African Economic and Monetary Union (WAEMU)

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Abstract

This paper measures the efficiency of WAEMU banks and its determining factors, after the banking system reforms from 1993 to 1996. Data envelopment analysis (DEA) was used for assessing technical efficiency and a stochastic frontier analysis (SFA) for cost efficiency. Results suggest similar evolutions for the two types of efficiency for all WAEMU countries except Côte d'Ivoire and Burkina Faso. A detailed analysis per banking shareholder's equity group reveals that local private banks are the most efficient ones, followed by foreign and then state-owned banks. Despite the technological changes that occurred in the banking system, the Malmquist index shows that the increase of technical efficiency is much more a factor of scale efficiency change than of the incorporation of technological innovations. Lastly, WAEMU banks' efficiency is sensitive to variables like financial soundness, the ratio of bad loans per country, the banking concentration and the GDP per capita.

Acknowledgements

1. Introduction

Financial institutions are the main intermediation channels between saving and investment in a country and the financial sector plays an important role in the economic development process. The best financial systems limit, quantify, gather and negotiate all operation risks, and incite the savers to invest, by offering them a payment proportional to the scale of the incurred risks. Efficient financial intermediaries mobilize saving from diverse sources and allocate it to more productive activities, which benefits not only investors and beneficiaries of the investments, but also the whole economy (Gulde et al., 2006). Indeed, a banking system that efficiently channels financial resources to productive use is a powerful mechanism for economic growth (Levine, 1997). Since banks in Sub-Saharan Africa are the main financial intermediaries, restructuring policies have been put in place to improve their efficiency.

Especially for the West African Economic and Monetary Union (WAEMU) monetary policy has since the creation of the zone intended to favour with preferential interest rates the main sectors supposed to lead the economic growth. This policy did not yield the expected results; on the contrary, it caused the banking crisis at the end of the 1980s and early 1990s. During this period, there were about 27 bank failures throughout the whole zone (Powo Fosso, 2000). In order to solve problems of bank insolvency and lack of profitability, monetary authority initiated reforms and restructuring measures. Quantitative control of loans ended, interest rates were liberalized and an institution for banking surveillance and regulation was created: WAMU Banking Commission (La Commission Bancaire de l'UMOA) and these reforms were intended to improve efficiency in financial resources mobilization and allocation.

Indeed, bank efficiency has attracted much interest in recent years. Most of the studies were done after important changes or restructuring measures periods in banking systems (Allen and Rai, 1996; Leigthner and Lovell, 1998; Grigorian and Manole, 2002).

At the African level, Hauner and Peiris (2005) measured the efficiency of Ugandan banks to ascertain the effect of the restructuring of the banking system. Similarly, Kirkpatrick et al., 2008 conducted a study of anglophone African banks after the period of banking crises (late 1980s and early 1990s) to work out possible solutions for managers of banks in Africa, as well as bank regulators and supervisors.

Efficiency measurement determines how banks provide an optimal combination of financial services with a set of inputs. This entails asking whether a bank is capable of efficiently and technically producing financial services for economic agents. On the other hand, banks as financial companies look for profitability, but are constrained from achieving maximum profit because of regulatory restrictions (minimum reserve, capital

adequacy requirements, etc.). Bank management has substantial control over the cost of inputs, whereas the output side is beyond their control.

Our study aims at assessing both technical and cost efficiency in order to identify suitable policies for increasing the efficiency of banks so that they will be able to fully play their role of financial intermediary in the WAEMU zone. The study is organized in three parts. First, we present the WAEMU banking system and its characteristics. Second, we review the theoretical and empirical literature on the methods of efficiency measurement. Finally, we estimate and analyse banks' efficiency scores and their determinants in the WAEMU countries.

2. The WAEMU banking system

For the countries of the WAEMU zone, the 1990s were years of financial distress. Interest rate controls as well as the intervention of governments in the management of state-owned banks introduced a bias in economic criteria for credit distribution. This meant, for example, that a productive project in a non priority sector could not find funds for financing, while a non productive project in a priority sector could be financed. In such conditions, market mechanisms – which should play a regulatory role through the interest rate equilibrium by allowing good financial resource allocation within the economy— could not be effective.

The evolution of the banking system

Monetary authorities' action to resolve the banking crisis entailed restructuring the WAEMU banking system. Insolvent banks were liquidated or privatized. In the latter case, bank ownership was opened to foreign and domestic investors. In addition, a subregional regulatory institution was created in 1990: the WAEMU Banking Commission. The commission ensures the supervision of bank activities and respect for banking regulations. In addition, BCEAO (Banque Centrale des Etats de L'Afrique de l'Ouest; the WAEMU Central Bank) changed monetary policy in 1993 by shifting from administrative control of monetary regulation to market mechanisms, which are more flexible. These changes intervened at three levels: the refitting of the grid of the main interest rates, the establishment of a renovated money market, and the liberalization of banking conditions, which resulted in the suppression of several minimum rates and the removal of the upper limit on debtor conditions.

The liberalization of banking conditions is generally intended to reinforce the mobilization of domestic resources and their optimal allocation for financing the economy. Moreover, it is supposed to allow credit institutions greater room for manoeuvre in determining their costs and prices. Liberalization should also lead to a better competition within the banking system through a greater transparency in setting costs and prices of banking services. Brownbridge and Harvey (1998) found evidence that the liberalization of 1990 may have led to more vigorous competition among African banks in the areas deposits and the distribution of other services. It was not clear, however, whether liberalization improved the efficiency of loan distribution in the presence of important distortions in the other economic sectors.

Considering the reform context, we investigate the level and the determining factors of bank performance in the WAEMU zone. In order to better answer this question, we first examine the characteristics of the banking system.

Characteristics of the WAEMU banking system

There are actually 90 credit institutions formally approved in WAEMU: 70 banks and 20 financial institutions.[2] Countries with the larger number of banks are Côte d'Ivoire (16) and Senegal (10). The WAEMU banking system is concentrated; only 19 of the 70 banks are large and these hold the major market share in the zone: 62.7%. Of the others, 24 are of medium size with a 27.6% share. The 9.7% residual share is held by the 27 small banks.

As financial intermediaries WAEMU banks collect resources from economic agents who have financial excess and provide loans to those who need financing. Therefore, they propose financial products such as loans, deposits and securities. The financial intermediation of WAEMU countries evolved as shown in Figure 1. The degree of economy monetization, represented by the ratio of M2 to the gross domestic product (GDP) remained constant at around 25% between 1990 and 1994, then decreased until 1998 to 21%, before finding its initial level in 2003. The ratio is lower than the average for sub-Saharan Africa, which was approximately 29% over the period 1990–2003.[3] In the same way, the private sector credit to GDP ratio strongly decreased from 25% to 15% between 1990 and 1994, before stabilizing.[4] A more detailed analysis of the banking products (Figure 2) reveals a balance sheet structure dominated by deposits and loans, which account for 72.74% and 58%, respectively, of average banks total assets. Securities share a very small proportion of the total assets (approximately 7.7% on average) over the study period.

Figure 1: Evolution of financial intermediation in WAEMU
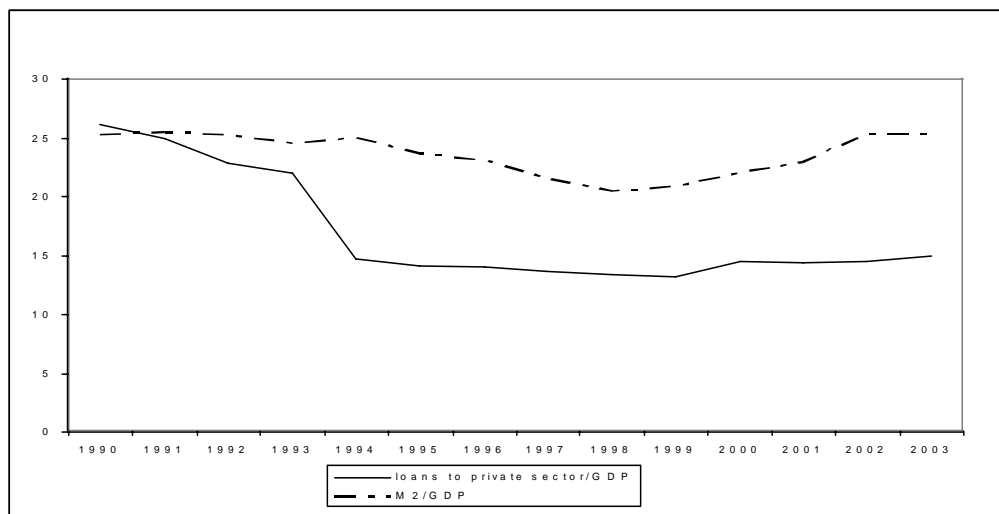
Source : Global Development Indicators and World Development Indicators.

