EVIDENCE OF OPTIMAL INFLATION CONVERGENCE THRESHOLD IN ECOWAS MEMBER COUNTRIES

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ABSTRACT

This paper examines inflation convergence within the region and whether the monetary policy rules across countries helped to accelerate towards the optimal convergence threshold. The study evaluated the dynamic properties of inflation dierentials with respect to the cross-sectional average and expressed inflation convergence as the reduction in inflation dierentials across countries. The estimated results show supporting empirical evidence for inflation convergence mainly across countries with formal inflation targeting frameworks that is WAEMU Member States and Ghana. We extend the analysis to investigate the optimal inflation threshold across the region. The empirical results suggest a threshold that averages the ECOWAS stipulated rate of 5% and the WAEMU target of 2%. In addition, the threshold value indicates that inflation above the obtained threshold value could be detrimental to economic growth. Lastly, we found that monetary policy rates are significantly sensitive to inflation expectations. This is mainly observed for monetary authorities in countries that have an explicit inflation target.

Keywords: *Inflation dierentials, Convergence, Threshold, Monetary policy, Panel data*

1. Introduction

The aim of this study is to investigate evidence of optimal Inflation Convergence Threshold in ECOWAS Member countries. Koènda & Papell (1997) pioneered the investigation of whether there exists evidence in support of inflation convergence within the European Union context. Their results are supportive of inflation convergence for the EU monetary integration. Although there is no consensus on the appropriateness of the direct or indirect inflation targeting frameworks for monetary authorities. Economic literature suggests that direct inflation targeting might be the right choice to curb actual inflation (Matoušek & Taci, 2003). Theoretically, the official announcement of an explicit inflation target is expected to strengthen the credibility of monetary authorities, mitigate the problem of dynamic inconsistency and anchors long-run inflationary expectations1. Formal inflation targeting is limited only to Ghana among the West African states, while most countries that have inflation targets have not implemented a policy for formal inflation targeting.

High inflation and inflation volatility could be detrimental to economic growth. Hence, policymakers through direct or indirect inflation targeting may keep inflation at low levels to achieve economic policy objectives. The question that remains unanswered is: what is the optimal level of inflation for sustainable long-term economic growth? Optimal level or threshold level of inflation is at inflexion point in which positive effects of inflation on growth exist when the inflation rate is low and negative effects when the inflation rate is high (Seleteng, Bittencourt, & Van Eyden, 2013). If threshold level of inflation exists, the relationship between inflation and growth is non-linear, switching from positive to negative.

In principle, myriad of policy instruments could be used to achieve inflation targets. However, in practice, short term interest rate has been used as the main monetary policy instrument in conjunction with inflation targets (Végh, 2013). Policymakers change interest rates with the aim of achieving explicit or implicit inflation targets. Analytically, the choice between nominal or real interest rates as policy instruments raise important questions regarding their impact on price levels. Under sticky prices, targeting nominal interest rate may lead to

[1] Studies in favour of formal inflation targeting include Svensson, , Mishkin . On the contrary, empirical work against inflation targeting including Mishkin, ; Bernanke and Woodford ; Caballero and Krishnamurthy , assert that countries with weak institutions can weaken or destroy their credibility and thus produce worst macroeconomic outcomes with the introduction if inflation targeting.

indeterminate inflation rate (Calvo, 1983), except by designing appropriate rules or by letting policy authorities set the interest rate on liquid bonds issued by the government (Reinhart, Calvo, & Leiderman, 1992; Calvo & Végh, 1996). Policy rules which rely in real interest rates may also lead to various indeterminacies (Reinhart et al., 1992). For example, given an average inflation rate, a lower steady-state real interest rate will cause the nominal interest rate to hit its zero lower bound more frequently, hampering the ability of monetary policy to stabilize the economy, bringing about more frequent episodes of recession and below-target inflation (Andrage, Gall, le Bihan, & Matheron, 2019).

Against this background, this study investigates the optimal inflation target levels for ECOWAS member countries to achieve sustainable economic growth and ensure regional convergence. Assessing the inflation rate that satisfies monetary union convergence could be quite challenging (Lopez & Papell, 2012). We estimate the threshold level of inflation and the smoothness of the transition from a low to high regime inflation. Although there are still controversies, the non-linear relationship between inflation and growth is widely accepted2. The analysis is extended to evaluate the sensitivity of monetary policy rates to the inflation expectation by the monetary authorities. The remainder of the paper is structured as follow. A brief literature review is rendered in the next section. Section 3 highlights some stylized facts on inflation targeting. The hypothesis and empirical methodology are discussed in section 4 while the results are discussed in section 5. Section 6 concludes the paper with some policy implications.

