Institutional Framework and Banking Efficiency in Sub-Saharan Africa: Evidence from CEMAC and UEMOA Countries

[redacted]

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Abstract

Applying the Stochastic Frontier Approach (SFA) to a translog production function, we investigate the influence of environment on banking efficiency in UEMOA and CEMAC zones, by introducing macroeconomic and the legal framework variables in defining the common frontier. We find that on their respective regional frontiers, banks are efficient in UEMOA and CEMAC even if they can perform better. For UEMOA countries, banks efficiency in terms of lending is more related to their management methods. Banks within the area operate in a homogeneous environment. Concerning the CEMAC, our results suggest that countries are heterogeneous within the zone. On a common frontier, in terms of lending the UEMOA banks are more efficient than CEMAC ones. The impact of the environment on efficiency is more important in CEMAC countries. Overall, macroeconomic conditions and the quality of institutions determine banking efficiency in UEMOA and CEMAC. The income, the index for enforcement of contracts, and the strength of legal rights index, are associated with an increase in credit production when their levels are high. Conversely, the financial development, and the regulatory quality tend to increase credit production in countries where their levels are weak.

JEL Classification: G2; G21; F36; O2; O55

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1. Introduction

Despite the reforms undertaken in the past decades, the financial sector of many Sub-Saharan Africa (SSA) countries still remains underdeveloped compared to other developing regions. For instance, examining the financial development in Africa in international comparison, Beck and Cull (2014) find that the median private credit to deposit ratio is 34% in non-African developing countries, but only 18% in Africa. The weakness of the financial inclusion is also one of the characteristics of SSA financial sector. Only 21% of the firms have a line of credit or loan from a formal financial institution, while this indicator reaches 43% in non-African developing countries. Moreover, the financial sector is widely bank-based. In many countries, the Non-bank financial institutions (NBFIs) are marginal, almost non-existent. In CEMAC[2] countries, the banking system accounts for more than 80% of the financial assets. In this context, where the financial sector is widely dominated by banks, it is important to investigate their efficiency to ensure that they fulfill their role especially since the financial development contributes to growth (Levine, 2005).

Moreover, with the growth of the banking sector, the institutional reforms, and the founding of sub-regional organizations, SSA countries have aroused interest for researchers regarding banking efficiency. By studying banking efficiency in SSA countries, the aim is often declined in two main questions: (1) what is the level of bank efficiency in SSA? (2) What factors determine this degree of efficiency? To investigate these questions, most of the studies generally proceed in two steps: first the efficiency level is determined, and then these efficiency scores are regressed on some factors. However, it is possible that this two steps methodology leads to a bias. In this paper, we suggest another approach to assess bank efficiency in SSA countries, with a particular focus on how institutional variables determine this efficiency.

We apply on the UEMOA[3] and CEMAC banks, the methodology developed by Dietsch and Lozano (2000). This methodology has been only implemented in industrial countries. Basically, Dietsch and Lozano (2000), by comparing banking efficiency between France and Spain, suggested that the definition of a common frontier has to incorporate country-specific environmental conditions. Indeed, banks within the two countries evolve in a different environment. Thus, in some extent a cross-country comparison would be biased if the

[2] In French, CEMAC refers to « Communauté Économique et Monétaire de l'Afrique Centrale ».
In English, CEMAC is called "Central African Economic and Monetary Community".
[3] In French, UEMOA refers to « Union Économique et Monétaire Ouest Africain »
In English, UEMOA is called "West African Economic and Monetary Union"

environmental conditions are not accounted for. We proceed to not only a cross-country, but also a cross-regional comparison of bank efficiency in UEMOA and CEMAC countries. The UEMOA and the CEMAC are two distinct sub-regional monetary unions. The two organizations appear to be ideal for these kinds of studies because they represent both the most successful economic and monetary integration in Africa. Moreover, they provide us the framework for the implementation of our methodology given the fact that the environmental conditions are different between the zones and/or between countries within the zones.

The results show that on average banks are efficient in UEMOA and CEMAC better even if there is scope to improve their efficiency. Countries within the UEMOA zone are homogeneous, while those of CEMAC are heterogeneous. Overall, the macroeconomic conditions, but also the strength of legal rights index, the index for enforcement of contacts, and the regulatory quality determine banking efficiency in SSA, especially in CEMAC countries. Reforms that promote the improvement of legal framework are recommended in order to lead the UEMOA and CEMAC banks to better efficiency. Our paper contributes to the literature in several ways. In our knowledge, it is the first which brings to light the important influence of the institutional framework in determining banking efficiency in SSA countries. Then, the paper makes a contribution to the few existing literature about cross-regional comparison between two distinct monetary unions, especially in Africa.

The remainder of the paper is organized as follows. Section 2 reviews the literature on banking efficiency in SSA. Section 3 provides an overview of the UEMOA and CEMAC countries. Section 4 focuses on the methodology. In section 5, the data and descriptive statistics are presented. Section 6 reports the obtained results, and section 7 concludes.

2. Literature review

Studies about banking efficiency in SSA are few. Unlike developed countries, to the best of our knowledge, the first investigations in the field have been conducted in 2000s. Before, the weakness of financial depth and specifically the lack of data were hindrances to such investigations. Much of them were first oriented on the nexus between competition and banking efficiency in SSA. Indeed, in the 80s and 90s most of SSA countries have implemented policies in order to restructure their financial sector. The aim was to promote the financial development and therefore boosting growth and reduce poverty. These policies have been accompanied by the entry of foreign banks in many SSA countries, and therefore the increasing of competition in the banking sector. Hauner and Peiris (2008) investigate the

effects of competition on bank efficiency after the banking sector reforms in Uganda. It appears that the level of competition has significantly increased. As a consequence, the banking system has become relatively more efficient. Specifically, the competition has been beneficial for larger banks and foreign ones, as they are the most efficient. Unlike, the competition has had a negative impact on smaller banks in terms of efficiency. Asongu (2010), studying the link between banking efficiency and openness in 29 low and middle income African countries, finds that trade and financial openness involve lower bank efficiency in low income countries than in middle income ones. Other studies have been conducted regarding the nexus competition - banking efficiency, such as Buchs and Mathisen (2005) on Ghana, or Mlambo and Ncube (2011) on South Africa. Leon (2012) also analyzes the effect of competition on banking efficiency, but in a monetary union-level, namely the UEMOA. His results suggest that the competition has a negative impact on cost-efficiency in the UEMOA countries. In the case of profit-efficiency, there is no impact.

Apart from papers related to the nexus competition - banking efficiency, studies about banking efficiency in SSA countries could be grouped in three classes: (1) studies which assess banking efficiency without any consideration of the environment influence, (2) studies which first determine the level of efficiency and then in a second stage investigate the determinants of these efficiency levels by using some bank specific factors and external environmental variables as explanatory variables, and (3) studies which account for the potential impact of environment in building the efficient frontier.

Among studies which assess banking efficiency without taking into account the potential impact of the environment, we can quote Ncube (2009) and Kamau (2011). The first one has measured the efficiency of the four larger banks and the four smaller banks in South-Africa during the 2000-2005. While the cost-efficiency has reaching 0.85, he finds that the profit-efficiency is low, averaging 0.55. Moreover, bank size is negatively correlated with cost efficiency. There is also a significant correlation between cost and profit efficiency in South-Africa. Kamau (2011) takes a look on intermediation efficiency and productivity in the Kenyan banking sector post liberalization period. Banks were performing better even if there is scope to improve their efficiency. In terms of ownership, foreign banks are the most efficient, then the private domestic banks, and lastly the public local banks. Regarding the size, large banks appear to be more efficient than medium and small ones. Moreover, there is an improvement in terms of productivity suggesting that Kenyan banks have integrated the technological change from liberalization reforms.

However, a large part of studies on banking efficiency in SSA countries did not only focus in determining bank efficiency levels. Indeed, the question of the determinants of these efficiency levels has also been widely addressed. And generally, this question is handled in two steps: first, bank efficiency levels are determined, and in a second stage, variables related to banks, macroeconomic conditions, legal and institutional framework, are used to explain the previous efficiency levels.

