Noble International Journal of Economics and Financial Research
ISSN(e): 2519-9730 ISSN(p): 2523-0565
Vol. 2, No. 2, pp: 27-49, 2017

Published by Noble Academic Publisher
URL: http://napublisher.org/?ic=journals&id=2

Open Access

Relative Efficiency of Commercial Banks in Nigeria: A Nonparametric Mathematical Optimization Analysis

Michael O. Nyong*
*Department of Economics, University of Calabar, Nigeria

Abstract: This paper investigates the relative efficiency of a cross section of Nigerian domestic commercial banks before and after recapitalization and consolidation in 2005. The method of analysis is the non-parametric mathematical optimization approach rooted in data envelopment analysis (DEA). Two-stage approach is adopted. In the first stage DEA is used to determine the degree of efficiency of the 66 banks (2001, 2002) and 22 banks (2008, 2009). In the second stage Tobit regression model is used to econometrically estimate the parameters of the model to examine the sources of bank inefficiency. The results revealed high level of inefficiency among the banks and hence of significant waste in utilization of resources. Inefficiency range from 36% in 2001 to 45% in 2002 and from 34% in 2009 to 35% in 2008. The inefficiency of the banks is due more to pure technical rather than scale effect. Thus, Nigerian commercial banks should worry less about not choosing the optimal scale for production though the study found economies of scale that have not been exhausted. The sources of inefficiency were identified to be low capital-asset ratio, high operating expense-income ratio, low returns on equity, market share, interest expense-deposit ratio, and low liquidity ratio. The results have strong policy implications for banks themselves, the deposit insurance corporation and central bank to minimize distress and avert bank failure.

Keywords: Relative Efficiency, Data Envelopment Analysis.

1. Introduction

The performance of the financial sector in any economy is an important determinant of stability and development of that economy. The banking system is the major component of the financial sector and hence its performance is critical to the stability and development of a country. This is so for three fundamental reasons. First, banks provide credit to both government and private sectors which contribute to country's industrialization and development over time. Second, banks serve as a conduit through which monetary policy is transmitted to the rest of the economy. Third, the funds available to banks do not belong to them. They belong to depositors who entrust them for the safety of these funds. Thus, the safety and soundness of the banking sector is necessary to maintain the confidence of the general public and avoid generalized distress with its negative consequences on the people and the economy. The extents to which banks perform these functions depend on how efficient they are. Consequently, measuring the efficiency of banks has become necessary to provide deep insight into the banking system and potential for economic development.

Indeed, regulators, customers, stakeholders, bank managers have clearly identified self-interests in bank efficiency. From the regulators' perspective, inefficient banks are riskier and have a higher probability of failure. Without a sound and efficiently functioning banking system, the economy cannot function smoothly and with soundness. When banking system fails, the nations' payments system is in jeopardy. From the point of view of customers, only efficient banks can offer better services at reasonable prices. While the position of bank stakeholders is that only efficient banks ensure reasonable returns, the perspective of bank managers is that in a dynamic and competitive market environment, only efficient banks will survive and maintain their market share, and inefficient ones will eventually be eliminated through Darwinian survival of the fittest. The efficient banks are better able to compete because of their lower operational costs which enable them to attract business away from less efficient ones. Overall, the

relative efficiency of banks is always a matter of great interest to the regulators, customers, stakeholders, managers and to some extent stock market analysts.

This paper attempts to investigate the efficiency of a cross section of Nigeria commercial banks before and after recapitalization and consolidation period. This will enable us to determine whether efficiency improved or declined during the two periods. The results will also enable us to unearth whether the observed inefficiency in Nigeria's commercial banking industry is due to managerial weakness or choice of inappropriate scale. The paper adopts a two – stage approach. In the first stage the degree of efficiency of each bank is determined using the nonparametric Data Envelopment Analysis (DEA). In the second stage, the factors accounting for the observed differences in the degree of efficiency/inefficiency are identified. The second stage results are of immense policy relevance and importance as it indicates the sources of inefficiency which are crucial to the formulation of policies to improve performance. It provides viable options on what banks should do to become efficient without sacrificing service quality (Shirvani *et al.*, 2011).

The rest of this paper is organized in five sections. Section I has been the introduction. In section II we provide some stylized facts about Nigeria banking industry. Section III presents a brief review of the theoretical and empirical literature. In section IV we articulates the research methodology. The empirical results, interpretations and analysis are presented in section V. We end the presentation in section VI with a summary of main findings and policy implications.

2. Stylize Facts of Nigeria Banking Industry

Before the adoption of structural adjustment program (SAP) in 1986, the banking industry in Nigeria operated in a regime of regulated interested rate, and restricted entry by the Central Bank of Nigeria (CBN). The industry was highly oligopolistic with about three banks, First Bank of Nigeria (FBN), United Bank for Africa (UBA) and Union bank of Nigeria (UBN) controlling over seventy-two percent of the banking market. With the adoption of structural adjustment program (SAP) in 1986 and deregulation of interest rate in 1987, the industry became liberalized. More new banks entered into the industry. With forty(40) banks in 1985 comprising twenty-eight(28) commercial banks and 12 merchant banks the total number of banks rose to one hundred and twenty(120) in 1991 consisting of sixty-six(66) commercial banks and fifty-four(54) merchant banks (Central Bank of Nigeria, 1985;1991;1992). Between 1991 and 2004 some banks failed while some few more entered into the industry so that by 2004 there were about eighty-nine (89) banks operating effectively in the country.

Following government policy on recapitalization and consolidation whereby the minimum capital base of banks was increased from 2 billion Naira to a minimum of 25 billion Naira ($180 million) in 2005 the number of banks fell from eighty-nine (89) to twenty-five(25) big banks (mega banks). With further consolidation, the number of banks fell further to twenty-four (24). Of the top 20 most capitalized firms listed on the Nigerian stock market in 2009, 11 of them were banks with FBN being the most capitalized at N407.54 million (Nigeria Stock Exchange, 2010-2011).

With the huge funds now at the disposal of banks some banks engaged in some sharp practices including overexposure to the capital market, to oil and gas industry, to foreign exchange round-tripping and to weak corporate governance. For, instance, the market capitalization of deposit money banks which was 41.8 percent of GDP in 2006 fell to 33.6 percent of GDP by 2010(Central Bank of Nigeria, 2010a), largely because of the global financial crisis of 2007 which affected Nigerian banks through their over exposure to the capital market. The margin trading loans of the banks stood at about N900.0 billion by December 2008 (Anyanwu, 2010). Following this development the Central Bank of Nigeria embarked upon another round of reform to avoid systemic distress in the banking system. The CBN financial sector reform of 2008 is the fifth in the series of banking sector reforms to maintain the safety and soundness of the system, the first being the 1987-1993 financial deregulation policy, the second the 1993-1999 re-regulation era arising from the financial distress in the banking system. The third phase 1999-2004 commenced with the return of liberalization and the adoption of universal banking model. The fourth phase or the era of banking sector recapitalization and consolidation occurred during the period 2004-2006.

The financial sector reform of 2008 focused on correcting the structural and operational weaknesses through improving banking infrastructure, strengthening the regulatory and supervisory framework, and addressing impaired capital and providing liquidity support. The Central Bank of Nigeria expanded its discount window to rescue eight (8) banks through capital and liquidity injection to avoid systemic distressed. Today, Nigerian banks are the largest in West Africa and some of them are among the top 10

banks in Africa. With these reforms Nigerian banks are expected to be more efficient than they were before consolidation.

