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Capital, risk and profitability of WAEMU banks: Does bank ownership matter?

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ABSTRACT

We investigate the simultaneous relationship among bank capital, risk and profitability, but also considering bank ownership and the emergence of Pan-African cross-border banks. We specify a simultaneous equation model and estimate it using hand-collected bank level data from all West African Economic and Monetary Union (WAEMU) countries for 2000–2014. We split the countries into lower middle-income (LMICs) and low-income (LICs) according to the World Bank classification. We uncover evidence that the sensitivity of bank profitability to an increase in capital ratio seems to be somewhat higher in LMICs (+0.10) than in LICs (+0.05). Moreover, we find that bank capital positions tend to comove positively with the business cycle in LICs, mimicking a key postulate of Basel III. After differentiating between cross-border Pan-African banks and foreign banks from outside the continent, we find that the overall effect of bank ownership on risk depends on the origin of banks (French versus Pan-African). These findings are robust to alternative estimation techniques and the use of competing measures of risk and profitability.

1. Introduction

The current Basel Capital Accord (Basel III) regulation proposes to increase bank capital adequacy ratio to contain risk-taking behaviour and contribute to making the banking sector more stable and resilient to crises. However, policy makers have mixed views on high capital requirements. For example, at the G20 meetings on July 22-23, 2016 at Chengdu, China, European Union Finance Ministers sought to protect their banks from high capital requirements.[1] The concern is that while they may provide a buffer against unexpected losses, high capital requirements constrain the banks' capacity to lend. On the one hand, an increase in capital requirements in the post-crisis environment – where the main concern is to strengthen financial institutions – will likely support resilience and increase lending in the banking sector (e.g., Kim and Sohn, 2017; Altunbas et al., 2016; Noss and Toffano, 2016; Buch and Prieto, 2014; Berrospide and Edge, 2010). On the other hand, high capital requirements may constrain banks' capacity to lend because equity funding is costly (e.g., Aiyar et al., 2014; Bridges et al., 2014; Gambacorta and Mistrulli, 2004; Kishan and Opiela, 2000).

Beyond this ambiguous relationship between bank capital and lending, what is more curious is the exact impact of bank capital on bank risk-taking and bank profitability, as these three interrelated indicators (capital, risk and profitability) affect bank asset allocation and lending in a simultaneous manner. Indeed, while some researchers document a positive relationship between capital and risk, i.e. bank capital and bank risk appetite increase together (e.g., Altunbas et al., 2007), others find a negative relationship between capital and risk, i.e. banks tend to increase (decrease) their risk positions as capital declines (increases) (e.g., Guidara et al., 2013; Lee and Hsieh, 2013). Similar dichotomous conclusions have been found regarding the relationship between bank capital and bank profitability. For instance, while Iannotta et al. (2007), among many others, found that a high level of bank capital is associated with a high level of bank profitability, others such as Goddard et al. (2013) uncovered an inverse relationship between the two indicators. Overall, these issues remain unresolved, notwithstanding the urgent need for research to inform

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[1] From John Rega, MLEX, on 8th July 2016: "EU will press G-20 to go easy on bank capital standards".

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policy on implications of adopting high bank capital requirements as an integral component of Basel III.

This paper responds to the above demand for more knowledge by policy makers as well as the gaps in existing research. It aims to investigate the simultaneous relationship among capital, risk and profitability in the banking sector of the West African Economic and Monetary Union (WAEMU). Several reasons justify the relevance of this study to the WAEMU banking sector. Firstly, the financial sector of the WAEMU[2] region is bank-based; i.e. banks are the predominant source of finance for businesses and households (see Appendix B for statistics related to access to financial services). In such an economic environment, increasing the bank capital adequacy ratio may constrain the lending capacity of banks, notwithstanding the possible benefit of providing a healthy banking system. Nevertheless, following several other banking sector regulators around the World, especially from the developed economies, the WAEMU regional banking sector regulator adopted the new Basel III regulatory framework in June 2016, which subsequently became effective on January 1st, 2018. The adoption constituted a steep jump from the Basel I regulation to the more complex Basel III regulation.[3] The effects of this new regulation on the region banking sector and its economy have yet to be proven, and to the best of our knowledge, no such study exists. In addition, we are not aware of any empirical investigation on the possible impact of the implementation of Basel III regulation in the WAEMU economies on bank risk and profitability in the region. There is need, therefore, of an empirical study that can serve as a guiding tool towards the implementation of Basel III framework in the WAEMU region and in other similar developing economies.

Secondly, although a substantial body of research exists on the relationship among bank capital, risk and profitability, the literature focuses mostly on the banking sector in developed economies (mostly U.S. and European banks) and banks in emerging markets in Asia,[4] with much less attention paid to the banking sector in the developing economies of Africa, particularly in the WAEMU region. The question that arises is whether the results found with respect to developed economies are meaningful for the WAEMU region. Moreover, the existing studies rely mainly on Bankscope data to construct the sample of banks (which covers less than 75% of banks in the region), perhaps missing valuable information on the WAEMU context. This region is, therefore, an interesting laboratory for investigation.

Thirdly, as shown later in the empirical section (Table 8), bank ownership in the region has been dominated by foreign investors and over the last decade there has been a steady increase in the share of cross-border Pan-African banks. There is a debate on the relationship between capital ownership and risk-taking behaviour of banks. To the best of our knowledge, this is the first study to investigate the effect of the entry of pan-African banks in the WAEMU on banks' risk-taking, profitability and capital.

Along with the focus on the banking sector in the WAEMU, this paper makes four contributions to the existing literature by providing answers to the following research questions: How sensitive is bank profitability to changes in bank capital ratio in WAEMU? How sensitive is bank risk-taking to changes in bank capital ratio in WAEMU? What is the relationship between bank capital and the business cycle in WAEMU? Does bank ownership status matter in WAEMU?

For the first contribution, we analyse the relationship between bank capital and profitability. The well-established puzzle in corporate finance is that leverage is inversely correlated with measures of profitability (Danis et al., 2014). The main prediction arises from the static trade-off theory of capital structure, which posits that firms choose levels of debt in order to balance the benefits of the tax-shield with the costs of future financial distress (Frank and Goyal, 2003). But, some recent studies which introduce capital adjustment into a dynamic trade-off model find evidence for both positive and negative relationship between profitability and leverage (Danis et al., 2014). The puzzle persists. Moreover, standard pecking order theory predicts that firms have a pecking order of the choices they make for increasing leverage, starting with retained earnings (if the firms is generating more profits), then bank debt and finally issuing of equity capital. Specifically, in the presence of asymmetric information, a firm typically follows a hierarchy of financing choices, in which the final choice is to issue new equity (Myers and Majluf, 1984). Profitable firms are more likely to generate more retained earnings; hence these firms do not need to depend so much on external finance; accordingly, the pecking order theory predicts a negative relationship between profitability and leverage. We test the relationship between capital and profitability of WAEMU banks, in the context of the predictions of the trade-off theory (inverse as well as positive relationship) and the pecking order theory (inverse relationship) from the corporate finance literature.

For the second contribution, we investigate if bank risk-taking behaviour in the WAEMU is sensitive to bank capital. The *regulatory hypothesis* predicts that better capitalised banks are susceptible to be riskier while the *moral hazard hypothesis* suggests that banks tend to increase their risk positions as capital declines. Therefore, there are two conflicting views regarding the effect of bank capital on risk-taking. Our empirical analysis will shed light on which one of these hypotheses holds for WAEMU banks.

For the third contribution, we try to understand how banks build their capital ratios. Specifically, we are interested in the dynamics of bank capital adjustment during the business cycle, mainly because a key postulate of the Basel III Accord is that banks can build strong capital buffers to achieve a countercyclical outcome. This is consistent with the theoretical literature which has identified the *liquidity channel* and the *lending channel* as being two of the main mechanisms through which business cycles affect banks activities.[5] After a macroeconomic shock, banks may face liquidity shortage, and this may affect their lending capability, given the limited resources available (Shleifer and Vishny, 2010; Allen and Gale, 2004; Bernanke and Gertler, 1989). In addition, because of the increased uncertainty on borrowers' ability to repay during economic downturns, it increases banks temptation to cut their loan volume (Berger and Udell, 2004; Stiglitz and Weiss, 1981). Hence, in the context of the Basel III regulatory framework in the WAEMU region, we would like to know how bank capital buffers behave throughout the business cycle.

Finally, for the fourth contribution, we study whether the presence of Pan-African banks affects the relationship among bank capital, risk and profitability. The banking sector in the WAEMU region is dominated by foreign banks, and over the last decade, the share of cross-border Pan-African banks has steadily increased.

[2] The WAEMU region is a common economic and monetary union of eight least developed countries (Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal and Togo) which share a common currency (the CFA Franc or XOF) pegged to the Euro. The CFA Franc was pegged to the French Franc before the introduction of the Euro. Based on the World Bank 2016's country classification, two of the eight countries of the region, Ivory Coast and Senegal, are among the group of lower-middle-income economies, while the other six countries belong to the low-income economies group.

[3] The regulation until December 31st, 2017 was mainly based on Basel I regulatory framework with a minimum capital adequacy ratio of 8% and a constraint on banks' core capital that must be at least equal to the statutory minimum capital (BCEAO, 2013). Table A1 gives a summary of the prudential framework in WAEMU until December 31st, 2017.

[4] See Lee and Hsieh (2013) for a comprehensive literature review and the extension of previous work on Asia.

[5] See Brunnermeier (2009) for a summary of the different channels.

Table 1
Comparison between our hand-collected data sample and Bankscope data sample.

Country	Number of banks		
	Sample of the paper	Bankscope	Listed
Benin	13	9	1
Burkina Faso	13	10	2
Ivory Coast	26	18	4
Guinea-Bissau	4	1	0
Mali	13	11	0
Niger	11	7	1
Senegal	20	20	1
Togo	13	8	1
Total	113	84	10

This table reports, for each of the WAEMU countries, the number of banks in our sample, the number of banks in Bankscope and the number of listed banks.

Pan-African banks are indigenous African banks whose headquarters are in Africa. While the proportion of foreign banks grew from 63% in 2000 to 79% in 2015, that of cross-border Pan-African banks steadily increased from 29% in 2000 to 64% in 2015. Given this feature on the ownership structure in the banking sector of the region, it is then appropriate to see how the increasing presence of foreign banks and cross-border Pan-African banks has affected the dynamics among capital, risk and profitability. The literature provides two contrasting predictions about bank ownership and risk-taking behaviour[6]. While the *theory of market risk* argues that foreign banks are riskier than domestic banks due to their limited knowledge of the host-country market (e.g., Iannotta et al., 2007; Gleason et al., 2006; Amihud et al., 2002), other studies, such as Barry et al. (2011), Berger et al. (2005) and Shleifer and Vishny (1997), show that foreign ownership is associated with lower risk since these banks may also have better access to capital markets, superior ability to diversify risks and access to superior technologies for collecting and assessing "hard" quantitative information. We examine the empirical validity of the two views in explaining the difference in risk-taking between cross-border Pan-African and non-Pan-African banks in the WAEMU.

Using hand-collected bank level data from all WAEMU countries for 2000-2014, this paper contributes to the ongoing debate by providing evidence relating to the potential impact of the current Basel III regulatory changes on the region banking system. The paper relies on official bank balance sheet data, which is an interesting alternative to the Bankscope data that do not cover the African countries very well, as shown in Table 1 in which we compare our dataset with that of Bankscope. Also, we split the countries into lower middle-income (LMICs) and low-income (LICs) according to the World Bank classification. We uncover four new important findings. Firstly, we find that higher capital ratios are associated with better profitability. The effect of bank capital on profitability seems to be somewhat higher in LMICs (+0.10) than in LICs (+0.05). Secondly, we uncover a positive relationship between risk and capital, consistent with the *regulatory hypothesis*: on average, one-unit percentage increase in capital ratio leads to 1.2 basis points increase in banks' credit risk (loan loss reserves ratio) in LMICs and 23.8 basis points increase in banks' risk (Z-score) in LICs. Thirdly, we find that bank capital positions tend to comove positively with business cycle in LICs as opposed to their LMICs peers, meaning that banks in LICs build up excess capital buffer during expansion and use the additional capital during recession to cover excess risk. Fourthly, the results show that international foreign banks (mainly French) lend more and are bigger in size than domestically-owned and cross-border Pan-African banks. It seems that domestic banks and cross-border Pan-African banks have higher risk-taking appetite. One possible explanation is that domestic and cross-border Pan-African banks strive to attract customers from well entrenched international foreign-owned banks and tend to be lax in granting credit. Perhaps, these banks attract less good customers who are not able to get credit with well-entrenched international foreign-owned banks.

Overall, the heterogeneity in levels of financial sector development and the institutional background of countries in WAEMU region seem to matter. Also, the findings are robust to the use of alternative measures of risk and profitability as well as alternative estimation techniques.

The remainder of this paper is organized as follows. Section 2 presents an overview of the related literature and the main hypotheses. Section 3 presents the data, the model and the variables. Section 4 presents the data cleaning method and the results from the univariate and bivariate analyses. Section 5 presents the multivariate empirical results, including additional robustness checks. Finally, Section 6 concludes.

2. Related literature and hypotheses development

There is a rich theoretical and empirical literature, exploring the relationship among capital, risk and profitability in the banking sector[7], which is related to this paper. The theoretical literature offers two conflicting views on the relationship between bank performance and bank capital. The *static trade-off-theory* states that firms balance tax savings from debt against deadweight bankruptcy costs. This theory predicts a negative relationship between bank's profitability and capital, where profitable firms are expected to have more debt (e.g., Jensen, 1986). However, capital adjustment plays an important role; for example, when Danis et al. (2014) introduce leverage rebalancing in a dynamic trade-off model, they find a positive relationship between leverage and profitability, but with further rebalancing towards an optimum leverage level, they find that at times the cross-section correlation between leverage and profitability is negative.

In addition, another interesting theory of corporate capital structure, the *pecking-order theory*, predicts an inverse relationship between profitability and leverage. In the presence of asymmetric information, a firm typically follows a hierarchy of financing choices. The firm prefers internal finance first, but if internal capital is insufficient, the firm issues debt. The last alternative is to issue new equity (Myers and Majluf, 1984). Profitable firms are more likely to generate more retained earnings; hence these firms do not need to depend so much on external finance. It follows that highly profitable firms tend to deplete their internal capital first rather than face the last resort of going for external finance and exposing themselves to external monitoring and possible loss of control to new shareholders, such that firm leverage decreases with profitability. The adverse selection costs of issuing equity are large enough to render either costs or benefits of debt and equity second order.

In terms of empirical verification, the trade-off theory and the pecking order theory have experienced both successes and challenges[8]. However, we argue that bank capital could serve as a cushion to increase the share of risky assets, such as loans. Although the existing literature presents an ambiguous view on the effect of bank capital on lending, we base our argument on the assumption that holding a large share of capital is a signal of cred-

[6] See Zhu and Yang (2016) for a review of the existing literature.

[7] See, for instance, Goddard et al. (2013), Guidara et al. (2013), Lee and Hsieh (2013), Jokipii and Milne (2011), Altunbas et al. (2007), Iannotta et al. (2007), Goddard et al. (2004), Rime (2001), Jacques and Nigro (1997), Kwan and Eisenbeis (1997), and Shrieves and Dahl (1992), among many others.

[8] See the review of Graham and Leary (2011).

itworthiness, especially in the context of WAEMU where banks are the main source of finance for businesses and households. In this context, we further argue that well-capitalised banks tend to borrow less to support their asset (lending) expansion compared to undercapitalised banks, suggesting a positive relationship between bank capital and profitability. Indeed, some empirical studies find support to this theoretical prediction that bank's capital is positively related to bank performance (Dietrich and Wanzenried (2014); Goddard et al., 2004; Demirguc-Kunt and Huizinga, 2000; Berger, 1995), even in Sub-Saharan Africa (Munyambonera, 2013). Given these empirical results and our arguments about the special role of bank capital in support of bank confidence to lend and increase profitability, we formulate the bank capital and bank profitability hypothesis, as:

Hypothesis 1. A positive relationship exists between capital and profitability among banks in WAEMU.

