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Bank Specific, Banking Sector, Macroeconomic and Democratic Determinants of Bank Efficiency in CEMAC and WAEMU Countries

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Abstract

This article aims to accomplish two objectives: first, to measure the efficiency scores of banks in CEMAC and WAEMU, and to identify the factors that have influenced them over the period 2008 to 2022. To achieve these goals, we opted for a modelling framework combining the fixed-effect panel models with the stochastic frontier approach (SFA). Regarding the first objective, our results reveal that banks in the CEMAC and WAEMU countries have consistently operated beneath their optimal production capacity. As for the second objective, the findings suggest that certain bank-specific, banking sector and macroeconomic factors exert positive impact on bank efficiency, while others detract it. A close examination of democracy factors indicate their negative effect on the technical efficiency of CEMAC and WAEMU banks. However, when combining the results of the two zones (CEMAC + WAEMU), control of corruption emerges as the only significant factor contributing to diminished technical efficiency of banks. This study has the merit of presenting valuable empirical evidence to inform strategic decision-making by bankers, banking market regulators and public authorities on measures to improve technical efficiency, resilience and financial soundness within the banking sector.

Keywords: banking sector, efficiency, macroeconomy, Democracy, CEMAC, WAEMU

1. Introduction

In developing countries, the fragility and underdevelopment of financial markets render the banking sector the backbone of the financial system and an indispensable force behind credit allocation. Specifically in developing countries, members of the Economic and Monetary Community of Central Africa (CEMAC) and the West African Economic and Monetary Union (WAEMU), the banking sector appears to play a pivotal role in facilitating structural transformation of economies and progress towards achieving the sustainable development goals. However, the sector's effectiveness hinges on its capacity to mobilize low-cost savings and optimize financial services production. To meet these two requirements, banks prioritize efficiency as a core strategic objective, focusing on innovative solutions to enhance efficiency levels and maintain competitiveness.

Efficiency, a key performance metric, denotes a firm's capacity to deliver services while minimizing input costs (Drucker, 1963; Coeli et al., 2005). In the banking sector, it represents a bank's ability to optimize resource utilisation at reduce costs while maximizing returns (Alber et al., 2019; Oredegbe, 2019; Blankson et al., 2022). By measuring bank efficiency, institutions can evaluate their potential to provide financial services based on an optimal combination of available resources (Berger & Humphrey, 1997). Furthermore, a bank qualified as efficient, in its intermediation and non-intermediation financial functions is one that contributes to greater stability of financial systems as it has the potential of withstanding external shocks (Diallo, 2018). In addition, an efficient bank positions itself as the engine of progress for economies on their long-term economic growth path (Waheed & Younus, 2010).

According to Farrell (1957), the concept of overall efficiency can be decomposed into two components: technical efficiency and allocative efficiency. However, between the two components, the one that has been most studied in the banking sector is technical efficiency. The concentration of a large number of studies on technical efficiency is rooted in the pioneering work of Debreu (1951), Koopmans (1951), and Farrell (1957) on efficiency, largely focused on technical efficiency, defined as a firm's capacity to use a given quantity of inputs to produce a given quantity of goods and/or services (Alber et al., 2019). Our research focuses on this critical aspect of bank efficiency.

Since the seminal work of Debreu (1951), Koopmans (1951), and Farrell (1957), researchers have sought to provide empirical evidence on the factors influencing changes in bank's technical efficiency over time. Given the paramount importance of efficiency in the functioning in banking and economic performance, existing literature allows us to classify the work of researchers into three main groups. First, studies that are limited to the examination of internal, bank-specific determinants of bank efficiency. Second, studies that, in addition to internal determinants, include sector-specific determinants in the analysis. Third, studies that, in addition to internal and sector-specific determinants, examine the impact of macroeconomic factors on bank efficiency. In recent literature, there are emerging studies that, in addition to the aforementioned determinants, are interested in the impact of factors such as democracy on bank efficiency thereby broadening the scope of analysis beyond traditional determinants.

However, to the best of our knowledge, in the CEMAC and WAEMU member countries, no research seems to have examined the joint impact of bank-specific, banking sector-specific, macroeconomic, and democratic factors on bank's technical efficiency. Most studies focus either on bank-specific and banking market factors or on macroeconomic factors, or on both these groups of determinants. Surprisingly, never have factors such as democracy been considered as potentially affecting the evolution over time of technical efficiency scores of countries operating in these two economic and monetary unions. Yet the effect of the political environment in the analysis of the determinants of the technical efficiency of banks in these two regions seems interesting for several reasons. The two regions have high levels of corruption in the world. The stability of institutions is constantly threatened by terrorist attacks by rebels, as is currently the case in Cameroon and the Central African Republic (CEMAC), Mali and Burkina Faso (WAEMU). In addition, the two regions are now characterized by the monopolization of state mechanisms by military officers who have come to power through coups d'état. There have been coups d'état in Chad and Gabon (CEMAC), Mali and Burkina Faso (WAEMU).

In this research, in addition to the most recurring determinants of technical efficiency of banks (bank-specific, banking sector and macroeconomic determinants), we are interested in the factors of democracy on technical efficiency of banks. The study raises a double question: Are banks of the CEMAC and WAEMU member countries technically efficient in their role as financial intermediaries? What factors explain their levels of technical efficiency? Is the role of factors related to democratic governance significantly determinant?

Two hypotheses are associated with this problem, firstly, banks of the WAEMU and CEMAC countries operate below their production capacity and secondly, the factors specific to the bank, banking sector, macroeconomic and democracy, influence the evolution of technical efficiency over time. The first hypothesis seems to be justified insofar as banks of the countries considered recorded technical inefficiency scores over the study period, 2008 to 2022, which suggests that they are not operating on their optimal efficiency trajectory. Similarly, the second hypothesis is confirmed, according to our results, because the factors specific to the bank, specific to the banking sector, macroeconomic and of democracy influence, either positively or negatively the evolution over time of the technical efficiency scores of banks.

The methodology used in this research has two stages. In the first stage, we measure the technical efficiency scores of banks using the preferred stochastic frontier approach, which can provide more robust results compared to the more commonly used Data Envelopment Analysis (DEA) approach. In the second stage, we verify the determinants of technical efficiency using a Fixed-effects Panel Model. The remainder of this research is organized as follows. Section 2 provides a selective review of the literature on the determinants of bank efficiency. Section 3 presents the methodological framework adopted in this research. Section 4 presents and discusses the results, and Section 5 concludes the study.

2. Review of Selected Literature

This literature review focuses solely on the determinants specific to banks, the banking sector, macroeconomic and democratic factors included in this research.

2.1 Determinants Specific to Banks and Banking Sectors

2.1.1 Determinants Specific to the Bank

In the prevailing empirical literature, bank-specific factors emerge as the recurrent determinants of bank efficiency (Gahé & Samuel, 2020). Through these factors, authors seek to verify the effect on bank efficiency of variables such as bank size, capitalization, loan rate, deposit rate, liquidity risk and loan loss provisions (Oredegbe, 2019; Ullah, 2023; Neves, 2020, Mvono Essono, 2023; Blankson, 2022). Overall, the changes in these variables resulting from the decisions of the Board of Directors and the executive management affect bank efficiency either negatively or positively.

In the specific case of the Chinese banking sector, Antunes et al. (2021) observe that bank size has a positive influence on the evolution of bank efficiency over time. Similarly, the study by Neves et al. (2020) also suggests the positive and significant effect of bank size on the efficiency of Portuguese and Spanish banks. Most studies also highlight the positive effect of capitalization on bank efficiency. Blankson et al. (2022) find in their research on the Ghanaian banking sector a positive and significant effect of capitalization on bank efficiency. In the Canadian banking sector, Oredegbe (2019) also observed the positive and significant effect of capitalization on bank efficiency. It follows that the more a bank has sufficient equity capital and, at the same time, strictly complies with equity capital requirements, the more it will be able to increase its efficiency in the long term.

