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Capital, risk and profitability of WAEMU banks: Does cross-border banking matter?[1]

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ABSTRACT

Using hand-collected bank level data from all West African Economic and Monetary Union (WAEMU) countries for 2000-2014, we investigate the simultaneous relationship among bank capital, risk and profitability, taking into account bank ownership and cross-border banking. We split the countries into lower middle-income (LMIs) and low-income (LICs). We find that the sensitivity of bank profitability to an increase in capital ratio is much higher in LMIs (+0.10) than in LICs (+0.05). Moreover, we uncover evidence to support the *regulatory hypothesis*, *i.e.* positive relationship between risk and capital. Also, we find that banks' capital positions tend to be counter-cyclical in LICs, mimicking Basle III. Differentiating between cross-border pan-African banks and foreign banks from outside the continent, we find that overall cross-border bank ownership reduces credit risk and profitability in the banking sector. These findings are generally robust to the use of alternative measures of risk and profitability and alternative estimation techniques.

Keywords: WAEMU banks; bank capital; bank risk; bank performance; Basel accords; cross border banking

JEL Codes: G21; G28

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1. Introduction

The current Basle Bank Capital Accord (Basel III) regulation proposes to increase banks' capital adequacy ratio in order to contain risk-taking behavior 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.[3] The concern is that while they may provide a buffer against expected risk, high capital requirements constrain the banks' capacity to lend. Moreover, the jury is still out there among researchers on the exact impact of capital increase on bank's risk-taking and profitability. Indeed, while some researchers document a positive relationship between capital and risk, i.e. banks' capital and risk appetite increase together (e.g. Lee and Hsieh (2013)), 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., Altunbas et al. (2007) and Guidara et al. (2013)). Similar dichotomous conclusions have been found regarding the relationship between banks' capital and profitability. For instance, while Goddard et al. (2004) and 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. (2010) uncovered an inverse relationship between the two indicators. Overall, these issues remain unresolved, notwithstanding the urgent demand for research to inform policy on implications of adopting high bank capital requirements as an integral component of Basel III.

Nevertheless, it is interesting to note that existing research has identified some systemic (non-bank-specific) factors that may influence bank capital, risk or profitability, albeit separately. For example, the impact of the business cycle on lending and profitability (e.g. Albertazzi and Gambacorta, 2009; Behn et al., 2016), or on capital buffers (e.g. Bikker and Metzemakers, 2007; Stolz and Wedow, 2011); the behavior of bank profitability in countries at different income levels (e.g. Dietrich and Wanzenried, 2014); and the impact of cross-border banking and foreign ownership (Kodongo et al., 2015; and Chen et al., 2017). It may well be the case that by integrating each of these three systemic factors (business cycle, country income

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

levels, and the wave of cross-border banking) into a simultaneous framework of bank capital, risk and profitability, we may shed more light on the unresolved issues.

This paper responds to the above demand and aims to investigate the relationship among capital, risk and profitability in the banking sector of the West African Economic and Monetary Union (WAEMU), taking into account the effect of the above three factors on the relationship. Specifically, we are interested in providing answers to three research questions. How sensitive to capital ratio adjustment are WAEMU banks' risk and profitability? Do the WAEMU banks' capital run counter to the business cycles? Do foreign ownership and pan-African banks presence affect the relationship among WAEMU banks' capital, risk and profitability?

Several reasons justify the relevance of this study on the WAEMU banking sector. First, the WAEMU region, a common economic and monetary union, is composed of eight least developed countries[4] which share a common currency (the CFA Franc). Like many other developing countries which are characterized by rudimentary bond markets, a low level of international integration and a strong intervention of the central banks in the foreign exchange markets (Mishra et al., 2012), WAEMU features a financial system where banks are the predominant source of finance for businesses and households. In this kind of environment, increasing banks' capital adequacy ratio while providing a healthy banking system could also constrain the lending capacity of banks. From the regulatory view-point, following several other banking sector regulators around the World, especially from the developed economies, the regional banking sector regulator adopted in June 2016 the new Basel III regulatory framework in effect since January 1st, 2018. This constitutes a steep jump from the Basel I regulation in effect to the more complex Basel III regulation.[5] The effects of this new regulation on the region banking sector and its economy have yet to be proven, and to our knowledge, no such study exist. What would the implementation of Basel III regulation in the WAEMU economies imply in terms of banks' risk and profitability? This paper contributes to the literature by providing an answer to this question and by focusing on the WAEMU economies. We think that this study

[4] The countries of the WAEMU are: Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal and Togo. These countries share the same currency, the CFA Franc, which is 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.

[5] 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).

can serve as a guiding tool towards the implementation of Basel III framework in the WAEMU region.

Second, as shown later in the empirical section (table 9), the banking sector ownership in the region has been dominated by foreigners, and over the last decade, they have been a steady increase in the share of cross-border pan-African banks. This increase presence of banks dominated by foreigners may expose the banking sector to external adverse shocks. However, despite the increase in the share of foreign owned banks, the banking sector of the region was less affected by the 2007-2009 financial turmoil as compared to the banking sector of Europe and U.S. where cross-border lending dropped significantly and remained at low level (Claessens and van Horen, 2014b).