With regard to the bank specific factors, the literature is unanimous concerning their impact on bank efficiency. Kirkpatrick et al., (2008)[4] by studying the cost x-inefficiency and the profit x-inefficiency in 9 SSA countries find that bad loans and high capital ratio contribute to both cost x-inefficiency and profit x-inefficiency. Bank size is also widely quoted as determinant of the efficiency level. Large banks appear to be the most efficient as they generally reach the lowest x-inefficiencies (Kirkpatrick et al., 2008). In terms of cost efficiency, the results from Kiyota (2011) suggest that the medium or relatively large banks are the most efficient, while the smallest banks perform better profit efficiency. The ownership also influences banking efficiency in SSA where almost half of the banking system is held by foreign investors (Allen, 2011). There is evidence that in SSA countries, foreign banks are the most efficient (Kirkpatrick et al., 2008; and Kiyota, 2011). However Kablan (2009a), by examining the efficiency with regard to ownership, finds that private local banks are the most efficient, followed by foreign ones, and lastly the public banks. The results from Kiyota (2011) also suggest that Pan-African banks are more profit efficient that non-Sub-Saharan Africa foreign ones.

Besides bank specific factors, the external environmental variables also determine banking efficiency in SSA countries. The first set of those external environmental variables, are the macroeconomic conditions. Indeed, variables such as the level of income, the inflation and the financial depth are emphasized by the literature as significant in determining the efficiency scores (Chen, 2009 and Kiyota, 2011). Thus, a stable macroeconomic framework contributes to higher banking efficiency. Moreover, the market structure also influences bank activities in terms of efficiency (Chen, 2009 and Kablan, 2009). Then, variables related to the legal framework and the quality of institutions are the others external factors that determine efficiency levels. Chen (2009) found that stronger legal institutions and enforcement of

[4] As stated in the paper, the findings have to be taken with caution because the sample is dominated by two countries namely Nigeria and Kenya which represent in total 64% of the banks

contracts, as well as political stability and government effectiveness are beneficial to banking efficiency.

And lastly, by resorting to the one-step procedure conceived by Battese and Coeli (1995), Kablan (2009b) investigates how efficient are banks in SSA, and what determine their degree of efficiency. With this method, the impact of variables that influence cost-efficiency is integrated to the cost frontier. Therefore, the obtained levels of efficiency are supposed to account for the potential influence of the environmental conditions. This paper is one of the few in SSA countries which directly integrated the effects of environmental factors in building the efficient frontier. Concerning external environmental factors, the results emphasize that the density of the rural population undermine efficiency in SSA. Indeed, most of the population lives in rural areas while banks are located in towns. Finally, these results suggest that the improvement of regulation and credit environment should improve banking efficiency in SSA countries.

In the mentioned cross-country studies, only Kablan (2009b) considers the environmental conditions in generating the common efficient frontier for the SSA countries. However, it is important to point out that only two environmental variables were included: the level of income, and the percentage of rural population. We believe that others variables such as those related to legal framework and the quality of institutions may determine banking efficiency, specifically in SSA where the institutions are fragile and immature. The remainder papers proceed to building, first the common frontier without any consideration regarding the impact of environment where banks operate. In a second stage, the obtained efficiency levels are supposed to be explained by environmental conditions. Therefore, this two-step methodology may leads to a bias. Dietsch and Lozano-Vivas (2000) suggested a methodology allowing comparing cross-country banking efficiency using the same standard. Comparing the French and Spanish banking industries, they highlight the influence of environmental variables in determining the differences in efficiency scores between the two countries. As stated in the paper, it appears that "the specific environmental conditions of each country play an important role in the definition and the specification of the common frontier of different countries". Indeed, when the common frontier is defined without environmental variables, the difference in cost-efficiency is huge. In particular, French banks tend to outperform Spanish ones. When the model integrates the environmental variables, the differences in cost-efficiency between the two countries decrease substantially.

In this paper, following the same methodology, we compare the banking efficiency of the UEMOA and CEMAC countries in terms of lending, bringing to light the influence of institutional framework in determining the efficiency levels.

3. Presenting the UEMOA and CEMAC

Established in 1994, the West African Economic and Monetary Union (UEMOA) is an economic and monetary organization which is made up of 8 member States: Benin, Burkina Faso, Ivory Coast, Guinea Bissau, Mali, Niger, Senegal, and Togo. These countries have a common Central Bank, the BCEAO[5], and a single currency, the *Franc CFA*. Among its objectives, the BCEAO is committed to develop and apply the common monetary policy for all the state members. It also ensures the stability of the banking and financial system of the community. Because of some historical reasons, the BCEAO has an agreement with the *Banque de France*, which allows fixing the *Franc CFA* exchange rate with euro. In return, the BCEAO has to deposit more than 50% of its foreign exchange reserves at the *Banque de France*.

The Central African Economic and Monetary Community (CEMAC) is exactly the equivalent of the UEMOA, but it gathers the central African countries. It has been founded in 1999, five years after the UEMOA. It has 6 member States, namely: Cameroun, The Central African Republic, The Republic of Congo, Gabon, Equatorial Guinea and Chad. Like the UEMOA, the CEMAC countries also have a common Central Bank, the BEAC[6], and a single currency, the *Franc CFA*[7], also linked to the *Banque de France,* and to the euro.

Seen in this way, the UEMOA and CEMAC appear to be two similar zones: they have the same currency linked to the *Banque de France* and, as economic and monetary organizations, they have virtually the same objectives. However, major differences can be outlined. These differences concern the demography, the macroeconomic framework, the business environment, and the financial sector.

In terms of demography, the differences between the UEMOA and the CEMAC countries are marked. First of all, the total population is obviously higher in UEMOA: around 106 million

[5] BCEAO means in French, « Banque *Centrale des Etats de l'Afrique de l'Ouest*. »

[6] BEAC : in French « *Banque des Etats de l'Afrique Centrale* »

[7] Even if they have the same name, « the *Franc CFA* BCEAO » and «the *Franc CFA* BEAC » are different and are not interchangeable : 1 euro = 655,957 "*Francs CFA* BCEAO" and 1 euro = 655,957 "*Francs CFA* BEAC"

inhabitants versus 46 million in CEMAC. The gap between the two areas reaches on average 60 million of inhabitants. Concerning the density of population, the same situation is observed. Indeed, the density of population in UEMOA is more than the triple of that of the CEMAC, respectively 63 inhabitants / km² against 19 inhabitants / km² (World Bank, 2013).This could produce some significant differences in the demand for banking products and services among households.

Significant macroeconomic differences also exist between the UEMOA countries and those of the CEMAC, especially when it comes to wealth. Among the 6 countries of CEMAC, 5 are oil producers. Only the Central African Republic is an exception to the rule. Oil represents 41% of the GPD of the region and 86% of the goods' exports. Therefore, the CEMAC countries enjoy significant oil revenues which often place them in surplus capacity of financing (FMI[8], 2012). As consequences, the macroeconomic performances in this area often depend on fluctuations in oil prices. On the other hand, the UEMOA countries are predominantly exporters of agricultural products, namely cotton, coffee and cocoa. But climatic risks tend to often limit export earnings. Some countries also have mineral resources such as gold and uranium. These countries usually face budget deficit problems, financed by recourse to external debt and foreign aid. The UEMOA countries are poorer than those of the CEMAC: in 2013, on average, the GPD per capita in the UEMOA area was USD 809, against USD 5,892 in the CEMAC countries (World Bank, 2013). Concerning the inflation, it is higher in CEMAC. Over 2009-2012 period, the average annual inflation was 2.1% in UEMOA versus 3.3% in CEMAC (FMI, 2013). Moreover, in UEMOA, since 16 March 2012, the reserve requirement ratio is 5% for the whole banks. In CEMAC there is no common reserve requirement ratio for all the member States. In fact, because of banking liquidity differences between member States, reserve requirement are applied on case-by-case from one country to the next (*Banque de France*, 2008).

With regard to the business environment, the UEMOA and CEMAC countries are classified in the 50 worst performing countries in the world. However, on average, the situation is better in UEMOA. The ease of doing business is evaluated by the Distance to Frontier (DTF). According to the definition of the World Bank, "the distance to frontier score aids in assessing the absolute level of regulatory performance and how it improves over time. This measure shows the distance of each economy to the "frontier," which represents the best performance

[8] Fond Monétaire International

observed on each of the indicators across all economies in the Doing Business sample since 2005." This indicator is ranked from 0 to 100, where 0 represent the lowest performance, and 100 the frontier. In 2013, on average, the DTF was 44.57 for the UEMOA countries, and 40.96 for CEMAC ones. Thus on average, compared to CEMAC, the UEMOA zone offers the best environment for doing business (Doing Business, 2013).

