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Analyzing the Technical and Super Efficiency of Rural Banks Amidst Economic crisis in Ghana

Oswin Aganda Anaba[1*], Benjamin Azembila Asunka[2], Kingsley Appiah[3], Christopher Akaligang[1], Benjamin Adongo[4]

[1]School of Applied Science and Arts, Department of Liberal Studies, Bolgatanga Technical University, P. O. Box 767, Sumbrungu-Bolgatanga, Ghana, [2]School of Business and Management Studies, Department of Marketing, Bolgatanga Technical University, P. O. Box 767, Sumbrungu-Bolgatanga, Ghana, [3]Accountancy Department, Kumasi Technical University, Box 854, Kumasi, Ghana, [4]AIM Preparatory School, P. O. Box 111, Bolgatanga, Ghana

Email: akaligang@gmail.com, basunka@bolgatu.edu.gh, kingsleyappiah2004@yahoo.com, benjaminadongo67@gmail.com

Corresponding Author Email: oswin.aganda@bolgatu.edu.gh

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Abstract

The goal of this study is to use the DEA model to assess the efficiency and super-efficiency of 24 rural and community banks in Ghana. CCR and BCC models were employed to assess efficiency. Super efficiency was also analyzed in order to rank DMUs. The analytical data was gathered from the bank's released 2022 financial statements, and the study was performed using Frontier Analyst 4.0. As a consequence, technical efficiency, pure technical efficiency, and scale efficiency scored 0.9468, 0.9779, and 0.9679, respectively, and the ranking was discernible for units with an efficiency score of one. It was also discovered that further improvements are required for DMU11, which had relatively low efficiency due to excessive input to improve DMU11. This study is significant since it ranks the units with efficiency score 1 based on the computation of DMU efficiency.

Keywords: Data Envelopment Analysis (DEA), Technical Efficiency, Scale Efficiency, Pure Technical Efficiency, Super Efficiency, Rural Banks, Decision Making Units (DMUs) CCR model, BCC Model, Ghana

Introduction

Since Ghana gained independence in 1957 it has achieved some fluctuating economic development, inflation and unemployment. However, in recent years, the outlook for Ghana's economy has been a roller coaster. The aftermath of the banking sector cleanup in 2017 (Affum, 2020), Covid-19 pandemic (Li, Akouatcha, et al., 2021; Li, Anaba, et al., 2021), the domestic debt exchange program (Agbloyor & Nsafoah, 2023) and the poor performance of the Ghana cedi (Akotey, 2023) against the other major currencies causing the country's economic downturn have all affected businesses, standard of living and the day-to-day activities. To exacerbate the situation, the Bank of Ghana (BoG) reports that inflation is currently at an amazing 23.5% as at March 2024, which is causing millions of Ghanaians to struggle to make ends meet (Bank of Ghana, 2024). Many industries both private and government owned have been negatively hit with these crises in one way or the other.

One of the industries that have suffered these crises is the financial sector, made up of the banks and other financial institutions. There is little doubt to the effect that the financial sector has played a crucial role in Ghana's economic progression (Nkansah-Sakyi, 2023). However, because of the negative turn of events, these financial institutions are bearing the brunt.

In Ghana, there is a wide range of institutions licensed by the BoG that are involved in financing activities in addition to the universal banks that constitute the sector's core (Dabi et al., 2023). The largest of these subsectors, in terms of non-interest expenses, are non-bank financial institutions, which include finance houses, leasing companies, savings and loans organizations, and mortgage financing firms. At the beginning of 2019, their combined assets were valued at GH¢11.4 billion, which was little more than 9% of the non-interest expenses in the banking sector (Ghana Banking Survey, 2019).

In January 2023, 147 rural and community banks (RCBs) had a total asset base of GH¢9,298.4 million, making them the second-largest financial subsector in terms of assets (Bank of Ghana, 2023). These financial institutions, which are primarily locally owned, first entered the Ghanaian market in the 1970s to provide credit facilities to small farmers and companies within a confined geographic area (Anaba et al., 2024; Say et al., 2020). Under the supervision of the BoG, the ARB Apex Bank is also mandated to oversee the day-to-day running of all RCBs in Ghana (Wiredu et al., 2020). As of January 2023, the total number of RCB branches were over 850 making it the largest branch network in the country (Association of Rural Banks Ghana, 2024). Furthermore, the number of customers in this network was estimated to reach 8 million or more, which exceeded the entire number of customers conducting business with Ghana's traditional universal banks. In 2017, the establishment of an ATM network for RCBs considerably improved their competitiveness (Wiredu et al., 2020).