Third, although a substantial body of research exists on the relationship among banks' capital, risk and profitability, the literature focuses mostly on developed economies banking sector (mostly U.S. and European banks) and emerging markets banks in Asia,[6] with much less attention paid to the banking sector in the less developed economies of Africa, in particular the WAEMU region. The question that arises is whether the results found on these regions are meaningful for the WAEMU region. Even when research is done on Sub-Saharan African (SSA) economies, the studies do not focus heavily on the WEAMU region, with its unique characteristic: a common monetary policy zone with heterogeneous member countries. Overall, studies which exclusively focus on the WAEMU banking sector are very scanty, and the few studies that exist are on the determinants of banks' profitability and banking sector development. Moreover, the existing studies rely mostly on Bankscope data to construct the sample of banks, perhaps missing valuable information in the WAEMU context. This region is, therefore, an interesting laboratory for investigation. With the WAEMU region case, we are able to study banks behavior across different heterogeneous less-developed countries having the same unique banking regulation and monetary policy.

Using hand-collected bank level data from all West African Economic and Monetary Union (WAEMU) countries for 2000-2014, we uncover four new important findings. First, we find that bank profitability is sensitive to changes in capital ratios, but the effect is much higher in lower-middle income WAEMU countries (+0.10) than their low income peers (+0.05). Second, 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

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

increase in banks' credit risk (loan loss reserves ratio) in lower-middle income countries and 23.8 basis points increase in banks' risk (Z-score) in low income countries. Third, we find that banks' capital positions tend to be counter-cyclical in low income countries as opposed to their lower-middle income peers, meaning that banks in LICs build up excess capital buffer during expansions and use these additional capitals during recessions to cover excess risk. Fourth, the results confirm that foreign bank ownership and cross-border pan-African banks presence reduce credit risk and profitability in the whole banking sector. Moreover, international foreign banks 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 take too much risk when granting loans. One possible explanation is that while international foreign-owned banks are usually the oldest in many cases, domestic and cross-border pan-African banks need more flexibility to attract some customers from international foreign-owned banks and therefore, they are lax when granting credit. Perhaps, they attract less good customers who are not able to get credit with international foreign-owned banks. In all these findings, the difference in financial sector development level and the institutional backgrounds of the countries composing the WAEMU region seem to matter. In general, these findings are robust to the use of alternative measures of risk and profitability, and alternative estimation techniques.

In what follows, Section 2 presents an overview of the related literature review and a summary of the regulatory environment in the WAEMU banking sector. Section 3 presents the data, the model and the variables. Section 4 presents the empirical results. Section 5 presents the additional robustness checks of our results. We conclude in Section 6.

2. Related literature

2.1 Selective literature review and research questions

Our work is related to three strands of the banking literature. The first strand concerns the relationship among banks' risk, capital and performance.[7] Demirguc-Kunt and Huizinga (2000) and Flamini et al. (2009) showed that financial development has an important impact on bank's performance, particularly in SSA. In addition, bank-specific characteristics and macroeconomic factors are found to be the most important explanatory variables. Flamini et al. (2009) found that greater competition among banks lowers profitability. Dietrich and Wanzenried (2014) confirmed this result on a large panel sample of banks. Evidence is uncovered for the *structure-*

[7] See, for instance, Altunbas et al. (2007), Goddard et al. (2004), Goddard et al. (2010), Guidara et al. (2013), Iannotta et al. (2007), Jacques and Nigro (1997), Jokipii and Milne (2011), Kwan and Eisenbeis (1997), Lee and Hsieh (2013), Rime (2001) and Shrieves and Dahl (1992), among many others.

conduct-performance hypothesis, which asserts that increased market power yields monopolistic profits. It is shown that market concentration has a positive and significant effect on profitability in low-income countries. The Dietrich-Wanzenried (2014) result therefore clarifies earlier findings by Munyambonera (2013) that bank's capital is positively related to bank performance in SSA. In fact, according to Micco et al. (2007) and Dietrich and Wanzenried (2014) state-owned banks operating in developing (low- and middle-income) countries seem to have a lower profitability, lower margins, and higher overhead costs than comparable privately owned banks.

It may be argued that banks with higher capital levels take on more risks. The *regulatory hypothesis* posits that regulators encourage banks to hold more capital to cover the risks being taken. In this context, a positive relationship between capital and risk may be attributed to the actions of regulators and supervisors (Shrieves and Dahl, 1992; Jacques and Nigro, 1997; Altunbas et al., 2007). 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, in particular 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.

The second strand of the banking literature concerns the dynamics of banks capital adjustment and its relationship with business cycles. For instance, while Ayuso et al. (2004), Behn et al. (2015), Jopikii and Milne (2008), Lindquist (2004), Repullo and Suarez (2008) and Shim (2013) documented a procyclical nature of banks' capital, i.e. a negative co-movement of capital buffer and business cycle; others such as Bikker and Metzemakers (2007), Guidara et al. (2013) and Stolz and Wedow (2011) found a positive co-movement between capital and business cycle, or a counter-cyclical relationship.

The third strand of literature related to our work, is the growing literature on the impact of the presence of cross-border banks on the domestic banking system, e.g. Beck (2015), Cull and Martinez Peria (2012), Claessens et al. (2001), Claessens and van Horen (2014a, 2014b, 2015), Demirguc-Kunt and Huizinga (2000), Detragiache et al. (2008), Dietrich and Wanzenried (2014) and Chen et al. (2016), among many others. Beck (2015) stresses the need to differentiate between different types of cross-border banks when assessing their impact on firms' access to bank finance in Africa. Kodongo et al. (2015) found institutional quality, macroeconomic stability, level of competition and market power at home, as well as bank

efficiency, to be the drivers of bank foreign expansion in East Africa. Demirguc-Kunt and Huizinga (2000) found that foreign-owned banks are less profitable in developed countries, while Dietrich and Wanzenried (2014) found foreign owned banks more profitable than domestic banks in low-income countries.