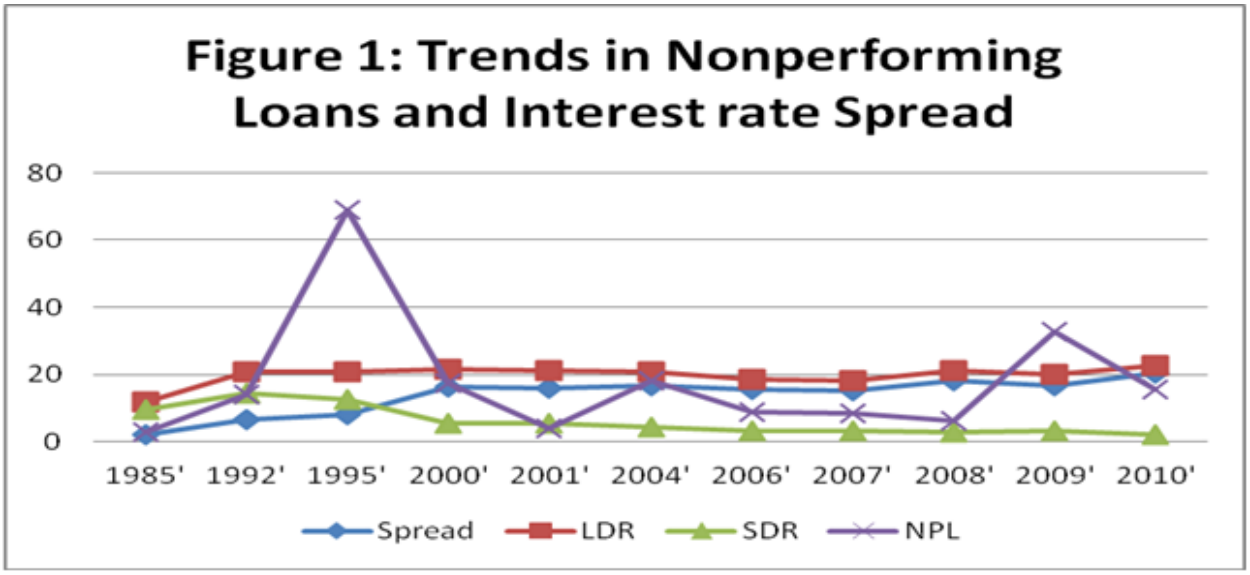
Table 1 shows the trends in number of banks, lending and deposit rates and 3-firm (FBN, UBA and UBN) concentration ratio from 1985 to 2010. A striking feature of the banking industry is the wide spread between the lending interest rate and the deposit rate, reflecting financial repression in the sense of Mckinnon (1973) and Shaw (1973). Table 1 also reveals gradual increase in the minimum capital base of banks in response to challenges posed by distress in the financial system and the need to maintain the soundness, stability and confidence in the banking system. Another important characteristics of banks is the substantial decline in the 3–firm bank deposit concentration ratio particularly in the era following banking capitalization and consolidation (2006-2010). The concentration ratio which was 49.58 percent in year 2000 fell to 31.20 percent by 2010. A deeper analysis of the maturity profile of bank deposits in 2008 reveals that 73 percent of their deposit mature in 30 days indicating that that there was paucity of long –term deposits in the system (Central Bank of Nigeria, 2008).

Table 1: Trends in Bank Market Structure and Interest Rate Spread

Year	Number of Banks	Number of Branch Offices	Minimum Capital Requirement (N million)	Lending Rate %	Saving Rate %	Nonperforming Loans (% Total Credit)	Concentration Ratio (3-firm)
1985	40	1,297	1.6	11.75	9.5	3.0	72.50
1992	120	2,275	20.0	20.80	14.29	14	32.73
1995	115	2,368	500.0	20.79	12.61	69	53.70
2000	92	2,193	500.0	21.55	5.29	17.6	49.58
2001	90	2,193	1,000.0	21.34	5.49	4.1	47.70
2004	89	3,492	2,000.0	20.82	4.19	18.1	33.69
2006	25	3,000	25,000.0	18.70	3.14	8.8	35.00
2007	24	3,897	25,000.0	18.24	3.24	8.3	36.10
2008	24	3,897	25,000.0	21.0	2.75	6.3	31.20
2009	24	5,565	25,000.0	20.0	3.3	32.8	34.70
2010	24	5,799	25,000.0	22.51	2.2	15.5	31.20

Sources: (i) Central Bank of Nigeria (2006) (ii) Central Bank of Nigeria (2010b) (iii) Central Bank of Nigeria (2010) (iv) Nigeria Deposit Insurance Corporation (2005) (v) Nigeria Stock Exchange (2010-2011).

Figure 1 shows the widening spread between bank lending rate and deposit rate of interest with the spread attaining the highest value at 20.31% in 2010. The same figure highlights trends in nonperforming loans as percentage of total bank credit. Figure 1 indicates that the ratio of non-performing credits to total credit which was only 3 percent in 1985 rose to 69 percent in 1995 which partly explain the financial distress in the system at that time. Casual empiricism suggests a positive correlation between interest rate spread and non-performing loans. Thus, there is need for banks to reduce the spread between the loan rate and deposit rate. Whereas an increase in loan rate is expected to lead to increase in profitability, the loan default risk arising from non-performing loans seems to have eroded the anticipated increase in bank profit.



3. Theoretical Framework and Empirical Literature Review

In market economies where markets exercise power on the behaviours of firms and individuals, they are expected to achieve the theoretical maximum either in production (firm) and/or consumption (households, individuals). Thus, efficiency refers to the success with which an organization uses its resources to produce maximum output. The failure of an organization to produce at the "best-practicing" frontier has been elaborated by researchers on the basis of different approaches (Debreu, 1951; Farrell, 1957; Hicks, 1935; Leibenstein, 1966). Hicks (1935) argued that monopolistic firms don't feel any market restraint on them to become fully efficient as enjoying benefits of monopoly. In a similar vein, Debreu (1951) and Farrell (1957) proposed that lack of market power on managers in certain cases may cause inefficiencies among the firms.

The most controversial argument in explaining the inefficiencies of firms is Leibenstein's X-inefficiency approach which contradicts the neo-classical microeconomics theory. To Leibenstein (1966), the failure of firms to produce on the efficient frontier is by and large due to "inadequate motivation, incomplete contracts, asymmetric information, agency problems" and attendant monitoring difficulties which he lumped together as X-inefficiency. Stigler (1976) objected to this approach insisting that all sources of inefficiency according to Leibenstein's X-inefficiency can be shown as the evidence for incomplete production model incorporating a whole set of relevant variables (Fried *et al.*, 2008).

The seminal study of Koopmans (1951) provided the earliest formal definition of technical efficiency as: "A producer is technically efficient if, and only if, it is impossible to produce more of any output without producing less of some other output or using more of some input." Subsequently, Debreu (1951) and Farrell (1957) developed a slightly different definition of technical efficiency by ruling out the slack units: "one minus the maximum equiproportionate (radial) reduction in all inputs that is feasible with given technology and output" (Fried *et al.*, 2008). In this paper our concern is on three dimensions of efficiency namely overall economic or technical efficiency, pure technical efficiency and scale efficiency. While overall technical efficiency refers to the success to which an organization uses its resources to produce maximum output or produce at the best practising frontier, pure technical efficiency is a measure of overall technical efficiency without scale efficiency and reflects managerial performance to organize the inputs in the production process. Scale efficiency on its part indicates the success to which an organization is able to choose the optimum input size of resources or able to choose the scale of operation that will attain the expected production level.