Our paper is also related to the theoretical and empirical literature examining the relationship between bank capital and risk-taking. This literature is driven by the *regulatory hypothesis* and the *moral-hazard hypothesis*. The former posits that regulators encourage banks to hold more capital to cover risk exposure. In this context, a positive relationship between capital and risk may be attributed to the actions of regulators and supervisors (Altunbas et al., 2007; Shrieves and Dahl, 1992). What is rather complex is the causality of the inverse relationship between bank capital and risk. It is intuitive to expect that as the bank builds more capital the impact is to reduce risk. But another possibility is offered by the *moral hazard hypothesis* whereby banks tend to increase their risk positions as capital declines, when their leverage and risk positions are already high. Our empirical analysis will help shed light on which one of these hypotheses hold for WAEMU banks. Specifically, we expect the behaviour of WAEMU banks to be supported by the regulatory hypothesis, i.e. *bank risk increases with bank capital,* because of the strong role of the regulator since the banking crisis of the 1980s, whereby the regulator has provided an enabling environment to support the ability of banks to lend (see Table A1). Based on the foregoing argument and related evidence in the literature, we formulate our second hypothesis as:

Hypothesis 2. In WAEMU, as bank capital increases, bank risk-taking also goes up.

Furthermore, the theoretical banking literature argues that following a macroeconomic shock, banks may face liquidity shortage from both wholesale market and depositors, which may limit their lending capability (Shleifer and Vishny, 2010; Allen and Gale, 2004; Bernanke and Gertler, 1989). In addition, because of the increased uncertainty on borrowers' ability to repay, banks may ration credit to remain solvent (Berger and Udell, 2004; Stiglitz and Weiss, 1981). Empirical evidence on the relationship between banks' capital buffers and the business cycle is conflicting. A positive co-movement has been found by Guidara et al. (2013), Stolz and Wedow (2011) and Bikker and Metzemakers (2007), among many others, implying that banks must accumulate capital during economic booms, to be used during troughs when capital is scarce and costly. However, negative co-movement between bank capital and the business cycle has been documented by Behn et al. (2016), Repullo and Suarez (2013), Shim (2013), Jokipii and Milne (2008), Ayuso et al. (2004), Lindquist (2004), among many others, suggesting that banks' capital ratio is higher during recessions and lower during economic expansions. In this paper, we expect a positive relationship between bank capital and the business cycle. In fact, banks in WAEMU tend to ride on the business cycle to meet not only the minimum capital requirement effective since 2008, but also to transition from Basel I to Basel II and III. Hence, we formulate our third hypothesis as follows.

Hypothesis 3. A positive relationship exists between bank capital and the business cycle in WAEMU.

Finally, our work is related to the growing literature on the impact of the presence of cross-border banks on the domestic banking system[9], especially their effect on capital, risk and profitability. The bank ownership literature provides two contrasting predictions about ownership and risk-taking behaviour. On the one hand, the *market risk theory* argues that foreign banks are riskier than domestic banks because the former face an information disadvantage (limited knowledge) in the host-country market due to problems in managing from a distance and accessing "soft" qualitative information about local conditions (e.g., Berger et al., 2003; Buch 2003). Also, some studies suggest that new entrants in the banking market incur higher risk (e.g. high level of non-performing loans) because they compete by granting loans mostly to insolvent customers that shift from incumbent banks (e.g., Chen et al., 2017; Iannotta et al., 2007; Gleason et al., 2006; Amihud et al., 2002). On the other hand, foreign-owned banks may also have better access to capital markets, superior ability to diversify risks, access to superior technologies for collecting and assessing "hard" quantitative information. Therefore, foreign ownership could be associated with lower risk (e.g., Barry et al., 2011; Berger et al., 2005; Shleifer and Vishny, 1997). Moreover, foreign banks might realize higher profitability than domestic banks in developing countries due to their higher operational efficiency and lower cost of funding (Pelletier, 2018; Dietrich and Wanzenried, 2014; Micco et al., 2007). We expect a positive relationship between foreign ownership and bank performance, as in Pelletier (2018) and Dietrich and Wanzenried (2014), but also possible is a negative relationship with risk as in Berger et al. (2005). Hence, based on the above theoretical and empirical literature, and given the intrinsic structure of the WAEMU banking structure, with entrenched French banks, we predict that bank ownership matters in WAEMU. Further, since Pan-African cross-border banks have expanded rapidly into the regional banking sector, these banks will more likely intensify competition within the industry. However, given the fact that French banks are the oldest and are well entrenched into the region banking system, the new comers need to expand credit to less creditworthy borrowers. We therefore argue that Pan-African ownership is associated with an increase in risk-taking in WAEMU. Hence, we formulate our fourth hypothesis as follows.

Hypothesis 4. Pan-African bank ownership increases bank risk-taking in WAEMU.

3. Sample, model and variables

3.1. Sample

We hand-collect the data from annual balance sheet reports of banks operating in the WAEMU region from 2000 to 2014. It is the unique dataset made available by the Banking Commission of WAEMU. The dataset is preferable to Bankscope data and helps to avoid selection bias since while all the banks of the region do not necessarily report to Bankscope, they are all required to report to the Banking Commission of WAEMU. Indeed, Table 1 compares our sample with the number of banks in Bankscope. From this table, it appears that 29 out of 113 banks do not report to Bankscope,

[9] See Pelletier (2018), Chen et al. (2017), Beck (2015), Kodongo et al. (2015), Claessens and van Horen (2015, 2014a, 2014b), Dietrich and Wanzenried (2014), Cull and Martinez-Peria (2010), Detragiache et al. (2008), Claessens et al. (2001) and Demirguc-Kunt and Huizinga (2000), among many others.

representing 26% of the sample. In addition, we report the number of listed banks. Only 10 banks are listed. Moreover, in the WAEMU regional stock market, many of the listed stocks are not traded frequently, making many of the observed market variables less reliable in this context.[10] We therefore prefer to rely on accounting audited financial statements data, which are readily available and more reliable.

The sample contains all type of banks (commercial, investment, private and public) as defined by the Banking Commission of WAEMU. We attempt to classify banks in terms of public versus private ownership based on the proportion of shares owned by the state and private investors. A bank is classified as state-owned if the public sector (the government or a government alike entity enterprise) of the country in which it operates (host country) is the main shareholder or the public sector in the home country is the main shareholder of the parent company. Only 27.15% of our sample (bank-year) are state-owned banks.

Although some banks (one per country except for Guinea-Bissau) bear the name of investment banks, it is not easy to differentiate them from their commercial peers based on their name or their balance sheet information. First, we do not know, from the balance sheet, the type of activities in which each bank is involved. Second, the asset side of the balance sheet does not allow us to identify the type and the maturity of the assets because this information is not reported. Hence, to avoid possible misclassification, we do not categorise the banks.

Our sample is composed of 113 banks over the study period 2000–2014, including surviving banks, non-surviving banks and merged banks. In 2014, the total number of surviving and new banks in the region was 107. This gap in the data is due to mergers and acquisitions over the sample period. We consider each bank over its period of existence and combine some observations in case of mergers and acquisitions. Therefore, any bank for which balance sheet information is available is considered in our analysis. Ivory Coast (26) and Senegal (20) have the largest number of banks and they belong to the lower-middle income group in the region. The total number of observations is 1293 and the average number of observations per bank is 11 (varying between 2 and 15).

3.2. The econometric model

We take inspiration from the trade-off theory and the pecking order theory of corporate capital structure, in terms of the predictions for the relationship between profitability and leverage. We also note that capital adjustment is important as highlighted in Section 2. In addition, we seek a theoretical and empirical framework that can capture the simultaneous interactions among capital, risk and profitability. For that matter, we adopt the partial adjustment framework of Rime (2001), Jacques and Nigro (1997) and Shrieves and Dahl (1992), by assuming that banks target optimal capital, risk and profitability levels toward which they adjust partially each period. The partial adjustment model is justified here by the fact that capital building, risk-adjustment and profit-generating activities are time sensitive and resource consuming, and banks cannot adjust totally these variables during a single period.

Denoting by ΔY_{it} the variable of interest, the partial adjustment behaviour is:

$$\Delta Y_{it} = \lambda\left(Y_{it}^{*} - Y_{it-1}\right) + \eta_{it} \tag{1}$$

where i indexes bank, t indexes year and η_{it} is the idiosyncratic error term. Eq. (1) reads as follows: Each year, banks adjust a proportion $\lambda(0 < \lambda < 1)$ of the difference between their *desired* (or long-term) level Y_{it}^{*} and their actual level, Y_{it-1}. We assume that the long-term target Y_{it}^{*} is a function of bank characteristics and is expressed as follows:

$$Y_{it}^{*} = \alpha_0 + X_{it-1}\beta^{*} \tag{2}$$

where X_{it-1} is the vector of bank-level variables and macroeconomic indicators. Plugging (2) into (1) yields:

$$\Delta Y_{it} = \lambda(\alpha_0 + X_{it-1}\beta^{*} - Y_{it-1}) + \eta_{it} = -\lambda Y_{it-1} + \lambda\alpha_0 + X_{it-1}\lambda\beta^{*} + \eta_{it} \tag{3}$$

However, unlike earlier studies (e.g., Rime, 2001; Jacques and Nigro, 1997; and Shrieves and Dahl, 1992) which use a system of two simultaneous equations, we consider a system of three simultaneous equations, as in Guidara et al. (2013), Altunbas et al. (2007) and Kwan and Eisenbeis (1997), to cope with potential endogeneity between capital, risk and profitability. We therefore consider the following system of simultaneous equations:

$$\Delta PROFIT_{it} = \alpha_0 + \alpha_1 PROFIT_{it-1} + \alpha_2 \Delta CAR_{it} + \alpha_3 \Delta RISK_{it} + \sum_{p=1}^{P} \delta_p X_{pit-1} + \sum_{k=1}^{K} \theta_k Z_{kjt-1} + \mu_{1i} + \upsilon_{1t} + \varepsilon_{it} \tag{4}$$

$$\Delta RISK_{it} = \beta_0 + \beta_1 RISK_{it-1} + \beta_2 \Delta CAR_{it} + \beta_3 \Delta PROFIT_{it} + \sum_{p=1}^{P} \vartheta_p X_{pit-1} + \sum_{k=1}^{K} \rho_k Z_{kjt-1} + \mu_{2i} + \upsilon_{2t} + \eta_{it} \tag{5}$$

$$\Delta CAR_{it} = \gamma_0 + \gamma_1 CAR_{it-1} + \gamma_2 \Delta RISK_{it} + \gamma_3 \Delta PROFIT_{it} + \sum_{p=1}^{P} \zeta_p X_{pit-1} + \sum_{k=1}^{K} \xi_k Z_{kjt-1} + \mu_{3i} + \upsilon_{3t} + u_{it} \tag{6}$$

where i=1,...,N and t=1,...,T denote bank and time respectively, $\mu_{1i}, \mu_{2i}, \mu_{3i}$ are unobserved bank-specific effects and $\upsilon_{1t}, \upsilon_{2t}, \upsilon_{3t}$ are time-specific effects, ε_{it}, η_{it} and u_{it} are idiosyncratic error terms. The parameters α_1, β_1, γ_1 correspond to $-\lambda$ (see Eq. (3)). Therefore, they are expected to be negative. $PROFIT_{it}$, $RISK_{it}$, and CAR_{it} are, respectively, the profitability, risk and capital ratio indicators of bank i at time t. $X_{1it}, X_{2it}, \ldots, X_{Pit}$ are bank-specific control variables, $Z_{1jt}, Z_{2jt}, \ldots, Z_{Kjt}$ are macroeconomic and institutional quality factors described below and j=1,...,8 is the country in which the bank operates. The parameters to be estimated are δ, θ, ϑ, ρ, ζ and ξ as well as α, β and γ.

Eqs. (4) and (5) are designed to examine the impact of capital adjustment on bank profitability and risk, respectively. Eq. (6) captures the simultaneous capital adjustment dynamic of the banks. Besides addressing endogeneity issues, this equation allows us to study the sensitiveness of bank capital to changes in risk and profitability.

3.3. Variables

3.3.1. Endogenous variables: capital, risk and profitability measures

We proxy bank capital ratio by total equity-to-asset ratio (*CAR*), as commonly done in the literature, e.g. Guidara et al. (2013) and Flannery and Rangan (2008). Capital is computed using the BCEAO (2013) definition of core and supplementary capital.[11] For

[10] The turnover ratio, i.e. the trading value as a proportion of market capitalisation, was 3.1% in the regional stock market based in Ivory Coast compared to 110% in the OECD countries in 2013.

[11] The capital ratio is equivalent to the non-risk based leverage ratio imposed by Basel III regulation. As alternative measure of capital, we could use the risk-based capital adequacy ratio, proxied by capital to risk-weighted assets (RWA); unfortunately, we do not have enough detailed information to compute the RWA, we therefore rely only on capital-to-asset ratio. Nevertheless, this latter variable is appropriate and will yield similar results as will capital-to-RWA, since in this region, RWA measures are composed of credit risk and assets are mainly loans.

the profitability indicator (*PROFIT*), we use three alternative indicators to measure profitability: return-on-assets (*ROA*), return-on-equity (*ROE*) and net-interest-margin to total assets ratio (NIM).[12] As mentioned before, over the study period, the prudential framework in the WAEMU region is based essentially on the Basel I regulation. However, the BCEAO and the Banking Commission adopted the Basel III regulatory frameworks with effect on January 1st, 2018. This study can therefore serve as a guiding tool towards its successful implementation. As summarized in Appendix A, risk is managed by imposing some solvency ratios to each bank of the Union: minimum capital amount requirement, risk coverage ratio (also known as the risk-based capital adequacy ratio), liquidity ratio and limitation of commitments on a same signature.

To assess the quality of bank assets, the Banking Commission uses the gross rate of banks' portfolio deterioration defined as the ratio of non-performing loans to total loans. Unfortunately, due to data constraints[13], we are unable to compute this indicator at the micro bank level. Instead, we use the following two alternative measures to capture bank's risk (*RISK*): loan loss reserves over total loan (*LLRL*) and the inverse *Z-score* calculated on ROA. Loan loss reserves (*LLRL*) is the portion of a bank's cash or cash equivalent holdings set aside to cover estimated potential losses in its loan portfolio. If the banks are more exposed to credit risk, the loan loss reserves will be higher, otherwise it will be lower. *LLRL* measures essentially credit risk. Indeed, lending is the main source of profit generating activities of banks in developing countries, like those of WAEMU, and that because financial markets are less developed, therefore companies and households rely more on bank loans. This indicator has been used by Altunbas et al. (2007) among others.

As opposite to loan loss reserves, Z-score is a risk measure commonly used to reflect a bank's probability of insolvency, e.g. Lepetit and Strobel (2013) and Hesse and Čihák (2007). According to these later authors, the indicator is inversely related to the probability of insolvency of the bank; therefore, an increase in the Z-score indicates a decrease in the bank's insolvency risk or an increase in bank stability. The standard Z-score is computed as follows.

$$Z{-}score = \frac{E[ROA] + E[CAR]}{\sigma(ROA)}, \tag{7}$$

where, $E[ROA]$ stands for expected return on average assets, $\sigma(ROA)$ denotes standard deviation of return on assets and $E[CAR]$ is the average bank's capital-to-assets ratio. We use a three-year rolling window to compute the averages and standard deviation in Eq. (7).

To facilitate the interpretation in terms of risk, we use a transformed version of the standard *Z-score*; that is:

$$\widetilde{Z{-}score} = \max(Z{-}score) - Z{-}score. \tag{8}$$

For the remainder of the paper, we refer to this transformed version as the *Z-score* measure. Therefore, an increase in the new *Z-score* indicator, called "inverse" *Z-score*, indicates an increase in a bank's risk exposure.

We use these two indicators (loan loss reserves and Z-score) because of their simplicity and because they are based on accounting information, which is readily available in developing countries, in contrast to market-based risk measures. These accounting measures of risk are, to the best of our knowledge, suitable to capture bank risk exposure in this region because of the limited depth of local financial markets. In fact, the money, bond, interbank and stock markets are not sufficiently developed (Kireyev, 2015). Particularly, the stock market is very shallow: the market capitalization in the region is only ten percent (10%) of GDP, with less than forty (40) listed firms, and less than ten (10) banks actively participating in the regional stock exchange. The equity risk exposure of the banks is therefore very limited. In addition, Beaver et al. (1970) note that accounting information is useful in assessing firm specific risk.

[12] We do not use market variables, such as stock returns, since most of these banks in the WAEMU region are not listed on the regional stock market. Even when they are listed, many of these stocks do not trade for many days, making these market variables noisy and less relevant for our study.

[13] Non-performing loans are not reported in the bank level statistics publicly available on the BCEAO website.

