Competition, Cost efficiency and Cross-border Banking: Evidence from African banking industry

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Abstract

A change in the number of firms is believed to modify the dynamics of market structure and strategies in the market. In a more globalized financial industry, most banking systems are exposed to this type of dynamics, particularly through cross-border banking (CBB). Assuming a market where banks compete à la Stackelberg, this study reveals that a higher number of CBBs may induce the increase of competition when they enter as novel banks. It also suggests that, more efficient banks are more likely to influence market competition. Morever, new banks can influence the improvement of efficiency in the market provided that they show higher level of efficiency than domestic banks. These results are empirically validated. Using a sample of 429 African active commercial banks from 2000 to 2015, this study suggests that CBB activities enhance competition and African CBBs seem to play a more significant role. However, African CBBs exhibit lower efficiency levels as compared to domestic banks and accordingly do not boost bank efficiency. This study also suggests that macroeconomic conditions and institutional variables are important drivers of Bank competition and efficiency. These results are robust to alternative specifications (system-GMM, Quantile regression-Adaptative MCMC, Matching) and proxies of competition.

KEYWORDS: **Cross-border banking, competition, Efficiency, SFA, Lerner index, Stackelberg oligopoly**

JEL classification : G11, G15, C14.

1 Introduction

The impact of cross-border banking activities on the banking market structure has become an important topic in the banking literature, as cross-border banking flows have considerably increased over the last years.

Although some papers have attempted to investigate the effects of cross-border banking in developed and emerging markets (Bremus, 2015; Jeon, Olivero, & Wu, 2011; Lozano - Vivas & Weill, 2012) only few have tested its implication on African banking market where CBB activities have drastically increased over the recent years. According to Thorsten Beck (2014) Thorsten Beck (2014), the number of CBBs subsidiaries in Africa has roughly doubled between 1995 and 2009, ranging from 120 to 227. These subsidiaries have established in a considerable number of African countries as it is depicted in the network representation in **Figure 1** we constructed using (Thorsten Beck, Fuchs, Singer, & Witte, 2014) data. For instance, Ecobank (Togo), Standard Bank (South Africa), United Bank of Africa (Nigeria) have respectively been operating across 36, 20 and 19 African countries Beck (2015)[c]. Moreover, the assets' values of these banks have shown an upward trend (see Figure 2) from 2000 to 2015 with an average growth rate of roughly 12%.

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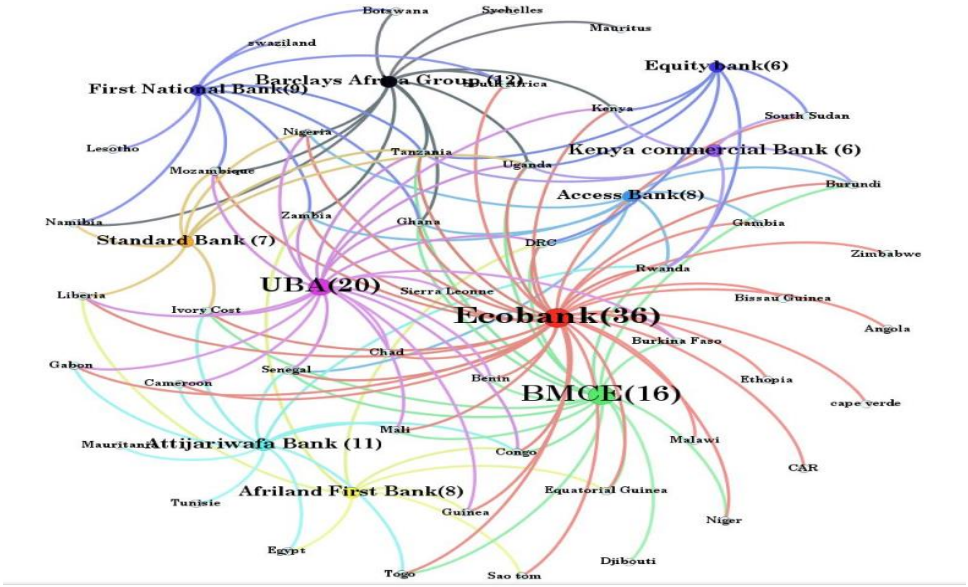
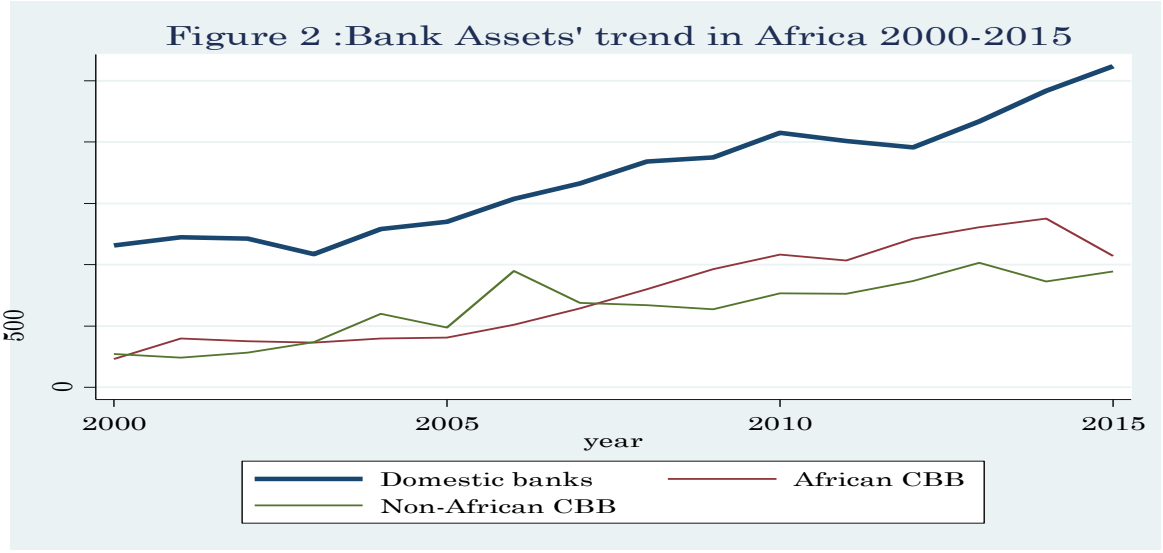
Despite this trend, less have been evidenced on how CBB may affect African banking market both in terms of competition and cost efficiency. Theoretically, Boone (2008) argues that new entries in the market may foster competition through a decrease of market concentration. Indeed, as the number of banks in different host countries' banking markets through cross-border subsidiaries increases, competition may tend to increase as well. However, the magnitude of the effect depends on the entry mode as suggested by (Lozano - Vivas & Weill, 2012). Subsidiaries established through Greenfield entry have more effects on competition than mergers and acquisitions as the second does not imply an increase of players in the market.

Figure 1 Network representation of Cross-border banking in Africa



On top of promoting competition, CBBs expansion may improve or deteriorate cost efficiency. To explain this, two hypotheses emerge in banking literature: The Quiet life hypothesis and the Efficient Structure hypothesis. According to the "quiet life" hypothesis, in monopoly, managers tend to reduce their efforts in cost management (Hicks, 1935). Therefore, in a more concentrated market, firms will tend to display low level of efficiency while in more competitive markets, firm best manage their cost because of competition challenges (Claessens, Demirgüç-Kunt, & Huizinga, 2001). The "efficient-structure" hypothesis posits that as competition grows higher, efficient banks may overpower and gain more market share. Hence, markets with more efficient banks tend to transform into more concentrated structure by defeating less efficient Banks. Specifically, if best managers' practice enables them to produce at lower cost, banks can increase their market power (Sturm & Williams, 2004). Does cross-border banking improve competition and cost efficiency in African banking market? Some empirical papers have assessed the impact of CBB's on market structure.

Figure 2 Bank Assets' trend in Africa :2000-2015



Bremus (2015) documents that higher volumes of cross-border lending result in a higher degree of competition in 18 OECD's countries. Similar results are documented by (Lozano-Vivas & Weill, 2012). Considering the European banking market, they suggest that the impact of CBB on competition depends on the entry mode. Greenfield CBBs have stronger effect on competition and cost efficiency than those which establish through M&A[d]. Jeon et al. (2011) find that foreign bank entry improves competition in Latin America and Asian emerging markets and in terms of spillovers, more efficient banks have stronger effects on competition.

In developing countries, not many studies have been conducted in this area. In Africa where CBBs have been expanding for instance, Léon (2016) was among the first to assess the impact of African CBB on competition in the banking industry using a sample of WAEMU[e] countries during the period of 2003-2009. The study consists of analyzing the trend of different competition measures (Lerner index, Boone indicator and Panzar-Rosse H-statistic) over time. As an increasing trend of competition during the study period was observed, he argues that this growth can mainly be explained by the expansion of African CBB. However, this conclusion fails to explain to what extent African CBB has contributed to the increasing level of competition in the banking industry. What's more, since the increase of competition may be explained by a set of regulation frameworks or macroeconomic conditions that may ease new domestic banks start, the conclusion fails to unveil this ambiguity.

To the best of our knowledge, research accounting for a direct effect of CBB on competition and efficiency in the African banking industry still exhibits a gap. We contribute to the literature in two ways. First, using a model where banks compete à la Cournot, this paper helps to provide a quite clear link between competition, cost efficiency and cross-border Banking. Second, unlike Léon (2016), we use a Panzar-Rosse time continuous curve model as a proxy of competition. This measure seems to be quite suitable as it accounts for changes that may affect a banking market. Third, the use of panel quantile regression approach to check

[d] Mergers and Acquisitions
[e] Western Africa Economic and Monetary Union

the validity of our results. To the best our knowledge, no study of this kind has used panel quantile regression in the link between competition and CBB.

The remainder of this paper is organized as follows. Section 2 discusses the relevant literature on competition, efficiency and CBB. Section 3 presents data and econometric approaches we have employed to measure both cost efficiency and competition as well as estimation techniques we have used to assess how they are affected by cross-border banking activities. Section 4 presents and discusses the empirical findings while section 5 implements different robustness checks and section 6 provides concluding remarks.

2 Literature Review

Over the last years, the growth of CBB activities has been an issue of concern in the banking literature, from market structure perspective to regulation and contagion view-points. In Africa, CBB activities have substantially increased over the last two decades. Thorsten Beck et al. (2014) documents a growth of CBBs subsidiaries in Africa, ranging from 120 to 227 between 1995 and 2009. The particularity of this expansion relies on the spread of so-called "panafican" banks which refer to as cross-border banks mostly owned by African investors and/or have their headquarters in Africa. Example of these banks includes, Ecobank (Togo), Standard Bank (South Africa), United Bank of Africa (Nigeria), among others, which have set their subsidiaries respectively across 33, 16 and 20 African countries (Thorsten Beck, 2015). This paper investigates the impact of this expansion on the market structure through competition and cost efficiency analysis.

In fact, some papers have attempted to examine the implication of cross-border banking on competition and efficiency in developed and emerging markets but few have focused on developing economies. However, the existing literature can be split into three classes.

The first class of papers studies the impact of foreign banks entry on host countries through two research directions. On one hand, the advocates of foreign bank presence in domestic markets, who suggest that foreign bank entry enhances competition, efficiency, leads to lower cost of financial services and boosts economic development through resource allocation. This position is in line with Boone (2008) theoretical prediction suggesting that, new entries in the market may bolster competition because an increase of players would diminish market concentration. Besides Allen (2011), suggest CBBs are important to promote competition because of the existence of competitive pressure due the increase of the number of banks. In the same spirit, Claessens et al. (2001) posits that as they promote competition, foreign banks would enhance efficiency since the increase of competition will decrease profitability and market power. As a consequence, banks will tend to minimize their operating cost to gain more in terms of efficiency. On the other hand, the opponents of foreign banks entry who support the idea that by selecting lower risk customers, foreign banks might lead domestic banks to select risky customers what can cause inefficiency, margins' decrease and impede competition. For instance, Lensink, Meesters, and Naaborg (2008) provides evidence that foreign ownership exerts a negative impact on bank efficiency.

The second stream of papers studies the impact of cross-border banking on domestic market. Unlike the previous, these studies focus on cross-border banking and competition in the host countries' market. Generally, results from related research suggest that cross-border banking

is beneficial to the domestic market's competition depending on the entry mode. Greenfield subsidiaries are shown to have stronger impact on competition than M&A subsidiaries. These results have been evidenced by Lozano-Vivas and Weill (2012) on european banking market. Morevover, other papers tackle this issue using a two-country general equilibrium mondel to predict the effect of cross-border banking on market structure (Bremus, 2015). Conclusions from these papers suggest that cross-boder lending leads to higher competitive pressure on domestic market which leads to a decrease of market concentration.

The third class of papers confronts competition to efficiency on the basis of two main hypotheses. On one hand, the "quiet life" hypothesis which states that competition enhances cost efficiency because in monopoly, managers tend to reduce their efforts (Hicks, 1935). An application to cross-border banking perspective is found in Bremus (2015)who suggests that more efficient CBBs tend to have higher impact on competition. Similar results are found in Jeon et al. (2011) use a continuous-time Panzar-Rosse model for a sample of Asian and Latin American banks to study the impact of foreign banks on domestic market. On the other hand, the "efficient-structure" hypothesis posits that as competition grows higher, efficient banks may overpower the later and gain more market share by becoming larger (Demsetz, 1973). As a consequence, market with more efficient banks tend to become more concentrated and therefore less competitive. Specifically, if best managers' practice enables them to produce at lower cost, banks can increase their market power (Sturm & Williams, 2004). In the same spirit, Schaek and Cihak (2008) provide evidence that efficiency can restrict competition through market power rising when best managers produce at lowest costs.