In their study on the banking sector in Côte d'Ivoire, Gahé and Samuel (2020) explain that an increase in loan rate has a positive and significant effect on technical efficiency of banks. This therefore indicates that a good internal policy of credit allocation is a source of efficiency. Furthermore, the same authors observe that the effect of the deposit rate on the technical efficiency of Ivorian banks is both negative and significant. Thus, a deposit policy that consists of increasing interest rates on deposits to attract more deposits proves to be ineffective for the bank. In fact, the implementation of such a policy leads to a reduction of the financial intermediation margin due to a significant increase in the costs related to the remuneration of deposits. Although deposits are a more stable and cheaper financial resource than other sources of financing (Neves et al., 2020), it is clear that the most efficient banks in their financial intermediation function are those that record low increases in deposits (Sufian, 2009).

Ullah (2023) indicates that risk management practices can be detrimental to bank efficiency. However, the negative effect observed proves to be statistically insignificant on bank efficiency in some cases. Blankson et al. (2022), in their study on Ghanaian banks, find that liquidity risk and loan loss provisions do not significantly affect the evolution of bank efficiency over time. This result corroborates the one found by Oredegbe (2019) on the Canadian banking sector, according to which loan loss provisions have a negative but statistically non-significant effect on bank efficiency. In the same study, Oredegbe (2019) observes the positive and significant effect of the liquidity ratio, as a measure of liquidity risk, on the efficiency of Canadian banks, indicating that the most efficient banks are the most liquid. In the Ivorian banking sector, the study by Gahé and Samuel (2020) concludes with a negative but significant effect of provisions for loan loss on bank efficiency. This therefore suggests inefficiencies in the internal management strategy of bank risks. In line with the empirical literature on the effects of bank-specific factors on bank efficiency, we formulate the following two contradictory hypotheses:

Hypothesis 1a: Bank-specific factors (size, capitalization, loan and deposit rates, loan loss provisions, liquidity) have a positive effect on bank efficiency.

Hypothesis 1b: Bank-specific factors (size, capitalization, loan and deposit rates, loan loss provisions, liquidity) have a negative effect on bank efficiency.

2.1.2 Determinants Specific to the Banking Sector

Factors specific to the banking sector are not without effects on the efficiency of banks. The work carried out is based on the efficient structure hypothesis (ESH) of Demsetz (1973), the quiet life hypothesis (QLH) of Hicks (1935) and the structure-conduct-performance hypothesis (SCPH) of Bain (1951) and Baumol (1982), which posit the existence of a positive relationship between competition and the efficiency of firms. Mvono Essono (2024) observes, in the particular case of banks in the CEMAC countries, the positive and significant effect of the market power of banks on banking efficiency, due to high market concentration. Gahé (2020) observe, indeed, that the concentration of the banking market has a positive impact on the technical efficiency of Ivorian banks, suggesting that competitive markets do not always foster the increased bank efficiency. In this perspective, Le et al. (2022) and Ullah (2023) argue that a competitive banking market, by favouring the increase in the adverse selection risk, can lead to a significant decrease in bank efficiency. However, in their work, Berger and Hannan (1998), Oredegbe (2019) conclude that too much market power can significantly harm the efficiency of banks. In this respect, as observed by Arrawatia et al. (2015), in some cases, a competitive banking environment can promote the increase in the efficiency scores of banks. The density of the banking network, by fostering increased competition between banks, disciplines the behaviour of banks in the face of risks and contributes to the increase in their efficiency. Indeed, Alber et al. (2019) and Le et al. (2022) find a positive and significant effect of banking network density on bank efficiency. However, for Harimaya and Kondo (2016), a strong expansion of the banking network can lead to cost management inefficiencies and significantly reduce the efficiency scores of banks. Based on this literature on the effects of factors specific to the banking sector on the efficiency of banks, we pose the following two contradictory hypotheses:

Hypothesis 2a: factors specific to the banking sector (banking concentration and the density of the banking network) have a positive effect on the efficiency of banks.

Hypothesis 2b: factors specific to the banking sector (banking concentration and the density of the banking network) have a negative effect on the efficiency of banks.

2.2 Macroeconomic and Democracy Determinants

2.2.1 Macroeconomic Determinants

The well-documented literature on the effects of GDP growth and inflation on banking efficiency suggests the positive effect of GDP growth on banking efficiency and the rather negative effect of inflation on the same efficiency. This is the conclusion of studies by Gayé and Samuel (2020), Neves et al. (2020), Le et al. (2022) who observe the positive and significant effect of the GDP growth rate and the negative and significant effect of inflation on the efficiency of banks in the countries and regions considered. The positive effect of GDP and in other cases GDP per capita, suggests that GDP growth, by promoting an increase in the demand for banking products and services, contributes to improving the efficiency of banks. Moreover, GDP growth, by leading to an increase in deposits and cash flows, increases the efficiency of banks in their financial operations (Defung et al., 2016). As for the negative effect of inflation on banking efficiency, it seems to result from the macroeconomic and financial instability caused by rising prices, as it increases the costs of banking inputs and reduces the value of banks’ profits, which leads to a deterioration of efficiency (Nassim et al., 2024). In some cases, the effect of GDP growth and GDP per capita can be negative. Indeed, in the Indian banking sector, Almaqtari et al. (2019) observe a negative and significant relationship between GDP growth and banking efficiency. During periods of economic prosperity, lending to companies that do not benefit from the economic upturn is a huge risk for the bank and a factor in the decline of its efficiency. They also find a negative relationship between GDP per capita and banking efficiency, which can be explained by the fact that increased GDP per capita, is accompanied by an increase in deposits and cash flows that cause the bank to incur operational and financial costs. The failure to control these costs will result in a deterioration of banking efficiency. In line with the literature, we formulate the following two contradictory hypotheses:

Hypothesis 3a: Macroeconomic factors (GDP growth, GDP per capita growth, and inflation) have a positive effect on banking efficiency.

Hypothesis 3b: Macroeconomic factors (GDP growth, GDP per capita growth, and inflation) have a negative effect on banking efficiency.

2.2.2 Determinants Related to Democracy

In the financial literature, very little research has examined the link between democracy, as a governance system, and banking efficiency. However, the few existing studies validate the existence of this link. Kamarudin et al. (2022) observe that the quality of regulation improves banking efficiency, while excessive political stability could deteriorate it. They conclude on the need to establish a strong regulatory framework through which democracy can positively influence bank efficiency. The effectiveness of this regulatory framework largely depends on its transparency and its ability to discipline bank behaviour. Nevertheless, on its own, it is not enough unless it is supported by anti-corruption policies aimed at sustainably reducing corruption levels in the country (Huang, 2010). Along the same lines, Luo et al. (2024) find that democratic governance is a real determinant of banking efficiency. Their observation corroborates the observation of Kamarudin et al. (2016), Ali et al. (2023) that good governance, guaranteed by the rule of law, contributes to improving banking efficiency because it reduces uncertainty and promotes effective decision-making in the allocation of resources by banks. Indeed, good governance proves to be an effective solution to the problems of information asymmetries between banks and borrowing clients. As such, it can promote an increase in banks’ efficiency scores. Based on this literature, we formulate the following two contradictory hypotheses:

Hypothesis 4a: Democracy (political stability, government effectiveness, regulatory quality, and control of corruption) has a positive effect on banking efficiency.

Hypothesis 4b: Democracy (political stability, government effectiveness, regulatory quality, and control of corruption) has a negative effect on banking efficiency.