As in most of SSA countries, the financial sector is underdeveloped in the UEMOA countries and those of the CEMAC. Moreover, the financial sector is widely dominated by banks. The Non-bank financial institutions (NBFIs) are almost non-existent. For instance, in the CEMAC the banking system accounts for more than 80% of the financial assets. In 2013, 50 banks were registered in the 6 member states. At the same period, in UEMOA the banking system was made up of 114 banks. However, a large part of the banking system is held by foreign investors. Indeed, in both zones, the foreign assets represent at least 50% of the banking system (BAD[9], 2010; Allen, 2011; IMF[10], 2016). One of the common characteristics to both zones is the concentration of the banking system. In each of the CEMAC's countries, about 70% of the assets are held by the three largest banks. In the whole UEMOA zone, five banks account for 50% of the banking assets (IMF, 2013; IMF, 2016).

Even if the financial markets are underdeveloped, the UEMOA and the CEMAC have stock exchange. The UEMOA countries have implemented one of the most successful regional stock exchange markets in Africa, the BRMV[11]: at the end of 2012, the BRVM had 37 quoted companies accounting on average for 12% of the UEMOA Gdp (IMF, 2013). The CEMAC countries have implemented the same institution called BVMAC[12], but unlike the BRVM, it is less efficient, even almost non-existent because of leadership rivalry between Cameroon and Gabon. Indeed, in addition to the BVMAC, Cameroon has created its own stock exchange, Douala Stock Exchange. However, the number of listed firms in both BVMAC and Douala Stock Exchange fails to reach five.

Despite the reforms in financial sectors during the past decades, the financial development is still weak and, the access to formal financial services is limited. However, comparing the two zones, the UEMOA countries have a level of financial development higher than CEMAC ones. Indeed, the ratio of credit to Gdp is 10% in CEMAC countries, while in the UEMOA

[9] Banque Africaine de Développement
[10] International Monetary Fund
[11] Bourse Régionale des Valeurs Mobilières
[12] Bourse des Valeurs Mobilières de l'Afrique Centrale

this ratio reaches 20%, either the double (IMF, 2013; IMF, 2016). The access to formal banking services is a hindrance in both zones. For example, on average, in the CEMAC countries, lees than 15% of adults are bank accounts holders (Beck and Cull, 2014).

4. Methodology

Sub-Saharan Africa has one of the most underdeveloped banking systems in the world, although large disparities exist between countries (Honohan and Beck, 2007; Beck and Cull, 2014). For instance, countries like Kenya or Nigeria have appeared to be major financial centers with a banking system closer to that of emerging countries. By contrast, the countries of the UEMOA and CEMAC have less developed banking systems. In some way, these two groups of countries can be bracketed together in terms of financial development. Within these economic and monetary unions, common economic and financial policies are implemented to facilitate convergence. Thus, there is a presumption that banking technology is more or less the same in UEMOA and CEMAC, respectively. However, banks operate in different environments. As stated previously, these differences might be related to the demography, the macroeconomic conditions, the legal framework, the business environment, and so on.

To summarize, on the one hand, banks in UEMOA and CEMAC have the same technology. In fact, most of the existing banks in the two zones are subsidiaries of French groups, and the executives are from French schooling. On the other hand, these banks operate in different environments. In this context, to properly measure and compare their level of efficiency, we have to control for environmental factors, in order to take into account the conditions in which banks evolve.

We follow the same methodology than Dietsch and Lozano-Vivas (2000) to assess the influence of environment on banking efficiency in UEMOA and CEMAC areas. We adopt the parametric approach[13] (Aigner et al. 1977; Meeusen and van den Broeck, 1977) to conduct our analysis. In the context of banking efficiency, parametric approaches consist generally in estimating an efficient frontier and then in measuring differences between the point at which each bank is operating (X-Efficiency) and the efficient frontier. Structural approaches have the advantages to discern between random errors and inefficiency even if they make some assumptions about their distribution. But in return, they impose a particular functional form

[13] We resort to Stochastic Frontier Analysis (SFA)

for the frontier. In the literature, for these kinds of analysis, the Cobb-Douglas and the Logarithmic Transcendental (Translog) production functions are usually used. The Translog function is a generalization of the Cobb-Douglas function. In this paper, we opt for the Translog production function because it offers a flexible (second-order) functional form.

We resorted to the intermediation approach to select inputs and output. Indeed, one of the characteristics of African banks is the low production of credit despite the predominance of commercial banks. Banks in the area are unable to ensure the financing of private sector. For instance, in Africa, only 22% of firms have access to credit, and 45% of the firms consider the Finance and the access to credit as an obstacle to their development (Global Findex, 2012). Moreover, only 74% of deposits are converted to credits, versus 109% for the others developing countries. In this context, it is important to investigate the loan production in SSA and, more specifically banks capacity to transform the collected deposits in loans.

Our methodology consists in two main steps: *(i)* bank efficiency is estimated for each zone, UEMOA and CEMAC, on its regional frontier; and *(ii)* bank efficiency of both zones, UEMOA and CEMAC, is estimated on a common frontier by pooling data from both zones. Basically, in each step the estimates are made by taking into account the differences in environment, because as Dietsch and Lozano-Vivas (2000), we consider the environment as an important factor in explaining the differences of loan production within the two areas.

Throughout the regressions, we consider a translog stochastic production function (Christensen et al, 1973):

$$LnY_i = \alpha + \sum_{k=1}^{3} \beta_k lnX_{ik} + \frac{1}{2} \sum_{k=1}^{3} \sum_{m=1}^{3} \gamma_{km} lnX_{ik} lnX_{im} + \sum_{p=1}^{5} \delta_p Z_{ip} + \varepsilon_i \qquad (1)$$

Where Y_i is the Production of the i-th bank; X_{ik} (k = 1, 2, 3) the input k of the i-th bank; Z_{ip} (p=1 to 5) the environmental variables p of the i-th bank. Note that, when the estimates are done without account for the environment, we drop the term $\sum_{p=1}^{5} \delta_p Z_{ip}$ in (1). $\varepsilon_i = V_i - U_i$ represents the error term of the i-th bank; V_i are traditional random variables and are assumed to be iid. $N(0, \sigma^2_v)$; $U_i \geq 0$, are random variables that are supposed to account for the technical inefficiencies in the production process. In our model, U_i are independent and identically distributed exponential with scale parameter σ_u.

The density function for U_i is given by:

$$f(u) = \frac{1}{\sigma_u} \exp\left\{-\frac{u}{\sigma_u}\right\} \quad (2)$$

V_i and U_i are distributed independently of each other, and of regressors. Thus, their joint density function can be written as the product of their individual density:

$$f(u,v) = \frac{1}{\sqrt{2\pi}\sigma_u\sigma_v}\ exp\ \{-\frac{u}{\sigma_u} - \frac{v^2}{2\sigma_v^2}\} \quad (3)$$

Model (1) represents a Translog production function with one output and three inputs. As stated previously, inputs and output are determined by the intermediation approach because in UEMOA and CEMAC, banks are specialized in collecting deposits, and granting loans. Market activities are few. Thereby, the production is approximated by *Loans*, while inputs are made up by *Borrowed Funds* to what we add *Labor* and *Capital*. These variables are defined more precisely in Table 2.

Using model (1), technical efficiencies *(TE_i)* are determined. The Technical Efficiency is defined as the ratio of observed output to maximum feasible output given the effects of random shocks out of the control of each bank. The Technical Efficiency has necessarily values between one and zero. Thus, when the bank achieves its maximum feasible, the technical efficiency is equal to 1; otherwise, $TE_i < 1$. Mathematically, this definition is formalized by the following expression:

$$TE_i = \frac{y_i}{f(x_i;\beta).exp\{v_i\}} \quad (4)$$

Where $f(x_i;\beta)$ is the production frontier; $epx\{v_i\}$ captures the effect of random shocks on each producer; y_i, x_i and β are already defined above.

