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BANKING SECTOR EFFICIENCY: A DATA ENVELOPMENT ANALYSIS

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Abstract

The study adopted firm two stage specific data envelopment analysis technique to empirically study the performance efficiency of deposit money banks listed in the Nigeria bourse from 2016 to 2018, the data were yearly data from the period covering twelve deposit money banks in Nigeria quoted on the capital market. Findings based on the period under review indicate that resource utilization of Nigeria's deposit money banks are grossly efficient, since 33% efficiency were obtained under CRS and VRS assumptions, while 42% was SCALE efficient in converting minimal input to maximum output, which is a strong indication that DMBs in Nigeria are efficient in their input to output operation in achieving their primary goal of profit making. The study recommends that the reference point of efficient banks (First bank, GTB, Stanbic IBTC and Unity bank) should be bench marked by the non-efficient banks with regards to their input to output orientation in the financial sector.

Keywords: Deposit Money Banks, Efficiency, Data Envelopment Analysis

1.0 Introduction

Banks are very vital to the development of any nation economic. The banking system, as noted by Schumpeter (1934), is regarded as a mainmediator in the course of development. Banks are distinct because all other industries rely on them for working capital. Generally, the method in which banks achieve their role, as observed by Cameron (1972), may well determine the degree of success of a nation's development effort.

In almost all countries of the world, whether advanced or emerging economies, the banking industry is more seriously regulated than any other sector. Banking is regulated from cradle to grave; indeed from processing of applications for licensing to as a bank remains in business. The reason for this is not far-fetched. This owes largely to the vitalpart of financial intermediation way played in the economy by banks and other financial institutions. The role of financial intermediation means that financial institutions of which the banking system occupies a central position, mobilize financial resources from the surplus units and channel them towards the deficit units of the economy where they are needed for investments.(Aigbovo&Igbinoba, 2019)

The primary purpose of DEA is to measure the performance efficiency of a sample of Decision Making Units (DMUs), by weighting and scaling the input – output ratio. Efficiency of DMUs (in this study, banking sector) is measured in terms of its relative or comparative performance. That is relative to the efficiency of other firms in the sample. DEA is a linear programming technique introduced by Charnes, Cooper and Rhodes (1978) to measure efficiency of DMUs under the assumption of Constant Returns to Scale (CRS). However, the technique was extended by Banker, Charnes and Cooper (1984) to give room for Variable

Returns to Scale (VRS). Usually, DEA compute efficiency in three different ways: (i) overall technical efficiency which is anchored on the assumption CRS (ii) pure technical efficiency which is based on the assumption of VRS and (iii) scale efficiency, which measures efficiency by taking the ratio of CRS to VRS. To the best of our knowledge, there is a lot of empirical evidence comparing the relative efficiency of banking sector in Nigeria but the input and out variables used are not common in Nigeria. In view of the many challenges in the industry coupled with various policy activities carried out by the regulatory bodies in the sector after the global financial crisis, it is important to re-examine the efficiency of DMBs in Nigeria using Expenses and Total asset as input variables and Gross Profit and PAT as out variables within DEA framework. Hence, this study empirically examines the relative efficiency of the Nigeria banking sector by reviewing related literatures, setting up methodologies and analysis of findings.

2.0 Literature Review

2.1 Concept of Efficiency

The efficiency concept is used to characterized the utilization of resources to produce outputs. According to Forsound and Hjalmarsson (1974), efficiency is a statement about the performance of processes transforming a set of inputs into a set of output. The authors point out that efficiency is relative concept, where the performance of an economic unit must be compared with a standard unit. The identification of a standard should involve value judgment about the objective of the economic activities. Important as it is from both the academic and practical viewpoints, the concept of efficiency has remained loosely defined in the literature (Farrel, 1957). The concept means different things to different people in different circumstances. As Lau and Yotopoulo (1971) put it economic efficiency is an elusive concept in which the policy maker, economist and the engineers all have great stakes. For example, the cost accountant uses the ratio of standard cost to actual cost percent to measure production efficiency (Horngren, 1972). While an engineer describes the efficiency of his machine by the relation of output to theoretical capacity or output / theoretical capacity opercent (Amey, 1970).