2. Literature review

The adoption of inflation targeting by the Reserve Bank of New Zealand in 1990 marked the first direct inflation targeting by monetary authority. Since the adoption, there has been a great deal of theoretical and empirical interests on the effect of inflation targeting on macroeconomic performance. Neumann and von Hagen (2002), Levin, Natalucci, & Piger (2004) and Hu (2006), are among the few studies which find that adopting inflation targets reduces both inflation level and its variance. Other evidence reveals that inflation targeting has been instrumental in reducing inflation expectations (see Johnson, 2002, 2003l Gürkaynak, Levin, Marder, & Swanson, 2007; Gonçalves & Salles, 2008). Goncalves & Salles (2008) evaluate inflation targeting for both inflation targeter and non-targeter countries. Their empirical evidence supports support that IT matters as the findings show that inflation targeters have experienced a greater drop in inflation rates than the non- targeters. The positive results on inflation

targeting further show that there is an overall improvement in the growth performance on inflation targeting countries and reduction in output growth volatility (Gonçalves & Salles, 2008; Mollick, Cabral, & Carneiro, 2011).

Empirical evidence on the effect of inflation target implementation on the process of inflation convergence is relatively scarce in general and lacking for ECOWAS countries in particular. Earlier studies have examined whether policies coordination which include the goal of common inflation, helped inflation rates to converge. For example under the European Monetary System (EMS). Caporale and Pittis (1993) find inflation convergence among EMS economies through the coordination of the exchange rate policies. The results of Westbrook (1998) also corroborate these findings for selected EMS countries. Busetti, Fabiani, & Harvey (2006) consider inflation convergence using two subsamples, pre- and post-adoption of Euro. They find evidence of convergence only for the former period. Two subgroups emerged in the second period - one for low inflation countries and the other relatively high inflation countries.

Extending empirical investigations on the importance attributed to inflation convergence beyond the context of coordinated monetary union, other authors evaluate inflation convergence among countries with different monetary policies. Brož & Koèenda (2018) provides evidence of various macroeconomic variables convergence including inflation among a group of non-EMU Central and Eastern European (CEE) countries. Becker and Hall (2009) also address inflation convergence for CEE countries over the period 1996 to 2007 and find evidence of convergence formation. Kutan & Yigit (2005) find contrary results. For evidence from advanced economies, Crowder & Phengpis (2007) find inflation convergence among G7 economies. Siklos & Wohar (1997) evaluate macroeconomic convergence across the US, Canada and Japan and EMU countries and find that inflation rates converge but interest rates do not.

The challenges in evaluating the inflation rate that satisfies monetary union convergence and the differences in results could be due to the choice of estimation techniques, data limitations and coverage. Using Pesaran (2007) pair-wise approach, Arestis, Chortareas, Magkonis, & Moschos (2014) find the convergence of inflation rates irrespective of the monetary policy framework

[2] The importance of non-linearities in accounting for convergence is highlighted by Gregoriou, Kontonikas, & Montagnoli. 2021

of inflation targeters and OECD non-targeters. Ball & Sheridan (2004) applied the differences-in-differences methodology on the inflation rates before and after adoption of IT for a group of 7 inflation targeters and 13 non-targeters. They conclude that the statistical significance of inflation rates before targeting implies that IT does not account for inflation convergence irrespective. Hyvonen & Hyvonen (2004) extends Ball and Sheridan's analysis using a larger number of countries and established similar conclusion that inflation convergence still holds for the extended grouping. This finding is attributed mainly to the anti-inflation policies of the 1990s, which include inflation targeting as one of the alternative monetary policy frameworks adopted to achieve inflation reduction.

3. Some stylized facts

Since the outset in 1990, an impressive feature of inflation targeting as an explicit monetary policy strategy is that no country has given up the regime after its adoption. Although, there is no general consensus in the literature on its impact on the macroeconomy. However, majority of empirical evidence suggest that the overall impact of IT has been mostly significant on the macroeconomy. An interesting feature of inflation targeting is that no country has actually given up the monetary policy framework after its adoption. However, as a result of their adoption of euro as their domestic currency three countries that comprising Spain, Finland and the Slovak Republic stopped the regime after adoption (Sarwat, 2012). Globally, there are currently about 38 countries practicing inflation targeting as a formal macroeconomic regime (see Table 1).

