and WAMU and shows that: (1) the correlation coefficients between GDP, and INV, POP and OPEN present the expected positive signs in both regions; (2) TOT are negatively correlated to GDP in both regions; and (3) there is a negative correlation between natural resource rent and GDP in WAMU countries.

Table 2 presents descriptive statistics for all variables in CAMU and WAMU. Based on this table, it can be concluded that GDP growth and inflation rate are the most dispersed variables in both groups of countries.

Table 1: Correlation Matrix of Variables in Level – CAMU and WAMU

Variables	GDP	INV	CPI	POP	OPEN	TOT	NRES
CEMAC/CAMU							
GDP	1.000	0.401	0.705	0.484	0.385	-0.244	0.073
INV	0.401	1.000	0.343	-0.177	0.563	-0.093	0.486
CPI	0.705	0.343	1.000	0.555	0.144	-0.286	-0.069
POP	0.484	-0.177	0.555	1.000	-0.210	-0.149	-0.452
OPEN	0.385	0.563	0.144	-0.210	1.000	-0.109	0.690
TOT	-0.244	-0.093	-0.286	-0.149	-0.109	1.000	0.140
NRES	0.073	0.486	-0.069	-0.452	0.690	0.140	1.000
WAEMU/WAMU							
GDP	1.000	0.166	0.560	0.838	0.314	-0.200	-0.411
INV	0.166	1.000	0.047	0.263	0.210	-0.015	-0.170
CPI	0.560	0.047	1.000	0.698	0.410	-0.429	-0.250
POP	0.838	0.263	0.698	1.000	0.288	-0.283	-0.450
OPEN	0.314	0.210	0.410	0.288	1.000	-0.330	-0.079
TOT	-0.200	-0.015	-0.429	-0.283	-0.330	1.000	0.116
NRES	-0.411	-0.170	-0.250	-0.450	-0.079	0.116	1.000

Table 2: Summary Statistics – CAMU and WAMU

Statistics	GDP Growth	Inflation Rate	POP Growth	Investment Rate	TOT	NRES	D.TOT	D.NRES
				CEMAC				
Mean	4.2	4.6	3.1	23.4	143.7	22.1	0.0	0.2
Median	3.6	2.9	2.9	19.1	104.2	16.3	0.0	0.3
S.D.	10.4	10.4	1.0	14.6	102.8	15.9	0.3	7.6
Min	-36.7	-17.6	0.3	3.3	23.2	5.0	-2.1	-21.3
Max	95.3	84.0	8.3	88.4	712.7	84.2	0.6	23.5
# Observations	228	234	228	234	240	224	234	217
				WAEMU				
Mean	3.9	6.8	2.8	18.0	138.4	8.5	0.0	0.1
Median	4.3	2.9	2.8	16.9	117.0	6.8	0.0	0.1
S.D.	5.4	12.9	0.7	8.3	62.4	5.8	0.2	2.6
Min	-17.0	-14.9	0.1	3.2	35.4	1.3	-0.7	-13.1
Max	37.2	112.7	4.8	58.0	383.1	32.4	0.6	14.6
# Observations	384	392	384	392	400	384	392	376

6. Results

Before estimating coefficients in equations [1] or [2] and its related form, we perform unit root tests to avoid spurious regressions, and cointegration tests at the country and regional levels. At the country level, PP unit root tests show that all series are *I(1)* in the CEMAC and WAEMU regions (Appendix 1 and Appendix 2). For each country, we estimate the potential long-run relationship by using the *Basic Model*, and the *Augmented 1 and 2 Models* to derive residuals. Unit root tests of these residuals show that they are stationary and can thus be used to estimate short-term coefficients. At the regional level, Fisher unit root tests suggest that some level and first differenced time series are stationary, and others are nonstationary (Appendix 3 and Appendix 4). Unit roots with structural breaks are used to test the significance of the impact of potential structural breaks on the stochastic properties of time series. These tests are justified by the inclusion of several dummy variables by AMOA (2016) in country level equations. We specifically focus on the GDP series and the Zivot & Andrews (1992) unit root test concludes that there is a structural break point in 1990 or 1993 (depending on the deterministic function of the break) in Cameroon, and in the mid-1990 for Burkina Faso and Mali. Different from AMOA (2016), who includes several country dummy variables without robust statistical reasons, we thus include

dummy variables that are endogenously determined by a stochastic property test: dummy variables for changes in drift and trend slopes.