The proportions of these products per country are more or less the same for loans and deposits, but one can observe a greater dispersion with securities: from a low of 0.06%

Figure 2: Evolution of WAEMU banking products from 1996 to 2004
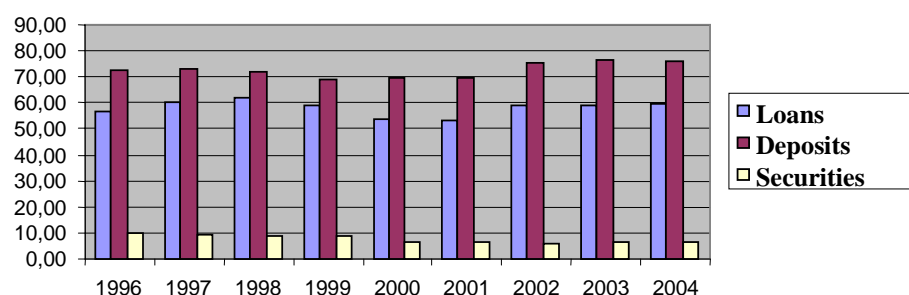
Source : "Bilans des banques et établissements financiers de l'UMOA", 1996-2004 and author calculations.

in Côte d'Ivoire to a maximum of 13% in Togo (Table 1). Bank credit from 1996 to 2004 is as follows: 5% for primary sector, 22% for industries, and 73% for services and trade. Thus, banks of the zone functioned primarily as deposit banks accompanying enterprises (mainly the services and trade sector), but rarely offered investment loans or long-term financing. As Figure 3 testifies, after the CFA franc devaluation of 1994, banks became illiquid but remained reluctant to distribute long-term loans to small and medium enterprises. Indeed, short-term loans were more than twice the level of medium- and long-term loans (approximately 70% of the total of loans granted by banks).

Table 1: Level of the principal balance sheet items expressed as a percentage of total assets of WAEMU banks in 2004

Country	Loans	Deposits	Securities
Bénin	54.53	77.64	7.24
Burkina Faso	58.45	78.67	9.48
Côte d'Ivoire	57.42	76.72	0.06
Mali	59.63	71.09	1.57
Niger	50.57	76.80	3.78
Sénégal	54.85	78.65	12.86
Togo	52.24	75.08	13.00
UMOA	59.59	76.26	6.64

Source: "Bilan des banques et"établissements financiers de l'UMOA" (2004).

The 1990s were years of technological change for WAEMU banks, with the appearance and diffusion of new information and communication technology (ICT). Within the zone, however, such technological changes have been late in becoming effective, especially compared with anglophone sub-Saharan African countries. The subsidiaries of foreign banks were the first to improve the distribution of financial service by using computers, installing automated teller machines (ATMs), providing banking cards and so on. In addition, the creation of the banking accounting plan ("plan comptable bancaire") in 1996 has had the effect of forcing banks to use computer in their activities.

Besides those technological changes, there has been a qualitative improvement in the banks' human capital. Indeed, the share of qualified staff increased from 22.5% in 1990,

to 28% in 1996 and 36.6% in 2004. Moreover, the number of bank branches increased from 394 in 1996 to 523 in 2004.

Figure 3: Evolution of short-, medium- and long-term loans in WAEMU
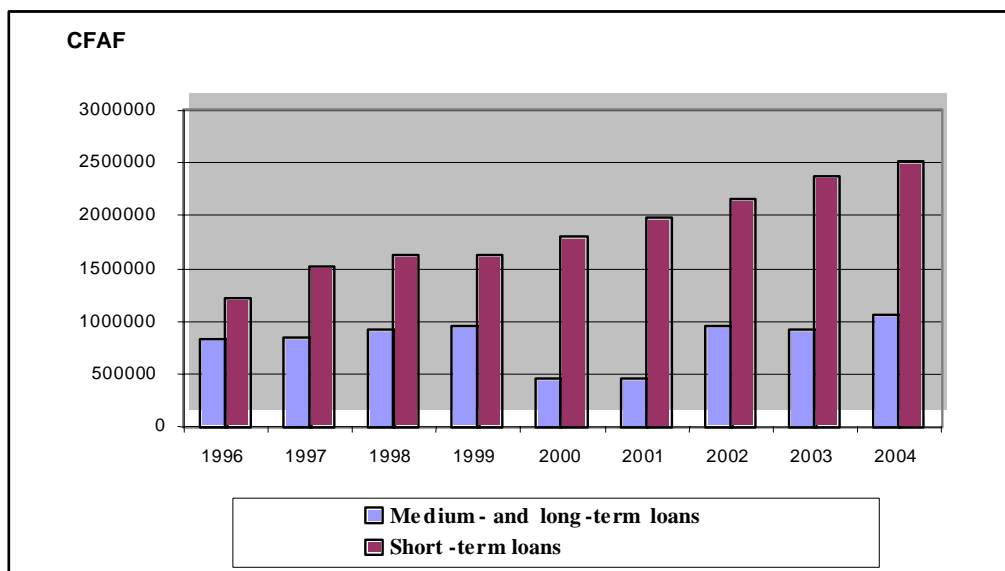
Source : Rapport de la Commission Bancaire de l'UMOA, 1996-2004.'

Besides the addition of branches of newly created bank, this rise is due to the rise in the number of branches of old banks in Benin, Burkina Faso, Mali, Niger and Senegal; the latter number decreased or stayed steady in Côte d'Ivoire and Togo, respectively.

Bank management has evolved as shown by the return on equity ratio, the net coefficient of exploitation and the raw rate of portfolio deterioration (Table 4). The ratio of net profit for the year to shareholder equity decreased from 30% to 13% between 1996 to 2004, showing a depreciation of banks' profitability. In contrast, the net coefficient of exploitation increased (from 59.6% to 66.2%), indicating an improvement of the financing of operating and depreciation expenses along with the value added created by banks. The raw rate of portfolio deterioration evolved in an almost steady way from 21.5% to 18.7%.

Figure 4: Evolution of bank management characteristics from 1996 to 2004
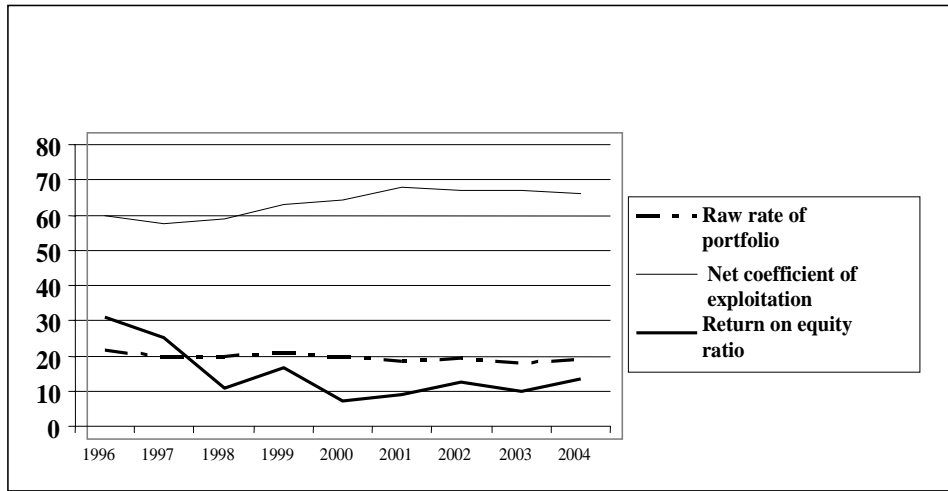
Source: Rapport de la commission bancaire de l'UMOA, 1996-2004.'

3. Literature review

The idea of efficiency of a production unit was first introduced by Farell (1957) under the concept of "input oriented measure". According to Farell, a technical efficiency measure is defined by one minus the maximum equiproportionate reduction in all inputs that still allows continuous production of given outputs. Technical efficiency is linked to the possibility of avoiding waste by producing as much output as the level of input allows (output-oriented measure), or by using as little input as possible to achieve the production objectives (input-oriented measure). This efficiency is measured by comparing observed and optimal values of production, costs, revenue, profit, etc., that the production system permits, given appropriate quantities and price constraints. Therefore, we can analyse technical efficiency in terms of deviation compared with an ideal production frontier isoquant. The literature proposes two ways of measuring frontier production: the mathematical programming approach (non parametric) and the econometric approach (parametric).

The nonparametric approach

Known as data envelopment analysis (DEA), the mathematical approach involves estimating the frontier by using non parametric mathematical linear programming. It offers an analysis based on the evaluation of the relative efficiency in an input/output multiple situation by taking into account each bank and comparing its relative efficiency with an envelopment surface made up of the best banks. This method does not allow for noise treatments.