3.3.2. Foreign ownership and Pan-African bank status

We add the ownership structure of bank capital (foreign versus domestic) to discriminate between foreign and domestic banks. The *FOREIGN* dummy takes 1 when foreigners hold more than 50% of the bank capital, and zero otherwise. We expect foreign-owned banks to perform better, to hold higher capital ratios and to bear less risk than domestic or nationally-owned banks (Chen et al., 2017; Dietrich and Wanzenried, 2014).

The cross-border Pan-African bank status (*AFRICAN*) captures the African origin of foreign banks; i.e. regional African or cross-border Pan-African banks versus international non-African banks. The *AFRICAN* indicator takes the value of 1 when the bank is a regional African cross-border bank, and zero otherwise. We expect a positive relationship between Pan-African bank status and capital and risk. According to Léon (2016), the rapid expansion of regional Pan-African banks in WAEMU region has increased competition in the sector. Higher competition may lead to more risk since these new comers will need to compete to gain costumers, and hence, they may be tempted to lend to less solvent clients. In addition, we expect the *AFRICAN* indicator to negatively impact the profitability of banks because intensive competition may generate lower profits for the banks.

3.3.3. Control variables

We use two types of control variables: bank characteristics; and macroeconomic or country-specific factors.

3.3.3.1. Bank-specific factors. Bank-specific factors are used to control for bank idiosyncratic characteristics and banking industry common factors. The main variables are loan-to-total assets ratio and bank size:

- *Loan-to-total assets* (*LA*) is expected to be positively related to profitability and risk, as an increase in the bank's loan portfolio will result in more interest income and more credit risk. The relationship between loan-to-assets and the capital ratio is mixed. Indeed, the loan-to-assets ratio is an indicator of bank riskiness: The higher the ratio, the more the bank is exposed to higher defaults since its liquidity is low. Therefore, the moral hazard hypothesis (negative relationship) or the regulatory hypothesis (positive relationship) can hold as mentioned above.
- *Bank size (SIZE)* is measured by the logarithm of total assets. We expect this variable to negatively impact the variation of bank capital and profitability (e.g., Jacques and Nigro, 1997; Rime, 2001; Guidara et al., 2013, among others) and positively impact risk. The positive relationship between bank size and risk is supported by several theories. Firstly, according to the *unstable banking hypothesis*, large banks tend to engage more in risky activities that are financed with short-term debts. This behavior makes them more vulnerable to generalized liquidity shocks and market failures (e.g., Gennaioli et al., 2013; Shleifer and Vishny, 2010; Kashyap et al., 2002). Secondly, the *too-big-to-fail hypothesis* states that regulators are reluctant to unwind large banks; therefore, these banks tend to take-on excessive risks in the expectation of government bailouts (e.g., Farhi and Tirole, 2012). Finally, according to the *agency cost hypothesis*,

large banks that engage in multiple activities suffer from increased agency problems and poor corporate governance that can translate into systemic risk (e.g., Bolton et al., 2007; Laeven and Levine, 2007).

3.3.3.2. Macroeconomic and institutional quality factors. Macroeconomic and institutional quality indicators are used to control for external factors. These variables are:

- *Income concentration ratio (CR3)* is computed as the ratio of total net income of the three biggest banks divided by total net income of the country's banking sector. This indicator is used to capture industrial concentration and competition in the banking sector. We expect the variable to positively impact bank profitability and risk (Beck et al., 2006) and capital through retaining earnings.
- *Output gap (OUTGAP)* is used to capture the business cycle (demand side effect). It is calculated as the cyclical component of real gross domestic product (GDP) growth by applying the Hodrick-Prescott filter. We use this cyclical output gap instead of real GDP growth because it removes the trend of the time series. According to the existing literature, the relationship between the business cycle and bank capital is mixed. We will observe positive co-movement if this indicator is positively related to capital ratio (e.g., Guidara et al., 2013), and negative co-movement (e.g., Behn et al., 2016) otherwise. Moreover, according to economic intuition, we expect a positive relationship between the business cycle and bank risk and profitability.
- *Domestic credit to the economy (DCREDIT)*, measured by the ratio of total credit to the economy divided by total GDP, is used to control for the level of development of the country's financial sector. An increase in *DCREDIT* may be viewed as an improvement in the level of financial development in the country, and presumably an increase in competition within the sector. As a result, we expect a negative relationship between this variable and profitability and capital, but a positive relationship with risk. *DCREDIT* can also be a measure of credit cycle, with a high value of this indicator being an indication of leverage build-up in the financial system, hence a signal for more risk accumulation in the banking sector, for example Boar et al. (2017) and Drehmann et al. (2011).
- *Real interest rate (INTEREST)* is a proxy for the borrowing cost in the economy and is used in the model to control for the impact of the interest rate on bank lending. Higher borrowing costs to households and firms generate high profits for the bank but can also reduce loan demand. Therefore, the effect of *INTEREST* on performance is indeterminate. But, following Lee and Hsieh (2013), we except a positive effect of *INTEREST* on profitability and capital because loan distribution in developing economies is determined by supply side (Ndikumana, 2016), especially given that the WAEMU financial system is bank-based. Also, banks build capital by retaining earnings. In addition, we expect a negative relationship between *INTEREST* and bank risk since an increase in the central bank rate increases the real interest rate, while a restrictive monetary policy may reduce bank risk-taking behavior.
- *Political stability and absence of violence/terrorism (POLSTAB)* measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. This variable is used to control for the institutional quality within the country. It is one of the indicators of the Worldwide Governance Indicators. A higher value of *POLSTAB* means lower political risk or higher quality of institutions. For example, the average for 2014 was 0.04 points; the highest value was 1.54 scored by peaceful and stable Liechtenstein and the lowest value was −2.76 scored by violent and war-torn Syria. A better quality of institutions is associated with low transaction costs (Mishra and Montiel, 2013) which allows firms to adjust faster to their target capital structure (Öztekin and Flannery, 2012) and, in the case of banks, to increase their lending (Haselmann, et al., 2010). Therefore, we expect a positive relationship between *POLSTAB* and bank capital (CAR) and between *POLSTAB* and profitability. With respect to risk, we expect both positive and negative relationship. Indeed, in an enabling institutional environment, we expect banks to have better internal corporate governance, which can reduce their risk exposure. At the same time, since we posit that bank loans increase with the quality of institutions, the banks' risk exposure may increase due to the consequent increase in the sheer volume of bank loans.
- *REG2008:* We add a dummy to capture the change of capital requirement in 2008. *REG2008* takes the value of 1 after 2007 and zero before. According to the prudential framework in force since January 1st, 2000 (BCEAO, 2013), bank core capital must be at least equal to the statutory minimum capital. The minimum capital threshold was XOF 1 billion from 2000 until end of 2007. It was raised to XOF 5 billion in September 2007 with effect from 2008 and was raised further to XOF 10 billion in March 2015, with a grace period, which allows banks to conform to this new standard by July 1st, 2017 at the latest (cf. Appendix A). These successive increases in the minimum capital level aim to promote a healthy and strong banking and financial system, which in turn, is expected to effectively contribute to the financing of economic development of WAEMU member States. We control for these changes.

Table 2 gives a summary of the variables, their description and sources of data. Bank-level data are hand-collected from the balance sheet reports of the banks, obtained from the Banking Commission of WAEMU, the banking sector regulatory arm of the Central Bank of the West African States (BCEAO). Macroeconomic and institutional quality data are obtained from the BCEAO and the World Bank's World Development Indicators (WDI) and Worldwide Governance Indicators (WGI) databases.

3.4. Estimation techniques

Our econometric model comprises a system of three equations. The presence of a lagged dependent variable in the empirical model suggests dynamic panel data estimation techniques. The lagged bank profitability, risk and capital variables are likely to be correlated with the error term; also, are the control variables (loans-to-assets ratio (LA), the bank size (SIZE), the concentration index (CR3), the domestic credit to the economy as a percentage of the GDP (DCREDIT) and the output gap (OUTGAP)), although these variables are lagged in the regression. This is due to the presence of the lagged dependent variables on the left-hand side of the equation. Hence, we use the two-step system GMM method suggested by Blundell and Bond (1998), which is a better method to deal with endogeneity and other econometric issues in this study. Since GMM is an instrumental variables method, we use the level and the first differences of the variables as instruments.

The indicator of the quality of the institutions, the real interest rate, the foreign dummy, the African dummy and the regulation dummy are assumed to be exogenous. These variables are used as standard instruments for the endogenous variables.

Given that two-step GMM standard errors are biased, we employ the Windmeijer (2005) correction to obtain robust estimates

Table 2
Description of the variables.

Bank-specific variables		
CAR	Capital-to-asset ratio	BCEAO
Z-SCORE	Z-score used as risk measure	BCEAO
ROA	Return on asset	BCEAO
ROE	Return on equity	BCEAO
NIM	Net interest margin divided by total asset	BCEAO
LLRL	Loan loss reserves to total loans	BCEAO
LA	Loans to total assets	BCEAO
SIZE	Logarithm of total assets	BCEAO
FOREIGN	1 if foreigners own at least 50% of capital, 0 otherwise	BCEAO
AFRICAN	1 if pan-African bank status = yes, 0 otherwise	BCEAO
Macroeconomic and institutional quality variables		
CR3	Concentration ratio: total net income of 3 biggest banks divided by total net income of all banks in the country	BCEAO
OUTGAP	Output gap: Cyclical component of the logarithm of real GDP	World Bank's WDI
DCREDIT	Domestic credit to the economy as percentage of GDP	BCEAO
INTEREST	Real interest rate	BCEAO
POLSTAB	Political stability and absence of violence/terrorism	World Bank's WGI
REG2008	Dummy capturing change in minimum capital requirement in 2008. It takes value of 1 after 2007 and zero before	

This table presents the dependent variables and the explanatory variables in the three-equation system, their definitions, the abbreviations used in empirical results, and sources of observed data.

of the variance-covariance matrix. We also conduct tests for the first- and second-order autocorrelation in the error term, and a Hansen Test of the validity of the over-identifying restriction in our model. While sensitive to the number of instruments, Hansen Test is robust to heteroskedasticity. In addition to the Hansen's p-value, we report the number of instruments because instruments proliferation can overfit endogenous variables. We follow closely Roodman (2009a) and try to have reasonable Hansen's p-value because "… *the conventional significance levels' of 5% or 10% are not appropriate when trying to rule out specification problems*…".

Year and country dummies are included in all specifications to account for time and country effects. We use forward orthogonal deviations to purge banks' fixed effects (see Roodman 2009b; or Arellano and Bover, 1995).

We use the three-stage least squares (3SLS) estimation technique which is a full-information estimation technique for robustness check. We use internal instruments – first difference of the variables – as it is not obvious to find external valid instruments. In the estimation, the system is just-identified.

4. Data cleaning, univariate and correlation analysis

This section explains how the data are cleaned before presenting summary statistics and correlation analysis.

4.1. Data cleaning

We hand-collect the data from annual balance sheet reports of banks operating in the WAEMU region for the period 2000 to 2014 as follows. Firstly, we convert the publicly available data from the PDF format (the only available format) into an Excel spreadsheet format. Secondly, we check for each bank entry if the information in the Excel spreadsheet format matches with the information originally contained in the PDF format. Thirdly, because we use a three-year window to calculate the components of the Z-score, banks with data for less than three years are automatically dropped. Fourthly, we winsorize all variables by using the (upper and lower) adjacent values (Tukey, 1977). Indeed, let x represent a variable for which adjacent values are being calculated. Define $x_{[25]}$ and $x_{[75]}$ as the 25th and 75th percentiles of the variable x. The upper adjacent value of x is given by $x_{[75]} + 1.5(x_{[75]} - x_{[25]})$ and the lower adjacent value is defined by $x_{[25]} - 1.5(x_{[75]} - x_{[25]})$. Any data greater (lower) than the upper (lower) adjacent value are considered outliers. This is a non-parametric way to clean the data based on Tukey's procedure[14].

4.2. Univariate and correlation analysis

Table 3 gives the summary statistics of the variables. Firstly, there is great heterogeneity in the sample banks. For example, the average value of capital is 9% but it lies between −7% and 24%. Some banks are undercapitalized and do not meet the minimum capital adequacy requirements, while others are overcapitalized, relative to the stipulated benchmarks by BCEAO as stated in Appendix A. Secondly, the median return on assets (ROA) and return on equity (ROE) are 1% and 11%, respectively. The mean net interest margin is 3%. Thirdly, the mean loan loss provision of the sample is 1%. Fourthly, the proportion of foreign banks (*FOREIGN*) is 72% which means that only 28% of the banks are owned by the national private actors or by the public sector. The proportion of cross-border Pan-African banks (*AFRICAN*) is 49%. This high proportion of foreign banks is consistent with Léon (2016), who provides an overview of the recent developments in the banking industry in WAEMU and shows the emergence, since the last decade, of cross-border banks from Africa. The high statistic also supports recent empirical studies, which highlight the expansion of cross-border banking in Africa (e.g., Pelletier, 2018; Léon, 2016; Beck, 2015; and Kodongo et al., 2015).

Table 4 presents the difference test of the mean of the variables between the subsamples of LICs and LMICs. We observe significant differences between the two subsamples in terms of the bank characteristics NIM, Z-score, LLRL, SIZE, and the countries' characteristics CR3, DCREDIT, OUTGAP and POLSTAB. The result seems to sug-

[14] To compare our results to the common practice as robustness check, we winsorize all variables at 1 percent level. The results of the comparisons are available upon request. The Tukey procedure leads to the same result – except for ROA – in terms of variation of the variables and sometimes reduces much better the variance, and therefore will best help us to mitigate the impact of outliers. In fact, the Tukey graphs of each winsorized variable at 1 percent show that all variables exhibit outliers except for political stability and absence of violence (POLSTAB) and the banks' size (SIZE). In other words, the common approach used in the literature – winsorizing at 1 percent level – does not clean all the outliers. For example, the winsorized variables at 1 percent contain severe outliers: 8% for ROA and CAR, 4% for Z-score, 3% for CR3 and 2% for output gap (OUTGAP) and real interest rate (INTEREST). These outliers can generate misleading conclusions when following the standard procedure in the literature. For these reasons, we winsorize the variables using the Tukey procedure.

Table 3
Summary statistics over the sample, 2000–2014.

Variable	Obs.	Mean	Std. Dev.	Min	Q1	Q2	Q3	Max
CAR	1293	0.09	0.07	−0.07	0.05	0.08	0.12	0.24
ROA	1293	0.00	0.02	−0.04	-0.01	0.01	0.02	0.05
ROE	1293	0.11	0.26	−0.38	0.00	0.11	0.26	0.64
NIM	1293	0.03	0.02	−0.03	0.01	0.03	0.04	0.09
Z-SCORE	1170	0.84	0.14	0.00	0.82	0.86	0.92	1.00
LLRL	1293	0.01	0.01	0.00	0.00	0.00	0.01	0.03
LA	1293	0.76	0.12	0.20	0.70	0.78	0.84	1.00
FOREIGN	1293	0.72	0.45	0.00	0.00	1.00	1.00	1.00
AFRICAN	1293	0.49	0.50	0.00	0.00	0.00	1.00	1.00
CR3	1293	0.45	0.17	0.08	0.33	0.40	0.57	0.73
SIZE	1293	11.07	1.25	6.79	10.31	11.16	11.96	13.84
DCREDIT	1293	0.18	0.06	0.07	0.15	0.18	0.21	0.30
OUTGAP	1293	0.00	0.01	−0.03	−0.01	0.00	0.01	0.02
INTEREST	1293	2.17	2.12	−1.84	1.31	2.54	3.44	6.32
POLSTAB	1293	−0.54	0.74	−2.30	−1.16	−0.30	−0.02	0.74

This table reports the summary statistics for the dependent and explanatory variables of the system of three equations. The Q1, Q2 and Q3 are 25%, 50% (median) and 75% percentiles. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. Except for binary variables (*FOREIGN* and *AFRICAN*), the size of the banks and variables that lie between 0 and 1 (Z-score), all the other variables have been winsorized based on Tukey's procedure.

Table 4
Difference test between LICs and LMIs subsamples, 2000–2014.

