MEASURING BANK EFFICIENCY IN DEVELOPING COUNTRIES: THE CASE OF WAEMU (WEST AFRICAN ECONOMIC MONETARY UNION)

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Abstract

This paper offers to measure WAEMU banks efficiency and its determining factors, after the banking system reforms from 1993 to 1996. At this purpose, we use Data Envelopment Analysis method (DEA) for assessing technical efficiency and Stochastic Frontier Analysis (SFA) for cost efficiency. Our results suggest similar evolutions for the two types of efficiency for every WAEMU countries apart from Ivory Coast 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 technological changes that occurred in the banking system, Malmquist index shows that the increase of technical efficiency is much more the fact of scale efficiency change than that of the incorporation of technological innovations. Lastly, we found that 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.

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TABLE OF CONTENTS

INTRODUCTION: 3

I) WAEMU BANKING SYSTEM 4

I-1) The evolution of the banking system: 4

I.2- WAEMU banking system characteristics 5

II) LITERATURE REVIEW : 8

II.1) The nonparametric approach: 8

II.2) The parametric approach: 9

III) METHODOLOGY: 10

III-1) DEA Method: 10

III-2) Stochastic Frontier Analysis: 12

III-3) Data: 13

III.4) results: 14

III-4-1) Technical efficiency scores 14

III-4-2) cost efficiency scores 16

III-4-3) Determinants of efficiency 19

CONCLUSION 22

APPENDICES 23

REFERENCES 27

Introduction:

The financial sector has an important role to play in the economic development process. Financial institutions are the main intermediation channels between saving and investment in a country. The best financial systems limit, quantify, gather and negotiate all operation risks, and incite the savers to invest, by offering them a proportional payment to the scale of the incurred risks. Financial intermediaries when they are efficient allow mobilizing saving from diverse sources and allocate it to more productive activities, what benefits not only investors and beneficiaries of the investments but also the whole economy (Gulde, Patillo and Christensen, 2006). Indeed, a banking system which efficiently channels financial resources to productive use is a powerful mechanism for economic growth (Levine 1997). In Sub Saharan Africa, banks are the main financial intermediaries. Therefore, restructuring policies have been led in order to improve their efficiency.

Especially, for the WAEMU zone since its creation, monetary policy purpose was to favour main sectors which were supposed to lead the economic growth, with preferential interest rates. However, this policy didn't give the expected results; on the contrary it caused the banking crisis at the end of the 80s and the beginning of the 90s. During this period, there were about 27 banks failures (Powo Fosso, 2000). In order to solve problems of banks insolvency and profitability, reforms and restructuring measures were taken by the monetary authority. The end of loans quantitative control, the creation of an organism for banking surveillance and regulation: WAMU Banking Commission (La Commission Bancaire de l'UMOA) and interest rates liberalization. Those reforms were set up for improving efficiency in financial resources mobilisation and allowance.

Indeed, bank efficiency has raised much interest those last years. Most of them were done, after important changes or restructuring measures periods in banking systems (Allen et Rai, 1996; Leigthner and Lovell, 1998 and Grigorian and Manole, 2000). Efficiency measurement determines how banks provide an optimal combination of financial services with a set of inputs. On the one hand, one is asking oneself bank capability to efficiently and technically produce, financial services for economic agents. On the other hand, banks as financial companies look for profitability. Therefore, they are constrained from achieving maximum profit, due to regulatory restrictions (minimum reserve, capital adequacy requirements, etc). Their management has substantial control on the cost of inputs, whereas the output side is beyond their control **(**Worthington, 1998). So our study aims at assessing both technical and cost efficiency, in order to identify the suitable policies for increasing banks efficiency, so that they will be able to fully play their role of financial intermediary in the WAEMU zone.

Our results suggest that WAEMU banks are efficient as far as they are acting as deposits banks providing short term loans to enterprises. Scale economy plays an important role in improving technical efficiency. Financial soundness and legal environment are also important factors.

Our study is organised in three parts. First, we present WAEMU zone while insisting on changes of the banking system and its characteristics. Second, we make a theoretical and empirical literature review on the methods of efficiency measurement. Lastly, we estimate and analyze banks efficiency scores and their determinants in the WAEMU countries.

I) WAEMU Banking system

I-1) The evolution of the banking system:

90s were years of financial distresses for the WAEMU countries. Interest rate control policy as well as the intervention of governments in the management of state owned banks introduced a bias in economic criteria for credit distribution. For example, a productive project in a non prioritary sector could not find funds for financing, while a non productive project in a prioritary sector could be financed. In those conditions, market mechanisms which should play a regulatory role through the interest rate equilibrium, by allowing good financial resources allowance within the economy, could not be effective.

After the crisis, monetary authorities restructured the banking system of the WAEMU. Failures banks were liquidated or privatized. In the later case, banks ownership was opened to foreign and domestic investors. In addition, a sub-regional regulatory institution was created in 1990: the WAMU Banking Commission. It ensures the supervision of banks activities, and the respect of the banking regulation. Beside that measure, the Central Bank changes the monetary policy, in 1993. It substitutes the administrative method of monetary regulation by market mechanisms, which are more flexible. These changes intervened at three levels: the refitting of the grid of the directing rates, the establishment of a renovated money market, and the liberalization of banks conditions, which results in the suppression of several directing rates floors and the removal of the upper limit of banks debtor conditions.

The liberalization of banks conditions would have been implemented for reinforcing the mobilization of domestic resources and their optimal allowance for financing the economy. This measure is supposed to give credit institutions a greater room for manoeuvre in the determination of their costs and their prices. It would also lead to a better competition within the banking system through a greater transparency in the invoicing of the banking services costs. Brownbridge and Harvey (1998)[1] found evidences according to which the liberalization of 1990 would have led to a more vigorous competition among African banks with regard to the deposits and the distribution of the other services. However, it is not sure that liberalization improved the efficiency of loans distribution in the presence of important distortions in the other economic sectors.

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

[1] Brownbridge M and Harvey C, 1998 “Banking in Africa: The impact of financial sector reform since independence (Trenton, New Jersey : Africa World Press”.

I.2- WAEMU banking system characteristics

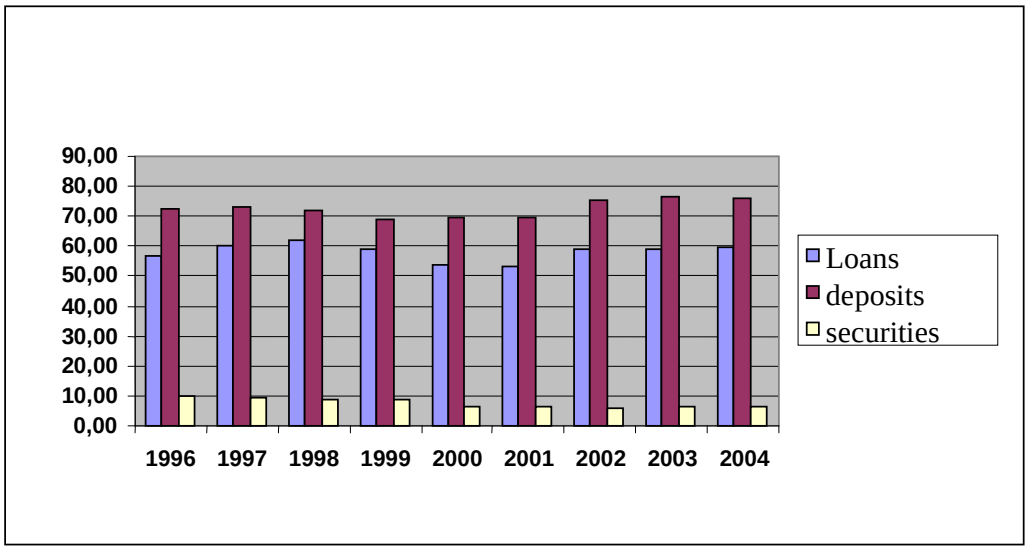
There are actually 90 credit institutions formally approved in WAEMU: 70 banks and 20 financial institutions[2]. Countries which present the larger number of banks are Ivory Coast (16) and Senegal (10). The WAEMU banking system is concentrated, indeed 19 banks are large ones and hold the major market share in the zone: 62,7%; 24 are of medium size with a 27,6% share while the 9,7% residual share is held by the 27 small banks.

