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In Search of a New-Keynesian Hybrid Phillips Curve for the West African Economic and Monetary Union

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Abstract *- The economic literature has been very sparse on the nature of the Phillips curve in the West African Economic and Monetary Union countries. This paper attempts to fill this gap and explores the dynamics of inflation in the sub-region over the period 1980-2018 using the hybrid form of the New Keynesian Phillips curve. I make some slight modifications to the specification proposed by Gali and Gertler (1999), due to the specificity of the small economies of the West African Economic and Monetary Union, to show, using the generalized method of moments, that the dynamics of inflation is not homogeneous in the zone. In practice, inflation is prospective for some groups of countries and retrospective for others. Thus, the output gap does not always perfectly reflect inflationary pressures in the zone. In fact, and contrary to theoretical predictions, the relationship between the output gap and the lagged inflation rate of k periods is not always positive.*

Keywords - *Monetary Union, Hybrid Phillips Curve*.

I. INTRODUCTION

The identification of the Phillips curve, originally by Phillips (1958), explaining a negative relationship between the unemployment rate and the inflation rate, has been of great importance for macroeconomic policies in recent years. The Phillips curve has been of great help to economic policymakers concerning inflation and output. The groundbreaking work on the Phillips curve was done in 1999 by Gali and Gertler. Indeed, since the introduction of the New Phillips Curve by Gali and Gertler (1999), much research has been done from their perspective. Among the concerns of the authors is the nature of the short-run dynamics of inflation. The main question often asked is what is the heart of price fluctuations and what should be the appropriate monetary policy stance. The answers to this question have been the subject of several studies. Phillips curve estimates have found application in countries such as the United States of America (Gali and Gertler, 1999; Gordon, 1977; Roberts, 1995; Sbordone, 2002), the United Kingdom (Balakrishnan and Lopez-Salido, 2002), Turkey (Domac, 2004), China (Scheibe and Vines, 2005), and more recently for the European Union (Boug et al., 2010). Indeed, recent advances have been made in modeling inflation dynamics and proposals on monetary policy orientations. This new literature is built around the work of Fischer (1997), Taylor (1980), Calvo (1983), Gali and Gertler (1999). This study aims to verify the existence and nature of the hybrid form of the neo-Keynesian Phillips curve and derive new perspectives on monetary policy in the West African Economic and Monetary Union (WAEMU).

II. REVIEW OF THE LITERATURE

Since unemployment is countercyclical, the relationship between inflation and the output gap becomes positive. Traditional and empirical Phillips curve theses emphasize that the level of inflation is positively correlated with economic activity. This positive relationship has been proven for the United States of America and other developing countries (Gordon, 1977, Phillips, 1958). Microeconomic explanations of the Phillips curve have remained key topics in macroeconomic theory (Friedman, 1968; Phelps, 1968; Rudd and Whelan, 2006).

The Phillips curve helps policymakers decide what policy measures to put in place concerning inflation and output. In this perspective, the estimation of the Phillips curve has been applied to economies such as the United States of America (Gali and Gertler, 1999; Gordon, 1977; Roberts, 1995; Sbordone, 2002), Australia (Gruen et al., 1999), the United Kingdom (Balakrishnan and Lopez-Salido, 2002), Turkey (Domac, 2004), and China (Sheibe and Vines, 2005), more recently.

The New Phillips Curve thus became popular insofar as it could help understand the dynamics of inflation. However, there is a divergence in the studies, depending on the nature of the data used, the time-space, and the econometric methods, so that there is no consensus on the evidence of the model in the economic literature (Henry and Pagan, 2004; Sbordone, 2005, Rudd and Whelan, 2007; Bjornstad and Nymoen, 2008; Juillard et al., 2008). The significant studies by Gali and Gertler

(1999) and Gali et al. 2001 showed evidence in favor of the model using post-war data for the United States and Europe in the framework of the generalized method of moments. More specifically, the authors' results are consistent with the hybrid form of the Phillips curve that relates inflation to expected future inflation, lagged inflation, and the actual marginal cost of production of firms. From this perspective, forward-looking behavior plays an essential role in explaining inflation.

