Technical Efficiency of Banks in the Franc Zone

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Abstract

This paper explores the technical efficiency of banks and its determinants in the CFA Franc Zone between 2009 and 2014. Technical efficiency can be measured by comparing observed performance relative to optimal performance. The research applies an innovative DEA (Data Envelopment Analysis) model, the $\mathbb{B}$-convex model to a representative sample of banks. It concludes that private domestic banks are slightly more efficient than foreign banks operating in the CFA Zone, and state banks recorded the lowest scores in terms of efficiency and productivity. The analysis of the determinants of efficiency scores shows that the efficiency of CFA zone banks is influenced by capitalisation and size of operations, and that inflation tend to improve efficiency. Income per capita and governance in the country of operation have no statistically significant effect on efficiency.

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1. Introduction

The technical efficiency of banks has been the subject of a dense literature since the pioneering article of Farrel (1957). Linear programming methods used to measure the efficiency of production units have then been applied to the banking sector; banks' efficiency was traditionally assessed through financial ratios extracted from published accounts. While the vast majority of studies have focused on banks based in developed countries, a growing number of researches are paying attention to emerging markets. Yet, Sub-Saharan African (SSA) banking systems, with the notable exception of South Africa, have no captured much attention from authors. This is particularly true for Francophone SSA countries, regrouped in the Franc Zone, which is relatively unknown for most academic and even professional searchers. Indeed, capital flows between the Franc Zone countries and the rest of the world are limited, due to the stringent exchange controls imposed by the monetary arrangements signed with France. This made them somewhat insulated from the developments in the global banking industry; Franc Zone banks were not directly affected by the 2008 financial crisis, as illustrated by the overall healthy financial performance they overall achieved in the years following the crisis. This raises the question of the efficiency of banks established in the Franc Zone.

This paper explores the efficiency of banks and its determinants in the Franc Zone between 2009 and 2014. The $\mathbb{B}$-convex model is applying as an instrument for assessing the technical efficiency of CFA banks, combining operational and financial data. The assumption of convexity of the data is questionable. In the line of operations research and analysis of technical efficiency, several studies proposed to relax the convexity assumptions; for example, the Free Disposal Hull model (Deprins, Simar and Tulkens, 1984; Tulkens and Vanden Eeckaut, 1995) and the $\mathbb{B}$-convex model (Briec and Horvath, 2004, 2009). The first is based on an extremely weak extrapolation of the production technology and is characterized by a zero or infinite marginal productivity. The main drawback of this model is the high number of efficient firms from its analysis. The second is built on the assumption that the least upper bound of a pair of input vectors can produce the upper bound of the outputs they can individually produce, and implies a cubic form of the output set. From this point of view, the technology involves a kind of externality. The advantage of this approach over alternative models is twofold. First, it is not necessary to suppose the nature of returns to scale for the technology. Second, this method allows us to take into account the possible complementarity of inputs.

The remainder of this paper is organized as follows. Section 2 presents the key features of Franc Zone banks, Section 3 reviews the literature on efficiency, Section 4 presents the research hypotheses. Section 5 details the methodology. Section 6 presents the data and the results. Section 7 discusses and concludes.

2. Key features of banks in the Zone Franc

Zone Franc comprises two distinct African monetary zones (Union Economique et Monétaire Ouest Africaine[1] and Communauté Economique et Monétaire d'Afrique central)[2] and one country (Comoros). The 15 countries,

[1] UEMOA : Benin, Burkina Faso, Côte d'Ivoire, Guinea Bissau, Mali, Niger, Sénégal, Togo
[2] CEMAC : Cameroun, Central African Republic, Chad, Congo (Rep. of), Gabon, Equatorial Guinea,

which use French as their official language, have pegged their currency[3] to the French Franc (and to the Euro since 1999) through a monetary arrangement put in place in the aftermath of the independence, in 1960[4]. Our research focuses on the banks established in the UEMOA and CEMAC; in the rest of this paper, Franc Zone refers to the 14 countries constituting these two monetary zones

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Banks in the Franc Zone display the same features as other SSA banks – except South Africa. These have been identified by several reports produced by academics in conjunction with development institutions, among whom Beck et Al., with the African Development Bank and the World Bank by Beck et al. (2012), and Kablan, with the International Monetary Fund (2010).

Beck's report highlights the small size of SSA banks, which have total assets of less than 1 billion US dollars in several SSA countries. SSA banks have limited outreach, with19% of household having access to banks[5]) and difficulties for private firms to obtain loans from banks. This translates in an overall low level of financial development, that can be measured by the ratio of private credit to GDP. Based on the 16 SSA countries rated by Fitchratings, private credit to the economy represented, on average, only 24.4% of GDP in 2013[6], compared with 189.5% in the US or 114,2% in France.

It seems that SSA banks, in general, prefer investing their funds in safe placements, such as treasury or public corporations paper, or deposits at the central banks. This is particularly the case in the Franc Zone. In her study of SSA bank's efficiency, Kablan (2010) noted that the ratio of loans to private sector relative to total deposits is lower in SSA than in other emerging countries, and that this ratio was particularly low in UEMOA. Low lending activity is also the outcome of the expensive cost of banking operations in SSA, mainly due to the difficulties of achieving economies of scale. Beck & al. (Op. cit) have demonstrated that in many SSA countries, less than half of the population can afford to pay the fees to open a checking account. Low lending activity is also attributable to the presence of a number of foreign owned banks, which can have a negative impact on the development of financial sector (Kaplan, Op cit). Although they import better practices, foreign banks force a number of local banks out of the market and, at the same time, concentrate their loans on large corporations, which has the effect of excluding smaller firms of the banking system and reducing the overall lending volume.