Two separate methods have been developed by researchers to measure the efficiency of firms namely the parametric stochastic frontier method and the non-parametric mathematical programming approach. Parametric stochastic frontier approach uses econometric estimation method and therefore confounds the effects of functional form misspecification errors (of both technology and inefficiency) with inefficiency. The econometric approach or stochastic frontier analytic framework has been used by some researchers such as Berger A. N. *et al.* (1993), Greene W. M. (1980), Stevenson (1980), Nyong (1989), Ferrier and Lovell (1990), (Berger A. N. *et al.* (1996); Berger A. N. and Humphrey, 1997) because of its ability to distinguish the impact of variation in technical efficiency from external stochastic error on the firm's output.

The mathematical programming approach which is also known as Data Envelopment Analysis (DEA) was originated by Charnes *et al.* (1978) hereafter CCR. In DEA, multiple outputs and inputs are reduced into a single output-input form in which efficiency measure is derived. DEA "involves the use of linear programming methods to construct a non-parametric piece-wise surface (or frontier) over the data" (Coelli T. *et al.*, 2005). Therefore, efficiency of each decision making unit (DMU hereafter) which can be a bank, hospital, university and so forth is calculated regarding to the "best practising" producer. In other words, DEA is based upon a comparative analysis of observed producers to their counterparts (Greene W. H., 2007). Hence DEA relies on actual firm behaviour to empirically derive the efficiency frontier.

The use of DEA to compute various efficiency scores has been preferred over other competing techniques, especially stochastic frontier analysis (SFA) for measuring relative efficiency of banks for several reasons. First, it allows the estimation of overall technical efficiency (OTE) and its components (pure technical efficiency (PTE) and scale efficiency (SCE). Further, it identifies the banks that are operating under decreasing or increasing returns-to-scale. Second, in DEA, there is no need to select a priori functional form relating to inputs and outputs like Cobb-Douglas and Translog production/cost functions (Banker *et al.*, 1984). Third, DEA easily accommodates multiple-inputs and multiple-outputs of the banks. Fourth, it provides a scalar measure of relative efficiency, and the areas for potential addition in outputs and reduction in inputs. Fifth, in DEA, it is not necessary to provide values for weights associated with input and output factors, although the user may exert influence in the selection of weight values. Sixth, DEA works particularly well with small samples (Evanroff and Israilevich, 1991). Finally, DEA can identify the 'peers' for organizations which are not observed to be efficient, thereby providing a set of potential role models that an organization can look to, in the first instance, for ways of improving its operations.

These advantages make DEA a potentially useful tool for benchmarking and change implementation programs. This role is strengthened by DEA's ability to incorporate differences in operating environments beyond management control and, thus, to make more like-with-like comparisons. On the other hand, DEA's major shortcoming is that it assumes data to be free of measurement error, and could therefore, give unreliable results if the integrity of data is not assured (Avkiran, 1999b).

The comprehensive literature of DEA methodology can be seen in Banker *et al.* (1984), Seiford and Thrall (1990), Ali *et al.* (1991), Ali and Seiford (1994), Charnes *et al.* (1995), Coelli T. J. (1996), Cooper *et al.* (2000), Cooper *et al.* (2007) and Erkoc (2012). The data Envelopment Analysis of Charnes *et al.* (1978) is an input-oriented model with constant return to scale (CRS) and is an extension of "Farrell's measure to multiple – input, multiple - output situations. The constant returns to scale DEA model of CRR was extended by Färe *et al.* (1983) and Banker *et al.* (1984) hereafter BCC to variable returns to scale (VRS) models in DEA literature. DEA efficiency estimation methodology is being used in wide range of areas including business management, operations research and economics.

A measure of technical efficiency under the assumption of constant returns-to-scale (CRS) is known as overall technical efficiency (OTE). The OTE measure helps to determine inefficiency due to the input/output configuration as well as the size of operations. OTE may be decomposed into two components: pure technical efficiency (PTE) and scale efficiency (SCE). This decomposition allows an insight into the source of inefficiencies. The PTE measure is obtained by estimating the efficient frontier under the assumption of variable returns-to-scale, and may be used as an index of managerial performance or quality of management. The ratio of OTE to PTE provides SCE measure. Inappropriate size of a bank (too large or too small) may sometimes be a cause of technical inefficiency. Scale inefficiency takes two forms: decreasing returns-to-scale (DRS) and increasing returns-to-scale (IRS). Decreasing returns-to-scale (also known as diseconomies of scale) implies that a bank is too large to take full advantage of scale and has supra-optimum size. In contrast, a bank experiencing increasing returns-to-scale (also known as economies of scale) is too small for its scale of operations and, thus, operates at sub-optimum scale size. A bank is scale efficient if it operates at constant returns-to-scale (CRS).

There are a number of studies that have been conducted to evaluate the relative efficiency of banks in various countries and continents. We present a brief review of some of these studies.

3.1. U.S Studies

Berger A. N. and Humphrey (1997) surveyed 130 studies focusing on efficiency of financial institutions in the United States and 21 countries. 116 of these studies were published between 1992 and 1997. They find that overall, depository financial institutions banks, savings and loans, and credit unions experience annual average technical efficiency ratios of around 77 percent and median score of 82

percent. While the median cost efficiency estimates for the U.S banking was as high as 80 percent, the scale inefficiency was found to be negligible at about 5 percent, according to Berger A. N. *et al.* (1993).

Berger Allan. N. and Humphry (1991) find that despite heavy deregulation of the banking industry in the 1980s in the U.S, productivity did not improve considerably. The low improvement in productivity was defended by Alam (2001) who insisted that deregulation takes several years to translate into productivity improvement. In a related study Seiford and Zhu (1999) examined the profitability and marketability of top 55 U.S. commercial banks using DEA. The results reveal that large banks performed better than small banks with respect to profitability while small size banks performed better with respect to marketability.

Wheelock and Paul (1995) investigated the determinants of U.S bank failures and acquisition using bank-specific information suggested by examiners' CAMEL rating categories. They found that the role of quality of management reflected in alternative measures of X-efficiency is a good predictor of bank failure. Bank inefficiency was found to increase the risk of failure.

3.2. Europe

In Europe Maudos and Pastor (2001) analyzed profit efficiency and cost efficiency in a sample of 16 countries in the Organization for Economic Cooperation and Development (OECD). They used the SFA and employed three outputs (loans, other earning assets, and deposits) and two inputs (net income and profit before tax) in their study. Their results showed that the efficiency level of the banking sector in the U.S. improved from 1986 to 1995 and that the efficiency level of the banking sector in Japan decreased sharply from 1988 to 1995. The banking sector in Europe was found to be stable during the period of study.

Maudos *et al.* (2002) examined the cost and profit efficiency of 832 European banks of ten European Union Countries for the period 1993-1996. The return on assets (ROA) and return on equity (ROE) were used as performance indicators to evaluate profit efficiency of banks within the framework of data envelopment analysis. Variations in profit were found to be greater than the variation in cost terms.

Favero and Papi (1995) used a sample of 174 banks in Italy to determine which of the two DEA models was better: CRS or VRS. They found that the VRS model was more appropriate to describe the efficiency level than the CRS model. They also regressed the efficiency level on a dummy which discriminated between banks located in the northern, in the central or in the southern part of Italy, and they found that the banks in southern Italy had the lowest level of efficiency.