WAEMU banks as financial intermediaries collect resources with economic agents who have financial excess and carry out 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 graph 1. The degree of economy monetization, represented by the ratio of M_2 to the GDP remains constant around 25% between 1990 and 1994, then decrease until 1998 to 21%, for then finding its initial level in 2003. It is lower than the average degree in Sub-Saharan Africa which is approximately 29% over the period 90-03[3]. In the same way the ratio of credit to private sector to GDP, strongly decrease from 25% to 15% between 1990 and 1994, for then stabilizing itself[4]. A more detailed analysis of the banking products (graph 2) reveals a balance sheet structure dominated by deposits and loans which respectively account for 72,74% and 58% of average banks total assets. Securities share a very small proportion of the total assets (approximately 7,7% on average) over all the studied period.

Graph 1: *Financial intermediation evolution in WAEMU*

[2] Rapport de la commission bancaire de l'UMOA, 2004.
[3] Author calculations, Source: Global Development Indicators and World Development Indicators.
[4] Analysing the evolution of M_2, credit to the private sector and GDP, we found that the first two variables increase during the period, but less quickly than the third one. This confirms the idea of a decreasing of the economy monetization and the financing of the economic activity by loans, the 1990-1994 period, corresponding to a restructuring period after the banking crisis.

Graph 2: *WAEMU banking products evolution from 1996 to 2004*



Source : « Bilans des banques et établissements financiers de l'UMOA » and author calculations

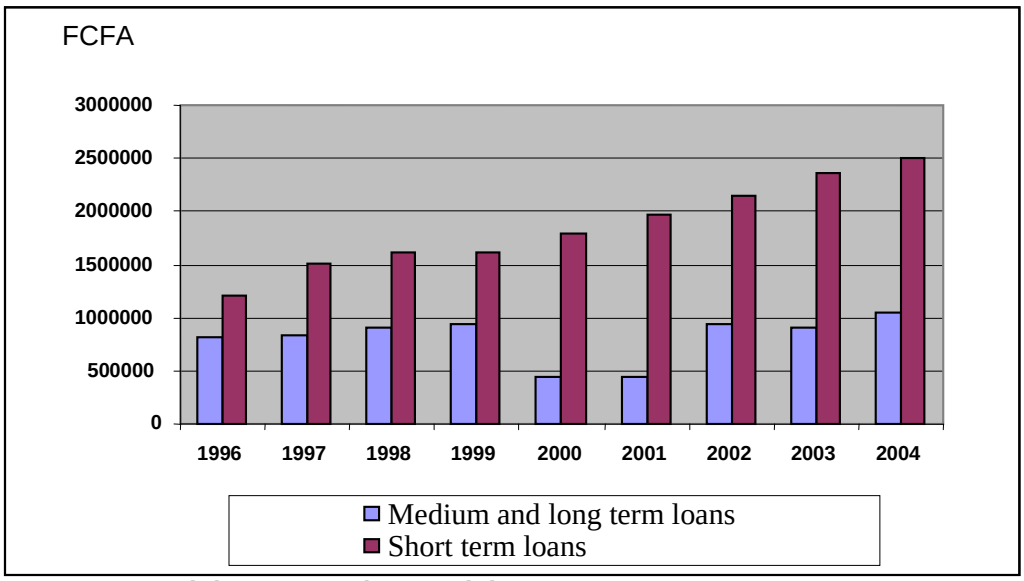
The proportions of these products per country are ranged in the same sections for loans and deposits, however one can observe a greater dispersion with securities: 0,06% for the minimum in Ivory Coast and 13% for the maximum in Togo (table 3). Banks credit from 1996 to 2004 is as followed: 5% for primary sector, 22% for industries and 73% for services and trade. Therefore, one can notice that banks of the zone primarily intervene like deposit banks accompanying enterprises (above all services and trade sector) in their treasury loans, but more rarely in investment loans or long financing. As graph 3 testifies it, after the devaluation, banks become on-liquid but remain reluctant in distributing long terms loans to small and medium enterprises. Indeed, short-term loans represent more than twice of the medium and long term loans (approximately 70% of the total of loans granted by banks).

Table 3: *Level of the principal balance sheet items expressed as a percentage of total assets of WAEMU banks in 2004.*

Countries	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 »

Graph 3 : E*volution of Short, Medium and Long term loans in WAEMU*



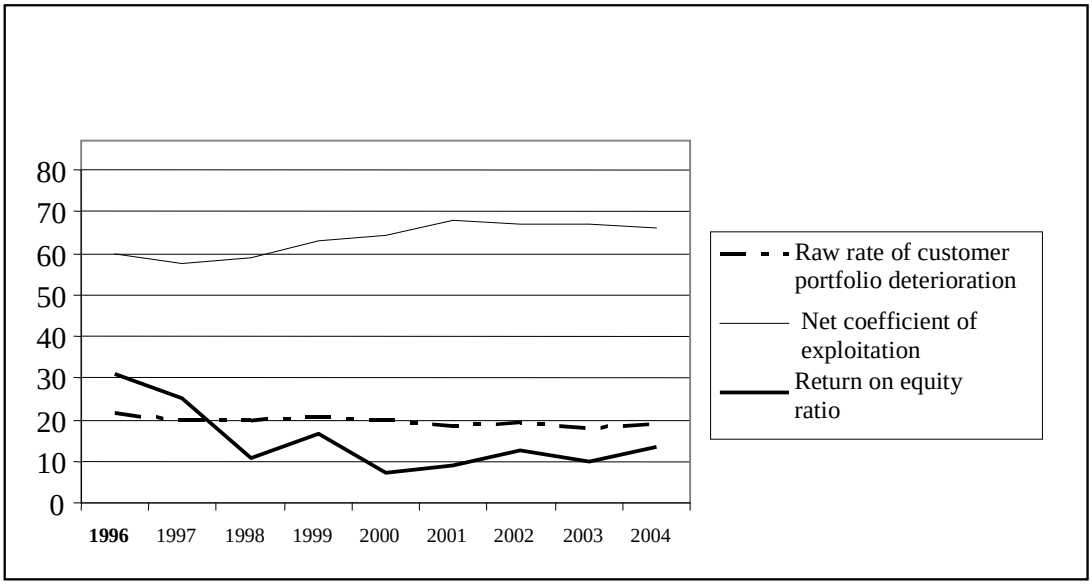
Source : Rapport de la commission bancaire de l'UMOA

90s have been for WAEMU banks years of technological changes, with the appearing and the diffusion of New Technology of Information and Communication (NTIC). Within the zone those technological changes are late to become effective, in comparison with other Sub-Saharan African Anglophone Countries. The subsidiaries of foreign banks are the first ones to improve financial service distribution by using those technological changes with computers, cash dispenser, providing banking cards and telematics. In addition, the creation of the banking accounting plan "plan comptable bancaire" in 1996, will force banks to use computer in their activities.