In contrast with a widespread belief, African banks are more profitable than their European, Asian or American peers: based on Beck's statistics, the median return on equity for SSA is above 20%, which is substantially higher than the median for other continents. In UEMOA, the aggregated return on equity of banks was 12,7%[7] in 2013; although it is lower than in the rest of SSA countries, this is significantly higher than developed countries . This is all the more striking that SSA banks's profits are negatively impacted by the large provisions they have to take to

[3] West African CFA Franc for UEMOA, Central African CFA Franc for CEMAC, Comorian Franc for Comoros. UEMOA and CEMAC have their own central bank, Banque Centrale des Etats d'Afrique de l'Ouest (BCEAO) and Banque des Etats d'Afrique Centrale (BEAC), respectively. Banque des Comores is the central bank for Comoros.
[4] See Rapport Annuel de la Zone Franc, in www.banquedefrance.fr for a detailed presentation of these arrangements.
[5] Figure from Banque de France, IBID
[6] Fitch Sovereign Comparator, Septembre 2014, www.fitchratings.com
[7] Source : Report of the Commission Bancaire de l'UEMOA 2013, www.bceao.int

cover their heavy credit risk exposure: in UEMOA, impaired loans (*créances en souffrances*) represented 15.2% of gross loans in 2013, a level which is well above loan impairment in industrialised countries.

Yet, high profitability does not mean greater efficiency. According to Beck, SSA banks' high profitability is rather due to limited competition in domestic markets; this is attributable to the small size of the banking sector, which enables banks to charge high interest rates to their clients. These findings can be easily verified by an analysis of bank's published annual accounts: Cost to income ratio, a widely used measure of bank's productivity, is higher than in SSA than in Europe; in UEMOA, it stood, on average, at 69.3% in 2013 d[8], which is an evidence of low productivity of West African banks. In contrast, lending margins are much higher than most countries of the world: in 2013, the UEMOA banks applied an average lending margin of 7.9% above their average cost of fund, well above margins normally applied by European or US banks.

Nevertheless, in terms of efficiency measured on financial ratios (so-called X efficiency), banks in the Franc Zone are underperforming those based in Anglophone and East Africa. This can be explained by lower intermediation ratio observed in francophone SSA countries: as banks produce less loans, they generate lower profits. Another explanation provided by Kablan is the lower computerisation of operations in UEMOA and CEMAC, where the use of Automated Teller machines (ATM) is not as widespread as in Anglophone countries. In the next section, we propose to revisit the literature on banks' efficiency.

3. How to measure efficiency for banks ?

There are several definitions of efficiency. In economic literature, technical efficiency of production units, first introduced by Farell (Op Cit.), relates to the capacity of a production process to maximize output for a given level of input (or vice-versa). Technical efficiency can be measured by comparing observed performance relative to optimal performance. This can be achieved by determining the best practice production frontier through linear programming; the distance of individual production unit to the frontier constitutes a quantitative assessment of efficiency, generally measured as a percentage of the production performance of the optimal production unit.

The measure of technical efficiency were first applied to US banks by Sherman and Gold (1985); an abundant literature has since then studied how linear programming approaches can be used to measure banks' efficiency. The early studies focused on banks established in developed countries: US banks (Rangan & Grabowski, 1988; Miller & Noulas, 1996), Italian banks (Resti, 1997), Japanese banks (Drake, 2001), German universal banks (Elisabetta et al, 2006). It was followed by a stream of literature studying the efficiency of banks based in emerging markets, among which a number have concentrated on SSA banks: (Kablan, Op Cit.; Kiyota, 2009), or on specific SSA zones or countries: East Africa (Raphael, 2013), Nigeria (Eriki and Osagie, 2014), South Africa (Cronje, 2007; Maredza, 2014; Ncube, 2009), Tanzania (Ally, 2013). Of particular interest for our research is the paper of Kablan (2007), which focuses on banks established in UEMOA.

In all of these studies, banks are considered as production units. However, the specification of input and output is

[8] Report of the Commission Bancaire de l'UEMOA, 2013

an issue which has been extensively discussed, as it depends upon the underlying theory upon which the authors base their approach. In the so-called intermediation approach of bank firm theory, the function of a bank is to turn deposits and funds raised from capital markets into loans and investments. In the production approach, banks are treated as other industrial firms; which aim is to use labor and capital to produce a variety of banking services. In the production approach, both deposits and loans are considered as a service produced by the banks, and must be treated as an output.

In all research papers on bank efficiencies, loans are considered as an output - an important issue, however, is to decide whether other banking services should be included as output, and whether impaired loans must be deducted from total loans. In most of the early articles, deposits were specified as output[9], and some researchers[10] treated deposits both as an input and output. In the article of Miller and Noulas (Op cit.), and in most recent studies, yet, deposits are included in input and loans in output[11], which implicitly assumes that banks' main function is the intermediation. However, most authors have also included among output measures of labor (number of employees, personnel expenses) and capital (shareholders'funds, share capital), this recognizing the production function of the banks.

Extending loan is not the sole function of a bank; as a firm, it shall also be able to generate profits from its operations. Hence, the assessment of bank's efficiency must also seize the capacity of the bank to maximize operating profits. Most studies on bank's efficiency include measures or operating profit in the output: some authors retain measures interest expense in input and interest (or non-interest) revenues in output[12]; other studies directly include in the output profitability measures such as the operating profit or the return on assets (ROA) ratio [13].

Another issue, originally raised by Resti (Op. cit), is whether measures of stock such as loans and deposits can be used as output and input. Indeed, under the original studies of technical efficiency, input and output should be flows – such as interest charges and income, or personal expenses - and not stocks. On the contrary, in the study performed by Rangan and Grabowski, input and output only included stocks - capital number of employees and purchased funds as input, loans and deposits as output. This raises an important question about the methodology used by the vast majority of studies on bank's efficiency: can measures of flow (expenses, revenues, …) and stock (loans, deposits) be included in the same test to assess efficiency ?

