Applied Economics and Finance; Vol. 10, No. 2; 2023
ISSN 2332-7294 E-ISSN 2332-7308
Published by Redfame Publishing

Heterogeneous Monetary Zone and Macroprudential Policy: The Case of the Waemu Zone

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Received: March 24, 2023 Accepted: May 9, 2023 Available online: May 23, 2023

doi:10.11114/aef.v10i2.6027 URL: https://doi.org/10.11114/aef.v10i2.6027

Abstract

This article raises the question of the conduct of a common macroprudential policy aimed at correcting specific financial imbalances in the presence of structural heterogeneity that characterizes the monetary zone, in this case the WAEMU zone. For this reason, we develop a neo-Keynesian DSGE[1] model in an open economy with two countries, namely the core countries and those of the periphery, with increased financial frictions. The results show that in the presence of structural heterogeneities, country-adjusted macroprudential measures, as opposed to a common macroprudential policy, are the best way to reduce specific financial imbalances. However, in financially integrated economies, the existence of negative externalities implies the need to coordinate national macroprudential policies in order to increase the degree of currency area optimality.

Keywords: macroprudential policy, structural heterogeneities, optimal currency region

JEL Classification : E12 ; F45 ; G28

1. Introduction

The challenges of macroeconomic stabilization induced by systemic risk have raised interest in a macroprudential approach to financial stability (Richter et al., 2019 ; Claessens et al., 2021).

However, if the financial crisis (2008) has shown the need to thoroughly renew the traditional approach to financial system regulation by complementing it with a macroprudential dimension, the structural specificities within monetary areas have renewed the debates on the appropriateness of conducting macroprudential policy (Poutineau and Vermandel, 2018). This concern is particularly acute in small open economies, in this case the WAEMU zone, which is characterized by structural heterogeneities.

According to the theory of optimal currency areas, a monetary union works best when the member countries are homogeneous and their economic structures are similar, thus guaranteeing nominal convergence between countries.

However, the WAEMU zone is heterogeneous and suffers from economic divergences (Gammadigbe et al., 2017). Table 1 below presents the productive structures of the WAEMU.

Table 1. Main export products in 2021

Country	Exported products	Weight (%)
Benin	Cotton (27 %)	9,3
Burkina-Faso	Gold (74 %) ; Cotton (10 %)	12,9
Côte d'Ivoire	Cocoa (43 %) ; Petroleum products (12 %)	41
Guinea Bissau	Cashew nuts (90 %)	0,6
Mali	Gold (81 %)	14
Niger	Uranium (23 %) ; Petroleum products (14 %)	3,2
Senegal	Fishery products (15 %) ; Petroleum products (18 %)	15
Togo	Phosphate (11 %) ; Cotton (10 %)	3,6

Source : BCEAO, 2021

[1] Dynamic Stochastic General Equilibrium

Note: The table refers to products that account for at least 10% of total exports. The weight refers to the contribution of each member country to exports of goods from the monetary union, with weight=(total exports of country i)/(total exports of WAEMU zone).

The productive structures of the WAEMU are characterized by their heterogeneity. Indeed, the production structures of the group of countries comprising Guinea-Bissau (cashew nuts account for 90% of total exports), Côte d'Ivoire (cocoa production accounts for 43% of total exports) and Benin (cotton accounts for 10% of total exports) are essentially based on the primary sector.

In Burkina Faso (gold 74%), Mali (gold 81%), Niger (uranium 23%), Senegal (petroleum products 18%) and Togo (phosphate 10%), the secondary sector is the main pillar of the productive fabric. Côte d'Ivoire[2] followed by Senegal are the main countries with a dominant share of exports from the monetary union (41% and 15% respectively).

Economic divergences also feed financial divergences. Indeed, insofar as the countries have different production structures, the financial cycles remain asynchronous and specific to each economy.

Figure 1 shows that the member countries of the union have divergent financial conditions, which have become more pronounced since 2012.

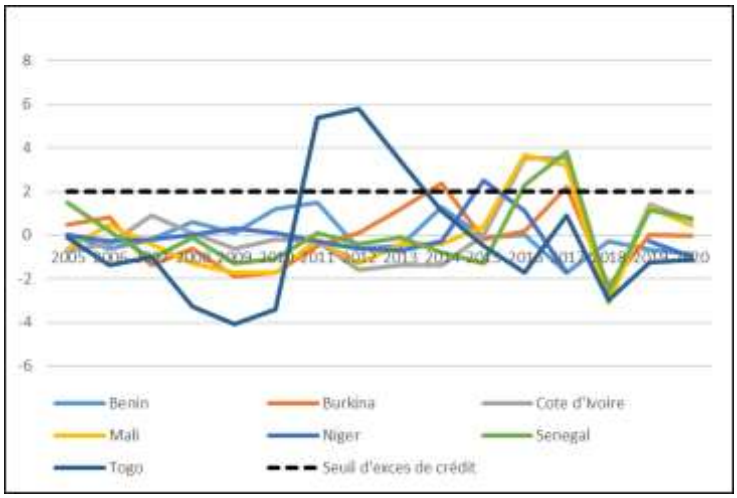

Figure 1. Evolution of financial cycles in WAEMU member countries (credit/GDP ratio gap)

Source : Author

Because of its undiversified[3] production structures, WAEMU is a zone of great uncertainty subject to fluctuations in world commodity prices and asymmetric shocks (BCEAO, 2019; Gammadigbe, 2021). Under these conditions, the new prudential measures could create distortions that could surround its effectiveness with a degree of uncertainty.