These existing studies rely mostly on Bankscope data to construct the sample of banks, perhaps missing valuable information in the WAEMU context. Moreover, as we pointed out above, this is the first study to document these interrelated different issues in the WAEMU region. More specifically, we explore the following four research questions:

(i) How sensitive is the profitability of WAEMU banks to changes in the banks' capital ratio?
(ii) How sensitive is WAEMU banks' risk to changes in the banks' capital ratio?
(iii) Do the WAEMU banks' capital run counter to the business cycles?
(iv) Does pan-African banks' presence affect the relationship among WAEMU banks' capital, risk and profitability?

2.2 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[8]) 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 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.

[8] 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 1: Summary of prudential regulation in WAEMU

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.

Indicator	**Definition**	**Threshold**
Solvency ratios		
Minimum capital requirement	Core capital	CFAF 1 billon up to 2008 CFAF 5 billion, 2008-2015 CFAF 10 billion since April 2015
Risk coverage	Capital to Risk-weighted-assets ratio[9]	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 prudential framework until December 31st, 2017 was strongly inspired by Basel I regulation with a minimum capital adequacy ratio of 8%.[10] Banks' 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 CFAF 1 billion from 2000 until 2008. At the Council of Ministers of the Union regular session of September 17th, 2007, it was raised to CFAF 5 billion with effect from 2008. Following the Council of Ministers meeting on March 30th, 2015, it was raised further to CFAF 10 billion, with a grace period which allows banks to conform to this new standard by July 1st, 2017 at the latest. These

[9] See BCEAO (2013) for the calculation details of these two components: Capital and Risk-weighted assets.

[10] 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.

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.[11] Table 1 gives a summary of the prudential framework in WAEMU based on this instruction.

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. This dataset is preferable to Bankscope data because it helps avoid the selection bias issue due to the fact that all the banks of the region do not necessarily report to Bankscope, whereas they all report to the Banking Commission of WAEMU.

Table 2 shows the total number of banks (113) and their distribution across countries. This total includes all the banks over the study period 2000-2014, i.e. 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 a 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 taken into account in our analysis regardless of its type (listed and unlisted). 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 1,293 and the average number of observations per bank is 11 (between 2 and 15).

It is worth noting that the banking sector of the region is small and the 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 1,000 adults in Niger while this number reaches 6.75 in Ivory Coast and 4.96 in Senegal in 2014 (cf. Table 1A in the appendix). The

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

highest number of banks account per 1,000 adults in the region is found in Togo, but does not exceed 250 accounts per 1,000 adults over the period 2010-2014.

Table 2: Numbers of banks and country income level

This table reports, for each of the WAEMU countries, the number of banks and the income level. The data for the number of banks are from the Banking Commission of WAEMU while the data on income levels are from the World Bank classification of countries for 2016.

Country	Number of banks	Income level
Benin	13	Low
Burkina Faso	13	Low
Ivory Coast	26	lower-middle
Guinea-Bissau	4	Low
Mali	13	Low
Niger	11	Low
Senegal	20	lower-middle
Togo	13	Low
Total	113	

3.2 Econometric model

We adopt the partial adjustment framework of Shrieves and Dahl (1992), Jacques and Nigro (1997) and Rime (2001), used by many other authors, 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 and resource consuming and that banks cannot adjust totally these variables during a single period.

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

$$\Delta Y_{it} = \lambda(Y_{it}^{*} - Y_{it-1}) + \eta_{it}, \quad (1)$$

where *i* indexes banks, *t* indexes year and η_{it} is the idiosyncratic error. Equation (1) reads as follows: Each year, banks adjust a proportion λ 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 banks' characteristics (both aggregate and idiosyncratic factors), and is expressed as follows:

$$Y_{it}^{*} = \alpha_0 + X_{it-1}\beta^{*}, \quad (2)$$

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

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

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

$$\Delta PROFIT_{it} = \alpha_0 + \alpha_1 PROFIT_{i,t-1} + \alpha_2 \Delta CAR_{it} + \alpha_3 \Delta RISK_{it} + \alpha_4 X_{it} + \mu_{1i} + \upsilon_{1t} + \varepsilon_{it}, \quad (4)$$

$$\Delta RISK_{it} = \beta_0 + \beta_1 RISK_{i,t-1} + \beta_2 \Delta CAR_{it} + \beta_3 \Delta PROFIT_{it} + \beta_4 X_{it} + \mu_{2i} + \upsilon_{2t} + \eta_{it}, \quad (5)$$

$$\Delta CAR_{it} = \gamma_0 + \gamma_1 CAR_{i,t-1} + \gamma_2 \Delta RISK_{it} + \gamma_3 \Delta PROFIT_{it} + \gamma_4 X_{it} + \mu_{3i} + \upsilon_{3t} + u_{it}, \quad (6)$$

where $i=1,\ldots,N$ and $t=1,\ldots,T$ denote bank and time respectively, μ_{ki} and ν_{kt} are unobserved bank-specific and time-specific effects, ε_{it}, η_{it} and u_{it} are idiosyncratic error terms. $PROFIT_{it}$, $RISK_{it}$, and CAR_{it} are, respectively, the profitability, risk and capital ratio indicators of bank *i* at time *t*. X_{it} is the vector of control variables of bank-specific, macroeconomic and institutional quality factors described below.