	Low income		Lower-middle income		Comparison test	
	Obs.	Avg.	Obs.	Avg.	Diff.	*P*-Value
CAR	794	0.087	499	0.074	0.012	0.264
ROA	794	0.001	499	0.002	−0.001	0.680
ROE	794	0.105	499	0.121	−0.016	0.271
NIM	794	0.030	499	0.026	0.004***	0.006
Z-SCORE	723	0.818	447	0.882	−0.064***	0.000
LLRL	794	0.007	499	0.009	−0.001**	0.013
LA	794	0.760	499	0.767	−0.007	0.297
SIZE	794	10.876	499	11.371	−0.495***	0.000
CR3	794	0.500	499	0.372	0.127***	0.000
DCREDIT	794	0.172	499	0.201	−0.029***	0.000
OUTGAP	794	0.000	499	0.001	−0.001**	0.037
INTEREST	794	2.133	499	2.217	−0.085	0.467
POLSTAB	794	−0.262	499	−0.979	0.717***	0.000

This table compares the means of the variables in the two subsamples: low income countries (LICs) and lower-middle income countries (LMIs). The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. Comparison tests are performed using the t-test (with unequal variance). Superscripts ***, ** and * denote significance at 1%, 5% and 10% respectively.

gest that banks in LMICs take more credit risk, are bigger in size and are less concentrated than banks in LICs. The high competition among banks in LMICs and the fact that banks in these countries grant more credit to the economy can explain their relative lower net-interest-margin. The lower value of political stability indicator (POLSTAB) for LMICs is due to a decade of political turmoil in Ivory Coast, which ended when the new elected Government took office in 2011.

The high value of domestic credit to the economy (DCREDIT) in lower-middle income countries suggests that the differences observed among countries (LICs versus LMICs) is due partly to their level of financial sector development as the variable DCREDIT is usually used in the literature to measure financial sector development. As a matter of fact, since 1990, bank loans have been much higher in the two LMICs than in the other six LICs. The institutional background seems to play less role during the 2000–2014 period in the observed differences, since during the sample period, the institutional quality has been relatively low in Ivory Coast and drives down the institutional quality of the LMICs. Overall, the results presented in Table 4 confirm the heterogeneity of the banks in our sample, in a seemingly homogenous regional block of eight countries that constitute the WAEMU.

Table 5 presents correlations between any two variables. Consistent with theory, capital (CAR) is inversely and significantly correlated with the profitability (in terms of ROE) and with risk indicators (Z-score and LLRL). But, CAR is positively correlated with the other two profitability measures, namely ROA and NIM. The explanation is that with a capital increase, banks can lend more, thereby generating more interest income, hence increasing banks' profits. The negative relation found between CAR and ROE is probably due to the scaling effect, where the marginal increase in the denominator (equity) in ROE is larger than that of the numerator (net earnings). Regarding the three measures of profitability, the correlation coefficient between ROA and ROE is relatively high, at 39.5%, while the correlation between ROE/ROA and NIM is positive, but relatively low (10 and 11.5%). The two risk indicators (Z-score and LLRL) are positively correlated with a low correlation coefficient of 6.8%. Overall, the correlation coefficients between the independent variables are not too high, as shown in Table 5 (less than 50%); therefore, the risk of multicollinearity is very low in our study.

5. Econometric results and discussion

To address our research questions, we first examine all banks together and then run the estimation for the different sub-panels separately using the simultaneous Eqs. (4)–(6), stated above. Sub-panels are first built based on countries' gross national income (GNI) per capita according to the World Bank classification in 2016. Based on this classification, the full sample is divided into two sub-panels: LICs (Benin, Burkina Faso, Guinea-Bissau, Mali, Niger and Togo) and LMICs (Ivory Coat and Senegal). Thereafter, we also build sub-samples based on ownership status of banks (foreign owned versus domestic owned) and on the Pan-African bank status (cross-border Pan-African banks versus foreign banks from outside Africa).

Table 5
Pair-wise correlation matrix.

	CAR	*ROA*	*ROE*	*NIM*	*Z*	*LLRL*	*LA*	*FOR*	*AFRI*	*CR3*	*SIZE*	*DCREDIT*	*OUTGAP*	*RIR*	*POLSTAB*
CAR	1														
ROA	0.175***	1													
	(0.000)														
ROE	-0.227***	0.395***	1												
	(0.000)	(0.000)													
NIM	0.054*	0.115***	0.100***	1											
	(0.052)	(0.000)	(0.000)												
Z	-0.183***	-0.198***	0.004	-0.066**	1										
	(0.000)	(0.000)	(0.896)	(0.024)											
LLRL	-0.165***	-0.123***	-0.009	0.031	0.068**	1									
	(0.000)	(0.000)	(0.761)	(0.270)	(0.020)										
LA	0.043	0.089***	-0.027	0.197***	-0.002	-0.232***	1								
	(0.120)	(0.001)	(0.340)	(0.000)	(0.960)	(0.000)									
FOR	-0.011	-0.013	-0.013	0.013	0.046	-0.100***	0.091***	1							
	(0.688)	(0.651)	(0.652)	(0.650)	(0.116)	(0.000)	(0.001)								
AFRI	-0.031	-0.144***	-0.033	-0.011	0.048	-0.156***	-0.026	0.590***	1						
	(0.269)	(0.000)	(0.237)	(0.684)	(0.101)	(0.000)	(0.349)	(0.000)							
CR3	0.045	0.012	-0.053*	-0.058**	-0.179***	0.003	-0.003	-0.012	0.002	1					
	(0.105)	(0.669)	(0.056)	(0.036)	(0.000)	(0.925)	(0.906)	(0.667)	(0.938)						
SIZE	-0.126***	0.425***	0.275***	0.024	-0.087***	0.101***	-0.171***	-0.028	-0.171***	-0.218***	1				
	(0.000)	(0.000)	(0.000)	(0.389)	(0.003)	(0.000)	(0.000)	(0.309)	(0.000)	(0.000)					
DCREDIT	-0.020	0.072***	0.098***	-0.017	0.207***	-0.015	-0.092***	-0.023	0.062**	-0.333***	0.303***	1			
	(0.463)	(0.009)	(0.000)	(0.535)	(0.000)	(0.603)	(0.001)	(0.407)	(0.025)	(0.000)	(0.000)				
OUTGAP	-0.003	0.006	-0.002	-0.026	0.023	0.032	0.007	0.000	-0.002	0.056**	0.043	0.062**	1		
	(0.924)	(0.842)	(0.952)	(0.347)	(0.427)	(0.255)	(0.813)	(0.989)	(0.951)	(0.044)	(0.125)	(0.027)			
RIR	0.021	0.071**	0.028	0.062**	0.013	-0.011	-0.011	-0.013	-0.026	0.014	0.029	0.019	-0.002	1	
	(0.452)	(0.011)	(0.312)	(0.027)	(0.651)	(0.694)	(0.690)	(0.642)	(0.358)	(0.622)	(0.291)	(0.493)	(0.952)		
POLSTAB	0.053*	-0.006	-0.052*	-0.043	0.097***	-0.146***	0.022	0.054*	0.154***	0.205***	-0.100***	0.171***	0.008	0.083***	1
	(0.056)	(0.822)	(0.062)	(0.119)	(0.001)	(0.000)	(0.441)	(0.051)	(0.000)	(0.000)	(0.000)	(0.000)	(0.781)	(0.003)	

This table reports the pair-wise correlation matrix for the dependent and explanatory variables of the system of three equations. The mnemonics used are: *Z* = Z-score, *FOR* = FOREIGN, *AFRI* = AFRICAN, *RIR* = INTEREST. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. Values in parentheses are *p*-values which reflect the significance of each correlation. Superscripts ***, ** and * denote significance at 1%, 5% and 10%, respectively.

5.1. Main results

As mentioned above, we adopt the two-step generalized method of moments (2SGMM) estimation technique. Table 6 reports the estimation results. These results confirm the importance of setting the model in a dynamic way and justifies the use of the 2SGMM approach to overcome potential endogeneity issues. Moreover, the Hansen over-identification test does not reject the null hypothesis of correct specification, which means that our instruments are valid.

The three main variables of interest (capital, profitability and risk) indicate evidence of strong persistence over time. Indeed, the coefficient of the lagged value of the dependent variable is negative and significant in all regressions. This stems from the partial adjustment framework presented in Eq. (3). The great heterogeneity across countries justifies the sub-panel estimation and highlights specific results that we would not have found if we had controlled only for individual effects.

5.1.1. How sensitive is bank profitability to changes in bank capital ratio in WAEMU?

We first focus on the return on assets (ROA) as our main measure of bank profitability. The results in Table 6 show that there is a persistence of profitability over time. Capital has a positive and significant impact on bank performance as in Dietrich and Wanzenried (2014), Munyambonera (2013), Iannotta et al. (2007) and Goddard et al. (2004). Intuitively, a bank that holds a relatively high level of capital can expand its loans and increase its income from loans and is therefore likely to earn high profits. The impact of capital on profitability seems somehow to be somewhat higher in LMICs (+0.10) than in LICs (+0.05), with one percentage point increase in bank capital ratio leading to 10 and 5 basis points increase in profitability in LMICs and LICs, respectively. These results are consistent with the predictions of Hypothesis 1. It may be argued that banks in relatively rich economies (LMICs in WAEMU) are more efficient than those in LICs in the region because they can generate more profits with relatively less capital compare to their low-income peers.

Moreover, in the regression with CAR as dependent variable, ROA has a positive and significant impact on capital, confirming the endogeneity of the relationship between the two variables (ROA and CAR). Indeed, when a bank is profitable, it can increase its capital ratio through retained earnings, which in turn generates more lending activities and hence more profits.

5.1.2. How sensitive is bank risk-taking to changes in bank capital ratio in WAEMU?

The existing literature found mixed results with respect to the impact of variations in bank capital ratio on bank risk-taking behaviour. For example, while Altunbas et al. (2007) found a positive relationship between capital and risk, consistent with the *regulatory hypothesis* which posits that banks increase their capital with an increase in risk-taking, other researchers instead found support for the *moral hazard hypothesis*, which stipulates that banks tend to increase (decrease) their risk positions as capital declines (increases). This latter negative relationship between capital and risk may be the consequence of regulation (Guidara et al., 2013), when banks' leverage and risk positions are already high.

In Table 6, we observe a weak positive relation between CAR and the Z-score especially in low income countries. This non-significant positive relationship between risk and capital dismisses the *moral hazard hypothesis* and supports the *regulatory hypothesis*. The results are generally consistent with our Hypothesis 2. The evidence suggests that with capital increase, banks do not decrease

Table 6
Estimation of the system with ROA and Z-SCORE as profitability and risk indicators, respectively.

	AFRICAN									***FOREIGN***								
	Full Sample			Lower-middle income			Low income			Full Sample			Lower-middle income			Low income		
	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR
ROA(-1)	-0.789***			-0.790***			-0.764***			-0.805***			-0.738***			-0.748***		
	(0.082)			(0.207)			(0.087)			(0.078)			(0.193)			(0.100)		
ΔROA		-0.187	0.718*		0.127	0.406**		0.474	0.232**		-0.156	0.949*		-0.073	0.347*		0.331	0.201**
		(0.379)	(0.400)		(0.198)	(0.177)		(0.494)	(0.090)		(0.399)	(0.559)		(0.048)	(0.177)		(0.576)	(0.089)
RISK(-1)		-0.608***			-0.769***			-0.580***			-0.603***			-0.727***			-0.568***	
		(0.073)			(0.094)			(0.099)			(0.073)			(0.107)			(0.090)	
ΔRISK	-0.006		0.002	-0.001		0.005	-0.007		0.003	-0.005		0.007	-0.000		-0.008	-0.006		0.003
	(0.005)		(0.013)	(0.008)		(0.014)	(0.004)		(0.012)	(0.005)		(0.013)	(0.007)		(0.016)	(0.004)		(0.013)
CAR(-1)			-0.174**			-0.204*			-0.219***			-0.179**			-0.232*			-0.218***
			(0.076)			(0.107)			(0.067)			(0.082)			(0.121)			(0.063)
ΔCAR	0.082***	0.032		0.100*	-0.056		0.047**	0.002		0.080***	0.038		0.111**	0.014		0.046*	0.035	
	(0.018)	(0.076)		(0.052)	(0.062)		(0.021)	(0.127)		(0.017)	(0.080)		(0.050)	(0.042)		(0.023)	(0.153)	
AFRICAN	-0.004	-0.020	-0.036*	0.023	-0.022	-0.003	0.005	0.007	0.022									
	(0.006)	(0.023)	(0.021)	(0.019)	(0.023)	(0.028)	(0.006)	(0.029)	(0.020)									
FOREIGN										-0.022**	-0.001	-0.069*	0.016	0.017	0.001	-0.001	0.033	0.014
										(0.009)	(0.032)	(0.040)	(0.016)	(0.023)	(0.042)	(0.009)	(0.027)	(0.017)
LA	0.024	-0.036	-0.048	-0.000	0.015	-0.289*	0.028	-0.003	0.013	0.013	-0.021	-0.023	-0.011	0.076	-0.215**	0.029	0.013	0.004
	(0.016)	(0.050)	(0.044)	(0.016)	(0.049)	(0.156)	(0.022)	(0.066)	(0.044)	(0.019)	(0.050)	(0.055)	(0.035)	(0.067)	(0.105)	(0.025)	(0.067)	(0.039)
SIZE	0.008**	-0.028***	-0.003	0.016*	-0.021*	0.029	0.009***	-0.024**	0.006	0.006	-0.023**	0.007	0.012*	-0.015**	0.018	0.008***	-0.026**	0.004
	(0.003)	(0.010)	(0.008)	(0.009)	(0.012)	(0.029)	(0.003)	(0.011)	(0.007)	(0.004)	(0.009)	(0.008)	(0.007)	(0.006)	(0.018)	(0.003)	(0.010)	(0.007)
CR3	-0.011	-0.057*	-0.171**	0.099*	0.094	-0.069	0.002	-0.009	-0.022	-0.011	-0.061*	-0.177**	0.065	0.061	-0.053	0.001	-0.019	-0.024
	(0.008)	(0.034)	(0.070)	(0.055)	(0.109)	(0.245)	(0.008)	(0.046)	(0.015)	(0.009)	(0.035)	(0.077)	(0.067)	(0.071)	(0.367)	(0.008)	(0.044)	(0.015)
OUTGAP	0.146**	0.592**	0.327*	0.352	0.474	0.745	0.010	0.784*	0.784***	0.188***	0.557**	0.212	0.270	0.166	-2.424	0.006	0.903**	0.781***
	(0.072)	(0.264)	(0.186)	(0.418)	(0.514)	(1.973)	(0.062)	(0.419)	(0.247)	(0.071)	(0.276)	(0.219)	(0.366)	(0.890)	(2.485)	(0.065)	(0.412)	(0.251)
INTEREST	-0.000	-0.000	0.001	0.003	0.002	-0.004	-0.001	-0.000	0.003	-0.000	0.000	0.002	0.003	0.008	-0.008	-0.001*	-0.001	0.003
	(0.001)	(0.003)	(0.001)	(0.002)	(0.006)	(0.012)	(0.001)	(0.004)	(0.003)	(0.001)	(0.003)	(0.002)	(0.002)	(0.005)	(0.014)	(0.001)	(0.005)	(0.003)
POLSTAB	-0.008***	0.008	-0.002	-0.020	-0.021	-0.010	-0.006	0.026*	-0.015**	-0.009***	0.011	-0.002	-0.016	-0.010	0.090	-0.005	0.025*	-0.014**
	(0.003)	(0.009)	(0.004)	(0.018)	(0.015)	(0.070)	(0.003)	(0.014)	(0.006)	(0.003)	(0.009)	(0.006)	(0.017)	(0.030)	(0.118)	(0.004)	(0.013)	(0.007)
DCREDIT	-0.091	-0.071	-0.033	-0.185	0.333	-0.681	-0.089*	-0.097	-0.128	-0.098*	-0.086	0.002	-0.199	-0.018	1.679	-0.086	-0.160	-0.132
	(0.056)	(0.216)	(0.104)	(0.232)	(0.398)	(1.739)	(0.052)	(0.202)	(0.086)	(0.056)	(0.210)	(0.129)	(0.210)	(0.538)	(2.316)	(0.056)	(0.213)	(0.096)
REG2008	-0.082*	0.016	0.024	-0.213	0.756***	0.046	-0.010*	0.761***	-0.038	-0.028	0.836***	0.013	-0.003	0.679***	-0.031	-0.099*	0.759***	0.004
	(0.042)	(0.023)	(0.018)	(0.137)	(0.216)	(0.136)	(0.006)	(0.224)	(0.103)	(0.054)	(0.162)	(0.015)	(0.024)	(0.153)	(0.076)	(0.051)	(0.195)	(0.095)
Constant	0.000	0.909***	0.159	0.000	0.000	0.000	-0.100**	0.000	0.000	0.000	0.000	0.064	-0.147	0.000	-0.073	0.000	0.000	0.000
	(0.000)	(0.170)	(0.135)	(0.000)	(0.000)	(0.000)	(0.043)	(0.000)	(0.000)	(0.000)	(0.000)	(0.138)	(0.091)	(0.000)	(0.352)	(0.000)	(0.000)	(0.000)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1048	1048	1048	398	398	398	650	650	650	1048	1048	1048	398	398	398	650	650	650
Number of banks	110	110	110	43	43	43	67	67	67	110	110	110	43	43	43	67	67	67
Number of instruments	42	56	44	54	44	50	51	54	66	42	56	41	54	50	54	51	54	66
AR1 Residual Test	0.000	0.002	0.000	0.015	0.095	0.003	0.001	0.005	0.002	0.000	0.002	0.000	0.010	0.094	0.003	0.001	0.004	0.002
AR2 Residual Test	0.496	0.285	0.870	0.621	0.982	0.177	0.169	0.213	0.674	0.649	0.302	0.697	0.584	0.733	0.134	0.169	0.237	0.654
Hansen *P*-value	0.124	0.164	0.136	0.162	0.131	0.303	0.207	0.234	0.204	0.264	0.132	0.185	0.113	0.641	0.752	0.129	0.304	0.144

This table reports the estimation results for a three-equation system, with ROA and Z-score as profitability and risk indicators, respectively, allowing for cross-border Pan-African bank status and foreign bank status. CAR is the capital-to-asset ratio. All the macro controls are lagged. Data for bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. The estimations are performed using the two-step generalized method of moments. We use forward orthogonal deviations to purge banks' fixed effects. Robust standard errors are in parentheses. Superscripts ***, ** and * denote significance at 1%, 5% and 10%, respectively.