Thus, considering the bank-specific, banking sector, macroeconomic, and democratic determinants retained in this research, figure 1 presents the conceptual model that emerges from the literature review and the formulated hypotheses is as follows:

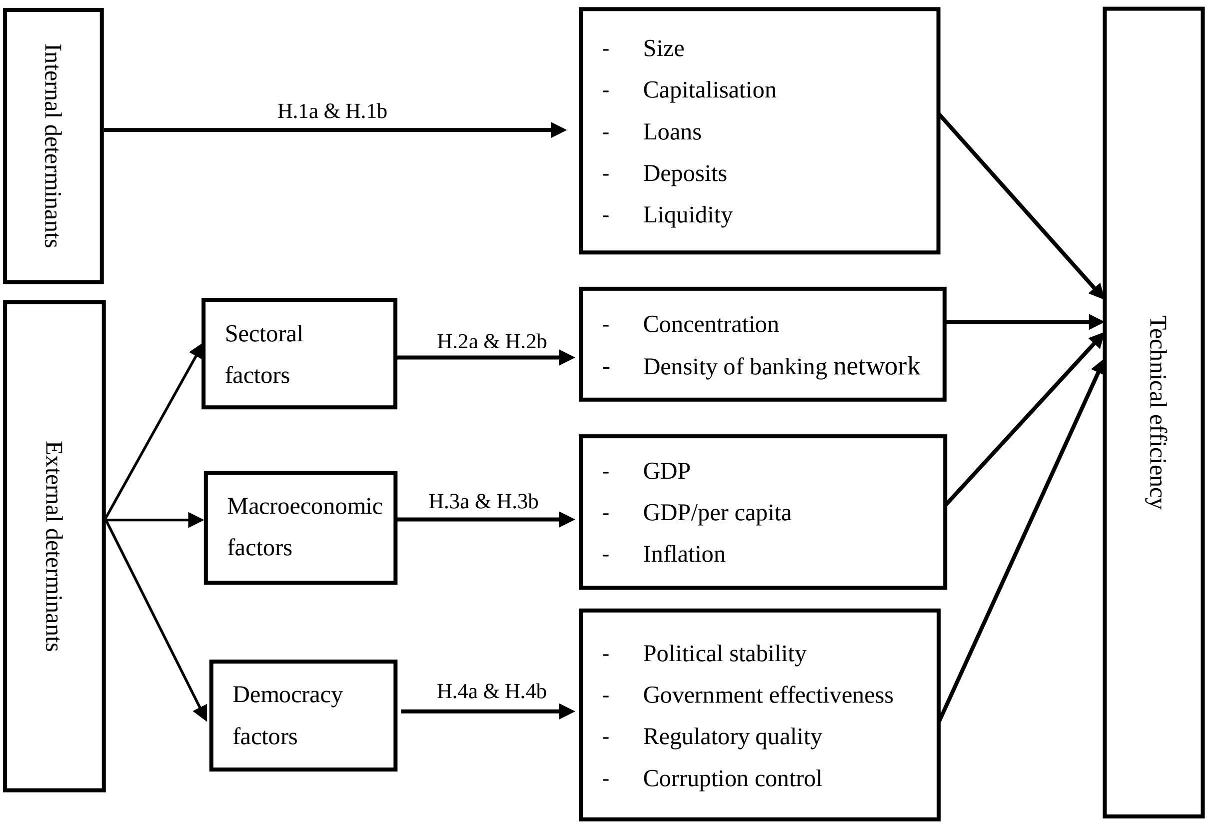

Figure 1. Conceptual framework of the study

Source: Authors.

Building upon this conceptual framework and the associated hypotheses, the objective of this study is to verify, for banks operating in the CEMAC and WAEMU countries, the bank-specific, banking sector, macroeconomic, and democratic factors that are likely to either improve or deteriorate the technical efficiency of banks over time.

3. Methodology and Data

This section is organized into two subsections. The first presents the methodological framework for measuring the technical efficiency scores of banks. The second discusses the regression model adopted in this research to identify the factors influencing the technical efficiency of banks.

3.1 Approach to Measuring Technical Efficiency

Technical Efficiency: A Metric estimated using Stochastic Frontier Analysis (SFA)

The literature on firm efficiency offers two main methods for measuring efficiency scores: parametric and non-parametric approaches. The parametric approaches include Stochastic Frontier Analysis (SFA), Thick Frontier Approach (TFA), and Distribution-Free Approach (DFA), while the non-parametric approaches include Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH). Each of these measurement approaches has advantages and disadvantages that are well documented in the literature (Le et al., 2022). It is therefore difficult to establish the superiority of one over the other, especially since they can provide similar or quasi-similar results. Moreover, it appears that there are no better methods for measuring efficiency (Berger & Mester, 1997; Bauer et al., 1998). According to Seiford and Thrall (1990), the DEA approach, a non-parametric method, is the most commonly used in the banking sector thanks to its potential to generate results that are more robust. However, like all approaches, DEA has three major limitations that can make the results less robust (Antunes et al., 2021). First, the efficiency scores are too sensitive to the choice of inputs and outputs; second, the failure to account for statistical noise can lead to biased results; and finally, the efficiency scores obtained through the DEA approach are too sensitive to measurement errors. In view of these limitations, in this research, we prefer the Stochastic Frontier Analysis (SFA) approach, an econometric method whose main advantage lies in the specification of a production function that can take the form of a Cobb-Douglas, Translog, or Constant Elasticity of Substitution (CES) production function.

Thus, drawing on the work of Nabi et al. (2020), the functional form adopted in this research is specified as follows:

$$Y_{it} = e^{(\beta X_{it} + V_{it} - U_{it})}, \text{ i=1,..... N; t=1, 2,.....T} \quad (1)$$

Where Y_{it} represents the total outputs for bank i at time t; X_{it} is the vector of banking inputs for the bank i at time t. β is a vector of unknown parameters to be estimated. V_{it} represents random errors, which are assumed independent, bilateral, and identically distributed according to a normal distribution with a mean of zero and a variance of $\sigma^2 v$. U_{it} are non-observable random variables and represent the measure of technical inefficiencies of bank i in period t. Based on the production function thus specified, Battese and Coelli (1992) measure the technical inefficiencies U_{it} as follows:

$$U_{it} = U_i \, e^{(-\eta(t-T)} \quad (2)$$

With η, an unknown scalar parameter to be estimated, allowing to determine whether Technical Efficiency (TE) scores increase (η<0) or remain constant (η =0), or decrease (η >0) over time (Battese & Coelli, 1992; Nabi et al., 2020). In the SFA approach, the technical efficiency of bank i's production in the year t is calculated as follows:

$$\text{TE} = e^{(-U_{it})} \quad (3)$$

Banking inputs and outputs

To define the inputs and outputs of a bank, previous studies in this research have favoured either the production approach or the intermediation approach. The approach we prefer for in this study is the financial intermediation approach. This choice is motivated by the fact that the traditional activity, which still occupies the largest share of the net banking income of banks in CEMAC and WAEMU, is financial intermediation. The technical efficiency evaluation model for banks includes two types of variables: an input variable and an output variable. The input variable is the total (banking and non-banking) loans granted by banks in the short, medium, and long term. The banking input variables are four in number: bank deposits, personnel expenses, physical assets, and time. Bank deposits represent the total of the bank's demand and time deposits from clients. Personnel expenses are equal to the total wage and social security costs borne by banks, and physical capital is equal to the tangible assets held by banks. Time, as an input variable, allows verifying the variation in the technical efficiency of banks over the study period.

Basic Regression Model

To estimate the technical efficiency scores of banks using the SFA approach, the functional form retained in this research is of the Cobb-Douglas type. This function has bank loans (banking output) as the dependent variable and the four banking inputs, namely bank deposits, banks' physical assets, personnel expenses, and time, as independent variables. Thus, the model to be estimated takes the following form:

$$ln\,(TBC) = \beta_0 + \beta_1 ln(TBD_{it}) + \beta_2 ln(TPE_{it}) + \beta_3 ln(TPA_{it}) + \beta_4 ln(Time) + v_{it} + u_{it} \quad (4)$$

$$i=1,2,3\ldots6,\ t=1,2,3,\ldots10$$

In this equation, TBC represents the total bank credits of bank i during period t; TBD is the total bank deposits of bank i at time t; TPE represents the total personnel expenses of bank i at time t; TPA is the total physical assets of bank i at time t, and Time represents the year. v is the error term, and u represents the unknown parameters to be estimated.

3.2 Regression Model of the Determinants of Technical Efficiency

3.2.1 Specification of the Empirical Model

In this research, we want to identify the factors that affect the technical efficiency of banks in the CEMAC and WAEMU countries over the period 2008 to 2022. To achieve this objective, the model we will estimate is as follows:

$$Y_{it} = \beta + \beta_1 X_{it} + \beta_2 Z_{it} + \beta_3 C_{it} + \beta_4 P_{it} + \beta_5 O_{it} + \varepsilon_{it} \quad (5)$$

Where, Y_{it} represents the endogenous variable, the technical efficiency (TE) of bank i at time t. X_{it} the vector of bank-specific determinants (size, capitalization, loan rate, deposit rate, risk provisions, and liquidity). C_{it}

designates the vector of sectoral determinants (banking network density and banking market concentration). P_{it} is the vector of macroeconomic determinants (GDP growth rate, inflation rate, and GDP per capita growth rate), and O_{it}, the vector of political determinants (political stability, government effectiveness, regulatory quality, and control of corruption). ε_{it} denotes the error term of bank i at time t.