A number of the studies not only provided measures of efficiencies of banks in a given geographic area, but also have identified the determinants of the best practice banks. After an efficiency score has been computed[14], they are regressed against several independent variables that can determine bank efficiency. These can be classified in two broad categories:

9 Berger and Humphrey (1991), Ferrier and Lovell (1990), Rangan and Grabowski (Op cit.), Resti (Op. Cit)
10 Humphrey (1990), Aly et al. (1990)
11 See Hassan et al (2009), Alkhathlan and Malik (2010)
12 See Ho and Zhu (2004), Mukharjee, Nath and Pal (2002), Wu, jang and Liang (2006), Kao and Liu (2004).
13 See Sakar (2006), Mostafa (2007),
14 The methodology developed for the computation of this score is based on Data Envelopment analysis technique (DEA); this approach is described in the next section.

- endogenous variables, which are representative of the bank's economic, financial or social features; the most commonly found in the litterature are size, profitability, number of employees, personnel expenses, interest expenses and revenues, diversification of the product range.
- exogenous variables, related to economic and social characteristics of the country or regional zone in which banks operate. GDP per head, population concentration, political risk indicators have been particularly used in researched focusing on banks in developing countries.

Overall, the tests come to the conclusion that efficiency is correlated to size, generally measured by total assets or deposits and profitability[15], and negatively influenced by asset quality (measured by non-performing loan to total loans)[16]. While all studies conducted on developed countries concluded that large banks are the most efficient, some researches performed on African banks found that small banks are more efficient than large institutions[17]; this conclusion was also reached by a study of Brazilian bank's efficiency[18], which suggest the effect of size on efficiency may be opposite in developing countries and in developed countries. Other internal factors explaining bank's efficiency are profitability (Miller and Noulas, Op. Cit) and ownership (Kaplan, Op cit) - some authors found that, in Africa, foreign banks are more efficient that local banks[19].

Empirical tests have shown that bank's efficiency is also explained by the environment in which the bank operates; this is particularly true for banks based in emerging countries, where the development of financial activities is linked to the overall level of development. Evidence of a strong relation between UEMOA bank's efficiency and GDP per capita was found by Kablan, who also stressed the influence of political environment of bank's efficiency.

4. Methodology

We first define the notations used in this paper. Let $\mathbb{R}_+^d$ be the non negative Euclidean d-orthant; for $z, w \in \mathbb{R}_+^d$ we denote $z \leq w \iff z_i \leq w_i \ \forall i \in \{1, \dots, d\}$. Now let $m, n \in \mathbb{N}$ be two positive natural numbers such that $d = m + n$. A production technology transforms inputs $x = (x_1, \dots, x_m)$ into outputs $y = (y_1, \dots, y_n)$. The set $T \subset \mathbb{R}_+^{m+n}$ of all input-output vectors that are feasible is called the production set. Namely, it is defined as follows:

$$T = \{z = (x, y) \in \mathbb{R}_+^{m+n} : x \text{ can produce } y\}. \qquad (1)$$

T can also be characterized by an input correspondence $L: y \longrightarrow L(y)$ and an output correspondence $P: x \longrightarrow P(x)$, where:

$$L(y) = \{x \in \mathbb{R}_+^m : z = (x, y) \in T\} \qquad (2)$$

is the set of all input vectors that yield at least y and:

$$P(x) = \{y \in \mathbb{R}_+^n : z = (x, y) \in T\} \qquad (3)$$

is the set of all the output vectors obtainable from x.

15 This was proven by Miller and Noulas (Op Cit) and Rangan and Gabowski (Op. Cit.)
16 This was evidenced in the test of Resti (Op Cit) and Kablan (2007 and 2010)
17 See Eriki and Osajie (2014), Ncube (2009). This is consistent with a study conducted by Marodza on financial ratios of South African banks, which found evidence of a negative correlation between profitability and size.
18 Staub, da Silva e Souza, and Tabak (2010)
19 This was particularly clear in the studies of Kiyota (Op Cit); the negative impact of the presence of foreign bank on the development of the banking sector in Africa was stressed by Kablan (2010)

Now, let us denote $K = \mathbb{R}_+^m \times (-\mathbb{R}_+^n)$. There are some assumptions that can be made on the production technology (Shephard, 1970).

T1: T is a closed set.

T2: T is a bounded set, i;e for any $z \in T$, $(z - K) \cap T$ is bounded.

T3: T is strongly disposable, i.e $T = (T + K) \cap \mathbb{R}_+^d$.

T1-T3 defines a technology with freely disposable inputs and outputs.

4.1. 𝔹-convex concept

We now present the 𝔹-convexity concept. Complete details are given in Briec and Horvath (2004) and Briec and Liang (2009). 𝔹-convexity is obtained from usual convexity, making the formal substitution $+ \mapsto \max$. Semilattice plays a crucial role in this context. A subset $L \subset \mathbb{R}^d$ is said to be a upper-semilattice if $\forall z, t \in L$ then $z \vee t \in L$, where:

$$z \bigvee_t = (\max\{z_1, t_1\}, \dots, \max\{z_d, t_d\}).$$

Let us consider $z^1, z^2, \dots, z^l \in \mathbb{R}^d$. In the remainder of the paper we denote:

$$\bigvee_{k=1}^{l} z^k = \left(\max\{z_1^1, \dots, z_1^l\}, \dots, \max\{z_d^1, \dots, z_d^l\}\right).$$

A new type of semilattice technologies is introduced where the connectedness assumption is important because it allows the possibility of transforming a production technique continuously. Since a semilattice is generally not path-connected, 𝔹-convex sets are path-connected. Let $A = \{z^1, \dots, z^m\} \subset \mathbb{R}_+^d$ then the set:

$$\mathbb{B}(A) = \left\{\bigvee_{k=1}^{d} \rho_k z^k, \rho \geq 0, \max_{k=1\dots l}\{\rho_k\} = 1\right\} \tag{4}$$

is called the 𝔹-convex set hull of A.