Many authors have re-examined the evidence found by Gali and Gertler (1999); Gali et al. (2001) using the same data and methodology and find that the results are not as robust. For example, Mavroeidis (2006) shows that the parameters in Gali and Gertler (1999) are weakly identified. The dynamics of inflation in the United States are both forward-looking and backward-looking, while real marginal cost is not determinant in explaining inflation. In the same perspective, Rudd and Whelan (2005) explain that the biases on the estimates of forward-looking inflation behavior can be much more significant when estimating the structural form of the New Keynesian Phillips curve. Gali and Gertler (2005) have responded to some criticism by maintaining their conclusion about the importance of forward-looking behavior in explaining inflation dynamics. More recently, Fanelli (2008) and Kurmann (2007) have re-examined the empirical evidence of Gali and Gertler (1999) and Gali et al. (2001) using the maximum likelihood estimation method. Fanelli (2008) proposes a two-step procedure that consists in specifying the expectations of economic agents with a vector autoregression model and concludes, using the same data as Gali and Gertler (1999), that the hybrid form of the New Phillips curve is far from explaining the dynamics of inflation in the European Union. Kurmann (2007), using a reverse engineering technique and data from the United States, concludes that the conventional maximum likelihood test cannot reject the hybrid form of the NKPC. More recently, for EU countries, Boug et al. (2010), using vector autoregression, find that the exact shape of the NKPC does not explain the dynamics of inflation for the US. Far from the controversy over the results of Gali and Getler (1999) and Gali et al. (2001), we seek to explain the nature of the hybrid form of the Phillips curve for the WAEMU countries.

III. MODELING THE NEW KEYNESIAN HYBRID PHILLIPS CURVE

In the hybrid form of the Phillips curve proposed by Gali and Gertler (1999), inflation follows the process:

$$\pi_t = \phi\pi_{t-1} + (1-\phi)E_t(\pi_{t+1}) + \delta mc_t + \varepsilon_t \quad (1)$$

Where π_t is the inflation rate in period t, E_t is the expected inflation for the period $t+1$ to the period t, mc_t is a random shock. The parameter ϕ is a normalization coefficient that is such that $0<\phi<1$ and implies a vertical Phillips curve in the long run. Lagged inflation introduces the retrospective behavior of economic agents into price formation. This is a stylized fact of price dynamics that is almost unjustifiable from a theoretical point of view. In Calvo's perspective, firms operate in a competitive monopoly environment and face certain pricing constraints. Specifically, each firm faces a constant probability $(1-\theta)$ of adjusting the prices to the period t and a corresponding probability (θ) of keeping its costs unchanged.

$$p_t = (1-\theta)\sum_{j=0}^{\infty}\theta^j p_{t-j}^* + (1-\theta)p_t^* \quad (2)$$

This relationship implies that the price level at the period is a convex combination of the optimal prices $\left(p_{t-j}^*\right)$ set in the previous period and the optimal prices (p_t^*) set at the period t according to the relationship:

$$p_t^* = (1-\beta\theta)\sum^{j}(\beta\theta)^j E_t\{mc_{t+j}\} \quad (3)$$

This relationship ensures that firms are identical and choose the same price level $\left(p_t^*\right)$ following their expected marginal cost $\left(mc_{t+j}\right)$ to a subjective factor β reasonably less than unity. Combining (2) and (3), we can write the inflation relation as follow:

$$\pi_t = \lambda mc_t + \beta E_t\pi_{t+1} \quad (4)$$

with

$$\pi_t = p_t - p_{t-1} \quad \text{et} \quad \lambda=(1-\theta)(1-\beta\theta)/\theta .$$

Gali and Gertler (1999) introduce the backward-looking view into the Calvo (1983) pricing model and use the labor income share to measure marginal cost instead of the output gap as suggested by the economics literature. The authors explain that since firms are not identical, a distinction is made between the price set by the share of firms.