The natural question raised in most literature is whether inflation targeting has facilitated improved macroeconomic performance than under alternative monetary policy approaches. Distinguishing between the specific impact of inflation targeting and the general impact of concurrent economic policies is a difficult task. However empirical evidence on the performance of inflation targeting broadly supports the effectiveness of IT framework in delivering low inflation, anchoring inflation expectations, and lowering inflation volatility (Sarwat, 2012). Figure 1 depicts that the annual average inflation rate for ECOWAS member countries (excluding Ghana) has been on the rise in the past few years. On the other hand, inflation targeting economies have either witnessed stable inflation rate (high- and middle-income countries) or a steady decline (low income IT countries). Also worthy of mention here is the impact of the 2007 global economic crisis on price level for all the economies. The global commodity price spikes and financial shocks resulted in a rise in inflation in

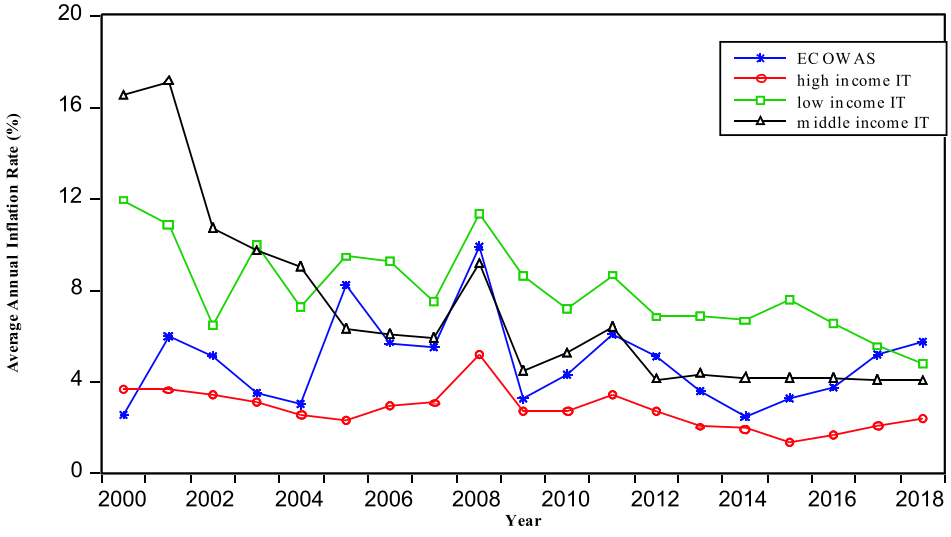
2006 but declines were witnessed around 2009 for all the countries. Ötker et al. (2009) reported that IT countries appear to perform better in minimizing the inflationary impact of the crisis.

Table 1: Inflation targeting countries

income group	Country	Date of adoption	Target rate at adoption date	current inflation*
high income	New Zealand	1990	1-3	1.60
	Canada	1991	2+/-1	2.27
	United Kingdom	1992	2†	2.29
	Australia	1993	2-3	1.91
	Sweden	1993	2†	1.95
	Czech Republic	1997	3+/-1	2.15
	Israel	1997	2+/-1	0.81
	Poland	1998	2.5+/-1	1.81
	Chile	1999	3+/-1	2.43
	Hungary	2001	3+/-1	2.85
	Iceland	2001	2.5+/-1.5	2.68
	Korea Republic	2001	3+/-1	1.48
	Norway	2001	2.5+/-1	2.76
	Uruguay	2007	3-7	7.61
	Japan	2013	2	0.98
upper middle income	Brazil	1999	4.5+/-2	3.66
	Colombia	1999	2-4	3.24
	South Africa	2000	3-6	4.50
	Thailand	2000	0.5-3	1.06
	Mexico	2001	3+/-1	4.90
	Peru	2002	2+/-1	1.32
	Guatemala	2005	5+/-1	3.75
	Romania	2005	3+/-1	4.63
	Armenia	2006	4.5+/-1.5	2.52
	Serbia, Republic	2006	4-8	1.96
	Turkey	2006	5.5+/-2	16.33
	Albania	2009	3+/-1	2.02
	Georgia	2009	3	2.62
	Paraguay	2011	4.5	3.98
	Dominican Republic	2012	3-5	3.56
	Kazakhstan	2015	4	6.03
	Russia	2015	4	2.88
low & lower middle income	Philippines	2002	4+/-1	5.21
	Indonesia	2005	5+/-1	3.20
	Ghana	2007	8.5+/-2	9.84
	Uganda	2011	5	2.62
	Moldova	2013	3.5-6.5	3.05
	India	2015	2-6	4.86

† indicates point inflation targets; * current inflation is defined as annual average inflation rate in 2018;
Source: Roger, 2010; Hammond, 2012l Sarwat, 2012; and World Bank database.

