ASSESSING THE EFFICIENCY OF SYSTEMICALLY IMPORTANT LISTED DEPOSIT MONEY BANKS IN NIGERIA: A DEA APPROACH

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ABSTRACT

Over the years, the efficiency of deposit money banks has been examined using financial ratios which examples such as return on equity, return on assets, profitability ratios among others as Key Performance Indicators (KPIs). However, these KPIs do not interpret the true and fair view of the bank's efficiency and profitability because it fails to directly measure the managerial capacity of converting an organization's inputs into outputs in the same organization. This study examined the efficiency of the systematically important listed Deposit Money Banks (DMBs) in Nigeria using total deposit, total asset, operating expenses for its inputs and net interest income, l& advances, and gross earnings for its output. The study used the summed data from the annual published financial statement of all the listed systemically important deposit money banks in Nigeria for the corresponding years spanning from 2009-2019. The study found that Access bank, and guaranty trust bank were technically efficient at both the input and output Constant Return to Scale (CRS) and (VRS), while Zenith bank was inefficient at the input-oriented variable return to scale with an efficiency score of 0.933103, United bank for Africa was inefficient at the input oriented variable return to scale and constant return to scale with the corresponding efficiency score of 0.806496 and 0.789307, respectively. The study concluded that big or large financial disclosures accrued to financial institutions does not secure its improved efficiency level which could metamorphose into financial stability, the study further recommended that huge total asset is not directly proportional to an efficient financial institution; therefore, the management of banks should introduce cost effective and/or efficient strategies as part of their strategic decisions and regulatory assessments should not be solely carried out by inferring on their financial figures, other key categorical examples which involves inputs such as number of employees and outputs such as number of hours worked should also be used in evaluating DMBs performance.

Keywords: Efficiency, Data Envelopment Analysis, Profitability, Variable Return to Scale, Constant Return to Scale

INTRODUCTION

Over time, banking as a financial concept anchored on financial intermediation has transformed from traditional brick and mortar banking to various convenience platforms to drive efficiencies in service deliveries. The banking sector remains an important sector driving the global economy. Apart from channeling resources from areas of surplus to the productive sectors of the economy, the sector acts as a lubricant facilitating trade and settlements within and outside a country. A sound banking sector aids the efficient management of assets and financial investments, which in turn strengthens the economic and business environment of a country (Claessens & leaven, 2005; Ahmad, Naveed, Ahmad & Bay, 2019). Against the background of the unique importance of

the banking sector to economic growth and development, several stakeholders of the economy such as the regulators, policymakers, investors among others have been concerned about the absolute performance of the industry, especially since the 2007 global financial crisis. Through the evaluation of a bank's efficiency, the internal structure of the bank is explored to identify the root cause of any inefficiencies impacting on performance (Shah, Wu & Korotkov, 2019).

Systemically important deposit money banks are banks classified as too big to fail in the Central Bank of Nigeria (CBN) draft paper (CBN, 2014). The 2007 global financial crisis led to the need to strengthen the regulation of both the global and domestic systemically important financial institutions (Osuma et al., 2019). This is because the failure of a systemically important financial institution may lead to the susceptibility of adverse externalities which could disrupt the real sector and the financial system of the economy. In November 2011, the G20 leaders requested the Basel Committee on Banking Supervision (BCBS) and financial Stability Board (FSB) to come up with a domestic systemically important banks framework in addition to the global systemically important financial institutions framework (Basel Committee, 2013; CBN, 2014). In time past, whenever there is distress in the banking sector, the government usually uses only capital injection (bailouts) as a measure to rescue banks and stabilize the financial system. This measure by the government to rescue banks has its own adverse effect on other stakeholders like the shareholders, which are usually worse-off because of the dilution of their shareholdings. Consequently, the challenge to ensure that all parties in the economy are protected compelled both the Nigeria Deposit Insurance Corporation (NDIC) and the Central Bank of Nigeria (CBN) and to develop their supervisory framework for its domestic systemically important deposit money banks in tandem with the Basel Committee on Banking Supervision. This is important to enhance financial system stability and reduce the systemic impact of bank distress on the economy.

Over the years, the efficiency of deposit money banks has been examined using financial ratios such as return on equity, return on assets, profitability ratios among others as Key Performance Indicators (KPIs) which suggest that financial ratios do not consider the difference in the businesses undertaken by different organizations, which would constitute the differences in the organization's inputs and outputs (Tripe, 2004). The frontier analysis comprises the parametric efficient frontier techniques and the non-parametric efficient frontier techniques. The efficiency score of Decision Making Units (DMU) is one of the germane principles that managers, policymakers and other top executives use to plan and forecast the improved performance of decision-making units (Mahmoudi, Emrouznejad & Rasti-Barzoki, 2019). On a wide spectrum, an efficient organization can produce more output without necessarily increasing its inputs, or where inputs of decision-making units (DMUs) are reduced without leading to a corresponding decrease in the output of the same decision making units. DEA is an instrument for decision making, which evaluates an organization's performance (Nafei, 2018). There are two main approaches used in the evaluation of bank performance. This includes the financial ratio analytical approach and the frontier technique. The financial ratio approach bases its measurement on financial indices such as profitability ratios, liquidity ratios, and the credit quality of the banks (Samad, 2004). The financial ratio approach has a drawback for its lack of consensus from academics about the portent combination of financial ratios and their weighting in the bank efficiency analysis (Yang, 2012). The frontier analysis involves both the non-parametric and parametric approaches, which are used in the determination of the efficient frontier of the various decision-making units after the assignment of relative efficiency scores.