According to the relationship(3), the adjusted price $\bar{p}_t^*$ of the period t is given by:

$$\bar{p}_t^* = (1-\omega)p_t^f + \omega p_t^b \quad (5)$$

Proportional forecasts $(1-\omega)$ of economic agents are determined at the period t are determined according to the relation :

$$p_t^f = (1-\beta\theta).\sum_{k=0}^{\infty}(\beta\theta)^j E_t\{mc_{t+j}\} \quad (6)$$

Proportional forecasts (ω) of economic agents are determined at the period t are determined according to the relationship :

$$p_t^b = \bar{p}_{t-1}^{*} + \pi_{t-1} \quad (7)$$

With p_t^f indicating the level of prices set according to the relationship (6) and p_t^b the adjusted price level according to the backward-looking inflation rule.

By combining the equations (2), (5), (6) et (7), the hybrid form of the Phillips curve is given by:

$$\pi_t = \lambda mc_t + \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} \quad (8)$$

with :

$$\begin{aligned} \lambda &= (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1} \\ \gamma_f &= \beta\theta\phi^{-1} \\ \gamma_b &= \omega\phi^{-1} \\ \phi &= \alpha + \omega\{1-\alpha(1-\beta)\} \end{aligned} \quad (9)$$

IV. SPECIFICATION OF THE HYBRID NEW KEYNESIAN PHILLIPS CURVE FOR WAEMU COUNTRIES

I adapt Gali and Gertler's (1999) specification to the case of small economies in the WAEMU countries. We make some slight modifications to the reduced form of the equation proposed by Galy and Gertler because of the specificity of the BCEAO's monetary policy by using two specifications (BCEAO, 2009). The first specification consists in estimating the hybrid form of the New Keynesian Phillips curve for the WAEMU countries under the assumption that the dynamics of inflation is determined according to the relationship :

$$\pi_t = \phi_1 INFLA_{t-1} + \phi_2 E_t(INFLA_{t+1}) + \gamma GDP\_GAP_t + \varepsilon_t \quad (10)$$

With GDP_GAP, the output gap is used as a proxy for the marginal cost of production and INFLA, the inflation rate.

I then consider a second specification in which I estimate, taking into account the specificities related to the open structure of the WAEMU economies, a version of the hybrid form of the New Keynesian Phillips curve that modifies equation (12) in two directions: (i) by introducing the effect of the 1994 nominal devaluation ($DEV94$), imported inflation ($\Delta IPCF$, the change in the consumer price index in France), and the change in the world oil price (ΔCMP), and (ii) by using the output gap as a proxy of the marginal cost of production as in the first specification. The relationship between the dynamics of inflation in an open economy in the WAEMU is given by :

$$\begin{aligned} \pi_t = {} & \phi_1 INFLA_{t-1} + \phi_2 E_t(INFLA_{t+1}) + \alpha_1 \Delta IPCF \\ & + \alpha_2 \Delta CMP + \alpha_3 DEV94 + \gamma GDP\_GAP_t + \varepsilon_t \end{aligned} \quad (11)$$

A. Data

The research focuses on a panel of eight WAEMU member states. Given the statistical data available, we used data on the inflation rate, GDP in WAEMU countries, consumer price indices in France. The data used covers the period from 1980 to 2018. The raw data are extracted in annual series from the World Bank World Development Indicators. We then transformed the annual series into quarterly series using quadratic interpolation. The output gaps are obtained from the potential GDP determined using the Hodrick and Prescott filter.