Figure 1: Annual Average Inflation Rate - ECOWAS and IT Countries



4. Hypotheses and Empirical methodology

In light of the expectations of the achievement of criteria for regional convergence among West African states, and thus achieving a monetary union which will usher in the single currency for the ECOWAS Member State, one of the key expectations, is the convergence of inflation rates. This expectation has been emphasized in earlier literature in the case of the euro and the European Union members countries (see Roger, Hufbauer, & Wada, 2001; Engel & Rogers, 2004; Weber & Beck, 2005; Busetti, Formi, Harvey, & Venditti, 2006; Rogers, 2007)3. Therefore, we begin the empirical investigation by evaluating whether there is inflation convergence among ECOWAS members or otherwise. Assessing the level of inflation rates among ECOWAS countries that will satisfy convergence in anticipation of possible advent of a single currency in the region is important, although doing this may be quite challenging given limited data availability and the poor performance of some of the methods available in the literature. Testing for inflation convergence for a group of countries requires evaluating the dynamic properties of each of the countries' inflation rate differentials relative to the cross-sectional average4. Time series approach in existing literature that evaluate convergence mainly rely on unit root tests of country inflation series. The rejection of null hypothesis of the presence of unit root is usually

[3] These authors all agree that prices were less dispersed and inflation rates among Euro area countries have converged in the mid-1990s.

[4] The notion of group-wise convergence implies that there is convergence toward a common behavior captured by the cross- sectional mean .

interpreted as evidence in support of convergence to equilibrium state, since any shock leading to deviations from the equilibrium state eventually dies out (Lopez & Papell, 2012).

We follow the methodology in Koèenda & Papell (1997) and Lopez & Papell (2012) by evaluating the dynamic properties of inflation differentials with respect to the cross-sectional average. Translated from the concept of ó -convergence of Barro and Sala-i-Martin (1991), Koèenda & Papell (1997) expressed inflation convergence as the reduction in inflation differentials across countries. Given the inflation differential (π_{it}^{d}) for a country *i* at period *t* such that: $\pi_{it}^{d} = \pi_{it} - \bar{\pi}$, where π_{it} is inflation rate of country *i* in period *t* and $\bar{\pi}$ is the cross-sectional average inflation rate. The homogenous rate of convergence follows the Augmented Dickey-Fuller (ADF) test equation specified as:

$$\Delta\pi_{it}^{d} = \alpha_{i} + \rho_{i}\Delta\pi_{it-1}^{d} + \sum_{j=1}^{k_i}\theta_{ij}\Delta\pi_{it-j}^{d} + \varepsilon_{it} \qquad (1)$$

Where $i = 1,..., N$, $t = 1,..., T$; N and T denotes cross-section and time dimensions; respectively $\rho_i = \rho = (\phi - 1)$ is the homogenous rate of convergence, k is the number of lags. ε_{it} is the error term and it is assumed to be stationary with a non-diagonal covariance matrix Σ. In this context, convergence requires that the inflation differentials become smaller and smaller over time and for this to be true, $\phi < 1$[6] The null and alternative hypothesis for the ADF test is respectively $H_0 : \rho = 0$ and $H_1 : \rho < 0$.

A large number of literature acknowledged the contribution of inflation targeting in reducing inflation rates[7]. This is corroborated by the evidence that suggest that inflation targeting reduces inflation expectations. In addition, other literature postulates the indirect benefits from inflation targeting in reducing exchange rate volatility (Rose, 200&; Lin, 2010), interest rates (de Carvalho Filho, 2011), and fiscal indiscipline (Minella, De Freitas, Goldfajn, & Muinhos, 2003; Lucotte, 2012). However, the positive results on inflation targeting performance mostly failed to account for the potential cost on economic output8. Besides, high inflation harms economic growth and the equitable distribution of income (Roger 2010).