4.2. 𝔹-convex estimation of the production technology

We now introduce the 𝔹-convex nonparametric estimation of a production set given a data set A.

Let $A = \{z^1, \dots, z^l\} \subset \mathbb{R}_{++}^d$ a set of l observed production vectors. Let $K = \mathbb{R}_+^m \times (-\mathbb{R}_+^n)$.

$$T_{\max} = (\mathbb{B}(A) + K) \cap \mathbb{R}_+^d \tag{5}$$

is called 𝔹-convex estimation of the production technology.

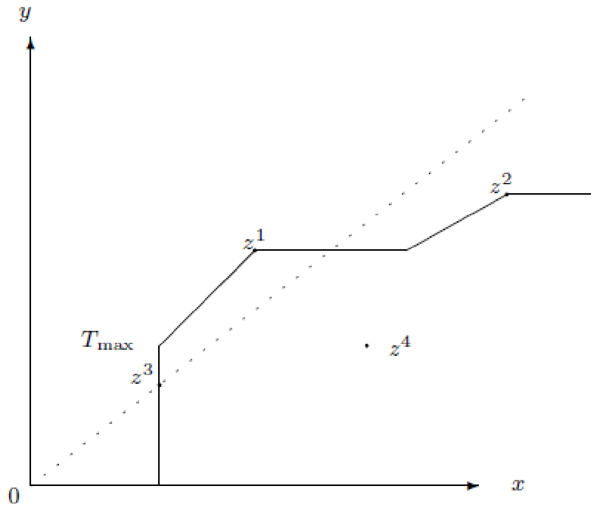
Note that in equivalent form, we can write:

$$T_{\max} = \left\{z = (x, y) \in \mathbb{R}_+^d : x \geq \bigvee_{k=1}^{l} \rho_k x^k, y \leq \bigvee_{k=1}^{l} \rho_k y^k, \max_{k=1\dots l}\{\rho_k\} = 1\right\}. \tag{6}$$

Where $\max_{k=1\dots l}\{\rho_k\} = 1$ characterizes the variable returns to scale assumption (VRS). By dropping the above constraint we can define the 𝔹-convex estimation of the production technology under a constant returns to scale assumption.

The above estimation has a comprehensive economic meaning. In short, the semilattice conditions imply that if a producer uses a greater input quantity then he/she is able to produce a greater output quantity. If the maximum of two input bundles is feasible, then the maximum that they produce is also feasible. This condition is of course stronger than the free disposal assumption. The following figure proposes an illustration of the $\mathbb{B}$-convex technology.

Figure 1. B-convex estimation



Observe that the lines joining the points are broken. The returns to scale are locally decreasing between points z3 and z1 and locally increasing between points z1 and z2. Comparing such an assumption to convexity, one can say that it has some advantages and some drawbacks. Regarding the input side, B-convexity encompasses as a special case the situation in which the technology assumes that the inputs are freely disposable. Looking at the output side, B-convexity implies, under a free disposal assumption, that the production set has an output cubic structure. This means that an assumption of output complementarity is implicitly made on the technology. The above model offers additional choice on the nature of the structure analysis technology. Compared to the DEA model, which postulates a priori a returns to scale assumption of the technology which may be variable, the B-convex model does not define the nature of returns to scale (increasing, decreasing, non-increasing etc.).

4.3. Measurement of technical efficiency of $\mathbb{B}$-convex nonparametric technologies

The expression for calculating the Farrell measure over a $\mathbb{B}$-convex set nonparametric technologies under a variable returns to scale assumption is given as follows:

Let $A = \{z^1, \dots, z^l\} \subset \mathbb{R}^d_{++}$. Assume that $\forall k = 1 \dots l,\ x^k \neq 0$. Let us consider $T^v_{\max} \quad = (\mathbb{B}(A) + K) \cap \mathbb{R}^d_+$. Moreover denote

$$\alpha_{\bar{k},k} = \min_{i=1\dots m} \frac{x_i^{\bar{k}}}{x_i^k}.$$

The input distance function is:

$$E_i(x^{\bar{k}}, y^{\bar{k}}, T^{v}_{\max}\quad) = \max\{ \max_{j=1\ldots n} \min_{\substack{k \\ y_j^{\bar{k}} \le y_j^{k}}} \{\frac{y_j^{\bar{k}}}{y_j^{k}\alpha_{\bar{k},k}}\}, \min_{k} \frac{1}{\alpha_{\bar{k},k}}\}.$$

The output distance function is:

$$E_o(x^{\bar{k}}, y^{\bar{k}}, T^{v}_{\max}\quad) = \min_{j=1\ldots n} \max_{k}\{\frac{y_j^{k}\, min\,\{\alpha_{\bar{k},k}, 1\}}{y_j^{\bar{k}}}\}.$$

5. Data and Results

To estimate the frontier, we use an unbalanced panel. The financial statements (banks balance sheets and income statements) of CFA banks are sourced from reports on Bankscope, for the period 2008-2014. Social and economic data are extracted from the World Bank data base “World Development Indicators” and Global Development Finance. According to data availability, we selected 71 banks which operate in the WAEMU zone (Benin, Burkina Faso, C^te d’Ivoire, Guinée Bissau, Mali, Sénégal, Togo), the CEMAC zone (Cameroon, Central African Republic, Chad, Equiatorial Guinea, Gabon, Republic of Congo) and the Democratic Congo Republic over the period 2008-2014. Therefore, our sample does not respect the proportions per country of the original population. Some of these banks are not observed over all the considered period. The intermediate approach in banking is adopted (Sealey and Lindley, 1977; Berger and Humphrey, 1992).