Equations (4) and (5) are designed to examine the impact of capital adjustment on bank profitability and risk, respectively. In each equation, CAR_{it} is the level of bank capital ratio measured by the capital-to-assets ratio. Equation (6) captures the simultaneous capital adjustment dynamic of the banks. Besides addressing endogeneity issues, this equation allows us to study the sensitiveness of banks' capital to changes in riskiness and profitability.

Since capital, risk and profit are determined endogenously and simultaneously, the above three equations (4, 5, 6) will be estimated simultaneously using the two-step generalized method of moments estimation technique of Arellano and Bover (1995) and Blundell and Bond (1998) to deal with potential endogeneity problems between variables, omitted variables issues and other potential econometric issues inherent in this kind of panel data analysis. Since GMM uses internal variables of the system as instruments, we use lagged level and first differences of the variables. To verify whether the instruments are valid, we use the Hansen test of over-identifying restrictions. For robustness check, we also use the three-stage least squares (3SLS) estimation technique.

Year and country dummies are included in all specifications to account for time and country effects. Banks' effects are assumed to be random when applying the GMM technique.

3.3 Variables

3.3.1 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.* Flannery and Rangan (2008) and Guidara et al. (2013).[12] Capital is computed using the BCEAO (2013) definition of core and supplementary capital. For 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).[13] 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 Table 1 above, 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[14], 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

[12] This capital ratio is equivalent to the non-risk based leverage ratio imposed by the current Basel III regulation. As alternative measure of capital, we could use the risk-based capital adequacy ratio, proxy 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 more or less yield similar results as will RWA, since in this region as in many other least developed economies, RWA are essentially composed of credit risk and assets are mainly loans.

[13] We do not use market variables, such as stock returns, since most of these banks in the region are not listed in 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.

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

developed, therefore companies and households rely more on banks' loans. This indicator has been used by Altunbas et al. (2007).

As opposite to loan loss reserves, Z-score is a risk measure commonly used to reflect a bank's probability of insolvency, e.g. Hesse and Čihák (2007) and Lepetit and Strobel (2013). 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 Z-score is computed as follows.

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

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 three-year rolling window to compute the averages and standard deviation in equation (7).

In order to facilitate the interpretation in terms of risk, we use a transformed version of the *Z-score*; that is

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

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 the bank risk exposure.

A large body of the literature used these two indicators (loan loss reserves and Z-score) due to their simplicity and the fact that they are based on accounting information, 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 banks' risk exposure in this region because of the limited depth of the financial markets. In fact, the money, the bond, the interbank, and the assets markets are not sufficiently developed (Kireyev, 2015). Particularly, the equity 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) argued that accounting information is usefulness in assessing firm specific risk.

3.3.2 Foreign ownership and pan-African status

We add the ownership structure of the banks' 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 more capital ratio 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 risk and capital. According to Léon (2016), the rapid expansion of regional pan-African banks in WAEMU region has increased competition in the sector. Higher competition is associated with more risk. 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.

Bank-specific factors:

Bank-specific factors are used to control for bank idiosyncratic characteristics and the banking industry common factors. These variables are:

- *Loan-to-total asset* (*LA*) is expected to be positively related to risk and profitability, as an increase in the bank's loan portfolio will result in more interest income and more credit risk. Its relationship with capital ratio is mixed. Indeed the loan-to-assets ratio is an indicator of bank riskiness: the higher the ratio, the more exposed a bank may be to higher defaults because its liquidity is low. Therefore, moral hazard hypothesis (negative relationship) or regulatory hypothesis (positive relationship) can hold as mentioned above.
- *Bank's size (SIZE)* is measured by the logarithm of total assets. We expect this variable to negatively impact the variation of 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. First, 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.; Kashyap et al., 2002; Shleifer and Vishny, 2010; Gennaioli et al., 2013). Second, 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).

- *Income concentration ratio (CR3)* is computed as the ratio of the total net income of the three biggest banks divided by the total net income of the country's banking sector. This indicator is used to capture the industrial concentration and competition in the banking sector. We expect this variable to positively impact bank profitability and risk (Beck et al., 2006) and capital by retaining earnings.

Macroeconomic and institutional quality factors:

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

- *Output gap (OUTGAP)* used to capture business cycle (demand side effect) is obtained 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 time series trend. According to the existing literature, the relationship between business cycle and bank capital is mixed. We will observe countercyclical behavior if this indicator is positively related to capital ratio, and pro-cyclicality otherwise. Moreover, according to economic intuition, we expect a positive relationship between 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 seen as 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, e.g. 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 banks' 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 risk-taking behavior of banks.

- *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 available at the World Bank. A high value of *POLSTAB* is associated with low political risk; 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. Hence, we expect this indicator to negatively impact profitability, risk and capital.
- *REG2008:* We add a dummy to capture the change of capital requirement in 2008. *REG2008* takes the value of 1 after 2008 and zero before. According to the prudential framework in force since January 1st, 2000 (BCEAO, 2013), banks' core capital must be at least equal to the statutory minimum capital. The minimum capital threshold was CFAF 1 billion from 2000 until 2008. It was raised to CFAF 5 billion on September 2007 with effect from 2008 and was raised further to CFAF 10 billion on March 2015, with a grace period, which allows banks to conform to this new standard by July 1st, 2017 at the latest (cf. Table 1 above). These successive increases in the minimum capital level aim at promoting a healthy and strong banking and financial system, which in turn, is expected to effectively contribute to the financing of the economic development of WAEMU member States. We control for these changes.