[5] Inflation is measured as a percentage change in the consumer price index over two successive corresponding periods.
[6] This proposition follows the base for convergence methodology proposed by Ben-David (1995 - 1996)
[7] Nonetheless, there are empirical research that reached contrary conclusions. For example, Ball and Sheridan (2004), Lin and Ye (2007), and Tawadros (2009) conclude that IT does not either lower the level or variability of inflation in any statistically significant way.

The starting point in evaluation the optimal inflation target is to evaluate the level of inflation or threshold that will ensure economic growth sustainability. The threshold level of inflation is at inflexion point which positive effects of inflation on growth exist when the inflation rate is low and negative effects on growth when the inflation rate is high (Seleteng et al., 2013). The existence of inflation threshold indicates a nonlinear relationship between inflation and growth, switching from positive to negative. Besides, ECOWAS's objective of monetary union and unique currency through monetary convergence among member countries requires that inflation rates in the region share a common pattern and stable relation among members. The first hypothesis therefore involves:

Hypothesis 1: To determine the optimal inflation threshold that will ensure sustainable growth.

We employ the threshold analysis into panel data framework to estimate the optimal inflation target for the region. In other words, we estimate the threshold level of inflation above which inflation exerts negative influence on growth. Relying Hansen (2000) a two-regime structural equation in a panel threshold autoregressive model given as:

$$y_{it} = \phi + \theta x_{it} + \tau_1 q_{it} I(q_{it} \le \gamma) + \tau_2 q_{it} I(q_{it} > \gamma) + \varepsilon_{it} \qquad (2)$$

Where $i = 1,..., N,\ t = 1,..., T$; N and T respectively denotes cross-section and time dimensions; respectively y_{it} is economic growth, x_{it} a vector of exogenous variables which include the lag of the dependent variable (y_{it-1}) as well as other determinants of growth; q_{it} denotes the threshold variable (inflation) and it divides the observed values into two regimes – lower and upper. γ is the threshold level; $I(\cdot)$ is the indication function denoting the specific regime defined by the threshold variable. The value of $I(\cdot)$ when the condition expresses in the brackets, that is $(q_t \le \gamma)$ and $(q_t > \gamma)$ are satisfied. τ_1 and τ_2 are parameters of the threshold dependent variable; θ is the coefficient of the explanatory variable; ϕ is the constant term and $\varepsilon_{i,t}$ the random disturbance term. The threshold model divides the regression model into multiple growth intervals according to the searched inflation threshold.

Although, some empirical evidence shows that there is overall improvement in growth performance of inflation targeting countries and it reduces output volatility (see Mollick et al, 2011; Goncalves and Salles, 2008). On the other hand, Gonçalves and Carvalho (2009) find that IT economies suffer less output losses during disinflationary periods compared to inflation non-targeters.

Since the outset of inflation targeting, theory and experience both suggest that monetary authorities cannot consistently pursue and achieve multiple goals using only one basic monetary instrument, mainly the policy interest rate (Roger 2010). In addition, the emergence of inflation targeting have included four key elements[9] which suggest that monetary policy can only influence nominal but not real macroeconomic variables. Therefore, to achieve the estimated optimal inflation target, the central bank is expected to make public the projected, or "target," inflation rate and then attempts to steer actual inflation towards that target, using monetary policy tools such as adjustment of monetary policy rates.

Hypothesis 2: to evaluate the monetary policy rules to achieve optimal inflation target

Monetary policy instrument is assumed to be based on short-term nominal interest rate, and that monetary authorities set and adjust the instrument in order to achieve a target level of inflation. Also, it may react to output deviations from equilibrium (Berg et al., 2006). Therefore, monetary policy rate is expressed as a function of output gap and inflation gap. $mpr_t = \varphi_0 + \varphi_1 y_t^g + \varphi_2 \pi_t^e + \varepsilon_t$ (3) where mpr_t is the monetary policy rate, y^g_t is the output gap, and π_t^e is the inflation gap. Output gap is computed as $100 \times \log\left(y_t / y_t^*\right)$ where y_t^* is the level of real GDP and y_t is the potential output measured as the trend level of GDP. The trend level of GDP is obtained using the Hodrick-Prescott filter. Inflation gap is measured as the difference current inflation and the estimated optimal inflation threshold.

The main data source for the variables of interest is the International Financial Statistics (IFS) database of the International Monetary Fund (IMF). Quarterly data on consumer price index, exchange rate, real GDP are collected from the IFS between 2007Q1 and 2017Q4. We collected data on monetary policy rate from each countries Central Bank's website. The real GDP for WAEMU countries is measured as the sum of the member countries' real GDP (see Siri, 2012).