Furthermore, Farrel (1957) now asserts that efficiency of a firm is made up of two components; technical efficiency and allocative efficiency. Technical efficiency is concerned with the ability of a firm (DMU) to maximize output from a given set of inputs. Allocative efficiency on the other hand shows the ability of a DMU to combine the inputs in an optimal proportion, given the prices of the inputs plus the production technology employed.

2.2 Empirical Review

Depren and Depren (2016) evaluate the efficiency of twenty deposit money banks in Turkey with monthly data using DEA and MPI. The input and output variables were prepared using intermediation and production approach. The result of their research showed that there were 11 and 14 efficient banks.

Geetha, Kishore and Shivaprasad (2017) analysed the quarterly efficiencies of selected public sector in India for recent three quarter of FY 2016-2017 using the non-parametric performance evaluation techniques of DEA. A total number of 20 banks, 15 public sector and 15 private sector banks were selected as samples for the study. Out of the sample units studied, some of the banks proved consistency in performance during the study period and also most of the banks did not have consistency, mainly public sector banks.

Jiang and He (2018) in their study of banks efficiency, data envelopment analysis (DEA) was combined with the Malmquist index, and we statically and dynamically analyzed the efficiency of listed banks during the period 2012–2017. The results showed that 12 of the 17 banks improved their technical efficiency. The technical efficiency of three banks remained the same, whilst that of two banks had dropped slightly by less than 1.0%.
Aigbovo and Igbinoba (2019) empirically evaluate whether listed banks in selected Sub-Saharan African countries are operating on production possibility frontier. They employ the Non-parametric Data Envelopment

Analysis (DEA) with input variables as interest expenses, operating expenses, customer deposit and total asset while the output variables are interest income, profit after tax and loans and advances to customers. The study reveals that majority of the banks in the banking industry in selected Sub-Saharan Africa countries are being successful in converting their inputs to outputs.

3.0 Data and Methods

The study used the longitudinal research design because the inputs and outputs variables under review are historical in nature. The data for this study were sourced from the financial statements of all the listed deposit money banks (DMB) in Nigeria stock exchange within the period of (2016-2018). The input variables used in this study are fixed asset, staff cost and total. The output variables for this study are profit after tax and gross profit.

Table 1: Variables for Input and Output

INPUT	CODE	OUTPUT	CODE
Expenses	Exp	Profit After Tax	Pat
Total Asset	Tasset	Gross Profit	Gp

Source: Researcher's Compilation (2020)

MODEL: Efficiency Score

This study will be related to the DEA input-oriented CCR model. The formulation developed by Charnes et al (1978) uses linear programming to extend Farrell's (1957) single output/single input efficiency measure (Farrell, 1957) to the multi-output/multi-input case. The focus is to optimize the ratio of outputs to inputs by solving for a group of weights that satisfy a system of linear equations.

Maximize φ_1

$\varphi_1\lambda_1$ ……………………………………………………………...……… ………..(1)

Subject to:

$$\varphi_1 Y_{r1} - \sum_{j=1}^{n} \lambda_{1j} + S_{ri} = 0 \ldots \ldots (2)$$

r = 1, … S- output of sampled of DMB

$$X_{ki} - \sum_{j=i}^{n} \lambda_j X k_j - e_{ki} = 0 \ldots \ldots (3)$$

k = 1, …,e input of DMB.

$$\lambda_j \geq 0, S_{ri} \geq 0, e_{ki} \geq 0 \ldots \ldots (4)$$

i,j= 1 …… nDMB in the sample.

Where φ is the proportional increase in outputs possible; S_r is the r-th output slack; ek, is the k-th input slack; and λ_i is the weight or intensity variable used to derive all possible linear combinations of the sample observations. When the value of φ_1 in equation (1) is 1, $\Lambda = 1$and $\lambda_i = 0$ for $j \neq i$, the i-thDMB lies on the frontier and is technically efficient furthermore, input and output slacks will always be zeros for the efficient DMB . For the inefficient DMB, $\varphi_1 > 1, \lambda_i$=0, and $\lambda_i \neq 0$for$j \neq 1$, where j denotes the efficient DMB in the sample. Inefficient DMB may also have some positive output or/and input slacks. The output based technical efficiency index of the i-thDMB (Te_j) can be computed as follows:

$$Te_j = \frac{1}{\emptyset_i} \ldots \ldots (5)$$

The frontier production of the r-th revenues of the i-thDMB (Naira) can be computed as follows:

$$Y_{ri} - \sum_{j=1}^{n} \lambda_{rj} Y_{ri} = \varphi_i Y_{ri} + S_{ri} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Equation (6) shows that the projected output consist of two components, one representing the proportional increase in all output (φY_{ri}) and the other accounting for non-proportional increase or output slack (S_{ri}). Besides estimating the maximum output from fixed quantities of resources (inputs), the output oriented DEA in equation (1) also estimates the input slacks (excess inputs) that need to be conserved for an inefficient DMB to be fully efficient. Mathematically, the projected amount of the k-th resource of the ithDMB (X_{ki}) can be expressed as follows:

$$X_{ki} - \sum_{j=i}^{n} \lambda_j X k_j = X_{ri} - e_{ki} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

k = 1,

It should be noted that the DMB DEA model given in equation (1) complies with the constant returns to scale (CRS) technology. Following Banker, Charnes and Cooper (1984), the corresponding model under variable returns to scale (VRS) can be obtained by imposing additional constraints on equation (1).

$$\sum_{j=i}^{n} \lambda_i = 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

The technical efficiency score obtained from CRS model (TE_{CRS}) is often referred to as "overall" technical efficiency and that obtained from the VRS model is called "Pure" technical efficiency (TE_{VRS}). The VRS frontier is more flexible and envelops the data in a tighter way than the CRS frontier. Under the VRS specification, dominance is weaker in the sense that a scale inefficient DMB may qualify as a 'best-practice' of it is technically efficient. Consequently, in general, a DMB will show a poorer performance under the CRS model than in the VRS model (i.e., $TE_{VRS} \geq TE_{CRS} <=> \varphi_{CRS} \geq \varphi_{VRS}$).

Thus relationship is often used to obtain a measure of scale efficiency (SE) as follows:

$$SE = \frac{TE_{CRS}}{TE_{VRS}} = \frac{\varphi_{VRS}}{\varphi_{CRS}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where SE = 1 indicates scale efficiency and $SE < 1$ indicates output based scale inefficiency. Scale inefficiency is due to the presence of either increasing (IRS) or decreasing returns to scale (DRS), which can be determined by solving non-increasing returns to scale (NIRS). DEA model which is obtained by substituting the VRS constraint $\sum_{j=1}^{n} \lambda_j = 1$ with $\sum_{j=1}^{n} \lambda_j \leq 1$. Let $\emptyset_{NIRS}$ represent the proportional increase in all outputs under NIRS DEA model. For scale inefficient observations, $\emptyset_{CRS} = \emptyset_{NIRS}$ indicates inefficiently small scale or operation in the region of increasing returns to scale and $\emptyset_{CRS} \geq \emptyset_{NIRS}$ indicates inefficiently large scale or decreasing returns to scale (Farell, Grosskopf, & Lovell, 1994), we examine three efficiency measures; DEA Overall technical efficiency score (CRSE), DEA Pure Technical Efficiency Score (VRSE) and Scale Efficiency Score (SCALE).

4.0 Data Presentation and Analysis

Descriptive Statistic

Table 2: Summary Statistic

Variable	Obs	Mean	Std. Dev.	Min	Max
EXP	36	52.68222	13.05924	21.61	80.76
TASSET	36	9.258889	.4833206	8.19	10.77
GP	36	58.62139	10.40353	37.24	75.36
PAT	36	19.89222	18.07821	-17.22	62.88

Source: Researcher's Estimation Using Stata 13.0 (2020)

The mean value of input and output variables, their corresponding extent of dispersion (Std. Dev.) and their maximum and minimum values, revealed some details of sampled banks used in this study as shown in table 4.1. The average value of EXP (52.68) and GP (58.62) is higher than that of TASSET (9.26). This showed the ability of deposit money banks in the financial sector to use low certain input quantity with low cost (expenses) to produce high output and generate higher profits.