Eriki & Osifo (2014) averred that Data Envelopment Analysis (DEA) has been observed to evaluate a bank's efficiency with more precision and to have a lower magnitude of inefficiency than other approaches used to measure or evaluate the efficiency of banks. Evaluation of efficiency varies depending on the purpose of the evaluation. Some evaluators may be more concerned about the bank's potential loan loss, profit after tax, capital adequacy ratio, net interest margin, and so on.

Bank's shareholders are more concerned about the bank's profitability and return on investment, while depositors are more concerned about the solvency, liquidity, and safety of the banks. Although each category of evaluators has its specific motivation, they are all moved by the interest to ascertain the right position of the banks. Therefore, the efficiency of deposit money banks remains an imperative issue in emerging economies like Nigeria to ensure the smoothness of monetary policy transmission mechanism, which affects the price level and the economy in general. Thus, an efficient Deposit Money Bank (DMB) is germane for the optimal use of financial resources in an economy (Moses & Ola, 2015). Li, Chiu, Lin & Huang (2019) asserted that the popular methodology used in the empirical investigation of banks efficiency and performance have been the Data Envelopment Analysis (DEA), which is inclined with the use of linear programming and the Stochastic Frontier Analysis (SFA) which uses regression analysis. This paper consists of the introduction, literature review, methodology, analysis and presentation of results, conclusion and recommendation, acknowledgement, and references.

LITERATURE REVIEW

We find that the extreme poor use more of the bank loans for other non-developmental leading to loan default (George, Okoye, Efobi & Modebe, 2017). Since the 2007 financial crisis and the recent poor global economic performance, the issue of organizational efficiency has remained a major challenge for the stakeholders of the economy. Importantly, one of the key objectives of examining efficiency is to attain the optimal level of output with the existing combination of inputs. Efficiency is associated with organizational performance since it reflects the evaluation of outputs and inputs. According to Muarief (2019), averred efficiency as the yardstick for assessing the progress of an organization when comparing it to its competitors *via* the optimization of its inputs and outputs. The use of frontier analysis which includes the parametric and non-parametric technique to measure efficiency has been on the increase over the years (Thagunna & Poudel, 2013; Lychev & Rozhnov, 2016; Khan, Khokhar, Hassan & Ahmad, 2018; Mahmoudi et al., 2019). The popular method which makes use of linear programming (nonparametric technique) is the Data Envelopment Analysis, while the other method that uses the (parametric technique) econometric method is the stochastic frontier analysis. Efficiency measurement was pioneered by Farrell (1957) in his research on the measurement of productive efficiency.

Cummins, Weiss & Zi (1999) analyzed the efficiency of two hundred and six (206) stocks and two hundred and eleven (211) mutual insurance companies in the United States of America for a period of ten (10) years spanning from 1981 through 1990, using two stage methodological approaches. The first stage Data Envelopment Analysis (DEA) scores were used in assessing the cost and production frontiers and Malmquist indices to measure the growth of productivity. From the second stage, the efficiency scores were regressed in terms of dummy variables and ratios. The study found that mutual insurance companies were more efficient in marketing mutual product, but less efficient in marketing proprietary insurance market product. Proprietary companies on the other hand, were more efficient technically when compared to the mutual companies. Luo (2003) carried out an extensive study on the marketability and profitability efficiency of two hundred and forty-five (245) large banks. The study found that in the United States of America (USA), large banks were inefficient compared to small banks that were efficient based on marketability. Brockett, Cooper, Golden, Rousseau & Wang (2004) averred that in evaluating insurance companies' efficiencies, two major approaches are involved: the production approach and financial intermediation approach. They opined that the financial intermediation approach channels funds from the savers and investors, while the production approach occurs when insurance companies provide essential services to their policyholders.