Initially the non parametric method usually assumed constant return to scale (CRS). But recently, however, the assumption of variable return to scale (VRS) has been used in specifications because this hypothesis is more relevant in the environment of imperfect competition in which banks operate. Such an assumption is made by Grigorian and Manole (2002) to evaluate the efficiency of transition country banks from Eastern Europe, following the technological changes that occurred in the banking industry and the banking system reforms after financial liberalization. Leigthner and Lovell (1998) are also interested in the impact of financial liberalization on the efficiency of Thai banks. They lead an analysis based on profit objectives of the Thai banks, on the one hand, and on the economic growth objective of the Bank of Thailand, on the other hand. Their results show that under appropriate conditions, financial liberalization can lead to growth, whatever the analytical objective is. Moreover, the size and the nature (domestic or foreign) of banks affect the productivity, growth and productivity change measures. In the same

way, Berg et al. (1993) study the productivity of banks in Finland, Sweden and Norway in the context of increasing financial integration and banks internationalization as a result of Europe integration. They conclude that the Swedish banks are the best placed to face internationalization and financial European integration.

The parametric approach

In the econometric approach, the best practice frontier is estimated econometrically by its specification in a Cobb–Douglas, Constant Elasticity and Substitution or translogarithmic (cost or production) function. The econometric method can be deterministic, in which case every deviation from the frontier is attributed to inefficiency. It can also be stochastic, making it possible to separate random errors from production unit inefficiency. The stochastic frontier method has two principal advantages over the non-parametric DEA method. First, it allows separating random error from the production unit inefficiency and thus takes into account the existence of exogenous shocks. For this purpose, the error term is divided into two components: an inefficiency component and a random component (which is composed of the error measurement and the exogenous shocks). Second, the stochastic frontier analysis is less sensitive to inconsistent values.

Using a distance function with a translogarithmic form, English et al. (1993) found that on average US banks were inefficient after the mergers and consolidations of the US banking system in the 1990s. Allen and Rai (1996), in a comparison of international banks, apply a stochastic frontier analysis (SFA) and the distribution-free approach (DFA)[5] and show that the inefficiency level displayed by universal banks is smaller than that of separated banks. In a second step, the authors analyse the determining factors of efficiency, but they don't take environmental variables into account in their explanation of efficiency. It is this caveat that Dietsch and Lozano-Vivas (2000) addressed in their study comparing French and Spanish banks that integrated the respective country's environmental specificities into the cost frontier.

Regarding African studies on the issue, Hauner and Peiris (2005) analyse Ugandan banks' efficiency after restructuring using the DEA method. They show that the improvement of the competitiveness of Ugandan banks after the reforms could be linked to that efficiency. More specifically, their increased competitiveness led to an improvement of the efficiency of the largest and foreign banks, while smaller banks have become less efficient. Kirkpatrick et al.(2008) examine the efficiency of anglophone African banks after a period of banking crisis (1992–1999). They use the stochastic frontier approach with cost and profit functions; as a second step they explain these cost efficiencies and profits by bank-specific factors and relevant macroeconomic variables. They find that profit X-inefficiency is slightly higher than cost X-inefficiency. The latter is exacerbated by the presence of non-performing loans, higher capital ratios and financial liberalization. Conversely, it is apparent that the largest banks are most efficient and the level of penetration of foreign banks reduced X-inefficiency.

In our study, we propose to make an analysis of WAEMU banks' efficiency after the banking reforms implemented by BCEAO. The studies reviewed above will be used as a basis of comparison to find suitable methods for efficiency measurement.

4. Methodology

O ur approach entails the use of both methods of efficiency measurement – the non-parametric and the parametric. This approach is justified by the fact that the first method will enable us to specifically consider the technical aspect of production – the use of an efficient combination of inputs in order to produce a given output. The second approach permits us to measure bank efficiency with a cost objective. WAEMU banks, like any rational producers, are especially oriented towards maximizing their profit and thus, other things being equal, minimizing production costs. To this purpose, banks presenting high cost-efficiency scores will not necessarily be the most technically efficient ones.

The DEA method

T echnical efficiency analysis aims at determining whether production units use as many inputs as the production of outputs requires – and only that many. We first ask the following question: As financial intermediaries, what do banks in WAEMU countries produce? According to the financial intermediation approach,[6] banks are supposed simultaneously to hold liquid deposits without risk and to offer loans, which are risky assets and less liquid. The principle of value added stipulates that the elements that contribute to added value are regarded as outputs. Thus even if the deposits collection costs to bank; it saves some resources which should differently be collected on the money or financial market. In the same way, loans represent an output that banks offer to agents with financial needs like enterprises (small and medium or large ones), as well as securities investment. Therefore, we find three principal activities for banking production: deposit collection, loan distribution and securities investment. To produce these outputs, banks use labour (qualified and unqualified), physical capital and financial capital. The linear mathematical programme used to calculate efficiency scores under the assumption of constant returns to scale (CRS) is as follows:

$$Max_{u,v}(u^{.}y_i / v^{.}x_i) \tag{1}$$

St u'y$_j$/v'x$_j$ $\leq$ *j=1,2,...,N* is the number of associated constraints for solving the mathematical problem, and *u, v* ≥ 0, with *x$_i$* being the vector of inputs matrix *K*N* of firm *i* and *y$_i$* being the vector of the output matrix *M*N* of firm *I*, while *u'* and *v'* are *M*1* and *K*1* vectors of input and output weights, respectively.

To avoid an infinite number of solutions, the constraint $v'x_i = 1$ is imposed, which provides:

$$Max_{u,v}(u'y_i) \qquad (2)$$

$$St\ u'y_i - v'x_i \leq 0,\ j = 1,2,...,N$$
$$u,v \geq 0$$

Because solving this problem in this form will be difficult, one can use the duality in linear programming and derive an equivalent form of the problem:

$$Min_{\theta\lambda}\theta \qquad (3)$$

$$Sc - y_i + Y\lambda \geq 0$$
$$\theta x_i - X\lambda \geq 0$$
$$\lambda \geq 0$$

where Y is a vector of all outputs of every firm and X is the vector of all inputs of every firm; θ is a scalar and λ is a $N*1$ vector of constants. The value of θ thus obtained will be the efficiency score for the ith firm.

To take into account changes in scale economies, the convexity constraint $N1'\lambda = 1$ can be added for giving the following:

$$Min_{\theta\lambda}\theta \qquad (4)$$

$$St - y_i + Y\lambda \geq 0$$
$$\theta x_i - X\lambda \geq 0$$
$$N1'\lambda = 1$$
$$\lambda \geq 0$$

where $N1$ is a $N*1$ vector of 1.

Following Berg et al.(1993), we estimate technical efficiency under those two assumptions of CRS and VRS[7]. The empirical estimated model will be:

(loans, deposits) = f (labour, physical capital, financial capital)

In addition, the use of panel data allows the calculation of the Malmquist index using the distance function:

$$M_0(y_s,x_s,y_t,x_t) = [d_0^s(y_t,x_t)d_0^t(y_t,x_t)]^{1/2}/[d_0^s(y_s,x_s)d_0^t(y_s,x_s)]^{1/2} \qquad (5)$$

It represents the productivity at the production point (y_t, x_t) relative to the point (y_s, x_s). A value higher than 1 means a positive growth of the total factors productivity between the periods s and t. An equivalent way to write this productivity index is:

$$M_o(y_{s,}x_{s,}y_{t,}x_t) = [d_o^t(y_{t,}x_t)/d_o^s(y_{s,}x_s)] * [(d_o^s(y_{t,}x_t)/d_o^t(y_{t,}x_t)) \\ * (d_o^s(y_{s,}x_s)/d_o^t(y_{s,}x_s))]^{1/2}$$

(6)

The second factor between square brackets is the geometric mean of measurements of the displacement of the frontier compared with the same individual, observed at period t (first ratio), then at period s (second ratio). This term measures technological change, i.e., the displacement of the frontier between the two appointed dates. The first factor measures the change of Farell technical efficiency level between periods s and t. It is the equivalent of Farell technical efficiency ratio at period t on this same efficiency at period s, under the assumption of CRS (*EFTcrs*). It has two components, one meaning pure inefficiency and the other one scale efficiency. The index of pure efficiency is obtained by recomputing efficiency indexes on the same data under the assumption of VRS (*EFTvrs*). The index of scale efficiency (EFE) is the ratio of efficiency under the assumption of CRS to efficiency under the assumption of VRS (*EFE = EFTcrs/EFTvrs*). We use the Malmquist index and its components in order to explain and understand the evolution of technical efficiency during the studied period.