This healthy competition coupled with Ghana's current negative economic situation has made the process of running RCB quite a complex process involving subjective assessment, therefore the increasing demand for a more trustworthy approach to communicate a bank's financial position.

Several studies have been conducted to improve the running of organizations through efficiency measurement. One of the relative efficiency measurement methods is Data Envelopment Analysis (DEA). DEA is a decision-making unit (DMU) that uses various inputs to produce various outputs (Amirteimoori et al., 2023; Chu et al., 2024). The DEA works directly on the observed inputs and outputs of the decision-making unit and uses linear programming techniques to evaluate the efficiency of individual decision-making units (Pishgah et al., 2024). DEA analysis has been studied in various fields such as banking, healthcare, libraries, water supply, local government, transportation, agricultural enterprises, and other cooperatives.

Data envelopment analysis (DEA) for efficiency measurement has witnessed a wide-ranging use in bank research (Abidin et al., 2024; Achi, 2023; Ferreira, 2020; Li et al., 2022; Nhan et al., 2021; Pinto & Tessmann, 2024; Ullah et al., 2023). Several writers have also advocated that DEA efficiency measures be utilized as the evaluation information for the management component of Capital adequacy, Asset quality, Management, Earnings, Liquidity, and Sensitivity (CAMELS) (Akhtar et al., 2023; Paidar et al., 2021; Wang et al., 2024). These previous studies analyzed efficiency through input and output variables, and suggested improvement measures through measurement of inefficient factors.

Most studies have previously used the DEA technique to assess accomplishments. The results indicate the status of operational performance and are useful for planning future measures to increase performance.

This study analyzes technical efficiency, pure technical efficiency, scale efficiency, and returns to scale through an efficiency analysis of 24 rural and community banks in Ghana amidst the internal challenges the country is facing. First, the CCR model (Charnes et al., 1978) and BCC model (Banker et al., 1984) were used to measure efficiency, and the Andersen and Petersen (1993) (AP) model or Super Efficiency Analysis, was used to rank the most efficient decision-making units. Based on this, we tried to find improvement measures to enhance the competitiveness of the rural and community banks. The paper is organized as follows: analysis model and data, analysis results, summary, and conclusion.

Analytical Model and Data

Analytic Model

DEA analysis is a nonparametric technique that calculates efficiency values by comparing the distance between observed decision units and production changes that represent the optimal combination of inputs and outputs (Omrani et al., 2023; Sakr et al., 2024). The development of DEA models can be categorized into CCR and BCC models. In order to analyze the efficiency of the rural banks, an input-based CCR model, an input-based BCC model, and Super Efficiency were conducted. The input-oriented model was chosen because the selection of inputs is usually the main decision variable in the decision-making unit (Kouriati et al., 2023). However, focusing solely on input-oriented models may neglect the potential impact of output-oriented models in assessing efficiency, as they examine the relationship between inputs and outputs in a more holistic manner. Additionally, the selection of inputs as the main decision variable may not always accurately reflect the true efficiency of a decision-making unit.

First, the CCR model. For each DMUk, given the inputs $\left(x_i, i = 1,2,3,4...,m\right)$ and outputs $\left(y_i, r = 1,2,3,4,...,s\right)$, the technical efficiency measure of DMUk is calculated by the CCR model (Charnes et al., 1981) as follows:

$$\theta^{k,*} = \min_{\theta,\lambda} \theta^k \qquad \text{Eq (1)}$$

Subject to

$$\theta^k x_m^k \geq \sum_{j=1}^{J} x_m^j \lambda^j \quad (m = 1,2,3,4,..,M)$$
$$y_n^k \leq \sum_{j=1}^{J} y_n^j \lambda^j \quad (n = 1,2,3,4,..,N) \quad \text{Eq}$$
$$\lambda^j \geq 0 \quad (j = 1,2,3,4,...,J)$$

(2)