Overall, the Pedroni and Kao cointegration tests strongly conclude to the existence of a cointegration relationship between variables in the *Augmented Models 1 and 2* in respectively CAMU and WAMU. In CAMU and WAMU, the Kao and Pedroni tests are not conclusive for respectively Augmented Model 1 (Table 3).[2]

Table 3: Results of Panel Cointegration Tests in the CAMU and WAMU regions.

Regions	Demeaned?	Augmented Model	Kao- ADF statistics	Kao test p-value	Pedroni-modified Philips Perron statistics	Pedroni-test p-value
WAMU	No	1	1.491	0.068	1.172	0.121
	No	2	1.363	0.086	1.548	0.061
	Yes	1	1.976	0.024	1.675	0.047
	Yes	2	1.838	0.033	1.922	0.027
CAMU	No	1	-0.994	0.160	1.777	0.038
	No	2	-1.460	0.072	1.895	0.029
	Yes	1	-2.348	0.009	2.511	0.006
	Yes	2	-1.397	0.081	3.374	0.000

We tested both initial equations [1] and [2] in a panel cointegration form according to the (Kao & Chiang, 2000) model. Table 4 contains results of estimated equations that adequately explain the inflation-growth nexus in the CAMU and WAMU regions. At the panel level, equation [2] better explains this nexus in CAMU and equation [1] best fits the WAMU. As the difference between the Augmented Model 1 and Augmented Model 2 is the inclusion the natural resource. As estimated equations suggest that natural resource rent significantly affect growth in both region (Appendix 5 and Appendix 6), the related thresholds could be reference points. For CAMU, Equatorial Guinea does not have data on natural resource rent. Thus, result from the augmented model 2 in CAMU cannot be considered as a reference point. This means that by considering a homogeneous cointegration relationship, the inflation threshold above which

[2] Cointegration tests for the *Basic Model* also conclude to the existence of a cointegration relationship.

price increases negatively affect growth would be 5 percent in the CAMU and 2 percent in the WAMU.

Table 4: Regional Threshold Levels in CAMU and WAMU – Panel Level Cointegration Analyses

Regions	Basic Model	Augmented Model 1	Augmented Model 2
CAMU – Eq [2]	4**	5**	9***
	(0.015)	(0.032)	(0.001)
WAMU – Eq [1]	3**	8***	2***
	(0.019)	(0.001)	(0.000)

*** p<0.01, ** p<0.05, * p<0.1 for the Wald test of significance associated to the threshold variable.
In bracket: p-value of Wald test of significance of the threshold variable.

Overall, regression results confirm the expected sign of most variables (Appendix 5). Investment, international trade openness and population contribute positively to growth in CAMU and WAMU countries. Inflation below the identified thresholds (for each model) contribute positively to growth in CAMU countries. In WAMU countries, inflation contributes negatively to growth and rates above the identified level increase the negative impact. Between both groups of countries, major differences are found on the impact of terms of trade, and natural resource rent. The increase in terms of trade negatively affects growth in CAMU countries, but it has a positive impact on growth in WAMU countries. This difference in results can be explained by the heavy reliance of CAMU countries on hydrocarbon resources while the price of the latter is quite volatile with adverse effects on GDP growth through changes in investment plans, and hydrocarbon export volumes. In WAMU countries, the reliance of commodity resources (proxy by *NRES*) has been slowly increasing and the growth of commodity prices fueled additional investment in this sector.