[9] These four elements include (see Mishkin, 2004; Peter, Roger, & Heenan, 2006): (i) an explicit monetary authority mandate to pursue price stability and a high degree of operational autonomy; (ii) explicit quantitative targets for inflation; (iii) central bank high-transparency requirements for policy strategy and implementation in achieving the inflation objective; and a policy approach based on a forward-looking assessment of inflation pressures.

5. The Results

We begin the empirical analysis by testing for the stochastic properties of the inflation differential series (π_{it}^{d}) employed Augmented Dickey-Fuller (ADF) unit root test. The null hypothesis of non-stationarity is tested against the alternative that the inflation rate differential is stationary. The evidence in favor of a unit root process implies that there is no convergence10, that is, individual country's inflation rate differs persistently from regional average inflation rate. On the contrary, the evidence against nonstationarity reveals that the difference between the individual inflation rate and inflation rate for the region is only transitory. The convergence test is also performed for all the countries against the two major economic sub-regions within ECOWAS namely, the West African Economic and Monetary Union (WEAMU) and the West African Monetary Zone (WAMZ).

Table 2: Inflation convergence towards region and sub-region average

	ECOWAS					SUB -REGION				
	(ρ)	t-stat	1%	5%	10%	(ρ)	t-stat	1%	5%	10%
WAEMU										
Benin	0.6899*	-2.8096	-3.5847	-2.9281	-2.6022	0.6093**	-3.3071	-3.5847	-2.9281	-2.6022
Burkina Faso	0.5081***	-4.2448	-3.5966	-2.9332	-2.6049	0.3130***	-4.3012	-3.5966	-2.9332	-2.6049
Cote d'ivor ie	0.7048	-2.4794	-3.5966	-2.9332	-2.6049	0.4312	-2.4803	-3.6210	-2.9434	-2.6103
Guinea -Bissau	0.2691***	-3.7786	-3.6056	-2.9369	-2.6069	-0.0963*	-2.8753	-3.6268	-2.9458	-2.6115
Mali	0.5527***	-4.4772	-3.5885	-2.9297	-2.6031	0.4393***	-5.2522	-3.5885	-2. 9297	-2.6031
Niger	0.5864**	-3.4249	-3.5847	-2.9281	-2.6022	0.5996**	-3.2674	-3.5847	-2.9281	-2.6022
Senegal	0.9930	-0.1402	-2.6308	-1.9504	-1.6112	-0.0015**	-3.4614	-3.6210	-2.9434	-2.6103
Togo	0.6602**	-3.1078	-3.5847	-2.9281	-2.6022	-0.2812***	-4.293 8	-3.6210	-2.9434	-2.6103
WAMZ										
Cabo Verde	0.7048	-2.4794	-3.5966	-2.9332	-2.6049	0.8833	-1.2942	-3.6010	-2.9350	-2.6058
Gambia	0.9204	-1.1659	-3.6268	-2.9458	-2.6115	0.8417	-1.8217	-3.6210	-2.9434	-2.6103
Ghana	0.7728* *	-2.9601	-3.6010	-2.9350	-2.6058	0.6772**	-3.4712	-3.6156	-2.9411	-2.6091
Guinea	0.9500	-0.5637	-3.6268	-2.9458	-2.6115	0.9342	-1.0711	-3.6156	-2.9411	-2.6091
Liberia	0.7323	-1.2749	-3.5966	-2.9332	-2.6049	0.5173	-2.1395	-3.6010	-2.9350	-2.6058
Nigeria	0.9750	-0.8024	-2.6186	-1.9485	-1.6121	0.7743*	-3.0090	-3.6010	-2.9350	-2.6058
Sierra Leone	0.9787	-0.3546	-3.5925	-2.9314	-2.6039	0.9655	-0.4814	-3.5925	-2.9314	-2.6039

Note: Estimated results are based on ADF unit root test; ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively

The convergence test results are summarized in Table 2. The evidence for relative inflation convergence is based on the statistical significance of as specified in Equation [1]. The results reveal that there is relative convergence of inflation towards ECOWAS average, although at different significant levels, for most countries in the WAEMU zone, except for Cote d'ivorie and Senegal. However, only Ghana, which is the only formal inflation targeting country in the region, exhibits relative inflation convergence to the regional average. Categorizing countries into sub-regions, that is WAEMU and WAMZ zones respectively, the estimated results confirms the previous results for ECOWAS average, except Senegal that report evidence of relative inflation convergence towards WAEMU average and Nigeria towards WAMZ average at 5% and 10% levels of significance respectively. In summary, the results show evidence that inflation rates across ECOWAS member countries mainly converged for countries in the WAEMU zone and otherwise for the WAMZ member countries.