Stochastic frontier analysis

Here we address the question, What is the optimal combination of inputs that makes it possible to produce an optimal combination of outputs while minimizing production costs? To allow the comparison of the two methods, we use the same inputs and outputs that were used for the DEA. Given the multiplicity of bank functions we choose a translogarithmic function model, which seems to be adapted to the multi-criteria character of bank efficiency. Indeed, this functional form makes it possible to take into account the multiple complementarity links among explanatory factors and it does not impose any restriction. Moreover, panel data with random errors allow us to mitigate the weakness of available quantity on bank-level data. In this model, the statistical noises vary through the banks and time, just as inefficiency (Battese and Coelli, 1992). We apply to this model the maximum likelihood method in order to estimate the parameters with the current assumption of a normal truncated distribution for the inefficiency term. We also consider that banking technology is the same throughout WAEMU, and indeed, most of the banks are subsidiaries of French banking groups. In addition, these banks operate in the same subregion of Western Africa and recruit bank workers who were trained according to French standards. The cost function thus arises in the following way:

$$LnCT = \alpha_o + \sum_{i} \alpha_i \ln p_i + \sum_j \beta_j \ln y_j + 1/2 \sum_i \sum_k \alpha_{ik} \ln p_i \ln p_k + \\ 1/2 \sum_h \sum_j \beta_{hj} \ln y_h \ln y_j + \sum_i \sum_j \delta_{ij} \ln y_j + v_{it} - u_{it}$$

(7)

with:

p_i = the inputs price vector

y_j = the outputs value vector

v_{it} = a statistical noise with the independent normal distribution $N(0, \v{s}_v^2)$

u_{it} = the positive inefficiency term and is assumed to be distributed independently of v_{it}.

The likelihood function is written in the following way:

$$LnL = N/2\ln(2/\pi) - N\ln\sigma - 1/2\sigma^2 \sum \varepsilon_i^2 + \sum \ln\left[\varphi(\varepsilon_i\lambda/\sigma)\right] \qquad (8)$$

Cost-efficiency scores are calculated with the following equation:

$$E\left(u_i/\varepsilon\right) = \left[\sigma\lambda/\left(1+\lambda^2\right)\right]\left[\varphi(\varepsilon_1\lambda/\sigma)/\psi(\varepsilon_1\lambda/\sigma) + \varepsilon_1\lambda/\sigma\right] \qquad (9)$$

where $\varepsilon_i = v_i - u_i, \sigma = (\sigma_u^2 + \sigma_v^2), \lambda = \sigma_u/\sigma_v, \varphi$ is the standard normal density function and ψ is the standard normal cumulative distribution.

Data

Among the 48 banks[8] operating in the WAEMU zone over the period 1996–2004, we selected 35 on the basis of data availability[9]. Therefore, our sample does not respect the proportions per country of the original population. Among these banks, some are not observed over all the considered period, but sample represents 82% of the total share of assets. For the stochastic frontier estimate we used the Bankscope database of Bureau Van Dijk for banks' balance sheets and income statements. With the DEA method, however, because of missing data for certain banks, we used "Bilan des banques et" établissements financiers de l'UMOA" edited by BCEAO, which contains exhaustive series on banks balance sheets.[10] Data on the number of bank employees and foreign shareholders in the equity capital are extracted from "Rapport Annuel de la Commission Bancaire - UMOA" of the central bank too. Social and economic data come from the World Bank databases, *World Development Indicators* and *Global Development Finance*. The average variable values are presented in tables 2 and 3.

Table 2: Average value of variables used for the estimate of cost frontier efficiency

Variables	Bénin	Burkina Faso	Côte d'Ivoire	Mali	Sénégal	Togo	WAEMU
Total assets	83605.57	84975.85	156651.04	104307.84	128683.70	47929.55	101025.59
Deposits	79064.33	73056.72	147896.31	84717.02	110341.42	39596.01	89111.97
Loans	55976.07	51960.54	140324.97	72439.74	93010.80	28049.64	73626.96
Investment assets	16143.39	14726.48	15017.09	5993.29	23431.66	4101.02	13235,49
Total costs	5415.31	5846.92	13389.34	5508.89	8483.78	3854.55	7083.13
PK	0.29	0.33	0.23	0.17	0.31	0.23	0.26
PL	8.22	6.82	11.40	8.08	9.75	7.55	8.64
PF	0.07	0.06	0.08	0.09	0.07	0.09	0.08

Notes: Total costs = interest payable, operating expenses and depreciation expenses out of total assets; Deposits = amounts owed to credit institutions and to customers out of total assets; Loans = loans and advances to credit institutions and to customers out of total assets; Investment assets: securities held for sale, investment securities and financial assets; PK = (depreciation expenses and provisions for assets)/ (tangible and intangible assets); PL = (personnel expenses)/average number of workers per year; and PF = interest payable and similar charges with credit institutions and customers/borrowed capital. Values in million CFA francs, except PK and PF, which represent ratios, and also L.

Table 3: Average value of variables used for the estimate DEA efficiency

Variables	Bénin	Burkina Faso	Côte d'Ivoire	Mali	Sénégal	Togo	WAEMU
Deposits	74461.09	71200.75	132765.21	89782.67	96623.21	41780.96	84435.65
Loans	62613.36	56557.67	126087.14	83052.92	84075.79	38601.16	75164.67
Investment assets	13019.42	15711.19	2991.20	1692.81	16645.44	2601.36	8776.90
KP	2072.84	3542.31	4296.91	3748.00	3195.17	3062.56	3319.63
KF	1531.11	3171.17	10390.73	5261.36	1420.72	682.62	3742.95
Lc	37.18	88.44	101.74	97.39	37.99	65.44	71.36
Le	112.60	164.47	238.23	99.06	154.69	117.44	147.75

Notes: Deposits = amounts owed to credit institutions and to customers; Loans = loans and advances to credit institutions and to customers; Investment assets : securities held for sale, investment securities and financial assets; KP = tangible assets; KF = financial assets; and L = average number of workers per year. Values in million of CFA francs, except PK and PF, which represent ratios, and also L.

5. Results

Results of efficiency scores estimated according to the DEA method are shown in Table 4 under the assumption of CRS and VRS. Efficiency scores are obtained by calculating the average score for each country. The average efficiency score over the entire period is 0.76 with CRS and 0.85 with VRS. These scores are lower than those found by Hauner and Peiris, 2005 for Uganda (0.99) but higher than those of Thai banks (0.62 and 0.59) found by Leigthner and Lovell ,1998. There is heterogeneity of the level of efficiency across countries. Indeed, Togo presents the lowest degree of efficiency (0.55 with CRS and 0.60 with VRS) and Senegal has the highest scores (0.83 and 0.95, respectively, for CRS and VRS).

Technical efficiency scores

The evolution of technical efficiency scores by country (under CRS and VRS assumptions) over the considered period reveals that Benin, Mali and Senegal have an increasing tendency, while Côte d'Ivoire and Burkina Faso have decreasing ones. The special case of Togo – a decreasing tendency from 1996 to 2001 but increasing thereafter – is due to the rise of the investment securities at the end of the period, while the inputs levels remained steady. Therefore, Togolese banks were more efficient in producing that specific asset with almost the same level of inputs than in previous years. However, efficiency degree of the WAEMU zone as a whole increases slightly for the CRS and decreases for the VRS (see Appendix A).

A more detailed analysis of technical efficiency degrees per bank groups (state-owned, local private and foreign) shows that local private banks are the most efficient, with an average efficiency of 0.85 and 0.92, respectively, under CRS and VRS, followed by foreign banks with 0.72 (CRS) and 0.,83 (VRS). State-owned banks score the lowest efficiency degrees: 0.56 (CRS) and 0.64 (VRS) (see Appendix B). Concerning network banks, efficiency evolution is generally homogenic apart from Bank of Africa and Banque Nationale de Paris networks, where one can observe heterogeneity across the countries where the subsidiaries are settled down, as shown in Appendix C.

Table 5 describes the Malmquist index and its components. Global technical efficiency change is equal to 1.5% for the whole zone during the studied period. This growth is due to scale efficiency change, which is equal to 1%, and pure technical efficiency (technical efficiency under the assumption of VRS), which increased by 0.4% over the period. The implication is that WAEMU banks (except in Côte d'Ivoire and Benin) knew to exploit the scale change that occurred during the period, while the increase in pure technical efficiency is due to the performance of banks in Mali, Senegal, Togo and Benin. Total factor productivity growth was around 1.4% over the period.