Besides those technological changes, we observe a qualitative improvement of human capital used by banks. Indeed, the share of qualified staff increased from 22,5% in 1990, to 28% in 1996 and 36,6% in 2004; what can be viewed as an increase of 61,8% between those two late dates. The number of branches has increased from 394 in 1996 to 523 in 2004. This rise is due besides the addition of new created banks branches, to the raise of the number of old banks branches in Benin, Burkina Faso, Mali, Niger and Senegal; that number having decreased or stayed steady respectively in Ivory cost and Togo.

Bank management has evolved as shown by the return on equity ratio, the net exploitation coefficient and the raw rate of customers portfolio deterioration. The first one representing the ratio of net profit for the year to shareholders' equity, decreased from 30 to 13% from 1996 to 2004, showing a depreciation of banks profitability. On the contrary, the net exploitation coefficient increase (from 59,6% to 66,2%) indicating an improvement of the financing of operating and depreciations expenses, by the value added created by banks. The raw rate of customers portfolio deterioration evolves in an almost steady way from 21,5% to 18,7%.

Graph 4*: Evolution of banks management characteristic ratio from 1996 to 2004.*



Source: Rapport de la commission bancaire de l'UMOA.

Knowing the characteristics of WAEMU banks, we turn now to the efficiency measurement concept, while reviewing the various theoretical and empirical studies on the subject.

II) 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 wasting by producing as much outputs as the use of input allows it (output oriented measure), or by using as less as input that the production objective plans it (input oriented measure). This efficiency is measured by comparing observed and optimal values of production, costs, revenue, profit or all that the production system can follow as objective and which is under appropriate quantities and prices constraints. Therefore, we can analyse technical efficiency, in terms of deviation compared with an idealistic production frontier isoquant. The literature proposes two approaches for measuring frontier production: the mathematical programming approach (non parametric) and the econometric one (parametric).

II.1) The nonparametric approach:

The mathematical approach known under the name of DEA method (Data Envelopment Analysis) consists in estimating the frontier by using non parametric mathematical linear programming. It offers an analysis based on the relative evaluation of the efficiency in an input/output multiple situation, by taking into account each bank and measuring its relative efficiency to an envelopment surface made up with the best banks. However, this method doesn't allow for noise treatments. The non parametric method was usually used by making

the assumption of constant return to scale (CRS). But recently, the assumption of variable return to scale (VRS) was used in specifications because this hypothesis is more relevant with the environment of imperfect competition in which banks operate. This assumption is therefore made by Grigorian and Manole (2002), to evaluate the efficiency of transition countries banks from Eastern Europe, following the technological changes which 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 Thai banks efficiency. They lead an analysis based on the one hand, on profit objective of the Thai banks and on the other hand, on the economic growth objective of the Bank of Thailand. 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, Forsund, Hjalmarsson, Suominen (1993), study the productivity of banks in Nordic European Countries (Finland, Sweden and Norway) vis-a-vis increasing financial integration and banks internationalization due to Europe integration. It comes out from their study, that the Swedish banks are the best ones to face financial European integration and banks internationalization.

Other studies analyse banks efficiency, by using the parametric approach.

II.2) The parametric approach:

The econometric approach consists of an econometric estimate of the best practice frontier by its specification in a Cobb-Douglas, CES or translogarithmic (cost or production) function. The econometric method can be deterministic. In this case, every deviation from the frontier is attributed to inefficiency. It can also be stochastic; it is then possible to separate random errors from the production unit inefficiency. The stochastic frontier method has two principal advantages compared to non-parametric DEA method. First, it allows separating random error from the production unit inefficiency and takes into account the existence of exogenous shocks. At this purpose, the error term is divided into two components: an inefficiency component and a random one (wich is composed of the error measurement and the exogenous shocks). Second, the stochastic frontier analysis is less sensitive to absurd values.

English, Grosskopf, Hayes and Yaisawarng (1993), using a distance function with a translogarithmic form found that on average US banks were inefficient after mergers and consolidations of the US banking system in the 90s. Allen and Rai (1996) in an international banks comparison use the 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 separate activities banks. Then in a second step, the authors analyse the determining factors of efficiency. However, they don't take into account environmental variables in the explanation of efficiency. It is this caveat that Lozano-Vivas and Dietsch (2000) depicted, in their study comparing French and Spanish banks. They make a comparison of Spanish and French banks, integrating in the cost frontier countries environmental specificities.

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

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

III) Methodology:

Our approach consists in using the two non-parametric and parametric methods of efficiency measurement. It is justified by the fact that the first will enable us to specifically be interested in the technical aspect of production in using efficient combination of inputs in order to produce a given output. And, the second one will lead us to measure bank efficiency with a cost objective. WAEMU banks, as any rational producer are especially carried towards the maximization of their profit and thus ceteris paribus the minimization of production costs. At this purpose, banks presenting high efficiency-cost scores will not necessarily be the most technical efficient ones. It is for explaining such a dichotomy, that we propose to measure the technical efficiency and the cost-efficiency of WAEMU banks.

III-1) DEA Method:

Technical efficiency analysis aims at answering the following question: Do production unit use as many inputs as the production of outputs requires it? Therefore, 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 offer liquid deposits without risk, and loans which are risky assets and less liquid. The principle of added value, stipulates that the elements which contribute to generate added value, are regarded as outputs. Thus even if the deposits collection costs a credit rate to bank; it saves the cost of the resources which should differently be collected on the money or financial market. In the same way, loans represent an output that bank 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: the activity of deposits collection, loans distribution and securities investment. To produce these outputs, banks use labour (qualified and unqualified), physical capital and financial capital. The linear mathematical program used to calculate scores efficiency under the assumption of CRS is as follow:

$\text{Max}_{u,v} (u'y_i/v'x_i)$,
St $u'y_j/v'x_j \leq 1$, $j=1,2,\ldots,N$
$u, v \geq 0$
With x_i the vector of inputs matrix K*N of firm i and y_i the vector of the output matrix M*N of firm I; and u' and v' are M*1 et 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:
$\text{Max}_{u,v} (u'y_i)$,
St $u'y_j - v'x_j \leq 0$, $j=1,2,\ldots,N$
$u, v \geq 0$

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

Because solving the problem on this form will be difficult, one can use the duality in linear programming, and derive an equivalent form of this problem:
Min $_{\theta\lambda}$ ɵ,
$Sc - y_i + Y\lambda \geq 0$,
$\theta x_i - X\lambda \geq 0$,
$\lambda \geq 0$,
Where ɵ is a scalar and λ is a N*1vector of constants.
The value of ɵ obtained will be the efficiency score for the i-th firm.