Table 1 summarize the repartition of the number of CFA banks for each period 2008-2014

Country	2008	2009	2010	2011	2012	2013	2014	TOTAL
BENIN	4	3	3	3	4	3	1	**21**
BURKINA FASO	6	4	3	3	3	3	2	**24**
CAMEROON	5	4	4	4	6	5	2	**30**
CENTRAL AFRICAN REPUBLIC	2	1	1	2	1			**7**
CHAD	1	1	1	1	2	2		**8**
COTE D'IVOIRE	7	5	5	8	7	6	4	**42**
DRC	4	4	2	3	2	3	1	**19**
GABON	2	2	1	3	2	1	1	**12**
GUINEA-BISSAU	1	1	1	1	1			**5**
MALI	7	7	6	5	3	3	2	**33**
NIGER	3	2	2	2	1	1	1	**12**
SENEGAL	6	6	8	8	8	5	4	**45**
TOGO	3	2	3	2	2	2	1	**15**
TOTAL	**51**	**42**	**40**	**45**	**42**	**34**	**19**	**273**

5.1. Efficiency Scores

Banks are assumed to produce three outputs that cover balance sheets and income statements : (i) Total securities, (ii) Gross Loans[20] and Gross interest and dividend income. Three inputs are used to produce bank outputs, which

[20]Our choice of bank output is consistent with the established literature. This is important because the definition and measurement of output could significantly affect the level of bank efficiency (Berger and Humphrey, 1997).

are assumed substitutable: (iv) Personnel Expenses, (v) Total Deposit (which include customer Deposit and Deposit for banks).

Table 2 presents the descriptive statistics of variables used in this study, the values are in USD.

Table 2. Characteristics of inputs and outputs, 2008 - 2014

in million USD	MEAN	Std.Dev	MEDIAN	MINIMUM	MAXIMUM
INPUT					
Total Deposit	767,13	1755,72	412,75	4,22	12950,28
Personnel Expenses	11,69	15,52	7,83	0,31	118,16
OUTPUT					
Gross Loans	351,82	289,53	264,40	1,08	2365,06
Total Securities	98,23	138,62	53,79	0,14	935,79
Gross Interest and Dividend Income	40,59	59,25	25,96	0,56	602,97

5.1.1. Efficiency analysis according to the bank's structure

We divided the 71 banks in our sample in four groups : public (or state) domestic bank, private domestic banks, mixed shareholding banks, and foreign banks . Domestic state, private domestic or foreign banks are those that capital is held predominantly or more than 50% respectively by the state or government , national and foreign private shareholders.

We count 55 foreign banks , 9 private domestic banks , 6 domestic public banks 1 mixed bank, the Commercial Bank of Burkina whose social capital is divided at 50 % between the state and foreign shareholders .

Table 3 shows the results of Farrell efficiency scores according to the bank's structure with the 𝔹-convex method under a VRS and CRS assumptions in input orientation. Scores efficiency are obtained by calculating the average score over the period 2008 to 2014.

Table 3 : Evolution of Farrell efficiency scores according to the bank's structure

	INPUT TECHNICAL EFFICIENCY		
	Variable Return to Scale	Constant Return To Scale	Scale Efficiency
DOMESTIC PUBLIC BANK	79,37%	78,20%	98,37%
DOMESTIC PRIVATE BANK	86,92%	82,81%	95,32%
FOREIGN BANK	84,84%	78,95%	93,43%
MIXED BANK	58,24%	58,24%	100,00%
MEAN	84,49%	79,09%	93,96%

To compare to the foreign banks, private domestic banks have a slight advantage in terms of pure technical, overall technical and scale efficiency. This result is consistent with the previous empirical literature which gives an advantage to the efficiency of domestic banks (Berger and al., 2000).

However, it does not corroborate the findings of studies Sturm and Williams (2005) who showed that Australian foreign banks are, in terms of efficiency of scale, more efficient than domestic banks . Furthermore, it is not consistent to the results of studies of Bhattacharya and al (1998), and Leightner and Lovell (1998) which stipulated that a bank open to the foreign capital improve its performance. This bank had a greater access to technology and especially the best governance practices.

The domestic state banks had the lowest scores in terms of efficiency and productivity. This finding is consistent with the study of Weill, 2006. Foreign banks and domestic private banks are better managed than state banks.

In Table 3 also show that the average technical efficiency score for CFA's Public Domestic bank industry is 79,37%. This implies that CFA's banks misused 20,63% of their inputs relative to the "best-practice" banks. On average, the CFA's Banks could reduce their inputs by at least 20,63% and still produce the same amount of output. Under CRS assumption, the average score is to the tune of 78.20 %. It is due to the underperformance of management in the course of banking operations, leading to inefficient used of the banks' resources; There are 21.80% of inputs misused due to insufficient management performance. The results suggest that CFA bank management did not use their inputs efficiently over the study period.

The efficiency scores in an input orientation are presented in Annex 1. A score equal to one indicates that the corresponding bank is technically efficient at 100%, whereas a score less than to one indicates that the bank is inefficient. According to the Table 4, one can see that Bank of Africa, Ecobank, Société Génerale and Orabank groups are classified as the most efficient CFA bank in the period of study, but they still couldn't perform optimally, which indicates that there are still inefficiencies in their management.