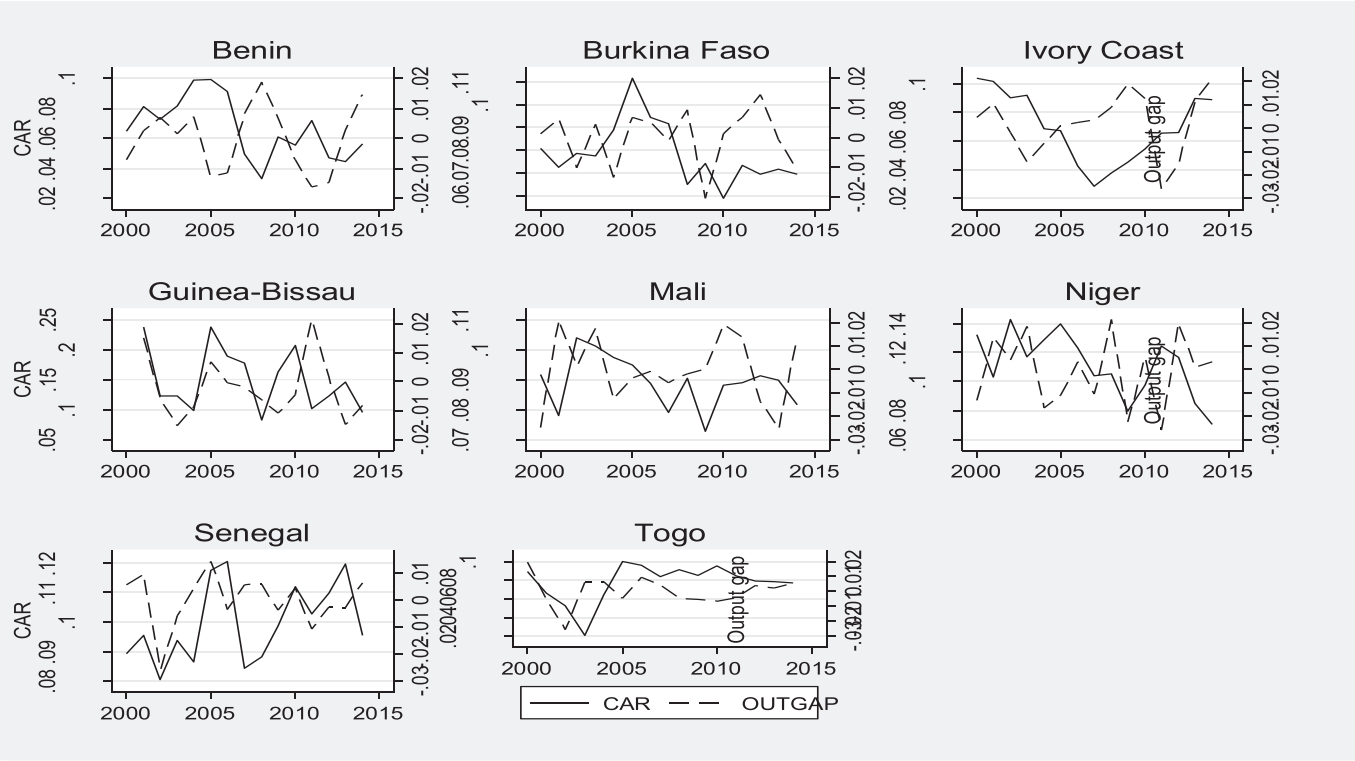

Fig. 1. Evolution of capital ratio and output gap for the WAEMU countries
The graphs in this figure plot the evolution of bank capital ratio and the output gap for each of the eight WAEMU countries. On each graph, the left axis shows the values of capital (CAR) and right axis shows the values of output gap (OUTGAP). Solid lines are CAR and dashed lines are OUTGAP. The raw data for computing bank capital ratios were obtained from the Banking Commission of WAEMU, while the GDP data for computing the output gap were obtained from the World Bank World Development Indicators.

their risky activities, which explains why risk increases as well as profits (risk-return trade-off). Moreover, we observe that the increase in the minimum capital requirement in 2008, captured by the dummy REG2008 in the regressions, had an increasing effect on bank risk and a decreasing effect on bank profitability. These effects are more pronounced in LICs.

5.1.3. What is the relationship between bank capital and the business cycle in WAEMU?

Although we analyze the impact of capital variations on bank risk-taking and bank profitability, still the three variables (capital, profit and risk) are endogenous and change simultaneously, i.e. risk and profitability also impact on capital. The significant coefficient of ROA in the capital ratio equation given in Table 6 confirms the above results, i.e. positive relationship between profit and capital across countries, as predicted in Hypothesis 1. These results are consistent with earlier findings by Iannota et al. (2007). The positive impact of the profitability measure ROA on capital is more pronounced for LMICs.

In terms of the impact of the business cycle on bank capital, Fig. 1 plots the evolution of the aggregate capital ratio and output gap for each of the eight WAEMU countries. For LICs, we can see clearly from the graphs in Fig. 1 that the output gap and the aggregate banking sector capital ratio co-move positively, while for the remaining two LMICs, the direction of co-movement of their output gap and banking sector capital ratio is unclear. The results from regression analysis, reported in Table 6, show that banks accumulate more capital in expansion periods. However, when the analysis is conducted with respect to the countries' income level, we find that banks accumulate more capital during expansions (high value of output gap) in LICs. In LMICs, bank capital accumulation remains insensitive to variations in the business cycle.

Hence, bank capital positions tend to co-move positively with the business cycle in LICs as opposed to LMICs. This capital adjustment behavior with the business cycle in LICs is interpreted as inducing countercyclical lending in nature, meaning that banks accumulate more capital buffer during expansion periods and use these additional buffers to support their credit activities during recessions when risk is high and capital scarce. This finding is consistent with the predictions of Hypothesis 3. As we can see in Fig. 1, the capital accumulation behavior depends on the specificity of the country where the bank operates. This is consistent with Jokipii and Milne (2008) who find that the cyclical behavior of bank capital varies according to the size, the type of bank, the country financial infrastructure and regulatory environment.

Moreover, the increase in the minimum capital requirement in 2008 had a non-significant effect on bank capital ratio level, but had an increasing effect on bank risk and a decreasing effect on bank profitability[15]. It is to be noted, however, that the increase in the minimum capital requirement was not followed by an increase in the minimum regulatory capital adequacy ratio (which remains at 8%), therefore, it looks like banks adjusted upward their assets

[15] The dummy REG2008 could capture, among other, the financial crisis. First, as mentioned in the introduction, the banking sector of the WAEMU region was less affected by the 2007-2009 financial turmoil. An analysis of the impact of the 2008 global financial crisis on the WAEMU concludes that "*the overall impact of the crisis on the WAEMU was relatively moderate compared to other regions*..." (International Monetary Fund, African Department, 2012, page 35). Second, in the regressions, we control for country-year fixed effects that should absorb global factors affecting the relationships estimated in the paper. Therefore, we think that the risk of mis-interpretation is limited. We thank one of the reviewers for raising this point.

Table 7
Comparison test results for the subsamples of foreign versus pan-African ownership, 2000–2014.

Panel A: Foreign ownership						
	Non-foreign owned banks		Foreign owned banks		Comparison test	
	Obs.	Avg.	Obs.	Avg.	Diff.	*P*-Value
CAR	365	0.085	928	0.081	0.005	0.699
ROA	365	0.002	928	0.001	0.001	0.651
ROE	365	0.116	928	0.109	0.007	0.653
NIM	365	0.028	928	0.029	−0.001	0.668
Z-SCORE	330	0.832	840	0.846	−0.014	0.128
LLRL	365	0.009	928	0.007	0.002***	0.001
LA	365	0.747	928	0.769	−0.022***	0.002
SIZE	365	11.124	928	11.045	0.079	0.291
CR3	365	0.454	928	0.449	0.004	0.677
DCREDIT	365	0.185	928	0.182	0.003	0.395
OUTGAP	365	0.000	928	0.000	0.000	0.989
INTEREST	365	2.209	928	2.148	0.061	0.634
POLSTAB	365	−0.603	928	−0.514	−0.090*	0.055
Panel B: Pan-African banks						
	Non- pan-African banks		pan-African banks		Comparison test	
	Obs.	Avg.	Obs.	Avg.	Diff.	*P*-Value
CAR	657	0.088	636	0.076	0.012	0.270
ROA	657	0.005	636	−0.002	0.007***	0.000
ROE	657	0.120	636	0.102	0.017	0.238
NIM	657	0.029	636	0.028	0.001	0.683
Z-SCORE	597	0.836	573	0.849	−0.013	0.101
LLRL	657	0.009	636	0.006	0.003***	0.000
LA	657	0.765	636	0.760	0.006	0.348
SIZE	657	11.278	636	10.850	0.428***	0.000
CR3	657	0.450	636	0.451	−0.001	0.937
DCREDIT	657	0.180	636	0.187	−0.007**	0.026
OUTGAP	657	0.000	636	0.000	0.000	0.951
INTEREST	657	2.219	636	2.110	0.109	0.358
POLSTAB	657	−0.652	636	−0.422	−0.230***	0.000

This table compares the mean values of variables in the subsamples of foreign versus non-foreign owned banks (Panel A) and subsamples of cross-border pan-African banks versus non-pan-African banks (Panel B). The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. Comparison tests are performed using the t-test (with unequal variance). Superscripts ***, ** and * denote significance at 1%, 5% and 10%, respectively.

in the expectation of minimum capital increase in 2008, which compensates for the capital increase, hence neutralizing the overall impact on the capital ratio.

Consistent with economic intuition, profit and risk increase altogether with positive variations in the business cycles as banks become highly levered during economic booms. Hence, in the spirit of the current Basel III regulations, banks need to constitute enough capital buffers during economic expansions to face possible future credit portfolio failures during economic downturns, which explains the behavior followed by banks in low income WAEMU countries.

5.1.4. Does bank ownership status matter?

We are interested in establishing whether bank ownership structure (foreign versus domestic) matters in determining bank capital, risk and profitability. We also investigate whether the presence of Pan-African cross-border banks impacts bank capital, risk and profitability. To achieve our objectives, we first compute the mean of the variables by subsample: foreign-owned banks versus domestically-owned banks, and cross-border Pan-African banks versus non-Pan-African banks. Table 7 presents the comparison tests between the mean values of the variables in the subsamples, namely foreign-owned banks versus domestically owned banks (Panel A), as well as cross-border Pan-African banks versus non-Pan-African banks (Panel B). We observe that foreign-owned banks lend more and have less loan loss reserves ratio as opposed to domestically-owned banks, whereas Pan-African cross-border banks are less profitable, have less loan loss reserves and are smaller in size than their non-Pan-African counterparts.

Furthermore, the econometric results presented in Table 6 above show that foreign bank presence drive down profit (measured by ROA) and capital ratio. When we look at the risk variable (in Table 7), we notice that the level of credit risk (measured by loan loss reserves ratio) taken by foreign-owned banks is lower than the risk taken by domestic banks. These results are consistent with the findings of Dietrich and Wanzenried (2014). It seems that domestic banks take too much risk when granting loans. One possible explanation is that foreign-owned banks, particularly French banks, are usually the oldest in many cases, domestic banks need more flexibility to attract some customers of the foreign-owned banks and therefore, they are lax when granting credit.

Overall, the effects of foreign bank ownership on bank capital, risk and profitability in LICs and LMICs in WAEMU region is not so clear-cut. The only clear evidence is that foreign bank ownership

Table 8
Country of origin for headquarters of foreign banks operating in WAEMU countries, 2000–2014.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total	Percent
Belgium	3	3	3	3	3	3	2	2	1	1	1	1				26	2.80
Burkina Faso														1	1	2	0.22
Cameroon												1	1	1	1	4	0.43
China		1	1	1	1		1	1	1	1	1	1	1	1	1	13	1.40
France	10	10	10	11	10	10	10	10	10	9	9	9	9	9	9	145	15.63
Gabon												2	2	2	2	8	0.86
Libya	4	4	4	5	9	8	10	10	10	10	10	10	10	10	9	123	13.25
Mali	6	7	7	7	7	7	8	9	9	9	10	9	10	10	10	125	13.47
Mauritania			1	1	1			1	1	1	1	1	1	1	1	11	1.19
Morocco							1		2	4	4	5	4	5	5	30	3.23
Nigeria	1	2	2	2	2	3	3	3	7	8	8	10	11	11	11	84	9.05
Saudi Arabia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15	1.62
Switzerland	2	2	2	2	3	3	3	3	3	1	2					26	2.80
Togo	8	8	8	8	8	16	23	23	24	24	23	24	25	25	24	271	29.20
United Kingdom		1	1	1	1	1	1	1	1	1	1	1	1	1	1	14	1.51
United States	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	31	3.34
Total	37	41	42	44	48	54	66	66	72	72	73	77	78	80	78	928	100

This table displays the headquarters of foreign banks in the WAEMU. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU.

Table 9
Comparison test results for the subsamples of main origin of foreign banks headquarters: outside Africa versus Africa, 2000–2014.

	Outside Africa(France)		Africa(Libya, Morocco and Nigeria)		Comparison test	
	Obs.	Avg.	Obs.	Avg.	Diff.	*P*-Value
CAR	145	0.094	237	0.101	−0.007	0.536
ROA	145	0.013	237	-0.006	0.019***	0.000
ROE	145	0.161	237	0.016	0.145***	0.000
NIM	145	0.032	237	0.027	0.004*	0.085
Z-SCORE	134	0.833	213	0.876	−0.044***	0.002
LLRL	145	0.012	237	0.009	0.003***	0.004
LA	145	0.793	237	0.739	0.054***	0.000
SIZE	145	11.845	237	10.852	0.993***	0.000
CR3	145	0.412	237	0.423	−0.011	0.498
DCREDIT	145	0.188	237	0.196	−0.008	0.143
OUTGAP	145	0.001	237	0.000	0.000	0.775
INTEREST	145	2.197	237	2.170	0.027	0.903
POLSTAB	145	−0.771	237	−0.335	−0.437***	0.000

This table compares the mean values of the variables in the subsamples of foreign banks with headquarters in France versus Africa (Libya, Morocco and Nigeria). The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. Comparison test are performed using the t-test (with unequal variance). Superscripts ***, ** and * denote significance at 1%, 5% and 10%, respectively.

is associated with a decrease in both profit and capital ratio in the overall banking sector.