The Std. Dev. of banks total assets (TASSET) is minimal and the high standard deviation of operating expenses (EXP) indicates that there is difference in assets and expenses employed by banks and each banks spent significant different amount on asset and expenses. The higher mean value of GP over EXP shows that the management of the selected banks is efficient in asset management to generate more income. Hence, this result to perpetual profit making by banks during the studied period, as indicated by the positive mean value of PAT. Finally, the extent of dynamics among input and output variables is very high considering the variation between the lowest (Min) and the highest (Max) values.

4.1 DEA Efficiency Estimates

The results of the standard DEA technical efficiency estimates of each banks under constant returns to scale (CRS), variable returns (VRS), scale efficiency (SCALE) and General efficiency (Rank & Theta) scores are presented in the table 3:

Table 3: Efficiency Result

Year	Companies	DMU	CRS	VRS	SCALE	Rank	Theta
2016	Access Bank	dmu:1	0.738453	0.746683	0.988978	24	0.746683
2017	Access Bank	dmu:2	0.66065	0.678079	0.974297	29	0.678079
2018	Access Bank	dmu:3	0.5899	0.604697	0.975529	34	0.604697
2016	Fidelity Bank	dmu:4	0.677147	0.685757	0.987444	27	0.685757
2017	Fidelity Bank	dmu:5	0.762811	0.765146	0.996949	20	0.765146
2018	Fidelity Bank	dmu:6	0.607115	0.612208	0.991681	32	0.612208
2016	First Bank Holding	dmu:7	0.946361	0.996815	0.949384	7	0.996815
2017	First Bank Holding	dmu:8	1	1	1	1	1
2018	First Bank Holding	dmu:9	0.825456	0.867967	0.951022	15	0.867967
2016	FCMB	dmu:10	0.753815	0.75989	0.992005	21	0.75989
2017	FCMB	dmu:11	0.856653	0.86954	0.98518	14	0.86954
2018	FCMB	dmu:12	0.740235	0.749157	0.988091	23	0.749157
2016	GTB	dmu:13	0.991166	0.991166	1	8	0.991166
2017	GTB	dmu:14	1	1	1	1	1
2018	GTB	dmu:15	1	1	1	1	1
2016	Stanbic Ibtc Holding	dmu:16	0.917092	0.917092	1	10	0.917092
2017	Stanbic Ibtc Holding	dmu:17	0.935035	0.935035	1	9	0.935035
2018	Stanbic Ibtc Holding	dmu:18	1	1	1	1	1
2016	Sterling Bank	dmu:19	0.774048	0.780183	0.992137	19	0.780183
2017	Sterling Bank	dmu:20	0.618394	0.623584	0.991678	31	0.623584
2018	Sterling Bank	dmu:21	0.599679	0.605089	0.991058	33	0.605089

2016	Union Bank PLC	dmu:22	0.898629	0.905484	0.99243	11	0.905484
2017	Union Bank PLC	dmu:23	0.865057	0.878954	0.984189	13	0.878954
2018	Union Bank PLC	dmu:24	0.67744	0.681161	0.994538	28	0.681161
2016	UBA	dmu:25	0.817723	0.830414	0.984717	17	0.830414
2017	UBA	dmu:26	0.824288	0.846072	0.974253	16	0.846072
2018	UBA	dmu:27	0.726611	0.751858	0.966421	22	0.751858
2016	Unity Bank	dmu:28	1	1	1	5	1
2017	Unity Bank	dmu:29	0.924705	1	0.924705	6	1
2018	Unity Bank	dmu:30	0.691263	0.691263	1	26	0.691263
2016	Wema Bank	dmu:31	0.594167	0.594167	1	35	0.594167
2017	Wema Bank	dmu:32	0.530462	0.530462	1	36	0.530462
2018	Wema Bank	dmu:33	0.660157	0.660157	1	30	0.660157
2016	Zenith Bank	dmu:34	0.809037	0.828822	0.976129	18	0.828822
2017	Zenith Bank	dmu:35	0.705005	0.721338	0.977358	25	0.721338
2018	Zenith Bank	dmu:36	0.78707	0.891322	0.883037	12	0.891322