Table 4: WAEMU banks technical efficiency scores estimated with DEA

a.) Constant return to scale assumption

Years	Bénin	Burkina Faso	Côte d'Ivoire	Mali	Sénégal	Togo	WAEMU
1996	0.74	0.76	0.79	0.69	0.55	0.59	0.74
1997	0.81	0.78	0.72	0.63	0.76	0.61	0.77
1998	0.83	0.67	0.80	0.75	0.78	0.57	0.78
1999	0.84	0.78	0.73	0.75	0.97	0.49	0.80
2000	0.67	0.68	0.67	0.73	0.92	0.43	0.73
2001	0.78	0.68	0.69	0.78	0.82	0.47	0.75
2002	0.85	0.55	0.66	0.78	0.83	0.44	0.73
2003	0.85	0.48	0.69	0.79	0.98	0.54	0.76
2004	0.84	0.54	0.70	0.84	0.94	0.89	0.81
Average value for the period	0.80	0.65	0.72	0.75	0.83	0.55	0.76

b.) Variable return to scale assumption

Years	Bénin	Burkina Faso	Côte d'Ivoire	Mali	Sénégal	Togo	WAEMU
1996	0.74	0.84	0.93	0.81	0.81	0.70	0.85
1997	0.82	0.88	0.97	0.79	0.94	0.64	0.89
1998	0.83	0.68	0.98	0.76	0.95	0.62	0.86
1999	0.85	0.81	0.92	0.77	0.98	0.51	0.86
2000	0.75	0.76	0.91	0.77	0.94	0.48	0.82
2001	0.83	0.80	0.85	0.81	0.95	0.49	0.83
2002	0.93	0.58	0.84	0.83	0.99	0.52	0.83
2003	0.96	0.53	0.82	0.79	1.00	0.63	0.83
2004	0.92	0.56	0.84	0.87	0.97	0.95	0.87
Average value for the period	0.84	0.70	0.89	0.80	0.95	0.60	0.85

That is the global technical efficiency increase rather than the incorporation by banks of technological changes. Indeed, the latter decreased by 0.4% from 1996 to 2004, because of bank performance in countries such as Benin, Burkina Faso and Côte d'Ivoire.

Table 5: Average growth rate of total factor productivity (Malmquist index) and its components from 1996 to 2004

Country	Total technical efficiency change	Techno-logical change	Pure technical efficiency change	Scale efficiency change	Total factor productivity change
Bénin	1.017	0.965	1.028	0.989	0.981
Burkina Faso	0.958	0.983	0.950	1.009	0.942
Côte d'Ivoire	0.985	0.988	0.987	0.999	0.978
Mali	1.026	1.010	1.009	1.017	1.036
Sénégal	1.055	1.026	1.018	1.036	1.082
Togo	1.053	1.005	1.039	1.013	1.073
WAEMU	1.015	0.996	1.004	1.010	1.014

Cost-efficiency scores

Because the banks in our sample are of different sizes, some heteroscedasticity may appear, leading to rank bias in the banks' efficiency scores. We propose to address this issue in future research. Here, we first tried to estimate the cost frontier in one step as in Battese and Coelli (1992), but we weren't able to conclude for the existence of the cost frontier. Because of that, we finally proceeded in two steps. Our estimates of the stochastic cost frontier function are presented in Table 6. The parameter $\bullet = \check{s}_u^2/(\check{s}_u^2 + \check{s}_v^2)$ is significantly different from zero. This result enables us to reject the assumption according to which the variance of the efficiency term $\check{s}_u^2$ is null.[11] Consequently, the u_{it} term cannot be isolated from the regression, the cost frontier does exist and the estimate of the parameters by ordinary least squares is inadequate.

Table 6: Estimated parameters of the translogarithmic cost function

Variable	Parameters	Coefficient	Standard deviation
constant	$\pm_0$	0,2690	2,4636
Y_1	$\pm_1$	*** 5,1821	1,7004
Y_2	$\pm_2$	***-3,7795	1,3320
Y_3	$\pm_3$	*-0,5452	0,3041
P_K	$^-_1$	0,1791	0,3779
P_L	$^-_2$	-0,2957	0,5878
Y_1Y_1	$\pm_{11}$	***-2,1611	0,5667
Y_1Y_2	$\pm_{12}$	*** 3,0719	0,8499
Y_1Y_3	$\pm_{13}$	*** 0,4539	0,1743
Y_2Y_2	$\pm_{22}$	***-1,0265	0,3383
Y_2Y_3	$\pm_{23}$	***-0,3596	0,1301
Y_3Y_3	$\pm_{33}$	-0,0127	0,0195
P_KP_K	$^-_{11}$	-0,0255	0,0329
P_KP_L	$^-_{12}$	**-0,1519	0,0726
P_LP_L	$^-_{22}$	0,0085	0,0787
Y_1P_k	$^,_{11}$	***-0,4733	0,1100
Y_1P_L	$^,_{12}$	0,2310	0,1712
Y_2P_k	$^,_{21}$	*** 0,4218	0,0803
Y_2P_L	$^,_{22}$	-0,1597	0,1331
Y_3P_K	$^,_{31}$	*** 0,1209	0,0249
Y_3P_L	$^,_{32}$	0,0029	0,0356
$\ln\check{s}^2 = \ln(\check{s}_u^2 + \check{s}_v^2)$	***-2,8611	0,3257	
$\bullet = \check{s}_u^2 / (\check{s}_u^2 + \check{s}_v^2)$	** 1,0173	0,4623	
Number of observations		234	
Log-likelihood		109,28	

***, **, * = significant at the 1%, 5% and 10% levels, respectively.

The estimated values of the cost function parameters enable us to calculate the gap of each observation compared with the frontier of best practices. As underlined above, this gap is divided into two terms: u_i characterizes banks inefficiency and v_i represents the random error term. Calculated inefficiency degrees, according to the Battese and Coelli methodology, vary between 0 and the infinite. Therefore, efficiency scores are

measured by its reverse which varies between zero and one. Table 7 and Appendix D present the annual average bank cost efficiency across countries for our studied sample from 1996 to 2004. For WAEMU as a whole, the average is 0.67; this result is close to that found by Chaffai, 1993, 1997 for Tunisian banks, which was about 0.66, but is less than the 0.80 found by Kirkpatrick et al., 2008 for anglophone African banks. The cost efficiency of WAEMU country banks increases at different speeds, except in Togo where it is steady. The extreme efficiency scores are displayed by the Malian banks for the maximum (0.76) and Burkina Faso banks for the minimum (0.56). The increase in the efficiency scores for all countries is reflected in the level of WAEMU average cost efficiency, which grows slightly from 0.67 in 1996 to 0.70 in 2004.

Table 7: WAEMU banks cost-efficiency scores

Year	Bénin	Burkina Faso	Côte d'Ivoire	Mali	Sénégal	Togo	UMOA
1996	0.68	0.57	0.62	0.73	0.73	0.63	0.67
1997	0.68	0.51	0.63	0.75	0.69	0.59	0.65
1998	0.68	0.52	0.67	0.73	0.69	0.60	0.65
1999	0.69	0.53	0.67	0.74	0.70	0.58	0.66
2000	0.70	0.57	0.70	0.76	0.73	0.60	0.68
2001	0.71	0.58	0.69	0.76	0.74	0.60	0.68
2002	0.73	0.58	0.65	0.77	0.76	0.60	0.69
2003	0.74	0.59	0.64	0.79	0.76	0.61	0.69
2004	0.74	0.60	0.65	0.79	0.77	0.62	0.70
Average value for the period	0.70	0.56	0.66	0.76	0.73	0.60	0.67

This result may be explained by the drop in total costs due at the same time to a decrease in the main interest rates of BCEAO and the bank restructuring that was introduced gradually by BCEAO in 1993 and has been effective since 1996. Indeed, the drop of loan administration and the liberalization of bank conditions encouraged by BCEAO supported a better competition within the banking system. This could have allowed banks to extend their market share by using scale economies to increase their efficiency, as suggested by the Malmquist index evolution.

An analysis of cost efficiency according to bank ownership reveals an analogous result with that of technical efficiency. Indeed, local banks display the highest cost-efficiency scores (0.76) on average, followed by foreign banks (0.68), while state-owned banks are the least cost efficient (0.56). In contrast, network banks' cost-efficiency scores are quite heterogenic (see Figure 5 and Appendix E). Only the Société Générale network presents homogeneity in the cost-efficiency evolution. This result testifies that the cost efficiency of network banks is sensitive to the environment of the country in which they evolve.

A synthesis between cost and technical efficiency shows that they evolve with the same tendency in the following countries: Benin, Mali, Senegal and Togo. Côte d'Ivoire and Burkina Faso, however, In the Burkina Faso case, the decrease of technical efficiency during the study period stems from total factor productivity (-6.8%). And this decrease of total factor productivity results in the decrease of 4.2% of total technical efficiency and that of technological changes (-1,7%).