As stated before, the error term of the translog production function is made up by two components: $\varepsilon = V_i - U_i$. The main problem is to distinguish between V_i et U_i, and more precisely extracting the information on U_i contained in ε. As a solution, Jondrow et al. (1982) proposed to consider the expected value of U_i conditional on ε. They showed that if U_i are distributed exponential, the conditional distribution of U_i given ε is :

$$f(u|\varepsilon) = \frac{f(u,\varepsilon)}{f(\varepsilon)}$$

$$= \frac{1}{\sqrt{2\pi}\sigma_v \Phi(-\frac{\tilde{\mu}}{\sigma_v})} \exp\left\{-\frac{(u-\tilde{\mu})^2}{2\sigma^2}\right\} \qquad (5)$$

Where $\tilde{\mu} = -\varepsilon - (\frac{\sigma_v^2}{\sigma_u})$; Φ is the standard normal cumulative distribution.

$f(u,\varepsilon)$ is the joint density function of u and ε, and is given by :

$$f(u,\varepsilon) = \frac{1}{\sqrt{2\pi}\sigma_u\sigma_v} exp\left\{-\frac{u}{\sigma_u} - \frac{1}{2\sigma_v^2}(u+\varepsilon)^2\right\} \qquad (6)$$

$f(\varepsilon)$ is the marginal density function of ε, and is obtained by integrating u out of $f(u,\varepsilon)$:

$$f(\varepsilon) = \int_0^\infty f(u,\varepsilon)du$$

$$= \frac{1}{\sigma_u} \Phi\left(-\frac{\varepsilon}{\sigma_v} - \frac{\sigma_v}{\sigma_u}\right) exp\left\{\frac{\epsilon}{\sigma_u} - \frac{\sigma_v^2}{2\sigma_u^2}\right\} \qquad (7)$$

$f(u|\varepsilon)$ is distributed as $N^+(\tilde{\mu}, \sigma_v^2)$, and its mean is given by the following expression :

$$E(u_i|\varepsilon_i) = \tilde{\mu_i} + \sigma_v \left[\frac{\phi\left(-\frac{\tilde{\mu_i}}{\sigma_v}\right)}{\Phi\left(\frac{\tilde{\mu_i}}{\sigma_v}\right)}\right]$$

$$= \sigma_v \left[\frac{\phi(A)}{\Phi(-A)} - A\right] \qquad (8)$$

With ϕ, the standard normal density distribution function.

After obtained the estimates of u_i, the Technical Efficiency of each Bank is measured by :

$$TE_i = exp\{-\hat{u}_i\} \qquad (9)$$

In our case, we generated two kinds of Technical Efficiency: $TE1_i$ and $TE2_i$.

The $TE1_i$ is proposed by Jondrow et al. (1982). They defined $\hat{u}_i$ as $E(u_i|\varepsilon_i)$. Thus, by substituting this expression in equation (9), we obtained the following measure of $TE1_i$,

$$TE1_i = \exp\{-E(u_i|\varepsilon_i)\} \qquad (10)$$

The estimate of $TE2_i$ is later proposed by Battese and Coelli (1988), who used $E(\exp\{-u_i\}|\varepsilon_i)$, rather than $exp\{-\hat{u}_i\}$ to assess the technical efficiency. Thus, $TE2_i$ is given by the following formula:

$$TE2_i = E(\exp\{-u_i\}|\varepsilon_i) \qquad (11)$$

5. Data and descriptive statistics

Given our methodology, we resorted to two kinds of data: data from banks' balance sheets and income statements, and data related to macroeconomic conditions and legal framework at the country level. Both cover the 2007-2013 period and consist of pooled cross-sectional data.

Data on banks are provided by Bankscope. We take into account all the banks available for UEMOA and CEMAC countries. However, for Guinea-Bissau (UEMOA) and Equatorial Guinea (CEMAC), there is a lack of data. Therefore, we drop these two countries. On UEMOA our sample is made up by 73 banks, and concerning CEMAC, we have 33 banks in the sample (Table 1). These data from banks are used to determine inputs and output.

Here, we consider one output (*Loans*) and three inputs production function. The first input is approximated by *borrowed funds*. *Borrowed funds* are made up by total customers deposits plus deposits and short term funding. The two remaining inputs are those which are traditionally used in the production, namely *Labor* and *Capital*. *Labor* is approximated by Personal Expenses, and Fixed Assets represent the *Capital*. Table 2 presents average values of inputs and outputs, in thousands of USD, for UEMOA and CEMAC from 2007 to 2013. The average values of inputs and output suggest that banks in UEMOA are bigger than CEMAC ones. Over 2007-2013, the collected deposits and the granted loans are broadly high in UEMOA, compared to CEMAC. Both Personal Expenses and Fixed Assets are higher in UEMOA than CEMAC, almost the double. Overall, we also notice that banks in UEMOA and CEMAC collect more deposits than they don't grant loans. In fact, the granted loans are barely one third of the borrowed funds.

Environmental variables are provided by World Bank Indicators and World Bank's Worldwide Governance Indicators (WGI). The Worldwide Governance Indicators (WGI) are a research dataset summarizing the views on the quality of governance provided by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries. These data are gathered from a number of survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms (Kaufmann and al, 2010). To properly select our environmental variables, we have begun with sixteen variables, and then we decided to retain only five which were the most significant. These five variables are: *income, financial development, strength of legal right index, index for*

enforcement of contracts, and *regulatory quality*. The first four variables are those which have been extracted from World Bank, while the latest is from Worldwide Governance Indicators (WGI). Descriptive statistics about these variables are presented in table 3.

The *Income* variable is represented by GDP per Capita. It is one of the most used variables in empirical studies and especially those related to efficiency (Dietsch and Lozano-Vivas, 2000; Chen, 2009; Kablan, 2009b). In our context, *Income* is a key variable because it could be a major determinant for bank loans and deposits level. In some way, the demand of banking services depends on the level of income. Moreover a high level of income should be associated with a more developed banking system. The figures in Table 3 show that on average the income level is higher in CEMAC than UEMOA. The difference is huge: on average, over 2007-2013 period, the income in CEMAC countries is about USD 3,622 per capita versus USD 852 in UEMOA countries. This difference is mainly due to Gabon. Indeed, this CEMAC country has a high level of income (USD 10,020) because it is among the biggest oil producers in Africa. In addition, Gabon has the lowest population in the sample: on average 1.75 million. Thus, this country has an amplifying effect on average income in CEMAC. Thereby, CEMAC countries are not homogenous in terms of income level, as the highest income is about USD 10,020 per capita (in Gabon) and the lowest income level is registered in Central African Republic with USD 455 USD (World Bank, 2013). UEMOA countries are poorer than CEMAC ones. These countries are predominantly exporters of agricultural products, but climatic risk is a hindrance to their export earnings. Some countries also have mineral resources such as gold (Mali, Burkina Faso) and uranium (Niger). Only Ivory Coast and Senegal have more than USD 1,000 of income. The remaining countries have almost the same level of income except Niger with the lowest one (USD 367). Regarding the income level, UEMOA countries are more homogeneous than CEMAC ones.

To determine *financial development*, we use a traditional indicator namely domestic credit to private sector in percentage of GDP (Credit to private sector/GDP). This variable has been used by Chen (2009)[14] on efficiency assessment in Sub-Saharan African middle-income countries. He found a positive impact with banking efficiency. A higher level of financial development could potentially improve bank performance and efficiency. On average the level of financial development is about 20.34% in UEMOA area versus 9.51% in CEMAC one (Table 3). The whole UEMOA countries have a level of financial development higher

[14] Chen (2009) used Deposits to GDP rather than Credits to GDP.

than 10%. Contrary, in the CEMAC area only Cameroon and Gabon have a level of financial development reaching 10%. Especially in Chad the financial depth is extremely low, about 4% (World Bank, 2013). Regarding the financial development, the UEMOA countries are more dynamic than CEMAC ones. Indeed, as stated before, they have a common stock exchange (the *BRVM*) while in CEMAC the same initiative is hampered by leadership rivalry between Cameroon and Gabon.

The *Strength of Legal Right Index is* also considered in our estimates because it plays an important role in regulating lenders and borrowers relationship. According to World Bank, the *Strength of Legal Right Index* "measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index ranges from 0 to 12, with higher scores indicating that these laws are better designed to expand access to credit." Basically, the UEMOA and CEMAC countries have inherited an institutional transfer from France during colonization. Thus, their legal systems are close (Bruyas, 2008). However, in order to attract investors, these countries have implemented some changes in their laws during the last decades. These changes are related to collateral and bankruptcy laws. Therefore some significant differences exist between UEMOA and CEMAC countries concerning the strength of legal rights. In this context, this variable could be important in our approach.