Pastor *et al.* (1997) compared the productivity, efficiency, and differences in the technology of different European and U.S. banking systems for the year 1992. They used non-parametric DEA approach to estimate the efficiency level with three outputs (loans, other productive assets, and deposits) and two inputs (non-interest expenses and personal expenses). The most efficient banks were in France, Spain, and Belgium, while the less efficient banks were in the U.K., U.S. Austria, and Germany.

Casu and Girardone (2002) used the data envelopment approach to study the efficiency of the Italian banking system. They compared banking groups and parent companies. They found that the banking groups had a lower mean efficiency level than parent companies and subsidiaries taken individually. They also found that there was no evidence of scale economies either in the sample of groups or in the one composed by the parent and subsidiaries taken individually.

Casu and Molyneux (2003) extended their previous study (Casu and Girardone, 2002) to investigate whether the efficiency degree of the European banking system improved between 1993 and 1997. They used the intermediation approach to specify two outputs (total loans and other earning assets) and two inputs (total costs and total customers and short term funding). The results indicate low average efficiency levels during the period of study. They concluded that there was a difference in the efficiency level across European banking systems and that this difference was due to each country's specific factors relating to banking technology.

Green *et al.* (2003) and Naaborg *et al.* (2003) analyzed the efficiency of foreign and domestic banks in Central and Eastern Europe in the late 1990s. The results show that foreign banks are not significantly more efficient than domestic banks, either in terms of cost advantage or in terms of economies of scale/scope. However, Naaborg suggested that in spite of the superiority of foreign banks in terms of profitability, there is convergence in their performance.

Bonin *et al.* (2005) introduced another dimension to efficiency analysis. They examined the effect of ownership on bank efficiency over the period 1996-2000 in transition economies using stochastic frontier estimation procedure. They found that government owned banks are not significantly less efficient than privately held banks, and that foreign owned banks are more efficient than other banks and provide

better service. They suggested, therefore, that privatization on its own is not sufficient to enhance the efficiency of the banking sector.

Yıldırım H. and Philippatos (2007) evaluated the efficiency level of commercial banks in 12 central and eastern Europe (CEE) countries for the period between 1993 and 2000. They employed two techniques — the SFA and the DEA — to estimate cost and profit efficiency for a panel of 325 banks over an eight year period for the 12 CEE countries and used three outputs (loans, investments, and deposits) and three inputs (borrowed funds, labor, and physical capital) in their analysis. Average cost efficiency level for twelve countries was found to be 72% with DEA and 77% with the SFA. Also, they found that the most cost efficient countries were Poland and Slovenia while Russian Federation, Lithuania, Latvia, and Estonia were the least efficient countries. The authors concluded that foreign banks were more cost efficient and less profit efficient than domestic banks and that competition in banking markets was positively related to cost efficiency and negatively related to profit efficiency.

Zaim (1995) analyzed the effects of liberalization on the performance of the Turkish banks in terms of efficiency. The results indicated that Turkish banks became more efficient during the post-liberalization era. Yıldırım (2002) investigated the technical and scale efficiency of the Turkish commercial banks during the period 1988-1999 using DEA methodology. Scale efficiency was found to be the main source of inefficiency. Pure technical efficiency were found to be very volatile during the period when there was instability in the Turkish economy. Moreover, efficient banks were found to be more profitable, and bank size was also found to be positively related to pure technical and scale efficiencies.

3.3. Middle East

In the Middle East Onour and Abdalla (2011) investigated the efficiency of 36 banks operating in Gulf Cooperation Council (GCC) countries during the period 2006-2008. The countries covered included Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirate. The results indicate that GCC banks showed considerable pure technical efficiency in the past three years with the year 2007 indicating the most efficient year. The number of pure technical efficient banks reached 33 percent of the total banks in 2007 compared to 25 percent in 2008. The fall in technical efficiency in 2008 was found to be due to simultaneous fall in pure technical efficiency and the scale efficiency. The output loss caused by scale inefficiency (fall of scale operations below optimum level) in 2008 was estimated at 16 percent compared to 5 percent in 2007. The results further revealed that scale efficiency is inversely related to banks' size implying a major source of scale inefficiency in GCC banks is due to sub-optimal size of operations. The paper also showed that scale efficiency is inversely related to risk, implying effective risk management policies may also enhance scale efficiency.

The performance of Saudis banks attracted Almumani (2003). He examined the determinants of relative efficiency of Saudi Arabian banks during the period 2007-2011 using DEA framework. The results show that Saudi Arabian banks were efficient in the management of their financial resources. The efficiency of the selected banks were found to be high and stable across the sample period and the management of the banks consistently improved their efficiency. The results also revealed that relative efficiency of small-size banks was higher than those for medium – and larger sized banks. The results also show that Saudi Arabian banks with higher capital adequacy ratio are less risky, managing safer and lower-earning portfolios.

Zeitun and Benjelloun (2013) evaluated the relative efficiency of 12 Jordanian banks over the period 2005-2010 using DEA. The results indicate that only few Jordanian banks were efficient in managing their financial resources and generating profit. Financial crisis were found to have significant impact on banks' efficiency.

Ramanathan (2007) investigated the performance of 55 banks in the oil-rich countries of the Gulf Cooperating Council over the period 2000-2004, Yudistira (2003) analysed the efficiency of 18 Islamic banks over the period 1997-2000. Both studies based on DEA methodology found average inefficiencies of about 10% and that the typical bank was 92% to 96% of optimal size.

3.4. Asia

Wahidudin (2010) analyzed technical efficiency of Malaysian banks during the period 1995-2009 using data envelopment analysis window approach. The results indicate lower level of technical efficiency among the banks than scale efficiency. He concluded that although Malaysian banks have not exhausted economies of scale, they should worry less about choosing the correct scale for production and apply themselves more to improvement in technical efficiency by reducing significant waste in resource use. Izah *et al.* (2009) compared the efficiency between foreign and domestic banks in Malaysia and found

that domestic banks were more efficient than foreign banks. Moreover it was found that domestic bank inefficiency was attributed to pure technical inefficiency rather than scale inefficiency.

The relative efficiency of Thai banks attracted the attention of Supachet (2008). Supachet used DEA to analyze relative efficiency of commercial banks using production and intermediation approaches. The empirical findings of the study revealed that small and medium size banks were 100 percent efficient. The results for Thailand are consistent with those of Seiford and Zhu (1999) for U.S.

Survita *et al.* (2013) focused on Nepal and investigated the technical and scale efficiency of 18 selected commercial banks during the period 2005-2010 using input-oriented DEA. The results reveal that the mean technical inefficiency of the banks was 16% while the average pure technical and scale efficiencies were 11.16 and 5.50% respectively. The impact of risk management factors on efficiency were also evaluated. They found that capital risk ratio (CAR), liquidity risk, profitability ratios (ROA, ROE) affect efficiencies positively but credit risk (NPL) reduces the level of bank efficiency. Bank size consistently had inverse impact across all three efficiency indicators (OTE, PTE, SCE).

Altunbas *et al.* (2000) used the stochastic cost frontier methodology to evaluate scale and X-inefficiencies and the impact of risk and quality factors on bank costs in Japanese commercial banks between 1993 and 1996. They specified three outputs (total loans, total securities, and total off-balance sheet items) and three inputs (wage rate, interest expenses, and depreciation rate). The results indicate strong evidence of scale economies across a wide range of bank sizes. They suggested that the largest banks could be more efficient in reducing costs by decreasing output rather than improving X-efficiency.