To take into account changes in scale economies, the convexity constraint N1' λ = 1 can be added for giving the following program:
Min $_{\theta\lambda}$ ɵ,
$St - y_i + Y\lambda \geq 0$,
$\theta x_i - X\lambda \geq 0$,
N1'λ = 1
$\lambda \geq 0$,
Where N1 is a N*1vector of 1.

Following, Berg, Forsund, Hjalmarsson and Suominen (1992), we will estimate technical efficiency under those two assumptions of CRS and VRS[7]. The empirical estimated model will be:

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

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

$M_o(y_s, x_s, y_t, x_t) = [d_o^s(y_t,x_t)\, d_o^t(y_t,x_t)]^{1/2} / [d_o^s(y_s,x_s)\, d_o^t(y_s,x_s)]^{1/2}$.
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:

$$M_o(y_s, x_s, y_t, x_t) = [d_o^t(y_t,x_t) / d_o^s(y_s,x_s)] * [(d_o^s(y_t,x_t)/ d_o^t(y_t,x_t)) * (d_o^s(y_s,x_s) / d_o^t(y_s,x_s))]^{1/2}.$$

The second factor between square brackets is the geometric mean of measurements of the displacement of the frontier compared to the same individual, observed at period t (first ratio), then at period s (second ratio). This term between square brackets 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 indices on the same data under the assumption of VRS (EFTvrs). The

[7] The VRS assumption is adapted to the environment in which banks evolves, and thus makes it possible to have scores robust to misspecification, while the CRS assumption allows to compare the largest banks with smallest ones and prevent the first ones to appear artificially efficient.

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 will use the Malmquist index and its components in order to explain and understand the evolution of technical efficiency during the studied period.

III-2) Stochastic Frontier Analysis:

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

$$\text{Ln } CT = \alpha_0 + \sum_i \alpha_i \ln p_i + \sum_j ß_j \ln y_j + 1/2 \sum_i \sum_k \alpha_{ik} \ln p_i \ln p_k + 1/2 \sum_h \sum_j ß_{hj} \ln y_h \ln y_j + \sum_i \sum_j \delta_{ij} \ln p_i \ln y_j + v_{it} - u_{it}$$

with:

p_i : the inputs price vector

y_j : the ouputs value vector

v_{it}: is a statistical noise with the independent normal distribution $N(0, \sigma_v^2)$,

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

The likelihood function is written in the following way:

$$\text{Ln } L = N/2 \ln(2/\pi) - N \ln\sigma - 1/2\sigma^2 \Sigma \varepsilon_i^2 + \Sigma \ln [\varphi(\varepsilon_i \lambda/\sigma)],$$

Cost efficiency scores are calculated with the following equation:

$E(u_i/\varepsilon) = [\sigma\lambda/(1+\lambda^2)] [\varphi(\varepsilon_i\lambda/\sigma)/ \psi (\varepsilon_i\lambda/\sigma) + \varepsilon_i\lambda/\sigma]$

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

III-3) Data:

Among the 48 banks[8] which operate in the zone over the period 1996-2004, we selected 35 according to data availability[9]. Therefore, our sample will not respect the proportions per country of the original population. Among these banks, some are not observed over all the considered period. Our sample represents 82% of the total share of assets. We used for the stochastic frontier estimate Bankscope data base for banks balance sheets and income statements. However for DEA method, because of missing data for certain banks, we rather used " Bilan des banques et établissements financiers de l'UMOA" which contains exhaustive series on banks balance sheets[10]. Data on banks number of employees and the foreign shareholders in the equity capital are extracted from "Rapport Annuel de la Commission bancaire - UMOA". Social and economic data come from the World Bank data base "World Development Indicators" and Global Development Finance. The average variables values are presented in tables 4 and 5.

Table 4: *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
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

Total costs = interests payable, operating expenses and depreciation expenses
Deposits = amounts owed to credit institution and to customers
Loans = loans and advances to credit institutions and to customers
PK= (depreciation expenses and provisions for assets)/(tangible and intangible assets)
PL = (personnel expenses)/average number of workers per year
PF = interest payable and similar charges with credit institutions and customers/borrowed capital

Tableau 5 : *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
Titres	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

Deposits = amounts owed to credit institution and to customers

[8] This number doesn't take into account new created banks and banks which cease their activities after 1996.
[9] Because of data availability banks of Niger won't be taken into account in our sample.
[10] Variables used in the parametric and non parametric methods are calculated by the same way.

Loans = loans and advances to credit institutions and to customers
KP = tangible assets
KF = financial assets
L = average number of workers per year

The variables values in the two tables are in million of CFA Francs, except PK and PF where they represent ratios, and also L.

III.4) results:

III-4-1) Technical efficiency scores

Tables 6.1 and 6.2, give results of efficiency scores estimated according to the DEA method respectively under the assumption of CRS and VRS. Scores efficiency are obtained by calculating the average score for each country. The average efficiency score over all the period is 0,76 with CRS and 0,85 with VRS. These scores are inferior to those found by Peiris and Hauner, 2005 for Uganda (0,99) but superior to the degree of thai banks found by Leigthner and Lovell, 1998 (0,62 and 0,59). There is heterogeneity of the level of efficiency across countries. Indeed, Togo presents the smallest efficiency degree (0,55 with CRS and 0,60 with VRS) and Senegal displays the highest ones (0,83 and 0,95 respectively in CRS and VRS). 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 Ivory Coast and Burkina Faso have decreasing ones. The special case of Togo, decreasing tendency from 1996 to 2001 and increasing after is due to the raise 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 the anterior years. However, the zone whole efficiency degree has a slight increasing tendency for the CRS and decreasing one for the VRS (cf appendix 1). A more detailed analysis, of efficiency degrees per banks groups (state owned, local private and foreign) shows that local private banks are the most efficient ones 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) (cf appendix 2). Concerning network banks, efficiency evolution is generally homogen apart from BOA and BNP networks, where one can observe heterogeneity across the countries where the subsidiaries are settled down, as shown in appendix 3.

Table 6: *WAEMU banks technical efficiency scores estimated with DEA*

6.1) 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

6.2) 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

Table 7 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 the fact of scale efficiency change which is equal to 1,1%, and that of pure technical efficiency (technical efficiency under the assumption of VRS) which increased of 0,4% over the period. What implies that WAEMU banks (except in Ivory Coast and Benin) knew to exploit the scale change which occurred during the period. Indeed, for all countries the falls of total technical efficiency are due to that of pure technical efficiency, except for Ivory Coast which also presents a fall of scale efficiency. Again the rise of pure technical efficiency is due to banks of Mali, Senegal, Togo and Benin. Total factors productivity growth was around 1,4% over the period. That is the fact of global technical efficiency increase rather than the incorporation by banks of technological changes. Indeed, the latter decreased of 0,4% from 1996 to 2004, drop due to countries such as Benin, Burkina Faso and Ivory Coast.

Table 7: *Average growth rate of total factors productivity (Malmquist index) and its components from 1996 to 2004.*

Countries	Total Technical Efficiency Change	Technological 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

III-4-2) cost efficiency scores

Considering that these banks are of different sizes, it may appear some heteroskedasticity leading to rank banks bias in scores efficiency. We propose to address this issue in future researches. We first tried to estimate the cost frontier in one step as in Battese and Coelli 1996, but we weren't able to conclude for the existence of the cost frontier. Because of that, we finally proceed in two steps. Estimate of the stochastic cost frontier function is presented in table 9. The parameter $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$ is significantly different from zero. This result enables us to reject the assumption according to which, the variance of the efficiency term σ_u^2 is null[11]. Consequently, the u_{it} term can not be isolated from the regression, the cost frontier does exist and the estimate of the parameters by Ordinary Least Squares is inadequate.