Indeed, in financial structures characterized by structural heterogeneities, financial cycles remain specific to each economy, despite community integration. A symmetrical reaction of macroprudential instruments in response to differentiated financial imbalances would be likely to accentuate heterogeneities, so as to reduce the degree of optimality of the monetary zone (Mundell, 1961).

In this context, it seems appropriate to analyze the relevance of macroprudential instruments, otherwise, are such instruments likely to allow for better regulation of the financial system so as to effectively correct and prevent financial imbalances in the framework of a heterogeneous monetary union such as the WAEMU?

[2] Côte d'Ivoire and Senegal are the countries that we will refer to as "core" countries in terms of their macroeconomic performance in this article. This distinction takes the place of Krugman's (1991) geographic polarization in terms of the agglomeration of economic activities in a monetary union, which is more concentrated in the core countries relative to those on the periphery (BCEAO, 2010).

[3] The more diversified (less specialized) the productive structures, the lower the probability of asymmetric shocks (Kenen, 1969; Ondo Ossa, 2000). Diversification tends to limit asymmetric shocks to the extent that greater diversification spreads the effect of shocks. Thus, export diversification is an effective means of preventing external shocks (commodity price volatility).

Macroprudential policies are relatively new and have not yet been the subject of particular attention in the context of debt economies and remain virtually unexplored, particularly in the WAEMU zone. We propose to fill this gap, to shed light on the issues at stake and to make concrete proposals that will enable better use of macroprudential measures.

This paper is structured as follows. Section 2 reviews the literature. Section 3 deals with the model. Section 4 deals with the methodology. Section 5 deals with the interpretation of the results. Finally, section 6 concludes.

2. Review of the Literature

The objective of macroprudential policy is to avoid the macroeconomic costs associated with financial disturbances in order to sufficiently guarantee financial stability (Galati and Moessner, 2018; Farhi and Tirole, 2020). However, new challenges have emerged, due to the structural heterogeneities that characterize currency areas.

Theoretical debates on the conduct of macroprudential policy within a monetary union can be divided into two analytical frameworks: the one that, in light of Mundellian teachings, indicates that the use of macroprudential measures is likely to reduce the degree of optimality of the monetary union, on the one hand, and the one whose use constitutes an additional means of adjustment (due to asymmetric shocks), on the other.

The first approach raises the question of the relevance of a common policy to correct specific financial imbalances (Dehmej and Gambacorta, 2018).

Indeed, given the existence of structural heterogeneities, the conduct of a single macroprudential policy would be likely to accentuate divergences and financial imbalances within a monetary zone (Poutineau and Vermandel, 2018).

Insofar as countries have different productive structures, financial cycles remain asynchronous. a common policy does not necessarily respond to the need for differentiated stabilization. Indeed, it would be likely to be simultaneously more accommodating for some countries while proving restrictive for others. The asynchronous nature of financial cycles implies an asymmetric transmission insofar as countries are frequently in different phases of the financial cycle.

The action of common macroprudential measures, insofar as it affects the financing of credit, would be likely to accentuate the cyclical shocks in certain economies, which would imply the accumulation of financial imbalances. The result is an increase in financial instability and a greater probability of financial crisis with regard to interconnections (cross-border activity of banking institutions)

Under these conditions, the impact of the new prudential requirements would therefore be an important cause of macroeconomic disruption and could prove to be less effective in preventing systemic risk within a monetary union.

The second approach favors the adoption of macroprudential measures adjusted to national characteristics to better address specific financial imbalances (Agenor and Silva, 2022). Such prudential measures would have potentially stabilizing effects not only for the financial system but also for the real economy.

In fact, within a monetary zone, in the presence of asymmetric shocks, monetary policy cannot inexorably adjust to divergent economic situations. And, while the use of the fiscal weapon seems to be preferred, it is unlikely that public spending will converge, requiring a complementary adjustment instrument (Parièès et al., 2019).

Under these conditions, the countercyclical action of national macroprudential measures would help reduce the build-up of financial imbalances.

However, when acting independently, domestic macroprudential policies have potential implications insofar as they spill over to other economies, and are thus subject to negative externalities in the form of cross-border spillovers and regulatory arbitrage (Rubio, 2020). Such a concern is particularly relevant given the interconnectedness of different economies in terms of integrated financial structures and trade links.

The recent literature on the spillover[4] effects of macroprudential policy indicates that countercyclical measures aimed at limiting the development of financial imbalances can have undesired[5] macroeconomic effects on neighboring economies, especially if they are in a different phase of the economic cycle (Agenor and Silva, 2022).

Moreover, the removal of frictions related to capital mobility may lead to a strong incentive for financial institutions to circumvent prudential measures by migrating a number of activities to countries with less stringent regulations (Farhi and Tirole, 2020). The channel through which this regulatory arbitrage takes place is the heterogeneity of regulation

[4] Spillover effects indicate an external effect (positive or negative) whereby the economic activity of one country affects another. In the context of economic policy, they indicate the effects of domestic macroprudential measures on other economies in the union.