This paper relies on Lozano-Vivas and Weill (2012)paper's which examines the effect of cross-border banking activities on European banking market structure. In this their study, cross-border banking is revealed to play key role in competition and cost efficiency enhancement. They argue that European cross-border banks are more efficient and have less market power than domestic banks. Furthermore, the paper highlights that Greenfield cross-border banks affect cost efficiency and competition more than M&A banks. They show that foreign entry fosters competition in host country's market and in terms of spillovers, more efficient banks have stronger effects on competition. In the same spirit, Sturm and Williams (2004) argue that foreign banks affect both efficiency and competition as they promote diversity in the Australian banking industry.

In Africa, not many studies have focused on the cross-border banking-competition-efficiency relationship. Although, Fosu (2013) has investigated on competition at sub-regional level in Africa, his study fails to explain to which extend cross-border banking affects competition in Africa . Recently, Léon (2016) has been among the first to establish an indirect link between cross-border banking expansion and competition in African banking Market. This study suggests a positive indirect effect of cross-border bank on competition in the WAEMU[f] countries during the period of 2003-2009. Léon (2016) argues that, the increase of competition observed from the 2000s in these countries can mainly be explained by the expansion of African cross-border banks. Although being indirect, this explanation can hold. However, it fails to establish the extent to which these banks have affected competition. These studies not

[f] Western African Economic and Monetary Union

only fail to provide a direct relation between cross-border banking and competition, but also, none of them has pinpointed the role of cross-border banking for cost efficiency enhancement.

Therefore, the contribution of this study stems threefold. First, our paper is to the best our knowledge the first to explain how cross-border banking in market structure using a Stackelberg oligopoly model. Second, our paper fills this gap of existing studies on African banking industry by providing a direct analysis on the role of cross-border banking on competition and efficiency. Finally, unlike the aforementioned studies on African banking industry, our study is the first to show the extend to which efficiency matters in the new bank-competition association.

3 Methodology and Data

3.1. Theoretical Framework

[g]We preliminary consider an oligopolistic banking market where there are N banks, including N^d domestic Banks, N^{ac}African CBBs, and N^{fc} Non-African CBBs competing à la Cournot following (Uchida & Tsutsui, 2005). Suppose a representative African CBB k, receiving deposits with amount ${D_k}^{ac}$ and grant an amount of loans ${L_k}^{ac}$at respective interest rates $r(D)$ and $r(L)$, r is the interbank market rate and ξ is the compulsory reserve rate. The profit of the representative Bank is defined as

$$\pi({L_k}^{ac}, {D_k}^{ac}) = max\left\{\left[r_L\left({L_k}^{ac} + \sum_{i\neq k}^{m} L_i\right) - r\right]{L_k}^{ac} + \left[r(1-\xi) - r_D\left({D_k}^{ac} + \sum_{i\neq k}^{m} D_i\right)\right]{D_k}^{ac}\right\} - C({L_k}^{ac}, {D_k}^{ac}) \quad (1)$$

The first derivative of bank k with respect to ${L_k}^{ac}$ is defined as

$$\frac{\partial \pi}{\partial {L_k}^{ac}} = \frac{\partial r_L(L^*)}{\partial {L_k}^{ac}}{L_k}^{ac} + r_L(L^*) - r - \frac{\partial C({L_k}^{ac}, {D_k}^{ac})}{\partial {L_k}^{ac}} = 0 \quad (2)$$

Where $\frac{\partial \boldsymbol{C}({\boldsymbol{L_k}}^{\boldsymbol{ac}}, {\boldsymbol{D_k}}^{\boldsymbol{ac}})}{\partial {\boldsymbol{L_k}}^{\boldsymbol{ac}}}$ is the Loan marginal cost of bank k. For simplicity, we use $MC({\boldsymbol{L_k}}^{\boldsymbol{ac}})$.

Therefore Equation (2) becomes:

$$\frac{\partial r_L(L^*)}{\partial {L_k}^{ac}}{L_k}^{ac} = r_L(L^*) - r - MC({L_k}^{ac}) \quad (3)$$

Dividing both sides by $\boldsymbol{r_L(L^*)}$ gives:

$$\frac{\partial r_L(L^*)}{\partial {L_k}^{ac}}\frac{{L_k}^{ac}}{r_L(L^*)}\frac{L}{L} = \frac{r_L(L^*) - r - MC({L_k}^{ac})}{r_L(L^*)} \leftrightarrow \frac{1}{\varepsilon_L}\frac{{L_k}^{ac}}{L} = \frac{r_L(L^*) - r - MC({L_k}^{ac})}{r_L(L^*)}$$

Where $\frac{{\boldsymbol{L_k}}^{\boldsymbol{ac}}}{L}$ denotes the market share ($\boldsymbol{s_k}^{\boldsymbol{ac}}$) of African CBB in the Loan market, the right hand-side indicates the Lerner index and ε_L the elasticity of loan to the variation of lending rate. The final equation yields:

$$\frac{{s_k}^{ac}}{\varepsilon_L} = \frac{r_L(L^*) - r - MC({L_k}^{ac})}{r_L(L^*)} = LI^{ac}{}_k \quad (4)^{h}$$

Equation (4) indicates that the market power of a bank in the loan market is a positive function of its market share and inverse function of the elasticity of loan to the loan rate. Furthermore, more efficient banks i.e. bank with less marginal costs, will likely enjoy grater market power. If we postulate a symmetric equilibrium and assuming that we are maximizing the profit of a domestic bank k, Equation (4) becomes:

$$\frac{1}{N\varepsilon_L} = \frac{r_L(L^*) - r - MC\left({L_k}^{d}\right)}{r_L(L^*)} = LI^{d}{}_k$$

Any increase of N^{ac} will decrease the market power of domestic bank. Let's Δn^{ac} be the number of cross-border banks that establish into the market. If they enter through greenfield, they will impact the market power of domestic banks because the number of players will increase. However, if they enter through mergers and acquisition, the effect will not be significant zero because Δn^{ac} will equal to a corresponding value of domestic bank variation: $-\Delta n^{d}$

To introduce the efficiency level in the cost function, we follow (Bolt & Humphrey, 2015; Boone, 2008). Unlike their studies, we consider a market where banks compete à la Stackelberg, that is the leader moves forward and the others firms follow. We assume that n banks are leaders and n followers. Leaders refers to as domestic and foreign cross-border subsidiaries that have spent much time in the market before the entry of African CBB which we consider here as followers. Note that the followers through so-called reaction functions maximize their profit conditional to the choice of the leader(s). Let's φ_k be the cost efficiency level of bank k, the cost function becomes: $C(L_k, D_k, \varphi_k)$ with: $\frac{\partial C(L_k, D_k, \varphi_k)}{\partial\, \varphi_k} < 0$ implying bank with higher efficiency level bear lower operating costs. To better understand the relationship between CBB and cost efficiency, let's assume a linear inverse demand function in loan like in Bolt and Humphrey (2015) and Boone (2008), where banks compete à la Stackelberg :

$$r_L = \alpha_0 - \alpha_1 {L_k}^{f} - \alpha_1 {L_{k-}}^{f} - \alpha_1 L^{h} \quad (5)$$

Where α_i are positive coefficients representing how sensitive is loan interest to loan variation. For simplicity, we assume a representative profit function defined as

$$\pi\left({L_k}^{i}, {D_k}^{i}\right) = max\left\{[r_L - r]{L_k}^{i} + [r(1-\xi) - r_D]{D_k}^{i}\right\} - \frac{\omega_i}{2\varphi_i}\left({L_k}^{i}\right)^2 - \frac{\sigma_i}{2\varphi_i}\left({D_k}^{i}\right)^2 \quad (6)$$

Where i denotes the nature of the bank which may be either domestic (h) or foreign bank (f); and k is the representative bank for either category. For simplicity, we conjecture that ω_i and σ_i are equal for all banks but the outcome differs in terms of efficiency. After computing the

[h] The same applies to deposits market.

first derivative with respect to ${L_k}^i$ and rearranging different terms, the equilibrium output for bank k considering the whole industry is given by[i]:

$$ {L^h}_k = \frac{(\alpha_0 - r)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right)}{\alpha_1(n+1)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right) + \frac{{\omega_k}^h}{{\varphi_k}^h}\left(\alpha_1(1+m) + \frac{{\omega_k}^f}{{\varphi_k}^f}\right)} \tag{7} $$

Proposition 1: When m increases the competition in the market and therefore the market share of incumbent bank, but most efficient banks keep higher market share i.e. $\frac{\partial {L^h}_k}{\partial m} < 0$ and $\frac{\partial {L^h}_k}{\partial {\omega_k}^h} > 0$.

Proof: Considering (7), the total derivative with respect to m and ${\omega_k}^h$ is :

$$ \begin{aligned} d{L^h}_k = & \frac{-\alpha_1(\alpha_0 - r)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right)\frac{{\omega_k}^h}{{\varphi_k}^h}}{\left[\alpha_1(n+1)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right) + \frac{{\omega_k}^h}{{\varphi_k}^h}\left(\alpha_1(1+m) + \frac{{\omega_k}^f}{{\varphi_k}^f}\right)\right]^2} dm \\ & + \frac{\alpha_1(\alpha_0 - r)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right)\left(\alpha_1(1+m) + \frac{{\omega_k}^f}{{\varphi_k}^f}\right)\frac{{\omega_k}^h}{{{\varphi_k}^h}^2}}{\left[\alpha_1(n+1)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right) + \frac{{\omega_k}^h}{{\varphi_k}^h}\left(\alpha_1(1+m) + \frac{{\omega_k}^f}{{\varphi_k}^f}\right)\right]^2} \end{aligned} \tag{8} $$

If we consider efficiency level to be endogenous, and determine it is value from (7), we obtain the following:

$$ {\varphi_k}^h = \frac{\left(\alpha_1(1+m) + \frac{{\omega_k}^f}{{\varphi_k}^f}\right){\omega_k}^h {L^h}_k}{(\alpha_0 - r)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right) - \alpha_1(n+1)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right){L^h}_k} \tag{9} $$

Proposition 2: As new banks establish in the market; the efficiency level of incumbent bank will increase to face the drop of price due to competition $\frac{\partial {\varphi_k}^h}{\partial {\varphi_k}^f} > 0$. However, incumbent banks will more likely increase their efficiency level as long as the new entrants are more efficient that they are.

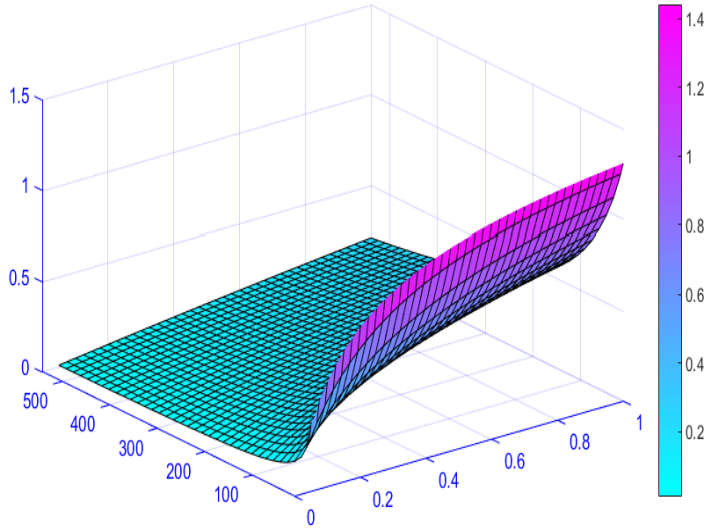
Proof: To prove this proposition, we quantify the first derivative of ${\varphi_k}^h$ which respect to ${\varphi_k}^f$

$$ \begin{aligned} & \frac{\partial {\varphi_k}^h}{\partial {\varphi_k}^f} \\ & = \frac{\left(-\frac{{\omega_k}^f}{{{\varphi_k}^f}^2}\right){\omega_k}^h {L^h}_k\left[(\alpha_0 - r)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right) - \alpha_1(n+1)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right){L^h}_k\right] + \left[\left(\frac{{\omega_k}^f}{{{\varphi_k}^f}^2}\right)(\alpha_0 - r) - \left(\frac{{\omega_k}^f}{{{\varphi_k}^f}^2}\right)\alpha_1(n+1){L^h}_k\right]\left(\left(\alpha_1(1+m) + \frac{{\omega_k}^f}{{\varphi_k}^f}\right){\omega_k}^h {L^h}_k\right)}{\left((\alpha_0 - r)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right) - \alpha_1(n+1)\left(\alpha_1 + \frac{{\omega_k}^f}{{\varphi_k}^f}\right){L^h}_k\right)^2} \\ & > 0 \end{aligned} \tag{10} $$

[i] We did not report all the proof for brevity but they are available upon request

For numerical analysis, we borrow Martinez-Miera and Repullo (2010) who considered a loan market where $\alpha_0 = 1$ and $\alpha_1 = 0.01$. We also assume that ${\omega_k}^f = {\omega_k}^h = 0.05$. Furthermore, we set the interbank market rate to 5% and the number of incumbent banks to 60.

Figure 3 Optimal loan vs new banks and efficiency



Using (7), Figure 3 show shat when the number of banks increase the market share of bank k decreases but this decrease if conditional to the efficiency level of the bank. Less efficient banks experience a higher drop of their market share compared to more efficient banks.