3.5. Latin America

Sanchez *et al.* (2013) investigated the determinants of efficiency and dynamic efficiency changes across Latin American banking industries during recent periods of financial liberalization. Allocative, technical, pure technical, and scale efficiency measures are calculated and analyzed for seven Latin American countries –Argentina, Brazil, Chile, Colombia, Ecuador, Mexico and Venezuela. The results revealed that profit inefficiency is higher than cost inefficiency across the countries in the sample, suggesting that most of the profit inefficiency comes from the revenue side. The decomposition of revenue efficiency into revenue allocative efficiency and technical efficiency suggests that the source of inefficiency is regulatory (allocative) rather than managerial (technical). Moreover, consistent with what practitioners would expect, efficient banks were found to have lower overhead costs relative to total income, use resources better, have higher quality portfolios, and have higher earnings (e.g., higher return on assets – ROA and return on equity – ROE) than inefficient ones. Furthermore, the results also show that financial liberalization has brought productivity increases throughout Latin America; but this increase in productivity is found to be a consequence of technological progress rather than enhanced technical efficiency.

Gonzalez-Hermosillos (1999) analyzed the contribution of microeconomic and macroeconomic factors in episodes of banking crisis and financial instability in Mexico, Colombia and US. The results show that low capital equity ratios, low reserve coverage of loan which reflect low technical efficiency are good predictors of banking system distress.

The results obtained in Gonzalez-Hermosillos (1999) were reinforced in Tabaki *et al.* (2011). Tabaki *et al.* (2011) sought to determine the causality between bank efficiency and high default rates in banks' credit portfolios in Brazil. Using Data Envelopment Analysis (DEA) model to estimate technical, allocative and economic efficiencies and both a dynamic panel and a panel VAR to determine causality they found that variations on bank efficiency precede loan quality deterioration. They concluded that bank efficiency measures may be important early warning indicators of financial instability, and hence that DEA efficiency measures should be used as macroeconomic tools to evaluate the financial system. The results are consistent with an earlier study by Podpiera and Jiri (2005). Popiera and Podpiera estimated cost efficiency scores for the Czech banking sector and found that cost inefficient management was a predictor of bank failures during the years of banking sector consolidation, thereby suggesting the inclusion of cost efficiency in early warning systems.

Goncalves (2006) presented a new paradigm approach for quantifying a bank's managerial efficiency, using a data envelopment analysis (DEA). The analysis of the largest 50 Brazilian banks over the twelve-year period 1995 - 2006 shows significant differences in management quality scores among the banks. He recommended that the use of DEA model for the early identification of troubled banks and as a tool for off-site bank supervision in Brazil.

3.6. Africa

Studies on bank efficiency in Africa based on optimization are few. Murinde and Moses (2002) examined the determinants of X-efficiency in commercial banks in sub Saharan Africa using translog stochastic cost and profit frontier approaches. The results indicate that the degree of cost inefficiency was exacerbated by bad loans, high capital ratio and financial liberalization. Moreover it was shown that the large banks were more efficient and the level of foreign bank penetration reduces X- inefficiency. The results obtained for Thailand, Asia by Supachet (2008) are consistent with the African findings.

Perhaps, one of the most comprehensive banking sector efficiency analysis in sub Saharan African (SSA) countries was carried out by Kiyota (2009). The study employs the familiar two stage analyses in examination of profit efficiency and cost efficiency of commercial banks to examine whether foreign banks are more efficient than domestic banks. The empirical results indicate that foreign banks outperform domestic banks, which is consistent with the agency theory postulates: banks with higher leverage or lower equity are associated with higher profit efficiency. In terms of bank size, smaller banks were found to be more profit efficient while medium size and larger banks are found to be cost efficient. On another hand the findings of the study suggests that non SSA Foreign banks are more cost efficient than Sub Saharan foreign and domestic banks for the period 2000-2003.

In Namibia Ikhide (2008) investigated the efficiency of commercial banks using the cost frontier approach. The study is different from others in that it integrated operating ratio and Stochastic frontier approach. Financial ratios such as interest margin, interest income, gross margin operating costs, loan loss provision, total cost, pre-tax income and after tax income were used. In the trans logarithmic cost function estimating model, labour, capital and deposits were used as inputs while outputs were prices of labour, capital and deposit. The empirical findings from translog cost function established the existence of economies of scale in banks operating in Namibia which can be exploited through expanding their scale of operation. The paper also revealed that more banks could still join the industry without compromising the industry profitability since most of the existing commercial banks are operating under the falling portion of their average cost curve. The results of the study are similar to those of Nyong (1987) for Nigeria.

In a separate study and in the same year Musonda (2008) adopted the stochastic frontier approach (SFA) to examine the relative efficiency of Namibian banks. Three inputs namely labour, funds and capital with corresponding price defined by labour cost, funding cost as well as capital cost and two outputs defined by net loans overdraft and interbank placement (loans) were used. The empirical findings show that, Zambian banks are on average inefficient in order of 11.4%. The study further revealed that foreign banks are more efficient than domestic banks, the reasons for inefficiency being the weak regulatory framework. The paper recommended the strengthening of the institutional framework to revitalize the sector.

In Kenya Kamau (2011) investigated the efficiency and productivity in the banking sector in the post liberalization period using DEA. The results show that though banks were not fully efficient in all aspect, they performed fairy well during the period under study. Commercial banks efficiency scores were found to be not less than 40% at any point. In terms of ownership and size, foreign banks were found to be more efficient than local banks, and large sized banks were more efficient than medium and small sized banks.

The study by Kamau (2011) was extended by Nasieku *et al.* (2013) who examined the efficiency and productivity of Kenyan commercial banks during the period 2001-2011 using DEA approach. Large banks were found to show higher technological improvement than small and medium scale banks. Two input measures namely total cost (interest and non-interest expenses, personnel expenses) and total customers and short term funds and two output measures namely loans and advances and earning assets were used. They found that although Kenyan banks have higher efficiency score they need to improve their scale of operations to be fully efficient.

Ncube (2009) examined South African banking sector efficiency. The main focus of the paper was on cost and profit efficiency. Applying stochastic frontier model, the paper examined cost and profit efficiency of small and four large banks. Results indicated that over the period of study (2000-2005) South African banks significantly improved their cost efficiencies but no significant gains on profitability fronts. The results also indicated that there is a weak positive correlation between cost and profit efficiency of South African banks. In Addition most cost efficient banks were also most profit efficient. A regression analysis of cost efficiency on banks size suggests an inverse relationship with cost efficiency, meaning that efficiency declines with the increasing bank size.

Aikaeli (2008) investigated the technical, scale and cost efficiency of commercial banks in Tanzania utilizing secondary time series of the Tanzania banking sector (1998-2004) and employing DEA. Results

of the study suggest that overall bank efficiency was fair, and there was room for marked improvements on all the three aspects of efficiency. The results of the study also show that foreign banks ranked highest in terms of technical efficiency followed by small banks and then large domestic banks.

Gwahula (2012) extended the study in Aikaeli (2008) using more recent data. The paper investigated the relative efficiency of some selected 20 commercial banks in Tanzania during the period 2008-2011 using DEA. The results show that technical efficiency averages from 0.54(2008) to 0.79(2011). The results also revealed a sharp decline in technical efficiency from 0.79 in 2008 to 0.54 in 2009 and thereafter rising to 0.74 in 2010. He concluded that banks were using more resources than was required for efficient operations. The findings are consistent with the earlier study by Aikaeli (2008).