The models with the integration of all the variables are as follows:

$$Y_{it} = \beta + \beta_1 size_{it} + \beta_2 CAPI_{it} + \beta_3 LR_{it} + \beta_4 DR_{it} + \beta_5 LQD_{it} + \beta_6 PR_{it} + \varepsilon_{it} \quad (6)$$

$$Y_{it} = \beta + \beta_1 Size_{it} + \beta_2 CAPI_{it} + \beta_3 LR_{it} + \beta_4 DR_{it} + \beta_5 LQD_{it} + \beta_5 PR_{it} + \beta_5 DBN_{it} + \beta_5 BC_{it} + \varepsilon_{it} \quad (7)$$

$$Y_{it} = \beta + \beta_1 size_{it} + \beta_2 CAPI_{it} + \beta_3 LR_{it} + \beta_4 DR_{it} + \beta_5 LQD_{it} + \beta_5 PR_{it} + \beta_5 DBN_{it} + \beta_5 BC_{it} + \beta_5 GDP_{it} + \beta_5 GDPC_{it} + \beta_5 INFL_{it} + \varepsilon_{it} \quad (8)$$

$$Y_{it} = \beta + \beta_1 size_{it} + \beta_2 CAPI_{it} + \beta_3 LR_{it} + \beta_4 DR_{it} + \beta_5 LQD_{it} + \beta_5 PR_{it} + \beta_5 DBN_{it} + \beta_5 BC_{it} + \beta_5 GDP_{it} + \beta_5 GDPC_{it} + \beta_5 INFL_{it} + \beta_5 PS_{it} + \beta_5 EG_{it} + \beta_5 QR_{it} + \beta_5 CC_{it} + \varepsilon_{it} \quad (9)$$

3.2.2 Description of Variables

The study is interested in four groups of variables: (i) the group of bank-specific determinants of technical efficiency, (ii) the group of variables specific to the banking sector, (iii) the group of macroeconomic variables, and (iv) the group of political governance variables. The table 1 below presents the variables of these four groups:

Table 1. Description of the study variables

variable	Name	Code	Measurement Method
Dependent	Technical efficiency	TE	SFA Method
Bank specific determinants	Size	Size	Logarithm of total assets
	Capitalisation	CAPI	Own funds/ Total Assets
	Loan rate	LR	Loan growth (annual %)
	Deposit rate	DR	Deposit growth (annual %)
	Provision for risk	PR	Provision for risk growth
	Liquidity	LQD	Loans / deposits
Industry specific	Density of banking network	DBN	Logarithm of branch count
	Banking concentration	BC	Herfindhal-Hirchman index
Socio-economic determinants	Gross Domestic Product	GDP	GDP growth (annual %)
	Inflation	INFL	Inflation rate (annual %)
	GDP per capita	PGDPH	GDP per capita rate (annual %)
Political determinants	Political stability	PS	Average political score
	Government effectiveness	GE	Average government effectiveness score
	Regulatory quality	RQ	Average regulatory quality score
	Control of corruption	CC	Average control of corruption score

3.2.3 Sample and Data Sources

Two samples are considered in this research. On the one hand, the sample of eight (8) member countries of the WAEMU (Benin; Burkina Faso; Côte d'Ivoire; Guinea-Bissau; Mali; Niger; Senegal; Togo) and the sample of six (6) member countries of CEMAC (Cameroon; Central African Republic, Congo, Gabon, Equatorial Guinea, Chad). These are two economic and monetary unions, members of the franc zone, linked by the common use of the CFA franc and the monetary cooperation agreements signed with France since the colonial era.

The data feeding this study are extracted from several databases for the period 2008 to 2022. Two reasons motivated the choice of this study period. Firstly, the availability of financial data and, secondly, the need to cover the crisis periods, particularly the COVID-19 crisis, the most recent, which has negatively affected the efficiency of banks in their primary function of financial intermediation (Mvono Essono, 2023). The data on bank inputs and outputs are extracted from the annual reports of the banking commissions and central banks of Central and West Africa. The same applies to the data on the determinants of technical efficiency specific to the bank and the banking sector. The data on the macroeconomic and political governance determinants of technical efficiency come from the World Bank's databases, the Development Indicator World (2022) and the Worldwide Governance Indicators (2022). The table 2 below presents the descriptive statistics on the determinants of technical efficiency.

Table 2. Descriptive statistics on the variables

	CEMAC					WAEMU				
Variables	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
TE	90	0.776	0.145	0.428	0.998	120	0.846	0.125	0.517	0.999
Size	90	6.109	0.443	5.056	6.799	120	6.139	0.627	4.148	7.334
CAPI	90	0.112	0.053	0.027	0.304	120	0.108	0.132	-0.038	1.470
LR	90	0.600	0.108	0.286	0.818	120	0.598	0.663	0.346	7.751
DR	90	0.740	0.082	0.542	0.882	120	0.682	0.366	0.386	4.546
LQD	90	0.819	0.203	0.337	1.305	120	0.856	0.236	0.509	1.832
PR	90	0.077	0.056	0.009	0.390	120	0.090	0.053	0.003	0.275
DBN	90	1.656	0.375	0.845	2.350	120	2.350	0.433	1.041	3.049
BC	90	0.241	0.091	0.105	0.438	120	0.123	0.042	0.062	0.297
GDP	90	1.776	6.356	-36.39	17.79	120	4.820	2.547	-5.370	11.48
GDPC	90	-1.110	6.081	-36.77	12.33	120	1.883	2.464	-7.314	8.499
INFL	90	3.078	2.720	-2.077	14.89	120	2.820	3.089	-3.370	14.29
PS	90	-0.791	0.808	-2.699	0.384	120	-0.734	0.666	-2.479	0.403
GE	90	-1.209	0.308	-2.699	-0.605	120	-0.718	0.440	-1.807	0.055
RQ	90	-1.148	0.318	-1.879	-0.435	120	-0.611	0.320	-1.321	-0.073
CC	90	-1.246	0.262	-1.798	-0.634	120	-0.653	0.391	-1.597	0.058

3.3 Estimation Techniques

Regarding the estimation of the parameters of the Cobb-Douglas function, we used the FRONTIER software program, under Stata 18. Two models were estimated to obtain the maximum likelihood estimates for the parameters of the stochastic frontier model. To evaluate the technical efficiency scores of banks, two models were therefore estimated: Model 1-CEMAC and Model 2-WAEMU. As for the determinants of technical efficiency, we estimate four (4) models in order to identify the determinants of the technical efficiency of banks in the CEMAC and WAEMU countries. Model 1 is limited to the internal determinants of bank efficiency only. Model 2, in addition to the internal determinants, includes the sectoral determinants of the technical efficiency of banks. Model 3, in addition to the internal and sectoral variables, includes the socio-economic variables. Model 4, finally, in addition to the variables specific to the bank, specific to the banking sector and the socio-economic variables, includes the democracy variables in the analysis.

We used the Spearman correlation matrix to check the correlation between the variables. According to the results of this matrix (Appendix 1: Model 1-CEMAC and Appendix 2: Model 2-WAEMU), none of the variables is strongly correlated to the point of creating serious multicollinearity problems. We also verified the stationarity of the variables using the Levin-Lin-Chu (LLC) unit root test, considered relevant and effective for small panel models. The results of this test (Appendix 3) reject the null hypothesis of the existence of a unit root at the 1% level, confirming the stationarity of the variables for the CEMAC and WAEMU models.

To estimate these models, we used fixed-effects and random-effects panel models. The Breusch and Pagan (1980) Lagrange multiplier test allows us to choose between a pooled panel model and the alternative fixed-effect and random-effect models. The results of this test suggest that the variances between groups are not zero, confirming the existence of a panel effect. Following the Breusch and Pagan test, the Hausman (1978) specification test was performed. The results for all models indicate that fixed effects are much better than random effects. To detect any potential heteroscedasticity problems, we performed the Breusch-Pagan/Cook-Weisberg test. The results of this test indicate the presence of heteroscedasticity in all models. To solve this problem, we had preference for the fixed-effects regression models with Rogers' (1993) "clustered robust" standard errors, which have the advantage of generating coherent and robust estimators. The Wooldrige (2010) test was also performed to verify any potential autocorrelation problems. The results obtained suggest the existence of a first-order autocorrelation for all models. To solve this, we used fixed effects with AR (1) disturbance for all models.