3.2. Empirical strategy

Our strategy is threefold:

Firstly, we estimate cost efficiency score following (Matousek, Rughoo, Sarantis, & George Assaf, 2015; Shaban & James, 2018; Weill, 2009) among others, using bank intermediary approach. In this approach, bank's objective is to collect deposits in order to produce loans (y_1) and investment assets (y_2) using three inputs: labor, physical capital and capital. Inputs prices are defined relying on (Lozano-Vivas & Weill, 2012; Shaban & James, 2018). According to these studies, the price of labor (w_1) is represented by the ratio of personal expenses over total assets, the price of physical capital (w_2) by the ratio of other operating expenses over the book value of fixed assets and the price of capital (w_3) as the ratio of total interest over the total deposits and short-term funding. The total cost (TC) is therefore computed as the sum of total interests paid, personal expenses and other operating expenses. To formalize the total cost, the aforementioned studies employ Stochastic Frontier Analysis (SFA) to estimate bank cost efficiency score. The SFA approach has the advantage of defining the distribution function of stochastic term which helps to extricate potential biases due to random events and measurement errors (Kumbhakar & Lovell, 2003). The multi-product cost function is written as follows:

$$TC_{it} = f(y_{1it}, \dots, y_{kit}, w_{1it}, \dots, , w_{lit}) + v_i + u_i \qquad (11)$$

where TC_{it}, y_{kit} and , w_{lit} stand resprectively for the total cost, the output k and the input l prices of bank i and time t and v_i and u_i represent respectively the measurement errors and the allocative efficiency. In line with Berger and Mester (1997) we include equity value and its quadratic term to account for risk profil differences among banks. Like in (Gaganis & Pasiouras, 2013; Shaban & James, 2018) amongs others, we account for technological changies overtime by including the time trend as measured by the ascending order of years and their quadratric terms. For instance, in this study the year 2003 corresponds to T=4 because our analysis window starts from 2000 (T=1). In line with the aforementionned, We divide all input prices and the total cost by the third input price as a way of imposing linear homogeneity. Furthermore, as this study pertains to African countries which may exibit heterogeneity, we follow Gaganis and Pasiouras (2013)and account for countries' degree of development by including dummies for each country.

Because Fourier flexible function (FFF) is believed to provide better approximated of the underlying function for the whole sample(Fenn, Vencappa, Diacon, Klumpes, & O'Brien, 2008), we add a number of trigonometric terms to the translog function to enable more flexibility like in (Cyree & Spurlin, 2012).

These ingredients help to specify the translog cost function for efficiency computation as follows:

$$\begin{aligned} ln\left(\frac{TC_{it}}{w_3}\right) = \beta_0 + \sum_{l=1}^{2}\beta_l lny_{\substack{l \\ it}} + \sum_{m=1}^{2}\varphi_m ln\left(\frac{w_{jit}}{w_3}\right) + \beta_2 lnE_{it} + \beta_3 T \\ + \frac{1}{2}\left[\sum_{j=1}^{2}\sum_{m=1}^{2}\delta_{mj} ln\left(\frac{w_{jit}}{w_3}\right)\left(\frac{w_{jit}}{w_3}\right) + \sum_{j=1}^{2}\sum_{m=1}^{2}\theta_{mj} lny_{mit} lny_{jit} + \theta_1 (lnE_{it})^2 + \theta_2 T^2\right] \\ + \sum_{j=1}^{2}\sum_{m=1}^{2}\alpha_{mj} ln\left(\frac{w_{jit}}{w_3}\right) lny_{mit} + \sum_{m=1}^{2}\gamma_{mj} ln\left(\frac{w_{jit}}{w_3}\right) lnE_{it} + \sum_{m=1}^{2}\omega_{mj} lny_{mit} lnE_{it} \\ + \sum_{m=1}^{2}\tau_{mj} ln\left(\frac{w_{jit}}{w_3}\right) T + \sum_{m=1}^{2}\varphi_{mj} lny_{mit} T + \theta_3 T lnE_{it} + \sum_{f=1}^{2}\left[\psi_f \cos(Z_f) + \eta_f \sin(Z_f)\right] \\ + \sum_{f=1}^{2}\sum_{g=1}^{2}\left[\lambda_{fg} cos(Z_f + Z_g) + \vartheta_{fg} sin(Z_f + Z_g)\right] + \delta DEVEL + lnv_i + lnu_i \end{aligned} \quad (12)$$

where TC_{it}, y_{kit} and , w_{lit} stand for the same as in (11), T stands for the time trend, E_{it} represents the book value of equity for bank i at time t, Z_f are rescaled variables of ouputs[j] ln is the natural log and $DEVEL$ a dummy variable which distinguishes high, medium and low level degree of developement for African countries as defined by the United Nations Developement Progam (UNDP, 2015). After perfoming this regression, the cost efficieny score is defined by :

$$CEFF_{it} = \frac{C^{min}}{C^a} = \frac{exp\left[c(y^f, w^f)\right] * exp\left(\ln u_c^{min}\right)}{exp[c(y^f, w^f)] * exp\left(\ln u_c^f\right)} = \frac{u_c^{min}}{u_c^a} \quad (13)$$

Where $CEFF_{it}$ stands for the cost efficiency of bank i and time t, C^{min} the minimum cost, $C^a$the actual cost, exp the exponential, $u_c^{min}$the the minum cost form the translog cost function as mentionned before.

[j] The rescaling process follows that of Fenn et al. (2008). Z_f is defined as follows : $Z_f = 0.2x\pi - \mu_f x Y_{min_i} + \mu_f x Y_i$, where Y_i stands for the output value in the sample for bank i. μ_f is defined by : $\mu_f = \frac{[(0.9x2\pi)-(0.1x2\pi)]}{Y_{max_i} - Y_{min_i}}$

Secondly, we compute a number of competition measures including Lerner Index, Panzar-Ross Continious-time curve and Boone Indicator.

The Lerner index is defined as the ratio of the difference between the price and the marginal cost over the price. The lower the lerner index, the lower the market power and hence, the higher the competition. The marginal cost is derived from a two-step procedure: (i) we first estimate a translog cost function using a single output proxied by total book values of assets like in (Lozano-Vivas & Weill, 2012).

Like in (12) the total cost is specified as follows :

$$\begin{aligned} ln\left(\frac{TC_{it}}{w_3}\right) = \beta_0 + \beta_1 \ln Y_{it} + \sum_{m=1}^{2} \varphi_m ln\left(\frac{w_{jit}}{w_3}\right) + \beta_2 lnE_{it} + \beta_3 T \\ + \frac{1}{2}\left[\sum_{j=1}^{2}\sum_{m=1}^{2} \delta_{mj} ln\left(\frac{w_{jit}}{w_3}\right)\left(\frac{w_{jit}}{w_3}\right) + \sum_{m=1}^{2} \delta_{mj} lnY_{it} lnY_{it} + \theta_1 (lnE_{it})^2 + \theta_2 T^2\right] \\ + \sum_{m=1}^{2} \alpha_{mj} ln\left(\frac{w_{jit}}{w_3}\right) lnY_{it} + \sum_{m=1}^{2} \gamma_{mj} ln\left(\frac{w_{jit}}{w_3}\right) lnE_{it} + \sum_{m=1}^{2} \tau_{mj} ln\left(\frac{w_{jit}}{w_3}\right) T + \vartheta lnY_{it} lnE_{it} \\ + \theta_4 T lnY_{it} + \theta_5 T lnE_{it} + \sum_{f=1}^{2}\left[\psi_f \cos(Z_f) + \eta_f \sin(Z_f)\right] + \delta DEVEL + v_i + u_i \end{aligned} \tag{14}$$

All variables and parameters stand for the same as in (12) with β_1 indicating for the elasticity of total cost relative to the total output. (ii) From Equation (14), we compute the derivative of total cost TC_{it} with respect to Y_{it} in order to assess the marginal cost (MC_{it}). Like in Thorsten Beck, De Jonghe, and Schepens (2013)and Léon (2016), the marginal cost is computed as follows[k]:

$$\begin{aligned} MC_{it} = \frac{dTC_{it}}{dY_{it}} = \left[\beta_1 + \delta_{11} lnY_{it} + \sum_{m=1}^{2} \alpha_{mj} ln\left(\frac{w_{jit}}{w_3}\right) + \vartheta lnE_{it} + \theta_4 T \right. \\ \left. + -\mu_f\left[\psi_f \sin(Z_f) - \eta_f \cos(Z_f)\right]\right] \frac{TC_{it}}{Y_{it}} \end{aligned} \tag{15}$$

The coefficients are elasticities and stand for the same as in (12) and (14). The price P_{it} is defined as the ratio of total bank revenue to total assets[l]. Therefore, the Lerner index is measured as follows:

$$L_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \tag{16}$$

where P_{it} and MC_{it} are respectively the price and the marginal cost of bank i at time t. we follow(Thorsten Beck et al., 2013; Lozano-Vivas & Weill, 2012; Schaek & Cihak, 2008) among others, to define proxies for these variables. As the marginal cost has been computed, we then estimate the Lernex index relying on Equation (16).

[l] From a microeconomics view point, $TR\ (Q) = PQ$, where $TR\ (Q)$ represents the total revenue, P the price and Q the output. We use this equation to estimate the price by diving the total revenue (total bank revenue) by the total quantity (bank's total assets)

Because the Lerner index is an indirect measure of competition, we use a direct measure of competition following Bikker and Haaf (2002)'s strategy like in (Jeon et al., 2011). This approach estimates time-varying PRH by the mean of the equation hereunder:

$$\ln(R_{it}) = \alpha_i + [\beta_1 ln(W_{1i,t}) + \beta_2 ln(W_{2i,t}) + \beta_3 ln(W_{3i,t})] exp(\varepsilon * T) + \sum \delta_i X_{it} + e_{i,t} \quad (17)$$

Where i and t stand for the bank and the time, R_{it} is the financial income as the measure of the bank's revenue, $W_{li,t}$ stand for the same as in Equation (12) , X_{it} represents different covariates including dummy variable for bank size[m], equity to total assets ratio, net loan to total assets, total operating income to interest income. T referrers to as a time variable and helps to account for time-variation whereas ε is a parameter that assesses the time-variation of competition within banking industry. The common PRH is obtained by summing up the three elasticities of the input prices i.e. $\beta_1 + \beta_2 + \beta_3$ estimated using nonlinear least squares. The time-continuous Panzar-Rosse extends this approach by multiplying the traditional PRH by ε i.e ($\beta_1 + \beta_2 + \beta_3) exp(\varepsilon * T)$. A statistically significant ε in the model indicates time-variation of competition within the banking industry, while its non-significant value will yield the same result as in the classical PRH. A conventional interpretation of the PHR statistics is set such that $PRH < 0$ corresponds to a monopolistic market, $PRH_{it} = 1$ refers to perfect competition and $0 < PRH < 1$ for monopolistic competition.

Another direct competition measure that is employed in this study is the Boone (2008) indicator. This measure assesses the intensity of competition using the elasticity of profit to the marginal cost. Although the original model uses the profit as the dependent variable, a modified version by Van Leuvensteijn, Bikker, Van Rixtel, and Sørensen (2011) rather uses the Market shared. Empirical studies such (Hossain, Galbreath, Hasan, & Randøy, 2020; Leon, 2015) have used this approach to assess competition respectively in the microfinance industry and the developing countries' banking industry. Concretely, the equation is specified as follow as:

$$lnMS_{it} = \alpha_i + \sum_{i=1}^{T} \beta_t D_t (lnMC_{it}) + \sum_{i=1}^{T} \sigma_t D_t + u_{it} \quad (18)$$

Where MS_{it} denotes the market share bank i at time t, β_t is the measure of competition that is generally negative. The higher $|\beta_t|$ is, the higher the level of competition. D_t denotes time dummies while MC_{it} is the marginal cost determined in Equation (15) and u_{it} the error term. The estimation is carried out following (Hossain et al., 2020; Leon, 2015) who used either fixed estimation or 2SLS[n].

[m] The dummy variables are classified as follows:
- $Dummyp25 = 1\ if\ Assets_{it} < q_1(AAssets_{jt})$
- $Dummyp50 = 1\ if\ Assets_{it} \geq q_1(AAssets_{jt}) < q_2(AAssets_{jt})$
- $Dummyp50 = 1\ if\ Assets_{it} > q_2(AAssets_{jt}) \leq q_3(AAssets_{jt})$ with $q_h$the qth quartile of Assets in Country j

[n]An endogeneity Housman-like test is conducted to decide whether 2SLS is preferred to OLS. Most equations are estimating using OLS because the endogeneity is rejected. When the endogeneity is confirmed, we instrument the $lnMC_{it}$ by its one period lagged value ($lnMC_{it-1}$). Results pertaining to this analysis are available upon request.

We finally address the impact of CBB on competition and efficiency following Lozano-Vivas and Weill (2012)'s strategy and Jeon et al. (2011). The first strategy consists of considering measures of competition and efficiency as dependent variables in regressions estimated using a panel data approach with a dummy representing cross-border banking. The second consist of regressing competition measures competition on the "penetration" of African cross-border banks both in the terms of number and assets. Different controls are including in the regressions.

For cost efficiency, we include bank assets to account for size differences among banks, equity and loan for risk profiles among banks like in Lozano-Vivas and Weill (2012).

In competition analysis, in addition to size, equity and risk, we include liquidity profile, cost efficiency and performance (ROA) following (Jeon et al., 2011). Unlike (Jeon et al., 2011) who measured efficiency as the ratio of non-interest expenses to total assets, we use cost efficiency as provided by the SFA analysis. Using cost efficiency has the advantage of comparing efficiency of all banks to the best practice in cost management using a common frontier. Moreover, we account for the liquidity level to examine how more liquid banks affect competition.