Izah, Nor Mazlin & Sudin (2009) evaluated the efficiency of Malaysian banks using DEA analysis, were the scale, pure and overall technical efficiencies were measured for a period of seven (7) years, spanning from 2000 to 2006. Their result portrayed that the local (domestic) banks were much more efficient when compared to the foreign banks. From the findings, it was suggested that the inefficiencies of some local banks were not based on their scale inefficiencies but on their pure technical inefficiencies, while that of some foreign banks is a result of the scale inefficiencies, rather than their pure technical inefficiencies. Usman & Akinlo (2009) examined inefficiencies in Nigerian Insurance companies from a cost structure perspective. Thirty (30) randomly selected insurance companies were used for the study and the result showed that only the large-scale firms were efficient. The study further recommended that for the insurance company's performance to be improved, premium income should be considered only when professional and sound investment decisions are made. Muhammad, Khizer & Shama (2010) used data envelopment analysis to analyze the relative efficiency of twelve (12) deposit money banks in Pakistan. They found that six (6) banks were efficient when Constant Return to Scale (CRS) was the measure for efficiency, leaving the remaining six (6) banks as inefficient and eight (8) banks were efficient when Variable Return to Scale (VRS) was the measure for efficiency making the remaining four (4) banks as inefficient.

Onour & Abdalla (2010) investigated the efficiency of twelve (12) Sudanese banks using the data envelopment analysis non-parametric approach and found those only two banks which include the medium-sized private bank and the biggest government banks that were technically efficient. Frimpong (2010) investigated the efficiency and profitability of twenty-two (22) Ghanaian banks for the year 2007. The study adopted the intermediation-based approach, Ghanaian bank's efficiency as regards ownership and size were highlighted and only four (4) banks were efficient. The remaining eighteen (18) banks had their efficiencies ranging from 0.33% to 0.89%. Private Banks were the most efficient of all the banks with an average efficiency of 0.87%, followed by foreign banks with an average efficiency of 0.72%. The state-owned banks were the least efficient of the entire banking group with an efficiency score of 0.51%. Eken & Kale (2011) investigated branch banking in Turkey where they analyzed their profitability and productions. They concluded that banks that have too few branches and those with too many branches need special attention. Eriki & Osifo (2014) investigated the overall efficiency of (19) deposit money banks in Nigeria using data envelopment analysis approach. Their study found that only four (4) out of the sample population of the nineteen (19) banks were scale efficient, making the remaining fifteen (15) scale inefficient. Wema Bank Plc, FinBank Plc, Bank PHB Plc, and Skye Bank were found to be technically efficient in converting inputs into a more than proportionate increase in outputs under the VRS and CRS models. Interestingly, as of 2021, only Wema Bank Plc out of the four (4) scale efficient banks in 2014 is still in operation

Eseoghene & Joseph (2014) also examined the performance efficiency of nineteen (19) Nigerian quoted deposit money banks with the Variable Return to Scale (VRS), Constant Return to Scale (CRS), and scale efficiency DEA models. The result of their constant return to scale model showed that Skye bank Plc, Fin-bank Plc, Wema Bank Plc, and Bank PHB Plc were technically efficient. The Variable Return to Scale (VRS) DEA model output showed that Eco Bank Plc, UBA Plc, Wema bank, Fin-bank Plc, Zenith Bank Plc, Skye Bank Plc, Bank PHB Plc, and Standard Chartered bank were all technically efficient, due to their successes achieved in converting inputs into outputs. While the scale efficiency result showed that Wema bank Plc, Skye bank Plc, Fin-bank Plc, and bank PHB were all scale efficient. They concluded that big banks in Nigeria are faced with the problem of total assets idleness while medium banks and small banks were more efficient in converting their equity and assets inputs into greater outputs which produced a not less than proportionate increase. Vidyarthi (2018) analyzed intellectual capital impacts and its subcomponents on thirty-eight (38) listed Indian banks. DEA technique was used for the estimation

of the technical, scale and pure efficiencies. The study suggested that increased investments in Intellectual Capital (IC) should be supported since it has been proven to improve banking efficiency. Saudi Arabia is one of the countries where convention and Islamic banking operates side by side. Khan, et al., (2018) examined the pure, scale and technical efficiency of Saudi Arabian banks. They found that Al-Rajhi is the only Islamic bank to achieve the highest score of pure, scale and technical efficiency, while in the conventional group; both the National deposit money bank and Saudi Hollandi were top position. They recommended that Islamic banks should improve managerial skills at the branch level and readdress their short-term and long-term marketing strategies.

Arora & Kanwar (2018) examined the overall technical efficiency and non-performing assets of eighty-one (81) Indian banks using the meta-frontier analysis technique were control and case models were used to estimate the bank's efficiency scores. They found that 0.4390 overall technical efficiency was estimated with the control model while 0.4715 overall technical efficiencies were estimated with the case model. It can be inferenced that there exists a high level of overall technical inefficiency in Indian banks. Ipeghan, Suka, Omankhanlen & Adegbite (2018) examined the post-2005 consolidation effects on the Nigerian banking sector's efficiency from the year 2005 through 2009. The study showed that none of the study's banks produce up to fifty (50) percent total efficiency in any of the years under study. Even after the consolidation era, many of the banks did not record full efficiency. Therefore, there is a need to formulate and put in use better monetary policies that will improve these banks' performances, including their efficiencies.