The estimated values of the cost function parameters enables us to calculate the gap of each observation compared to the frontier of best practices. As underlined above, this gap is divided into two terms: u_i characterizes banks inefficiency, v_i represents the term of random error. 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 9 presents the annual average banks efficiency for our studied sample from 1996 to 2004, across countries. The average cost efficiency score in WAEMU is 0,67; this result is closed to that found by Chaffai (1993 and 1997) for Tunisian banks which was about 0,66. However it's inferior to 0,80 found by Kirkpatrick, Murinde and Tefula (2007) for anglophones african banks. Cost efficiency of WAEMU countries increases at different speeds, apart from Togo, where it is steady. Thus, the extreme efficiency scores are displayed by the Malian banks for the maximum (0,76) and Burkina Faso banks for the minimum (0,56). However, the increase in the efficiency scores for all countries is reflected on the level of WAEMU average cost-efficiency which slightly grows up from 0,67 in 1996 to 0,70 in 2004.

[11] Indeed, the stochastic frontier does exist when γ is significantly different from 0, ie when σ_u is different from 0: therefore the share of the error term which depends on inefficiency does exist and we can consider a best practices frontier.

Table 8: *Estimated parameters of the translogarithmic cost function*

Variables	Parameters	Coefficient	Standard deviation
constant	α_0	0,2690	2,4636
Y_1	α_1	*** 5,1821	1,7004
Y_2	α_2	***-3,7795	1,3320
Y_3	α_3	*-0,5452	0,3041
P_K	β_1	0,1791	0,3779
P_L	β_2	-0,2957	0,5878
Y_1Y_1	α_{11}	***-2,1611	0,5667
Y_1Y_2	α_{12}	*** 3,0719	0,8499
Y_1Y_3	α_{13}	*** 0,4539	0,1743
Y_2Y_2	α_{22}	***-1,0265	0,3383
Y_2Y_3	α_{23}	***-0,3596	0,1301
Y_3Y_3	α_{33}	-0,0127	0,0195
P_KP_K	β_{11}	-0,0255	0,0329
P_KP_L	β_{12}	**-0,1519	0,0726
P_LP_L	β_{22}	0,0085	0,0787
Y_1P_k	δ_{11}	***-0,4733	0,1100
Y_1P_L	δ_{12}	0,2310	0,1712
Y_2P_k	δ_{21}	*** 0,4218	0,0803
Y_2P_L	δ_{22}	-0,1597	0,1331
Y_3P_K	δ_{31}	*** 0,1209	0,0249
Y_3P_L	δ_{32}	0,0029	0,0356
$\sigma^2 = \sigma_u^2 + \sigma_v^2$		***-2,8611	0,3257
$\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$		** 1,0173	0,4623

Number of observations	234
Log-likelihood	109,28

****, **, * significant at the 1%, 5%, and 10%levels*

This result could be explained by the drop of total costs due at the same time to a decrease in the directing interest rates and the banking restructuring gradually implemented by BCEAO since 1993 and which has been effective since 1996. Indeed, the drop of loans administration and banks conditions liberalization process encouraged by BCEAO, supported a better competition within the banking system. This could have allowed banks by extending their market share, to use scale economies in order to increase their efficiency, as suggested by the Malmquist index evolution.

Table 9: *WAEMU banks cost efficiency scores*

Years	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

Analysing cost efficiency according to banks 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 ones (0,56). On the contrary, network banks cost efficiency scores are quite heterogenic, as shown in appendix 6. Only "Société Générale" network presents homogeneity in the cost efficiency evolution. This result testifies that network banks cost efficiency 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. However, Ivory Coast and Burkina Faso present different tendencies. In the Burkina Faso case, the decrease of technical efficiency during the studied period is the fact of the total factor productivity (-6,8%) which results in the decrease of 4,2% of total technical efficiency and that of technological changes (-1,7%). Indeed, for Burkina Faso the decrease of pure technical efficiency of 5%, is not reversed by the gain in scale economies which are very low (0,9%). Again for Ivory Coast, we observe a decrease of total factor productivity of 2,2% which is the fact of total technical efficiency evolution (-1,5%) and some waste due to the lack of effective incorporation of technological changes (-1,2%). The decreasing of total technical efficiency coming from that of pure technical efficiency (-1,3%) and scale efficiency (0,1%).

Our results need to be interpreted with caution, indeed banks 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 the fact that they act as deposit banks mostly 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 on the one hand and at the methodological level on the other hand, lead us to ask the question of the determinants of banks efficiency in WAEMU.

III-4-3) Determinants of efficiency

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

- *Endogenous factors impacting efficiency:*

These variables are decision variables specific to each bank; in other words, they can influence directly or indirectly their technological process[12]. They are: the ratio of stockholders' 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 the customers in the total assets and the share of deposits of each bank in their total assets (DEP).

- *Exogenous factors:*

Most of them are variables which describe the principal environmental conditions in which banks operate. Indeed, the distribution of banking services in the areas with low population density (Dp) involves important costs and do 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 WAEMU banks efficiency.[13] The income per capita (PIBt), affects many factors related to demand and banking services distribution (mainly deposits and loans). Countries with a higher income per capita have a banking system which operates in a mature environment, resulting in more competitive interest rates and profit margin. We will also integrate the share of stockholders' equity held by the foreign investors (Kf) in the explanation of banks efficiency. Indeed, Azam, Biais and Dia (2004) in their study on the restructuring of WAEMU banking system after the crisis of 1990, show 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). Again, Grigorian and Manole (2000) in their study on the determining factors of commercial banks efficiency in transition countries, find that banks which are controlled by foreign head offices are generally more efficient. Bad loans tend to increase banks production costs as well as efficiency in loans distribution. Indeed, facing an environment in which the share of bad loans is high, banks will be more reluctant in granting loans because of possible incurring losses. Therefore, we test whether the variable "badloans" is significant in determining bank efficiency. It 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.[14]

Given the fact that, efficiency scores are ranged between 0 and 1, a double truncated Tobit model seems to be suitable to generate consistent estimates of regression coefficients. Therefore, we regress efficiency degrees, on the variables coded above with 0, when they are

[12] Allen and Rai, 1996

[13] Herfindahl-Hirschmann index is calculated as the sum of the market share squares of each bank.

[14] We use this variable instead of individual bad loans which were not available for each banks of our sample.

lower than the average over one year and 1 when they are higher than this average[15]. The results of the estimates are presented in table 11.

Tableau 11 *: 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
Loglikelihood	144,17	-64,62	-71,90
Number of observations	260	260	260

****, **, * significant at the 1%, 5%, and 10%levels*

The income per capita (PIBt), the ratio of bad loans (badloans) and the population density are significant for the three regressions with the same respectively positive for the first one and negative for the two others. Those signs are consistent with the theory apart from the population density. Indeed, a high GDP per capita has a positive impact on cost and technical efficiency under CRS (i.e. when banks operate on 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 banks efficiency. On the contrary, the non expected sign of the population density

[15] However K_f is equal to one, when the share of stockholders capital held by foreigners is superior to 50% and 0 on the contrary.

is explained by the fact that WAEMU banks do not integrate in their strategy for efficiency improvement the effect of population density.