The results reported in Table 6 show that Pan-African cross-border banks tend to reduce the capital ratio in the overall banking sector. Although from the regression analysis, there is no evidence to support the effect of Pan-African banks presence on bank risk and profit in the full WAEMU sample, or in the LMICs or their low-income peers, the comparative analysis of Table 7 indicates that cross-border Pan-African banks have less loan loss reserves and are less profitable than their non-Pan-African peers. Overall, cross-border Pan-African banks do matter in the WAEMU countries; their presence seems to reduce profit, loan loss reserves and the capital ratio in the overall banking sector.

As further analysis on the role of the key foreign banks, Table 8 gives an overview of the distribution of foreign banks headquarters in the WAEMU region. Cross-border banks operating in WAEMU countries are mainly from France (outside Africa), Libya, Nigeria and Morocco (Pan-African banks). Although Morocco represents a relatively smaller percentage of the sample relative to the other key big players (France, Libya and Nigeria), its penetration into the region has been recent and more aggressive.

We conduct additional comparative tests between the mean values of variables for the main countries of origin of foreign banks: outside Africa (France) and Africa excluding WAEMU (Libya, Morocco and Nigeria). The results reported in Table 9 show that cross-border Pan-African banks from Libya, Morocco and Nigeria are less profitable and less stable (in terms of Z-score measure) compared to international foreign banks with headquarters in France. Moreover, French banks, on average, lend more, hold more loan loss provision, and are bigger in size than their counterparts cross border banks from Libya, Morocco and Nigeria. This confirms our argument that banks with headquarters in France are usually the oldest in many cases in this Francophone region of West Africa. Therefore, they are much bigger in size, have a larger loan portfolio, are more profitable and bear less overall risk (measured by Z-score). Consequently, the overall finding here supports our Hypothesis 4, indicating that cross-border Pan-African banks presence increases risk in the WAEMU banking system.

5.2. Estimation results for the effects of other control variables

Firstly, the income concentration variable, a proxy for banking sector competition within a country, has a significant decreasing effect on bank capital and risk in the full sample and significant positive effect on profitability in lower-middle income countries. In lower-middle income WAEMU countries, higher value of income concentration increases profitability (ROA). This result for lower-middle income countries suggests that income concentration, analogous to market concentration, increases profitability of commercial banks. In low income WAEMU countries, however, the income concentration has a non-significant impact on profitability.

Secondly, the effect of real interest rate is mixed. It is negatively (positively) related to performance in low income (lower-middle income) countries, but not significant in all regressions. This confirms the uncertain impact of real interest rate on performance raised in Section 3.3.3. It is found that real interest rates have no significant impact on bank capital as well.

Thirdly, the results for the quality of institutions (or political stability) variable are not clear-cut. Most regressions generate non-significant coefficients between the quality of institutions and bank profitability, and in one or two cases where the coefficients are significant, they are negatively signed, contrary to the expected positive relationship. Overall, according to the results, political stability has a negative significant impact on bank profitability and non-significant impact on bank capital and bank risk-taking in the overall banking sector.

Fourthly, as expected, domestic credit to the economy (*DCREDIT*) negatively impacts profitability in WAEMU countries in all regressions, but the coefficient is not always significant. Moreover, its coefficients for risk and capital are not significant. This result may indicate that the market in which banks operate is not saturated. Indeed, WAEMU countries are small countries in which firms and households have a critical unmet need of financing. An increase in credit to the economy will not automatically drop profitability of banks. Intuitively, an increase in credit to the economy may come from more lending by banks, hence asset increase, while at the same time capital increases.

Fifthly, bank size (*SIZE*) has a significant positive impact on profit and a negative impact on risk. Its impact on capital is positive for both LICs and LMICs, but not significant. Intuitively, big banks (mainly French banks) in the region are relatively more efficient than small banks in their income generation process and bear relatively less risk.

Finally, as expected, loan-to-asset ratio (*LA*) has a negative significant impact on the capital ratio variation in lower-middle income countries, but the coefficient is not significant in low income countries. Its impacts on profit and risk are non-significant.

5.3. Robustness checks

We check if the previous regression results are sensitive to the metric used to proxy profitability and risk. We use two other measures of profitability ROE and NIM and one other measure of risk LLRL to study the robustness of the regression results. Tables 10 and 11 report the estimation results for the three-equation system when we use NIM and ROE as measure of profitability, respectively. In these two tables, the risk measure is Z-score. As regard to profitability, we find that capital is not significantly related to these alternative bank profitability measures (NIM and ROE) and risk in both tables. However, NIM has a positive (non-significant) impact on capital ratio in all regressions with CAR as dependent variable (in Table 10). For the profitability measure ROE (in Table 11), capital does not have a significant impact on profit and risk, although its coefficient is negative in all the profit equations. This is also confirmed by the significant negative impact of ROE on capital ratio. These findings are consistent with our earlier results. Indeed, let us consider the following decomposition of ROA:

$$ROA = \frac{Return}{Assets} = \frac{Return}{Equity} \times \frac{Equity}{Assets} = ROE \times \text{CAR},$$

From the decomposition, it can be argued that an increase in capital ratio is due to equity increasing marginally faster than assets, hence causing a decrease on the return on equity (ROE). Therefore, ROE can decrease while at the same time ROA increases, which seems to be the case here. However, although assets may increase at a slower pace than equity, the marginal increase in asset can come from very risky loans, which may explain the positive impact of capital increase on risk.

In both Tables 10 and 11, the positive co-movement between business cycles variations and capital ratio in low income countries is confirmed. Moreover, in Table 10, the increase in the minimum capital requirement in 2008 had an increasing effect on bank capital ratio in low income countries and increasing effect on risk in the overall banking system, with more pronounced effect in low income countries. For the effect of cross-border banking, the results are not clear-cut. Finally, the control variables have the expected signs and confirm our previous findings. Overall, these results are similar as before. Hence, the results are robust to the three metrics of profit used (ROA, NIM and ROE).

We also run the regressions with the alternative risk measure, the loan loss reserves ratio (LLRL). We only report the results for the profitability measure ROA in Table 12, the results with the other profitability measures (NIM and ROE) are available from the authors upon request. The results confirm the positive significant relationship between capital ratio variations and bank profitability. Moreover, we find strong evidence for the regulatory hypothesis in LMICs, i.e. banks increase their capital together with their risk appetite, which is consistent with our predictions in Hypothesis 2. Also, the positive co-movement between capital ratio and business cycles variations is confirmed for LICs.

Finally, as alternative estimation technique, we adopt the three-stage least squares (3SLS) estimation technique. The estimation results (for ROA as a profitability measure and Z-score as risk indicator) reported in Table 13 confirm our previous findings, i.e. positive significant impact of capital on banks profitability, as predicted in Hypothesis 1. We also find support for the regulatory hypothesis. The other results remain valid as well.

Additional robustness analyses have been done. All the results are available upon request. Firstly, our use of the Z-score is not standard in the banking literature. We re-do our main table (Table 6) by using the common definition of the Z-score (insolvency risk: lower Z-score = higher insolvency risk). We show that the transformed Z-sore does not alter our results although we should change the interpretation of the estimated parameters. Secondly, we re-do our main table by winsorizing variables at 1 percent level. It is worth noting that this procedure does not lessen the impacts of outliers compared to the Tukey's procedure. It is confirmed that capital has a positive and significant impact on bank's performance. Capital does not significantly affect the bank risk exposure measured by the Z-score as found in the main table. The noticeable difference is higher impact of bank capital on profitability in low-income countries compared to lower-middle-income countries. Thirdly, we re-estimate the model for a sample of banks with only positive observations for the variables CAR, Z-score, ROA, ROE and NIM. We uncover the same main results except for one. We find that bank profitability is sensitive to changes in capital ratios and the regulatory hypothesis is no longer valid. Moreover, we find a non-significant positive relationship between output gap and capital. Again, the effect of foreign and Pan-African ownership on risk is not clear-cut. Fourthly, we control for State versus private sector ownership status by using a dummy variable

Table 10
Estimation of the system with NIM as profitability measure.

	AFRICAN									***FOREIGN***								
	Full Sample			Lower-middle income			Low income			Full Sample			Lower-middle income			Low income		
	ΔNIM	ΔRISK	ΔCAR	ΔNIM	ΔRISK	ΔCAR	ΔNIM	ΔRISK	ΔCAR	ΔNIM	ΔRISK	ΔCAR	ΔNIM	ΔRISK	ΔCAR	ΔNIM	ΔRISK	ΔCAR
NIM(-1)	-0.564***			-0.621***			-0.519***			-0.592***			-0.640***			-0.297**		
	(0.100)			(0.182)			(0.087)			(0.087)			(0.182)			(0.122)		
ΔNIM		-0.007	0.028		-0.054	0.889		0.086	0.061		-0.015	0.005		-0.052	0.127		0.066	0.010
		(0.098)	(0.068)		(0.514)	(0.602)		(0.211)	(0.086)		(0.132)	(0.078)		(0.536)	(0.181)		(0.164)	(0.127)
RISK(-1)		-0.631***			-0.735***			-0.569***			-0.583***			-0.744***			-0.601***	
		(0.066)			(0.101)			(0.094)			(0.107)			(0.100)			(0.091)	
ΔRISK	-0.002		0.001	0.026		-0.004	0.027*		0.000	-0.003		-0.000	0.012		-0.097	0.041		-0.004
	(0.006)		(0.008)	(0.052)		(0.037)	(0.015)		(0.009)	(0.004)		(0.008)	(0.035)		(0.224)	(0.028)		(0.011)
CAR(-1)			-0.209***			-0.353*			-0.194***			-0.217***			-0.324			-0.259**
			(0.059)			(0.186)			(0.065)			(0.076)			(0.226)			(0.107)
ΔCAR	**-0.017**	**0.055**		**0.019**	**-0.019**		**0.005**	**0.078**		**0.017**	**0.013**		**0.015**	**0.000**		**-0.027**	**0.058**	
	(0.025)	**(0.087)**		**(0.024)**	**(0.045)**		**(0.038)**	**(0.105)**		**(0.030)**	**(0.081)**		**(0.027)**	**(0.032)**		**(0.067)**	**(0.104)**	
AFRICAN	0.041*	-0.039	-0.014	0.016	0.003	-0.026	-0.014	0.019	0.008									
	(0.023)	(0.030)	(0.021)	(0.012)	(0.020)	(0.052)	(0.011)	(0.027)	(0.016)									
FOREIGN										0.004	0.028*	0.019	0.024	0.005	0.004	-0.008	0.012	0.044
										(0.008)	(0.016)	(0.028)	(0.019)	(0.014)	(0.084)	(0.011)	(0.030)	(0.058)
LA	0.003	0.171	-0.067*	0.054*	0.020	-0.323*	-0.006	-0.011	-0.020	0.060	-0.012	-0.202*	0.076**	0.016	-0.171	-0.008	-0.034	0.049
	(0.057)	(0.114)	(0.040)	(0.031)	(0.050)	(0.172)	(0.029)	(0.065)	(0.059)	(0.048)	(0.055)	(0.104)	(0.037)	(0.038)	(0.150)	(0.017)	(0.077)	(0.057)
SIZE	0.001	-0.022*	-0.001	0.012	-0.014**	0.010	-0.005**	-0.024**	0.002	0.003	-0.018**	0.003	0.009**	-0.014**	0.011	-0.004*	-0.031***	0.004
	(0.007)	(0.012)	(0.008)	(0.007)	(0.007)	(0.022)	(0.002)	(0.011)	(0.009)	(0.004)	(0.009)	(0.008)	(0.004)	(0.006)	(0.021)	(0.002)	(0.010)	(0.011)
CR3	-0.077	-0.020	-0.027*	-0.054	0.061	0.530	0.012	-0.002	-0.031**	0.050*	-0.042	-0.039**	-0.010	0.042	0.540	0.009	-0.030	-0.041
	(0.050)	(0.028)	(0.016)	(0.043)	(0.086)	(0.496)	(0.007)	(0.038)	(0.013)	(0.026)	(0.036)	(0.019)	(0.051)	(0.080)	(0.789)	(0.010)	(0.033)	(0.030)
OUTGAP	0.079	1.009*	0.343	-0.593*	0.018	-2.369	0.170**	0.703*	0.289**	-0.170	0.676*	0.168	-0.029	-0.106	-1.768	0.185**	0.942**	0.853**
	(0.468)	(0.509)	(0.212)	(0.350)	(0.638)	(2.412)	(0.066)	(0.381)	(0.112)	(0.147)	(0.341)	(0.171)	(0.475)	(0.516)	(2.991)	(0.079)	(0.382)	(0.366)
INTEREST	0.004	0.002	0.002	-0.003	0.005	0.016	-0.001	-0.002	0.000	0.004**	0.002	-0.003	-0.000	0.003	0.020	-0.000	-0.002	0.010
	(0.003)	(0.002)	(0.002)	(0.003)	(0.006)	(0.031)	(0.001)	(0.004)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.041)	(0.002)	(0.004)	(0.009)
POLSTAB	-0.009	0.016	-0.002	0.018	-0.002	0.279*	0.000	0.026**	-0.006	0.016	0.011	0.006	0.004	-0.001	0.203	-0.002	0.020*	-0.035
	(0.018)	(0.016)	(0.013)	(0.015)	(0.023)	(0.145)	(0.003)	(0.013)	(0.004)	(0.010)	(0.010)	(0.010)	(0.017)	(0.019)	(0.271)	(0.002)	(0.011)	(0.023)
DCREDIT	-0.001	-0.458*	-0.026	0.095	0.104	4.982**	0.067	-0.093	-0.016	0.297*	-0.275	0.085	-0.075	0.075	3.492	0.040	-0.231	-0.254*
	(0.262)	(0.244)	(0.117)	(0.166)	(0.343)	(2.325)	(0.050)	(0.199)	(0.077)	(0.173)	(0.267)	(0.215)	(0.233)	(0.318)	(3.897)	(0.058)	(0.202)	(0.150)
REG2008	0.013	0.778***	0.103	-0.130	0.000	-0.352	0.065*	0.750***	0.014*	-0.150*	0.763***	-0.009	0.041***	0.025	-0.409	-0.039***	0.956***	0.029
	(0.115)	(0.187)	(0.121)	(0.088)	(0.000)	(0.490)	(0.038)	(0.196)	(0.008)	(0.078)	(0.171)	(0.013)	(0.012)	(0.038)	(0.579)	(0.010)	(0.204)	(0.053)
Constant	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.119	-0.185***	0.000	0.000	0.091**	0.000	-0.070
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.128)	(0.000)	(0.000)	(0.135)	(0.050)	(0.000)	(0.000)	(0.041)	(0.000)	(0.184)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1048	1048	1048	398	398	398	650	650	650	1048	1048	1048	398	398	398	650	650	650
Number of banks	110	110	110	43	43	43	67	67	67	110	110	110	43	43	43	67	67	67
Number of instruments	47	97	69	54	46	55	73	62	54	56	53	56	49	46	55	48	73	46
AR1 Residual Test	0.000	0.002	0.000	0.010	0.086	0.091	0.000	0.005	0.002	0.000	0.003	0.000	0.008	0.096	0.057	0.001	0.006	0.001
AR2 Residual Test	0.621	0.256	0.901	0.154	0.738	0.441	0.408	0.204	0.463	0.104	0.366	0.805	0.104	0.759	0.399	0.482	0.186	0.994
Hansen *P*-value	0.251	0.628	0.135	0.357	0.139	0.472	0.391	0.264	0.284	0.329	0.112	0.453	0.177	0.155	0.509	0.125	0.794	0.117

This table reports the estimation results for three-equation system, with NIM as profitability measure, allowing for pan-African bank status and foreign bank ownership structure. NIM and Z-score are profitability and risk indicators, respectively. CAR is the capital-to-asset ratio. All the macro controls are lagged. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. The estimations are performed using the two-step generalized method of moments. We use forward orthogonal deviations to purge banks' fixed effects. Robust standard errors are in parentheses. Superscripts ***, ** and * denote significance at 1%, 5% and 10%, respectively.

Table 11
Estimation of the system with ROE as profitability measure.