Charles & Toby (2019), investigated the overall technical efficiency, scale efficiency and x-efficiency in Nigeria's banking industry. They analyzed the bank-specific variables with regression analysis and used DEA to estimate the efficiency scores of fifteen (15) deposit money banks from 2007 through 2015. Their x-efficiency and scale efficiency result showed a high level of efficiency amongst megabanks compared to smaller banks. They suggested that the financial sector current technology promotes efficient growth of the banking industry and promote competitive advantage. Moreover, the incorporation of technology creates a foundational channel enabling banks to connect information with their customers, by allowing their customers/ users to utilize the various banking services at their convenience anytime and anywhere *via* the Internet (Wang, Luu, Nguyen & Day, 2019). This technology integration tends to attract more customers and positions the bank to be termed as efficient due to their hitch-free services and increased customer satisfaction.

Aghayi & Raayatpanah (2019) examined the banking industry of Iran's overall efficiency using a robust optimization approach with data uncertainty. Their findings showed that a robust overall profit efficiency score provided a significant performance improvement, as uncertainty increases. Babu (2019) examined seventeen (17) top Indian banks with reference to their liquidity and profitability. He averred that the CAMELS approach was effective in determining the pre-merger and post-merger analysis of the seventeen (17) banks. While DEA was used in determining the efficiency of the banks. The result of his study showed that bank of Baroda, HDFC bank ltd and Federal bank were efficient when compared with other banks in terms of financial performance.

Theoretical Review

The research anchors on the x-efficiency hypothesis propounded by Leibenstein (1966). The theory argues that banks that have better corporate governance practice, manage their operational expenses (inputs) tend to raise their profit level and move banks closer to the efficient frontier. Under the "x-efficiency" an efficient bank is profitable because of their reduced operational costs. These banks gain a larger market share which commensurate to an improved bank concentration level. The causal relationship between profitability and concentration is not considered here. The underlying assumption of the x-efficiency theory includes low productivity can occur because of the

focus of the work of top managers. The focus of top managers is aimed at the commercial and financial affairs (Leibenstein, 1966).

METHODOLOGY

This study adopted the quasi-experimental research design and examined the efficiency of the systematically important listed deposit money banks in Nigeria. The study used data from the published annual financial reports of all the listed deposit money banks in Nigeria for their various corresponding years spanning from 2009 through 2019 (summed together, see appendix I & II), out of which the systemically important DMBs was used. Four (4) indicator-based measures were used to classify the systemically important deposit money banks in Nigeria, and these include size, interconnectedness, substitutability, and complexity. Size is measured by total assets, in 2014, eight (8) deposit money banks accounted for over 70% of the industry's total assets. Interconnectedness is measured by net-interbank transactions and intra financial systems assets and liabilities. Substitutability is measured by total net credits, total deposits, and ease with which the DMBs can be replaced. While complexity is measured by branch network, the total number of its foreign subsidiaries, and how costly or difficult it would be to liquidate the DMBs.

The data envelopment notations used in this study are written below:
DMUs (Banks), can be denoted as DMU_j, j=1,…,*n*
Inputs (*total deposit, total asset,* and *operating expenses*), can be denoted as x_{ij}, i=1,…*m*
i=1, …,*m* for inputs (*m* is the number of inputs)
*j*th DMU's *i*th input
5th DMU's 3rd input: X_{35}
Outputs (*net interest income, loans and advances,* and *gross earnings*), can be denoted as y_{rj}, r=1,…, *s*
r=1,…*s*, for outputs (*s* is the number of outputs)
*j*th DMU's *r*th output
6th DMU's 3rd output: Y_{36}
The values on these inputs and outputs are known – they are observations (although they are expressed in symbols in the DEA models)
Inputs (*m*=1, 2, 3; *b*=3)

- *Total deposit*
- *Total Asset*
- *Operating expenses*

Outputs (*s*=1, 2, 3; *p*=3)

- *Net interest income*
- *Loans and advances*
- *Gross earnings*

Figure 2 in the appendix shows the review comments on specific cells and from figure 1 cell E18 represents the DMU under evaluation and the output in cell F15 shows the efficiency of the seventh deposit money banks, while the changing cells represents the spreadsheets decision variables (Zhu, 2009). For this study, the changing cells represents the λ_k under cell "K" (k=1, 2, 3……11) which represents the eleven (11) listed deposit money banks in Nigeria. The six (6) various constraints correspond to the reference set (in cell B16:21) and DMU under evaluation (in cell D16:21) for both the input and output-oriented data envelopment analysis. For calculating the data envelopment analysis reference set, which is usually referred to as the left-hand side of the

envelopment model, the formula was used to calculate the weighted sum of all the variable inputs and outputs across all the decision-making units. These formulae was adopted from Zhu (2009).