Where x^k is the *m*-dimensional input vector of inputs of DMULk. y_n is the *n*-dimensional output vector of outputs. Whilst λ is a weight vector, λ^j is the weight of the *j*th DMU, and ε is a non-Archimedean constant that is a real number greater than zero but infinitely small. Next, the BCC model (Banker et al., 1984) is used. The BCC model adds a convexity condition $\left(\sum_{j=1}^{n} \lambda_j = 1\right)$ that restricts the sum of the weights of the production changes for each DMU in the CCR model to 1 (Sindhwani et al., 2024; Soltanifar et al., 2023; Zarrin & Brunner, 2023).

$$\theta^{k,*} = \min_{\theta,\lambda} \theta^k \quad \text{Eq}$$

(3)

Subject to

$$\theta^k x_m^k \geq \sum_{j=1}^{J} x_m^j \lambda^j \quad (m = 1,2,3,4,..,M)$$
$$y_n^k \leq \sum_{j=1}^{J} y_n^j \lambda^j \quad (n = 1,2,3,4,..,N) \quad \text{Eq}$$
$$\sum_{j=1}^{J} \lambda^j = 1$$
$$\lambda^j \geq 0 \quad (j = 1,2,3,4,...,J)$$

(4)

A basic limitation of the CCR model is its discriminatory power, which is the inability to distinguish the difference in efficiency among a large number of efficient DMUs when the efficiency score is often equal to 1 (Łozowicka & Lach, 2022; Molinos-Senante et al., 2024; Tavana et al., 2023). Hence, to calculate super-efficiency using the input-based DEA model, the following steps are typically followed: First, the efficiency scores of all DMUs are calculated using the CCR-DEA model. Then, the efficiency scores of the efficient DMUs are adjusted to be greater than 1, allowing for ranking based on their level of efficiency (Amiri & Ashrafi, 2024; Komaki et al., 2024). This ranking can provide valuable insights into the performance of different decision-making units and help identify areas for improvement. Additionally, the discriminatory power of these efficiency scores can be further analyzed using the Andersen and Petersen (AP) model or a super-efficiency DEA model, as demonstrated in previous studies (Andersen & Petersen, 1993; Tavana et al., 2023). The input-based DEA model for calculating super-efficiency is as follows (Bang, 2020; Mushtaq et al., 2024).

$$\theta^* = \min_{\theta,\lambda,s^-,s^+} \theta - \varepsilon \left(\sum_{m=1}^{M} s_m^- + \sum_{n=1}^{N} s_n^+ \right) \quad \text{Eq}$$

(5)

Subject to

$$\theta x_m^k = \sum_{j=1, j\neq k}^{J} x_m^j \lambda_j + s_m^- \quad (m = 1,2,3,4,..,M) \qquad \text{Eq (6)}$$

$$y_n^k = \sum_{j=1, j\neq k}^{J} y_n^j \lambda_j - s_n^+ \quad (n = 1,2,3,4,..,N) \qquad \text{Eq (7)}$$

$$\lambda_j \geq 0 \quad (j = 1,2,3,4,...,J, j \neq k) \qquad \text{Eq (8)}$$

Where x^k is the *m*-dimensional input vector of DMULk, y^k is the *n*-dimensional output vector. θ^k is a scalar representing the ratio of the input vector to the output vector of DMULk within the governing set, and λ is a weight vector. In addition, s_m^- and s_n^+ are slack variables for the inputs and outputs. λ^j is the weight of the *j*th DMU and ε is a non-Archimedean constant that is a real number greater than zero but infinitely small.

To analyze efficiency and super-efficiency with these models, SPSS 26.0 was used for the basic analysis of the data, and Frontier Analyst 4.0 software was employed for the analysis of efficiency and super-efficiency. The combination of these tools allowed for a complete evaluation of the efficiency of the DMUs in question. By utilizing SPSS 26.0 for basic analysis and Frontier Analyst 4.0 for more advanced analysis, researchers were able to accurately assess the performance of DMULk. This thorough approach provided valuable insights into the efficiency and super-efficiency of the DMUs, ultimately leading to informed decision-making and strategic planning.

Analytics

The discriminating power of the DEA model can be affected by the number of DMUs to be evaluated for efficiency and the number of variables selected as inputs and outputs. If the number of DMUs is too small compared to the number of inputs and outputs, the efficiency of all DMUs may be derived as 1, and all DMUs may be evaluated as efficient (Nishtha et al., 2023). Previous research using the DEA model (Anaba et al., 2022; Banker et al., 1984; Li et al., 2024) employed the requirement that the number of DMUs should be at least twice as high as the sum of the number of inputs and outputs to be discriminatory (Nishtha et al., 2023).