Furthermore, the estimated values of the convergence coefficient $\tilde{n}$ can be used for additional interpretation of the strength of the convergence or otherwise (see Lopez & Papell, 2012; Brož & Koèenda, 2018). Higher value of $\tilde{n}$ coefficient indicates that inflation differential is more persistent for such country, that is any shock would have longer lasting impacts on inflation. On the other hand, lower value of the $\tilde{n}$ indicates weaker inflation convergence. From Table 2, the small value of the $\tilde{n}$ for WAEMU countries as reported in the upper pane when compared to their WAMZ counterparts as reported in the lower pane of Table 2 further indicates stronger inflation convergence compared to WAMZ countries.

Table 3: Threshold regression result

	Inflation threshold (%)	Growth coefficient (lower regime)	Growth coefficient (higher regime)
ECOWAS	3.82	1.19e-10***	-3.19e-11***
WAEMU	2.41	0.1760***	-0.0834
Benin	2.08	-3.6647**	-2.5941
Burkina Faso	4.51	0.6640 ***	-0.5465* *
Cote d'Ivorie	2.93	-16.5946	-19.1308
Guinea -Bissau	2.04	2.7745*	2.0276
Mali	2.41	6.0249	4.0624
Niger	4.87	4.8014***	2.4042**

Senegal	2.57	-21.0352	-22.5061*
Togo	3.13	1.8706***	1.9362***
WAMZ	4.55	0.0207	-0.2796***
Cabo Verde	4.07	0.2013	-1.0477***
Gambia	3.98	2.0482 ***	0.3759
Ghana	7.12	-0.6633	0.1594
Guinea	7.61	1.2685 ***	0.3103
Liberia	5.35	0.0378 *	-0.6318
Nigeria	13.27	0.4612 ***	-0.9222 ***
Sierra Leone	4.54	-3.7369 ***	1.7627 ***

***,** and * indicate statistical significance respectively at 1%, 5% and 10%; standard errors are in parenthesis.

Following the empirical evaluation of relative convergence across countries, we proceed to estimate threshold regression in line with the first hypothesis. In analyzing the threshold effects of inflation on economic growth, we follow existing literature by including a number of control variables that determines growth (see Ibarra & Trupkin, 2016; Kremer et al., 2013; Seleteng et al., 2013). The variables mainly considered include initial income, population growth rate and trade openness (see Ndoricimpa, 2017). The estimated regression result is summarized in Table 3[11]. The baseline results from the panel threshold regression estimation suggest an inflation threshold of about 3.82% for ECOWAS, which is about the average of the 5% convergence threshold set by the region and the 2% target by monetary authorities in the WAEMU sub-region. Consistent with most empirical and theoretical conclusions in the literature, the estimated threshold level suggests that inflation below the threshold level of 3.82% will ensure positive and significant economic output. On the other hand, inflation above the threshold could be detrimental to economic growth (see also Baglan & Yoldas, 2014; Eggoh & Khan, 2014; Thanh, 2015).

Considering the threshold inflation for each country, the estimated results show that inflation threshold is lower for most countries in the WAEMU subregion but higher for other countries in the ECOWAS region. For example, the inflation threshold for Nigeria reveals a double-digit value of about 13% which although is quite high. However, this value is consistent with findings in previous

[11] We summarized and reported only the main coefficients of interests, which are the threshold inflation and the coefficients of growth at both lower and upper regimes.
[12] https://www.theafricareport.com/21515/cfa-franc-members-need-improved-governance-flexible-inflation-targets/

literature that inflation to a certain degree could be growth enhancing for Sub-Sahara African countries (see Tapsoba, 2014. Besides, as widely documented in previous literature, being a member of the WAEMU sub-region may be conducive to lower inflation rate especially with their adoption of a uniform currency in the sub-region which is pegged to French Franc and implicit adoption of the European Central Bank's 2% inflation target (Tapsoba, 2014. However, as widely documented in previous empirical literature, the lower rate of inflation at 2% may be too luxurious for the region given that the costs and implications on economic growth could outweigh the benefits from price stability[12].