The *Index for Enforcement of Contracts* is defined by the number of procedures. It is "the number of independent actions, mandated by law or courts that demand interaction between the parties of a contract or between them and the judge or court officer" (World Bank, 2013). Countries which have a low number of procedures have the best effectiveness in terms of enforcing a contract. Conversely in countries with high number of procedures, the court system is slow and the plaintiff has to wait a long time before to get actual payment after filing a dispute. On average, in CEMAC countries, the number of procedures for enforcement a contract is 42 (table 3). This number is quite homogeneous for all the countries within the area, with the lowest number of procedures in Gabon (38) and the highest in Central African Republic (43) and Republic of Congo (44). In UEMOA, on average, plaintiff has to go through 38 procedures before getting actual payment after filing a dispute. However, there are differences across countries: in Ivory Coast the number of procedures is 33, while it is almost 44 in Senegal (World Bank, 2013). Overall, the index for enforcement of contracts is low in both zones, as the number of procedures is high.

The fifth and last variable which we used is *Regulatory Quality*. This variable "reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development" (Kaufmann and al, 2010). The indicator is ranged from -2.5 (weak) to 2.5 (strong). Overall, regulatory quality is weak in both zones, as it is on average -0.55 in UEMOA and -0.91 in CEMAC. All the countries within the two areas have a non-positive rating, below zero (World Bank, 2013). These rating are consistent with 2013 Doing Business Report where UEMOA and CEMAC countries are classified in the 50 worst performing countries in the world. A high level of regulatory quality potentially allows bank to evolve through an attractive environment. Therefore, this should have a positive impact on their efficiency.

Regarding the environmental variables, all the indicators are weak for both zones, but they seem to be more favorable in UEMOA than CEMAC. Indeed, except for income, all the indicators are higher in UEMOA.

6. Results

We present our results in this section. Given our methodology, we first present estimates on UEMOA and CEMAC estimating separate frontiers (6.1), and then for a common frontier (6.2). We conclude this section by determining the most important variables in explaining the gap of efficiency in lending production (6.3).

6.1. Results on separate frontiers

6.1.1. Results on the UEMOA regional frontier

The production function is first estimated for each zone by supposing that the efficiency is determined by banking technology only. So, implicitly we suppose that the environment in which banks operate does not matter. The average technical efficiency (TE1) for the UEMOA countries without environmental variables is 0.8306 (Table 6). This value is high and allows us to say that on their regional frontier, banks in UEMOA are efficient in terms of lending. In a previous study, Kablan (2009a) find that the average technical efficiency for the UEMOA Banks is 0.67. However, the covered period was 1996-2004, and a cost function was estimated rather than a production function.

Before controlling for the environment, we tested the homogeneity through each zone by introducing dummy variables for each country within each area. This estimate investigates the impact of countries' effects on efficiency. The idea is that the results could give us a first impression of the environment impact on efficiency. Indeed, if countries' effects are significant for the UEMOA resp. the CEMAC, there is a presumption that the environmental variables would also have to influence the efficiency. To some extent, the country effect is here assimilated to an aggregated environmental index for a given country. We observe that there are no countries effects in UEMOA (Table 4). These first results allow us to conclude that the UEMOA countries have more or less the same characteristics in terms of lending technology.

Then, we introduce the impact of environment in a final estimate because as Dietsch and Lozano-Vivas (2000), we consider the environment as an important factor in explaining the differences of loan production. Indeed, as banks evolve in an environment, this environment should influence their activities and so, their efficiency. Regarding the results for the UEMOA regional frontier, we observe that none of the five variables is significant, except the Strength of Legal Right Index (Table 5). This result is consistent with our previous finding concerning the fact that there is no country effect on banking efficiency in the UEMOA. Moreover, the technical efficiency level is 0.8403 versus 0.8306 previously. The difference is just 0.0097 (Table 6). Thus, by controlling for the environmental conditions, we find that in the UEMOA the difference in efficiency score is almost constant. In addition, this difference is not statistically significant at the 1% confidence level.

All these results suggest that the UEMOA countries are homogeneous. The banking technology is similar through the zone. In others words, the operating conditions seem to be the same for each bank whatever the country. Thus, Countries within the UEMOA seem to have very close characteristics in terms of banking technology as well as governance practices. In some way, our results confirm those of Sy (2007) who found that financial integration in the UEMOA area is well advanced when it comes to markets participants facing the same rules. Moreover, Diarra (2014) also finds that the UEMOA countries are convergent with regard to total outstanding debt and tax pressure. In 2013[15], among the first four convergence criteria in force, three was respected by all the eight UEMOA countries. Then,

[15] See International Monetary Fund (IMF) report (2013) concerning the UEMOA countries.

the UEMOA countries have begun their convergence and this is already noticeable in the banking sector.

To summarize, in UEMOA, the efficiency of banks, in terms of lending, is more related to bank management, i.e. the way banks combine their inputs to produce outputs. Moreover, the implemented policies in the context of financial integration seem to be effective as the countries within the area are homogeneous.

6.1.2. Results on the CEMAC regional frontier

The results for the CEMAC regional national frontier, without environmental variables, show that on average, banks have 0.7807 of technical efficiency level (Table 9). This efficiency score is not high. CEMAC banks' still have scope to improve their efficiency. Moreover, the technical efficiencies are heterogeneous within the area. For instance, the difference between the country with the highest efficiency level (0.8605 for Central African Republic), and the country with the weakest one (0.6814 for the Republic of Congo) is 17.91% (Table 9). The average standard deviation is 12.92%. Then, we take a look at country effects. Unlike the UEMOA case, all the countries dummies are significant, suggesting that there are some differences between CEMAC's countries (Table 7). In some way, this result confirms our previous findings concerning the heterogeneity within the CEMAC zone. Moreover, the results also give the trend on the behavior of environmental variables. Indeed, as the countries' effects matter, the inclusion of environmental variables in estimating the efficient frontier should influence the levels of technical efficiency in CEMAC countries.

By taking into account the environmental conditions in CEMAC, we find that the average technical efficiency reaches 0.8204. Previously, without environmental variables, the level was 0.7807 (Table 9). The difference is about 4%, and is statistically significant at the 1% confidence level. For the UEMOA regional frontier, the difference was 0.97% only, but also non-significant. Thus these results point out the heterogeneity of the CEMAC zone. Within the area, countries don't have the same characteristics so that banks operate in different environments. The financial integration seems to be limited between countries through the zone.

Considering the environmental variables, four of them are significant (Table 8). Only the Regulatory Quality is not significant. The Income variable appears with a negative sign in our

regressions. Financial development has a positive impact on CEMAC banks efficiency. This result was expected. A high level of financial depth contributes to more performance and efficiency. The result is also consistent with Chen (2009) in the case of cost efficiency. The index for enforcement of contracts has the expected sign (negative). This variable represents the number of procedure to enforce a contract. A high level of the Index for enforcement of contracts tends to reduce technical efficiency. The Strength of legal right index, which measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending, has a negative sign.

To conclude this part on CEMAC regional frontier, two main results can be outlined: countries within the zone are heterogeneous, and the institutional variables determine banking efficiency in terms of lending.

6.2. Results on a common frontier

However, as we were considering regional frontiers, the previous results do not allow comparing efficiency levels and the impact of institutional variables on UEMOA and CEMAC banks. For this purpose, we estimate an UEMOA and CEMAC common frontier.

Results without environmental variables (Table 12) show that on average the technical efficiency is higher in the UEMOA countries (0.8252) than in the CEMAC zone (0.7492). The difference between the two zones is slightly high: 7.60%. Besides, this difference is statistically significant at the 1% confidence level (Table 13). Thus banks in UEMOA are technically more efficient than CEMAC, concerning lending activities.

Previously, on the separate frontiers, we investigated the differences between countries by introducing countries dummies. Here, we propose to capture zone effects. For this purpose, a dummy variable is set for the UEMOA Zone. Thus the reference zone is CEMAC. The results show that the dummy variable is significant at the 1% confidence level (Table 10). In some extent, this result reflects the institutional and economic differences between the two zones.