Cell B16 =SUMPRODUCT(B2:B12,$J$2:$J$16)*
Cell B17 =SUMPRODUCT(C2:C12,$J$2:$J$16)*
Cell B18 =SUMPRODUCT(D2:D12,$J$2:$J$16)*
Cell B19 =SUMPRODUCT(F2:F12,$J$2:$J$16)*
Cell B20 =SUMPRODUCT(G2:G12,$J$2:$J$16)*
Cell B21 =SUMPRODUCT(H2:H12,$J$2:$J$16)*.... …. …. …. …. (1)

In calculating the DMU under evaluation, which is usually referred to as the right-hand side (RHS) of the envelopment spreadsheet the following formulas were used to calculate the RHS;

*Cell D16 =$F$15*INDEX(B2:B12,E14,1)*
*Cell D17 =$F$15*INDEX(C2:C12,E14,1)*
*Cell D18 =$F$15*INDEX(D2:D12,E14,1)*
Cell D19 =INDEX(F2:F12,E18,1)*
Cell D20 =INDEX(G2:G12,E18,1)*
Cell D21 =INDEX(G2:G12,E18,1)*…. …. …. …. …. …. …. (2)

For calculating the data envelopment analysis reference set, the output-oriented data envelopment analysis is inputted as

Cell B16 =SUMPRODUCT(INDEX*(InputUsed,0,1),Lambdas)*
Cell B17 =SUMPRODUCT(INDEX*(InputUsed,0,2),Lambdas)*
Cell B18 =SUMPRODUCT(INDEX*(InputUsed,0,3),Lambdas)*
Cell B19 =SUMPRODUCT(INDEX*(OutputProduced,0,1),Lambdas)*
Cell B20 =SUMPRODUCT(INDEX*(OutputProduced,0,2),Lambdas)*
Cell B21 =SUMPRODUCT(INDEX*(OutputProduced,0,3),Lambdas)*…. …. …. (3)

Just as it applies in the in the input-oriented approach, the DMU under evaluation, is still referred to as the right hand side (RHS) of the envelopment spreadsheet and the formulas used to calculate the RHS is given below;

Cell D16 =INDEX(InputUsed,DMU,1)*
Cell D17 =INDEX(InputUsed,DMU,2)*
Cell D18 =INDEX(InputUsed,DMU,3)*
*Cell D19=Efficiency*INDEX(OutputProduced,DMU,1)*
*Cell D20=Efficiency*INDEX(OutputProduced,DMU,2)*
*Cell D21=Efficiency*INDEX(OutputProduced,DMU,3)*.... …. …. …. (4)

ANALYSIS AND PRESENTATION OF RESULTS

Table 1
JUSTIFICATION OF BANKS VARIABLES

Variable Name	Identifier	Source of Data	Definition and Measurement
Total Assets (TA)	Input	The deposit money banks annual report.	This is calculated mathematical by summing (additing) all current and fixed assets (non-current assets) owned by a company or banks. From the four (4) indicator-based measures used to classify the systemically important deposit money banks, total asset is used to measure size.
Total deposit	Input	Bank financial Statement	This includes the term deposits, demand deposits, non-interest and interest bearing deposits of the deposit money

			bank. From the four (4) indicator-based measures used to classify the systemically important deposit money banks, total deposit is used to measure Substitutability.
Operating Expenses (OE)	Input	Banks financial Statement	These are part of the daily operation cost that the banks use to achieve their actual objectives. For this study operating expenses is measured by complexity which is measured by branch network.
Net interest income (NII)	Output	Annual reports of the bank	For this study interconnectedness is used to measure the net interest income. Since banking business anchors on financial intermediation, the net interest income covers the income generated from the banks interest bearing assets.
Loans and advances (LA)	Output	Banks financial Statement	From the four (4) indicator-based measures used to classify the systemically important deposit money banks, interconnectedness which is measured by net-interbank transactions would best fit the loan and advance measurement because it covers any loan transaction that helps in enhancing the liquidity of the market.
Gross earnings (GE)	Output	Banks financial Statement	This is the sum of all salaries, profits, and other investment dividends e.tc before tax deduction is made. For this study gross earning is measured by size.

Source: Authors' Synthesis, 2021.

Table 2
INPUT-ORIENTED VARIABLE RETURN TO SCALE ENVELOPMENT TABLE OUTPUT FOR DEPOSIT MONEY BANKS

DMU's	Total deposit	Total asset	Operating expenses	Net interest income	Loan and advances	Gross earnings	Efficiency
Access Bank	18552139519	26811466047	738551597	1062635050	13088973192	2964975995	1
Guarantee Trust Bank	7904886220	17901083117	456049910	1533961594	4505588712	2840067597	1
United Bank for Africa	19166747	26404450	720383	1091776	10069454	2729387	0.806496
Zenith Bank	26492890	40395106	1098480	2055895	16568217	4480885	0.933103

Source: Authors' computation, 2021

Table 2 shows that only two (2) deposit money banks are efficient using the VRS frontier. The efficient deposit money banks are Access bank, and Guarantee trust bank. The inefficient deposit money banks include United bank for Africa PLC, and Zenith bank PLC. The results using the envelopment spreadsheet reveals that the left-hand side which shows the constraints remains static when analyzing the efficiencies of different DMUs, while the right-hand side that shows the DMU under evaluation changes as new DMUs are being evaluated (see cell B16:B22 and D16:D22, in Figure 1).