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. This result was also found by Allen and Rai (1996) for small banks in separated banking countries, They explained this sign as the fact of the reduction of moral hazard agency costs.

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

Conclusion

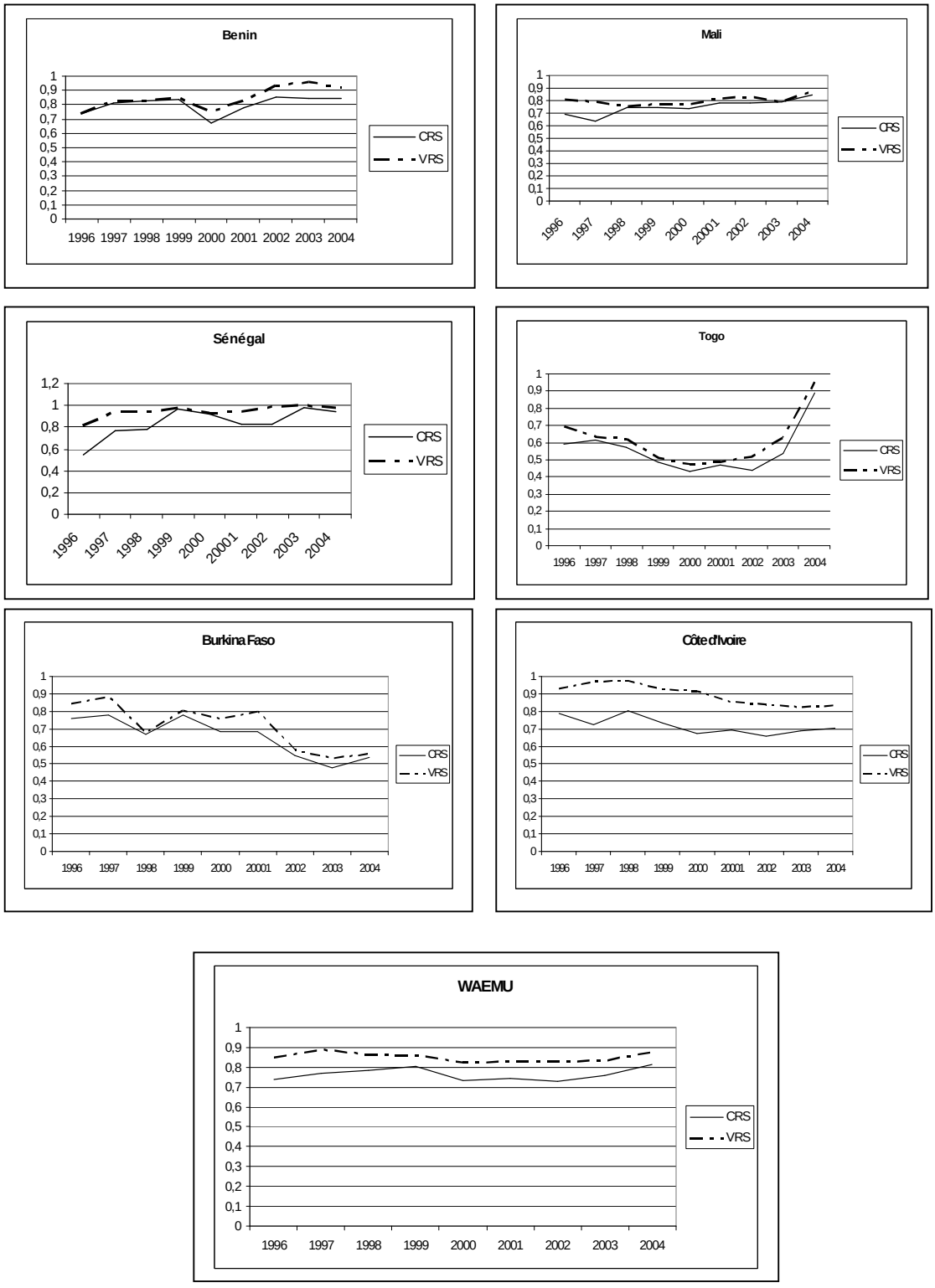
The estimated scores efficiency of WAEMU banks are on average equal to 0,67 for cost efficiency and 0,76 and 0,85 for technical efficiency under CRS and VRS respectively. Generally, estimated efficiency levels increase during the studied period apart from Ivory Coast, Burkina Faso, where we observe different evolutions of cost-efficiency and technical efficiency. A more detailed analysis (per banks group) reveals that local banks with private capital are the most efficient ones, followed by foreign banks subsidiaries, and lastly state owned banks which display the lowest cost and technical efficiency scores.

The evolution of Malmquist index and its components during the studied period shows that WAEMU banks did not integrate technological changes during the studied period. Indeed, even if banks have imported those new technologies, they don't contribute to the improvement of technical efficiency. Whereas technological changes allow banks in developed countries to increase in speed, quality and ease financial services access, the ratio of people owning a bank account (3,02%) in WAEMU countries and its implications gives to the incorporation of those innovations a non productive effect. Scale economies on the contrary play a more important role. Therefore, it would be interesting for the authorities to implement measures (for instance fostering the increase of the percentage of people with a bank account in WAEMU countries), in order to allow banks through scale economies to better incorporate technological changes. In this case, a multiplication of automatic cash dispensers for example would more significantly impact bank efficiency.

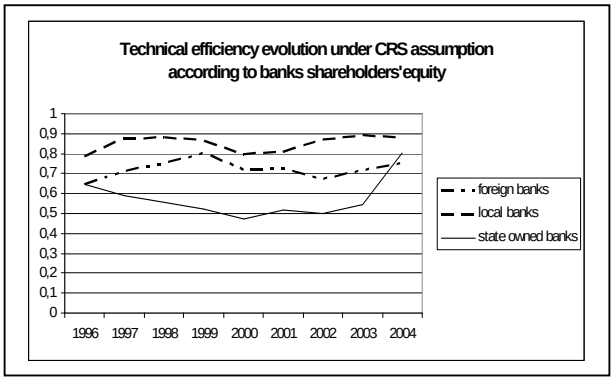
Besides, strengthening the legal and judicial environment in which banks operate would allow them to better play their role of financing the economy. Indeed, the more confident would banks be in the local environment, the less reluctant they would be in loans distribution. Finally, it is important for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

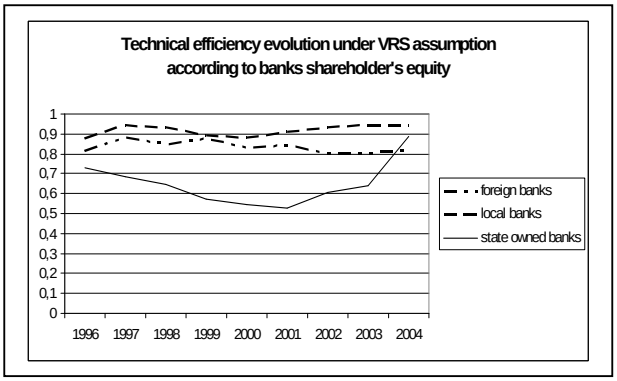
Appendices

Appendix 1 : Technical efficiency evolution under the assumptions of Constant Return to Scale (CRS) and Variable Return to scale(VRS).