Another class of control variables includes macroeconomic and institutional variables following (Allen, Qian, & Qian, 2005; Barth, Lin, Ma, Seade, & Song, 2013; Pasiouras, Tanna, & Zopounidis, 2009; Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998). Tsai, Chang, and Hsiao (2011) suggest that better institutions and financial development are important spillovers for competition and efficiency enhancement because they alleviate information asymmetries. Therefore, we test for the relevance of cross-border banking on cost efficiency using the following framework:

$$\mathrm{CEFF}_{it} = \varphi_0 + \varphi_{1i}\mathrm{CBB}_{it} + \sum \omega_{bt} X_{it} + \sum \gamma_{jt} Z_{jt} + \alpha_i + \epsilon_{it} \qquad (19)$$

Where CEFF_{it} represents the cost efficiency for bank i at time t, CBB_{it} denotes on one hand either the proportion or the number of Cross-border banks in market j at time t and on the other hand a dummy variables that takes 1 if the Bank is cross-border and 0 otherwise. X_{it} is a vector of bank specific variables (such as size measured by log of assets, equity to assets ratio, loan to investment asset ratio, etc). Z_{jt} represents a set of macroeconomic variables (such as inflation, GDP and domestic credit to private as a ratio of GDP) and institutional variables (such as political stability, government effectiveness, corruption control and quality of regulation). αi Indicates an individual unobserved effect and ϵ_{it} the disturbance term.

To address the link between competition and cross-border banking, we follow (Barth et al., 2013; Lozano-Vivas & Weill, 2012) and set up the following baseline specification:

$$COMP_{it} = \varphi_0 + \varphi_{1i} CBB_{it} + \sum \omega_{bt} X_{it} + \sum \gamma_{jt} Z_{jt} + \alpha_i + \epsilon_{it} \qquad (20)$$

$COMP_{jt}$ stands for competion in market j duridng time t, CBB_{it} denots on hand either the proportion or the number of Cross-border banks in market j at time t and on the other hand a dummy variables that takes 1 if the Bank is cross-border and 0 otherwise. X_{it} is a vector of bank specific variables, Z_{jt} represents a set of macroeconomic and institutional variables, αi indicates an individual unobserved effect and ϵ_{it} the disturbance term. Since our panel includes time-invariant variables, a random effects model is well suited as fixed

effects would produce inconsistent estimations (Baltagi, 2013; Wooldridge, 2010). Also, because cost efficiency and Lerner index are generally bounded between 0 and 1, we estimate use a panel fashion of the tobit regression like in (Peng, Jeng, Wang, & Chen, 2017).

3.3 Data

This study employs bank specific, macroeconomic and governance variables. Bank specific variables are retrieved from Bankscope Bureau van Dijk in Brussels[o], a commonly used database for banks' data and which covers around 90% of most countries' banking systems. Values are converted in millions of US dollars for all banks to assure measurement homogeneity. The original sample comprises 530 active commercial banks stretching from 2000 to 2015. Non-Active banks are directly filtered out from the database what allows us to avoid any survivorship bias. All observations with negative equity, operating expenses and zero fixed assets book value are cancelled out to avoid any misinterpretations or bias. Some countries such as Bissau Guinea, Congo, Eritrea and Sao Tomé are cancelled out for cost efficiency estimation while Equatorial Guinea is dropped for Lerner index analysis because of data lack. Unconsolidated data are used to avoid any multiple record as we are working on cross-border banking. To distinguish CBBs and other banks, this paper relies on Beck et al. (2014) list[p] which has the advantage of distinguishing African cross-border banks from non-African. This information is complemented with information provided by Bankscope and some banks' websites. The final sample consist of 429 banks yielding a maximum of 3935[q] observations split into 2056 for host country banks and 1879 for cross-border banks (with 1357 from Africa and 528 elsewhere). Hence, in the final sample, 208 (48.48%) are cross-border banks and 221 (51.52%) are host country banks. Accounting for cross-border origin yields 149 (71.6%) subsidiaries from Africa and 59 (28.4%) from other continents (mostly from Europe, Asia and USA). Performing our regressions considers the number of available data and variables. Hence, the number of observations varies across different models especially when controlling for variables that have some missing values.

Macroeconomic and institutional variables are retrieved from the World Bank data. In this database, inflation and GDP are taken from world development indicator, financial development related variable (Domestic credit to private as ratio of GDP) from Global financial development database and institutional variables (Political stability, Government effectiveness, control of corruption and regulation quality) from Worldwide Governance indicator data. Since data are not available for all banks during all years, regressions are performed using an unbalanced panel.

[o] This database was closed since 31 January 2017, but same data are distributed by Fitch-Connect which I access from Paris Dauphine University's Library for data comparison.

[p] On page 60 of this book, it is provided the list of cross-border banks operating in Africa.

[q] This sample varies across regression due to missing data. For instance, in the cost efficiency estimation we include 3220 observations but the cross-border banking impact only 2964 observations are used due to missing value among other covariates.

4. Empirical results

4.1. Descriptive statistics and correlation matrix

As reported in **Table 1**, the average value of bank assets is about US dollars 1299.775 million with a high standard deviation (US $ 4186.403 million) supporting the idea of heterogeneity among African banks based on size (small, medium and big banks). High standard deviations are also observed within outputs (Loan and investments assets) suggesting that African banks differ in terms of business model. Compared to the price of Labor (w_1) and capital (w_3), the price of physical capital (w_2) show higher ratios. This is because unlike the two others, the price of physical capital is computed as the ratio of other operating expenses to the book value of fixed assets which has smaller values than total assets. In addition, **Table 1** discloses results pertaining to a t-test of mean comparison between cross-border banks and domestic banks in the last column, for SFA inputs and banks specific variables.

Table 1 Descriptive statistics

This table reports descriptive statistics related to our analysis. Asset, Loans, others earning assets are presented in millions of US dollars while w_i (the prices of inputs), liquidity, LOANDIVA, EQTA, RISK are reported in ratios and Return of average asset (ROAA) is reported in percentage. Mean-test comparison is performed to compare Cross-border banks to Domestic banks. A negative value of t implies that Cross-border banks have a lower value than None cross-border banks. Statistically significant differences in means at the 1%, 5% and 10% level have ***, **, * symbols respectively. See **Table 13** for variables definitions

Variable	Obs	Mean	Std. Dev.	t-test
Variables for cost frontier analysis				
Y	3924	1302.685	4192.444	-8.1607***
y1	3885	500.4814	1483.687	-8.5282***
y2	3,899	576.8594	2354.848	-7.2290***
w1	3,380	0.0260648	0.0405273	-1.8849*
w2	3,820	1.893644	5.717507	2.3507**
w3	3,771	0.0380317	0.0883466	-5.0742***
Bank specific variables				
Liquidity	3,882	46.29115	40.83218	-0.0318
LOANTINVA	3,864	218.9673	12810.58	1.0174
EQTA	3,924	0.1437074	0.1228835	-6.5972***
RISK	3,361	0.0262083	0.1052194	-3.3839***
ROAA	3,906	1.206527	4.222339	-0.8973
Macroeconomic variables				
	Obs	Mean	Std. Dev.	Min	Max
DPRIVATE	3,902	2.348693	4.688358	-62.2144	44.48477
GDPGRTH	3,464	24.89428	25.70361	0.198286	160.125
INFL	3,886	8.598492	27.71246	-35.8367	1096.678
Institutional variables					
POLSTAB	3,929	-0.57615	0.825415	-2.66528	1.200234
CONTCOR	3,929	-0.61784	0.512481	-1.6627	1.039068
GOVEFF	3,929	-0.61011	0.537256	-2.06817	1.049441
REGQUAL	3,929	-0.53882	0.54458	-2.23625	1.12727

Results indicate that cross-border banks have lower size, lower capitalization and run lower riskiness compared to host-country banks. This may be explained by the fact that CBBs are

progressively establishing with relatively lower size than well-established domestic and foreign banks. Moreover, CBBs might have a high screening ability to avoid any loss due to non-performing loans. Because of political instability and weak business environment in most African countries some CBBs might be reluctant to grow their investments, especially in lending activities. As a consequence, CBBs appear to carry more liquidity than other banks.

Macroeconomic and institutional variables descriptive statistics support heterogeneity among African countries in terms of economic development, financial development and governance. For instance, inflation has a 1096.678% maximum value. Zimbabwe may be one case among others the reason for such situation due to the hyperinflation underwent by the country from early 2008. Furthermore, these results document that some African countries show more stability than others. For instance, political stability and regulation quality display high standard deviations (0.82 and 0.54).

Table 2 reports pair-wise correlation levels among our main variables. Most correlations are statistically significant. Moreover, governance effectiveness and regulatory quality display the highest correlation (84.1%).

4.2 Efficiency score and Lerner index computation: a cross-country analysis in Africa

To compute Cost efficiency score, estimates obtained from (12) are used. For Weill (2009), cost efficiency assesses the existent to which a bank is close to the ideal best practice of a bank that produces the same quantity of outputs. Formally, cost efficiency score is obtained by the ratio of the minimum cost to the actual cost. This score is bounded between 0 and 1 by construction. The higher the score, the more efficient a bank is. Related results are reported in Table 3 at regional level and some others criteria.

Panel A.1 displays results on the distribution of efficiency by legal origin. We conduct this analysis since in line with some empirical studies documenting that legal origin has an impact on financial development (Allen et al., 2005; Porta et al., 1998). Porta et al. (1998) argue that English common-law Countries origin provide sounder legal protection to stakeholders (shareholders and creditors) compared to French Civil-Law. English Common-Law Countries have the highest efficiency score (82.38%). As better protection can be beneficial to financial services, it is hence by nature that English common-law origin has higher efficiency scores.

These results are complemented by Panel B.1 which classifies mean cost efficiency score by region. Eastern Africa has the highest Efficiency score (85.02%) and Central Africa the lowest (70.69%). The case of Eastern African may be related to the predominance of English common-law origin for most countries and as suggested by Fosu (2013) the increase of financial inclusion is due to the increase of regional integration and technological advance such as Mobile banking[r] in East Africa.

As reported in Panel C.1 and D.1, African CBBs are less cost-efficient than other banks. This may be in part explained by diseconomies of scale due to the increase of operating expenses such as personal and marketing expenses engaged in the search of new costumers and establishing new branches across different countries.

[r] The case of Kenya worth to be presented in the sense that Mobile banking have played an important role in financial inclusion especially for rural areas. For instance, according to the African Development Bank, M-pesa clients grew by 61% in a year for unbanked people.

Since for analytical purposes the cost efficiency score has to be left skewed, the last row of Table 3, show D'Agostino (1970) and Anscombe and Glynn (1983) results respectively for skewness and kurtosis used to test for normality.

Results (see also kernel density estimation Figure 4) ascertain the theoretical prediction that efficiency is left skewed (-1.86***) and have fatter tail than the normal distribution (6.75***>3[s]) depicts kernel density estimations of cost efficiency.

[s] This number (3) represents the Kurtosis of a Normal distribution with mean μ and standard deviation σ

Table 2 Correlation matrix

This table reports pair-wise correlation levels among our main variables. Most of the correlation are statistically significant with Governance effectiveness and Regulatory quality showing the highest correlation (84.1%). Significantly different to zero correlations at 0. 1%, 1% and 5% are marked ***, **, * respectively. For variables definitions, see **Table 13**

	Log(ASSET)	LIQUID	LOANTINVA	EQTA	RISK	ROAA	Cost Efficiency	FinDevel	GDPGRTH	INFL	DEVLEVEL3	POLSTAB	CONTCOR	GOVEFF	REGQUAL
Log(ASSET)	1														
LIQUID	-0.118***	1													
LOANTINVA	0.005	-0.00493	1												
EQTA	-0.258***	0.405***	-0.0115	1											
RISK	-0.0569***	0.108***	-0.00188	0.0610***	1										
ROAA	0.134***	-0.0964***	-0.00546	-0.127***	-0.0995***	1									
Cost efficiency	0.0207	-0.0871***	0.0225	0.0459**	-0.121***	0.0829***	1								
FinDevel	0.170***	-0.0337*	-0.0134	0.0179	-0.0394*	-0.0313	0.107***	1							
GDPGRTH	0.0151	-0.0344*	0.00533	-0.0222	-0.0588***	0.0188	0.0575**	0.000148	1						
INFL	-0.0722***	0.0636***	0.000645	0.0195	0.271***	-0.00726	-0.119***	-0.0427*	-0.0949***	1					
DEVLEVEL3	0.216***	-0.0314	-0.00831	-0.0348*	-0.0197	-0.0133	0.0462**	0.391***	0.0336*	-0.0102	1				
POLSTAB	-0.0454**	-0.0328*	-0.023	-0.000105	-0.0764***	-0.0527**	0.0821***	0.334***	0.0687***	-0.0936***	0.234***	1			
CONTCOR	0.0493**	-0.0733***	-0.0232	-0.0291	-0.0948***	0.0193	0.128***	0.549***	0.0741***	-0.113***	0.339***	0.650***	1		
GOVEFF	0.101***	-0.0615***	-0.0278	0.0191	-0.0968***	0.0117	0.197***	0.676***	0.104***	-0.0927***	0.324***	0.571***	0.828***	1	
REGQUAL	-0.0128	-0.140***	-0.0277	0.0136	-0.0918***	-0.0143	0.232***	0.614***	0.0690***	-0.115***	0.308***	0.573***	0.713***	0.841***	1

Recall that Lerner index assesses the market power for each firm in a given industry. In a perfect competition framework, this index is set to zero since by nature, the price equals the marginal cost. Consequently, a lower Lerner index indicates higher a degree of competition. Results related to this analysis are reported in Table 3. Common-law countries display the lowest Lerner index (0.258) because they offer better institutional features to promote market competition as suggested by (Thorsten Beck, Demirgüç-Kunt, & Maksimovic, 2004; Porta et al., 1998).