5.2. Determinant of efficiency

In this section, we aim to explain banks scores efficiency with macroeconomic and environmental variables (exogenous variables) and variables linked to banks decision process (endogenous variables).

- Endogenous factors impacting efficiency: variables describing bank characteristics: Size measured as the natural logarithm of banks' total assets; Capitalization leveln measured by the book value of total equity; and the ratio of non-interest expense to gross revenues.
- Exogenous factors: These variables describe the principal environmental conditions in which banks operate. Two macroeconomic variables are used: GDP per capita and inflation. Per capita GDP is used to reflect the general income level. A higher income level is more likely to be associated with a more developed banking sector. Inflation is an indicator of macroeconomic stability, and is directly related to the interest rate levels and, thus, interest expense and revenue. Macroeconomic instability would, in general, have an adverse impact on banking sector performance. A bank's ability to manage interest rate risk under inflationary conditions can also affect its cost structure. Exogenous factors also include political risk indicators obtained from the World Bank's Worldwide Governance Indicators (WGI).

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We used the static panel data model to determine the bank-specific and macroeconomic factors that affect CFA banks technical efficiency. It is given by the equation :

EFFit = α0 + α1SIZEit + α2NEGRit + α3INFit + α4GDPit+ α5Capiit + α6Ruleit +ηi + µit

where i represents the individual bank and t denotes time, α are the parameters to be estimated, ηi is the individual bank specific-effect, EFFit is technicalefficiency scores, SIZEit is bank size, NEGRit is the ratio between the non interest expense and the gross revenues , GDPit is real gross domestic product growth rate, INFit is inflation rate, Capiit represents the ratio between the total Equity and total assets, Ruleit represents the rule of law.and µit is the random error term.

Table 4. Determinants of Bank technical Efficiency : Fixed effect model results

Dependant Variables	**Input Technical Efficiency (Variable Return to Scale)**
Capitalization	**0.712*** (0.000)**
Size	**0.0465* (0.031)**
Non Interest Expense /Gross Revenue	-0.0413 (0.054)
Inflation	**0.00725*** (0.000)**
GDP	0.000604 (0.766)
Rule	0.0215 (0.174)
Constant	**0.665*** (0.000)**
F-Statistic(p-value)	**0.0000**
Wald Test Heteroscedasticity (p-value)	**0.0000**
Number of banks	**71**
Number of observations	**273**
p-values in parentheses:* p<0.05, ** p<0.01, *** p<0.001	

The results are presented in table 4. The coefficient for Capitalization is significant coefficient, and the sign is positive, as expected. This indicates that a higher level of capitalization for a bank translates in greater efficiency. This leads us to conclude that a well-capitalized bank faces relatively low future bankruptcy costs, which in turn reduces its cost of capital. These results correspond to the findings in Garcia-Herrero et al.(2009). This result is in line with the conclusions of Miller & Noulas (1997) on US banks, Yildirim (2002) on Turkish banking industry, Ataullah & Le (2006) on India banks, Rezitis (2006) on Greece banks and Sufian (2009) on Malaysia banks..

The bank's size is significantly positively related to our measure of technical efficiency across all specifications at the 5-percent level of significance. This means that size has a positive and statistically significant effect on technical efficiency. This is attributable to the economies of scale made possible in large banks. The production of banking services iimply a large amount of fixed cost, in particular personnel expeses; as for other production system involving large fixed costs, the marginal cost of production decreases as the volume of unit produced increases. Hence, large banks are generally more profitable than smaller banks. This finding is overall consistent with researches already performed on the effect of size on efficiency; they provide further evidence to Beck's thesis; which attributes the underperformance of African financial system to its small size

The ratio between the non-interest expense and Gross revenue is negatively related to efficiency; this negative relationship was expected, as high cost relative to banking revenues translates an overall low efficiency. However, the coefficient is not statistically significant.

The GDP variable is positively related to the efficiency but statistically insignificant, implying that GDP has a weak influence on efficiency. In other words, there is no statistical evidence that banks operating in the richest countries enjoy higher technical efficiency than those based in poorest countries.

No relationship has been identified between banks' efficiency and the World Bank's Governance Indicator. This suggest that the business climate and political risk in a country does not affect the efficiency and productivity of banks. This is not consistent with Beck's conclusions, which considers that weak public governance is one of the factors underpinning the low development of financial systems in Africa.

The effect of inflation rate on technical efficiency is significant and positive. This result is similar to those of Grigorian & Manole (2006). They confirm the conclusions of Cahn & Karim (2010), who show that banks are able to charge higher rates in a high inflationary environment to compensate for their returns. The positive sign on inflation shows that CFA banking industry is able to benefit from inflationary economic environment as the banks are able to pass on the cost of inflation to their customers by charging higher lending rates relative to deposit rates. Thus, the high inflation may be influencing bank behaviour such as stimulating banks to compete through excessive branch networks (Kasman & Yildirim, 2006)

6. Conclusion

The aim of this study was first to measure the efficiency and productivity of banks based in the Franc Zone over the period 2008 to 2014 and, secondly, to highlight the main determinants of managerial efficiency of these banks. The use of fixed-effects models allowed to measure the managerial variables of efficiency scores .

The result show that private domestic banks have a slight advantage in terms of overall technical efficiency, pure technical efficiency and scale efficiency compared to the foreign banks. This result is interesting, as it suggest that African financial systems do not benefit from the penetration of foreign banks, which appear as less efficient. State banks record the lowest scores in terms of efficiency and productivity; this is not surprising, as these banks generally have no or limited incentive to improve efficiency. Besides, in many countries, their role is to intervene in geographical or sectorial areas which cannot attract private sector banks.