[5] Domestic macroprudential measures in one country can affect credit dynamics and create pressures on asset prices in neighboring economies. Cross-border capital flows are the main transmission channel.

between countries. This arbitrage will exacerbate the dynamics of the economy and contribute to the accumulation of systemic risk.

Such effects are likely to undermine the effectiveness of macroprudential policy, which underpins a holistic approach at the supranational level, because in financially intertwined economies national macroprudential measures aimed at domestic financial stability without taking into account the interconnections of the financial systems of the union may prove ineffective (Rubio, 2020).

Under these conditions, the existence of negative externalities points to the need for national policy coordination at the supranational level in order to take full advantage of financial integration (Aiyar et al., 2014).

Macroprudential policy has characteristics that distinguish it from traditional economic policies (common monetary and national fiscal policies). It has the advantage of being adjustable at different levels. At the national level (countercyclical macroprudential policy) as a means of adjusting to asymmetric shocks with regard to structural heterogeneities. Conducted at the supranational[6] level (structural macroprudential policy), it allows for the internalization of spillover effects and regulatory arbitrage (negative externalities) that could be induced by national macroprudential measures.

The empirical analyses conducted in parallel with the theoretical developments are relatively new, notwithstanding the development of numerous works in recent years (Galati and Moessner, 2018). They mostly focus on recent Dynamic and Stochastic General Equilibrium (DSGE) models. Recent developments focus on filling the gaps in standard New Keynesian models that assumed a « cashless » economy by accounting for financial frictions (Gertler and Karadi, 2011 ; Woodford, 2012).

The work of Angelini et al., (2014) based on a DSGE model incorporating financial frictions, analyzes the role of macroprudential instruments in correcting financial imbalances in the Eurozone setting. The results show that macroprudential instruments combined with the nominal interest rate in an integrated coordination regime allow for better stabilization of the financial system and economic policy convergence.

Using a DSGE model in a heterogeneous monetary union, Rubio (2020) analyzes the potential impact of a national macroprudential policy in the presence of cross-border banking activities. The macroprudential instrument in the form of the loan-to-value ratio (LTV) associated with the single monetary policy allows for the reduction of financial imbalances within the national economy.

Poutineau and Vermandel (2018), using a neo-Keynesian model, analyze the relevance of the implementation of macroprudential policy within a heterogeneous monetary union. Due to the structural heterogeneities that feed the heterogeneity of financial cycles within the euro area, the conduct of national macroprudential policy is effective in preserving financial stability in contrast to joint action.

Empirical results mostly indicate the effectiveness of macroprudential instruments. While most of the analyses take into account financial openness and structural heterogeneity, national macroprudential policy coordination remains almost absent in open economies in the presence of cross-border banking activities.

The present research attempts to fill this gap, which requires a re-reading of macroprudential measures at the global level.

3. The Model

We develop an augmented New Keynesian model of financial frictions based on the model of Angelini et al., (2014), which captures the relevance of macroprudential instruments as a means of enhancing financial stability in a monetary union.

While the focus of our model is similar to the benchmark model, it differs in that it is set in the context of a small open economy, in this case the WAEMU, which is a heterogeneous monetary union.

The macroprudential instruments in the model are defined by a countercyclical capital rule (national dimension) and a limit on common exposures (supranational dimension). Taking into account structural heterogeneities within the union means distinguishing between two groups of countries, namely the core countries and the periphery.

The hypothesis of the model is formulated as follows : the use of countercyclical capital as a macroprudential instrument is the best way to reduce financial imbalances within a heterogeneous monetary union such as the WAEMU.

We present the agents and their behavior before analyzing the relevance of national macroprudential measures as the best way to reduce financial imbalances within a heterogeneous monetary union.

[6] The role of supranational macroprudential action should help mitigate the effects of cross-border financial spillovers in a way that is more effective in reducing systemic risk and enhancing macroeconomic stability.

3.1 Agents and Their Behavior

We distinguish between the second-tier bank and the macroprudential authority.

3.1.1 The Second-Tier Bank

The bank in monopolistic competition grants loans to the non-financial private sector (Gerali et al., 2010). In relation to the rest of the world, it holds liabilities to the foreign economy.

Its asset portfolio is composed of loans and marketable securities, including government bonds that can be traded on the secondary market (Revelo and Levieuge, 2022). Most of the financing comes from external commitments and bank capital. The balance sheet equilibrium is established as follows :

$$l_t + b_t = k_t + b_t^{(E)} \tag{1}$$

We assume that part of the government bonds finance external liabilities denominated in foreign currency and are taken as collateral, such as :

$$(1-\alpha_B)b_t = (1-\alpha_B)exb_t^{(E)} \tag{2}$$

The banking business is capital constrained k¯which equates to regulatory fund requirements (Basel I and II). Thus the bank pays an adjustment cost $\left[\frac{\psi_t}{2}\left(\frac{k_t}{w_t L_t} - \bar{k}\right)^2 k_t\right]$ when it deviates from the optimal value $\bar{k}$.