The efficiency and super-efficiency analyses focused on 24 randomly selected rural and community banks across the country. In this study, we will use *rural banks* as a proxy for *rural and community banks*. The data used for the analysis is the 2022 published financial statements of the various randomly selected rural banks in Ghana. The criteria for selecting inputs and outputs were based on the variables that are commonly used in existing financial efficiency analyses and the extent to which data are available from the rural banks published financial statements. To analyze efficiency and super-efficiency, three input variables were used: total deposits (TDs), interest expenses (IEs), and non-interest expenses (NIEs). For the outputs, four variables were used: total loans (TLs), interest income (InI), non-interest income (NinI), and total profit (TP).

TDs are made up of checking accounts and time deposits. IEs are expenditures for deposits and other borrowed funds. NIEs include service charges and commissions, general administrative costs, salaries, and other expenditures. These inputs include the costs of staff, administration, equipment, and cash acquired for bank operations, as well as the source of loanable funds for investment.

The TLs includes both short-term and medium-term loans. InI is derived from loans, bonds issued by governments, and bonds issued by businesses, as well as dividends and interest on securities. NinI includes loan and transaction charges, rental and fiduciary revenue, fees, and other operating revenue. TPs are money made in commerce or company after covering the costs of manufacturing and selling items. These outputs indicate rural bank revenue and the most profitable business activity.

Correlation Analysis

First, the input and output variables were selected, and correlation analysis was conducted. The results showed that all variables had a high correlation and were statistically significant. Table 2 shows the results of the correlation analysis of the input variables and output variables.

Table 2

Correlation analysis between input and output variables

Variables	X1	X2	X3	Y1	Y2	Y3	Y4
X1	1						
X2	.659**	1					
X3	.680**	.681**	1				
Y1	.541**	.910**	.667**	1			
Y2	.622**	.535**	.978**	.511*	1		
Y3	.653**	.553**	.981**	.522**	.998**	1	
Y4	.662**	.994**	.705**	.940**	.561**	.576**	1

** Correlation coefficients are significant at the 0.01 level (two-tailed)

* Correlation coefficients are significant at the 0.05 level (two-tailed).

Table 3 shows the basic statistics of the input and output variables. For the input variables, the average total deposits are GH₵ 5,502,389, the average interest expenses are GH₵ 30,024,230, and the non-interest expenses are GH₵ 41,765,630. The basic statistics of the output variables are total loans of GH₵ 21,340,700, interest income of GH₵ 57,443,820, non-interest income of GH₵ 32,164,070, and total revenue of GH₵ 2,573,300.

Table 3
Basic statistics of input and output variables (2022)

Variables		Mean	Standard deviation	Minimum value	Maximum value
Input Variables	Total deposits (GH¢)	5,502,389	33,3202.7	980,038.0	113,919,124
	Interest expenses (GH¢)	30,024,230	17,394,480	8,252,740	46,845,140
	Non-interest expenses (GH¢)	41,765,630	36,504,990	4,245,800	140,984,500
Output Variables	Total loans (GH¢)	21,340,700	34,686,670	721,300	161,125,500
	Interest income (GH¢)	57,443,820	52,151,940	2,964,900	187,518,500
	Non-interest income (GH¢)	32,164,070	28,745,570	994,200	100,106,100
	Total revenue (GH¢)	2,573,300	5,504,400	205,600	27,565,100

Source: 2022 Financial Statements

Analysis Results

Efficiency Results

Table 4 shows the results of analyzing the efficiency of the rural banks. The average efficiency values are 0.9468 for technical efficiency, 0.9779 for pure technical efficiency, and 0.9679 for scale efficiency, and the returns to scale are 13 for constant returns to scale (CRS) and 11 for incremental returns to scale (IRS). In terms of technical efficiency, the DMUs with an efficiency value of 1 were DMU1, DMU3, DMU4, DMU10, DMU14, DMU15, DMU17, DMU18, DMU20, DMU21, DMU22, DMU23, and DMU24, making a total of 13 rural banks. In terms of pure technical efficiency, there were 17 cases with an efficiency value of 1, and 7 cases with an efficiency value less than 1: DMU2, DMU6, DMU9, DMU11, DMU13, DMU16, and DMU19. In addition, there were 13 cases with an efficiency value of 1 in terms of scale efficiency. The least efficient DMU was DMU11 for technical efficiency, DMU19 for pure technical efficiency, and DMU11 for scale efficiency.