Table 3 Bank efficiency and competition in Africa: a synthesis

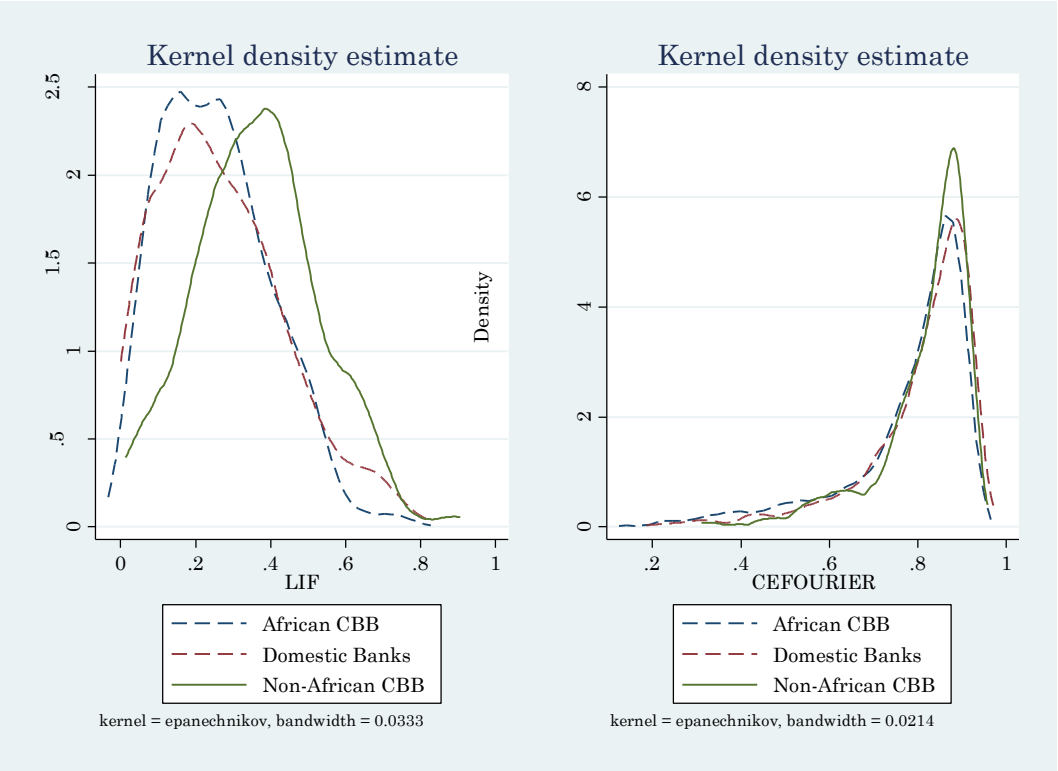
This table provides descriptive statistics of bank cost efficiency score in Africa derived from Equation (12) and Lerner index implemented from Equation (16) .We split the sample using four criteria as presented in different panels in order to disentangle any bias due to heterogeneity and legal origin effects.

Panel A.1: Efficiency score by Official language				**Panel A.2: Lerner index by Official language**		
Civil Law	0.774	0.140	1791	0.291	0.168	1483
Common Law	0.824	0.118	1429	0.258	0.162	1049
Total	0.796	0.133	3 220	0.277	0.166	2,532
Panel B.1: Efficiency score by Region				**Panel B.2: Lerner index by Region**		
Central Africa	0.707	0.177	310	0.330	0.161	256
East Africa	0.850	0.080	766	0.278	0.167	537
North Africa	0.791	0.144	417	0.302	0.208	332
South Africa	0.783	0.1143	788	0.265	0.170	605
West Africa	0.794	0.114	939	0.258	0.139	802
Total	0.796	0.133	3 220	0.277	0.166	2,532
Panel C.1: Efficiency score by Bank type				**Panel C.2: Lerner index by Bank type**		
Cross-border	0.788	0.136	1,696	0.285	0.161	1,356
Domestic	0.804	0.128	1,524	0.267	0.172	1,176
Total	0.796	0.133	3 220	0.277	0.166	2,532
Panel D.1: Efficiency score by Bank type				**Panel D.2: Lerner index by Bank type**		
African CBB	0.779	0.143	1,266	0.255	0.146	975
Non-African CBB	0.816	0.106	430	0.363	0.168	381
Domestic banks	0.805	0.128	1,524	0.267	0.172	1,176
Total	0.796	0.133	3 220	0.277	0.166	2,532
Normality test	Skewness	-1.866***	Kurtosis	6.753**		

Another important result from Table 3 is the comparison for Lerner index at regional. Central Africa displays the highest Lerner index (0.330) indicating a possible higher market concentration. Another possible explanation is that not only Central Africa has the lowest financial development but also the lowest institutional quality (such as political stability) and most of the countries have been or are still subjected to civil law rules.

For West Africa, we find almost quite different Lerner index (0.258) as Léon (2016) who found an average Lerner index of 0.346 for WAEMU countries. This difference may be explained by the fact that Léon (2016) have used data from Banks' reports while this study uses Bank scope, the period and a quite different methodology.

Figure 4 Kernel density of Efficiency Score and Lerner Index in Africa



Moreover, Table 3 reveals that CBBs have higher market power (0.285) than host-country banks (0.267). More specifically, we find that accounting for cross-border bank origin, is important this analysis since African CBBs have less market power than others CBBs which entails that African CBB promote competition more than the first.

4.3. African CBB expansion and Bank Cost efficiency

We investigate in this section the effect of CBB, especially African CBBs on Cost efficiency. Related results are provided in Table 4. Wald statistics indicate that in all the models, coefficients are jointly significant. To avoid any multicolinearity problem, we perform regressions by separating CBB based on their origin. We also split the sample into four subperiods to detect any event across time. The full period, the pre-crisis, the crisis and the post crisis. From Model A.1 to Model A.4, results show a negative significant effect of CBB on cost efficiency whereas non-African CBB have a positive impact on cost efficiency implying that African CBB are lest cost efficient. Lozano - Vivas and Weill (2012) found similar results for European in accordance with global advantage hypothesis (Berger, DeYoung, Genay, & Udell, 2000) . As most of Non-African CBB are from Europe and have been established decades ago (some years before/after independence), one can argue that they master business environment and governance issues due to experience as compared to African CBB which are in most cases penetrating into new markets. Unlike African CBB, their effects are only significant in the full sample period and in the pre-crisis period.

Table 4 Cost efficiency and cross-border banking

This table reports results bank specific determinants, macroeconomic and governance related variables determinants of Competition as measured by Lerner Index using random effects Generalized least squares. A negative sign associated to each covariate indicates a decrease of market power and hence an increase of competition. Panel A reports results obtained without controlling for Cross-border bank origin while Panel B distinguishes between African and non-African Cross-border banks. Model A.1 (B.1) presents estimates for the full period and controls respectively for macroeconomic, Macroeconomic and governance variables. Model A.3 (B.3), Model A.3 (B.3), Model A.4 (B.4) and Model A.5 (B.5) report Pre-crisis 2000-2006), Crisis(2007-2009) and Post-crisis(2010-2015) estimates respectively. The size is computed as the natural logarithm of Assets, EQTA stands for the equity to total asset ratio and LOANTIN stands for Net loans to investment assets ratio. Macroeconomic variables are respectively GDP growth (DGPCH), inflation rate (INFL) and Credit to domestic privation to GDP ratio. Governance variables are Political stability (POLSTAB), Governance effectiveness (GOVEFF) and Regulation quality (REGQUAL). Variables' definitions are reported in **Table 13**. Standard errors are reported in parentheses. Standard errors are reported in brackets. Wald test help to test for joint significance of covariates. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **,* symbols respectively.

	Panel A : Efficiency and African Cross-border banks					**Panel B : Efficiency and Non- African Cross-border banks**			
	Model A.1	Model A.2	Model A.3	We	Model A.5	Model B.1	Model B.2	Model B.3	Model B.4
VARIABLES	2000-2015	2000/15	2000/06	2007/09	2010/15	2000/15	2000/06	2007/09	2010/15
$African\ CBB$	-0.04557***	-0.04841***	-0.04000**	-0.04945***	-0.05022***				
	(0.01269)	(0.01203)	(0.01683)	(0.01355)	(0.01385)				
$Non-African\ CBB$	0.01225					0.03256*	0.02847	0.00567	0.02583
	(0.01752)					(0.01694)	(0.02247)	(0.01871)	(0.01990)
$ln(ASSET_{it})$	0.00120	0.00126	-0.00163	0.00237	0.00893**	0.00159	-0.00099	0.00394	0.00909**
	(0.00275)	(0.00275)	(0.00480)	(0.00392)	(0.00361)	(0.00278)	(0.00482)	(0.00399)	(0.00366)
$EQTA_{it}$	0.01137	0.01115	0.00706	-0.01034	0.02390	0.01916	0.02748	0.00902	0.03416
	(0.03029)	(0.03029)	(0.05460)	(0.05410)	(0.04464)	(0.03035)	(0.05432)	(0.05480)	(0.04485)
$LOANTINVA_{it}$	0.00000***	0.00000***	0.00003	-0.00002	0.00000***	0.00000***	0.00003	-0.00002	0.00000***
	(0.00000)	(0.00000)	(0.00005)	(0.00001)	(0.00000)	(0.00000)	(0.00005)	(0.00001)	(0.00000)
$IDIV_{it}$	0.04526**	0.04554**	0.14718***	0.03565	0.06354*	0.04103*	0.14556***	0.02477	0.05332
	(0.02119)	(0.02119)	(0.03514)	(0.04316)	(0.03481)	(0.02121)	(0.03524)	(0.04364)	(0.03490)
$DPRIVATE_{jt}$	0.00019	0.00017	0.00009	-0.00028	-0.00049	0.00034	0.00022	-0.00011	-0.00030
	(0.00026)	(0.00026)	(0.00041)	(0.00036)	(0.00033)	(0.00026)	(0.00041)	(0.00037)	(0.00033)
$GDPGrowth_{jt}$	0.00018	0.00018	0.00024	0.00034	-0.00050	0.00019	0.00029	0.00057	-0.00050
	(0.00044)	(0.00044)	(0.00070)	(0.00129)	(0.00057)	(0.00045)	(0.00070)	(0.00130)	(0.00057)
$INFL_{jt}$	-0.00038***	-0.00038***	-0.00028***	0.00053	0.00095	-0.00038***	-0.00028***	0.00059	0.00100
	(0.00010)	(0.00010)	(0.00010)	(0.00050)	(0.00070)	(0.00010)	(0.00010)	(0.00050)	(0.00070)
$GOVEFF_{jt}$	0.02208*	0.02235*	0.01260	0.02990	-0.00481	0.02168*	0.01169	0.03544	-0.00573
	(0.01262)	(0.01261)	(0.02013)	(0.02310)	(0.02147)	(0.01267)	(0.02021)	(0.02340)	(0.02169)
$REGQUALh_{jt}$	0.00364	0.00362	0.01072	0.01093	0.09461***	0.00009	0.00735	-0.00259	0.08952***
	(0.01310)	(0.01310)	(0.02156)	(0.02476)	(0.02241)	(0.01310)	(0.02156)	(0.02480)	(0.02255)
$LEGALOR_{jt}$	0.02486*	0.02596*	0.03876**	0.00037	-0.00304	0.02330*	0.03673**	0.00085	-0.00259
	(0.01380)	(0.01372)	(0.01814)	(0.01670)	(0.01791)	(0.01407)	(0.01849)	(0.01721)	(0.01830)
$Constant$	0.74416***	0.74671***	0.74547***	0.79726***	0.72492***	0.72101***	0.71943***	0.76347***	0.69799***
	(0.02541)	(0.02516)	(0.03630)	(0.03784)	(0.03722)	(0.02483)	(0.03539)	(0.03756)	(0.03706)
Observations	2,687	2,687	840	625	1,222	2,687	840	625	1,222
Number of banks	361	361	201	262	319	361	201	262	319
Country dummy	yes	yes	Yes	yes	yes	Yes	yes	yes	yes
Year dummies	yes	yes	Yes	yes	yes	Yes	yes	yes	yes
Wald test	128.85***	128.32***	57.37***	36.60***	117.64***	114.18***	52.91**	22.54***	103.99***

Regarding bank specific variables, bank size displays a negative non-significant impact before the crisis and a positive impact during and after the crisis. These results indicate that big banks tended to be less cost-efficient before the crisis. Chortareas, Girardone, and Ventouri (2012) document similar results on the negative impact of size on cost efficiency for EU banking during 2000-2008. However, banks became more cost-efficient after the crisis because not only regulatory requirements and market discipline after the crisis may have explained this situation but also, as the "too big to fail" paradigm failed during the crisis, big banks might have adopted another management style oriented toward efficiency after the crisis. Similar results on the positive impact of size on cost efficiency are documented by Lozano - Vivas and Weill (2012) and Barth et al. (2013).

In addition, this study documents a positive link between cost efficiency and equity to total assets suggesting that the higher the equity the more cost-efficient a bank is. These results are consistent with Berger and Udell (1995) who suggests that banks with higher capital may decrease their expected returns since their interest expenses are not enough to reduce taxable income. Similar findings are evidenced by (Barth et al., 2013) and Lozano - Vivas and Weill (2012). Loan to investment assets ratio and diversification index display a positive and significant effect in the full sample period and after the crisis while during and before the crisis the impact is negative and highly significant. This may be explained by the fact that banks have adopted more austere policies to their loan management during and after the crisis to mitigate their risks. Such policies have resulted into credit rationing that has incidentally limited loan grants to potential borrowers. Thorsten Beck et al. (2013) documents similar results in relation to the crisis effect on bank efficiency.