After controlling for the environment, bank efficiency level still remains higher in UEMOA than CEMAC. The average technical efficiency is now 0.8324 for UEMOA banks versus 0.8270 for CEMAC ones (Table 12). The average gap between the two zones has reduced significantly, falling now to 0.54% versus 7.60% previously. The gap does not only decrease,

but it also became statistically non-significant (Table 13). By controlling for the environmental effects of each zone, in some way we set a comparable basis. This process allows highlighting the fact that banking efficiency in terms of lending is strongly sensitive to institutional framework. In addition, we find an increase on efficiency level in both zones. In UEMOA zone, the difference after having controlled for the environmental effects is 0.72%, while in CEMAC it reaches 7.78%. As on the separate frontiers, in the UEMOA zone, this difference is non-significant, while in the CEMAC zone, there is significance at the 1% confidence level. The increase is higher in CEMAC than UEMOA suggesting that the effects of environment in banks' efficiency are more important in CEMAC. But, as emphasized in section 5, even if the environmental indicators are weak for both zones, they are more favorable in UEMOA. Thus, as Dietsch and Lozano-Vivas (2000), we can conclude that, the less environmental conditions are favorable, the greater are the improvement in efficiency levels once having controlled for environmental differences.

Concerning the set of environmental variables, they are all significant at the 1% confidence level, except the *regulatory quality*. Moreover, the signs are consistent with those observed on CEMAC countries' regional frontier. The income, the index for enforcement of contracts, and the Strength of legal rights index tend to influence negatively lending production in UEMOA and CEMAC. Then a high financial development is beneficial for banks technical efficiency.

To summarize, with or without environmental variables, banks in UEMOA are more efficient than CEMAC ones in terms of lending. But the gap between the two zones reduces significantly when we control for the environment, suggesting that to proper compare efficiency level between two countries or groups of countries, we have to define the best common frontier by taking into account the impact of their respective and specific environment. Moreover, the results also point out that the impact of environment in more important in CEMAC than UEMOA. More the environmental variables are unfavorable; greater is the increase in efficiency level after controlling for the environment.

6.3. Explaining the gap of efficiency in lending production: which variables are the most determinant?

The results, both on separate and common frontiers, show that in the UEMOA and the CEMAC, the institutional variables play an important role in determining the technical efficiency levels. The knowledge of the particular influence of each of these variables could

be useful to make recommendations for the reform of institutional framework. In this last section, we try to determine the influence and the weight of each variable in the difference in technical efficiency between the frontiers without and with these environmental variables. The following model is estimated:

$$Diff\_TE_i = \alpha + \sum_{i=1}^{5} \beta_i EV_i + \varepsilon_i \quad (12)$$

With EV_i, the set of five Environmental Variables used through the regressions; TE_{iWith} ($TE_{iWithout}$) is the technical efficiency level *with* (*without*) environmental Variables; $Diff\_TE_i$ is the difference in technical efficiency between the frontiers given by:

$$Diff\_TE_i = TE_{iWith} - TE_{iWithout} \quad (13)$$

We split the set of variables in two parts: *Income* and *Financial Development* are classified as Macroeconomic variables, while *Regulatory Quality*, *Index for Enforcement of Contracts, and Strength of Legal Rights Index* are grouped as Legal Framework variables. Thus, three kinds of model are estimated (Table 14). First, the model is estimated with macroeconomic variables only, then we estimate the model supposing that the gap is explained by only legal framework variables, and to finish, the whole model is estimated by taking into account all the five variables.

We begin our analysis with this latest. It is the most complete as it takes into account all the two sides of the environment: the macroeconomic conditions and the legal framework. All the variables are statistically significant. Throughout our regressions, efficiency was measured as the capacity of the banks to produce the maximum of credits, given the inputs. Considering the legal framework variables, the strength of legal right index and, the index for enforcement of contract, influence positively the technical efficiency. A high level of both variables is associated with an increase in credit production. The production of credit is better when banks perform in an environment where the legal rules are powerful and guaranteed, all things being equal. The regulatory quality has a negative sign. Thus, a weak regulatory quality tends to increase banks efficiency, i.e. their ability to produce credits, given the inputs and others institutional variables. The inclusion of the regulatory quality has an important effect on the measure of the technical efficiency, especially when its level is low. Banks tend to grant more credit when they evolve in an environment where the regulation is not strict.

Concerning the macroeconomic variables, the income and the financial development both have an impact on banks efficiency in terms of lending. In countries with a high level of

income, banks perform high level of credits. The financial development has a negative sign, suggesting that the technical efficiency is positively influenced in countries where this variable is weak. This could partially explain the fact that the increase of efficiency level is more important in CEMAC after controlling for the environment. As a reminder, the financial depth is about 10% in CEMAC versus 20% in UEMOA countries (IMF, 2013; IMF, 2016)[16].

In the second model, the implicit assumption is that the gap of efficiency scores in lending production is exclusively related to the legal framework. The results are consistent with the former: all the variables are significant at the 1% confidence level. The strength of legal right index and the index for enforcement of contract are positive, while the regulatory quality is negative. With regard to partial correlations, the Regulatory Quality appears as the most important factor in explaining the dependant variable. Indeed, the squared partial correlation related to Regulatory Quality is the highest, either about 16%, while it is respectively about 8% and 3% for the Strength of Legal Rights Index and the Index for Enforcement of Contracts.

The first model explains the gap of efficiency scores in lending production by macroeconomic variables. The financial development and the income are all significant at the 1% confidence level, confirming findings in model 3. The highest level of partial correlation is reached by the income variable (46%), while the financial development is limited to 14%.

7. Conclusion

Following Dietsch and Lozano (2000), we investigate the influence of environment on banking efficiency. Our analysis focuses on two SSA regional organizations: the CEMAC and UEMOA. For the estimates, the SFA is applied to a translog production function.

First we conduct the estimates on each UEMOA and CEMAC regional frontier. We find that in both zones, banks are efficient even if they can perform better. In the UEMOA, our results suggest that countries have very close characteristics. The financial integration seems to be well advanced as we found that countries are homogeneous within the zone. In contrast, on the CEMAC regional frontier, we observe heterogeneity between countries.

[16] We find the same results in our descriptive statistics (See Table 3)

In order to be able to compare between the two zones, a common frontier is estimated. The results indicate that, whether with or without environmental variables, the UEMOA banks are more efficient than CEMAC ones, in terms of lending. However, after having controlled for the effects of environment, the gap between the two zones has reduced significantly, becoming statistically non-significant. This result points out the importance of environment on banking efficiency. Overall, the environment has had a more important impact on technical efficiency in CEMAC than UEMOA. This result is consistent with Dietsch and Lozano (2000), confirming that the less environmental conditions are favorable, the greater are the improvement in efficiency levels once having controlled for the environmental differences.

The environmental variables play an important role in determining the efficiency level in UEMOA and CEMAC. The legal framework variables, such as the strength of legal rights index, the index for enforcement of contacts have a positive impact on technical efficiency. We found that a high level of both variables is associated with an increase in loans production. The regulatory quality also determines banks efficiency especially when its level is low. Concerning macroeconomic variables, countries with the highest income grant high level of credits, while banks tend to be more efficient in countries where the financial depth is weak.

Overall, the paper point out the importance of the institutional framework on banking efficiency. The institutional variables influence significantly the production of loan in CEMAC and UEMOA. Given the importance of lending activities, especially in SSA countries, it is the responsibility of the leaders to take on the necessary reforms in order to set up a favorable institutional environment for the banks.

Table 1
Distribution of the Sample

This table provides the number of Banks for each Zone, and each country in the sample.