Table 3
INPUT-ORIENTED CONSTANT RETURN TO SCALE ENVELOPMENT TABLE OUTPUT FOR DEPOSIT MONEY BANKS

DMU's	Total deposit	Total asset	Operating expenses	Net interest income	Loan and advances	Gross earnings	Efficiency
Access Bank	18552139519	26811466047	738551597	1062635050	13088973192	2964975995	1

Guarantee Trust Bank	7904886220	17901083117	456049910	1533961594	4505588712	2840067597	1
United Bank for Africa	19166747	26404450	720383	1091776	10069454	2729387	0.789307
Zenith Bank	26492890	40395106	1098480	2055895	16568217	4480885	1

Source: Authors' computation, 2021

From table 3, which is the input-oriented constant return to scale envelopment model, three (3) deposit money banks are efficient, and the efficient deposit money banks include Access bank, Guarantee trust bank, and Zenith. The inefficient deposit money bank is united bank for Africa. From the excel solver the left-hand side which shows the constraints remained static when analyzing the efficiencies of different DMUs, while the right-hand side that shows the DMU under evaluation changes as new DMUs are being evaluated. In calculating the input oriented efficient DMUs, under the CRS model the $\sum_{k=1}^{n} \lambda = 1$ was deleted from the solver constraint parameter.

Table 4
OUTPUT-ORIENTED VARIABLE RETURN TO SCALE ENVELOPMENT TABLE OUTPUT FOR DEPOSIT MONEY BANKS

DMU's	Total deposit	Total asset	Operating expenses	Net interest income	Loan and advances	Gross earnings	Efficiency
Access Bank	18552139519	26811466047	738551597	1062635050	13088973192	2964975995	1
Guarantee Trust Bank	7904886220	17901083117	456049910	1533961594	4505588712	2840067597	1
United Bank for Africa	19166747	26404450	720383	1091776	10069454	2729387	1
Zenith Bank	26492890	40395106	1098480	2055895	16568217	4480885	1

Source: Authors' computation, 2021

In table 4, Access bank, Guaranty trust bank, united bank for Africa and Zenith bank were efficient (on the output oriented-VRS frontier).

Table 5
OUTPUT-ORIENTED CONSTANT RETURN TO SCALE ENVELOPMENT TABLE OUTPUT FOR DEPOSIT MONEY BANKS

DMU's	Total deposit	Total asset	Operating expenses	Net interest income	Loan and advances	Gross earnings	Efficiency
Access Bank	18552139519	26811466047	738551597	1062635050	13088973192	2964975995	1
Guarantee Trust Bank	7904886220	17901083117	456049910	1533961594	4505588712	2840067597	1
United Bank for Africa	19166747	26404450	720383	1091776	10069454	2729387	1
Zenith Bank	26492890	40395106	1098480	2055895	16568217	4480885	1

Source: Authors' computation, 2021

The results in table 5, which is the output-oriented constant return to scale envelopment model, shows that all deposit money banks are efficient. In calculating the input oriented efficient DMUs, under the CRS model the $\sum_{k=1}^{n} \lambda = 1$ was deleted from the solver constraint parameter.

Table 6
EFFICIENCY SCORES AT THE FOUR ENVELOPMENT MODELS

DMU's	Efficiency Input-Oriented (VRS)	Efficiency Input-Oriented (CRS)	Efficiency Output-Oriented (VRS)	Efficiency Output-Oriented (CRS)
Access Bank	1	1	1	1
Guarantee Trust Bank	1	1	1	1
United Bank for Africa	0.806496	0.789307	1	1
Zenith Bank	0.933103	1	1	1

Source: Authors' computation, 2021

Table 6 gives a bird eye view of the efficiency scores at the various envelopment models, and it can be deduced that both Access Bank, and Guarantee trust bank were efficient at all the envelopment models, followed by Zenith bank which was efficient in three (3) out of the four (4) envelopment model and United bank for Africa which was efficient in only two envelopment models. One major objective of financial institutions apart from profit maximization is improving its firm's capital efficiency and reducing operational cost. In the variable return to scale envelopment model, input should be reduced (decreased) while output should be increased to enhance performance and reach best practice frontier. In other words, if an undesired output is being treated as input, it means that the data envelopment analysis model does not show the accurate picture of the production process. Some scenarios where some input needs to be added to enhance performance are susceptible to occur. For example, in improving the performance of a company that deals with the transportation and disposal of bulk liquids and sludge, the quantity of sludge (unwanted input) to be treated should be increase rather than decrease as presumed in other conventional data envelopment models.