The capital constraint is defined as follows :

$$k \geq \bar{k}, \qquad \text{où} \quad k = \frac{k_t}{w_t L_t} \tag{3}$$

With l_t, bank loans ; b_t, government bonds ; k_t, bank capital ; $b_t^{(E)}$, external liabilities ; $(1-\alpha_B)\, b_t$, the share of government bonds taken as collateral ; ex, the exchange rate expressed in domestic currency per unit of foreign currency ; $(1-\alpha_B)exb_t^{(E)}$, the amount of external liabilities expressed in domestic currency per unit of foreign currency ; ψ_t, the parameter that measures the cost of deviating from $\bar{k}$ in period t ; $\bar{k}$, the optimal level of bank capital ratio of banks ; $w_t l$, the risk-weighted assets at period t.

The bank's utility function is formulated as follows :

$$U = E_0 \sum_{t=0}^{\infty} \gamma_t \left[R_t l_t + R_t^{(B)} \alpha_B b_t - R_t^{(B)} (1-\alpha_b) exb_t^{(E)} - k_t - \frac{\psi_t}{2}\left(\frac{k_t}{w_t l_t} - \bar{k}\right)^2 k_t \right] \tag{4}$$

under the balance sheet constraint :

$$l_t + b_t = k_t + b_t^{(E)} \tag{5}$$

After solving the maximization program[7], we derive :

$$S_t = -\psi_t \left(\frac{k_t}{w_t l_t}\right)^2 \left(\frac{k_t}{w_t l_t} - \bar{k}\right) - r_t \alpha_B ex \tag{6}$$

The relation (6) represents the credit supply equation that negatively relates the capital constraint and the external liabilities to the interest rate differential. This leads to two main sources of financial imbalances. First, the capital constraint $\psi_t \left(\frac{k_t}{w_t l_t}\right)^2 \left(\frac{k_t}{w_t l_t} - \bar{k}\right)$ acts as a financial gas pedal favoring the accumulation of financial imbalances.

The size of the financial imbalances is determined by the value of the elasticity of the capital constraint with respect to the

[7] See appendix 1.1 for solving programm

financial gap $\psi_t \succ 0$.

The second source of financial imbalances $r_t \alpha_B ex$ represents cross-border financial flows, which constitute a transmission channel for external shocks but also a regulatory arbitrage channel.

3.1.2 The Macroprudential Authority

The Macroprudential Authority is responsible for conducting financial regulatory policy with a mandate for financial stability.

Maintaining financial stability implies a dual objective in terms of systemic risk management: stabilizing the financial cycle through countercyclical action and strengthening the resilience of financial institutions by reducing contagion effects (Angelini et al., 2014).

We thus distinguish two categories of macroprudential instruments: countercyclical and structural macroprudential instruments.

Countercyclical macroprudential instruments correspond to countercyclical capital buffers (CCB). They aim to reduce the intertemporal dimension of systemic risk, and more broadly the procyclicality of the financial system. For this reason, they react to deviations of the credit deviation from its target (Quint and Rabanal, 2014), as follows:

$$mcp = \bar{k} + \phi^{mcp}\left(\frac{l_t}{y_t} - \frac{\bar{l}_t}{\bar{y}}\right) \tag{7}$$

Structural macroprudential instruments correspond to systemic capital buffers defined by the leverage ratio (lev). Such an instrument aims to reduce systemic risk in its structural dimension, and more broadly the effects of contagion, that is :

$$lev = \phi^{lev}\left(\frac{l_t}{k_t} - \overline{lev}\right) \tag{8}$$

where $k_{ss} = \bar{k}$,

with mcp, the countercyclical capital buffer ; $\bar{k}$, the steady-state bank capital target ;, l_t, the supply of credit; $\emptyset^{mcp}$, the response of macroprudential measures to deviations in the credit spread ; $\left(\frac{l_t}{y_t} - \frac{\bar{l}_t}{\bar{y}}\right)$, the credit gap ; lev, the leverage ratio ; ϕ^{lev}, the response of macroprudential measures to bank exposures ; $\overline{lev}$, the limit on bank exposures.

3.2 Analysis of the Relevance of National Macroprudential Policy

To better appreciate the impact of a common macroprudential policy within a monetary union, we distinguish between core and periphery countries (Poutineau and Vermandel, 2018).

This dichotomy allows us to take into account the structural heterogeneities that characterize the currency area. To the extent that economic divergences also feed financial divergences, the financial cycles of the two groups of countries are asynchronous, so that we have:

Core countries :

$$S_t^{(core)} = S_t = mcp \tag{9}$$

Periphery countries:

$$S_t^{(Periphery)} = -S_t = mcp \tag{10}$$

Thus, the effect of a common macroprudential policy affects the evolution of credit dynamics differently $S_t^{(core)}$ and $S_t^{(periphery)}$.. Macroprudential instruments are more effective in reducing financial imbalances in the core countries. However, in the periphery country, the countercyclical action of macroprudential measures seems more difficult to carry out insofar as they are likely to amplify financial imbalances and accentuate the cyclical shock. Thus, in a

monetary area with structural heterogeneities, the asymmetric transmission of a common macroprudential policy accentuates the differences between member countries, which argues in favor of a decentralized or national macroprudential policy.

3.2.1 National Macroprudential Policy (Decentralized Action)

Insofar as the conduct of a common macroprudential policy does not necessarily respond to the need for stabilization in each country of the monetary union, it could be conducted at the national level in order to respond to the financial imbalances specific to each country and thus reduce the divergences between the core countries and those of the periphery

Core countries

$$S_t^{(core)} = S_t = mcp_{core} \tag{11}$$

Periphery countries:

$$S_t^{(periphery)} = -S_t = -mcp_{periphery} \tag{12}$$

Thus, insofar as a monetary union experiences asynchronous financial cycles, a macroprudential policy adjusted by country makes it possible to correct the financial imbalances specific to each country more effectively.