Table 1. Descriptive statistics

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Variables	***N***	***mean***	***sd***	***min***	***max***
Inflation (INFLA)	1,420	10.11	18.77	-17.23	90.54
Gross domestic produc gap (GDP_GAP)	1,420	-0.000179	0.0178	-0.141	0.116
Oil prices (CMP)	1,420	30.97	20.50	9.617	132.8
Consumer price indices in France (IPCF)	1,420	84.55	12.52	63.83	106.9

B. Econometric method

I assume that expectations of inflation rates in the WAEMU are rational. From this perspective, we can directly adopt the hypotheses Muth (1961) and Lucas (1972) formulated, which state that economic agents efficiently use all available past and current information. Following equations (12) and (13), this assumption implies that errors in anticipating the future rate of inflation or simply forecasting errors $\pi_{t+1} - E_t(\pi_{t+1})$ are independent of all the information available to economic agents at the time t. If we consider this set of information available at

the period by a vector z_t, we can deduce the following equation for the first specification:

$$E\left\{\begin{pmatrix} INFLA_t - \phi_1 INFLA_{t-1} \\ -\phi_2(INFLA_{t+1}) - \gamma GDP\_GAP_t \end{pmatrix} z_t\right\} = 0 \quad (12)$$

And for the second specification:

$$E\left\{\begin{pmatrix} INFLA_t - \phi_1 INFLA_{t-1} - \phi_2(INFLA_{t+1}) \\ -\gamma GDP\_GAP_t - \alpha_1 \Delta IPCF - \alpha_2 CMP - \alpha_2 DEV94 \end{pmatrix} z_t\right\} = 0 (13)$$

To estimate the parameter vector $\{\phi_1\ \phi_2\ \gamma\}$, under the orthogonality conditions between the error term and the vector according to the generalized method of moments, the estimation technique used is related to the generalized method of moments (Hansen, 1982) in the dynamic method panel.

The dynamic panel GMM method proposes several estimators, such as Arellano and Bond [1991], aiming to eliminate the fixed effects by retaining the first difference of the specification and instrumenting it with the lagged level variables. Nevertheless, this approach would generate biased estimators because the regressors of our specification are supposed to be predetermined and not strictly exogenous. Moreover, Griliches and Hausman [1986] claim that the first difference estimator accentuates the biases generated by the measurement errors. Another estimator, called the system estimator proposed by Blundell and Bond [1998], compensates for the shortcomings of the first. It considers a system composed of the first difference equations instrumented by the lagged level variables and the level equations instrumented by the lagged difference variables. Blundell and Bond [1998] have shown using Monte Carlo simulations that the system GMM estimator performs better than the first difference estimator, the latter giving biased results in finite samples when the instruments are weak.

Panel data have two dimensions: one temporal and one individual (here country)—the temporal dimension results from a stochastic (random) process indexed by time. Several problems are specific to it, notably the correlation between observations (autocorrelation) and the possibility of change in the data generating process from one epoch to another. Therefore, it is essential to test the stationarity of these data. To this end, we administered three-panel unit root tests. The stationarity was tested with individual methods and in a more detailed way. These are respectively the Im, Pesaran, and Shin (IPS) test, in a series of contributions (1997, 2002, and 2003), and Maddala and Wu (1999) are administered. The last two tests rely on a combination of individual statistics: Augmented Dickey-Fuller (ADF) statistics in IPS and significance levels in Maddala and Wu.

Like the test proposed by IPS, the Madalla and Wu test is a joint test of the null hypothesis of unit root (i = 0), and under the alternative view, two types of individuals can coexist: individuals indexed i = 1; ...; N1 for which the variable considered is stationary and individuals indexed i = N1 + 1; ...; N for which the dynamics of the variable admits a unit root The results of these tests are given in the following tables.

Table 2. Unit root test of IM PESARAN and SHIN

Variables	***IM PESARAN and SHIN unit root test***			***Numbers of observations***	***Decisions***
	Stat	Prob	Number of delays		
CMP	-4,0917	0,0067	0	1420	Stationary
INFLA	-4,2466	0,0039	2	1420	Stationary
IPCF	-5,1395	0,0001	0	1420	Stationary
GDP_GAP	-8,5436	0,0000	0	1420	Stationary

Table 3. Unit root test of augmented Dickey-Fuller.