	AFRICAN									***FOREIGN***								
	Full Sample			Lower-middle income			Low income			Full Sample			Lower-middle income			Low income		
	ΔROE	ΔRISK	ΔCAR	ΔROE	ΔRISK	ΔCAR	ΔROE	ΔRISK	ΔCAR	ΔROE	ΔRISK	ΔCAR	ΔROE	ΔRISK	ΔCAR	ΔROE	ΔRISK	ΔCAR
ROE(-1)	-0.898***			-0.991***			-0.787***			-0.848***			-1.059***			-0.764***		
	(0.075)			(0.118)			(0.085)			(0.063)			(0.118)			(0.075)		
ΔROE		0.005	-0.026***		0.004	-0.021**		0.004	-0.028**		-0.005	-0.025***		0.003	-0.021**		0.005	-0.026***
		(0.006)	(0.008)		(0.005)	(0.010)		(0.017)	(0.011)		(0.008)	(0.008)		(0.006)	(0.010)		(0.007)	(0.009)
RISK(-1)		-0.617***			-0.745***			-0.664***			-0.628***			-0.732***			-0.577***	
		(0.063)			(0.091)			(0.099)			(0.124)			(0.112)			(0.086)	
ΔRISK	-0.076		-0.000	0.035		-0.005	-0.012		0.007	-0.047		-0.002	-0.003		-0.004	-0.071**		-0.001
	(0.048)		(0.009)	(0.132)		(0.008)	(0.079)		(0.016)	(0.042)		(0.009)	(0.111)		(0.015)	(0.032)		(0.013)
CAR(-1)			-0.229***			-0.257**			-0.273***			-0.232***			-0.214*			-0.255***
			(0.084)			(0.116)			(0.083)			(0.070)			(0.109)			(0.078)
ΔCAR	**-0.217**	**0.104**		**-0.505**	**-0.012**		**-0.105**	**0.215**		**-0.149**	**-0.083**		**-0.576**	**-0.024**		**-0.403**	**0.066**	
	(0.368)	**(0.092)**		**(0.532)**	**(0.047)**		**(0.402)**	**(0.252)**		**(0.307)**	**(0.154)**		**(0.807)**	**(0.052)**		**(0.295)**	**(0.100)**	
AFRICAN	0.521***	-0.039	0.031	0.111	-0.011	-0.000	0.435	-0.009	0.025									
	(0.197)	(0.030)	(0.025)	(0.122)	(0.027)	(0.011)	(0.294)	(0.039)	(0.025)									
FOREIGN										-0.095	0.014	0.050*	-0.104	0.007	0.017	-0.090	0.019	0.037
										(0.114)	(0.024)	(0.027)	(0.321)	(0.024)	(0.023)	(0.061)	(0.028)	(0.023)
LA	-1.450**	0.189*	-0.250**	-0.692**	0.012	-0.027	-0.808	0.101	0.006	-0.883*	-0.091	-0.225**	-1.208*	0.050	-0.033	-0.091	-0.017	-0.004
	(0.626)	(0.108)	(0.114)	(0.331)	(0.053)	(0.063)	(0.886)	(0.151)	(0.044)	(0.458)	(0.091)	(0.089)	(0.661)	(0.058)	(0.046)	(0.234)	(0.068)	(0.040)
SIZE	0.221***	-0.020*	0.007	0.130*	-0.022*	0.017*	0.074	-0.029**	0.006	0.052*	-0.024***	0.004	0.118*	-0.014**	0.019*	0.003	-0.024**	0.000
	(0.075)	(0.011)	(0.008)	(0.075)	(0.013)	(0.010)	(0.072)	(0.013)	(0.007)	(0.028)	(0.007)	(0.006)	(0.062)	(0.007)	(0.010)	(0.030)	(0.010)	(0.009)
CR3	0.184	-0.023	-0.053**	0.288	0.053	0.030	0.090	-0.019	-0.022	-0.114	-0.010	-0.051**	1.707*	0.101	-0.032	-0.055	-0.043	-0.039*
	(0.418)	(0.031)	(0.022)	(1.600)	(0.121)	(0.085)	(0.618)	(0.074)	(0.019)	(0.076)	(0.040)	(0.021)	(0.941)	(0.148)	(0.145)	(0.078)	(0.040)	(0.022)
OUTGAP	-1.181	1.266**	0.248*	-0.956	0.930	-0.300	4.218	0.810	0.087	0.481	0.626	0.203	12.991	0.237	0.258	1.829**	1.094***	1.061***
	(1.204)	(0.489)	(0.142)	(8.270)	(0.687)	(0.595)	(7.824)	(0.672)	(0.206)	(0.694)	(0.401)	(0.145)	(14.979)	(1.090)	(0.551)	(0.911)	(0.345)	(0.301)
INTEREST	-0.003	0.003	-0.005*	0.009	0.010*	0.001	-0.058	-0.002	0.001	-0.003	0.002	-0.004*	0.112*	0.010	0.000	-0.004	-0.000	0.001
	(0.025)	(0.002)	(0.002)	(0.040)	(0.005)	(0.002)	(0.044)	(0.011)	(0.002)	(0.006)	(0.004)	(0.002)	(0.056)	(0.007)	(0.004)	(0.006)	(0.005)	(0.002)
POLSTAB	0.031	0.015	-0.002	0.203	-0.075*	0.027	-0.042	0.023	-0.004	-0.005	0.006	0.001	0.188	-0.010	0.014	0.002	0.024**	-0.007
	(0.089)	(0.016)	(0.010)	(0.270)	(0.040)	(0.028)	(0.180)	(0.018)	(0.006)	(0.026)	(0.010)	(0.009)	(0.409)	(0.036)	(0.024)	(0.027)	(0.011)	(0.015)
DCREDIT	1.595*	-0.490**	-0.022	-1.676	-0.448	0.252	1.604	-0.310	-0.024	-0.140	0.174	-0.022	-2.321	0.289	0.033	-0.184	-0.358	-0.129
	(0.943)	(0.234)	(0.190)	(6.837)	(0.572)	(0.304)	(2.952)	(0.259)	(0.144)	(0.673)	(0.301)	(0.171)	(8.787)	(0.602)	(0.518)	(0.600)	(0.246)	(0.101)
REG2008	-2.079*	0.737***	0.151	-0.118	0.087	-0.185	-0.419	0.898***	-0.009	-0.062	0.824***	0.018	-0.212	0.655***	-0.007	0.243	0.030	-0.010
	(1.077)	(0.169)	(0.123)	(0.231)	(0.054)	(0.140)	(0.357)	(0.262)	(0.014)	(0.070)	(0.167)	(0.014)	(1.275)	(0.148)	(0.026)	(0.457)	(0.029)	(0.014)
Constant	0.000	0.000	0.000	-0.463	0.962***	0.000	-0.381	0.000	-0.034	0.408	0.000	0.126	0.000	0.000	-0.172	0.000	0.797***	0.035
	(0.000)	(0.000)	(0.000)	(2.402)	(0.238)	(0.000)	(1.275)	(0.000)	(0.096)	(0.555)	(0.000)	(0.109)	(0.000)	(0.000)	(0.214)	(0.000)	(0.182)	(0.121)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1048	1048	1048	398	398	398	650	650	650	1048	1048	1048	398	398	398	650	650	650
Number of banks	110	110	110	43	43	43	67	67	67	110	110	110	43	43	43	67	67	67
Number of instruments	44	97	56	69	46	50	54	73	78	65	42	56	46	50	62	62	62	58
AR1 Residual Test	0.000	0.001	0.000	0.005	0.084	0.004	0.000	0.005	0.001	0.000	0.003	0.000	0.007	0.098	0.005	0.000	0.003	0.001
AR2 Residual Test	0.116	0.305	0.732	0.884	0.857	0.102	0.101	0.165	0.724	0.195	0.183	0.819	0.739	0.736	0.104	0.106	0.209	0.873
Hansen *P*-value	0.615	0.633	0.556	0.990	0.164	0.169	0.156	0.723	0.293	0.245	0.157	0.606	0.268	0.153	0.936	0.285	0.553	0.179

This table reports the estimation results for three-equation system, with ROE as profitability measure, allowing for pan-African bank status and bank ownership structure. ROE and Z-score are profitability and risk indicators, respectively. CAR is the capital-to-asset ratio. All the macro controls are lagged. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. The estimations are performed using the two-step generalized method of moments estimation technique. We use forward orthogonal deviations to purge banks' fixed effects. Robust standard errors are in parentheses. Superscripts ***, ** and * denote significance at 1%, 5% and 10% respectively.

Table 12
Estimation of the system with ROA as profitability measure and LLRL as risk measure.

	AFRICAN									***FOREIGN***								
	Full Sample			Lower-middle income			Low income			Full Sample			Lower-middle income			Low income		
	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR	ΔROA	ΔRISK	ΔCAR
ROA(-1)	-0.751***			-0.820***			-0.761***			-0.782***			-0.846***			-0.726***		
	(0.061)			(0.071)			(0.104)			(0.066)			(0.070)			(0.083)		
ΔROA		-0.022***	0.319***		-0.026*	0.390***		-0.012*	0.176**		-0.017**	0.274***		-0.024	0.334**		-0.017*	0.184
		(0.008)	(0.095)		(0.013)	(0.132)		(0.007)	(0.074)		(0.008)	(0.078)		(0.017)	(0.161)		(0.010)	(0.455)
RISK(-1)		-0.152***			-0.258***			-0.127*			-0.117**			-0.255***			-0.194**	
		(0.049)			(0.079)			(0.072)			(0.049)			(0.082)			(0.087)	
ΔRISK	-0.642***		-0.555	-0.762***		-0.133	-0.795***		-0.758**	-0.376***		-0.533	-0.805***		-0.233	-0.595***		-0.819*
	(0.111)		(0.398)	(0.192)		(0.774)	(0.200)		(0.365)	(0.128)		(0.400)	(0.164)		(0.815)	(0.168)		(0.477)
CAR(-1)			-0.289***			-0.290**			-0.289***			-0.292***			-0.253*			-0.267***
			(0.068)			(0.132)			(0.076)			(0.071)			(0.127)			(0.092)
ΔCAR	**0.092*** **	**0.005**		**0.081** **	**0.012***		**0.086*** **	**-0.005**		**0.091*** **	**-0.000**		**0.089***	**0.013** **		**0.076** **	**-0.003**	
	(0.017)	**(0.005)**		**(0.031)**	**(0.006)**		**(0.031)**	**(0.005)**		**(0.019)**	**(0.005)**		**(0.048)**	**(0.006)**		**(0.030)**	**(0.004)**	
AFRICAN	0.001	-0.001	0.070**	0.011	-0.001	-0.014	0.000	0.000	0.028									
	(0.003)	(0.001)	(0.032)	(0.015)	(0.002)	(0.024)	(0.014)	(0.002)	(0.029)									
FOREIGN										-0.051**	0.006*	0.010	-0.013	-0.003	0.090	-0.005	-0.004	0.037
										(0.021)	(0.003)	(0.031)	(0.028)	(0.004)	(0.069)	(0.012)	(0.007)	(0.029)
LA	0.017	0.000	0.013	-0.057*	-0.006	-0.061	0.067*	0.004	0.015	0.004	0.004	-0.036	-0.039	0.006	-0.180	0.054**	-0.002	0.025
	(0.011)	(0.003)	(0.041)	(0.029)	(0.011)	(0.101)	(0.036)	(0.005)	(0.047)	(0.019)	(0.008)	(0.045)	(0.043)	(0.009)	(0.185)	(0.027)	(0.005)	(0.039)
SIZE	0.006***	0.001	0.026***	0.011***	0.000	0.019	0.010***	0.001	0.003	0.006**	0.001**	0.007	0.007	-0.001	0.040***	0.007**	0.000	0.007
	(0.002)	(0.000)	(0.009)	(0.004)	(0.001)	(0.016)	(0.003)	(0.001)	(0.008)	(0.003)	(0.000)	(0.005)	(0.005)	(0.001)	(0.015)	(0.003)	(0.001)	(0.006)
CR3	-0.008	-0.001	0.039	0.058	-0.004	0.161	0.006	0.001	-0.008	-0.011	-0.002	-0.008	0.072	-0.019*	0.555	0.003	-0.001	-0.001
	(0.007)	(0.002)	(0.043)	(0.037)	(0.015)	(0.416)	(0.010)	(0.002)	(0.025)	(0.007)	(0.006)	(0.019)	(0.045)	(0.010)	(0.424)	(0.006)	(0.003)	(0.037)
OUTGAP	0.011	0.030**	-0.225	0.158	-0.133*	1.182	-0.042	0.027	0.238**	0.106	0.007	-0.038	0.245	-0.079	-1.348	-0.023	0.022	0.013
	(0.044)	(0.013)	(0.157)	(0.260)	(0.074)	(1.846)	(0.066)	(0.025)	(0.103)	(0.097)	(0.016)	(0.138)	(0.285)	(0.061)	(1.506)	(0.049)	(0.051)	(0.166)
INTEREST	-0.000	0.000	-0.000	0.000	-0.000	-0.005	0.000	0.000	-0.002	-0.000	0.001	-0.001	0.003	-0.000	0.021	-0.001	0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.022)	(0.001)	(0.000)	(0.004)	(0.000)	(0.000)	(0.002)	(0.003)	(0.001)	(0.013)	(0.001)	(0.000)	(0.002)
POLSTAB	-0.002	-0.000	0.013	-0.013	0.005	-0.076	-0.002	0.000	0.003	-0.009**	-0.000	0.013	-0.017	0.004	-0.016	-0.004	0.001	0.000
	(0.002)	(0.001)	(0.011)	(0.016)	(0.004)	(0.100)	(0.004)	(0.001)	(0.007)	(0.003)	(0.001)	(0.011)	(0.022)	(0.004)	(0.047)	(0.003)	(0.001)	(0.010)
DCREDIT	-0.099**	-0.020*	0.292**	-0.156	0.099	-0.486	-0.133*	-0.017	-0.015	-0.082	-0.020*	0.211*	-0.062	0.051	0.489	-0.086	-0.015	0.244*
	(0.048)	(0.012)	(0.117)	(0.153)	(0.061)	(1.481)	(0.074)	(0.013)	(0.121)	(0.075)	(0.011)	(0.114)	(0.188)	(0.038)	(0.665)	(0.054)	(0.018)	(0.140)
REG2008	-0.061***	0.001	-0.405***	-0.015	-0.002	-0.214	-0.143***	-0.005	-0.036	0.003	-0.012	-0.010	-0.065	0.010	-0.704*	-0.103**	0.004*	-0.145
	(0.022)	(0.001)	(0.141)	(0.015)	(0.003)	(0.343)	(0.039)	(0.009)	(0.112)	(0.036)	(0.008)	(0.012)	(0.086)	(0.012)	(0.386)	(0.042)	(0.002)	(0.101)
Constant	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.060	0.000	0.000	0.000	0.000	0.001	0.000
	(0.000)	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.099)	(0.000)	(0.000)	(0.000)	(0.000)	(0.019)	(0.000)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1169	1169	1169	450	450	450	719	719	719	1169	1169	1169	450	450	450	719	719	719
Number of banks	113	113	113	46	46	46	67	67	67	113	113	113	46	46	46	67	67	67
Number of instruments	109	54	56	57	51	71	79	59	61	75	49	70	51	51	50	64	46	43
AR1 Residual Test	0.000	0.000	0.000	0.001	0.000	0.005	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.000	0.001
AR2 Residual Test	0.222	0.248	0.756	0.555	0.156	0.349	0.129	0.945	0.385	0.533	0.435	0.840	0.454	0.187	0.897	0.115	0.831	0.399
Hansen *P*-value	0.254	0.230	0.155	0.405	0.373	0.853	0.393	0.245	0.295	0.223	0.437	0.126	0.154	0.129	0.318	0.206	0.105	0.169

This table reports the estimation results for three-equation system, with ROA as profitability measure, allowing for pan-African bank status and bank ownership structure. LLRL is the risk indicator. CAR is the capital-to-asset ratio. All the macro controls are lagged. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. The estimations are performed using the two-step generalized method of moments estimation technique. We use forward orthogonal deviations to purge banks' fixed effects. Robust standard errors are in parentheses. Superscripts ***, ** and * denote significance at 1%, 5% and 10%, respectively.

Table 13
3SLS estimation of the system with ROA and Z-SCORE as profitability and risk indicators.