3.2.2 Supranational Macroprudential Policy (Action at the Community Level)

Macroprudential policy at the level of the Union will make it possible to internalize the effects of regulatory spillovers and arbitrage within the zone in order to better coordinate national actions and promote greater convergence, i.e. :

$$S_t^{(core)} + S_t^{(periphery)} = lev \tag{13}$$

4. The Methodology

The purpose of the model is to show that the use of national macroprudential measures is a way to reduce systemic risk in a heterogeneous monetary union such as the WAEMU. We present the variables of the model before proceeding to the econometric approach and the interpretation of the results.

4.1 The Variables

The explained variable of our model taken as a measure of systemic risk is the crd_gap[8], which describes the differential between the deviation of the credit/GDP ratio from its long-run trend (Castro and Martins, 2020). This financial gap or «basel-gap », as proposed by the Basel III accords, uses a broad definition of credit that includes the debt of domestic non-financial private agents (Drehmann and Juselius, 2014). The recent theoretical literature and the Basel Committee's guidelines, make it a benchmark indicator to capture the dynamics of systemic risk accumulation with respect to the evolution of the financial cycle.

In terms of explanatory variables, we distinguish macroprudential variables from financial variables.

Macroprudential variables concern all macroprudential instruments. They include :

- Countercyclical capital buffers (crr_uemoa) defining capital buffers that change with the state of the financial cycle (Lim et al., 2011, Cerutti et al., 2017). They take the form of an indicator variable with a value of 1 in the presence of excessive credit growth and a value of 0 otherwise ;
- Reserve requirements are a tax that affects the intermediation margin and increases the cost of credit (Glocker and Towbin, 2015). The value of this instrument in a debt economy in the absence of a close substitute for credit is as a means to effectively curb credit growth. It is determined from the reserve requirement rate and defined as an indicator variable with a value of 1 for any upward change in the reserve requirement rate and 0 otherwise (Revelo et al., 2020). We distinguish respectively between whether the reserve requirement rate is defined at the union level $reserve\_fed$ and at the national level $reserve\_nat$. To this end, we distinguish with respect to structural heterogeneities between core countries (Côte d'Ivoire and Senegal) and periphery countries (composed of the other countries), in order to discuss the interest or conduct of a common macroprudential policy (Poutineau and Vermandel, 2018);

[8] The deviation of the credit/GDP ratio from its long-term trend in the economy obtained by the Hodrick-Prescott smoothing method.

- The leverage ratio lev , which defines the limit of banks' common exposures. It takes the form of additional capital in order to internalize bank risk taking (Lim et al., 2011). It takes the value 1 when the bank deviates from the exposure limit and 0 otherwise.

The financial variables are as follows :

- The solvency ratio cap, describes the ratio of effective capital to the risk-weighted bank asset portfolio. This microprudential instrument aims to ensure bank solvency (Gertler al., 2020) ;

- Cross-border financial flows nfa, which capture the union's financial links with the rest of the world. Such linkages are approximated by the external financial position of banks determined from the difference in the balance of the stock of financial assets and liabilities vis-à-vis non-residents expressed as a ratio of GDP (Lane and Milesi-Ferretti, 2018) ;

The relationship for estimation purposes is as follows :

$$crd\_gap_{it} = \mu_i + \alpha_0 crd\_gap_{itr-1} + \alpha_i X_{it} + \beta_i Z_{it-1} + \varepsilon_{it} \quad (14)$$

with :

crd_gap_{it} , the credit gap ;

crd_gap_{it-1}, the lagged endogenous variable ;

$X_{it} = \begin{bmatrix} nfa_{it} \\ cap_{it} \end{bmatrix}$, the vector of financial variables ;

$Z_{it} = \begin{bmatrix} crr\_uemoa_{it-1} \\ reserve\_fed_{it-1} \\ reserve\_nat_{it-1} \\ lev_{it-1} \end{bmatrix}$, the vector of macroprudential variables ;

où :

nfa_{it}, the cross-border financial flows in period t ;

cap_{it}, the solvency ratio in period t ;

crr_uemoa_{it-1}, the countercyclical capital buffer in period $t-1$;

$reserve\_fed_{it-1}$, the reserve requirements depending on whether the conduct of macroprudential policy is common in period $t-1$;

$reserve\_nat_{it-1}$, the reserve requirements according to whether the conduct of macroprudential policy is national in period $t-1$;

lev_{it-1}, the leverage ratio in period $t-1$;

μ_i, the parameter of individual heterogeneities ;

α_0, the parameter associated with the lagged endogenous variable ;

α_i avec $i = (1, \ldots, 3)$, the vector of parameters associated with the financial variables ;

β_i avec $i = (1, \ldots, 4)$, corresponds to the vector of parameters associated with the macroprudential variables and the expected sign is negative because the tightening of macroprudential measures is likely to reduce excessive credit growth so as to limit the accumulation of systemic risk.

4.2 The Econometric Approach

The data used comes from the BCEAO[9] database (2020) and the WAEMU Banking Commission (2020) covering the period from 2000 to 2020 for all countries in the union, excluding Guinea-Bissau for reasons of data availability.