4. Results and Discussions

4.1 Results of Technical Efficiency

4.1.1 Estimation of the Cobb-Douglas Production Function

Table 3 below presents the results of the maximum likelihood estimation of the Cobb-Douglas production function obtained using the Frontier 4.1 software under Stata. The positive or negative sign of the coefficients of the input variables indicates that the corresponding variable increases or decreases the bank's production.

Table 3. Results of the estimation of the Cobb-Douglas production function

Variables	Parameters	Model 1-CEMAC	Model 2-WAEMU
Constant	β_0	0.888***	0.562***
		(0.050)	(0.118)
Deposits	β_1	0.944***	0.626***
		(0.050)	(0.057)
Fixed assets	β_1	0.013 **	0.249***
		(0.052)	(0.057)
Staff costs	β_1	-0.004	0.102*
		(0.042)	(0.060)
Time	β_1	-0.496**	0.070*
		(0.225)	(0.037)
sigma-squared	σ^2	0.003	0.009
		(0.001)	(0.002)
gamma	γ	0.048	0.026
		(0.038)	(0.003)
mu	μ	0.065**	-0.609**
		(0.030)	(0.289)
eta	η	0.178***	0.436***
		(0.019)	(0.059)
Prob>chi2		0.0000	0.0000

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Source: Authors.

The results indicate that in the CEMAC Model 1, bank deposits and fixed assets have a positive and significant effect on banking production at the 1% and 5% significance levels, respectively. However, in the same model, the effect of personnel expenses is negative and insignificant, while the negative effect of the time variable on banking production is significant at the 5% level. Overall, 94.4% of banking production is the result of bank deposits. Consequently, bank deposits are the most important determinant of the production of banks in the CEMAC countries. The negative and significant coefficient of the time variable suggests that the production of CEMAC banks has experienced a downward trend over the entire study period. In the WAEMU Model 2, all the coefficients of the input variables are positive and significant. As such, they all contributed to the increase in the production of WAEMU banks. The most determining factor is bank deposits, which explain 62.6% of the evolution of bank production. It is followed by the weight of fixed assets in banking production, estimated at 24.9%. In addition, personnel expenses have a favourable effect on banking production as they increase the efficiency of the bank's human capital. The negative and significant effect of the time variable here means that the production of banks operating in the WAEMU countries has experienced an upward trend over the study period.

In both models (Model 1-CEMAC and Model 2-WAEMU), the values of σ and μ reveal that banking production is not situated on the optimal production frontier due to the existence of internal inefficiencies in banks. In both models, the estimated value of μ (0.665) (Model 1-CEMAC) and μ (0.609) (Model 2-WAEMU), significant at the 5% significance level, respectively indicate that 6.5% of the difference between actual production and potential production of banks and 66.5% of the same difference result from their technical inefficiency. The results also show a positive and significant η at 1% of 0.178 (Model 1-CEMAC) and 0.436 (Model 2-WAEMU). This suggests that the effects specific to the banking industries associated with technical efficiency vary over time and that at the same time technical inefficiencies have decreased between 2008 and 2022.

4.1.2 Estimated Technical Efficiency Scores

This section presents and interprets the technical efficiency scores of banks in the CEMAC and WAEMU countries over the period 2008-2022. A score equal to unity (1) indicates that the bank is operating on its optimal production frontier, signifying peak performance. Conversely, a score below unity (1) suggests that the bank is operating below its optimal production capacity, thereby rendering it technically inefficient. The further the score deviates from unity (1), the more pronounced the technical inefficiency. The accompanying figure 2 illustrate the trajectory of technical efficiency scores over the specified period.

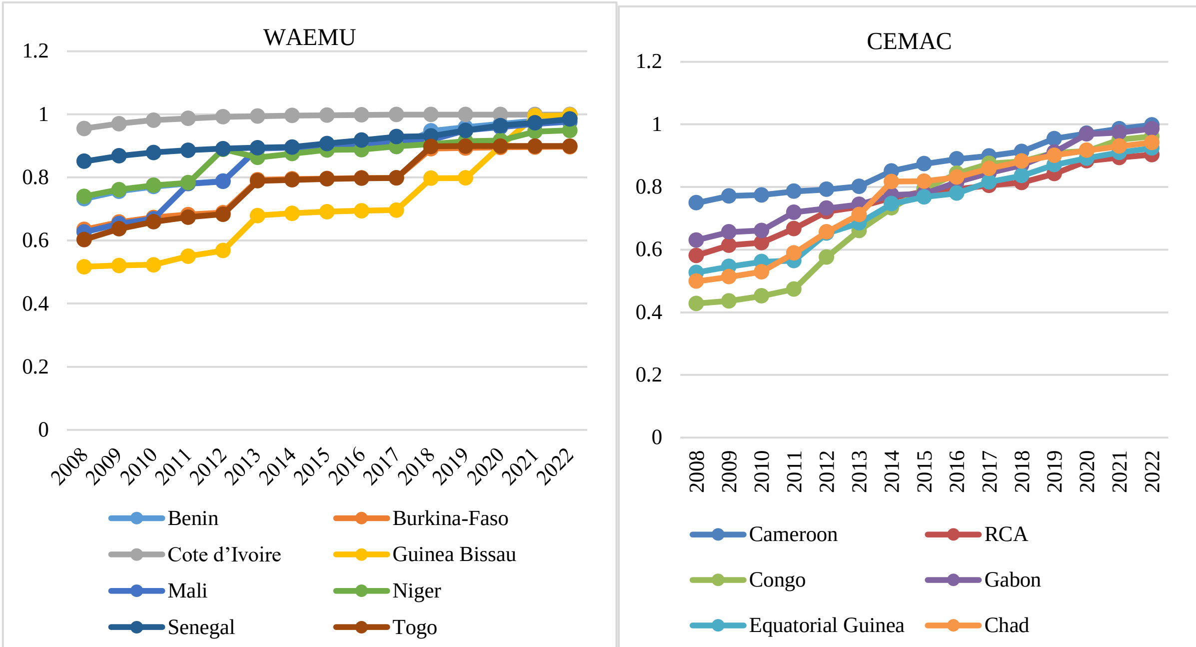

Figure 2. Evolution of technical efficiency in banks

Source: Authors.

The technical efficiency scores of the eight (8) banking sectors in the WAEMU region fall below their optimal production frontier. However, a clear positive trend in technical efficiency scores is observed across these eight sectors over the study period. Overall, the evolution of efficiency scores is positive. A similar observation can be made in the CEMAC region, where all six (6) banking sectors operate below their production capacities, with technical efficiency scores below the optimal threshold of 100%. Nevertheless, in all CEMAC countries, there is a strong upward trend in technical efficiency scores.

In both banking systems, over the period 2008-2022, the average technical efficiency scores by country and rank are presented in the following table 4:

Table 4. Technical efficiency and inefficiency scores in WAEMU and CEMAC

Average Technical Efficiency Scores of WAEMU Banks			
Country	**Technical efficiency**	**Technical inefficiency**	**Rank**
Benin	0,876	0,124	3rd
Burkina-Faso	0,785	0,215	6th
Cote d'Ivoire	0,990	0,010	1st
Guinea Bissau	0,707	0,293	8th
Mali	0,852	0,148	5th
Niger	0,866	0,134	4th
Senegal	0,914	0,086	2nd
Togo	0,782	0,218	7th
WAEMU	**0,846**	**0,154**	-
Average Technical efficiency scores of CEMAC Banks			
Country	**Technical efficiency**	**Technical inefficiency**	**Rank**
Cameroon	0,867	0,133	1st
RCA	0,762	0,238	3rd
Congo	0,726	0,274	6th
Gabon	0,804	0,196	2nd
Equatorial Guinea	0,739	0,261	5th
Chad	0,760	0,240	4th
CEMAC	**0,776**	**0,224**	-

Source: Authors.