CONCLUSION AND RECOMMENDATIONS

This study assesses the efficiency of banks, which play pivotal roles in the economy. It is highly expedient for the monetary authorities to ensure strict compliance with its rules and regulations by these financial institutions especially the once that engages in financial intermediation where they carry out maturity transformation and liquidity transformation. Based on the importance of an efficient financial institution and with regards to this study's findings the following recommendations are made. The regulatory assessment of DMBs performance should not be solely carried out by inferring on their financial figures, instead, other key categorical variables such as staff strength, and standard working hours which represents input and output variables respectively can be used in analyzing firm's performance. In essence, performance review should be carried out both qualitatively (non-numerical) and quantitatively.

Big or large financial disclosures accrued to financial institutions do not secure its improved efficiency level which could metamorphose into financial stability. Although, when these financial institutions possess a high level of liquidity, it automatically helps to facilitate financial stability and serves as a cushion for its sensitivity to market risk when loans and advances exposures that were inadequately reviewed lead to an improvement in the financial institutions non-performing loan

accounts. This study contributes that in determining the operating efficiencies of financial institution, data envelopment analysis is a better measure than the conventional key performance indicators such as financial ratios. This study also proves that FIs input specific variables and its output variables should be used when examining their efficiency which is a better measure of performance.

When using KPIs in determining efficiency let us consider DMB "A" and DMB "B" are two financial institutions with a profit after tax of twenty billion naira (₦20,000,000,000) each. From their output of twenty billion each, a financial analyst would draw their inferences by judging the two DMBs as being profitable and efficient. Whereas when using the nonparametric technique of Data Envelopment Analysis (DEA) in analyzing the same scenario, we would consider both the DMB's input and output variables before determining its efficiency level. Thus DMB "A" and DMB "B" produces an output of twenty billion naira (₦20,000,000,000) each with a thousand staff for DMB "A" as an input variable and five thousand staff for DMB "B" as an input variable, it can be inferenced that DMB "A" is much more efficient than DMB "B" inferencing that a DMBs can be profitable without being efficient. This example is solely to aid reader understanding and can only be logical when other external factors that affect performance are held constant.

For enhance efficiency the COVID-19 had make it more glaring that industries that were able to leverage on digitalization channels during the Pandemic lockdown in 2020, experienced expansionary growth in their financials. In essence, the era of armchair banking and brick & mortar banking have passed. Deposit money banks should invest more in their Information Technology (IT) department to improve on the operational efficiency. Regulators should carry out a periodic efficiency test on the financial institutions because some deposit money banks that are profitable were not efficient in the input-oriented variable return to scale for United bank for Africa and Zenith bank and input-oriented constant return to scale for United bank for Africa (see table 6). Therefore, the result of this study has made it clear that efficiency is a better measure of performance when compared to profitability.

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REFERENCES

Aghayi, N., & Raayatpanah, M.A. (2019). A robust optimization approach to overall profit efficiency with data uncertainty: Application on bank industry application on bank industry. *Journal of the Chinese Institute of Engineers*, *00*(00), 1–9.

Ahmad, N., Naveed, A., Ahmad, S., & Bay, T. (2019). Banking sector performance, profitability, and efficiency: A citation-based systematic literature review, 00(0), 1–34.

Babu, M.R. (2019). Research on profitability and liquidity position of banks with reference to pre and post-merger. *International Journal of Recent Technology and Engineering*, *8*(1), 253–261.

Basel Committee (2013). Basel Committee on Banking Supervision Global systemically important banks: Assessment methodology and the additional loss absorbency requirement Rules text.

Barros, C.P., Barroso, N., & Borges, M.R. (2005). Evaluating the efficiency and productivity of insurance companies with a Malmquist index: A case study for Portugal. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *30*(2), 244-267.

CBN (2014). Framework for regulation and supervision of domestic systemically important banks.

Claessens, S., & Laeven, L. (2005). Financial dependence, banking sector competition, and economic growth. *Journal of the European Economic Association*, *3*(1), 179–207.

Eken, M.H., & Kale, S., (2011). Measuring bank branch performance using Data Envelopment Analysis: The case of Turkish bank branches. *African Journal of Business Management, 5*(1), 889-901

Eriki, P.O., & Osifo, O., (2014). Performance efficiency of selected quoted commercial banks in Nigeria: A DEA Approach. *International Journal of Economics, Commerce, and Management, 2*(9), 1-16.

Eseoghene, J.I., & Joseph, E.A. (2014). Measuring performance efficiency of Nigerian publicly quoted banks: A Data Envelopment Analysis approach. *Multi-Disciplinary Journal of Research and Development Perspectives*, *3*(2), 38-58.

Farrell, M.J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society (A, general), 120*(3), 253-281.

Frimpong, J.M. (2010). Investigating efficiency of Ghana banks: A non-parametric approach. *American Journal of Scientific Research, 7*(2010), 64-76.

George, T.O., Okoye, L.U., Efobi, U., & Modebe, N.J. (2017). Financial decision and poverty: Examining the financial behavior of the extreme poor in Nigeria. *Proceedings of the 29th International Business Information Management Association Conference - Education Excellence and Innovation Management through Vision 2020: From Regional Development Sustainability to Global Economic Growth, 2017*, 3106–3116.