Method	**Statistics**	**Probability**
ADF-Fisher Chi- Square	99,0139	0,0000
ADF-Choi Z-stat	-8,08826	0,0000

Variables	***Unit root test of augmented Dickey-Fuller***			***Numbers of observations***	***Decisions***
	Stat	Prob	Number of delays		
CMP	-	0,0067	0	1420	Stationnary
INFLA	-	0,0039	2	1420	Stationnary
IPCF	-	0,0001	0	1420	Stationnary
GDP_GAP	-	0,0000	0	1420	Stationnary

All these unit root tests are consistent and reflect the stationarity of all our level variables.

V. RESULTS AND DISCUSSION

For the WAEMU zone as a whole, the results found show that our variables of interest $\{\phi_1\ \phi_2\}$ are globally significant (Table 4). The first important result is a substantial component of forward-looking behavior in the price formation of economic agents in the WAEMU. The results also show that economic agents have a past-oriented price formation behavior in the zone. However, the relative values $\{\phi_1\ \phi_2\}$ give much greater weight to the forward-looking inflation component in the area.

Table 4. GMM-System estimation of inflation dynamics in the WAEMU 1980q1-2018q4

Variables	Coefficients	T-Stat	P-Values	Error-Standard
INFLA(t-1)	0,4383259***	17,31	0,000	0,0253273
INFLA(t+1)	0,5115187***	19,01	0,000	0,0269081
GDP_GAP	-2,187486	-1,38	0,168	1,58788

NB D'OBS	Country	WALD Chi2	PROB
1065	8	6088,05	0,0000

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

Moreover, the results show that over the study period, the relationship between the output gap and the current inflation is not statistically significant for the zone as a whole and suggests the non-existence of the Phillips curve. I extract the country-specific effects to ensure that the results are consistent for each WAEMU country (Table 5). The forward-looking and backward-looking components are equally significant for all countries individually. However, the relative weights of the forward-looking and

Backward-looking components are not the same for all countries. In line with our variables of interest, Benin, Burkina Faso, Côte d'Ivoire, Mali, and Senegal have economic agents that behave prospectively in setting prices. In contrast, Guinea, Niger, and Togo have a structure with agents that act retroactively. Paradoxically, under this specification, the coefficients of the output gap for the latter countries are not statistically significant, which casts doubt on the existence of the Phillips curve. On the other hand, there is a statistically significant relationship between the output gap and inflation in Benin, Burkina Faso, Côte d'Ivoire, Mali, and Senegal.

Table 5. Comparison of inflation dynamics in WAEMU countries (1980q1 - 2018q4).

Variables	Benin	Burkina Faso	Côte d'Ivoire	Guinée	Mali	Niger	Senegal	Togo
INFLA(t-1)	0,3709***	0,4079***	0,4305***	0,4877***	0,3934***	0,3899***	0,2722***	0,4160***
INFLA(t+1)	0,4411***	0,4748***	0,4543***	0,4621***	0,4491***	0,3723***	0,3579***	0,3794***
GDP_GAP	4,5030**	5,9829**	1,6265	-3,4569	5,1507**	-1,8086	11,3252***	-2,904
Obs	134	134	134	134	134	134	134	134
WALD Chi2	234,18***	1028,17***	255,08***	1318***	594,18***	113,6***	161,14***	177,27***

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

I then estimated this first model by considering two successive periods: the pre-devaluation period (1980q1 to 1993q4) and the post-devaluation period (1994q1 to 2018q4). For the pre-nominal devaluation period (Table 6), our results show that the retrospective and prospective components of economic agents' pricing behavior in each WAEMU country are equally significant.

However, the relative weight of forward-looking components is greater than that of backward-looking components in all countries. The relationship between output gaps and inflation is statistically significant for Benin, Burkina Faso, and Senegal for the period considered.

Table 6. Comparison of inflation dynamics in WAEMU countries (1980q1 - 1993q4).