In Nigeria, Sobodu *et al.* (1998) investigated bank performance and supervision during transition and deregulated economy to assess whether the policy package resulted in an improvement in the technical efficiency of the industry. The study found that banking industry intermediation efficiency declined significantly during the years immediately following the adoption of deregulation with slight improvements noticed only in recent times. The results concluded that this may be the effect of inconsistent policies to which the sector was subjected during this period. More over the study revealed that private and government banks differ in their technical efficiency; average efficiency measures were higher for private banks than for the government's banks.

Nyong (1989) conducted a comparative analysis of the impact of quality of management on the profitability of banks in Nigeria using the econometric stochastic frontier approach to measure quality of management. Different measures of bank profitability were regressed against quality of management (technical efficiency) and other variables. In all cases the results revealed that the quality of management exerted a statistically significant impact on bank profitability.

Nyong (2005) adopted DEA framework to examine the technical efficiency of 18 commercial banks in Nigeria during the period 2002-2003. The mean efficiency of banks was found to be about 0.773. Only one-third of the banks were found to be technically efficient including Chartered Bank, Diamond, First Bank, International Merchant Bank, Marina Bank, Nigeria American Bank and UBA.

Obafemi (2012) widened the scope of study in Nyong (2005) by investigated the technical efficiency of a cross section of Nigerian commercial banks during the period 1984/85, 1994/95, 1999/2000 and 2003/2004. The results showed that efficiency improved from 0.570 in 1985 to 0.738 in 1995. Thereafter, efficiency declined to 0.731 in 2000 and fell further to 0.640 in 2003. She concluded that although financial liberalization led to improvement in bank efficiency, the improvement was not sustained.

The review of the empirical studies across countries and continents indicate that DEA has become an important tool for bank efficiency analysis, for benchmarking and may be used by regulatory authorities for monitoring performance to avert bank failure. The review also reveals that some studies obtained different results depending on the measure of output and input, production approach or intermediation approach adopted in the study. In the next sections we implement the DEA methodology to assess the level of relative efficiency of banks in Nigeria and identify its key determinants.

4. Analytical Methodology

Equations 4.1 – 4.5 summarise the basic DEA mathematical programming model. We assume that each decision-making units (DMUs) use *m* inputs for the production of *n* outputs with given technology. Let X_{ij} denote the amount of input *i (i=1,2,.....,m)* produced by *jth* DMU *(j=1,2,....,k)*, and Y_{sj} the corresponding quantity of output s *(s=1,2,.....,n)* produced by *jth* DMU *(j=1,2,....,k)*. The variables u_r *(r=1,2,....,n)* and w_i *(i=1,2,.....,m)* are weights of each output and input respectively. The technical efficiency of DMU_0 can be

Written as: Max $$E = \frac{\sum u_r Y_{r0}}{\sum w_i X_{i0}} \qquad (4.1)$$

Subject to:

$$\frac{\sum u_r Y_{rj}}{\sum w_i X_{ij}} \leq 1 \quad \text{for } j=1,2,\ldots,k \qquad (4.2)$$

$$\sum w_i X_{ij}$$

u_r and $w_i \geq 0$ *(r=1,2,.....,n)* and *(i=1,2,……,m)* (4.3)

Equations (4.1)- (4.3) can be clarified as finding the appropriate values for ***u*** and ***w*** that maximise efficiency level of the observed firm subject to all efficiency scores are less than or equal to unity. Given that the primal form given in equations (4.1)-(4.3) could lead to infinite solutions (Banker *et al.*, 1984; Coelli T. *et al.*, 2005) obtain a linear programming model under duality transformation of the form:

Min $\boldsymbol{\Theta}$ (4.4)

Subject to:

$\sum \boldsymbol{\lambda_j X_{ij} \leq \Theta X_{i0}}$ (i=1,2, . . .,m) (4.5)

$\sum \boldsymbol{\lambda_i Y_{rj} \geq Y_{r0}}$ (r=1,2, . . ., n)

$\lambda_i \geq 0$ for j=1,2, . . .,k

where λ_i is the weight given to each bank j in its efforts to dominate bank 0 and Θ is the efficiency of bank 0; X_{i0} is the vector of inputs of bank , Y_{r0} the corresponding vector of outputs. Θ is a scalar and is a k x 1 vector of constants. The solution of this linear system will end up with finding Θs corresponding to the efficiency level of each DMU. In the equations above, X_0, Y_0 are vector of inputs and outputs respectively of bank 0 for which we want to determine its efficiency. A value of Θ =1 indicates efficiency and lies on the pareto-optimal frontier or production possibility frontier. Θ <1 indicates inefficiency by the amount to which it is less than unity.

4.1. Selection of Inputs and Outputs in Banking

In computing the efficiency scores, the most challenging task that an analyst always encounters is to select the relevant inputs and outputs for modeling bank behaviour. It is worth noting here that there is no consensus on what constitute the inputs and outputs of a bank (Casu and Girardone, 2002; Sathye, 2003). In the literature on banking efficiency, there are mainly two approaches for selecting the inputs and outputs for a bank: i) the production approach, also called the service provision or value added approach; and ii) the intermediation approach, also called the asset approach (Hjalmarsson *et al.*, 2000; Humphrey, 1985). Both these approaches apply the traditional microeconomic theory of the firm to banking and differ only in the specification of banking activities. The production approach as pioneered by Benston (1965) treats banks as the providers of services to customers. The output under this approach represents the services provided to the customers and is best measured by the number and type of transactions, documents processed or specialized services provided over a given time period. However, in case of non-availability of detailed transaction flow data, they are substituted by the data on the number of deposits and loan accounts, as a surrogate for the level of services provided. In this approach, input includes physical variables (like labour, material, space or information systems) or their associated cost. This approach focuses only on operating cost and completely ignores interest expenses.

The intermediation approach as proposed by Sealey and Lindley (1977) treats banks as financial intermediaries channeling funds between depositors and creditors. In this approach, banks produce intermediation services through the collection of deposits and other liabilities and their application in interest-earning assets, such as loans, securities, and other investments. Thus the use of physical capital (value of fixed assets), labour, and deposits as inputs and loans and advances, investments in securities, and gross earnings, are consistent with the intermediation approach. This approach is distinguished from production approach by adding deposits to inputs, with consideration of both operating cost and interest cost. Berger A. N. and Humphrey (1997) pointed out that neither of these two approaches is perfect because they cannot fully capture the dual role of banks as providers of transactions/document processing services and being financial intermediaries. Nevertheless, they suggested that the intermediation approach is best suited for analyzing bank level efficiency, whereas the production approach is well suited for measuring branch level efficiency. This is because, at the bank level, management will aim to reduce total costs and not just non-interest expenses, while at the branch level a large number of customer service processing take place and bank funding and investment decisions are mostly not under the control of branches. Also, in practice, the availability of flow data required by the production approach is usually exceptional rather than in common.

For our empirical analysis of banking efficiency in Nigeria we use the intermediation approach to banking where the outputs are bank loans and gross earnings and inputs are bank deposit and labour. Data for 66 banks for 2001 and 2002 were obtained for the pre-consolidation period and for 21 banks for 2008,

2009 for the post consolidation era. It is worth noting here that our choice of output variables is consistent with the managerial objectives that are being pursued by Nigerian banks. In the post-reform years, intense competition in banking sector has forced the banks to reduce all the input costs to the minimum and to earn maximum revenue with less inputs. We also experimented with the use of fixed assets or number of bank branch offices as other measures of bank inputs but the results did not change significantly. For X-efficiency we use input minimization subject to given output in the context of DEA framework. Coelli DEAP 2.1 computer software was used. The results of the calculation of X-efficiency and scale efficiency are presented in Table 5.1.