Furthermore, like in Barth et al. (2013) and Chortareas et al. (2012)), we include macroeconomic and institutional variables to test for the impact of CBB on cost efficiency. For instance, we find positive effect for financial development (measured by credit to private as ratio of GDP) and GDP growth on cost efficiency in the full sample. However, these results are not similar in the sub-periods analysis. A unit-increase in GDP growth indicates an increase in bank cost efficiency until the crisis period and after the crisis the effect becomes negative. In other words, before the crisis, the GDP growth rate is associated with improved bank cost efficiency. This relationship is reversed during and after the crisis in such a way that the effect becomes negative.

The possible explanation is that before and during the financial crisis, African countries exhibited high potential of economic growth but due to commodity prices decline, the trend has taken an opposite direction. Financial development indicator shows a quite similar effect although the negative impact begins from the crisis period as the credit to private begun to decline during the crisis. These results are consistent with Barth et al. (2013), Chortareas et al. (2012) and Pasiouras et al. (2009).

Inflation shows a negative significant effect suggesting that an increase in inflation is detrimental to cost efficiency. Nonetheless, as Central Banks defined accommodate monetary policy in most countries in the aftermath of the crisis, the inflation's effect becomes favorable to cost efficiency after the crisis. Another possible explanation is the anticipation behavior that motivates banks to incorporate inflation rate in their pricing.

Institutional effectiveness is important to promote finance as suggested by (Allen et al., 2005; Barth et al., 2013; Thorsten Beck et al., 2004; Pasiouras et al., 2009; Porta et al., 1998) Barth et al. (2013) and especially for multinational banks(Tsai et al., 2011). We test their relevance for cost efficiency. This study reveals that among institutional variables, regulation quality and legal origin show most significant and positive effect on cost efficiency. A better regulation and common-law enhance bank cost efficiency. This finding is consistent with the aforementioned studies, and particularly with (Barth et al., 2013; Pasiouras et al., 2009), who also found favorable impact of regulation on cost efficiency.

4.4. Cross-border expansion and bank competition in Africa

Research has documented that foreign bank entry as well as CBBs promote competition (see for instance (S.-H. Chen & Liao, 2011; Jeon et al., 2011; Lozano - Vivas & Weill, 2012). In Africa, CBBs expansion has reached a high pace with a remarkable growth in African CBBs (Thorsten Beck et al., 2014). To that end, some research has been conducted to assess the impact of this expansion on African banking system. Regarding competition, Léon (2016) has suggested that African CBBs improves competition. His study suffers from employing an indirect methodology which lacks clear explanation of to what extent these banks have boosted competition. Our study circumvents this gap by analyzing the question through a different methodology. Instead of performing an indirect analysis, we identify CBBs regarding their origins based on Thorsten Beck et al. (2014), then, we regress competition measure on CBBs Dummy in the first stage, and on their frequencies in the second. This analysis shows two different results about CBB activities and competition as reported in Table 5.

On one hand, a negative link between African CBB and Lerner index for all models in Panel A is documented. This sign suggests that African CBB have low market power and likely to improve competition during all subperiods. Moreover, it is worthy to stress that this effect is higher before the financial crisis than during and after the financial crisis. Interestingly, most African CCB begun expanding on the continent during this period.

Non-African CBB on the other hand, enjoy higher market power indicating less potential to enhance competition as compared to African CBB. Higher market power among these banks can be associated with increased entry barriers (like political instability, corruption, etc) to potential players willing to move into the industry. The negative sign associated with African cross-border banks supports the idea that they more promote competition. Lozano-Vivas and Weill (2012) found similar results for European CBBs. Similarly, Jeon et al. (2011) found consistent results for emerging markets and most recently M. Chen, Wu, Jeon, and Wang (2017) have documented that foreign banks have been important to emerging credit market because of their role in promoting competition. We also argue as suggested by Léon (2016) that African CBBs have improved African bank market competition.

We also control for bank specific variables and results suggest that size, risk, Cost efficiency and ROAA are positively related to bank market power. Like in Jeon et al. (2011) we find that size , profitability and risk are detrimental to competition. Results on the cost efficiency impact on market power are similar with the prediction in the previous section.

Moreover, we include macroeconomic variables (inflation, GDP and private credit to GDP) as well as institutional variables (political stability, government effectiveness, control of

corruption and regulation quality and legal origin). Inflation and credit to private are important to promote bank competition while GDP growth shows a significant positive impact on market power entailing that during good times, banks in more concentrated markets enjoy high profits and hence increase their market power. Constistent results are documented in (Jeon et al., 2011).

Table 5 Competition and cross-border banking

This table reports results on the determinants of Competition as measured by Lerner Index using random effects Generalized least squares technique. A negative sign associated to each covariate indicates a decrease of market power and hence an increase of competition. Panel A reports results obtained without controlling for African Cross-border bank o Panel B provides results for non-African cross-border banks. Model A.1 (B.1) presents estimates for the full period and control respectively for bank specific, macroeconomic and governance variables. Model A.3 (B.3), Model A.3 (B.3), Model A.4 (B.4) and Model A.5 (B.5) report Pre-crisis 2000-2006), Crisis (2007-2009) and Post-crisis(2010-2015) estimates respectively. The size is computed as the natural logarithm of Assets, RISK as the ratio of loss provision total loans liquidity as the ratio of liquid assets over deposits, EQTA stands for the equity to total asset ratio and efficiency is derived from SFA approach. Macroeconomic variables are respectively GDP growth (DGPCH), inflation rate (INFL) and Credit to domestic privation to GDP ratio. Governance variables are Political stability (POLSTAB), Governance effectiveness (GOVEFF), Regulation quality (REGQUAL) and Legal origin (LEGALO). Standard errors are reported in parentheses. Standard errors are reported between brackets. Wald test help to test for joint significance of covariates. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively. For variable definition, see **Table 13**

	(1) Model A.1	(2) Model A.2	(3) Model A.3	(4) Model A.4	(5) Model A.5	(6) Model B.1	(7) Model B.2	(8) Model B.3	(9) Model B.4
VARIABLES	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$
$African\ CBB$	-0.01305	-0.03399*	-0.03917	-0.02917	-0.00564				
	(0.01836)	(0.01772)	(0.02464)	(0.01967)	(0.01101)				
$Non-African\ CBB$	0.08956***					0.09524***	0.09152***	0.08283***	0.06370***
	(0.02510)					(0.02381)	(0.03144)	(0.02604)	(0.01533)
$ln(ASSET_{it})$	0.01724***	0.01740***	0.01735**	0.03622***	0.02447***	0.01740***	0.01755**	0.03671***	0.02328***
	(0.00423)	(0.00428)	(0.00756)	(0.00698)	(0.00371)	(0.00423)	(0.00743)	(0.00684)	(0.00368)
$Liquidity_{it}$	0.00095***	0.00098***	0.00126***	0.00013	0.00303***	0.00095***	0.00116***	0.00010	0.00283***
	(0.00023)	(0.00023)	(0.00041)	(0.00034)	(0.00033)	(0.00023)	(0.00041)	(0.00034)	(0.00033)
$EQTA_{it}$	-0.11557**	-0.11672**	-0.08592	-0.18650**	-0.06942	-0.11199**	-0.04774	-0.17372**	-0.08534
	(0.05447)	(0.05477)	(0.09582)	(0.08852)	(0.06367)	(0.05420)	(0.09349)	(0.08635)	(0.06296)
$RISK_{it}$	0.13062***	0.13043***	0.06462**	1.62373***	1.32341***	0.13060***	0.06316**	1.61207***	1.35373***
	(0.02423)	(0.02424)	(0.02606)	(0.13785)	(0.13803)	(0.02423)	(0.02603)	(0.13699)	(0.13690)
ROA_{it}	0.01714***	0.01720***	0.01537***	0.04683***	0.03406***	0.01714***	0.01510***	0.04643***	0.03339***
	(0.00103)	(0.00103)	(0.00166)	(0.00270)	(0.00198)	(0.00103)	(0.00165)	(0.00268)	(0.00196)
$COEFF_{it}$	0.37281***	0.37637***	0.44135***	0.29189***	0.26120***	0.37423***	0.43693***	0.29896***	0.24471***
	(0.03129)	(0.03136)	(0.05875)	(0.05191)	(0.04455)	(0.03122)	(0.05848)	(0.05134)	(0.04377)
$DPRIVATE_{jt}$	0.00025	0.00012	-0.00152**	-0.00070	-0.00056**	0.00029	-0.00120*	-0.00045	-0.00044
	(0.00038)	(0.00039)	(0.00064)	(0.00049)	(0.00028)	(0.00038)	(0.00064)	(0.00049)	(0.00027)
$GDPGrowth_{jt}$	0.00176**	0.00176**	-0.00108	0.00117	0.00650***	0.00176**	-0.00099	0.00115	0.00634***
	(0.00076)	(0.00076)	(0.00114)	(0.00144)	(0.00139)	(0.00076)	(0.00114)	(0.00144)	(0.00137)
$INFL_{jt}$	0.00046***	0.00046***	0.00044**	-0.00041	-0.00560***	0.00046***	0.00045***	-0.00035	-0.00525***
	(0.00015)	(0.00015)	(0.00017)	(0.00055)	(0.00128)	(0.00015)	(0.00017)	(0.00055)	(0.00127)
$DEVL_{jt}$	-0.11174***	-0.11336***	-0.01648	-0.10386***	-0.08019***	-0.11127***	-0.03096	-0.10890***	-0.07965***
	(0.02271)	(0.02310)	(0.04374)	(0.02770)	(0.01393)	(0.02271)	(0.04336)	(0.02743)	(0.01372)
$CONTCOR_{jt}$	0.06394***	0.06467***	0.02178	0.05365*	0.05240***	0.06290***	0.02243	0.04951	0.05167***
	(0.01817)	(0.01827)	(0.03058)	(0.03127)	(0.01960)	(0.01811)	(0.03037)	(0.03086)	(0.01919)
$GOVEFF_{jt}$	0.01865	0.01982	-0.01838	0.01957	0.11043***	0.01913	-0.02220	0.01835	0.10712***
	(0.02168)	(0.02175)	(0.03691)	(0.03595)	(0.03071)	(0.02167)	(0.03675)	(0.03564)	(0.03019)
$REGQUALh_{jt}$	-0.07334***	-0.07223***	-0.01712	-0.09927***	-0.14762***	-0.07409***	-0.02142	-0.10130***	-0.14477***
	(0.01941)	(0.01949)	(0.03563)	(0.03133)	(0.02652)	(0.01939)	(0.03538)	(0.03099)	(0.02600)
$LEGALOR_{jt}$	-0.09297***	-0.08688***	-0.08009***	-0.07444***	-0.04259***	-0.09342***	-0.08617***	-0.07961***	-0.04677***
	(0.01993)	(0.02017)	(0.02693)	(0.02379)	(0.01639)	(0.01993)	(0.02667)	(0.02356)	(0.01625)
Constant	-0.14826***	-0.13002***	-0.16509**	-0.25243***	-0.25622***	-0.15685***	-0.19869***	-0.28833***	-0.24102***
	(0.04574)	(0.04584)	(0.07420)	(0.07298)	(0.05224)	(0.04412)	(0.07137)	(0.06899)	(0.05055)
Observations	2,449	2,449	792	574	1,083	2,365	708	574	1,083
Number of Bank	344	344	190	244	292	344	189	244	292
Country dummy	yes	yes	yes	yes	yes	Yes	yes	Yes	yes
Year dummy	yes	yes	yes	yes	yes	Yes	yes	Yes	yes
Wald test	691.05***	670.06***	198.49***	485.41***	705.52***	690.27***	207.94***	500.61***	733.19***

What's more, this study shows that regulation quality and legal origin and control of corruption are important to promote competition. Unlike control of corruption, regulation quality and legal origine are signicant drivers of competition in the banking industry expept before the financial crisis. These results are consistent with Jeon et al. (2011) regarding macroeconomic variables and with (Allen et al., 2005; Barth et al., 2013; Porta et al., 1998) regarding the importance of institutions for financial sector promotion.

4.6 Competition and cross-border banking: a direct measure

We perform regressions using direct measures of competition namely PRH continuous-time curve, Boone indicator and Cross-border banking. In this modelling CBB_{kt} indicates the ratio of CBB to the total number of banks at time t in country k, $ACBB_{kt}$ is computed using African CBB as a ratio of the total number of banks at time t in country k and $FCBB_{kt}$ indicates the total number of non-African CBB over the total number of banks at time t in country k

Table 6 : Direct competition Panzar-Rosse continuous-time and Boone indicator

In this table we report results regarding the impact CBB on competition, using PRH as a competition measure derived from the PHR continuous-time curve model and Boone indicator. We report, only our variables of interest namely, different CBB categories. In Panel A CBB_{kt} indicates the ratio of CBB to the total number of banks at time t in country k, $ACBB_{kt}$ is computed using African CBB as a ratio of the total number of banks at time t in country k and $FCBB_{kt}$ indicates the total number of non-African CBB over the total number of banks at time t in country k. In panel B, the ratios are expression in terms of Assets for each category of Banks at time t in country k Standard errors are reported between brackets. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively.