Table 3 gives a summary of the variables, their description and sources of data. Banks variables are drawn from the balance sheets 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.

Table 3: Description of the variables

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.

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
CR3	Concentration ratio: total net income of 3 biggest banks divided by total net income of all banks in the country	BCEAO
Macroeconomic and institutional quality variables		
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 2008 and zero before	

4. Empirical results

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 equations (4-6), given above. Sub-panels are first built on the basis of countries' gross national income (GNI) per capita. Based on the 2016 classification of the World Bank, the full sample is divided into two sub-panels: low income countries and lower-middle income countries (see Table 2 for the countries categorization). Thereafter, we also build sub-samples on the basis of ownership status of banks (foreign owned versus domestic owned) and on the pan-African bank status (cross-border pan-African versus non-cross-border pan-African). Before presenting the regressions' results, we show summary statistics of the variables.

4.1 Univariate and correlation analysis

Table 4 gives the summary statistics of the variables. First, there is a 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 Table 1. Second, the median return on assets (ROA) and return on equity (ROE) are 1% and 11%, respectively. The mean net interest margin (NIM) is 3%. Third, the mean loan loss provision of the sample is 1%. Fourth, 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 State. 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 sector 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., Beck, 2015; Kodongo et al., 2015; and Léon, 2016).

Table 4: Summary statistics over the sample, 2000-2014

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 to exclude the outliers.

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

Table 5 presents the difference test of the mean of the variables between the subsamples of low income countries and lower-middle income countries. We observe significant differences between the two samples banks' characteristics NIM, Z-score, LLRL, CR3, SIZE and countries' characteristics DCREDIT, OUTGAP and POLSTAB. The result seems to

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

Table 5: Difference test between LICs and LMIs subsamples, 2000-2014

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). ***p<0.01, **p<0.05, *p<0.10.

	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

The high value of domestic credit to the economy (DCREDIT) in lower-middle income countries seems to suggest that the differences observed among countries (low income versus lower-middle income) 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 these two lower-middle income countries than in the other countries of the region. 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 bad in Ivory Coast and drives down the institutional quality of the lower-middle income group.

Table 6: Pair-wise correlation matrix

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. ***p<0.01, **p<0.05, *p<0.10.

	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)	

Table 6 presents correlations between any two variables. Consistent with theory, capital (CAR) is inversely and significantly correlated with the profitability ROE and with risk indicators (Z-score and LLRL). But, CAR is positively correlated with the other two profitability measures, ROA and NIM. The explanation is that with capital increase, banks are able to lend more, which generate 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 6 (less than 50%); therefore, the risk of multicollinearity is very low in our study.

4.2 Regression results and discussion

As mentioned above, we adopt the two-step generalized method of moments (2SGMM) estimation technique of Arellano and Bover (1995) and Blundell and Bond (1998). Table 7 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 the 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) highlight 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 equation 3. The great heterogeneity across countries justifies the sub-panel estimation and highlights specific results that we could not find if we were to control only for individual effects.

Table 7: Estimation of the system with ROA and Z-SCORE as profitability and risk indicators, respectively

This table reports the estimation results for three-equation system, with ROA and Z-score as profitability and risk indicators, allowing for cross-border pan-African bank status and foreign bank ownership structure. 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. Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

	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	1,048	1,048	1,048	398	398	398	650	650	650	1,048	1,048	1,048	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

4.2.1 How sensitive is WAEMU banks' profitability to changes in their capital ratio?

We first focus on the return on assets (ROA) as our main measure of banks' profitability. There is a persistence of profitability over time. Capital has a positive and significant impact on banks' performance as in Dietrich and Wanzenried (2014), Goddard et al. (2004), Iannota et al. (2007) and Munyambonera (2013). Intuitively, a bank that holds a relatively high level of capital is able to expand its loans and increase its income from loans and is therefore likely to earn high profits. The impact of capital on profitability is much higher in lower-middle income countries (+0.10) compared to low income countries (+0.05), with one percentage point increase in bank capital ratio leading to 10 and 5 basis points increase in profitability in lower-middle income and low income countries, respectively. It may be argued that banks in relatively rich economies (lower-middle income WAEMU countries) are more efficient than those in least developed (low income) countries 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 is able to increase its capital ratio through retained earnings, which in turn generates more lending activities and hence more profits.

4.2.2 How sensitive is WAEMU banks' risk to changes in their capital ratio?

The existing literature found mixed results with respect to the impact of banks' capital variations on bank risk. For example, while Lee and Hsieh (2013) found a positive relationship between capital and risk, consistent with the *regulatory hypothesis* which posits that banks increase their capital with the amount of risk-taken, 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), in particular when banks' leverage and risk positions are already high.

From Table 7, we observe a weak positive relation between CAR and the Z-score, the risk measure, especially in low income countries. This non-significant positive relationship between risk and capital dismisses the *moral hazard hypothesis* and supports the *regulatory hypothesis*. It looks like with capital increase, banks do not decrease 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 banks' risk and a decreasing effect on their profitability. These effects are more pronounced in low income countries.