Figure 5:   Cost-efficiency evolution of WAEMU banks according to shareholder
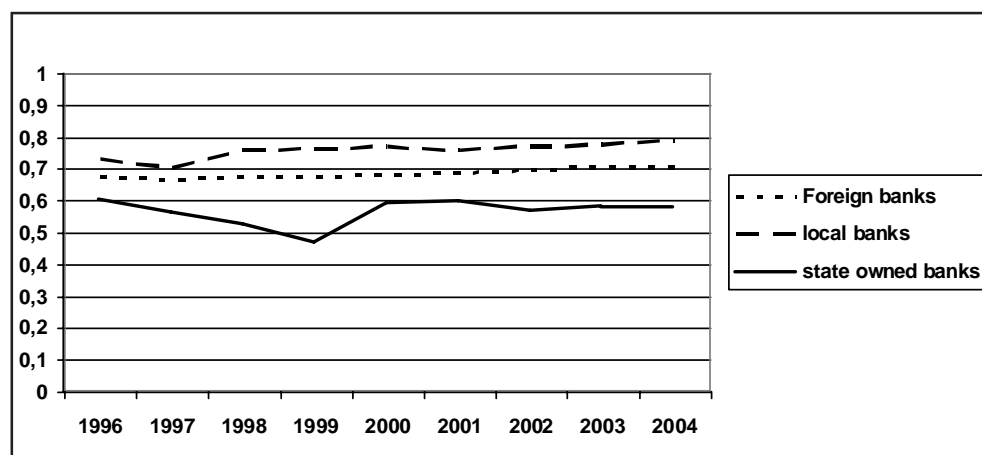
Indeed, for Burkina Faso the 5% decrease of pure technical efficiency is not reversed by the gain in scale economies, which are very low (0.9%). Again for Côte d'Ivoire, we observe a decrease of total factor productivity of 2.2%, which is rooted in total technical efficiency evolution (-1.5%) and some waste owing to the lack of effective incorporation of technological changes (-1.2%). The decrease of total technical efficiency comes from that of pure technical efficiency (-1.3%) and scale efficiency (0.1%).

Our results need to be interpreted with caution, as the bank assets used for estimating the cost function are heterogeneous and are not risk-adjusted. Among the three bank products used to estimate the cost frontier efficiency, credits are riskier than deposits and securities. Therefore, WAEMU banks seem to be technically efficient on average, considering that they mostly act as deposit banks providing short-term loans.

Technical efficiencies differ from cost efficiencies. However, the difference between the two methods does not make it possible to make a direct comparison of these two efficiency measurements. Different efficiency degrees (while considering bank ranking) at the geographical level, as well as at the methodological level lead us to ask the question of the determinant of banks efficiency in WAEMU.

Determinants of efficiency

Following Dietsch and Lozano-Vivas (2000) ; Allen and Rai (1996) and Grigorian and Manole (2002) we explain banks' efficiency scores with macroeconomic and environmental variables (exogenous variables) and variables linked to banks' decision processes (endogenous variables).

Endogenous factors affecting efficiency

These are decision variables specific to each bank; in other words, they can directly or indirectly influence technological processes (Allen and Rai, 1996). The variables are: the ratio of shareholder equity to total assets (CP), the ratio of economic profitability defined as net income out of total assets (RN), the share of loans granted to customers in the total assets and the share of deposits of each bank in their total assets (DEP). For all these variables, the suggested coefficients are positive. Indeed, the use of internal funding generates cost savings, while better results can have a positive impact on bank efficiency. Finally, a stable base of deposits is expected to increase the efficiency of WAEMU banks, which as we saw above act more like deposit banks.

Exogenous factors

Most of these factors are variables that describe the principal environmental conditions in which banks operate. Indeed, the distribution of banking services in areas with low population density (*Dp*) involves important costs and does not encourage banks to increase their level of efficiency. We also include the Herfindahl–Hirschmann Index for taking into account the impact of market concentration on the efficiency of WAEMU banks.[12] If market concentration reflects the power of banks, it may increase costs for the industry in general through slacks and inefficiency. Conversely, if the market concentration reflects the selection of the market and consolidation across the survival of the most efficient banks, then concentration will be associated with lower costs given that the market remains contestable.

Income per capita (*PIBt*) affects many factors related to demand and banking services distribution (mainly deposits and loans). Countries with higher per capita income have banking systems that operate in a mature environment, resulting in more competitive interest rates and profit margins. We integrate the proportion of shareholder equity held by foreign investors (*Kf*) into the explanation of bank efficiency. Indeed, a study by Azam et al. (2004) on the restructuring of the WAEMU banking system after the crisis of 1990 finds the link between this variable in period *t* and the performance of the banks at period *t-1* (measured by the ratio of the net profit to total loans). Moreover, Grigorian and Manole (2002), in their study on the determining factors of commercial bank efficiency in transition countries, find that banks that are controlled by foreign head offices are generally more efficient.

Non performing loans tend to increase banks' production costs as well as inefficiency in loan distribution. Indeed, facing an environment in which the share of bad loans is high, banks will be more reluctant to grant loans because of the risk of incurring loss. Therefore, we test whether the variable *badloans* is significant in determining bank efficiency. This is calculated as the ratio of total bad loans in each country to the total loans; it catches the negative impact of problem loans that banks face in WAEMU countries.[13]

Given that efficiency scores ranged from 0 to 1, a double truncated tobit model (Appendix E) seems to be suitable for generating consistent estimates of regression coefficients. Therefore, we regress efficiency degrees on the variables coded above

with 0 when they are lower than the average over one year and 1 when they are higher than this average.[14] The results of the estimates are presented in Table 8.

Table 8: Regression results of efficiency measures derived from the stochastic cost frontier and DEA method against endogenous and exogenous banks variables

Dependent variable	Cost efficiency	Technical efficiency (CRS)	Technical efficiency(VRS)
Constant	***0,6581	***0,8691	***0,9072
	(-0,0265)	(0,0794)	(0,0834)
RN	-0,1357	0,0429	0,0401
	(0,0131)	(0,0359)	(0,0395)
CP	*0,0317	-0,0460	-0,0188
	(0,0182)	(0,0498)	(0,0610)
DEP	0,0067	-0,0191	0,0045
	(0,0173)	(0,0472)	(0,0518)
HH	**0,0394	0,0348	0,0272
	(0,0156)	(0,0385)	(0,0410)
PIBt	***0,1314	*0,1162	***0,2743
	(0,0199)	(0,0725)	(0,0767)
Badloans	*-0,0265	**-0,0925	**-0,0982
	(0,0140)	(0,0372)	(0,0414)
Dp	*-0,0245	**-0,0795	**-0,0943
	(0,0133)	(0,0342)	(0,0533)
Kf	0,0244	0,0588	0,0377
	(-0,0161)	(-0,0562)	(-0,0533)
Prob> chi2	0,00	0,01	0,00
Log likelihood	144,17	-64,62	-71,90
Number of observations	260	260	260

***, **, * = significant at the 1%, 5% and 10% levels, respectively.

Income per capita *(PIBt)*, the ratio of bad loans (*badloans*) and the population density are significant for the three regressions with the same respective positive sign for the first one and negative for the two others. Except for population density those signs are consistent with theory. Indeed, a high GDP per capita has a positive impact on cost and technical efficiency under either the CRS (i.e., when banks operate at an optimal scale) or VRS assumption (i.e., when one takes into account the environment of imperfect competition and the prudential rules that banks face). Again, the increase of the bad loans ratio of a country has a negative impact on bank efficiency. The unexpected sign for population density is explained by the fact that WAEMU banks do not integrate the effect of population density into their strategies for improving efficiency.

Concerning the other variables, they are not significant. However, for the cost efficiency the ratio of stockholders' equity to total assets (*CP*) has a significant positive impact. A similar result was found by Allen and Rai (1996) for small separated banks, They explained this sign as a result of the reduction of moral hazard agency costs.

The Herfindahl–Hirschmann index is significant, indicating the positive impact of bank concentration on banks' cost efficiency, which confirms the idea that WAEMU banks gain advantage of scale economies offered by this market structure.

6. Conclusion

T he estimated efficiency scores of WAEMU banks are on average equal to 0.67 for cost efficiency and 0.76 and 0.85 for technical efficiency under CRS and VRS, respectively. Generally, estimated efficiency levels increased during the study period, except for Côte d'Ivoire and Burkina Faso, where we observe different evolutions of cost efficiency and technical efficiency. A more detailed analysis (per bank group) reveals that local banks with private capital are the most efficient, followed by foreign bank subsidiaries. State-owned banks have the lowest scores for both cost and technical efficiency.

The evolution of the Malmquist index and its components during the study period indicates that WAEMU banks did not integrate technological changes during the period. Indeed, even if banks did import those new technologies, the technologies did not contribute to the improvement of technical efficiency. Whereas technological changes allow banks in developed countries to increase the speed, quality and accessibility of their financial services, the low proportion of people owning a bank account (3.02%) in WAEMU countries and its implications are not conducive to the incorporation of such innovations. Scale economies, on the other hand, play a more important role. Therefore, it would be interesting for the authorities to implement measures promoting the increase of the percentage of people with a bank account in WAEMU countries. That would allow banks through scale economies to better incorporate technological changes. In this case, a multiplication of ATMs, for example, would more significantly affect bank efficiency.

Besides these technical steps, strengthening the legal and judicial environment in which banks operate would allow them to be more effective in their role of financing the economy. Indeed, the more confident banks would be in the local environment, the less reluctant they would be in loans distribution. Finally, it is important for the monetary authority to keep an eye on the financial health of banks, especially their return on equity.