Ipeghan, I., Suka, A., Charles, L., & Toby, A.J. (2019). Modeling data envelopment analysis and bank-specific determinants of profitability in Nigeria, *International Journal of Research in Finance and Management, 2*(2), 34-46.

Izah, M.T., Nor Mazlina, A.B., & Sudin, H. (2009). Evaluating efficiency of Malaysian banks using data envelopment analysis. *International Journal of Business and Management*, *4*(8), 96-106.

Khan, M.N., Amin, F.B., Khokhar, I., Hassan, I., & Ahmad, K. (2018). Efficiency measurement of Islamic and conventional banks in Saudi Arabia : An empirical and comparative analysis. *Journal of Islamic thought and civilization of the international Islamic university Malaysia* (IIUM), (special issue), 111-134.

Leibenstein, H. (1966). Allocative efficiency *vs*." X-efficiency". The American Economic Review, 392-415.

Li, Y., Chiu, Y., Lin, T., & Huang, Y.Y., (2019). Market share and performance in Taiwanese banks: Min/max SBM DEA. *Society for Statistics and Operations Research, 2*(29), 1-20.

Lychev, A.V., & Rozhnov, A.V. (2016). Advanced analytics software for performance analysis and visualization of financial institutions. *2017 IEEE 11th International Conference on Application of Information and Communication Technologies (AICT)*, 1–5.

Mahmoudi, R., Emrouznejad, A., & Rasti-Barzoki, M. (2019). A bargaining game model for performance assessment in network DEA considering sub-networks: a real case study in banking. *Neural Computing and Applications*, *31*(10), 6429–6447.

Moses, F., & Ola, A.O. (2015). Pure and scale efficiency change consideration of banking industry in Nigeria. *Journal of Research in Business and Management, 3*(8), 1–6.

Muhammad F.A., Khizer A., & Shama S. (2010). Performance efficiency of commercial banks of Pakistan: Non-parametric technique Data Envelopment Analysis (DEA). *Asian Journal of Business and Management Sciences, 1*(2), 150-156.

Muarief, R. (2019). Analysis of commercial bank efficiency in Indonesia using data envelopment analysis (DEA) method as banking performance consideration. *International Journal of Mechanical Engineering and Technology*, *10*(02), 688–696.

Nafei, A.H., (2018). An Approach in solving data envelopment analysis with stochastic data. *Fuzzy Information and Engineering and Decision, Advances in Intelligent Systems and Computing, 2*(3), 154-162.

Omankhanlen, A.E., & Adegbite, O.E. (2018). Efficiency performance analysis in the Nigerian banking industry: Post 2004 reforms. *International Business Management, 12*(3), 253-261.

Onour, I.A., & Abdalla, A.M.A. (2010), Efficiency of Islamic banks in Sudan: A nonparametric approach. API/WPS 1012.

Osuma, G.O., Babajide, A.A., Ikpefan, O.A., Nwuba, E.B., & Jegede, P.W. (2019). Effects of global decline in oil price on the financial performance of selected deposit money banks in Nigeria. *International Journal of Energy Economics and Policy*, *9*(3), 187–195.

Piot-lepetit, I., & Nzongang, J. (2018). Performance assessment and definition of improvement paths for microfinance institutions: An application to a network of village banks in Cameroon. *International transactions in operational research*, 1–23.

Samad, A. (2004). Performance of interest-free Islamic banks vis-a-vis interest-based conventional banks of Bahrain. *International Journal of Economics, Management and Accounting, 12*(2), 1-10

Shah, A.A., Wu, D., & Korotkov, V., (2019). Are sustainable banks efficient and productive? A data envelopment analysis and the Malmquist productivity index analysis. *Sustainability*, 2019(11).

Thagunna, K.S., & Poudel, S., (2013). Measuring bank performance of Nepali banks: A Data Envelopment Analysis (DEA) perspective. *International Journal of Economics and Financial Issues*, *3*(1), 54-65.

Tripe, D., (2004). Efficiency in integrated banking Markets-Australia and New Zealand. Centre for Banking Studies, Massey University.

Usman, O.A., & Akinlo, A.E., (2009), Scale economies and performance evaluation of insurance market in Nigeria. *Journal of social sciences of Pakistan, 4*(1), 1-11.

Vidyarthi, H. (2018). Dynamics of intellectual capitals and bank efficiency in India. *The Service Industries Journal*, 0(0), 1–24.

Wang, C., Luu, Q., Nguyen, T., & Day, J., (2019). Assessing bank performance using dynamic SBM Model. *Mathematics 2019, 7*(73) 1-13.

Yang, C.C. (2012). Service, investment, and risk management performance in commercial banks. *The Service Industries Journal*, *32*(12), 2005–2025.

Zhu, J. (2009). *Quantitative models for performance evaluation and benchmarking: Data envelopment analysis with spreadsheets (2nd edition)* Springer. Worcester Polytechnic Institute Worcester, MA, USA.