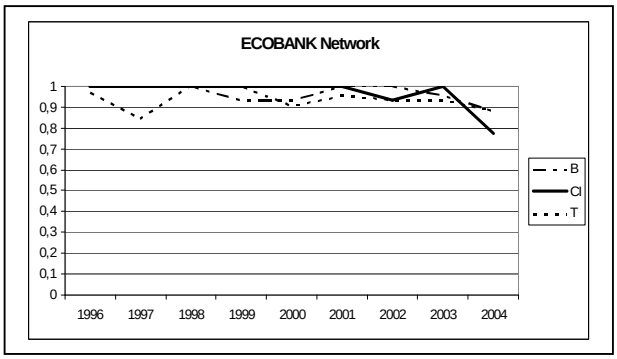


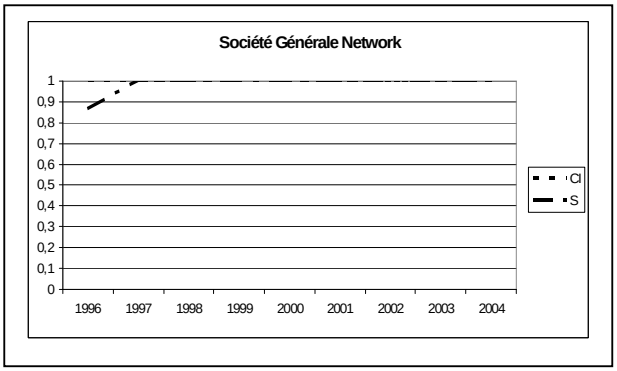
Appendix 2 : *Technical efficiency evolution according to banks shareholder's equity*

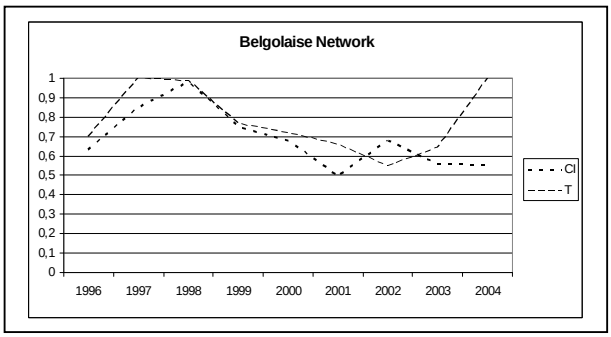


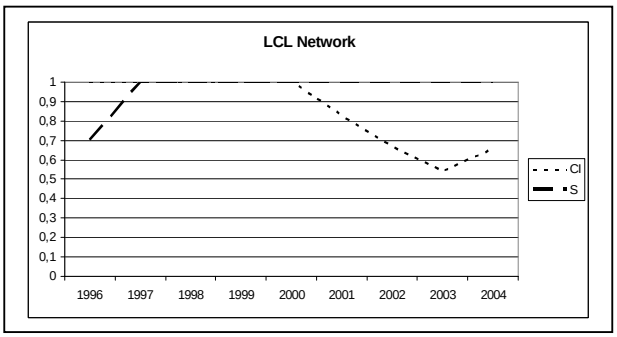


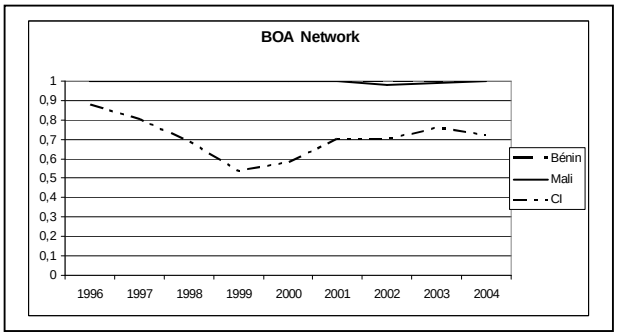
Appendix 3 : *Technical efficiency(VRS) evolution of WAEMU banks per network .*

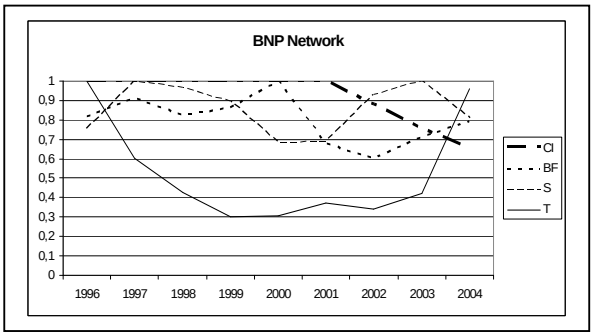




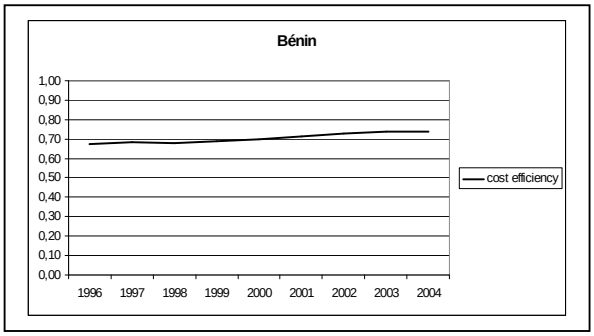


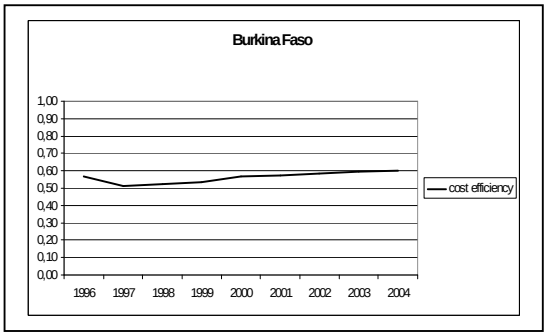


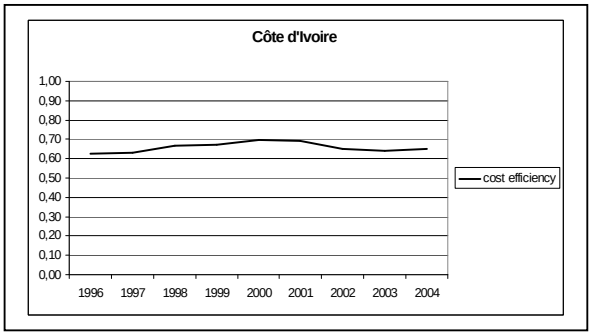


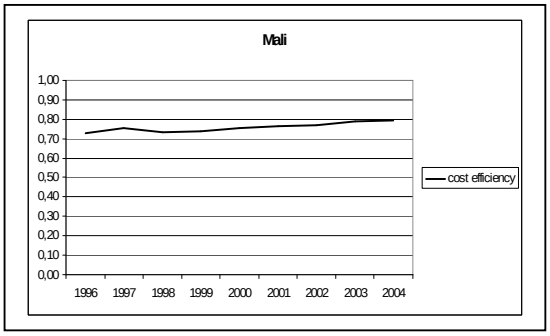


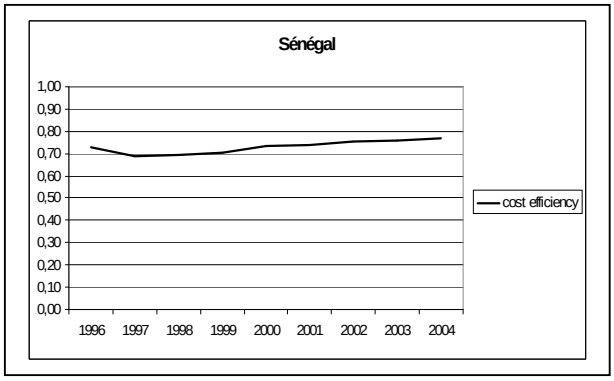
Appendix 4 *: Cost efficiency evolution of WAEMU banks per countries from 1996 to 2004*