The average technical efficiency scores by region and by country are generally less than 1 (100%). This implies that banks in these countries can save resources to the level of their technical inefficiency score while producing the current level of banking outputs.

In the WAEMU, the Ivorian banking sector obtains an average score of 99% and ranks first with a technical inefficiency of 1%. The Senegalese banking sector ranks second with an average technical efficiency score of 91.4%, i.e. a technical inefficiency score of 8.6%. It is followed by the Beninese banking sector, with an average score of 87.6%, i.e. a technical inefficiency of 12.4%, thus occupying the third rank in the ranking. The banking sectors of Niger and Mali occupy the fourth and fifth places respectively, with average technical efficiency scores of 86.6% and 85.2%, i.e. technical inefficiency scores of 13.4% and 14.8% respectively. The sixth position is occupied by the Burkinabe banking sector, which recorded an average technical efficiency score of 78.5% over the study period, i.e. a technical inefficiency of 21.5%. The Togolese banking sector occupies the second-to-last rank, with a technical efficiency score of 78.2%, i.e. a technical inefficiency of 21.8%. The last position is occupied by the Burkinabe banking sector, which recorded an average technical efficiency score of 70.7%, i.e. a technical inefficiency level of 29.3% over the entire study period.

In the CEMAC zone, the Cameroonian banking sector appears to be the most technically efficient and thus occupies the first rank with an average technical efficiency score of 86.7%, i.e. a technical inefficiency score of 13.3%. The Gabonese and Central African banking sectors occupy the second and third ranks respectively, with technical efficiency scores of 80.4% and 76.2%, i.e. Technical inefficiency scores of 27.4% and 23.8% respectively. The fourth and fifth ranks are respectively occupied by the banking sectors of Chad and Equatorial Guinea, which recorded technical efficiency scores of 76% and 73.9%, i.e. technical inefficiencies of 24% and 26.1% respectively. Finally, the Congolese banking sector ranks sixth with an average technical efficiency score of 72.6%, i.e. a technical inefficiency of 27.4% over the entire period.

According to table 5, the aggregation of average technical efficiency scores over the period 2008 to 2022 shows that the technical efficiency scores of the WAEMU banks are slightly higher than those recorded by banks operating in the CEMAC countries over the same period.

Table 5. Evolution of the aggregated technical efficiency scores of WAEMU and CEMAC

Years	WAEMU	CEMAC	Gap (WAEMU-CEMAC)
2008	0,707	0,569	0,138
2009	0,728	0,589	0,138
2010	0,741	0,599	0,141
2011	0,765	0,633	0,132
2012	0,785	0,688	0,097
2013	0,849	0,723	0,125
2014	0,853	0,781	0,072
2015	0,858	0,803	0,055
2016	0,860	0,825	0,035
2017	0,866	0,849	0,016
2018	0,910	0,866	0,044
2019	0,920	0,898	0,022
2020	0,937	0,924	0,013
2021	0,956	0,940	0,016
2022	0,961	0,952	0,009
Average	0,846	0,776	0,070

Source: Authors.

4.2 Determinants of Technical Efficiency of Banks in CEMAC and WAEMU

The table 6a and the table 6b below presents the results on the factors that can deteriorate or improve the technical efficiency of banks in CEMAC and WAEMU over the period 2008-2022.

Table 6a. Determinants of bank technical efficiency

	CEMAC			
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Size	1.159*** (0.141)	0.867*** (0.163)	0.833***(0.187)	0.815*** (0.152)
CAPI	0.537***(0.128)	0.324 (0.226)	0.250 (0.265)	0.400*(0.181)
LR	1.454***(0.225)	0.767**(0.323)	0.753***(0.282)	0.701**(0.297)
DR	-0.625* (0.332)	-0.077(0.315)	-0.221 (0.322)	-0.075(0.296)
LQD	-0.438** (0.147)	-0.129(0.169)	-0.252 (0.198)	-0.158 (0.195)
PR	0.029 (0.395)	0.142 (0.350)	0.043 (0.305)	-0.0560 (0.242)
DBN		0.394*** (0.158)	0.322*** (0.154)	0.249** (0.165)
BC		-0.741**(0.398)	-0.848*** (0.390)	-0.655** (0.443)
GDP			-0.061***(0.036)	-0.039** (0.032)
GDPC			0.064*** (0.037)	0.041** (0.033)
INFL			-0.003 (0.001)	-0.006** (0.001)
PS				-0.056** (0.026)
GE				-0.006 (0.104)
RQ				-0.169** (0.065)
CC				-0.075 (0.061)
Constant	-6.498*** (1.108)	-5.418*** (0.988)	-4.643*** (1.083)	-5.023*** (0.879)
F-Test	121.80***	118.88***	101.13***	87.60***
R^2(Within)	0.9036	0.9260	0.9384	0.9501
Number of countries	6	6	6	6
Observations	90	90	90	90
Hausman Test	60.96***	63.30***	61.48***	49.43***
B-P/Cook-Weisberg Test	14.15**	8.60	0.78	3.36
Wooldridge Test	64.000***	37.867***	54.18***	51.799***
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1				

Source: Authors.

Table 6b. Determinants of bank technical efficiency

	WAEMU			
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Size	0.043*** (0.017)	0.027***(0.006)	0.028*** (0.005)	0.032*** (0.005)
CAPI	-0.005 (0.072)	0.012 (0.054)	0.013 (0.049)	0.030(0.046)
LR	0.100** (0.042)	0.107*** (0.036)	0.066*(0.035)	0.054 (0.033)
DR	-0.163**(0.068)	-0.187*** (0.059)	-0.117** (0.057)	-0.101* (0.053)
LQD	0.027(0.037)	-0.032 (0.032)	0.005(0.031)	0.024 (0.029)
PR	0.015(0.046)	-0.0004 (0.039)	-0.0095 *(0.035)	-0.007 (0.041)
DBN		0.043*** (0.009)	0.034*** (0.009)	0.034***(0.008)
BC		-0.049*** (0.011)	-0.039***(0.011)	-0.038***(0.009)
GDP			-0.039***(0.011)	-0.054***(0.011)
GDPC			0.040*** (0.011)	0.055*** (0.011)
INFL			-0.002***(0.001)	-0.002***(0.001)
PS				-0.006 (0.004)
GE				-0.018* (0.010)
RQ				0.063*** (0.013)
CC				-0.018* (0.010)
Constant	0.743*** (0.083)	0.865*** (0.08)	0.093*** (0.083)	0.931*** (0.077)
F-Test	12.35***	18.34***	18.56***	17.61***
R^2(Within)	0.4114	0.5852	0.6691	0.7314
Number of countries	8	8	8	8
Observations	120	120	120	120
Hausman Test	14.49**	55.70***	44.049***	51.47***
B-P/Cook-Weisberg Test	109.8***	141.2***	118.01***	51.42****
Wooldridge Test	936.6***	243.6***	105.42***	110.41***
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1				

Source: Authors.

Table 6a and table 6b above is a balance sheet of the main results of the study obtained from the estimation of four models per banking system (CEMAC and WAEMU). Globally, the results obtained on the bank-specific determinants for all models are interesting. Indeed, they indicate that size has a positive and significant effect on the technical efficiency of banks in CEMAC and WAEMU. These results correspond with those found by Neves et al. (2020) and Blankson et al. (2022) in their study. Overall, the positive and significant coefficient of size means that the larger a bank grows, the more it is able to increase its technical efficiency. A larger size bestows on the bank the ability to achieve economies of scale by offering a wide range of financial services while minimizing costs. Capitalization positively and significantly influences the efficiency of CEMAC banks (Models 1 and 4), while its effect is generally insignificant in the WAEMU area. The positive and significant effect observed in the CEMAC region is consistent with the study by Oredegbe (2019) who concludes on the positive influence of capitalization on bank efficiency. This positive and significant effect seems to be the result of a better and stricter application of equity requirements such as the minimum Basel 3 capital requirement. The coefficient associated with this variable, which is 0.537 (Model 1-CEMAC), suggests that a 1% increase in bank capitalization improves the technical efficiency of banks by 53.7%. The best-capitalized banks are therefore the most technically efficient.