Variables	Benin	Burkina Faso	Côte d'Ivoire	Mali	Niger	Senegal	Togo
INFLA(t-1)	0,3146***	0,3259***	0,4088***	0,2812***	0,2530**	0,2580**	0,3324***
INFLA(t+1)	0,3631***	0,3896***	0,4249***	0,3323***	0,2904***	0,3600***	0,3811***
GDP_GAP	3,4751**	6,4798*	1,2505	6,4432	6,3545	13,3779**	5,0111
OBS	45	45	45	45	45	45	45
WALD Chi2	35,59***	79,75***	67,11***	57,20***	17,13***	44,17***	30,39***

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

For the post-devaluation period (Table 7), the retrospective and prospective components of price dynamics are significant in all countries in the zone. On the other hand, the relative weight of the retrospective components is greater than that of the prospective components, except for Benin, where the difference is very small in favor of the prospective component. The devaluation undoubtedly significantly impacted the dynamics of inflation in the region over the period under review. The change in the economic environment concerning exchange rate policy has a noticeable impact on inflation dynamics in individual WAEMU countries.

Table 7. Comparison of inflation dynamics in WAEMU countries (1994q1 - 2018q4).

Variables	Benin	Burkina Faso	Côte d'Ivoire	Mali	Niger	Senegal	Togo
INFLA(t-1)	0,5000***	0,5048***	0,5024***	0,5028***	0,5053***	0,5024***	0,4936***
INFLA(t+1)	0,5010***	0,4935	0,4975***	0,4946***	0,4938***	0,4950***	0,4472***
GDP_GAP	-0,0680	0,1332	0,0038	0,1403	-0,0391	0,0801	-2,6628
OBS	89	89	89	89	89	89	89
WALD Chi2	253117,46***	1,97e+06***	1,99e+06***	271412,52***	144878,11***	3,83e+06***	150303,40***

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

The results of the open economy model (Table 8) show that, in relative terms, the forward-looking component has a greater weight in the pricing behavior of economic agents in the WAEMU zone than our variables of interest $\{\phi_1 \ \phi_2\}$. The consumer price index in France has an insignificant impact on price dynamics, whereas the world oil price has a significant influence in the zone. The output gap in the open economy model still has a negative relationship with inflation but is statistically significant. The explanation is that high inflation has a negative effect on growth, contrary to what the classical Phillips curve shows. The negative effect can be explained by the indirect role of inflation on an investment. Indeed, high inflation probably modifies the composition of investments by favoring the least risky and the least profitable. This is consistent with the view that uncertainty about inflation, as reflected in its variability, affects growth primarily through distortions in resource allocation rather than by discouraging investment spending. High inflation, on the other hand, reduces savings and investment. Finally, it can be said that the output gap does not fully reflect inflationary pressures in the WAEMU area as a whole.

Table 8. GMM-System estimation of inflation dynamics in the WAEMU open economy 1980q1-2018q4

Variables	COEFFICIENTS	T-STAT	PROBABILITES	ERREUR-STD
INFLA(t-1)	0,4261***	16,76	0,000	0,0254
INFLA(t+1)	0,4792***	16,89	0,000	0,0283
GDP_GAP	-3,9359**	-2,39	0,017	1,6458
IPCF	-0,0075	-1,15	0,250	0,0065
CMP	1,46e-06**	2,46	0,014	5,93e-07

OBS	COUNTRY	WALD Chi2	PROB
2368	8	6279,13	0,0000

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

I proceeded the same way as the first specification to check the results for individual countries in the zone (Table 9). The forward-looking components of price dynamics are equally significant in all WAEMU countries except Guinea. The consumer price index in France significantly explains the dynamics of inflation in the individual countries. The world oil price explains the dynamics of inflation significantly in Burkina Faso, Niger, and Senegal.