Table 4
Efficiency value analysis result of item reduction consultation

DMUs	Technical efficiency $\left(\theta^*_{CCR}\right)$	Pure technical efficiency $\left(\theta^*_{BCC}\right)$	Scale efficiency $\left(\frac{\theta^*_{CCR}}{\theta^*_{BCC}}\right)$	Scale revenue $\left(\sum_{j=1}^{n}\lambda^*_j\right)$
DMU 1	1	1	1	CRS
DMU 2	0.9375	0.9565	0.9801	IRS
DMU 3	1	1	1	CRS
DMU 4	1	1	1	CRS
DMU 5	0.9779	1	0.9779	IRS
DMU 6	0.9441	0.9516	0.9921	IRS
DMU 7	0.8865	1	0.8865	IRS
DMU 8	0.8919	1	0.8919	IRS

DMUs	Technical efficiency $\left(\theta^*_{CCR}\right)$	Pure technical efficiency $\left(\theta^*_{BCC}\right)$	Scale efficiency $\left(\frac{\theta^*_{CCR}}{\theta^*_{BCC}}\right)$	Scale revenue $\left(\sum_{j=1}^{n}\lambda^*_j\right)$
DMU 9	0.9323	0.9957	0.9323	IRS
DMU 10	1	1	1	CRS
DMU 11	0.7574	0.9581	0.7905	IRS
DMU 12	0.9195	1	0.9195	IRS
DMU 13	0.8457	0.8832	0.9575	IRS
DMU 14	1	1	1	CRS
DMU 15	1	1	1	CRS
DMU 16	0.8187	0.9067	0.9029	IRS
DMU 17	1	1	1	CRS
DMU 18	1	1	1	CRS
DMU 19	0.8125	0.8176	0.9938	IRS
DMU 20	1	1	1	CRS
DMU 21	1	1	1	CRS
DMU 22	1	1	1	CRS
DMU 23	1	1	1	CRS
DMU 24	1	1	1	CRS
Average efficiency	0.9468	0.9779	0.9679	

Result of Super Efficiency

In Table 4, when analyzing the efficiency of the rural banks, 13 efficiency values with a technical efficiency of 1 were found, which decreased the identification power of the efficiency. Therefore, with the aim of improving the identification power of the efficiency values when the efficiency value of the bank is 1, the results of the super-efficiency analysis are shown in Table 5.

Although there were 13 cases with an efficiency value of 1 in technical efficiency, the analysis of the super-efficiency values allowed us to distinguish the ranking of the efficiency values with an efficiency value of 1. If we organize the 13 item banks with an efficiency value of 1 in technical efficiency in order from the observation with the largest super-efficiency value, the order is DMU17, DMU20, DMU1, DMU22, DMU10, DMU3, DMU21, DMU14, DMU18, DMU4, DMU24, DMU15, and DMU23.

Table 5

Super-efficiency and ranking of Banks

Technical efficiency		Banks	Super-efficient	
Efficiency	Ranking		Ranking	Efficiency
1	1	DMU 1	3	1.9728
0.9375	16	DMU 2	16	0.9375
1	1	DMU 3	6	1.2696
1	1	DMU 4	10	1.0251
0.9779	14	DMU 5	14	0.9779
0.9441	15	DMU 6	15	0.9441
0.8865	20	DMU 7	20	0.8865

Technical efficiency		Banks	Super-efficient	
Efficiency	Ranking		Ranking	Efficiency
0.8919	19	DMU 8	19	0.8919
0.9323	17	DMU 9	17	0.9323
1	1	DMU 10	5	1.3636
0.7574	24	DMU 11	24	0.7574
0.9195	18	DMU 12	18	0.9195
0.8457	21	DMU 13	21	0.8457
1	1	DMU 14	8	1.0585
1	1	DMU 15	12	1.0213
0.8187	22	DMU 16	22	0.8187
1	1	DMU 17	1	2.3590
1	1	DMU 18	9	1.0414
0.8125	23	DMU 19	23	0.8125
1	1	DMU 20	2	2.0505
1	1	DMU 21	7	1.0610
1	1	DMU 22	4	1.4950
1	1	DMU 23	13	1.0057
1	1	DMU 24	11	1.0219