	Model (1)	Model (2)	Model (3)
VARIABLES	PRH_{it}	PRH_{it}	PRH_{it}
Panel A: Penetration in terms of number of cross-border banks			
CBB_{kt}	0.00057**		
	(0.00022)		
$ACBB_{kt}$		0.00051**	
		(0.00021)	
$FCBB_{kt}$			0.00005
			(0.00036)
Goodness of fit	0.907	0.907	0.906
Wald test	13565***	13555***	13492***
Panel B: Cross-border Penetration in terms of Assets			
CBB_{kt}	0.00060**		
	(0.00022)		
$ACBB_{kt}$		0.00154***	
		(0.00026)	
$FCBB_{kt}$			-0.00060**
			(0.00025)
Goodness of fit	0.907	0.908	0.906
Wald test	13568***	13854***	13554***
Observations	1,440	1,440	1,440
Number of banks	181	181	181
Panel C: Penetration in terms of number of cross-border banks			
	$BOONE_{ik}$	$BOONE_{ik}$	$BOONE_{ik}$
CBB_{kt}	-0.01708**		
	(0.00736)		
$ACBB_{kt}$		-0.02078**	
		(0.00687)	
$FCBB_{kt}$			0.01516
			(0.01105)
Wald test	369.18***	373.55***	365.13***
Observations	2,340	2,340	2,340
Number of Banks	342	342	342
Controls	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

Using PRH time-continuous curve requires two important steps: In the first step, we run a regression using Equation (17)[1] where estimates are obtained using non-linear least squares including only countries with at least 50 total observations following (Jeon et al., 2011). From this estimation, we classify market structures on the basis of the significance level of ε. Results suggest that in the majority of countries related to this study, the banking markets have undergone changes in competition. In the second step, after computing the $PRH_{it}$for each

[1] Pertaining results are available upon request. They are not disclosed for brevity.

country in which change in competition have occurred, we regress this new measure on the same covariates used for the Lerner Index.

We also use Boone indicator as a direct proxy of competition as suggested in Equation (20). Note that the interpretation of the coefficient is opposite to that of PHR. Indeed, a higher negative coefficient of Boone indicator implies a higher degree of competition.

Results reported in Table 6 indicate that an increase in the number of CBB in a country leads to an increase in competition. Most importantly, African CBB display significant coefficients for both measures, indicating that the changes in African banking market structure is mainly driven by their expansion. Similar results were found by Jeon et al. (2011) who conducted an identical analysis for Asian and South American emerging markets specifically for foreign banks.

5 Robustness Checks

This section provides further analyses to support the robustness of our results. To this end, we use Boone indicator's regression both for the entire and the loan market, concentration measure (HHI index) and a battery of other econometric approaches (System GMM, matching, Panel quantile, etc) to address different issues, like endogeneity among others.

5.1. Accounting for sub-regional differences

We investigate the role African CBB's in competition and Cost efficiency through a regional perspective. We first split our sample into North, South, East, West and central African regions. Following Fosu (2013), we investigate what role African CBB play across different regions (North, West, East and Central African). Furthermore, due to heterogeneous level of financial development, an analysis which takes into account the difference between SSA and North African financial systems is performed. In fact, the SSA's financial system is classified among the least developed in the World, considering their financial development indicators. To that end, our study intends to gauge how these differences may affected the relationship between competition, cost efficiency and African cross-border banking. Results in Table 7 suggest that cross-border banking effects vary across different regions. For cost efficiency, Central African banking market is the most affected given also that they display the lowest efficiency level while SSA banking markets is more affected compared to NA's markets. Interestingly, increasing in competition in more pronounced and significant for SSA banking market. It turns out that, the expansion of African cross-border banking has had heterogenous effect on African banking markets, and this has been more beneficial to SSA's market in terms of competition.

Table 7 Region analysis of the Effect of African CBB on competition and efficiency

In this table we report results regarding the effect of CBB on competition and cost efficiency at regional level in Africa. Competition is measured by Lerner index and PRH continuous-time curve and cost efficiency is derived from a parametric approach using a Fourier flexible function. For brevity, we only report our variable of interest namely, $African\ CBB$ which is a dummy variable taking 1 if the Bank is an African CBB and 0 otherwise. In panel A and B, we use Tobit panel regression respectively for cost efficiency and competition. Model (1) to Model (5) in these panel display results pertaining respectively to Central, East, North, South and West Africa. In Panel C and B same analysis is performed for Sub-Sahara and North African banking system. Panel C in which Model (1) present SSA and Model (2) North reports results related to Cost efficiency. In panel D Model (1) and (2) present results pertaining to competition respectively in SSA and North Africa using PHR as a measure of competition while Model (3) Model (4) report the same using Lerner Index. Standard errors are reported between brackets. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively

Panel A: Efficiency and African Cross-border banking in Sub-regional perspective

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
VARIABLES	$COEFF_{it}$	$COEFF_{it}$	$COEFF_{it}$	$COEFF_{it}$	$COEFF_{it}$
$African\ CBB$	-0.10227***	-0.00909	-0.07343*	-0.00459	-0.03077**
	(0.02919)	(0.01516)	(0.04052)	(0.02906)	(0.01567)

Constant	0.86229*** (0.14089)	0.78000*** (0.05174)	0.55752*** (0.06376)	0.64809*** (0.06092)	0.84271*** (0.04359)
Observations	265	584	352	667	819
Number of Banks	34	82	59	76	110
Wald stat	121.54***	62.72***	94.16***	48.26***	84.25***

Panel B: Competition and African Cross-border banking in Sub-regional perspective

	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$
$African\ CBB$	0.03256 (0.02460)	-0.02121 (0.02182)	-0.00208 (0.05910)	-0.07091*** (0.02519)	-0.02278 (0.02095)
Observations	210	399	248	494	624
Number of Banks	32	68	52	67	93
Wald test				222.12***	610.03***

Panel C: Efficiency and African Cross-border banking in a Sub-Sahara vs North African perspective

	Model (1)	Model (2)
	$COEFF_{it}$	$COEFF_{it}$
$African\ CBB$	-0.04376*** (0.01266)	-0.08652* (0.04635)
Constant	0.78709*** (0.02475)	0.57643*** (0.06706)
Observations	2,335	352
Number of Banks	302	59
Wald stat	116.69***	65.95***

Panel D: Competition and African Cross-border banking in a Sub-Sahara vs North African perspective

	Model (1)	Model (2)	Model (3)	Model (4)
	PRH_{it}	PHR_{it}	$LERNER_{it}$	$LERNER_{it}$
CBB_{kt}	0.00057*** (0.00022)			
$ACBB_{kt}$		0.00051** (0.00021)		
$African\ CBB$			-0.04038*** (0.01524)	-0.00586 (0.06308)
Observations	1,440	1,440	2,142	307
Number of Banks	181	181	288	56
Goodness of fit	0.9067	0.9066		
Wald stat	13565.38***	13555.42***	926.91***	272.07***

5.2 Alternative measure of competition

We use an alternative approach to study the implication of cross-border banking on competition. In Panel A. we used the Boone (2008) indicator by including a dummy related to African CBB. Formally, we estimated the following equation:

$$lnMS_{it} = \alpha_i + \sum_{i=1}^{T} \beta_t (lnMC_{it}) + \sum_{i=1}^{T} \theta_t ACBB_t (lnMC_{it}) + \sum_{i=1}^{T} \sigma_t D_t + u_{it} \qquad (21)$$

Where all subscripts and variables stand for the same as in Equation (20), θ_t is the effect of Cross-border banking. To compute the marginal cost of loan, we borrow Hossain et al. (2020)'s strategy and use the first derivative of Equation (12) with respect to y_1. We also use the HHI index as an inverse proxy of market competition.

Table 8 Alternative measures of competition: Boone indicator and HHI

This table reports results pertaining to the relationship between market concentration measure, competition measure and African cross-border banking. Market concentration is proxied by Herfindahl-Hirschman Index, competition is represented by Boone indicator. In Panel A Cross-border banking is measured by a dummy variable that takes one if the ACBB is owned by African group and 0 otherwise and in Panel b by the number of African cross-border banks in year t in country j. lMS_{it}, $lMSL_{it}$ represent respectively the markets share of assets and loans, lMC_{it}, $lMCL_{it}$ their respective marginal cost. Standard errors are reported between brackets. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively

	Panel A: Boone indicator and Cross-border banking			
	Model (1)	Model (2)	Model (3)	Model (4)
VARIABLES	$\boldsymbol{lMS_{it}}$	$\boldsymbol{lMS_{it}}$	$\boldsymbol{lMSL_{it}}$	$\boldsymbol{lMSL_{it}}$
lMC_{it}	-0.17311***	-0.09907***		

	(0.02450)	(0.03172)		
$lMC_{it} * Afican\ CBB$		-0.17918***		
		(0.04892)		
$lMCL_{it}$			-0.23348***	-0.18651***
			(0.02505)	(0.03215)
$lMC\ Loans_{it} * Afican\ CBB$				-0.11726**
				(0.05036)
$Constant$	1.93781***	1.94610***	1.80675***	1.80693***
	(0.07543)	(0.07529)	(0.07598)	(0.07592)
Observations	3,243	3,243	3,195	3,195
R-squared	0.06326	0.06770	0.06438	0.06620
Number of Banks	408	408	400	400
Country dummies	No	No	No	No
Year dummies	Yes	Yes	Yes	Yes

	Panel B: Herfindahl-Hirschman Index and Cross-border banking		
	Model (1)	Model (2)	Model (3)
VARIABLES	$\boldsymbol{HHI_{jt}}$	$\boldsymbol{HHI_{jt}\ Loans}$	$\boldsymbol{HHI_{jt}\ Deposits}$
$ACBB_{it}$	-353.70376***	-456.15723***	-337.87853***
	(20.37520)	(20.66572)	(21.10455)
Constant	2,414.82668***	1,929.19639***	3,186.43598***
	(251.51064)	(254.64786)	(264.05609)
Observations	2,514	2,514	2,514
Number of Banks	353	353	353
RE	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Wald test	6586.77***	7277.11***	5830.94***

Results are reported in Table 8 and confirm the conclusion that African CBB have played much role in African banking market. Results show significant effects in the entire market, loan market and the deposit market.

5.3 Controlling for efficiency channel.

We aim at performing further analyses on the effect of cross-border banking on competition in Africa conditional to the level of efficiency. To that end, we split the sample into 3 different subsets with respect to the level of efficiency. Low efficiency (when the mean efficiency of a bank is less to the first quartile), average efficiency (when the efficiency is greater than the first quartile and less or equal to the third quartile) and high efficiency (when the efficiency score is greater than the third quartile). For each year, we computed number of African CBB in each category, and then regress with different competition measures.

Like Jeon et al.(2011) we find that more efficient banks have stronger effects on competition. In terms competition measure, highly efficient banks seem of have more effect while in terms of market power average efficient banks display stronger effects.

Table 9 Cross-border banking and competition conditional to efficiency

This table reports results pertaining to the relationship between market power measure, competition measure and African cross-border banking conditional to cost efficiency level. HE stands for high efficiency, AE for Average efficiency and LE for low efficiency. In Panel A disclosed results pertaining to PRH_{jt} while Panel B shows results regarding Lerner index. Interactions terms between CBB and different level of efficiency. Standard errors are reported between brackets. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively

	(1)	(2)	(3)
	Panel A: Direct competition measure and CBB conditional to Efficiency level		
VARIABLES	PRH_{jt}	PRH_{jt}	PRH_{jt}

$HECBB_{jt}$	-0.00143*		
	(0.00076)		
$AECBB_{jt}$		-0.00338	
		(0.00218)	
$LECBB_{jt}$			0.00141
			(0.00171)
Constant	0.42716***	0.37280***	0.34923***
	(0.07024)	(0.07642)	(0.05007)
Observations	151	429	147
Number of banks	52	84	52
	(1)	(2)	(3)
	Panel B: Lerner Index and CBB conditional to Efficiency level		
VARIABLES	$LERNER_{jt}$	$LERNER_{jt}$	$LERNER_{jt}$
ABB_{jt}	-0.00224	0.00056	-0.00186
	(0.00249)	(0.00247)	(0.00251)
$ABB_{jt} * HE$	0.00402**		
	(0.00177)		
$ABB_{it} * AE$		-0.00383**	
		(0.00152)	
$ABB_{jt} * LE$			0.00267
			(0.00275)
Constant	-0.01860	-0.03672	-0.04362
	(0.03997)	(0.03946)	(0.04189)
Observations	1,752	1,752	1,752
Number of Banks	299	299	299
Year dummies	Yes	Yes	Yes

5.2. Addressing endogeneity: System GMM approach

Solving for endogeneity has become a big concern in empirical studies, especially in empirical banking where issues of unobserved heterogeneity, omitted variables and reserve causality are often encountered. For instance, a bank might be more efficient than others because of its managers' skills. Therefore, in addition to managerial decisions taken and variations in the input prices, management skills may explain cost efficiency within a bank. However, it appears very cumbersome to observe or measure management skills. Ignoring that fact, will more likely cause endogeneity. Moreover, efficiency and Lerner index are related. On one hand, in perfect competitive market for instance, more efficient banks will enjoy higher price-cost margins and hence higher market powers. On the other hand, in more concentrated market, banks may not care about cost minimization given their higher market power, and hence higher Lerner index.

To deal with any bias due to endogeneity, Generalized Method of moments (GMM), a dynamic panel data as first proposed by Arellano and Bond (1991) is usually suggested. However,Arellano and Bover (1995) and Blundell and Bond (1998) argue that, although it helps to circumvent endogeneity to a given extent, mostly lagged level variables are poor instruments for first-differenced variables, especially when close to random walk.

They provide an alternative approach that uses both lagged levels and difference variables as instruments. This approach refers to as system Generalized Method of Moment (System-GMM) and allows to control for heterogeneity, omitted variables and persistence of dependent variable.