Zone/ Country	Number of Banks
CEMAC	**33**
Cameroon	12
Central African Republic	2
Chad	4
Republic of Congo	7
Gabon	8
UEMOA	**73**
Benin	9
Burkina Faso	9
Ivory Coast	19
Mali	10
Niger	5
Senegal	10
Togo	11

Table 2
Desciptive Statistics for Inputs and Outputs [CEMAC and UEMOA]

This table provides main descriptive statistics for Inputs and Outputs in UEMOA and CEMAC
All variables are in thousands of USD

Variables	Definition	N	Mean	Std Dev	Minimum	Maximum
CEMAC						
Y : Loans	Total Loans	124	303008.59	582132.56	918.2166341	4437432.92
X1: Labor (L)	Personnal Expenses	121	9442.05	12787.15	910.0232316	94003.67
X2: Physical Capital (K)	Fixed Assets	122	13172	16841.84	283.3072718	110057.8
X3: Borrowed Funds (F)	Borrowed Funds	115	970043.79	1669841.01	25612.61	10648842.46
UEMOA						
Y : Loans	Total Loans	327	388052.55	1011403.28	44.8020802	11421600
X1: Labor (L)	Personnal Expenses	300	15784.4	59115.69	3.0171191	641100
X2: Physical Capital (K)	Fixed Assets	323	29035.36	91116.21	2.5642999	872100
X3: Borrowed Funds (F)	Borrowed Funds	319	1153227.58	3220403.02	216.7630056	34364800

Table 3
Descriptive Statistics for environment Variables [CEMAC and UEMOA]

This table provides descriptive statistics for Environment variables in CEMAC and UEMOA. Income values are in thousands of USD. Strenght of legal Rights Index is ranged from 0 (weak) to 12 (strong). Index for Enforcement of Contracts represents the number of procedures to enforce a contract. Regulatory Quality is ranged from -2,5 (weak) to 2,5 (strong).

Variables	Definition	N	Mean	Std Dev	Minimum	Maximum
CEMAC						
Income	GDP per Capita	231	3621.61	3781.54	333.1968806	11791.59
Financial Development	Credit/GDP	231	9.5074176	3.6420108	2.2673205	14.9305322
Strenght of Legal Rights Index	Strenght of Legal Rights Index	231	4.1818182	1.4690483	3	6
Index for Enforcement of Contracts	Index for Enforcement of Contracts	231	41.6536797	2.2518537	38	44
Regulatory Quality	Regulatory Quality	231	-0.9123254	0.2683813	-1.3783001	-0.5074239
UEMOA						
Income	GDP per Capita	511	851.9726706	335.820667	302.2664078	1528.94
Financial Development	Credit/GDP	511	20.3427604	5.0553911	9.3315142	33.0372769
Strenght of Legal Rights Index	Strenght of Legal Rights Index	511	4.2857143	1.4860698	3	6
Index for Enforcement of Contracts	Index for Enforcement of Contracts	511	38.1272016	3.8767107	32	44
Regulatory Quality	Regulatory Quality	511	-0.5474438	0.2925618	-0.9955416	-0.0626616

Table 4
Stochastic Frontier Production Estimate (UEMOA)

This table displays stochastic frontier production results in UEMOA.
***, **, * denotes coefficients that are statiscally significant at 1%, 5% and 10% level.
[1] represents the model without environment variables, and [2] the model with country effects.
The Reference Country in [2] is Ivory Coast

Variables	**[1]**		**[2]**	
	Coef.	**Std. Dev.**	**coef.**	**Std. Dev.**
Intercept	2.120	3.117	1.823	3.157
Labor (L)	1.419***	0.502	1.132**	0.531
Physical Capital (K)	-0.347	0.735	-0.193	0.733
Financial Capital (F)	0.036	0.861	0.174	0.867
LL	0.995***	0.216	1.031***	0.216
LK	-0.807***	0.298	-0.839***	0.298
LF	-0.925***	0.168	-0.902***	0.168
KK	-0.006	0.055	-0.010	0.056
KF	0.600***	0.234	0.607***	0.234
FF	0.139	0.110	0.115	0.110
Benin			0.061	0.083
Burkina Faso			-0.039	0.087
Mali			-0.056	0.082
Niger			0.056	0.108
Senegal			0.101	0.077
Togo			-0.082	0.086
Sigma V	0.302***	0.020	0.298***	0.021
Sigma U	0.209***	0.032	0.207***	0.033
Obs.	255		255	
Log Likehood	-106.682		-103.38874	
Dependant Variable : Loans				

Table 5

Stochastic Frontier Production Estimate (UEMOA)

This table displays stochastic frontier production results in UEMOA, with environment variables.
***, **, * denotes coefficients that are statiscally significant at 1%, 5% and 10% level.

Variables	Coefficients	Standard Error
Intercept	5.208	3.389
Labor (L)	1.367***	0.522
Physical Capital (K)	0.232398	0.738
Financial Capital (F)	-0.986	0.905
LL	0.938469	0.216
LK	-0.820***	0.298
LF	-0.833***	0.165
KK	0.001***	0.055
KF	0.506101	0.235
FF	0.225**	0.114
Income	0.121	0.075
Financial Development	-0.011	0.009
Strenght Of Legal Rights Index	-0.053***	0.020
Index For Enforcement Of Contracts	0.014	0.011
Regulatory Quality	0.107	0.098
Sigma V	0.295***	0.021
Sigma U	0.195***	0.033
Obs.	255	
Log Likehood	-96.7294	
Dependent Variable : Loans		

Table 6

Technical Efficiencies in UEMOA

This table displays Technical Efficiencies in UEMOA, with and without Environment Variables.
Two kinds of Technical Efficiencies have been estimated : TE1 (Battese and Coelli, 1988) and TE2 (Jondrow et al. 1982).
Standard Deviation are given in brackets.

	Without Environment Variables (1)		**With Environment Variables (2)**		**Difference [(2)-(1)]**	
	TE1	TE2	TE1	TE2	TE1	TE2
Zone UEMOA	**0.8306 (0.092)**	**0.8216 (0.095)**	**0.8403 (0.0855)**	**0.8320 (0.088)**	**0.0097**	**0.0104**
Benin	0.8438	0.8351	0.8465	0.8381	0.0028	0.0031
Burkina Faso	0.8298	0.8201	0.8382	0.8293	0.0084	0.0092
Ivory Coast	0.8382	0.8169	0.8295	0.8213	-0.0088	0.0044
Mali	0.8393	0.8302	0.8513	0.8433	0.0120	0.0131
Niger	0.8529	0.8449	0.8627	0.8556	0.0098	0.0107
Senegal	0.8542	0.8464	0.8501	0.8422	-0.0041	-0.0042
Togo	0.7894	0.7791	0.8171	0.8083	0.0278	0.0292
Obs. 255						
TE1 : Battese and Coelli (1988)						
TE2 : Jondrow et al. (1982)						

Table 7

Stochastic Frontier Production Estimate (CEMAC)

This table displays stochastic frontier production results in CEMAC.

***, **, * denotes coefficients that are statiscally significant at 1%, 5% and 10% level.

[1] represents the model without environment variables, and [2] the model with country effects.

The Reference Country is Central African Republic

Variables	**[1]**		**[2]**	
	Coef.	**Std. Dev.**	**coef.**	**Std. Dev.**
Intercept	11.799***	4.493	1.531	5.488
Labor (L)	1.924	1.268	0.940	1.328
Physical Capital (K)	0.092	0.778	0.704	0.818
Financial Capital (F)	-2.164*	1.152	-0.453	1.257
LL	-0.081	0.246	0.502	0.337
LK	0.023	0.391	-0.184	0.378
LF	-0.182	0.186	-0.673***	0.235
KK	0.037	0.069	0.155**	0.070
KF	-0.070	0.287	-0.188	0.278
FF	0.304***	0.082	0.392***	0.079
Cameroon			-0.5***	0.185
Chad			-0.347*	0.180
Republic of Congo			-0.786***	0.181
Gabon			-0.58***	0.219
Sigma V	0.258***	0.033	0.259***	0.030
Sigma U	0.295***	0.054	0.224***	0.051
Obs.	98		98	
Log Likehood	-43.215		-32.3138	
Dependant Variable : Loans				

Table 8

Stochastic Frontier Production Estimate (CEMAC)

This table displays stochastic frontier production results in CEMAC, with environment variables.
***, **, * denotes coefficients that are statiscally significant at 1%, 5% and 10% level.

Variables	Coefficients	Standard Errors
Intercept	12.742***	4.316
Labor (L)	1.385754	1.254
Physical Capital (K)	0.129705	0.771
Financial Capital (F)	-1.161161	1.115
LL	0.228855	0.323
LK	-0.064399	0.354
LF	-0.462**	0.219
KK	0.127*	0.067
KF	-0.142762	0.253
FF	0.356***	0.077
Income	-0.202***	0.057
Financial Development	0.041**	0.017
Strenght Of Legal Rights Index	-0.0602*	0.036
Index For Enforcement Of Contracts	-0.120***	0.034
Regulatory Quality	-0.480837	0.304
Sigma V	0.252***	0.029
Sigma U	0.227***	0.048
Obs.	98	
Log Likehood	-31.322	
Dependent Variable : Loans		

Table 9

Technical Efficiencies (CEMAC)

This table displays Technical Efficiencies in CEMAC, with and without Environment Variables.
Two kinds of Technical Efficiencies have been estimated : TE1 (Battese and Coelli, 1988) and TE2 (Jondrow et al. 1982).
***,**,* denotes that the difference in means is significant at 1%, 5% and 10%.