Since DEA results are influenced by the size of the sample, some discussion on the adequacy of sample size is warranted here. The size of the sample utilized in the present study is consistent with the various rules of thumb available in DEA literature. Nunamaker (1985) and Cooper *et al.* (2007) provide some of these rules that can be jointly expressed as: n>=max[mxs ; 3(m+s)] where n=number of DMUs, m=number of inputs and s=number of outputs. The first rule of thumb states that sample size should be greater than equal to product of inputs and outputs. While the second rule states that number of observation in the data set should be at least three times the sum of number of input and output variables.

Given m=2 and s=2, the sample size (n=21 or 66) used in the present study exceeds the desirable size as suggested by the abovementioned rules of thumb to obtain sufficient discriminatory power. The sample size in this study is feasible and larger than that used in some of the studies in the DEA literature (see, for example, (Avkiran (1999a)).

4.2. Sources of Inefficiency: Tobit Regression Model

To identify the sources of inefficiency among the banks we formulate a Tobit regression model based on CAMEL of the form:

$$EFF_i = \psi_0 + \psi_1 ROC_i + \psi_2 KAPAS_i + \psi_3 LADEP_i + \psi_4 OEXY_i + \psi_5 MKS_i + \psi_6 IDP_i + \psi_7 EA_i + \psi_8 LQTY_i + u_i \quad (4.6)$$

where EFF_i= efficiency score of bank i and takes the value between 0 and 1, ROC= return on equity of bank i, KAPAS= equity - asset ratio capturing capital risk, LADEP = loan –deposit ratio, OEXY= operating expense (overheads)/ total earnings, MKS= market share, IDP= interest paid on deposit /total deposit, EA=earning –asset ratio reflecting earning ability, LQTY = liquidity ratio (short term funds divided by total asset) and u_i is the stochastic error term with the usual white noise properties. CAMEL is a rating technique adopted by regulatory authorities representing Capital adequacy, asset quality, management quality, earning ability and liquidity.

The regression was performed for four years, 2001 (66 banks), 2002(66 banks), 2008(21 banks), 2009(21 banks). Data were obtained from published annual report of banks, from Nigerian Banking, Finance and Commerce 2003/2004(REDASEL Lagos), and Nigerian Stock Exchange Factbook 2010/2011. As stated earlier we adopt a two stage procedure. In the first stage we calculated the relative technical and scale efficiency of banks and used the results for the second stage to econometrically investigate the determinants of efficiency/inefficiency. Heteroskedasticity is controlled for by using White's heteroskedascity correction method provided in EVIEW 7 package.

5. Empirical Results and Analysis

The empirical results are presented in nine (9) Tables. Table 5.1 indicates the results of overall technical efficiency of the 66 banks in 2001 and its decomposition into pure technical (managerial) efficiency and scale efficiency. The results show that the average technical efficiency of the banks is about 0.638. This means that banks were about 64 percent efficient or 36 percent inefficient. This means that banks are using too much resources to produce the same level of output. The same level of output would have been generated by using 36 percent less of the resources (deposit and labour) in 2001. Given the fact that the pure technical efficiency(PTE) score at 0.721 is lower than scale efficiency (SCE)score at 0.902, banks are more managerial inefficient than scale inefficient, and hence that they should worry more about improvement in managerial efficiency to reduce their overall technical inefficiency. The results also show that only 4 banks namely COOPT bank, Nigerian American bank, Trans International bank, and IBTC were technically efficient. The results for Table 5.2 for 2002, Table 5.3 for 2008, and Table 5.4 for 2009 are similarly interpreted. Table 5.5 summarizes the results for the 4 year period. Overall technical efficiency improved marginally from 0.651 in 2008 to 0.661 in 2009. Similarly, scale efficiency improved significantly from 0.812 in 2008 to 0.883 in 2009. However, there was significant reduction in managerial efficiency (PTE) from 0.793 to 0.747 in 2009.

Three important facts about efficiency of Nigerian banks emerge. First, overall technical efficiency fell from 64% in 2001 to 55% in 2002, rose to 65 percent in the 2008, and improve marginally to 66 percent in 2009. Second, Recapitalization and consolidation may have led to some improvement in the level of technical efficiency in Nigerian banks. Third, Nigerian banks showed great dynamism in efficiency. As seen in Table 5.5 the banks that were found to be efficient in 2001 are not the same they were efficient in 2002. Nigerian American bank is the only bank that was consistently efficient in the two years. Similarly, whereas only two banks (FCMB and Skye) were efficient in 2008, only four banks (Access, FBN, Oceanic, and Stanbic IBTC) were found to be efficient in 2009, and none maintained its efficiency in the two- year period.

Table 5.1. DEA Efficiency Scores for 2001

SN	Bank	Overall Technical Efficiency (OTE)	Pure Technical Efficiency (PTE)	Scale Efficiency (SCE)
1	ACCESS	0.563	0.588	0.958
2	AFRIBANK	0.535	0.700	0.764
3	BON	0.756	1.000	0.756
4	BROADBANK	0.699	0.700	0.998
5	CAPITAL	0.585	0.621	0.942
6	CENTREPOINT	0.916	1.000	0.916
7	CHARTERED	0.804	1.000	0.804
8	CITIBANK	0.865	1.000	0.865
9	CITIZENS	0.734	0.933	0.787
10	CITY EXP	0.44	0.457	0.963
11	COOPT	1.000	1.000	1.000
12	COP DEV	0.409	0.423	0.968
13	DEVCOMB	0.548	0.556	0.986
14	DIAMOND	0.522	0.65	0.803
15	ECOBANK	0.515	0.556	0.926
16	EQUITO TR	0.753	0.960	0.784
17	EQUITY	0.402	0.414	0.97
18	FIDELITY	0.885	1.000	0.885
19	FIRST ATLANTIC	0.621	0.630	0.986
20	FBN	0.917	1.000	0.917
21	FCMB	0.589	0.589	1.000
22	FIRST INTERSTATE	0.861	0.870	0.99
23	FORTUNE	0.539	0.550	0.98
24	FOUNTAIN	0.492	0.498	0.987
25	FSB INTER	0.548	0.725	0.756
26	GATEWAY	0.487	0.515	0.945
27	GLOBAL	0.466	0.489	0.952
28	GUARANTY	0.720	1.000	0.72
29	GUARDI EXP	0.640	0.645	0.993
30	GULF	0.580	0.610	0.95
31	HALLMARK	0.690	0.875	0.788
32	INLAND	0.560	0.637	0.879
33	INMB	0.808	0.808	1.000
34	INTERCITY	0.599	0.637	0.941
35	INTERCONTI	0.615	0.866	0.71
36	LEAD	0.575	0.601	0.957
37	LION	0.561	0.562	0.999
38	MAGNUM	0.559	0.620	0.901
39	MANNY	0.393	0.407	0.966
40	MARINA	0.567	0.577	0.982
41	MBC INTERNA	0.480	0.496	0.967
42	METROPO	0.402	0.418	0.961
43	NAL	0.546	0.649	0.842