Source: Researcher's Estimation Using Stata 13.0 (2020)

4.2 Constant and Variable Return to Scale (VRS) Technical Efficiency

Table 3 shows that under CRS and VRS assumption, only four (4) banks (First bank, Stanbic IBTC, GTB and Unity bank) were technically efficient respectively with GTB and Unity bank being the most efficient as indicated by the ratio 2:3 efficiency in the period considered as shown by the VRS technical efficiency score. This means that these banks, gets the same output result from increasing input by same percentage. And increase large production and efficiency via technical economic of scale increase, as informed by the Decision Making Unit (8, 14, 15, 18, 28, and 29). Specifically, under CRS Technical efficiency scores, four (4) out of twelve (12) banks were efficient (i.e CRS = 1) as indicated by their respective dmu (dmu: 8, dmu: 14-15, dmu: 18 and dmu: 28). This means that about 67% of listed banks in Nigeria are not technically efficient in using their total asset and operating expenses to produce superior outputs (i.e profit after tax and gross earnings). Since, only 33% of the banks in the industry can actually used fewer inputs to produce relative more output in the long run. The result also revealed that larger banks in terms of size (total asset) are more efficient in using its size and expenses to generate higher income compared to banks with smaller total asset and operating expenses that are not efficient under constant return to scale assumption. Hence, the null hypothesis that deposit money banks in Nigeria are not technically efficient under a constant and variable return to scale assumption is rejected, since eight (4) out of twelve (12) banks considered in the sample are efficient.

4.3 Scale Efficiency Results

Outputs have to be further enlarged to attain the most productive scale size if a firm must be scale efficient. Table 3 shows that on basis of scale efficiency scores (ratio of CRS to VRS technical efficiency) five (5) out of twelve (12) banks considered were scale efficient as indicated by their corresponding dmu values that is equal to one. Also, on the average, GTB, Stanbic IBTC and WEMA banks are the most efficient banks under the scale efficient assumption. This means that only these five (5) banks efficiently used their input factors (total asset and expenses) to produce better outcome (GP and PAT) during the studied period. Hence, the null hypothesis that all listed banks in Nigeria are not scale efficient is rejected in this study. This means that listed banks in Nigeria are scale efficient since 4 and 5 banks were found to be efficient under both constant, variable return and scale efficiency assumptions.

Finally, the total efficiency score (theta) for DMU 9 is 0.867967, and DMUs 8 and 14 are the reference DMUs for 9 to 13, because the slack level of profit has no effect on efficiency evaluation.Thus, first bank (dmu:8), GTB (dmu:14-15), Stanbic IBTC (dmu:18) and Unity bank dmu:28-29) are the efficient points that inefficient DMUs (7 – 36) can target to move in input oriented resources for more efficiency and higher output DEA calculations, as indicated by the theta and rank coefficients individually. This finding agrees with that of Chuling (2009), Eriki and Osifo (2014), Depren and Depren (2016), Aigbovo and Igbinoba (2019) in the literature that most banks operate in their production possibility frontier.

5.0 Conclusion and Recommendations

The researcher adopted firm two stage specific data envelopment analysis technique to empirically study the performance efficiency of deposit money banks listed in the Nigeria bourse from 2016 to 2018. The study concludes that resource utilization of Nigeria's deposit money banks are grossly efficient since 33% efficient under CRS and VRS, while 42% was SCALE efficient in converting minimal input to maximum output, which is a strong indication that DMBs in Nigeria are efficient in their input to output operation in achieving their primary goal of profit making. This could be attributed to the effective policy guide by the regulatory body (apex bank) in regulating the activities of banks since the 2008 financial crisis to promote sound financial system. In the light of the findings, the following recommendations are informed:

1. Reference point of efficient banks (First bank, GTB, Stanbic IBTC and Unity bank) should be bench marked by the non-efficient banks with regards to their input to output orientation in the financial sector.
2. Stable macroeconomic policies particularly with respect to stable interest rate and exchange rate are needed to curtail the increasing dimension of input cost so as to enhance efficient output in the long run.
3. Finally, banks in Nigeria required greater managerial competency and capacity to increase productive, allocative and scale efficiency in the sector.

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