The analysis of the determinants of efficiency scores shows that efficiency of banks in the CFA Zone is influenced by capitalization and size. This results provides evidence of the necessity, for African banks, to merge and create larger banking groups. The authorities have already responded to this concerns in several countries, in particular in Nigeria, but also in the UEMOA zone, where the minimum capital for a bank has been progressively raised to 10 billion CFA Francs (from previously 1 billion). The positive relationship between inflation and banks' efficiency suggest that the business model of African bank allow them to accommodate with inflation. Our results indicate that African banks' efficiency is not influenced by the income per capita and by the business climate in the countries in which they operate.

Annex 1. Farrell Measure in input orientation under a VRS assumption in $\mathbb{B}$-convex model for each bank

	Input Technical efficiency (Variable Return To Scale)							
	2008	2009	2010	2011	2012	2013	2014	MEAN
BENIN	79,25%	90,79%	96,39%	90,94%	82,64%	87,86%	100,00%	87,88%
FOREIGN BANK	79,25%	90,79%	96,39%	90,94%	82,64%	87,86%	100,00%	87,88%
BANK OF AFRICA	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
Banque Atlantique du Benin	55,31%							55,31%
Diamond Bank Benin S.A.	80,03%				74,07%			77,05%
Ecobank Benin	81,65%	100,00%	100,00%	92,85%	87,18%	91,64%		92,22%
Orabank Benin		72,38%	89,17%	79,98%	69,31%	71,93%		76,56%
BURKINA FASO	88,71%	86,31%	79,30%	84,45%	84,37%	90,27%	100,00%	87,19%
DOMESTIC PRIVATE BANK	100,00%	100,00%						100,00%
Coris Bank International SA	100,00%	100,00%						100,00%
FOREIGN BANK	89,72%	95,42%	95,46%	84,45%	84,37%	90,27%	100,00%	90,42%
B I CIA				62,19%	57,93%	78,78%		66,30%
BANK OF AFRICA	92,64%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	98,95%
Banque Atlantique du BF	71,84%							71,84%
Banque Internationale du BF	100,00%							100,00%
Ecobank-Burkina	94,39%	90,84%	90,92%	91,17%	95,19%	92,02%	100,00%	93,50%
MIXT	73,38%	54,39%	46,96%					58,24%
Banque Commerciale du BF	73,38%	54,39%	46,96%					58,24%
CAMEROON	76,11%	79,68%	84,75%	91,93%	77,27%	88,57%	94,67%	83,39%
FOREIGN BANK	76,11%	79,68%	84,75%	91,93%	77,27%	88,57%	94,67%	83,39%
BICEC	100,00%	96,69%	92,02%	100,00%	86,38%	93,63%	100,00%	95,53%
CA SCB Cameroun	52,92%		69,26%	67,72%	77,75%			66,91%
Ecobank Cameroon	80,13%	80,95%	77,71%	100,00%	100,00%	100,00%	89,35%	89,73%
Societé Generale de Banques au Cameroun	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%		100,00%
Standard Chartered Bank Cameroon S.A.	47,49%	41,07%			60,40%	66,69%		53,91%
United Bank for Africa Cameroon SA					39,08%	82,51%		60,79%
CENTRAL AFRICAN REPUBLIC	84,44%	76,75%	85,51%	88,30%	100,00%			86,82%
DOMESTIC GOVERNMENT BANK	90,66%			100,00%	100,00%			96,89%
Commercial Bank Centrafrique SA	90,66%			100,00%	100,00%			96,89%
FOREIGN BANK	78,22%	76,75%	85,51%	76,60%				79,27%
Ecobank Centrafrique	78,22%	76,75%	85,51%	76,60%				79,27%
CHAD	73,06%	75,91%	68,04%	72,40%	95,64%	95,08%		83,86%
FOREIGN BANK	73,06%	75,91%	68,04%	72,40%	95,64%	95,08%		83,86%
Ecobank Tchad SA	73,06%	75,91%			91,28%	90,17%		82,61%
Orabank Tchad			68,04%	72,40%	100,00%	100,00%		85,11%