Notes

1. The author is grateful to African Economic Research Consortium for having funded this research project, and also to Banque Centrale des Etats de l'Afrique de l'Ouest for the documentation provided.

2. Report of the Commission Bancaire de l'UMOA, 2004.

3. Author calculations, based on Global Development Indicators and World Development Indicators.

4. When analysing the evolution of M2, credit to the private sector and GDP, we found that the first two variables increased during the period, but less quickly than the third one. This confirms the idea of a decline of the economy monetization and the financing of the economic activity by loans during the 1990–1994 period, corresponding to a restructuring period after the banking crisis.

5. This approach employs the average residuals of the cost function estimated with panel data to construct a measure of cost X-efficiency.

6. With average variables of the production approach, banks are supposed to produce services of transaction and information. Therefore the banking product is made up of accounts opened by the bank for managing deposits and loans.

7. The VRS assumption is adapted to the environment in which banks evolve, and thus makes it possible to have scores robust to misspecification, while the CRS assumption allows the comparison of the largest banks with smallest ones and prevents the former from appearing artificially efficient.

8. This number doesn't take into account new created banks and banks that cease their activities after 1996.

9. Because of data availability banks of Niger are not taken into account in our sample.

10. Variables used in the parametric and non parametric methods are calculated in the same way.

11. Indeed, the stochastic frontier does exist when • is significantly different from 0, i.e., when $š_u$ is different from 0; therefore the share of the error term that depends on inefficiency does exist and we can consider a best practices frontier.

12. The Herfindahl–Hirschmann index is calculated as the sum of the squares of the market share of each bank.

13. We use this variable instead of individual bad loans, which were not available for all of the banks of our sample.

14. However, Kf is equal to one when the share of stockholders capital held by foreigners is more than 50% and zero otherwise.

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Appendix A:

Technical efficiency evolution under the assumptions of constant return to scale (CRS) and variable returns to scale (VRS)
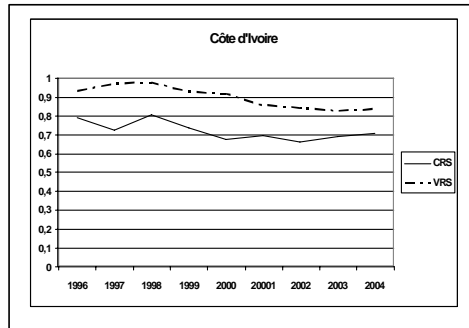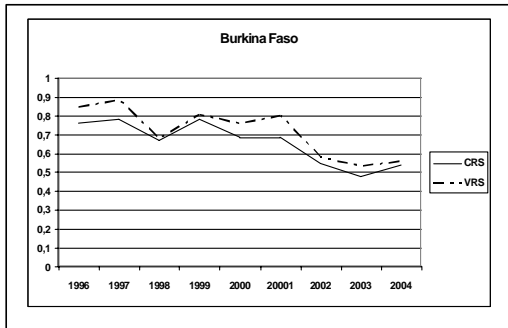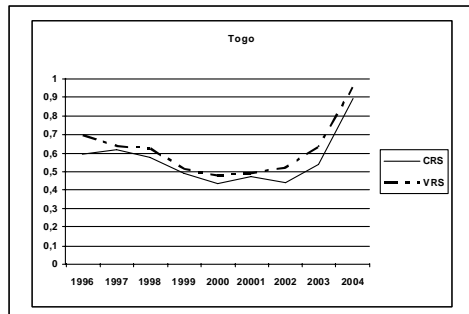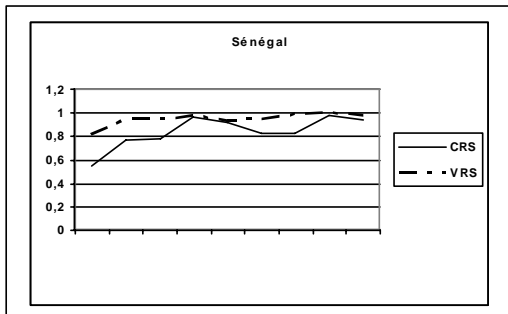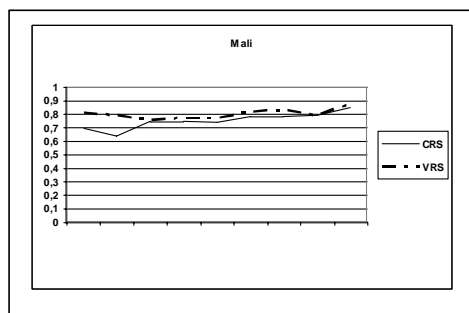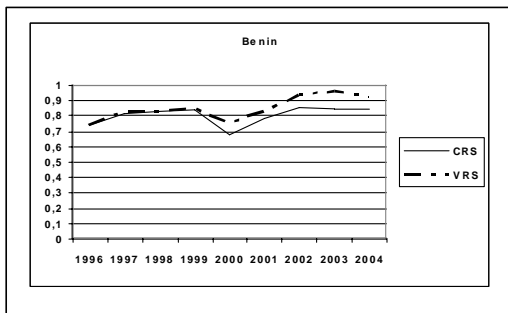
Appendix B:

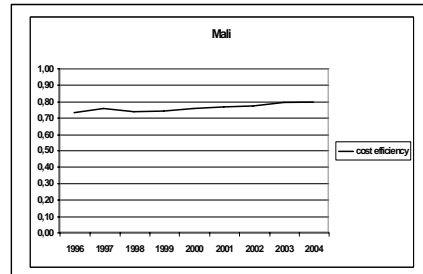**Technical efficiency evolution according to bank shareholder equity**

Technical efficiency evolution under CRS assumption according to banks shareholders'equity

- - - foreign banks
- - - local banks
--- state owned banks

Technical efficiency evolution under VRS assumption according to banks shareholder's equity
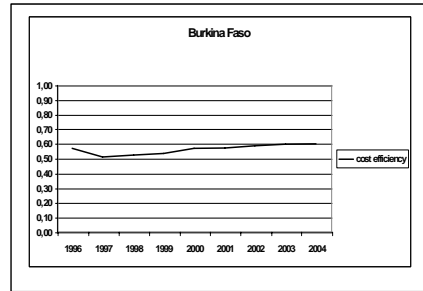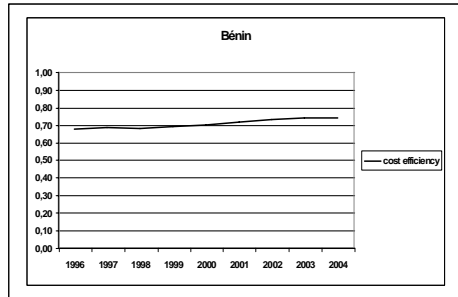
- - - foreign banks
- - - local banks
--- state owned banks
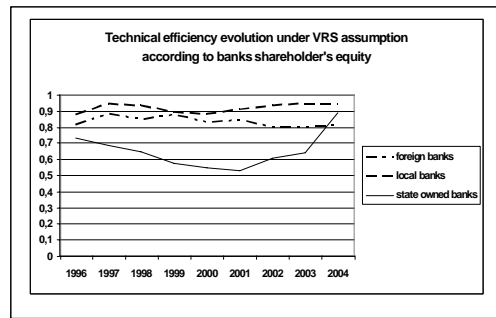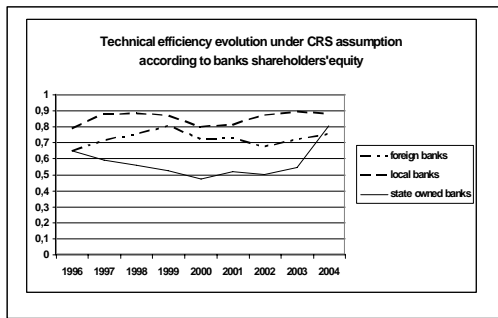
Appendix C:

**Technical efficiency(VRS) evolution of WAEMU banks per network**

ECOBANK Network

Société Générale Network
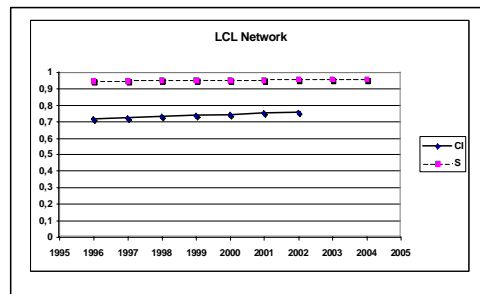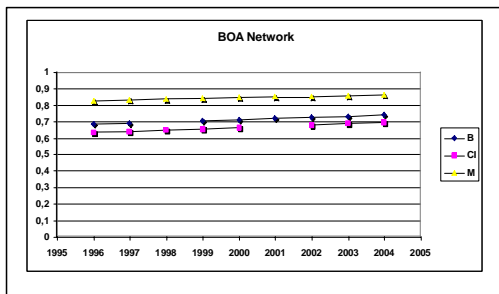