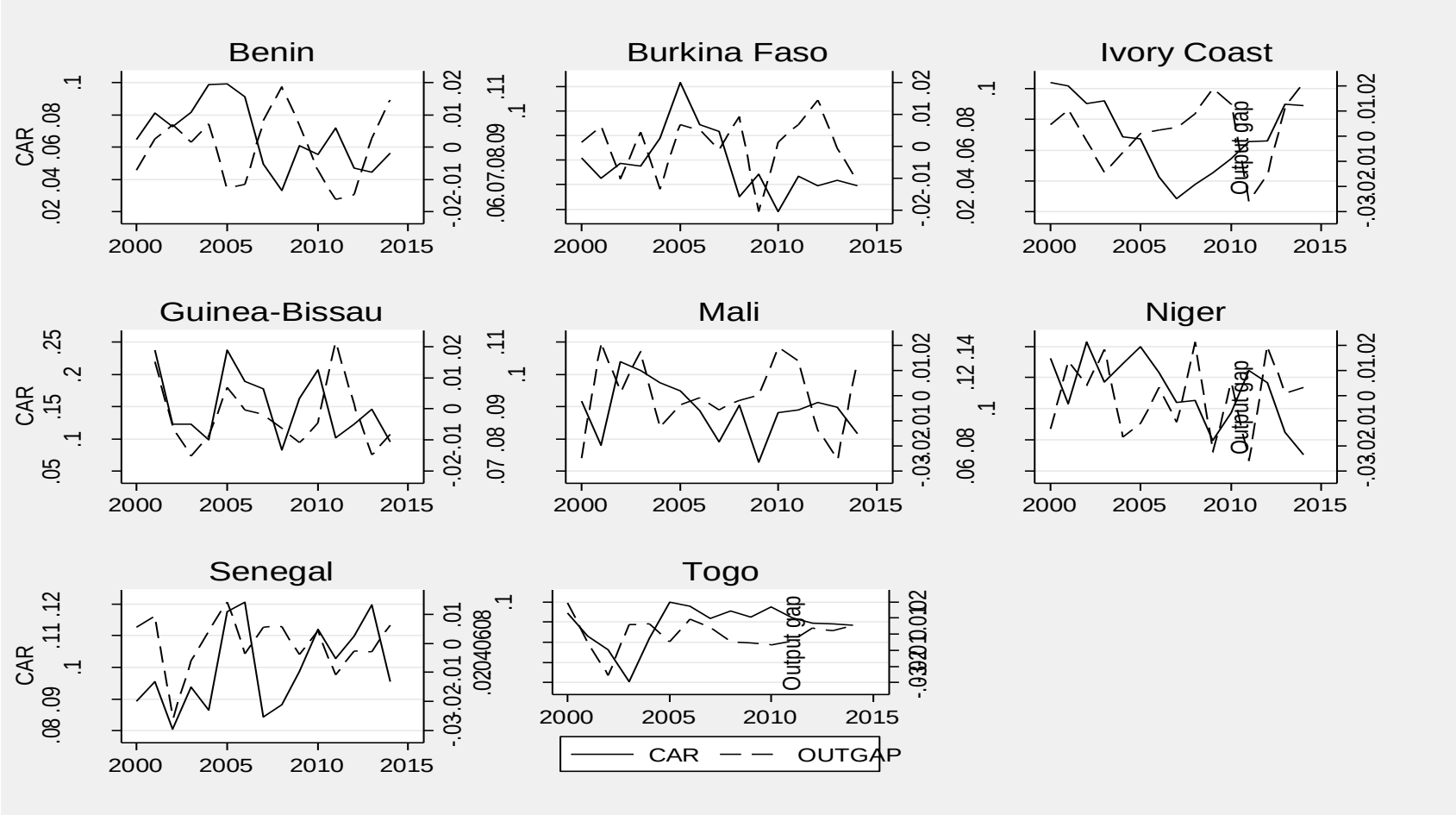
4.2.3 What is the relationship between WAEMU banks' capital and business cycle?

Although above we analyze the impact of capital variations on risk and profits, 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 7 confirms the above results, i.e. positive relationship between profit and capital across countries. These results are in the same line of those found by Iannota et al. (2007). The positive impact of the profitability measure ROA on capital is more pronounced for lower-middle income WAEMU countries. As for the risk, it has a non-significant positive impact on capital in most regressions.

In terms of the impact of the business cycle on banks' capital variations, Figure 1 plots the evolution of the aggregate capital ratio and output gap for each of the eight WAEMU countries. For the low income countries (Benin, Burkina Faso, Guinea-Bissau, Mali, Niger and Togo), we can clearly see from the graphs that their output gap and their aggregate banking sector capital ratio co-move positively together, while for the remaining two lower-middle income countries (Ivory Coast and Senegal), the direction of co-movement of their output gap and banking sector capital ratio is unclear. Further multivariate analysis with regression (results in Table 7) shows that overall banks accumulate more capital in expansion periods. However, when the analysis is conducted with respect to the countries' income level, it looks like banks accumulate more capital during expansions (high value of output gap) in low income WAEMU countries. In lower-middle income WAEMU countries, banks capital accumulation remains insensitive to business cycles variations.

Figure 1: Evolution of capital ratio and output gap for the WAEMU countries

The graphs in this figure plot the evolution of the capital ratio and output gap for each of the eight WAEMU countries. On each graph, 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.