COTE D'IVOIRE	82,68%	95,10%	95,97%	78,85%	81,82%	86,41%	100,00%	87,05%
DOMESTIC GOVERNMENT BANK				53,99%				53,99%
Banque Nationale d'Investissement (BNI)				53,99%				53,99%
DOMESTIC PRIVATE BANK				77,71%	82,15%	86,22%	100,00%	86,52%
NSIA Banque				77,71%	82,15%	86,22%	100,00%	86,52%
FOREIGN BANK	90,13%	95,10%	95,97%	83,18%	81,77%	86,45%	100,00%	89,39%
BANK OF AFRICA	100,00%	100,00%	100,00%	84,33%	89,71%	87,85%	100,00%	94,56%
Banque Atlantique de Cote d'Ivoire,S.A.				66,42%	56,29%			61,36%
Banque Int. pour le Commerce et L'Industrie	100,00%	94,55%	89,41%	75,74%	82,34%	100,00%		90,34%
Bridge Bank Group	61,47%							61,47%
Ecobank	94,18%	92,73%	90,42%	90,01%	84,17%	90,36%	100,00%	91,70%
Societe Generale de Banques en Cote d'Ivoire	100,00%	100,00%	100,00%	100,00%	94,61%	67,77%	100,00%	94,62%
Societe Ivoirienne de Banque	85,16%	88,22%	100,00%	82,61%	83,48%	86,26%		87,62%
MICROFINANCE	37,92%							37,92%
Access Bank Cote d'Ivoire	37,92%							37,92%
DRC	55,87%	67,40%	43,76%	67,49%	52,42%	85,64%	100,00%	65,52%
DOMESTIC PRIVATE BANK	53,93%	53,49%	41,32%	57,59%	49,14%			51,10%
Banque Commerciale du Congo	53,93%	53,49%	41,32%	57,59%	49,14%			51,10%
FOREIGN BANK	56,52%	58,06%	46,19%	72,44%	55,70%	85,64%	100,00%	68,41%
BIA Congo		85,17%						85,17%
Ecobank RDC sarl		30,94%				100,00%	100,00%	76,98%
FBNBank DRC SA	67,57%			88,04%				77,80%
ProCredit Bank (Congo)						100,00%		100,00%
Rawbank SARL	61,35%		46,19%	56,85%	55,70%	56,91%		55,40%
Standard Bank RDC s.a.r.l.	40,64%							40,64%
MICROFINANCE		100,00%						100,00%
Access Bank (R.D. CONGO)		100,00%						100,00%
GABON	96,24%	100,00%	77,17%	69,41%	63,79%	95,16%	93,65%	82,86%
DOMESTIC GOVERNMENT BANK	100,00%	100,00%		91,48%				97,16%
Banque Gabonaise de Developpement	100,00%	100,00%		91,48%				97,16%
DOMESTIC PRIVATE BANK	92,48%	100,00%						96,24%
Bgfibank	92,48%	100,00%						96,24%
FOREIGN BANK			77,17%	58,38%	63,79%	95,16%	93,65%	72,90%
Ecobank Gabon			77,17%	50,78%	56,52%	95,16%	93,65%	74,65%
Union Gabonaise de Banque				65,98%	71,05%			68,52%
GUINEA-BISSAU	100,00%	100,00%	100,00%	100,00%	100,00%			100,00%
FOREIGN BANK	100,00%	100,00%	100,00%	100,00%	100,00%			100,00%
Banque Regionale de Solidarite - Guinee Bissau	100,00%	100,00%						100,00%
Ecobank Guinea Bissau			100,00%	100,00%	100,00%			100,00%

MALI	70,83%	69,54%	76,60%	80,59%	73,71%	81,76%	68,98%	74,23%
DOMESTIC GOVERNMENT BANK	65,24%	57,77%	70,92%	74,93%				66,26%
Banque de l'Habitat du Mali		43,13%	62,15%					52,64%
Banque Malienne de Solidarite	65,24%	72,40%	79,70%	74,93%				73,07%
FOREIGN BANK	71,76%	74,25%	79,44%	82,00%	73,71%	81,76%	68,98%	76,00%
BANK OF AFRICA	75,51%	69,58%	73,66%	67,73%	70,74%	77,90%	76,81%	73,13%
Banque Atlantique Mali SA	64,83%							64,83%
Banque de Developpement du Mali SA	64,06%	81,83%	100,00%	87,89%	81,78%	94,25%		84,97%
Banque Internationale pour le Mali	87,40%	82,91%						85,15%
Banque Nationale de Developpement Agricole	75,52%	69,22%	79,73%	95,19%				79,91%
Ecobank Mali	63,24%	67,70%	64,37%	77,21%	68,61%	73,14%	61,16%	67,92%
NIGER	91,12%	96,95%	90,78%	85,36%	88,30%	72,40%	100,00%	90,02%
FOREIGN BANK	91,12%	96,95%	90,78%	85,36%	88,30%	72,40%	100,00%	90,02%
BANK OF AFRICA	100,00%	100,00%	100,00%	100,00%			100,00%	100,00%
Banque Atlantique Niger	89,28%							89,28%
Ecobank Niger	84,07%	93,91%	81,56%	70,72%	88,30%	72,40%		81,83%
SENEGAL	94,57%	95,65%	93,36%	92,21%	89,36%	90,94%	87,08%	92,08%
DOMESTIC PRIVATE BANK	100,00%	100,00%	100,00%	93,41%	86,54%	86,73%		95,41%
Banque de L'Habitat du Senegal			100,00%					100,00%
Banque Regionale de Marches	100,00%	100,00%	100,00%	100,00%				100,00%
Caisse Nationale de Credit Agricole du Senegal	100,00%	100,00%	100,00%	100,00%	100,00%			100,00%
CBAO Croupe Attijariwafa Bank	100,00%		100,00%	80,22%	83,96%	86,73%		90,18%
Credit du Senegal					75,66%			75,66%
FOREIGN BANK BANK	89,15%	93,47%	86,71%	91,49%	91,05%	92,00%	87,08%	90,25%
BANK OF AFRICA	80,62%	85,89%	83,08%	92,90%	97,97%	100,00%	100,00%	91,49%
Banque Atlantique Senegal				100,00%	91,74%			95,87%
Banque Int. pour le Commerce et l'Industrie Senegal	100,00%	97,90%	76,66%	84,70%	77,58%	84,46%	77,97%	85,61%
Ecobank Senegal	86,83%	91,56%	87,12%	79,85%	87,96%	83,53%	76,29%	84,73%
Societe Generale de Banques au Senegal		98,55%	100,00%	100,00%	100,00%	100,00%	94,05%	98,77%
TOGO	80,95%	85,28%	91,27%	89,93%	85,64%	82,92%	74,22%	85,23%
DOMESTIC GOVERNMENT BANK BANK	77,54%							77,54%
Union Togolaise de Banque	77,54%							77,54%
FOREIGN BANK BANK	82,66%	85,28%	91,27%	89,93%	85,64%	82,92%	74,22%	85,78%
Banque Togolaise de Developpement	99,77%	100,00%	100,00%					99,92%
Ecobank-Togo	65,55%	70,56%	73,80%	79,87%	71,28%	77,00%	74,22%	73,18%
Orabank Togo			100,00%	100,00%	100,00%	88,83%		97,21%
MEAN	**81,29%**	**84,74%**	**85,65%**	**83,90%**	**81,89%**	**87,53%**	**91,76%**	**84,49%**

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