[9] Central Bank of State of West Africa

The econometric approach leads to the following tests (inter-individual dependence test, stationarity test) before presenting the estimation method.

- The inter-individual dependence test :

It allows us to verify the existence of inter-individual dependence which authorizes the use of second generation stationarity tests (Pesaran, 2015). The results of the test confirm the hypothesis of the presence of interindividual dependence.

-The stationarity test :

We analyze the stationarity of the variables using the second generation unit root test of Pesaran (2007), which has the advantage of taking into account, in addition to individual heterogeneities, the hypothesis of dependence between individuals in the panel (Baltagi, 2013). The results obtained from the retained Pesaran test indicate that the variables of the model are stationary in level.

-The estimation method :

The model is estimated using the instrumental variables method in panel data (Greene, 2007 ; Hill et al., 2011). This method has two advantages :

First, allow for unobservable heterogeneities among WAEMU member countries described by inter-individual dependencies to be taken into account ;

Second, to provide solutions to the problems of estimation bias induced by the endogeneity of the variable explained, so as to correct the heteroscedasticity and non-normality of the disturbances, unlike standard regression models.

4.3 The Results

The following table presents the results of the estimation carried out at the level of the monetary union (WAEMU zone), at the national level and separately for core and peripheral countries.

Table 1.2. Results of the instrumental variables estimation (IV)

Dependent variable	**Macroprudential policy conduct**			
	WAEMU area	*National*	*Core*	*Periphery*
crd_gap_{it-1}	0.89**	1.26**	-0.12	0.99**
	(2.58)	(3.86)	(0.22)	(4.59)
cap_{it}	- 0.40	-0.03	0.04	- 0.19
	(- 0.17)	(-0.52)	(0.23)	(- 0.71)
nfa_{it}	- 0.16	0.31	1.08	0.51
	(- 0.74)	(1.23)	(1.96)	(1.25)
$reserve\_fed_{it-1}$	0.68		-3.04**	3.64**
	(1.16)		(-2.20)	(3.18)
$reserve\_nat_{it-1}$	- 1.21**	-0.74		
	(-2.39)	(-1.16)		
crr_uemoa_{it-1}	*- 7.42***	-11.70**		
	(-2.01)	(-2.52)		
lev_{it-1}	*- 1.35*			
	(-1.55)			
Prob>Chi2	0.0276	0.0293	0.0238	0.0000
Wu-Hausman Test	0.3449	0.0787	0.0906	0.9221
Sargan	0.1082	0.1803	0.3213	0.3872

Source : Author, from Stata 16. T-student in bracket. Significance at 10% (*), 5% (**) et à1% (***),

The estimation results indicate, that reserve requirements ($reserve\_fed_{it-1}$) have a negative (-3.04**) and significant effect on the credit gap with respect to core countries on the one hand, and a positive (3.64**) and significant effect for periphery countries on the other. Thus, common macroprudential policy seems to be more responsive to correcting financial imbalances in core countries compared to periphery countries.

However, when conducted at the national level, macroprudential instruments prove to be particularly effective in reducing systemic risk in terms of their negative (-11.70**) and significant effect on the countercyclical capital crr_uemoa_{it-1} on credit gap.

However, the negative (-7,42**) and significant effect of countercyclical capital buffers (crr_uemoa_{it-1}) on the credit gap at the scale of the monetary union helps to confirm that when conducted independently without taking into account negative externalities, the effectiveness of national macroprudential policies is reduced.

Moreover, the insignificant effect of the solvency ratio variable (cap_{it}) reveals that the use of such an instrument is not an effective means of reducing systemic risk.

Similarly, the insignificant effect of the macroprudential and microprudential instrument cross-variable ($cap\_crr\_uemoa_{it-1}$) seems to indicate a lack of convergence induced by insufficient or lack of coordination.

With respect to cross-border financial flows, the insignificant effect of the coefficients associated with the variable nfa_{it} indicates that cross-border lending does not contribute to the accumulation of financial imbalances within the WAEMU.

It is found that the estimated model is globally significant at the 5% level. The Wald probabilities (Prob>Chi2) attest to the overall robustness of the model. The Sargan test confirms the validity of our instruments. The Wu-Hausman test confirms the absence of autocorrelation of errors.

5. Interpretation

The estimation results validate our hypothesis. The use of countercyclical capital is the best way to reduce systemic risk in a heterogeneous monetary union such as the WAEMU. However, such effectiveness is conditional on taking into account negative externalities, which requires coordination of national macroprudential measures.

The negative and significant effect of reserve requirements on the credit gap with respect to core countries, on the one hand, and the positive and significant effect with respect to peripheral countries, on the other hand, points to the fact that a common macroprudential policy is not an effective means of reducing differentiated financial imbalances within a heterogeneous currency area.

Thus, while reserve requirements are effective in limiting the supply of credit in core countries whose dynamics are characterized by excessive credit growth, they are pro-cyclical and accentuate financial imbalances in peripheral countries.

Thus, in the presence of structural heterogeneities, a common macroprudential policy is characterized by asymmetric transmission and cannot be a means of preventing systemic risk within a monetary union.

However, action at the national level would seem to be the best way to respond to asymmetric shocks, so as to make the union a zone of lesser divergence, as opposed to symmetric action of macroprudential instruments across the union.