The results suggest the positive and significant effect of the loan rate on the technical efficiency of banks in CEMAC and WAEMU. This result concurs with the literature on the technical efficiency of banks, which highlights the positive and significant effect of the loan rate on the technical efficiency of banks (Gayé & Samuel, 2020). However, this is only possible when banks have a perfect mastery of the risks incurred during loan granting operations. This seems to be the case for banks in the CEMAC and WAEMU zones, where financial intermediation remains the main activity. In these two banking systems, the underdevelopment of financial markets automatically places banks at the heart of financing the economy. As such, they monitor the efficiency of their loan policy, which is regulated by the prevailing banking regulations. Contrary to bank loans, the results show the negative and significant effect of the deposit rate on the technical efficiency of banks in CEMAC (Model 1) and WAEMU. This result also corroborates with the literature on bank efficiency. This result is justified by the fact that the increase in bank deposits, because it is accompanied by an increase in the bank's market share, implies additional costs of remunerating deposits. These costs, when significant or poorly controlled, can deteriorate the efficiency of banks. The deterioration of technical efficiency will become more significant when the rate of transformation of deposits into loans is sufficiently low, as is the case in the countries of CEMAC and WAEMU. In this regard, Sufian (2009) indicates that the most technically efficient banks in their traditional function of financial intermediation are those that record a low growth in their bank deposits.

Concerning liquidity, the results suggest its negative and significant effect in the banking sector of CEMAC (Model 1) at the significant threshold of 5%, while its effect is rather insignificant in the WAEMU zone. In the CEMAC zone, this result indicates that banks become less technically efficient when their level of liquidity increases. Bank liquidity is normally a good thing. It becomes a handicap for technical efficiency when banks find themselves in a situation of excess banking liquidity. This is the observation that emerges in the CEMAC zone where most, if not all, banks are in a situation of excess banking liquidity. They have sufficient resources that they do not allocate in the form of credit due to a very low risk appetite. As for loan loss provisions, their effect appears negative and significant at a 10% threshold in the WAEMU banking system (Model 3). It follows that an increase in loan loss provisions, the result of ineffective risk management strategies, not only impairs profitability but also and above all the technical efficiency of banks.

Concerning variables specific to the banking sector, the results indicate that the density of the banking network has a positive and significant effect on the technical efficiency of banks in CEMAC and WAEMU. The expansion of branches is therefore a means of improving technical efficiency as it allows for optimal use of available resources. Conversely, the results suggest that greater concentration of the banking market is negatively associated with the technical efficiency of banks in CEMAC and WAEMU. As indicated by Demirguc-Kunt et al. (2004) and Berger, Hannan (1998), Oredegbe (2019), the concentration of the banking market by hindering competition between banks has a negative effect on the time variation of their technical efficiency. It is therefore necessary to improve the conditions of banking competition in the CEMAC and WAEMU zones in order to improve the technical efficiency scores of banks.

Regarding macroeconomic determinants, the results show the negative and significant effect of GDP growth rate on the technical efficiency of banks in CEMAC and WAEMU countries. It appears that banks can become technically less efficient during periods of economic prosperity. This result is not in line with the dominant literature on bank efficiency, in which most studies establish a positive and significant link between GDP growth and bank efficiency (Gayé, 2020; Neves et al., 2020; Le et al., 2022). However, it is in line with the results of the study by Almaqtari et al. (2019) which suggest the negative and significant effect of GDP growth rate on bank efficiency because GDP growth may be accompanied by excessive risk-taking by banks. The results also show the negative and significant effect of inflation on the technical efficiency of banks in CEMAC and WAEMU. Inflation, by reducing the value of the bank's return, therefore leads to the deterioration of its technical efficiency (Nassim et al., 2024). From the same results, we can observe the positive and significant effect of GDP per capita growth on the technical efficiency of banks in CEMAC and WAEMU. This result therefore suggests that when per capita wealth increases, the risk of borrower insolvency decreases and significantly improves the technical efficiency scores of banks.

Finally, regarding the effect of democracy variables on the technical efficiency of banks in CEMAC and WAEMU, the results suggest that in the CEMAC zone, political stability and the regulatory quality have a negative and significant influence on the technical efficiency of banks. Indeed, the fact that banks are aware that they are operating in a politically stable environment where the regulation is of good quality, can lead them to be less vigilant on certain risks and to make inefficient decisions. However, the effect of the quality of regulation is rather positive and significant on the technical efficiency of WAEMU banks. Indeed, the discipline it engenders in banks has a positive effect on their technical efficiency and improves it over time. The results also indicate the negative and significant effect on the technical efficiency of banks of the control of corruption in the WAEMU zone, the effect being insignificant in the CEMAC zone. Overall, in a context marked by terrorist attacks and a high risk of money laundering, the control of corruption becomes a constraint for banks and requires lengthy verification and validation procedures transactions. This constraint of corruption control therefore has a negative effect on the technical efficiency of banks.

Overall, the results confirm the alternative hypotheses formulated on the bank-specific, sector-specific, macroeconomic, and democracy determinants of the technical efficiency of banks in CEMAC and WAEMU.

4.3 Robustness Check in the Franc Zone (CEMAC+WAEMU)

We consider a broader banking market consisting of the countries of CEMAC and WAEMU, linked by their membership in the Franc zone and the use of the CFA franc. The table 7 below presents the results of our estimates.

Table 7. Determinants of efficiency in the Franc Zone

	WAEMU+CEMAC			
Variables	Model 1	Model 2	Model 3	Model 4
Size	0.226**(0.029)	0.164***(0.029)	0.092***(0.027)	0.096*** (0.0280)
CAPI	-0.034(0.210)	-0.035(0.192)	-0.146(0.172)	-0.057 (0.178)
LR	0.5830***(0.153)	0.285*(0.147)	0.360***(0.134)	0.303** (0.138)
DR	-0.936***(0.237)	-0.465**(0.228)	-0.555***(0.209)	-0.491** (0.213)
LQD	0.069(0.135)	0.087(0.124)	-0.132(0.118)	-0.106 (0.120)
PR	0.391**(0.171)	0.248(0.158)	0.066(0.142)	-0.048 (0.1664)
DBN		0.192*** (0.049)	0.163*** (0.0443)	0.180*** (0.046)
BC		-1.538***(0.315)	-1.430***(0.282)	-1.323***(0.286)
GDP			-0.136*** (0.019)	-0.126***(0.019)
GDPH			0.139*** (0.0200)	0.129**(0.020)
INFL			-0.005** (0.0023)	-0.005**(0.002)
PS				-0.019 (0.020)
GE				0.043 (0.052)
RQ				-0.071 (0.062)
CC				-0.088* (0.049)
Constant	-0.301 (0.324)	-0.204***(0.307)	-0.917*** (0.318)	0.691***(0.336)
F-Test	28.36***	30.62***	33.20***	24.96***
R^2 (Within)	0.4725	0.5658	0.6638	0.6741
Number of countries	14	14	14	14
Observations	210	210	210	210
Hausman test	31.41***	62.38***	71.94***	96.78***
B-P/Cook-Weisberg Test	654.06***	926.40***	1735.39***	1318.89***
Wooldridge Test	1881.784***	545.888***	303.891***	306.105***

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Source: Authors.

Overall, the coefficients maintain the same sign. The results confirm the positive and significant effect of bank size and loan rate on the technical efficiency of banks in the Franc Zone, as was observed separately in the WAEMU and CEMAC zones. The negative and significant influence of the deposit rate is also confirmed in the Franc Zone. The results suggest a positive and significant relationship between loan loss provisions and the technical efficiency of banks in the CEMAC zone, an effect that was not significant when the two sub-zones were considered separately. Although negative in sign, bank capitalization does not appear to have a significant impact on the technical efficiency of banks. The coefficients associated with banking sector-specific variables, banking network density and banking market concentration, retain the same sign and are significant, confirming the results obtained when considering the two unions separately. Similarly, for macroeconomic variables, the results confirm the positive and significant effect of GDP per capita growth on the technical efficiency of banks. In addition, the negative and significant influence of inflation and GDP growth rate on technical efficiency are also confirmed. As for the democracy variables, although the other variables maintain the same sign, it appears here that only control of corruption has a negative and significant effect on the technical efficiency of banks in the franc zone. This implies that control of corruption has a negative effect on the technical efficiency of banks due to the existence of anti-corruption mechanisms defined by the CEMAC and WAEMU countries with the support of regional and international organizations as a response to potential acts of money laundering and terrorist financing, through banks in the two economic and monetary unions.