Table 5 and Table 6 present country level results of regression analyses and aggregate inflation levels for respectively CAMU and WAMU countries. In both tables, we use equation [1] for all models as equation [2] specification did not produce sensible results. Models 1-3 refer to an ARDL form of the equation with an AIC-based lag selection. Models 4-6 are (Stock & Watson, 1993) ECMs with exogeneous inflation variables. An adjusted regional inflation rate is a weighted average for which the inflation rate is equal to 3 percent (the current norm) for countries with a p-value of Wald test of significance of the threshold variable greater 10 percent. Unadjusted average refers to the weighted average without considering the significance of the threshold variable.

Model 4 is the *"Basic Model"* and it refers to the model that aims at explaining growth dynamic by only using investment, total population, and inflation. *Model 5* and *Model 6* respectively refer to the "*Augmented 1"* and "*Augmented 2"* model (see above). They refer to models aiming at explaining the growth dynamic by using the basic model's variables and the respective following combination of additional control variables: [OPEN, TOT] and [OPEN, TOT, NRES and/or GEXP].

Table 5: Threshold levels in the Central African Monetary Union – Country Level Analyses

Countries	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Cameroon	3*	3*	6**	3*	3	1
	(0.087)	(0.098)	(0.045)	(0.079)	(0.191)	(0.202)
Central African Republic	6***	6**	6**	6***	6***	6**
	(0.004)	(0.013)	(0.039)	(0.000)	(0.004)	(0.012)
Chad	10	10**	10***	3	2	1
	(0.144)	(0.017)	(0.009)	(0.307)	(0.117)	(0.103)
Congo, Rep.	10	4*	4	10***	10**	10***
	(0.470)	(0.090)	(0.149)	(0.000)	(0.015)	(0.001)
Equatorial Guinea	8**	7**	4**	9**	4	7***
	(0.021)	(0.030)	(0.018)	(0.019)	(0.255)	(0.000)
Gabon	1	8	8	11	11***	11***
	(0.387)	(0.128)	(0.449)	(0.112)	(0.002)	(0.003)
CAMU-Adjusted	3.7	4.6	5.2	4.9	5.6	5.9
CAMU-Unadjusted	5.2	5.6	6.3	6.4	5.6	5.1

*** p<0.01, ** p<0.05, * p<0.1 for the Wald test of significance associated to the threshold variable.
In bracket: p-value of Wald test of significance of the threshold variable.
Note: Regional inflation rate is computed by using a weighted average; with weights being proportional to the GDP at constant prices, 2010 USD of each country in the union. "Adjusted" means that the inflation rate is equal to 3 percent for countries with a p-value of the Wald test (of significance of the threshold variable) above 10 percent. "Unadjusted" average refers to the weighted average without considering the significance of the threshold variable.
Models 4, 5 and 6 are ECM models; and Models 1-3 are ARDL models.

Overall, these results show that from the current inflation thresholds there are opportunities to increase the current thresholds that are used by regional central bank in each currency union. Results from the ARDL models and ECMs consistently confirm these findings in both currency unions. In CEMAC countries, the level is broadly consistent with the one found with panel data analyses (Augmented Model 1 - Table 3). The adjusted average suggest that the regional inflation threshold is around 5.6 percent (Model 5). However, the regional inflation rate of CEMAC countries could have been higher if one was considering the best-fitted model with significant threshold coefficients. In WAEMU countries, the regional averages, which is based on country thresholds, are higher than the one estimated with panel analyses. This result reinforces the existence of structural differences that expose countries to asymmetric shocks. Robustness analyses provide similar results by considering inflation rate as an endogenous variable (Appendix 6 and Appendix 7). Based on the above analyses and robustness analyses, it could be concluded that it is possible to increase the threshold levels used by both regional central banks to 5.4-5.6

percent in the CAMU, and 4.3-4.5 percent in the WAEMU, well above the conservative 2 percent being used by the region central bank of this currency union.