Table 4: Estimates of Monetary policy rule

	Cabo Verde	Gambia	Ghana	Nigeria	Sierra Leone	WAEM U
At inflation threshold of 3.82%						
Constant	8.0874***	15.2547***	10.5864***	9.7936***	15.0553***	4.1704***
	(0.2768)	(0.4819)	(1.7626)	(0.9244)	(1.4061)	(0.2498)
y^g	-0.0956	-0.2203	0.2431	0.1635	0.0421	0.5110**
	(0.1139)	(0.2243)	(0.3770)	(0.3324)	(0.1439)	(0.2410)
$\therefore^e$	0.0788	1.3160***	0.9437***	0.1448	-0.2350	0.1949***
	(0.0903)	(0.3470)	(0.2296)	(0.1422)	(0.2692)	(0.0701)
At ECOWAS inflation target of 5%						
Constant	7.9617***	16. 8076 ***	11.70 01***	9.9644 ***	14.7781***	4.4005***
	(0.2975)	(0.4 81 9)	(1.5062)	(0.7 760)	(1.2056)	(0.3040)
y^g	-0.0590	-0.2203	0.2431	0.1635	0.0421	0.5110**
	(0.0886)	(0.2243)	(0.3770)	(0.3324)	(0.1439)	(0.2410)
$\therefore^e$	0,0247	1.3160***	0.9437***	0.1448	-0.2350	0.1949***
	(0.0744)	(0.3470)	(0.2296)	(0.1422)	(0.2692)	(0.0701)

Note: y^g and ∂^e respectively denote output gap and inflation expectation respectively;

***,** and * indicate statistical significance respectively at 1%, 5% and 10%; standard errors are in parenthesis .

Next, we estimate the consistency of the countries' monetary policy rule by evaluating the sensitivity of their monetary policy rates to the inflation expectation and output gap. We compute inflation expectation as the difference between each country's actual inflation and the estimated threshold of 3.82%. The results are summarized in Table 4. The estimated results show that expected inflation, which is computed at the estimated threshold level of 3.82%, is positive across all monetary authorities, except for Sierra Leone. Although, the coefficient is significant only for Gambia, Ghana, and WAEMU. The significance for Ghana and WAEMU may not be unconnected with the explicit inflation targeting framework adopted by both. Although the monetary authority in Ghana had explicitly declared a formal inflation targeting regime, the monetary authorities in WAEMU countries stipulated and adopted a 2% inflation target. On the other hand, the Central Bank of Gambia maintains an inflation rate that is anchored on the 5% ECOWAS target[13].

In addition, the non-significance of the coefficient of inflation expectation on monetary policy rate determination at lower threshold inflation rates mainly for countries in WAEMU sub-region could be a further illustration of growth trade-off of the benefits lower inflation target and price stability. On the other hand, the statistically significant coefficient for output gap in WAEMU might imply that output gap across member countries is taken into consideration by the monetary authorities in their determination of rates.

Lastly for robustness purposes, we considered another scenario for the monetary policy rules determination by computing inflation expectation using ECOWAS inflation target as benchmarks. We calculate inflation expectation as the difference between each country's actual inflation and the regional benchmark target of 5%. The estimated results are summarized in the lower pane of Table 3. The results reveal that irrespective of the threshold inflation benchmark, the results remain consistent both in terms of magnitude and statistical significance. By implication, the estimated inflation threshold obtained resonates with ECOWAS stipulated convergence target in country's determination of monetary policy rules.

6. Conclusion and Policy options

This paper examines whether there exists convincing evidence of ECOWAS countries towards achieving inflation convergence within the region and whether the monetary policy rules across countries helped to accelerate towards the optimal convergence threshold. We begin by adopting methodology originally developed to investigate cross-country output convergence to investigate inflation convergence within the region. The estimated results show supporting empirical evidence of inflation convergence mainly across countries with formal inflation targeting framework, that is WEAMU member countries and Ghana. We extend the analysis to investigate the optimal inflation threshold across the region. The empirical results suggest a threshold that averages the ECOWAS stipulated rate of 5% and the WAEMU target of 2%. In addition, the threshold value suggests that inflation above the obtained threshold value could be detrimental to economic growth. Lastly, we found that monetary policy rates are significantly sensitive to inflation expectation. This is mainly observed for monetary authorities in countries that have explicit inflation target.

[13] See https://www.african-markets.com/en/news/west-africa/gambia/gambia-maintains-rate-as-inflation-seen-heading-to- target

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