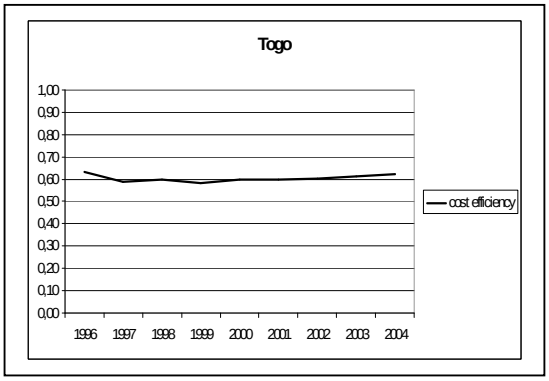


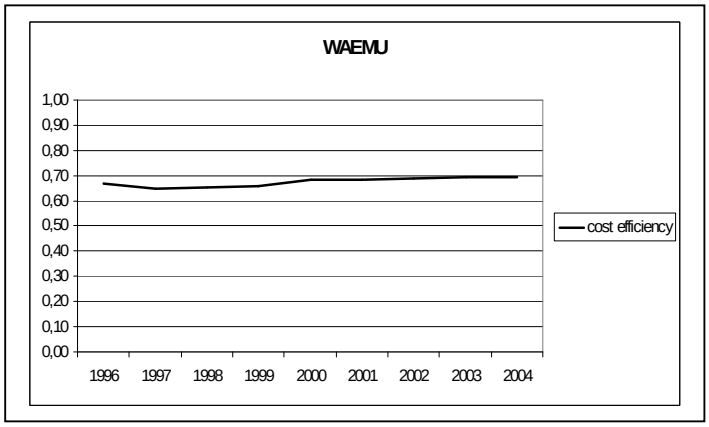




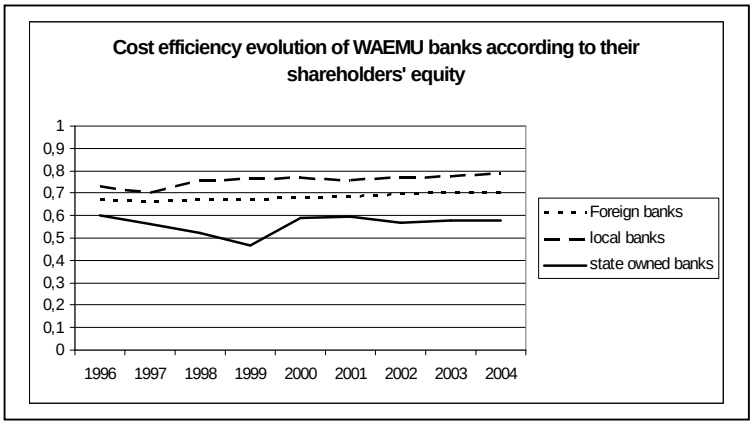




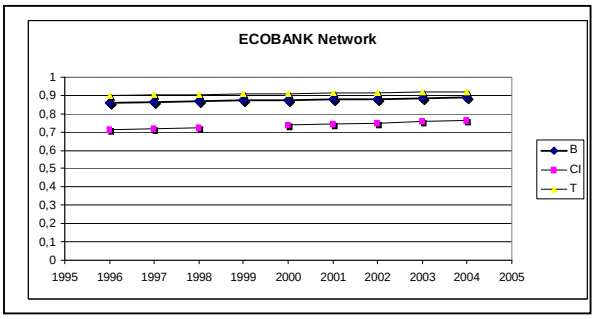


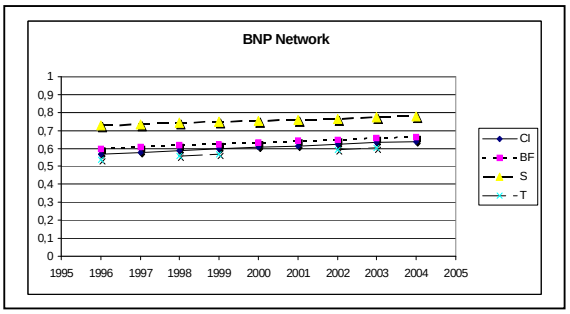


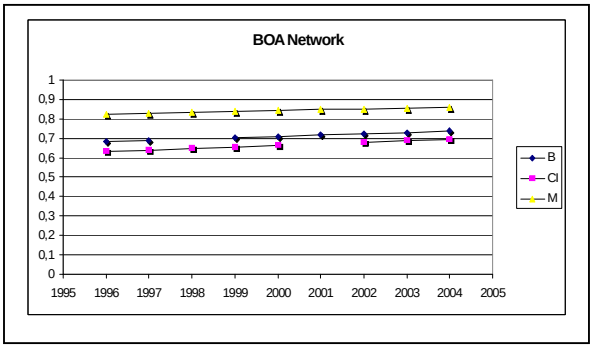
Appendix 5 : *Cost efficiency evolution according to WAEMU banks shareholder's equity*

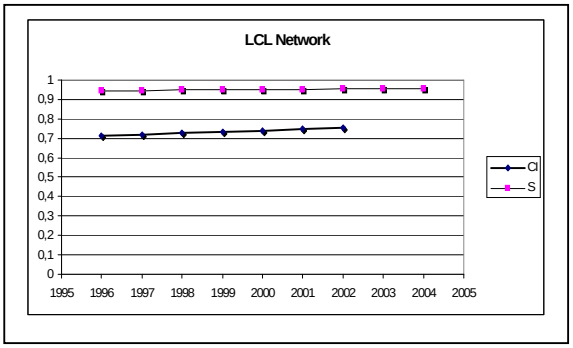


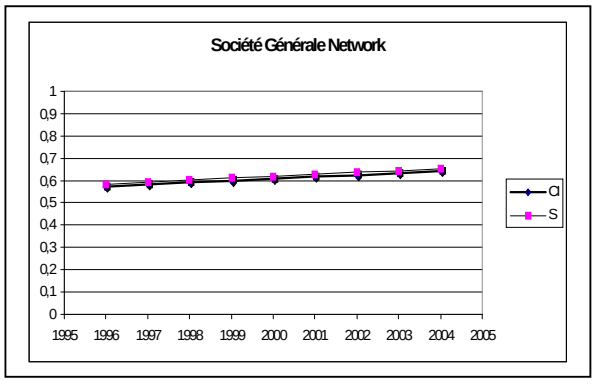
Apendix 6 : *Cost efficiency evolution of WAEMU banks per network .*











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