Table 9. Comparison of inflation dynamics in WAEMU countries *(1980q1 - 2018q4).*

Variables	Benin	Burkina Faso	Côte d'Ivoire	Guinée	Mali	Niger	Senegal	Togo
INFLA(t-1)	0,2091***	0,1504**	0,3082***	0,4496***	0,2151***	0,1754**	0,2122***	0,2581***
INFLA(t+1)	0,2430***	0,1691**	0,3313***	0,3899***	0,2463***	0,2692***	0,3219***	0,3498***
GDP_GAP	3,2164*	5,4552**	2,5181	-6,6600	6,3607***	13,2291***	14,7566***	9,6229*
IPCF	0,0265***	0,0209***	0,2794***	0,0175	0,0131*	0,0320***	0,0180**	0,0165**
CMP	-1,09e-06	1,97e-07**	-3,79e-06***	5,58e-07	8,70e-07	-6,94e-06***	-2,33e-06**	1,82e-07
OBS	296	296	296	296	296	296	296	296
WALD Chi2	32568***	1641,04***	304,50***	1408,92***	787,73***	168,99***	180,29***	233,11***

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

I then proceeded to estimate this second model by considering two successive periods, as in the case of the first specification: the pre-devaluation period (1980q1 to 1993q4) and the post-devaluation period (1994q1 to 2018q4).

The results show that before devaluation (Table 10), the pricing behavior of economic agents in WAEMU countries is essentially dictated by a forward-looking view of inflation, except for Burkina Faso, where the results are not statistically significant. The consumer price index in France significantly explains price dynamics in countries such as Benin, Burkina Faso, Mali, Niger, and Senegal. There is a significant relationship between the output gap and inflation in Burkina Faso, Mali, Niger, and Senegal. The world oil price explains the dynamics of inflation significantly in Niger and Senegal.

Table 10. Comparison of inflation dynamics in open economy WAEMU countries (1980q1: 1993q4)

Variables	Benin	Burkina Faso	Côte d'Ivoire	Mali	Niger	Senegal	Togo
INFLA(t-1)	0,2041*	0,1432	0,3018***	0,1591	0,1703	0,1481**	0,2501**
INFLA(t+1)	0,2404**	0,1695	0,3316***	0,2147**	0,2752**	0,3000***	0,3452***
GDP_GAP	3,3900	0,02458*	2,9698	8,4542**	14,3060**	21,2211***	10,0065
IPCF	0,0305*	0,0245*	0,0246	0,0281*	0,0343*	0,0419**	0,0185
CMP	-1,96e-06	1,02e-06	-2,88e-06	-2,47e-06	-7,73 e-06*	-8,06 e-06**	-3,85 e-07
OBS	151	151	151	151	151	151	151
WALD Chi2	47,14***	120,02***	77,95***	71,24***	21,14***	56,58***	36,59***

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

The results of the estimates for the post-devaluation period (Table 11) show that economic agents are relatively forward-looking in their pricing behavior in Benin and Niger. On the other hand, the weight of the retroactive view of inflation is much greater than that of the forward-looking statement of inflation for Côte d'Ivoire, Mali, Senegal, and Togo. There is a statistically significant relationship between the output gap and inflation in Benin, Burkina Faso, Mali, and Togo over the period considered period. The consumer price index in France has a significant influence on inflation dynamics in all WAEMU countries except Senegal. The world oil price plays an essential role in inflation dynamics in Togo and Mali.

Table 11. Comparison of inflation dynamics in open economy in WAEMU countries (1994q1: 2018q4)

Variables	Benin	Burkina Faso	Côte d'Ivoire	Mali	Niger	Senegal	Togo
INFLA(t-1)	0,5082***	0,1723***	0,5254***	0,2212***	0,4232***	0,4924***	0,2678***
INFLA(t+1)	0,5554***	0,2402***	0,5047***	0,1790***	0,4564***	0,4885***	0,2161
GDP_GAP	28,5911**	23,1751***	1,4298	56,0112***	-2,1917	0,6952	-31,49995***
IPCF	0,0370**	0,0234***	0,0009	0,1000***	0,0129***	-0,0002	0,0181***
CMP	2,11 e-06*	5,32 e-06***	2,27 e-07*	1,04 e+05***	-1.89 e-06***	1,88 e-08	1,42 e-06***
OBS	145	145	145	145	145	145	145
WALD Chi2	254717,71***	1,51 e+0,7***	2,03 e+06***	996043,97***	192113,15***	3,74 e+06***	393719,41***