	Without Environment Variables (1)		**With Environment Variables (2)**		**Difference [(2)-(1)]**	
	TE1	TE2	TE1	TE2	TE1	TE2
Zone CEMAC	**0.7807 (0.1292)**	**0.7705 (0.1320)**	**0.8204 (0.1061)**	**0.8120 (0.1085)**	**0.0397****	**0.0415****
Cameroon	0.8026	0.7927	0.8145	0.8054	0.0118	0.0127
Central African Republic	0.8605	0.8537	0.8634	0.8568	0.0028	0.0031
Chad	0.8143	0.8046	0.8063	0.7967	-0.0079	-0.0079
Gabon	0.7844	0.7745	0.8303	0.8221	0.0459	0.0476
Republic of Congo	0.6814	0.6686	0.7996	0.7917	0.1182	0.1231
Obs. 98						
TE1 : Battese and Coelli (1988)						
TE2 : Jondrow et al. (1982)						

Table 10

Stochastic Frontier Production in CEMAC and UEMOA

This table displays stochastic frontier production results in CEMAC and UEMOA common frontier.
***, **, * denotes coefficients that are statiscally significant at 1%, 5% and 10% level.
[1] represents the model without environment variables, and [2] the model with environment zone effects.
The Reference Zone is the CEMAC

Variables	**[1]**		**[2]**	
	Coef.	**Std. Dev.**	**coef.**	**Std. Dev.**
Intercept	4.295*	2.195	7.070***	2.045
Labor (L)	1.83***	0.452	1.285***	0.422
Physical Capital (K)	-0.551031	0.442	0.518072	0.435
Financial Capital (F)	-0.473873	0.554	-1.332**	0.519
LL	0.699***	0.161	0.689***	0.144
LK	-0.622***	0.210	-0.678***	0.188
LF	-0.744***	0.127	-0.598***	0.117
KK	0.030047	0.042	0.007292	0.039
KF	0.471***	0.154	0.361**	0.141
FF	0.169**	0.067	0.226***	0.061
UEMOA			0.378***	0.049
Sigma V	0.0195***	0.019	0.311***	0.016
Sigma U	0.031***	0.030	0.224***	0.027
Obs.	353		353	
Log Likehood	-188.057		-161.282	

Dependant Variable : Loans

Table 11

Stochastic Frontier Production in CEMAC and UEMOA

This table displays stochastic frontier production results in CEMAC and UEMOA common frontier, with environment variables.

***, **, * denotes coefficients that are statiscally significant at 1%, 5% and 10% level.

Variables	Coefficients	Standard Errors
Intercept	10.488***	2.095
Labor (L)	1.68***	0.414
Physical Capital (K)	0.380859	0.419
Financial Capital (F)	-1.759***	0.514
LL	0.731***	0.146
LK	-0.744***	0.189
LF	-0.669***	0.115
KK	0.016285	0.038
KF	0.409***	0.140
FF	0.270***	0.062
Income	-0.137***	0.029
Financial Development	0.0127***	0.004
Strenght Of Legal Rights Index	-0.067***	0.015
Index For Enforcement Of Contracts	-0.017***	0.006
Regulatory Quality	0.079	0.077
Sigma V	0.305***	0.016
Sigma U	0.209***	0.026
Obs.	353	
Log Likehood	-149.54302	
Dependent Variable : Loans		

Table 12

Technical Efficiencies in CEMAC and UEMOA on a Common Frontier

This table displays Technical Efficiencies in UEMOA, with and without Environment Variables.
Two kinds of Technical Efficiencies have been estimated : TE1 (Battese and Coelli, 1988) and TE2 (Jondrow et al. 1982).
***,**,* denotes that the difference in means is significant at 1%, 5% and 10%.

	Without Environment Variables		With Environment Variables		Difference [(2)-(1)]	
	TE1	TE2	TE1	TE2	TE1	TE2
Zone UEMOA + CEMAC	**0.8041**	**0.7927**	**0.8309**	**0.8218**	**0.0268*** **	**0.0291*** **
Zone UEMOA	**0.8252 (0.0841)**	**0.8151 (0.0873)**	**0.8324 (0.0850)**	**0.8233 (0.0880)**	**0.0072**	**0.0083**
Benin	0.8360	0.8262	0.8407	0.8316	0.0047	0.0055
Burkina Faso	0.8286	0.8182	0.8196	0.8090	-0.0091	-0.0092
Ivory Coast	0.8144	0.8045	0.8315	0.8232	0.0171	0.0187
Mali	0.8242	0.8134	0.8329	0.8232	0.0087	0.0099
Niger	0.8500	0.8414	0.8589	0.8514	0.0089	0.0100
Senegal	0.8449	0.8359	0.8551	0.8474	0.0102	0.0115
Togo	0.7927	0.7810	0.7935	0.7827	0.0008	0.0017
Zone CEMAC	**0.7492 (0.1239)**	**0.7343 (0.1276)**	**0.8270 (0.0981)**	**0.8177 (0.1004)**	**0.0778*** **	**0.0834*** **
Cameroon	0.7886	0.7751	0.8297	0.8199	0.0411	0.0449
Central African Republic	0.8342	0.8242	0.8732	0.8668	0.0390	0.0426
Chad	0.7717	0.7569	0.8369	0.8276	0.0652	0.0706
Gabon	0.7242	0.7077	0.8361	0.8268	0.1118	0.1191
Republic of Congo	0.6669	0.6491	0.7801	0.7698	0.1132	0.1207
Obs. 353						

TE1 : Battese and Coelli (1988)
TE2 : Jondrow et al. (1982)

Table 13

Technical Efficiencies in UEMOA and CEMAC on a Common Frontier

This table displays the results of Student test performed on difference in means between efficiency scores with and without environmental variables. ***,**,* denotes that the difference in means is significant at 1%, 5% and 10%.

	Zone UEMOA (1)		Zone CEMAC (2)		Difference [(1)-(2)]	
	TE1	TE2	TE1	TE2	TE1	TE2
Without Environment Variables	**0.8252 (0.0841)**	**0.8151 (0.0873)**	**0.7492 (0.1239)**	**0.7343 (0.1276)**	**0.0760*** **	**0.0808*** **
With Environment Variables	**0.8324 (0.0850)**	**0.8233 (0.0880)**	**0.8270 (0.0981)**	**0.8177 (0.1004)**	**0.0054**	**0.0056**

Table 14

Regressions of Efficiency Level differences on CEMAC and UEMOA Common Frontier

This table presents regressions of efficiency level differences on CEMAC and UEMOA common frontier, after controlling for environment. ***, **, * denotes coefficients that are statiscally significant at 1%, 5% and 10% level.
Standard errors are in brackets. [1] the model is estimated with macroeconomics variables
[2] the model is estimated with Legal Framework Variables , [3] the whole model is estimated

Variables	[1]		[2]		[3]	
	Coef.	Partial Corr.	Coef.	Partial Corr.	Coef.	Partial Corr.
Intercept	-0.16837***		-0.1246		-0.2807***	
	(0.018)		(0.0247)		(0.022)	
Macroeconomic Variables						
Income	0.0331***	0.4646			0.0276***	0.4646
	(0.0023)				(0.002)	
Financial Development	-0.002***	0.1418			-0.0028***	0.1418
	(0.0003)				(0.0003)	
Legal Framework Variables						
Strenght of Legal Rights Index			0.0097***	0.0797	0.0109***	0.1909
			(0.0015)		(0.0011)	
Index for Enforcement of Contracts			0.002***	0.03401	0.0029***	0.1442
			(0.0006)		(0.0004)	
Regulatory Quality			-0.0533***	0.1596	-0.0088*	0.0082
			(0.0066)		(0.0052)	
Obs.	353		353		353	
F	205.83***		32.38***		150.5***	
Adj. R^2	0.5379		0.2414		0.6798	

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