The WAEMU thresholds are like the ones presented by Sall (2020). Sall (2020) finds a threshold of 3.9 percent in WAMU and robustness analyses suggest that the threshold could be between 2.7 percent and 4.1 percent. However, our results are well below the threshold found by Combey and Nubukpo (2010); these authors estimate a threshold at 8.08 percent. For CEMAC countries, our results are similar to the ones inferred by Mvondo (2018) who suggests the CEMAC threshold could be at 6 or 5 percent in this region.

Table 6: Threshold Levels in the Western African Monetary Union – Country level Analyses

Countries	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Benin	11*	11*	11**	11	11	11*
	(0.058)	(0.060)	(0.042)	(0.123)	(0.326)	(0.056)
Burkina Faso	11***	11***	8**	8***	8***	8***
	(0.001)	(0.000)	(0.012)	(0.000)	(0.000)	(0.000)
Côte d'Ivoire	8**	9*	8**	2***	2***	2***
	(0.031)	(0.062)	(0.023)	(0.000)	(0.000)	(0.000)
Guinea-Bissau	8***	8***	8***	11***	8***	11***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Mali	7	7	7	3*	2***	2***
	(0.152)	(0.139)	(0.197)	(0.066)	(0.000)	(0.000)
Niger	8***	8	8*	8**	8**	8***
	(0.009)	(0.183)	(0.071)	(0.012)	(0.049)	(0.004)
Senegal	3**	4*	3**	3***	3***	1***
	(0.024)	(0.075)	(0.049)	(0.006)	(0.000)	(0.000)
Togo	5**	5	8	5***	5***	5***
	(0.050)	(0.119)	(0.121)	(0.000)	(0.000)	(0.000)
WAMU-Adjusted	7.0	7.0	6.6	3.9	3.8	4.3
WAMU-Unadjusted	8.7	9.2	8.3	5.2	5.0	5.0

*** p<0.01, ** p<0.05, * p<0.1 for the Wald test of significance associated to the threshold variable.
In bracket: p-value of Wald test of significance of the threshold variable.
Note: Regional inflation rate is computed by using a weighted average; with weights being proportional to the GDP at constant prices, 2010 USD of each country in the union. "Adjusted" means that the inflation rate is equal to 3 percent for countries with a p-value of the Wald test (of significance of the threshold variable) above 10 percent. "Unadjusted" average refers to the weighted average without considering the significance of the threshold variable.
Models 4, 5 and 6 are ECM models; and Models 1-3 are ARDL models.

7. Conclusions and Policy Implications

This paper examines the existence of inflation thresholds in 14 African countries in the Franc zone during the period 1970-2018. It contributes to the literature on the inflation-growth nexus by integrating the existence of a cointegration relationship in the analytical framework and derives indicative thresholds. In this research, we have confirmed theoretical and empirical arguments for a non-linear inflation-growth relationship for CAMU and WAMU countries. By considering a homogeneous cointegration relationship, the inflation threshold above which price increases negatively affect growth would be 5 percent in the CAMU and 2 percent in the WAMU. However, aggregate thresholds that are derived from country-level cointegration analyses show that it is possible to increase the threshold levels used by both regional central banks. Our empirical evidence has thus shown that the current levels of the inflation-based convergence criteria used by central banks in the Franc zone are below the threshold that could be used to spur additional growth in these developing countries. For instance, in comparison with 3 percent used by the regional central bank of CAMU (BEAC) and 2 percent by the one of WAMU (BCEAO), we find inflation thresholds at about 5.4-5.6 percent in the CAMU and 4.3-4.5 percent in the WAMU.

These results could have policy implications that would affect growth prospects of the Franc zone countries, particularly on recovery policies in the post-COVID-19 era and the revision of monetary agreements. Concerning recovery policies in the post-COVID-19 era, results from this study emphasize the role of the central bank in supporting economic recovery while achieving its objectives on domestic and external price stability. Pertaining to the revision of monetary agreements, it seems that there are opportunities to exploit the range of margins that is derived from the inflation difference between the current 3 percent level (or 2 percent) that is used by regional institutions and levels derived in this study.