5. Conclusion

The member states of the Economic and Monetary Community of Central Africa (CEMAC) and the West African Economic and Monetary Union (WAEMU) are still characterized by underdeveloped financial markets, making banks the primary actors in financing the economy. Through their main and traditional function of financial intermediation, banks facilitate the transformation of deposits into loans. However, they can only fulfil this crucial role if and only if they are solid, viable, and technically efficient. Hence, measuring their technical efficiency and identifying internal and external factors influencing its variation over time is essential. This study therefore had a twofold objective: first, to measure the technical efficiency scores of banks operating in these two regions and second, to identify the determinants of the efficiency levels achieved over the period 2008 to 2022. To achieve these two objectives, we opted for a modelling framework combining the use of fixed-effect panel models with the stochastic frontier approach. As for the second objective, the examination of the determinants of the technical efficiency of banks focused on bank-specific, banking sector-specific, macroeconomic, and democratic governance determinants.

Our results show, firstly, that over the study period, banks in CEMAC and WAEMU countries operated below their optimal production capacity, i.e., below the optimal threshold of 100%. However, over the entire period, the average technical efficiency scores of banks have shown a positive trend in the two economic and monetary unions. However, over the entire period, average technical efficiency scores exhibited a positive trend in both economic and monetary unions. A comparative analysis of technical efficiency scores in WAEMU and CEMAC reveals that banks operating in the WAEMU space have been the most technically efficient. Secondly, regarding bank-specific factors, our results indicate that size, capitalization, and loan ratios enhance technical efficiency, while deposit ratios, liquidity, and loan loss provisions are factors that deteriorate efficiency in both regions. Concerning banking sector-specific factors in CEMAC and WAEMU, our results suggest that geographic expansion of the branch network improves technical efficiency, whereas market concentration deteriorates it. Regarding macroeconomic factors, our results show a negative and significant impact of GDP growth rate and inflation on technical efficiency in both CEMAC and WAEMU. However, GDP per capita growth rate is a factor that improves technical efficiency. Finally, as for the democracy variables, the results suggest that the quality of regulation has a negative effect on the technical efficiency of CEMAC and WAEMU banks. The same results also show that political stability is a factor that deteriorates the technical efficiency of CEMAC banks, and that government effectiveness and control of corruption have a negative and significant effect on the technical efficiency of banks in the WAEMU zone. Overall, the results obtained separately in CEMAC and WAEMU are confirmed in the franc zone after merging the two unions.

These findings could be of interest to the scientific community and, more importantly, to bank managers, banking market regulators, economic policymakers, and public policymakers in CEMAC and WAEMU. All these stakeholders are called upon to take adequate measures (micro and macro-prudential) that enhance bank efficiency and minimize the impact of factors that deteriorate it. As for the democracy factors, whose effect seems to be negative on the efficiency of banks, it seems relevant, as an extension of this research, to determine the threshold of the democracy variables that deteriorate or improve the technical efficiency of banks.

Authors Contributions

Both authors wrote, read and approved the final manuscript and all authors contributed equally to the paper.

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Appendix

Appendix A. Correlation Matrix (CEMAC)

	TE	Size	CAPI	LR	DR	LQD	PR	DBN	BC	GDP	GDPH	INFL	PS	GE	RQ	CC
TE	1.00															
Size	0.12	1.00														
CAPI	0.29	-0.51	1.00													
LR	0.59	-0.29	0.43	1.00												
DR	-0.54	-0.43	-0.55	-0.51	1.00											
LQD	0.59	-0.38	0.51	0.72	-0.73	1.00										
PR	0.21	-0.46	0.63	0.28	-0.37	0.25	1.00									
DBN	0.28	0.77	-0.25	-0.01	0.15	-0.08	-0.25	1.00								
BC	-0.24	-0.51	0.15	-0.11	0.04	-0.07	0.17	-0.70	1.00							
GDP	-0.29	0.01	-0.25	-0.20	0.33	-0.29	-0.06	0.04	-0.09	1.00						
GDPC	-0.23	-0.03	-0.17	-0.12	0.27	-0.21	-0.01	0.061	-0.09	0.79	1.00					
INFL	-0.26	-0.34	0.19	0.07	0.01	0.07	0.13	-0.31	0.26	-0.03	-0.02	1.00				
PS	-0.28	0.62	-0.41	-0.46	0.54	-0.52	-0.46	0.15	0.09	0.02	-0.05	-0.22	1.00			
GE	-0.14	0.80	-0.39	-0.25	0.47	-0.37	-0.34	0.61	-0.37	0.11	0.07	-0.24	0.64	1.00		
RQ	-0.12	0.36	-0.08	-0.03	0.13	-0.08	-0.11	0.51	-0.55	0.22	0.22	-0.14	0.16	0.62	1.00	
CC	-0.23	0.07	0.09	-0.07	0.29	-0.18	0.11	0.13	0.08	0.21	0.24	0.03	0.23	0.49	0.60	1.00

Appendix B. Correlation Matrix (WAEMU)

	TE	Size	CAPI	LR	DR	LQD	PR	DBN	CB	GDP	GDPC	INFL	PS	GE	RQ	CC
TE	1.00															
Size	0.29	1.00														
CAPI	0.04	-0.36	1.00													
LR	0.06	-0.30	0.94	1.00												
DR	-0.02	-0.19	0.89	0.96	1.00											
LQD	0.26	-0.44	0.42	0.41	0.16	1.00										
PR	-0.12	0.08	-0.29	-0.15	-0.07	-0.31	1.00									
DBN	0.49	0.47	0.11	0.19	0.13	0.36	-0.13	1.00								
BC	-0.39	-0.53	-0.01	-0.06	-0.03	-0.27	0.11	-0.72	1.00							
GDP	0.09	0.08	0.23	0.24	0.24	0.07	-0.11	0.17	-0.16	1.00						
GDPC	0.09	0.09	0.20	0.20	0.21	0.03	-0.14	0.145	-0.15	0.98	1.00					
INFL	-0.37	-0.07	0.07	0.06	0.09	0.01	-0.01	-0.08	0.07	-0.09	-0.08	1.00				
PS	-0.24	-0.08	-0.06	-0.11	-0.07	-0.13	0.19	-0.28	0.01	0.05	0.10	0.04	1.00			
GE	0.20	0.42	0.05	0.04	0.03	0.23	-0.23	-0.58	-0.58	0.05	-0.01	-0.01	-0.18	1.00		
RQ	0.22	0.50	-0.01	0.01	-0.01	0.18	-0.19	0.62	-0.72	0.17	0.13	-0.01	0.12	0.75	1.00	
CC	0.27	0.45	0.06	0.05	0.01	0.26	-0.31	0.62	-0.69	0.22	0.18	-0.01	0.09	0.69	0.76	1.00

Appendix C. Panel Data Unit Root Test (Levin–Lin–Chu)

	CEMAC		WAEMU	
Variables	T-Statistics	P-value	T-Statistics	P-value
Size	-7.3942	0.0000	-2.2288	0.0054
CAPI	-4.0355	0.0062	-4.9678	0.0094
LR	-4.4929	0.0047	-5.7488	0.0032
DR	-3.6639	0.0083	-3.7600	0.4340
LQD	-2.7155	0.0065	-4.7998	0.0009
PR	-3.4403	0.0008	-7.6912	0.0000
DBN	-6.6231	0.0000	-6.4211	0.0000
BC	-3.1745	0.0015	-6.9894	0.0002
GDP	-5.9126	0.0005	-7.1987	0.0013
GDPC	-6.4767	0.0037	-7.3774	0.0010
INFL	-8.4280	0.0000	-4.6993	0.0001
PS	-3.9986	0.0069	-3.4778	0.0066
GE	-4.2469	0.0075	-1.3390	0.0088
RQ	-3.9251	0.0060	-3.1630	0.0044
CC	-3.1597	0.0037	-3.3690	0.0001