Results regarding this implementation are reported in Table 10 for respectively cost efficiency and competition. Arellano & Bond tests on the first order autocorrelation is statistically

significant while the second order autocorrelation is not. Moreover, Hansen test allows to reject overidentification. Hence, the system GMM is well suited for our analysis. Results indicate that cost efficiency and market power are persistent since their lagged-values are respectively significant. In addition, like in the linear panel model, CBBs have different effects on cost efficiency and competition. Unlike other CBBs, African CBBs are competition drivers although they do not encourage cost efficiency. Similarly, regulation quality remains an important driver of both cost efficiency and competition.

5.3 Quantile regression using adaptative Markov Chain Monte-Carlo parametrization

Quantile regression as first proposed by Koenker and Bassett Jr (1978) has the advantage of providing a better description of the heterogeneity among banks and goes beyond the identical distribution of error term assumption. Unlike OLS regression, quantile regression provides robust estimates to outliers and heavy tail distribution because rather than accounting for the mean, it provides conditional estimates at the median or other quantiles. Most recently, (D. Powell, 2016; D. L. Powell, 2017) proposed a panel approach to quantile regression with fixed effects allowing for one or more covariates as well as instrumental variables.

We use this approach coupled with an adaptative Markov Chain Monte-Carlo optimization which eases the tractability of the model and the robustness of estimators. Results are reported in **Table 11** respectively in Panel A. for Panzar-Rosse Time continuous curve and in Panel B. for Lerner Index.

Our variable of interest (cross-border banking) is proxied by the number of cross-border banks in a given country either in terms of ratio to the total number of banks or by the number of African CBBs[2]. Results suggests that the more we move higher in the distribution, the more the impact of cross-border banking on competition increases.

Table 10 Competition, efficiency and cross-border banking: GMM estimation

This table displays estimates obtained using a two-step system GMM approach to investigate the link between Efficiency, competition and Cross-border bank activities. Model (1) and (3) report results on the effect of African CBB and while Models (2) and (4) control for non-African CBBs. Some additional covariables except are not displayed in the table but were included in the regression. Variables' definitions are reported in **Table 13**. Standard errors are reported in parentheses. We follow Arellano and Bover (1995) and Blundell and Bond (1998) to estimate coefficients. Standard errors are reported between brackets. While Over-identification test is constructed from Hansen and Arellano Bond test of autocorrelation represented by autoregressive process respectively AR (1) and AR (2), Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively.

VARIABLES	Model (1) $LERNER_{it}$	Model (2) $LERNER_{it}$	Model (3) $LERNER_{it}$	Model (4) $LERNER_{it}$	Model (5) $COEFF_{it}$	Model (6) $COEFF_{it}$
Y_{it-1}	0.02868***	0.02798***	0.62052***	0.54362***	0.59587***	0.59492***
	(0.00035)	(0.00036)	(0.00233)	(0.00162)	(0.00619)	(0.00638)
$African\ CBB$	-0.02389***		-0.00334***		-0.01186***	
	(0.00321)		(0.00094)		(0.00195)	
$Non-African\ CBB$		0.05342***		0.02664***		0.00419
		(0.00772)		(0.00184)		(0.00283)
$ln(ASSET_{it})$	0.01708***	0.01716***	0.00410***	0.00482***		
	(0.00190)	(0.00192)	(0.00042)	(0.00046)		
$COEFF_{it}$	0.47807***	0.49715***	0.12432***	0.15375***		
	(0.00753)	(0.00782)	(0.00293)	(0.00259)		
$IDIV_{it}$					0.05462***	0.04542***
					(0.00782)	(0.00705)
$REGQUALh_{jt}$	-0.14020***	-0.14484***	-0.05865***	-0.06809***	0.03412***	0.03000***
	(0.00429)	(0.00414)	(0.00158)	(0.00138)	(0.00290)	(0.00269)

$LEGALOR_{jt}$	-0.00719	-0.00820*	-0.01180***	-0.01650***	0.01979***	0.01631***
	(0.00445)	(0.00459)	(0.00150)	(0.00138)	(0.00271)	(0.00255)
Constant	14.41155***	15.12693***	2.84673***	3.38990***	4.34716***	4.56675***
	(0.80246)	(0.74860)	(0.22281)	(0.19305)	(0.48202)	(0.50270)
Observations	2,059	2,059	1,565	1,565	2,238	2,238
Number of Banks	331	331	271	271	346	346
Year dummies	yes	yes	Yes	Yes	Yes	Yes
AR (1) p-value	-2.61***	-2.61***	-6.04***	-6.08***	-4.80***	-4.80***
AR (2) p-value	0.431	0.445	0.572	0.474	0.642	0.644
Hansen test p-value	0.378	0.347	0.427	0.369	0.251	0.262

For instance, CBBs belonging to the first decile show 0.047% less points than those belonging to the first quantile. This conclusion holds for both measures, although for Lerner index, the negative sign implies a decrease of market power and implicitly the increase of competition.

These results are consistent with our baseline regression's findings and those of Lozano - Vivas and Weill (2012) for the European banking markets.

5.3. Propensity score matching approach

In this section, we investigate any bias which may result from difference in sample size between African CBBs and others Banks in line with (Beccalli, Frantz, & Lenoci, 2018; Bitar, Hassan, & Walker, 2017) . This test helps also to assure our results are not driven by any sample selection bias. To this end, we use propensity score matching (PSM) which was first proposed by (ROSENBAUM & RUBIN, 1983)

For the implementation, we follow (Beccalli et al., 2018; Bitar et al., 2017; Byun & Oh, 2018) using a two-step strategy. First, we estimate the propensity score using a probit regression. The dependent variable is our treatment, which takes value one if the bank is an African cross-border subsidiary and 0 otherwise. Independent variables include all the covariates used in the baseline regression of this study for competition and Cost efficiency. The objective is to compare matched samples by computing the probability for a given bank to be an African CBB (Bitar et al., 2017).

Table 11 Quantile regression estimation: Adaptative MCMC approach

This table presents results related to the analysis of the relationship between competition and the cross-border banking. We use quantile regression approach with an adaptative MCMC optimization technique. Used quantile are reported in Column Quantile and are respectively 10%, 25%, 50% and 90% Regressions (1), (2), (3) and (4) report estimation results at respective quantiles. In Panel A, competition is measured by Panzar-Rosse Time continuous approach (PRH_{it}) and in Panel B by Lerner Index. $ACBB_{kt}$ is computed using African CBB as a ratio of the total number of banks at time t in country k Standard errors are reported in parentheses. Standard errors are reported between brackets. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively

	(1)	(2)	(3)	(4)
Quantiles	**10%**	**25%**	**50%**	**90%**
Panel A: PRH Time continuous as proxy of competition				
VARIABLES	PRH_{it}	PRH_{it}	PRH_{it}	PRH_{it}
$ACBB_{kt}$	0.00136***	0.00189***	0.00025***	0.00022***
	(0.00010)	(0.00008)	(0.00003)	(0.00000)
$COEFF_{it}$	0.10539***	0.10718***	0.23989***	0.18067***
	(0.00885)	(0.00954)	(0.01317)	(0.00028)
$LEGALOR_{jt}$	0.14693***	0.15886***	0.02349***	0.09480***
	(0.00175)	(0.00235)	(0.00370)	(0.00013)
Observations	1,440	1,440	1,440	1,440
Number of groups	181	181	181	181
Panel B: Lerner index as proxy of competition				
VARIABLES	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$	$LERNER_{it}$
$ACBB_{kt}$	-0.00046***	-0.00035***	-0.00019**	-0.00053***

	(0.00008)	(0.00009)	(0.00007)	(0.00004)
$COEFF_{it}$	0.45796***	0.31298***	0.31950***	0.25228***
	(0.00761)	(0.00196)	(0.00315)	(0.00634)
$LEGALOR_{jt}$	-0.04046***	-0.05552***	-0.08420***	-0.11489***
	(0.00436)	(0.00196)	(0.00296)	(0.00128)
Number of groups	2,449	2,449	2,449	2,449
Number of draws	344	344	344	344
FE	Yes	Yes	Yes	Yes
Year dummies	yes	yes	yes	yes
Number of draws	1000	1000	1000	1000

Second, we use the propensity scores to match our sample in order to compute the Average Treatment of the Treated (ATT) employing a set of matching approaches including Nearest neighbors, Kernel matching and radius matching. Using different matching methods allow to assess the sensitivity of our results.

Table 12 Propensity Score matching

This table presents results pertaining to the propensity score matching approach using Nearest Neighbor, Kernel and Radius matching methods. For the radius matching, we use a 0.05 capiler value like in Smith (2016). Propensity scores are estimated using a probit regression where the dependent variable dummy variable taking 1 if the Bank is a CBB and 0 otherwise; and the covariables include all variables used in the baseline regression. Our Variables of interest are Lerner index and cost efficiency. Standard errors are reported between brackets. Statistically significant coefficients at 1%, 5% and 10% levels have ***, **, * symbols respectively

Variables	Cost Efficiency			Lerner Index		
Matching estimators	**Nearest Neighbor**	**Kernel Matching**	**Radius matching (0.05)**	**Nearest Neighbor**	**Kernel Matching**	**Radius matching (0.05)**
ATT	-0.0233***	-0.0200***	-0.0202***	-0.0290***	-0.0270***	-0.0274***
SE	[0.0083]	[0.0067]	[0.0067]	[0.0113]	[0.0102]	[0.0101]
t-Statistics	-2.81	-2.98	-3.03	-2.55	-2.65	-2.71
Observations	2,522	2,522	2,522	1,990	1,990	1,990
Common Support	Yes	Yes	Yes	Yes	Yes	Yes

We report the related results in

Table 12. Our variables of interest are cost efficiency and Lerner index. These results are in conjunction with the previous findings of this study, suggesting that African CBBs have less market power and hence enhance competition. Moreover, like in previous analyses, African CBBs appear to be less-cost efficient than other banks. Hence, we argue that our results are robust to sample selection bias.

6. Conclusion

This paper uses a model where Banks compete à la Stackelberg to investigate the effect of CBB expansion on the market structure. It focuses on the study of competition and efficiency, to understand how CBB affect these dynamics in domestic market. Empirical analysis is applied on developing markets where less related research has been conducted, and African banking industry where the expansion of CBB has been experienced over the last two decades is considered for the sample.

This study reveals that a higher number of CBBs may induce the increase of competition when they enter as new entities in the market. It also reveals that, more efficient banks are more likely to influence market competition. Morever, the number of CBB can influence efficiency in the market provided that they display higher level of efficiency than domestic banks.

Empirically, these results are confirmed. We rely on the study of Lozano - Vivas and Weill (2012), who conducted a similar research for European Banks to construct our empirical framework. Unlike Léon (2016), we directly analyse the link between CBB activities and market structure to assess to what extent the later may affect African banking industry in terms of competition and cost efficiency. Cost efficiency is measured using a SFA approach ; while competition is respectively measured by Lerner index, Panzar-Rosse time-continuous curve following (Jeon et al., 2011) and Boone indicator.

Using a sample of 429 commercial banks during the period of 2000-2015 and by distinguishing between African and other cross-border banks, this study reveals that African CBB foster competition but do not improve cost efficiency. Alternative approaches such as Time continuous curve Panzar-Rosse model for competition analysis, system GMM, Panel quantile regression with adaptative Markov Chain Monte-Carlo optimization and matching support the robustness of the findings.

Furthermore, this study suggests that banks with big size have improved their management practice and have become more responsive and resilient after the financial crisis. Incidentally, this has led to cost efficiency. Banks with high profits, large size, high cost efficiency and high risk increase market power while highly capitalized banks tend to promote competition.

Finally, this research shows that macroeconomic conditions play an important role for both cost efficiency and competition enhancement like in Thorsten Beck et al. (2004) and Fungáčová, Shamshur, and Weill (2017).By reducing information asymmetries, financial development and regulation quality mitigate the effect of CBB on competition and cost efficiency.

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[3]Appendix 1 Variables description

Table 13 Variables presentation

Variables	Description	Sources
Efficiency Study		
Total cost	Operating cost =interest expenses+personal expenses+others operating cost	Author's calculation from Banscope
Total profit	Profit before tax	Author's calculation from Banscope
Price	Operating income to total Assets	Author's calculation from Banscope
Input prices		
Price of capital	Interest expenses divided by total deposits	Banscope
Price of physical capital	Overheads-personal expenses dived b	Banscope
Price of labor	Personal expenses over number of employees or over the total assets	Banscope
Inptuts		
Loan	Gross-loan minus nonperforming loan	Banscope
Security investment	Other earning assets	Banscope
Bank specific variables and competition analysis		
Capital ratio	Equity to total assets value	Bankscope
Loan to deposit ratio	Loan value divided as percentage of deposit	Banscope
Overheads to total assets	Operating expenses over total assets	Banscope
Nonperforming loan provision	Loss provision over total assets	Banscope
Bank size	Log of total assets	Banscope
Net income	Difference between revenue and total expenses of a bank at time t	Banscope
Total interest revenue	The interest revenue of the bank at year t	Banscope
Macroeconomic variables		Banscope
GDP growth	Yearly GDP growth rate in %	WDI[4]
Inflation rate	Yearly consumer price index variable in percentage %	WDI
Private to credit ratio	Credit to private over GDP per year in %	GFD[5]
Control of corruption	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	W[6]GI
Political stabilitity	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI	WGI
Government Effectiveness	Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	WGI
Regulatory quality	Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	WGI
Legal origin	It is a dummy variable which takes 1 if the bank is located in a country where English Common-law is applied or 0 otherwise.	Porta et al. (1998)

[3] Further appendix will be added especially graphs related to country level means
[4] World Development Indicator
[5] Global financial Developement
[6] World Gouvernance Indicator