However, such changes should not be made at the expense of the implementation of deep structural reforms that would support productivity growth, enhanced financial intermediation and an improved transmission of the monetary policy. For instance, it is necessary to acknowledge that using the monetary policy tool (in the long-term) would not be effective

without a strong reform agenda that supports innovation and enhanced productivity. In addition, there is also a need to implement reforms that would reduce nominal lending rates because higher inflation could contribute to an increase in nominal lending rates offered by commercial banks, thus offsetting the growth benefits that could be derived from the implementation of this policy.

In the context of limited fiscal space, WAMU and CAMU countries would benefit from the use of prospects offered by using the inflation thresholds that are beyond the set inflation convergence criteria up to the levels where it becomes excessively harmful to their economies. In fact, the COVID-19 crisis is expected to heavily affect African countries while the latter do not have enough fiscal space to launch major economic stimulus programs. Countries depending on mining and oil exports are expected to experience huge falls in growth that could be below 7 percentage points for oil-exporting countries, and below 8 percentage points for metal-exporting countries (Calderon et al, 2020). The potential losses in already low tax revenues due to the disruption of economic activities, the collapse in commodity revenues, and the increase in public health spending are expected to weaken fiscal positions in several Franc zone countries; resulting thus in limited room to fund economic stimulus plans (AU, 2020; World Bank, 2020a; World Bank, 2020b). However, under the current fixed exchange rate regime, the implementation of such type of policy would be contingent to the strict adherence to external coverage criteria while considering the trade-off between growth and inflation that is underpinned by the Phillips curve.

As WAMU countries and France announced changes in monetary agreements surrounding the CFA franc, there might be opportunities to further the reform agenda. While the current reform agenda mainly encompasses changes in the currency name, deposits at the Banque de France, and the representation of France in governing bodies of the regional central bank of WAMU, there might be an opportunity to strengthen the growth agenda of the central bank through the adoption of a higher inflation target or the establishment of a system to determine the inflation targets for specific time periods.

It should be noted however that this paper presents some limitations related to the underlying equation used to determine some thresholds. In fact, we tested several models and reported

results from for the most economically and theoretically sound models. As such, the derived thresholds are the ones beyond which inflation becomes excessively harmful to economic expansion. The analyses could also have been improved by using core inflation but there are some data limitations.

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Appendix

Appendix 1: Results from Unit Root Tests in the WAEMU region – Country Level

Countries/ Variables	Benin	Burkina Faso	Cote d'Ivoire	Guinea-Bissau	Mali	Niger	Senegal	Togo
RGDP	0.881	1.554	-0.160	0.748	1.568	2.026	2.482	0.945
	(0.993)	(0.998)	(0.943)	(0.991)	(0.998)	(0.999)	(0.999)	(0.994)
CPI	-2.234	-2.749*	-3.408**	-1.379	-3.331**	-3.139**	-3.985***	-3.044**
	(0.194)	(0.066)	(0.011)	(0.592)	(0.014)	(0.024)	(0.001)	(0.031)
D.RGDP	-7.512***	-9.220***	-4.748***	-8.901***	-5.805***	-6.354***	-7.841***	-5.748***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D.CPI	-5.119***	-6.646***	-3.653***	-2.457	-4.910***	-4.199***	-4.722***	-4.407***
	(0.000)	(0.000)	(0.005)	(0.126)	(0.000)	(0.001)	(0.000)	(0.000)
INV	-2.133	-2.592*	-1.553	-2.753*	-3.621***	-1.811	2.035	-2.198
	(0.231)	(0.095)	(0.507)	(0.065)	(0.005)	(0.375)	(0.999)	(0.207)
NRES	-2.561	-0.860	-2.289	-3.530***	-0.923	-1.009	-3.288**	-2.507
	(0.101)	(0.801)	(0.175)	(0.007)	(0.780)	(0.750)	(0.015)	(0.114)
D.INV	-8.451***	-12.285***	-5.302***	-9.488***	-7.914***	-5.807***	-7.284***	-5.499***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D.NRES	-10.117***	-7.352***	-6.462***	-10.145***	-7.312***	-7.620***	-8.945***	-8.343***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
TOT	-2.394	-1.558	-2.339	-0.582	-0.400	-1.138	-3.344**	-4.082***
	(0.143)	(0.505)	(0.160)	(0.875)	(0.910)	(0.700)	(0.013)	(0.001)
OPENESS	-1.734	-1.427	-1.596	-1.107	-3.386**	-2.903**	-3.680***	-1.981
	(0.414)	(0.569)	(0.486)	(0.712)	(0.011)	(0.045)	(0.004)	(0.295)
D.TOT	-8.295***	-8.252***	-7.592***	-8.785***	-7.789***	-6.826***	-6.452***	-7.508***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D.OPENESS	-5.647***	-6.156***	-7.746***	-8.543***	-7.719***	-8.155***	-13.025***	-7.341***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