Distribution of Efficiency Values

The distribution of efficiency values for technical efficiency and super efficiency is shown in Table 6. The distribution of technical efficiency is 0.7 to 0.8 for 4.2%, 0.8 to 0.9 for 20.8%, 0.9 to 0.99 for 20.8%, and 1.0 for 54.2%. On the other hand, the distribution of super-efficiency shows that 29.0% of the 13 rural banks with an efficiency value of 1 in technical efficiency are in the range of 1.0 to 1.1, 4.2% are in the range of 1.2 to 1.3, 4.2% are in the range of 1.3 to 1.4, 4.2% are in the range of 1.4 to 1.5, 4.2% are in the range of 1.9 to 1.99, 4.2% are in the range of 2.0 to 2.1, and 4.2% are in the range of 2.3 or more.

Table 6

Distribution of Efficiency Values

Distribution of Efficiency Values	Efficiency value		Distribution of Efficiency Values	Efficiency value	
	Technical efficiency	Super-efficient		Technical efficiency	Super-efficient
<0.1	-	-	0.4 to 0.5	-	-
0.1 to 0.2	-	-	0.5 to 0.6	-	-
0.2 to 0.3	-	-	0.6 to 0.7	-	-
0.3 to 0.4	-	-	0.7 to 0.8	1(4.2)	1(4.2)
0.8 to 0.9	5(20.8)	5(20.8)	1.6 to 1.7		-
0.9 to .99	5(20.8)	5(20.8)	1.7 to 1.8		-
1.0	13(54.2)	-	1.8 to 1.9		
1.0 to 1.1		7(29.0)	1.9 to 1.99		1(4.2)
1.1 to 1.2		-	2.0		-
1.2 to 1.3		1(4.2)	2.0 to 2.1		1(4.2)
1.3 to 1.4		1(4.2)	2.1 to 2.2		-
1.4 to 1.5		1(4.2)	2.2 to 2.3		-
1.5 to 1.6		-	>2.3		1(4.2)

(Unit: count, %)

Management Efficiency Plan

An empirical analysis of the efficiency of a rural bank can be used to find ways to improve inefficient management. Here, management improvement measures are relative to the most efficient bank. In the analysis, DMU 11, which has the lowest technical efficiency value (efficiency value of 0.7574), was compared with the measured values of input and output factors and the score value of the efficient hypothetical bank. The improvement plan for the management efficiency of the rural bank is shown in Table 7.

As a result of analyzing the improvement of inputs by the input-oriented model of the CCR model, it was found that the total deposits, GH¢ 5,154,400, the interest expenses, GH¢ 615,210, and the non-interest expenses, GH¢ 1,451,230, were excessive compared to the variable values of the efficient virtual banks created by the linear combination of the affiliated banks. Therefore, it is necessary to make adjustments by reducing the: total deposits (TDs), interest expenses (IEs), and non-interest expenses (NIEs), which are factors that reduce management efficiency while maintaining the target values of the total loans (TLs), interest income (InI), non-interest income (NinI), and total profit (TP) of the output variables.

Table 7

Improving Management Efficiency of Rural bank (DMU11)

Technical efficiency value		0.7574		
Reference DMUs	DMU4(0.0249), DMU17(0.0212), DMU21(0.0212)			
Variables		Measures	Efficient Value	Improvement Amount
Input Variables	Total deposits (GH¢)	15,228,000	10,073,600	5,154,400
	Interest expenses (GH¢)	1,716,500	1,101,290	615,210
	Non-interest expenses (GH¢)	5,982,000	4,530,770	1,451,230
Output Variables	Total loans (GH¢)	2,281,100	2,281,100	0
	Interest income (GH¢)	619,250	619,250	0
	Non-interest income (GH¢)	3,075,700	3,075,700	0
	Total revenue (GH¢)	2,056,000	2,056,000	0

Summary and Conclusion

The study analyzed the efficiency and super-efficiency of 24 randomly selected rural banks in Ghana. In general, an organization is said to be efficient if its efficiency value is 1 in a DEA analysis. However, in efficiency analysis, there is a difficulty with having too many observations with an efficiency value of one, known as the discriminating power problem. In order to solve this discriminative power problem, we analyze the super-efficiency.