However, given the existence of negative externalities, such measures should be complemented by a supranational dimension in order to increase the degree of optimality of the monetary area.

Indeed, given the transnational dimension of systemic risk, a better correction of financial instability would not be limited to the national level, hence the need for macroprudential action at two levels : countercyclical action at the national level specific to the financial characteristics of each member country, and transversal action at the community level so as to internalize contagion effects.

As regards the removal of frictions linked to capital mobility, the spillover effects of cross-border financial flows seem relatively better controlled within the union, given the fixed exchange rate regime pegged to the euro and the absence of dollarization. However, this should not obscure the underlying risk of regulatory arbitrage and financial instability insofar as they constitute a channel for the transmission of external shocks.

Thus, because of financial openness, a macroprudential policy aimed at internal stability, independent of external shocks, could be less effective when cross-border financial flows are not subject to prudential supervision.

6. Conclusion

This paper has analyzed the relevance of instruments in terms of their impact on the correction of financial imbalances in a heterogeneous monetary zone such as the WAEMU. The main results of the empirical analysis indicate that countercyclical macroprudential instruments are effective in correcting differentiated financial imbalances.

However, a number of factors are likely to alter the effectiveness of national macroprudential policy, namely negative externalities that require coordination at the supranational level to take full advantage of financial integration.

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Appendices

Appendix 1.1 : Solving the maximization program :

$$U = E_0 \sum_{t=0}^{\infty} \gamma_t \left[R_t l_t + R_t^{(B)} \alpha_B b_t - R_t^{(B)} (1-\alpha_b) ex b_t^{(E)} - k_t - \frac{\psi_t}{2} \left(\frac{k_t}{w_t l_t} - \bar{k} \right)^2 k_t \right], \quad [1.4]$$

under the constraint of the balance :

$$l_t + b_t = k_t + b_t^{(E)}, \quad [1.5]$$

The Lagrangian associated with the maximization program is :

$$L\left(l_t, b_t^{(E)}, \lambda_t\right) = \left\{ \begin{array}{l} E_0 \sum_{t=0}^{\infty} \gamma_t \left[R_t l_t + R_t^{(B)} \alpha_B b_t - R_t^{(B)} (1-\alpha_b) ex b_t^{(E)} - k_t - \frac{\psi_t}{2} \left(\frac{k_t}{w_t l_t} - \bar{k} \right)^2 k_t \right] + \\ \lambda_t \left(l_t + b_t = k_t + b_t \right) \end{array} \right\}$$

The first order conditions:

$$\left\{ \begin{array}{l} \frac{\partial L}{\partial l_t} = 0 \Leftrightarrow R_t (1-\alpha_L) - \psi_t \left(\frac{k_t}{w_t l_t} \right)^2 \left(\frac{k_t}{w_t l_t} - \bar{k} \right) + \lambda_t = 0 \\ \frac{\partial L}{\partial b_t^{(E)}} = 0 \Leftrightarrow -R_t^{(B)} (1-\alpha_B) ex - \lambda_t = 0 \\ \frac{\partial L}{\partial \lambda_t} = 0 \Leftrightarrow \left(l_t - k_t - b_t - b_t^{(E)} \right) = 0 \end{array} \right.$$

We deduce :

$$R_t = -\psi \left(\frac{k_t}{w_t l_t} \right)^2 \left(\frac{k_t}{w_t l_t} - \bar{k} \right) + R_t^{(B)} (1-\alpha_B) ex$$

$$\Rightarrow \quad R_t - R_t^{(B)} ex = -\psi_t \left(\frac{k_t}{w_t l_t} \right)^2 \left(\frac{k_t}{w_t l_t} - \bar{k} \right) - R_t^{(B)} \alpha_B ex$$

We assume that $R_t^{(B)}$ is remunerated at the money interest rate r_t with $r_t = R_t^{(B)}$. Where $r_t = R_t^{(B)} ex$ for simplicity of writing, we deduce :

$$S_t = -\psi_t \left(\frac{k_t}{w_t l_t} \right)^2 \left(\frac{k_t}{w_t l_t} - \bar{k} \right) - r_t \alpha_B ex \text{, où : } S_t = R_t - r_t \qquad [1.6]$$

Appendix 1.2 : Interindividual dependency test

```
  Frees' test of cross sectional independence =     0.093
|-------------------------------------------------------------|
  Critical values from Frees' Q distribution
                     alpha = 0.10 :   0.1719
                     alpha = 0.05 :   0.2262
                     alpha = 0.01 :   0.3351
```

H0 (null hypothesis) : presence of inter-individual dependence ;

H1 (alternative hypothesis) : absence of inter-individual dependence ;

As can be seen, the Frees test statistic strongly rejects the alternative hypothesis of no cross-sectional dependence.