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%

VI. CONCLUSION

Recent developments in an empirical perspective of inflation dynamics ensure intertemporal optimization of behavior in a non-competitive environment. The relative importance of the analysis of inflation dynamics is linked to the introduction of retroactive components in the modeling of inflation by considering that a fraction of the economic agents making decisions may be oriented towards past inflation in their pricing decisions. The resulting model is known as the hybrid New Keynesian Phillips curve. Using dynamic panel modeling, we estimated the hybrid form of the New Keynesian Phillips curves for WAEMU countries over the period 1980-2008. We extended the basic model to the case of the small open economies of the WAEMU by comparing the pre-devaluation period with the post-devaluation period. We found that both backward-looking and forward-looking components are essential in explaining price dynamics in the WAEMU zone in both closed and open economies. However, the relative weight of forward-looking components is greater than that of backward-looking components. The output gap explains inflationary pressures in the zone more in open economies than in closed economies. However, the relationship between the output gap and inflation is significantly negative. This suggests that the output gap does not perfectly reflect inflationary pressures in the WAEMU zone as a whole.

When we consider individual countries, our results show that the relative weights of the forward and backward-looking components are not the same for all countries. Consistent with our variables of interest, Benin, Burkina Faso, Côte d'Ivoire, Mali, and Senegal have a structure with economic agents behaving much more prospectively than retrospectively in setting prices. In contrast, Guinea, Niger, and Togo have a structure with agents acting more retrospectively than prospectively.

Comparing the inflation dynamics in WAEMU considering the period before and after the 1994 nominal devaluation, we find that the relative weight of forward-looking components is greater than that of backward-looking components in all countries for the period before and after the devaluation. The relationship between output gaps and inflation is statistically significant for Benin, Burkina Faso, and Senegal for the period considered. On the other hand, for the post-devaluation period, the relative weight of the retrospective components is greater than that of the prospective components, except for Benin, where the difference is very small in favor of the prospective component. These results suggest that the change in the economic environment concerning exchange rate policy has a noticeable impact on inflation dynamics in individual WAEMU countries.

From an open economy perspective, the results show that before the devaluation, the pricing behavior of economic agents in WAEMU countries is essentially dictated by a forward-looking view of inflation, except for Burkina Faso, where the results are not statistically significant. The consumer price index in France significantly explains price dynamics in countries such as Benin, Burkina Faso, Mali, Niger, and Senegal. There is a significant relationship between the output gap and inflation in Burkina Faso, Mali, Niger, and Senegal. The world oil price explains the dynamics of inflation significantly in Niger and Senegal. The estimates for the post-devaluation period show that economic agents are relatively forward-looking in their pricing behavior for Benin and Niger.

On the other hand, the weight of the retroactive view of inflation is much greater than that of the perspective view of inflation for Côte d'Ivoire, Mali, Senegal, and Togo. There is a statistically significant relationship between the output gap and inflation in Benin, Burkina Faso, Mali, and Togo over the period considered. The consumer price index in France has a significant influence on inflation dynamics in all WAEMU countries except Senegal. The world oil price plays an essential role in inflation dynamics in Togo and Mali.

The estimations suggest that inflation dynamics are not the same in all member states of the union. Also, the hybrid shape of the New Keynesian Phillips curve is not stable over time for individual WAEMU countries. The relationship between the output gap and inflation variability shows a relatively different economic structure from one country to another. All in all, it seems clear that adopting a single monetary policy for all WAEMU countries is not an optimal strategy.

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