*** p<0.01, ** p<0.05, * p<0.1

Appendix 2: Results of Unit Root Tests in the CEMAC Region – Country Level

Variables/Countries	Cameroon	Central African Republic	Chad	Congo, Rep.	Equatorial Guinea	Gabon
RGDP	0.495 (0.985)	-2.188 (0.211)	-0.153 (0.944)	-1.787 (0.387)	-0.820 (0.813)	-0.353 (0.918)
CPI	-2.996** (0.035)	-0.991 (0.757)	-1.557 (0.505)	0.075 (0.964)	-3.550*** (0.007)	-2.512 (0.113)
D.RGDP	-2.106 (0.242)	-6.199*** (0.000)	-5.701*** (0.000)	-5.186*** (0.000)	-3.477*** (0.009)	-6.117*** (0.000)
D.CPI	-3.423** (0.010)	-4.147*** (0.001)	-6.905*** (0.000)	-4.110*** (0.001)	-3.258** (0.017)	-4.697*** (0.000)
INV	-0.752 (0.833)	-2.628* (0.087)	-1.597 (0.485)	-2.254 (0.187)	-1.918 (0.324)	-2.157 (0.222)
NRES	-4.904*** (0.000)	-1.927 (0.319)	-1.798 (0.381)	-2.548 (0.104)	-0.831 (0.810)	-3.290** (0.015)
D.INV	-7.819*** (0.000)	-10.083*** (0.000)	-5.450*** (0.000)	-6.065*** (0.000)	-6.386*** (0.000)	-8.613*** (0.000)
D.NRES	-9.113*** (0.000)	-7.300*** (0.000)	-5.198*** (0.000)	-6.987*** (0.000)	-4.221*** (0.001)	-8.151*** (0.000)
TOT	-2.249 (0.189)	-2.684* (0.077)	-1.529 (0.519)	-1.456 (0.555)	-1.608 (0.480)	-1.286 (0.636)
OPENESS	-1.232 (0.660)	-1.654 (0.455)	-2.485 (0.119)	-1.944 (0.312)	-1.326 (0.617)	-1.605 (0.481)
D.TOT	-6.828*** (0.000)	-6.516*** (0.000)	-6.716*** (0.000)	-7.423*** (0.000)	-7.204*** (0.000)	-5.927*** (0.000)
D.OPENESS	-4.979*** (0.000)	-5.558*** (0.000)	-6.334*** (0.000)	-7.653*** (0.000)	-6.143*** (0.000)	-6.043*** (0.000)

*** p<0.01, ** p<0.05, * p<0.1

Appendix 3: Results of Fisher Panel Unit Root Test in the WAEMU Region – Panel Level