Belgolaise Network
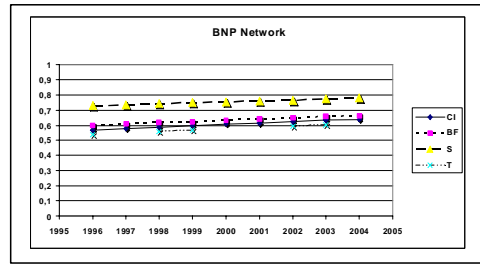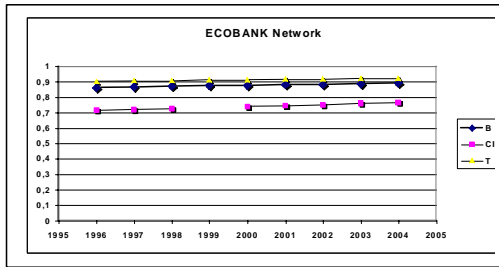

LCL Network

BOA Network

BNP Network
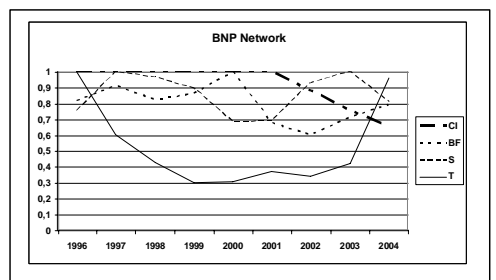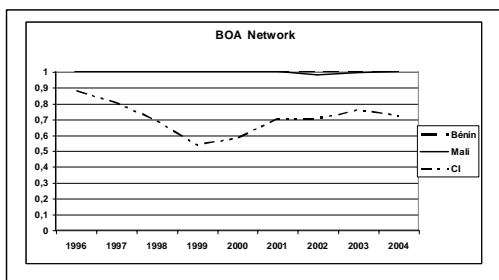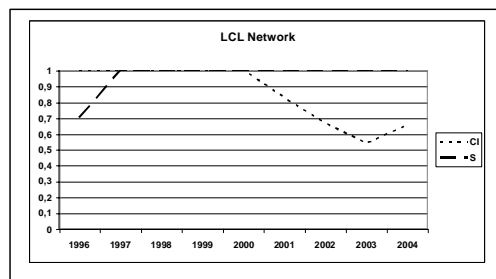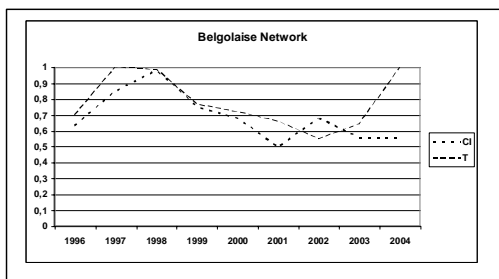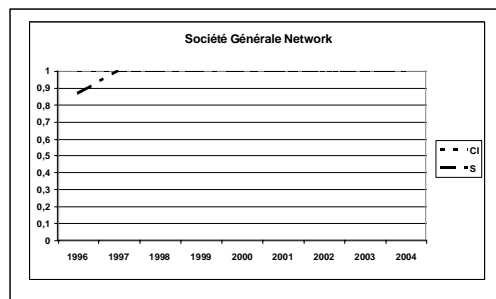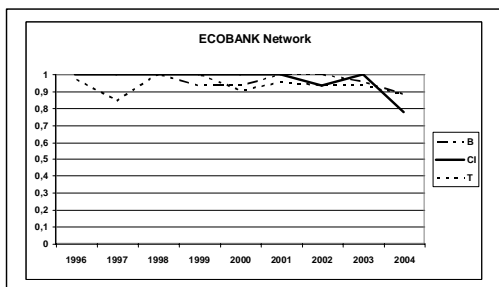
Appendix D:

Cost-efficiency evolution of WAEMU banks per country from 1996 to 2004
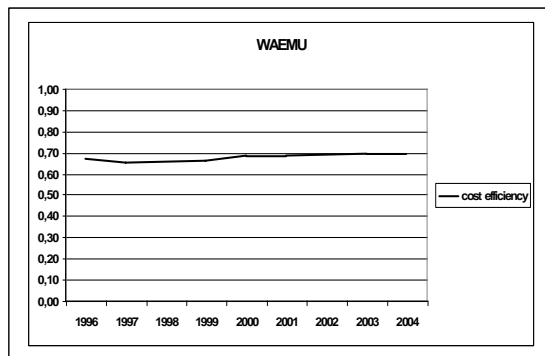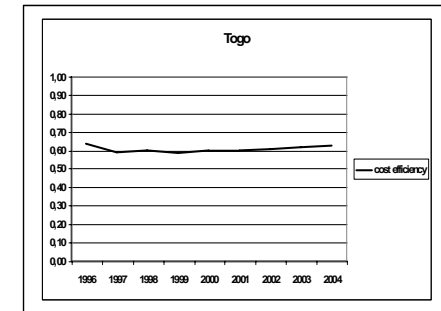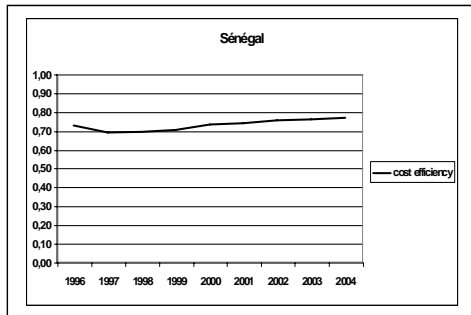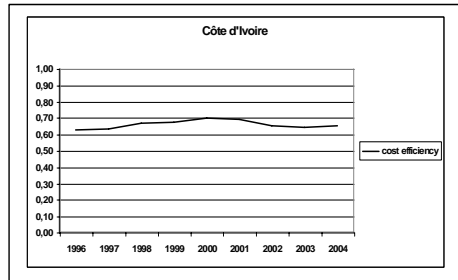
Appendix E:

Cost-efficiency evolution of WAEMU banks per network

ECOBANK Network

BNP Network

BOA Network

LCL Network

Société Générale Network
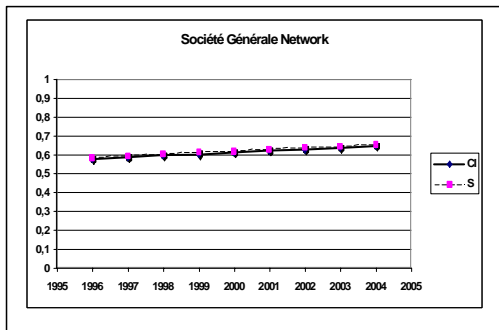
Appendix F:

Choice of a double truncated Tobit model

The tobit model is a model in which the dependent variable is continuous and observable on a certain interval. This is the case with the efficiency variable that we are trying to explain. Indeed, efficiency evolves between 0 and 1, and can therefore not be modelled by a logit or probit model because it is not a dichotomous variable. The tobit model is located midway between the linear regression models in which the endogenous variable is continuous and observable and qualitative models. The simple tobit model generally is expressed in the following manner:

$$E(y_i * / x_i) = x_i \beta + \varepsilon_i \text{ where } \beta \ \varepsilon \ \mathrm{R}^k.$$

y_i*is only observed if its value exceeds a threshold c_i, generally 0. You can build $y_i = y_i$*
if y_i* > *0* and $y_i = $ *0;* if not, *i= 1, 2, ...N.*
    An ordinary least square (OLS) estimate of this kind of truncated or censured model is not convergent. It is biased and one cannot determine the sense of the bias. There is also multiple censorship tobit model. In this case, the latent variable y_i* is observed within a truncated interval. Indeed, in some applications, the dependent variable can be censored to the left and right. When thresholds of censorship are identical for all individuals, the model is called a double truncated tobit model. It is presented as follows:

$$y_i = c_1 \ si \ \mathrm{y_i}^* \le c_1$$
$$y_i = y_i * \mathrm{c}_1 < y_i^* \le c_2$$
$$y_i = c_2 si \ y_i^* \ge c_2$$

where *(c_1;c_2)ε R^2* are the boundaries of the censorship.
    This model is used in applications where the dependent variable react to large variations (or high values) of the explanatory variables.
    That is why in our study we code the explanatory variables to 0 or 1. For example, if for a given variable, we realize that it is above the average of all the countries, we believe it has a positive impact on efficiency, therefore we code it to 1. On the other hand, if it is lower than the average for the country and it has a negative impact, we code it to 0. This codification also accounts for the fact that the idea of the efficiency refers to a relative frontier.

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