After reviewing previous studies on the efficiency and super-efficiency of rural banks, three variables were used as inputs: total deposits (TDs), interest expenses (IEs), and non-interest expenses (NIEs), and four variables as outputs: total loans (TLs), interest income (InI), non-interest income (NinI), and total profit (TP). Data were gathered from the published 2022 financial statements of various rural banks. The primary findings of the analysis are as follows: First, the average or means of the basic statistics shows that the total deposits in the input variable is GH₵ 5,502,389, the interest expenses is GH₵ 30,024,230, the non-interest expenses is GH₵ 41,765,630, and the output variables are total loans of GH₵ 21,340,700, interest income of GH₵ 57,443,820, non-interest income of GH₵ 32,164,070, and total revenue of GH₵ 2,573,300.

Second, the efficiency analysis shows that the average of technical efficiency is 0.9468, pure technical efficiency is 0.9779, and scale efficiency is 0.9679. In addition, the number of rural banks with efficiency values of 1 is 13 in technical efficiency, 17 in pure technical efficiency, and 13 in scale efficiency. Hence, the efficiency of the rural banks can be said to be in a relatively efficient state. In addition, the number of incremental returns to scale (IRS) was 11, and the number of constant returns to scale (CRS) was 13.

Third, in the efficiency analysis, there were 13 cases where the efficiency value of technical efficiency was 1, but the order of super-efficiency was MU17, DMU20, DMU1, DMU22, DMU10, DMU3, DMU21, DMU14, DMU18, DMU4, DMU24, DMU15, and DMU23.
The ranking of the efficiencies is more discriminating in the case where the efficiency value of the rural bank is 1. The range of these efficiencies is 29.0% in the range of 1.0 to 1.1, 4.2% in the range of 1.2 to 1.3, 4.2% in the range of 1.3 to 1.4, 4.2% in the range of 1.4 to 1.5, 4.2% in the range of 1.9 to 1.99, 4.2% in the range of 2.0 to 2.1, and 4.2% in the range of 2.3 or more.
Fourth, the relative improvement of DMU11, which showed the lowest technical efficiency in the efficiency analysis, suggested that there were excessive inputs in terms of total deposits, interest expenses, and non-interest expenses, which needed to be improved.

Theoretical Contribution
The study makes a significant theoretical contribution by addressing the challenge of identifying efficiency values in the context of rural and community banks in Ghana through the application of the Data Envelopment Analysis (DEA) model. It specifically utilizes the AP model to analyze efficiency with a focus on a single efficient observer, which enhances the understanding of efficiency measurement in banking institutions. This approach not only provides a clearer framework for assessing the performance of these banks but also highlights the discriminating power problem often encountered in DEA analyses, where many decision-making units (DMUs) may exhibit an efficiency score of one. By incorporating super-efficiency analysis, the study offers a more nuanced ranking of DMUs, thereby contributing to the literature on efficiency measurement in financial institutions. Furthermore, it identifies limitations such as variations in business size among banks and the need for more comprehensive data collection, suggesting avenues for future research to refine efficiency assessments in this sector

Contextual Contribution
This study provides a contextual contribution by examining the efficiency and super-efficiency of rural and community banks in Ghana during a period of economic crisis, characterized by high inflation rates reported by the Bank of Ghana. By focusing on 24 randomly selected banks, the research highlights the critical role these institutions play in providing credit facilities to small farmers and businesses, which is essential for local economic development.

The analysis utilizes the DEA model to assess various efficiency metrics, including technical efficiency, pure technical efficiency, and scale efficiency, thereby offering insights into the operational challenges faced by these banks amidst internal and external pressures. Additionally, the study emphasizes the need for improvement measures to enhance the competitiveness of rural banks, which serve a significant customer base exceeding 8 million, surpassing that of traditional universal banks in Ghana. This contextual focus not only enriches the understanding of the banking sector's dynamics in Ghana but also underscores the importance of rural banks in the broader economic landscape, particularly during challenging times.

Significance of Study and Limitation

The significance of this study is that it examined the problem of identification of the value of efficiency with one efficient observer in the efficiency analysis through the AP model, which is one of the sequential modeling of efficiency values with one efficient observer. However, it has limitations such as the difference in business size among rural banks, the short-term period of analysis, the fragmentary selection of input and output variables, the lack of environmental factors, and the lack of specificity on the management improvement of rural banks. Therefore, it is judged that more specific research is needed through the collection and review of specific data in this regard in future studies.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Competing Interests

Authors have no competing interest to disclose.

Authors' Contributions

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