Hence, banks' capital positions tend to co-move positively with the business cycle in low income countries as opposed to lower-middle income countries. This capital adjustment behavior with the business cycle in low income countries is qualified as counter-cyclical, 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. As we could see the capital accumulation behavior depends on the specificity of the country where the bank operates. This is consistent with Jokipii and Milne (2008) suggesting 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 banks' capital ratio level, but had an increasing effect on banks' risk and a decreasing effect on their profitability. Note however that, the increase in the minimum capital requirement has not been followed by an increase in the minimum regulatory capital adequacy ratio (which remains at 8%), therefore, it looks like banks adjusted upward their assets in the expectation of minimum capital increase in 2008, which compensates for the capital increase, hence neutralizing the overall impact on 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, therefore, in the spirit of the current Basel III regulations, they need to constitute counter-cyclical capital buffers to face possible future credit portfolio failures in economic downturns, and this is the behavior followed by banks in low income WAEMU countries.

4.2.4 Do foreign ownership and pan-African banks presence play a critical role?

We are interested in establishing whether bank ownership structure (foreign versus domestic) matters in determining bank capital, risk and profitability. We also investigate whether pan-African banks presence impact 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 8 presents the comparison tests between the variables means in the subsamples of foreign-owned banks versus domestically owned banks (Panel A) and 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 cross-border pan-African 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 7 above show that foreign banks presence drive down profit (measured by ROA) and capital ratio. When we look at the risk (in Table 8), we notice that the level of credit risk (measured by loan loss reserves ratio) taken by foreign-owned banks is less than 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 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. Or they attract less good customers who are not able to get credit with foreign-owned banks.

Overall, the effects of foreign bank ownership on bank capital, risk and profitability in low income and lower middle-income WAEMU countries is not so clear-cut; the only clear evidence is that foreign bank ownership is associated with a decreased in both profit and capital ratio in the overall banking sector.

The results reported in Table 7 show that cross-border pan-African 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 lower middle-income countries or their low income peers, the comparative analysis of Table 8 indicates that cross-border pan-African banks have less loan loss reserves and are less profitable than their non-pan-African pairs. Overall, cross-border pan-African banks do matter in the WAEMU countries; their presence reduces profit, risk and the capital ratio in the overall banking sector.

As further analysis on the role of the key foreign players, Table 9 gives an overview of the distribution of foreign banks headquarters origin in 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.

Table 8: Difference tests in the subsamples of foreign/pan-African ownership, 2000-2014

This table compares the means of the 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). ***p<0.01, **p<0.05, *p<0.10.

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

We conduct additional comparative test between variables means of the main countries of origin of foreign banks headquarters: outside Africa (France) and Africa excluding WAEMU (Libya, Morocco and Nigeria). The results given in Table 10 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, banks from France, on average, lend more, hold more credit risk 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 and are more profitable.

4.2.5 Impact of the control variables

First, the income concentration (*CR3*), 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 (*CR3*), a proxy for competition, increases profitability ROA. This provides an empirical evidence for the *structure-conduct-performance (SCP) hypothesis* in lower-middle income countries, i.e. 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.

Second, the effect of real interest rate (*INTEREST*) 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 subsection 3.3.3. Real interest rate has no significant impact on capital as well.

Third, we expect the variable for political stability and absence of violence/terrorism (*POLSTAB*) to negatively impact performance, risk and capital. According to the results, political stability has a negative significant impact on banks' profitability and non-significant impact on capital and risk in the overall banking sector. The impact of political stability on risk depends on the countries. In low income WAEMU countries, as expected, it increases risk and reduces capital contrary to their lower-middle income peers where the impact is non-significant.

Table 9: 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
Chine		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**

Source: BCEAO

Table 10: Difference tests in the subsamples of main origin of foreign banks headquarters: outside Africa versus Africa, 2000-2014

This table compares the means 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). ***p<0.01, **p<0.05, *p<0.10.

	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

Fourth, 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. This is also confirmed by the non-significant impact of this variable on capital and risk. Intuitively, increase in credit to the economy may come from more lending by banks, hence asset increase, while at the same time capital increases.

Fifth, bank size (*SIZE*) has a significant positive impact on profit and negative impact on risk. Its impact on capital is positive for both low income and lower-middle income countries, but not significant. Intuitively, big 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. Robustness checks

In this section, we check whether or not 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.

Table 11 and Table 12 report the results of the estimations of 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 banks' 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 (Table 11). For the profitability measure ROE, in Table 12, 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 do not contradict our previous findings. Indeed, from the following decomposition of ROA:

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

an increase in capital ratio can be 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, the positive co-movement between business cycles variations and capital ratio in low income countries is confirmed. Moreover, in Table 11, 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 more or less similar as before. Hence, the results are robust to the three metrics of profit used (ROA, NIM and ROE).

Table 11: Estimation of the system with NIM as profitability measure

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 estimation technique. Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

	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	1,048	1,048	1,048	398	398	398	650	650	650	1,048	1,048	1,048	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

Table 12: Estimation of the system with ROE as profitability measure

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. Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

	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	1,048	1,048	1,048	398	398	398	650	650	650	1,048	1,048	1,048	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

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 13, 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 lower-middle income WAEMU countries, i.e. banks increase their capital together with their risk appetite. Here also the positive co-movement between capital ratio and business cycles variations is confirmed for low income countries. The results show that foreign ownership has a reducing effect on the banking sector profitability as stated previously.