	AFRICAN									***FOREIGN***								
	Full sample			Lower-middle income			Low income			Full sample			Lower-middle income			Low income		
	ROA	RISK	CAR	ROA	RISK	CAR	ROA	RISK	CAR	ROA	RISK	CAR	ROA	RISK	CAR	ROA	RISK	CAR
ROA(-1)	-0.566***			-0.546***			-0.566***			-0.563***			-0.547***			-0.564***		
	(0.029)			(0.046)			(0.037)			(0.029)			(0.046)			(0.037)		
ΔROA		0.091	0.585***		0.096	0.746***		0.003	0.466***		0.085	0.586***		0.107	0.733***		-0.002	0.469***
		(0.152)	(0.058)		(0.197)	(0.091)		(0.219)	(0.077)		(0.152)	(0.058)		(0.198)	(0.092)		(0.219)	(0.077)
RISK(-1)		-0.555***			-0.706***			-0.521***			-0.557***			-0.705***			-0.523***	
		(0.026)			(0.046)			(0.033)			(0.026)			(0.046)			(0.033)	
ΔRISK	0.001		0.010	0.010		0.000	-0.003		0.021*	0.001		0.011	0.010		-0.000	-0.003		0.021*
	(0.005)		(0.010)	(0.009)		(0.020)	(0.005)		(0.012)	(0.005)		(0.010)	(0.009)		(0.020)	(0.005)		(0.012)
CAR(-1)			-0.170***			-0.182***			-0.164***			-0.167***			-0.174***			-0.163***
			(0.018)			(0.033)			(0.023)			(0.018)			(0.032)			(0.023)
ΔCAR	0.166***	0.090		0.204***	-0.023		0.138***	0.238**		0.166***	0.089		0.202***	-0.031		0.139***	0.238**	
	(0.013)	(0.077)		(0.021)	(0.102)		(0.017)	(0.108)		(0.013)	(0.077)		(0.021)	(0.102)		(0.017)	(0.108)	
Cross-border	-0.001	0.003	-0.005	0.001	0.014	-0.009*	-0.002	-0.001	-0.003									
	(0.001)	(0.007)	(0.003)	(0.002)	(0.010)	(0.005)	(0.002)	(0.010)	(0.003)									
Ownership										0.001	0.010	-0.001	0.003	0.011	0.002	-0.001	0.008	-0.003
										(0.001)	(0.008)	(0.003)	(0.002)	(0.009)	(0.005)	(0.002)	(0.011)	(0.004)
LA	0.007	-0.039	0.001	0.003	-0.016	-0.004	0.012	-0.061	0.009	0.007	-0.043	0.002	0.001	-0.026	-0.003	0.011	-0.064	0.009
	(0.005)	(0.031)	(0.012)	(0.008)	(0.036)	(0.017)	(0.007)	(0.047)	(0.017)	(0.005)	(0.031)	(0.012)	(0.008)	(0.036)	(0.018)	(0.007)	(0.047)	(0.017)
SIZE	0.003***	-0.014***	0.002*	0.004***	-0.009**	0.002	0.002***	-0.020***	0.003*	0.003***	-0.015***	0.003**	0.004***	-0.010***	0.002	0.003***	-0.020***	0.003**
	(0.001)	(0.003)	(0.001)	(0.001)	(0.004)	(0.002)	(0.001)	(0.005)	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)	(0.004)	(0.002)	(0.001)	(0.005)	(0.002)
CR3	-0.002	-0.020	-0.008	0.033	0.208	-0.009	0.000	-0.027	-0.016	-0.003	-0.020	-0.009	0.032	0.202	-0.006	-0.000	-0.028	-0.017
	(0.006)	(0.033)	(0.013)	(0.030)	(0.136)	(0.066)	(0.007)	(0.045)	(0.016)	(0.006)	(0.033)	(0.013)	(0.030)	(0.136)	(0.066)	(0.007)	(0.045)	(0.016)
OUTGAP	-0.016	0.640**	0.085	-0.026	0.598	0.311	0.000	0.872**	0.135	-0.018	0.635**	0.084	-0.028	0.569	0.327	0.001	0.875**	0.136
	(0.055)	(0.315)	(0.123)	(0.184)	(0.835)	(0.404)	(0.068)	(0.439)	(0.156)	(0.055)	(0.314)	(0.123)	(0.183)	(0.836)	(0.405)	(0.068)	(0.438)	(0.156)
INTEREST	-0.001	0.001	0.002*	0.002	0.010*	-0.001	-0.001*	-0.004	0.003*	-0.001	0.001	0.002*	0.002	0.009	-0.000	-0.001*	-0.004	0.003*
	(0.000)	(0.003)	(0.001)	(0.001)	(0.006)	(0.003)	(0.001)	(0.004)	(0.002)	(0.000)	(0.003)	(0.001)	(0.001)	(0.006)	(0.003)	(0.001)	(0.004)	(0.002)
POLSTAB	-0.002	0.017*	0.001	-0.012*	-0.041	0.018	-0.003	0.028**	-0.005	-0.002	0.017**	0.001	-0.012*	-0.040	0.016	-0.003	0.028**	-0.005
	(0.001)	(0.009)	(0.003)	(0.007)	(0.031)	(0.015)	(0.002)	(0.013)	(0.005)	(0.001)	(0.009)	(0.003)	(0.007)	(0.031)	(0.015)	(0.002)	(0.013)	(0.005)
DCREDIT	-0.030	-0.073	-0.031	-0.080	0.113	0.032	-0.017	-0.165	-0.012	-0.030	-0.070	-0.033	-0.082	0.127	0.011	-0.018	-0.163	-0.013
	(0.029)	(0.168)	(0.065)	(0.099)	(0.452)	(0.219)	(0.033)	(0.211)	(0.075)	(0.029)	(0.168)	(0.065)	(0.099)	(0.452)	(0.220)	(0.033)	(0.211)	(0.075)
REG2008	-0.004	0.012	-0.008	0.018	0.122*	-0.015	-0.003	0.053	-0.024*	-0.005	0.011	-0.010	0.018	0.122*	-0.016	-0.004	0.051	-0.024*
	(0.004)	(0.025)	(0.010)	(0.016)	(0.073)	(0.035)	(0.006)	(0.038)	(0.014)	(0.004)	(0.025)	(0.010)	(0.016)	(0.073)	(0.035)	(0.006)	(0.038)	(0.014)
Constant	-0.027**	0.669***	-0.010	-0.077**	0.439***	0.021	-0.027*	0.734***	-0.015	-0.029***	0.670***	-0.015	-0.076**	0.461***	0.008	-0.028**	0.728***	-0.015
	(0.011)	(0.066)	(0.023)	(0.036)	(0.165)	(0.077)	(0.014)	(0.091)	(0.030)	(0.011)	(0.065)	(0.023)	(0.035)	(0.165)	(0.077)	(0.014)	(0.091)	(0.030)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1041	1041	1041	396	396	396	645	645	645	1041	1041	1041	396	396	396	645	645	645
R-squared	0.342	0.320	0.151	0.387	0.404	0.194	0.350	0.314	0.147	0.341	0.321	0.148	0.391	0.403	0.188	0.348	0.314	0.147

This table reports estimation results for a three-equation system, with ROA and Z-SCORE as profitability and risk indicators. CAR is the capital-to-asset ratio. All the macro controls are lagged. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and Worldwide Governance Indicators databases. The estimations are performed using the three-stage least squares (3SLS) estimation technique. Robust standard errors are in parentheses. Superscripts ***, ** and * denote significance at 1%, 5% and 10%, respectively.

that takes 1 when more than 50% of shareholding held by the private sector, meaning that private investors are the majority shareholders, and 0 otherwise. Our main results do not change significantly.

6. Conclusion

This paper has investigated the simultaneous relationship among bank capital, risk and profitability, considering bank ownership status, specifically foreign ownership and Pan-African cross-border status, with respect to all WAEMU countries over the period 2000-2014. We seek to add new dimensions to the existing literature in terms of the empirical framework, the data, the classification of the sample countries and their capital regulatory challenges, the alternative measurements of bank capital, risk and profitability and the consideration of three new issues, namely: the influence of the business cycle; the effect of foreign bank ownership; and the effect of Pan-African cross-border bank ownership.

The focus on WAEMU banks, using hand-collected data from the regional central bank, is particularly relevant here to generate new evidence not only on existing controversies in the literature (e.g. the relationship between capital and risk as well as capital and profitability) but also to shed more light on the WAEMU banking system, with its heterogeneity of banks which exist in a seemingly homogenous regional block with a single central bank.

Among the main interesting results of this paper, four new findings should be noted. Firstly, we find a positive relationship between bank capital and profitability, as predicted in Hypothesis 1. The effect of bank capital on profitability seems to be somewhat higher in lower-middle income WAEMU countries (+0.10) than in low income countries (+0.05). It is interesting that although WAEMU is taken to be a regional monetary block, the heterogeneity in the banks and financial structure does matter, and the classification of the countries into low income countries and lower middle-income countries yields useful insights. The different levels of financial sector development and the institutional backgrounds of the countries within the WAEMU region seem to matter. Secondly, we uncover a positive relationship between bank risk and bank capital, consistent with the *regulatory hypothesis*: on average, one-unit percentage increase in capital ratio leads to 1.2 basis points increase in bank credit risk (loan loss reserves ratio) in lower-middle income countries and 23.8 basis points increase in bank risk (Z-score) in low income countries. These results also confirm the predictions of Hypothesis 2. Thirdly, we find that bank capital positions tend to co-move positively with the business cycle in low income countries as opposed to their lower-middle income peers, as predicted in Hypothesis 3. This positive cyclical movement of bank capital positions in LICs mimics a key postulate of Basel III. Fourthly, the results show that the presence of French banks reduces risk, while the presence of Pan-African cross-border banks increases risk in the WAEMU banking sector, as predicted in Hypothesis 4. In general, these findings are robust to the use of competing measures of risk and profitability, and to alternative estimation techniques.

In terms of policy implications, the empirical results of our paper imply that in implementing Basel III, the WAEMU bank regulatory authorities must bear in mind that 'one size fits all' does not work for all the eight WAEMU countries. Rather, the heterogeneity of the countries, in a seemingly homogenous regional economic community, into LICs and LMICs must be recognized because an increase in capital ratio affects bank profitability and bank risk appetite differently. Moreover, the banking regulator of the region should pay careful attention to the capital behavior of banks operating in LMICs, as these banks, which are on average the largest, seem to have procyclical behavior, contrary to what is being proposed by Basel III. The policy challenge here is that while bank capital positions tend to imply countercyclical lending in LICs, mimicking a key postulate of Basel III, they encourage procyclical lending behaviour in LMICs.

Overall, these findings are important not only for the implementation of the adopted Basel III regulation and the cautious balance among bank capital ratios, risk-taking and profitability by bank regulators, but also for bank managers who take bank portfolio decisions. There are some interesting ideas for further research, including the design of capital buffers, the risk-taking behavior of cross-border banks, the competition in the banking sector, the lending behavior of banks, and microstructure study of the interbank market.

CRediT authorship contribution statement

Désiré Kanga: Software, Conceptualization, Data curation, Writing - original draft, Writing - review & editing. **Victor Murinde:** Conceptualization, Writing - original draft, Software, Writing - review & editing, Project administration, Funding acquisition. **Issouf Soumaré:** Conceptualization, Software, Data curation, Validation, Writing - original draft, Writing - review & editing.

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Appendix A: Relevant aspects of WAEMU banking sector regulation

Central to issues of bank capital, risk and profitability in the WAEMU region is the fact that the banking sector in the region is overseen by three supervisory bodies: The Council of Ministers, the Central Bank of West African States (BCEAO[16]) and the Banking Commission. The Council of Ministers is the supreme organ with remit for the BCEAO and the Banking Commission. The BCEAO is empowered to take any measures concerning instruments and

[16] BCEAO stands for Banque Centrale des États de l'Afrique de l'Ouest. It is the central bank of the eight (8) countries of the WAEMU.

Table A1
Summary of prudential regulation in WAEMU.

Indicator	Definition	Threshold
Solvency ratios		
Minimum capital requirement	Core capital	XOF 1 billon before 2008 XOF 5 billion, 2008-2015 XOF 10 billion since April 2015
Risk coverage	Capital to Risk-weighted-assets ratio[a]	8% (until December 31st, 2017)
Limitation of fixed assets and participations	Fixed assets and participations divided by total equity	1
Other ratios		
Coverage of the medium and long-term assets by stable liabilities	Transformation ratio	75% before 2013 50% since January 1st, 2013
Limitation of commitments on a same signature	Total exposure on the same beneficiary or the same signature divided by Equity	75%
Limiting the overall volume of individual risks	Exposure on all the beneficiaries reaching individually 25% of the equity divided by Equity	8
Limitation of loans to major shareholders, managers and staff	Total loans to major shareholders, managers and staff divided by Equity	20%
Portfolio structure ratio	Performing loans divided by Total loans	60%, but no longer in force since 2013
Liquidity ratio	Liquid assets divided by short-term liabilities	75%

The table presents some key indicators of the solvency ratios, the definition of each ratio and the threshold of the ratio in force since 2000 until December 31st, 2017. Also presented in the table are other prudential regulatory ratios used in WAEMU, their definitions and the thresholds before and after 2013.
[a] See BCEAO (2013) for the calculation details of these two components: Capital and Risk-weighted assets.

rules related to the credit policy applicable to credit institutions, including compulsory reserves and the fees and conditions of the operations made by these institutions with their clients. The control of the banking activity is entrusted to the Banking Commission of the WAEMU. This last regulatory body was created on April 24th, 1990 in Ouagadougou, Burkina Faso at the WAEMU headquarters by an agreement signed by the Ministers of Finance of member states. This agreement was revised on April 6th, 2007 in Lomé, Togo.

The role of the Banking Commission is to ensure a consistent and effective supervision of banking activity in the WAEMU. The Commission's mission covers, primarily: the approval and withdrawal of authorization of credit institutions; the control of credit institutions and decentralized financial systems; and the liquidation of credit institutions.

The prudential framework until December 31st, 2017 was strongly inspired by Basel I regulation with a minimum capital adequacy ratio of 8%.[17] Bank core capital must be at least equal to the statutory minimum capital following the prudential framework in force since January 1st, 2000 (BCEAO, 2013). The minimum capital threshold was XOF 1 billion from 2000 until end of 2007. At the Council of Ministers of the Union regular session of September 17th, 2007, it was raised to XOF 5 billion with effect from 2008. Following the Council of Ministers meeting on March 30th, 2015, it was raised further to XOF 10 billion, with a grace period which allows banks to conform to this new standard by July 1st, 2017 at the latest. These successive increases in the minimum capital level and the recent adoption of the macro-prudential Basel III regulation aim at promoting a healthy, strong and stable banking and financial system, which in turn, is expected to effectively contribute to the financing of the economic development of WAEMU member States.

Over our study period, the bank supervision is compliant with the risk-based prudential framework of Basel I.[18] Table A1 gives a summary of the prudential framework in WAEMU based on this instruction.

[17] But the regional banking regulator adopted recently new capital adequacy rules in the spirit of Basel III effective in January 1st, 2018: BCEAO, "Dispositif prudentiel applicable aux établissements de crédit et aux compagnies financières de l'Union Monétaire Ouest Africaine", Annexe de la Décision 013 du 24/06/2016.

[18] Instruction N°2000/01/RB relating to the modalities of application of the prudential framework applicable to banks and financial institutions of the WAEMU.

Appendix B: Selected statistics on access to financial services

Table B1.

Table B1
Some indicators of access to financial services.

	ATMs per 100,000 adults					Bank accounts per 1000 adults				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Benin	2.42	2.76	3.44	4.3	4.33	106.49	118.9	128.41	139.82	155.37
Burkina Faso	1.35	2.22	2.31	2.66	3.21	78.64	90.51	105.45	112.27	126.55
Ivory Coast	**3.76**	**4.56**	**4.41**	**5.69**	**6.75**	**129.71**	**218.25**	**182.52**	**185.62**	**202.76**
Guinea-Bissau	1.36	1.33	1.89	3.67	..	43.5	57.22	69.08	58.1	71.99
Mali	2.68	3.19	3.33	3.94	4.23	95.9	122.61	152.2	141.76	143.52
Niger	0.59	0.92	0.93	1.26	1.28	26.44	30.67	35.25	41.34	50.82
Senegal	**3.92**	**4.57**	**4.86**	**4.81**	**4.96**	102.34	132.43	131.53	149.08	163.44
Togo	2.85	3.19	4.32	4.8	..	**159.75**	**158.04**	**157.67**	**168.77**	**249.52**

This table reports, for each of the WAEMU countries, two indicators on the access to financial services. The data are from the Global Financial Development Database of the World Bank (extraction on January 5th, 2018). It is worth noting that the banking sector of the region is small and access to financial services is heterogeneous and limited even though it has been improving over the years. For example, the number of ATMs is close to one per 1000 adults in Niger while this number reaches 6.75 in Ivory Coast and 4.96 in Senegal in 2014. The highest number of bank accounts per 1000 adults in the region is found in Togo, but does not exceed 250 accounts per 1000 adults over the period 2010–2014.

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