Tests/Variables	Real GDP	CPI	INV	OPENESS	TOT	NRES
Potential existence of cross-sectional dependence						
Fisher-level	0.165 (1.000)	55.405*** (0.000)	29.562** (0.020)	32.849*** (0.008)	32.434*** (0.009)	31.021** (0.013)
Fisher-difference	343.157*** (0.000)	142.952*** (0.000)	376.952*** (0.000)	389.267*** (0.000)	397.303*** (0.000)	443.593*** (0.000)
Fisher-level with trend	6.841 (0.976)	2.932 (1.000)	27.119** (0.040)	28.657** (0.026)	25.008* (0.070)	31.257** (0.012)
Fisher-difference with trend	322.142*** (0.000)	162.014*** (0.000)	343.528*** (0.000)	345.654*** (0.000)	357.512*** (0.000)	389.253*** (0.000)
Correction of cross-sectional dependence						
Fisher-level	9.940 (0.870)	5.792 (0.990)	25.880* (0.056)	30.422** (0.016)	19.359 (0.250)	20.794 (0.187)
Fisher-difference	332.563*** (0.000)	177.349*** (0.000)	364.865*** (0.000)	399.112*** (0.000)	447.566*** (0.000)	491.887*** (0.000)
Fisher-level with trend	21.832 (0.149)	1.070 (1.000)	19.630 (0.237)	25.517* (0.061)	31.977** (0.010)	23.589* (0.099)
Fisher-difference with trend	292.081*** (0.000)	150.017*** (0.000)	316.916*** (0.000)	347.124*** (0.000)	402.657*** (0.000)	433.642*** (0.000)

*** p<0.01, ** p<0.05, * p<0.1

Appendix 4: Results of Fisher Panel Unit Root Test in the CEMAC Region – Panel Level

Tests/Variables	Real GDP	CPI	INV	OPENESS	TOT	NRES
Potential existence of cross-sectional dependence						
Fisher-level	5.885 (0.922)	22.171** (0.036)	15.062 (0.238)	10.990 (0.530)	12.687 (0.392)	38.838*** (0.000)
Fisher-difference	128.458*** (0.000)	106.253*** (0.000)	276.957*** (0.000)	197.134*** (0.000)	237.099*** (0.000)	225.071*** (0.000)
Fisher-level with trend	7.170 (0.846)	23.121** (0.027)	17.429 (0.134)	5.096 (0.955)	17.540 (0.130)	35.546*** (0.000)
Fisher-difference with trend	101.832*** (0.000)	87.174*** (0.000)	238.981*** (0.000)	167.599*** (0.000)	203.091*** (0.000)	189.482*** (0.000)
Correction of cross-sectional dependence						
Fisher-level	2.970 (0.996)	52.903*** (0.000)	17.224 (0.141)	24.478** (0.018)	12.134 (0.435)	33.991*** (0.001)
Fisher-difference	119.337*** (0.000)	174.975*** (0.000)	259.930*** (0.000)	248.146*** (0.000)	241.216*** (0.000)	203.729*** (0.000)
Fisher-level with trend	6.101 (0.911)	26.172** (0.010)	9.525 (0.658)	19.229* (0.083)	20.375* (0.060)	28.851*** (0.004)
Fisher-difference with trend	95.338*** (0.000)	164.550*** (0.000)	224.263*** (0.000)	213.819*** (0.000)	206.280*** (0.000)	169.251*** (0.000)