Appendix 1.3 : Stationarity test

- crd_gap

```
Pesaran's CADF test for crd_gap
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (7,21)          Obs = 133

    t-bar      cv10       cv5       cv1    Z[t-bar]     P-value
   -3.198    -2.730    -2.860    -3.100     -2.526       0.006
```

- cap

```
Pesaran's CADF test for cap
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (7,21)          Obs = 140

    t-bar      cv10       cv5       cv1    Z[t-bar]     P-value
   -3.095    -2.730    -2.860    -3.100     -2.233       0.013
```

-aen

```
Pesaran's CADF test for aen
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (7,21)          Obs = 133
```

t-bar	cv10	cv5	cv1	Z[t-bar]	P-value
-3.711	-2.730	-2.860	-3.100	-3.985	0.000

-cap_crr_uemoa

Pesaran's CADF test for cap_crr_uemoa
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (7,21) Obs = 140

t-bar	cv10	cv5	cv1	Z[t-bar]	P-value
-4.100	-2.730	-2.860	-3.100	-5.092	0.000

-nfa

Pesaran's CADF test for nfa
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (7,21) Obs = 140

t-bar	cv10	cv5	cv1	Z[t-bar]	P-value
-3.013	-2.730	-2.860	-3.100	-2.000	0.023

Appendix 1.4 : Estimation of instrumental variables method

- Estimate 1 : Conduct of macroprudential policy in the WAEMU area

G2SLS random-effects IV regression — Number of obs = 130
Group variable: Années — Number of groups = 20

R-sq:
within = 0.1624
between = 0.2808
overall = 0.2166

Obs per group:
min = 4
avg = 6.5
max = 7

Wald chi2(9) = 36.71
corr(u_i, X) = 0 (assumed) — Prob > chi2 = 0.0000

crd_gap	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Lcrd_gap	.8905367	.3445149	2.58	0.010	.2152998	1.565774
cap	-.0121267	.0723107	-0.17	0.867	-.153853	.1295996
Lcrr_bale3	-1.140635	1.110893	-1.03	0.305	-3.317945	1.036676
Lcrr_uemoa_cap	.4029609	.2918969	1.38	0.167	-.1691465	.9750682
Lcrr_uemoa	-7.428054	3.690975	-2.01	0.044	-14.66223	-.1938752
Llev_bale	-1.347703	.8694007	-1.55	0.121	-3.051697	.3562913
Lreserve_nat	-1.218332	.5103406	-2.39	0.017	-2.218581	-.2180827
Lreserve_fed	.6840573	.5909634	1.16	0.247	-.4742097	1.842324
nfa	-.1591412	.2151638	-0.74	0.460	-.5808546	.2625722
_cons	2.694484	1.520644	1.77	0.076	-.2859235	5.674892

- Estimate 2 : Conduct of macroprudential policy at the national level

```
G2SLS random-effects IV regression              Number of obs      =       140
Group variable: Pays                            Number of groups   =         7

R-sq:                                           Obs per group:
     within  = 0.1729                                         min =        20
     between = 0.2693                                         avg =      20.0
     overall = 0.1705                                         max =        20

                                                Wald chi2(6)       =     32.40
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

crd_gap	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Lcrd_gap	1.265504	.3281476	3.86	0.000	.6223471	1.908662
Lcrr_uemoa_cap	.501488	.3555057	1.41	0.158	-.1952905	1.198266
cap	-.0368816	.070776	-0.52	0.602	-.1755999	.1018367
Lcrr_uemoa	-11.70501	4.63615	-2.52	0.012	-20.7917	-2.618327
Lreserve_nat	-.7442812	.6416796	-1.16	0.246	-2.00195	.5133877
nfa	.0311711	.0254341	1.23	0.220	-.0186787	.081021
_cons	.8532949	1.015493	0.84	0.401	-1.137034	2.843624

- Estimates 3 and 4 : Conduct of macroprudential policy common to core and periphery countries (presence of structural heterogeneity)

✓ «Core »countries

```
G2SLS random-effects IV regression              Number of obs      =        32
Group variable: Pays                            Number of groups   =         2

R-sq:                                           Obs per group:
     within  = 0.3837                                         min =        13
     between = 1.0000                                         avg =      16.0
     overall = 0.3494                                         max =        19

                                                Wald chi2(5)       =     12.96
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0238
```

crd_gap	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Lcrd_gap	-.1284427	.5967405	-0.22	0.830	-1.298033	1.041147
Lcrr_uemoa_cap	.0342561	.1724034	0.20	0.842	-.3036484	.3721605
cap	.0428832	.1873435	0.23	0.819	-.3243034	.4100697
Lreserve_fed	-3.040226	1.383434	-2.20	0.028	-5.751707	-.328745
nfa	1.081905	.5582116	1.94	0.053	-.0121695	2.17598
_cons	-1.538812	2.496586	-0.62	0.538	-6.43203	3.354406

✓ «periphery »countries

G2SLS random-effects IV regression — Number of obs = 81
Group variable: Pays — Number of groups = 5

R-sq:
within = 0.7075
between = 0.9600
overall = 0.8037

Obs per group:
min = 13
avg = 16.2
max = 18

Wald chi2(5) = 157.00
corr(u_i, X) = 0 (assumed) — Prob > chi2 = 0.0000

crd_gap	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Lcrd_gap	.9922443	.2160195	4.59	0.000	.5688539	1.415635
Lcrr_uemoa_cap	.0163162	.1358851	0.12	0.904	-.2500136	.2826461
cap	-.1893557	.2663881	-0.71	0.477	-.7114667	.3327553
Lreserve_fed	3.640297	1.143259	3.18	0.001	1.399551	5.881043
nfa	.5068399	.4062294	1.25	0.212	-.2893552	1.303035
_cons	2.957531	7.572232	0.39	0.696	-11.88377	17.79883