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 14 confirm our previous findings,[15] i.e. positive significant impact of capital on banks profitability. We also find support for the *regulatory hypothesis* in low income WAEMU countries. The other results remain valid as well.

6. Conclusion

This paper has investigated the simultaneous relationship among bank capital, risk and profitability, taking into account bank foreign ownership structure and cross-border pan-African status, with respect to all WAEMU countries over the period 2000-2014. We build on the existing literature, but also seek to add new dimensions in terms of 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 cross-border pan-African banking.

The focus on WAEMU banks, using data from the central bank, is particularly relevant here in order 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 West African banking systems.

[15] Again here, the results with the other profitability measures (ROE and NIM) and risk measure (LLRL) are available from the authors upon request. The non-reported results confirm our previous findings as well.

Table 13: Estimation of the system with ROA as profitability measure and LLRL as risk measure

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. Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

	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	1,169	1,169	1,169	450	450	450	719	719	719	1,169	1,169	1,169	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

Table 14: 3SLS estimation of the system with ROA and Z-SCORE as profitability and risk indicators

This table reports the estimation results for three-equation system, with ROA and Z-SCORE as profitability and risk indicators, allowing for pan-African bank status and bank ownership structure. 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) method. Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

	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)	-0.566***			-0.547***			-0.566***			-0.562***			-0.548***			-0.563***		
	(0.029)			(0.046)			(0.037)			(0.029)			(0.046)			(0.037)		
ΔROA		0.093	0.584***		0.097	0.746***		0.008	0.465***		0.087	0.585***		0.107	0.732***		0.002	0.468***
		(0.152)	(0.058)		(0.197)	(0.091)		(0.219)	(0.077)		(0.152)	(0.058)		(0.197)	(0.092)		(0.219)	(0.077)
RISK(-1)		-0.554***			-0.706***			-0.520***			-0.557***			-0.705***			-0.523***	
		(0.026)			(0.046)			(0.032)			(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		-0.001	-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***			-0.163***			-0.166***			-0.174***			-0.163***
			(0.018)			(0.033)			(0.023)			(0.018)			(0.032)			(0.023)
ΔCAR	**0.166*** **	**0.089**		**0.204*** **	**-0.024**		**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)**	
AFRICAN	-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)	(0.004)									
FOREIGN										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	0.008	-0.040	0.000	0.004	-0.019	-0.006	0.012	-0.058	0.007	0.007	-0.045	0.000	0.002	-0.030	-0.005	0.012	-0.062	0.007
	(0.006)	(0.033)	(0.013)	(0.009)	(0.040)	(0.019)	(0.008)	(0.050)	(0.018)	(0.006)	(0.034)	(0.013)	(0.009)	(0.041)	(0.020)	(0.008)	(0.050)	(0.018)
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	0.207	-0.009	0.000	-0.028	-0.016	-0.003	-0.020	-0.009	0.032	0.201	-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	0.639**	0.085	-0.026	0.596	0.309	-0.001	0.875**	0.134	-0.018	0.635**	0.084	-0.028	0.567	0.325	0.000	0.879**	0.135
	(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)	(0.439)	(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*	-0.042	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	-0.081	0.115	0.034	-0.017	-0.169	-0.011	-0.030	-0.069	-0.032	-0.083	0.130	0.012	-0.018	-0.167	-0.012
	(0.029)	(0.168)	(0.065)	(0.099)	(0.452)	(0.219)	(0.033)	(0.211)	(0.075)	(0.029)	(0.168)	(0.066)	(0.099)	(0.452)	(0.220)	(0.033)	(0.211)	(0.075)
REG2008	-0.004	0.011	-0.009	0.018	0.122*	-0.015	-0.003	0.054	-0.024*	-0.005	0.011	-0.010	0.018	0.122*	-0.016	-0.004	0.052	-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	-0.028**	0.670***	-0.009	-0.078**	0.442***	0.023	-0.027*	0.731***	-0.013	-0.029***	0.672***	-0.014	-0.076**	0.465***	0.009	-0.028**	0.725***	-0.013
	(0.011)	(0.067)	(0.024)	(0.036)	(0.166)	(0.077)	(0.014)	(0.092)	(0.030)	(0.011)	(0.066)	(0.024)	(0.035)	(0.166)	(0.077)	(0.014)	(0.092)	(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	1,041	1,041	1,041	396	396	396	645	645	645	1,041	1,041	1,041	396	396	396	645	645	645
R-squared	0.342	0.320	0.151	0.387	0.404	0.194	0.350	0.313	0.146	0.341	0.321	0.148	0.391	0.403	0.188	0.348	0.314	0.147

Among the main findings of this paper, four new findings should be noted. First, it is found that bank profitability is sensitive to changes in capital ratios, but the effect is much higher in lower-middle income WAEMU countries (+0.10) than their low income peers (+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. Second, 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 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. Third, we find that banks' capital positions tend to co-move positively with the business cycle in low income countries as opposed to their lower-middle income peers. Fourth, the results confirm that foreign bank ownership and pan-African banks presence reduce credit risk in the WAEMU banking sector. In general, these findings are robust to the use of alternative 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 LIC and LMI must be recognized because an increase in capital ratio affects bank profitability and bank risk appetite differently.

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. In particular, 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.

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Appendix

Table 1A: Some indicators of access to financial services

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).

	ATMs per 100,000 adults					Bank accounts per 1,000 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**