*** p<0.01, ** p<0.05, * p<0.1

Appendix 5: Panel Cointegration Results – CAMU and WAMU

VARIABLES	(1)	(2)	(3)	(4)
	Augmented Model 1	Augmented Model 2	Augmented Model 1	Augmented Model 2
	CAMU	CAMU	WAMU	WAMU
INV	0.631***	0.672***	0.462***	0.512***
	(9.140)	(15.572)	(5.900)	(6.768)
TOT	-0.196***	-0.384***	0.206**	0.176**
	(-2.694)	(-6.409)	(2.411)	(2.112)
OPEN	0.006***	-0.002	0.011***	0.012***
	(3.086)	(-1.294)	(5.426)	(5.612)
POP	0.519**	0.415***	1.121***	1.075***
	(2.557)	(3.324)	(5.661)	(5.345)
Inflation-below	0.015**	0.009***		
	(2.149)	(2.604)		
Inflation-above	-0.029***	-0.013***		
	(-9.182)	(-3.180)		
NRES		0.015***		-0.015**
		(6.628)		(-2.495)
Inflation-dummy			-0.157***	-0.141***
			(-3.215)	(-3.285)
CPI			-0.150***	-0.160***
			(-2.770)	(-3.025)
Observations	204	165	352	344
R-squared	0.934	N/A	0.831	0.743
Number of countries	6	5	8	8

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix 6: Threshold levels in the Central African Monetary Union – Country Level Analyses with Endogenous Price Variables

Row Labels	Model 4'	Model 5'	Model 6'
Cameroon	3* (0.089)	3 (0.123)	5* (0.074)
Central African Republic	6*** (0.000)	6*** (0.007)	6** (0.014)
Chad	3 (0.313)	2 (0.142)	1 (0.193)
Congo, Rep.	10*** (0.000)	10*** (0.000)	10*** (0.000)
Equatorial Guinea	9** (0.028)	5 (0.176)	7*** (0.000)
Gabon	7** (0.014)	5*** (0.000)	5 (0.184)
CAMU-Adjusted	5.6	4.4	5.4
CAMU-Unadjusted	5.6	4.6	5.5

*** p<0.01, ** p<0.05, * p<0.1 for the Wald test of significance associated to the threshold variable.
In bracket: p-value of Wald test of significance of the threshold variable.
Note: Regional inflation rate is computed by using a weighted average; with weights being proportional to the GDP at constant prices, 2010 USD of each country in the union. "Adjusted" means that the inflation rate is equal to 3 percent for countries with a p-value of the Wald test (of significance of the threshold variable) above 10 percent. "Unadjusted" average refers to the weighted average without considering the significance of the threshold variable.
Models 4', 5' and 6' are ECM models with endogenous inflation rate.

Appendix 7: Threshold levels in the Western African Monetary Union – Country Level Analyses with Endogenous Price Variables

Row Labels	Model 4'	Model 5'	Model 6'
Benin	11***	11***	11***
	(0.000)	(0.001)	(0.007)
Burkina Faso	8***	8***	8***
	(0.000)	(0.000)	(0.000)
Côte d'Ivoire	2***	2***	2***
	(0.000)	(0.000)	(0.000)
Guinea-Bissau	11***	11***	11***
	(0.000)	(0.000)	(0.000)
Mali	2**	2***	2***
	(0.019)	(0.000)	(0.000)
Niger	8***	8*	8**
	(0.004)	(0.076)	(0.019)
Senegal	3***	3***	3***
	(0.002)	(0.000)	(0.000)
Togo	5***	5***	1***
	(0.000)	(0.000)	(0.000)
WAMU-Adjusted	4.7	4.7	4.5
WAMU-Unadjusted	5.0	5.0	5.0

*** p<0.01, ** p<0.05, * p<0.1 for the Wald test of significance associated to the threshold variable.
In bracket: p-value of Wald test of significance of the threshold variable.
Note: Regional inflation rate is computed by using a weighted average; with weights being proportional to the GDP at constant prices, 2010 USD of each country in the union. "Adjusted" means that the inflation rate is equal to 3 percent for countries with a p-value of the Wald test (of significance of the threshold variable) above 10 percent. "Unadjusted" average refers to the weighted average without considering the significance of the threshold variable.
Models 4', 5' and 6' are ECM models with endogenous inflation rate.

Appendix 8: List of Countries

CEMAC/CAMU	WAEMU/WAMU
Cameroon	Benin
Central African Republic	Burkina Faso
Chad	Côte d'Ivoire
Congo, Rep.	Guinea-Bissau
Equatorial Guinea	Mali
Gabon	Niger
	Senegal
	Togo