44	NBN	0.984	1.000	0.984
45	NIG AMERICAN	1.000	1.000	1.000
46	NUB INTERNAT	0.592	1.000	0.592
47	OCEANIC	0.806	0.940	0.857
48	OMEGA	0.508	0.508	1.000
49	PLATINUM	0.379	0.398	0.953
50	PRUDENT	0.564	0.623	0.906
51	REGENT	0.862	0.879	0.981
52	SGB	0.440	0.469	0.938
53	STANBIC	0.479	0.488	0.982
54	STD CHARTERED	0.825	0.846	0.975
55	STD TRUST	0.713	1.000	0.713
56	TRADE	0.442	0.464	0.952
57	TRANS INTER	1.000	1.000	1.000
58	TRIUMPH	0.522	0.522	1.000
59	UNION	0.567	1.000	0.567
60	UBA	0.692	1.000	0.692
61	UNIVER TB	0.516	0.619	0.833
62	WEMA	0.644	0.865	0.744
63	ZENITH	0.762	0.978	0.779
64	FBN MB	0.469	0.496	0.945
65	IBTC	1.000	1.000	1.000
66	UNION MB	0.628	0.642	0.978
	AVERAGE	**0.638**	**0.721**	**0.902**

Table 5.2. DEA Efficiency Scores for 2002

SN	Bank	Overall Technical Efficiency (OTE)	Pure Technical Efficiency (SCE)	Scale Efficiency (SCE)
1	ACCESS	1	1	1
2	AFRIBANK	0.675	0.743	0.909
3	BON	0.724	0.904	0.801
4	BROADBANK	0.308	0.66	0.466
5	CAPITAL	0.28	0.712	0.393
6	CENTREPOINT	1	1	1
7	CHARTERED	0.51	0.84	0.607
8	CITIBANK	1	1	1
9	CITIZENS	0.507	0.873	0.581
10	CITY EXPRESS	0.353	0.594	0.594
11	COOPT	0.27	0.683	0.395
12	COP DEV	0.348	0.648	0.537
13	DEVCOMB	0.948	0.948	1
14	DIAMOND	0.66	0.738	0.894
15	ECOBANK	0.385	0.667	0.577
16	EQUITORIAL TRUST	0.822	1	0.822
17	EQUITY	0.545	0.756	0.721
18	FIDELITY	0.326	0.654	0.498
19	FIRST ATLANTIC	0.459	0.719	0.638
20	FBN	1	1	1
21	FCMB	0.505	0.728	0.694
22	FIRST INTERSTATE	0.559	1	0.559
23	FORTUNE	0.673	0.673	1
24	FOUNTAIN	0.59	0.705	0.837
25	FSB INTER	0.639	0.771	0.829
26	GATEWAY	0.396	0.622	0.636
27	GLOBAL	0.417	0.74	0.563

28	GUARANTY	0.998	1	0.998
29	GUARDI EXP	0.474	0.894	0.53
30	GULF	0.729	0.771	0.945
31	HALLMARK	0.704	0.831	0.847
32	INLAND	0.382	0.647	0.59
33	INMB	0.882	0.882	1
34	INTERCITY	0.32	0.724	0.442
35	INTERCONTI	0.698	0.795	0.878
36	LEAD	0.645	0.742	0.869
37	LION	0.282	0.795	0.355
38	MAGNUM	0.351	0.621	0.566
39	MANNY	0.354	0.586	0.604
40	MARINA	0.554	0.699	0.793
41	MBC INTERNA	0.412	0.649	0.635
42	METROPO	0.611	0.661	0.924
43	NAL	0.391	0.646	0.605
44	NBN	0.231	0.722	0.32
45	NIG AMERICAN	1	1	1
46	NUB INTERNAT	0.13	0.856	0.152
47	OCEANIC	0.719	0.986	0.729
48	OMEGA	0.327	0.652	0.501
49	PLATINUM	0.243	0.794	0.306
50	PRUDENT	0.364	0.727	0.501
51	REGENT	0.509	1	0.509
52	SGB	0.29	0.658	0.44
53	STANBIC	0.231	0.659	0.35
54	STD CHARTERED	0.34	0.752	0.452
55	STD TRUST	0.624	0.907	0.688
56	TRADE	0.544	0.573	0.95
57	TRANS INTER	0.421	0.66	0.638
58	TRIUMPH	0.436	0.88	0.495
59	UNION	0.707	0.927	0.763
60	UBA	0.679	0.814	0.834
61	UNIVER TB	0.576	0.695	0.829
62	WEMA	0.579	0.813	0.712
63	ZENITH	0.701	0.902	0.777
64	FBN MB	0.631	0.631	1
65	IBTC	0.484	1	0.484
66	UNION MB	1	1	1
	AVERAGE	**0.552**	**0.787**	**0.690**

Table 5.3. DEA Efficiency Scores 2008

SN	Bank	Overall Technical Efficiency (OTE)	Pure Technical Efficiency(PTE)	Scale Efficiency (SCE)
1	ACCESS	0.510	0.516	0.989
2	AFRIBANK	0.968	1	0.968
3	BANK PHB	0.767	1	0.767
4	DIAMOND	0.724	0.976	0.742
5	ECOBANK	0.599	0.616	0.972
6	FIDELITY	0.998	1	0.998
7	FINBANK	0.799	0.849	0.941
8	FBN	0.880	1	0.88
9	FCMB	1	1	1
10	GUARANTY	0.484	0.616	0.786
11	INTERCON	0.210	0.289	0.725

12	OCEANIC	0.436	0.859	0.507
13	SKYE	1	1	1
14	SPRING	0.756	0.937	0.807
15	STANBIC IBTC	0.484	0.726	0.667
16	STERLING	0.717	1	0.717
17	UBN	0.158	0.277	0.572
18	UBA	0.615	1	0.615
19	UNITY	0.505	0.534	0.945
20	WEMA	0.513	0.755	0.679
21	ZENITH	0.556	0.709	0.784
	AVERAGE	**0.651**	**0.793**	**0.812**

Table 5.4. DEA Efficiency Scores 2009

SN	Bank	Overall Technical Efficiency (OTE)	Pure Technical Efficiency (PTE)	Scale Efficiency (SCE)
1	ACCESS	1	1	1
2	AFRIBANK	0.450	0.487	0.925
3	BANK PHB	0.336	0.348	0.966
4	DIAMOND	0.461	0.532	0.866
5	ECOBANK	0.573	0.575	0.997
6	FIDELITY	0.623	0.718	0.867
7	FINBANK	0.437	0.437	1
8	FBN	1	1	1
9	FCMB	0.798	1	0.798
10	GUARANTY	0.864	0.864	1
11	INTERCON	0.281	0.357	0.788
12	OCEANIC	1	1	1
13	SKYE	0.841	0.848	0.992
14	SPRING	0.229	0.436	0.525
15	STANBIC IBTC	1	1	1
16	STERLING	0.590	0.68	0.867
17	UBN	0.668	0.727	0.919
18	UBA	0.696	1	0.696
19	UNITY	0.677	0.689	0.982
20	WEMA	0.572	1	0.572
21	ZENITH	0.788	1	0.788
	AVERAGE	**0.661**	**0.747**	**0.883**

Table 5.5. Dynamics of Relative Technical Efficiency

Efficiency	2001	2002	2008	2009
Overall Technical Efficiency	0.638	0.552	0.651	0.661
Pure Technical Efficiency	0.721	0.787	0.793	0.747
Scale Efficiency	0.902	0.690	0.812	0.883
The Efficient banks in each period	Co-opt Nig. Amer Trans Inter IBTC (4/66)	Access CentrePoint Citibank FBN Nig. Amer Union (6/66)	FCMB Skye (2/21)	Access FBN Oceanic Stanbic- IBTC (4/21)

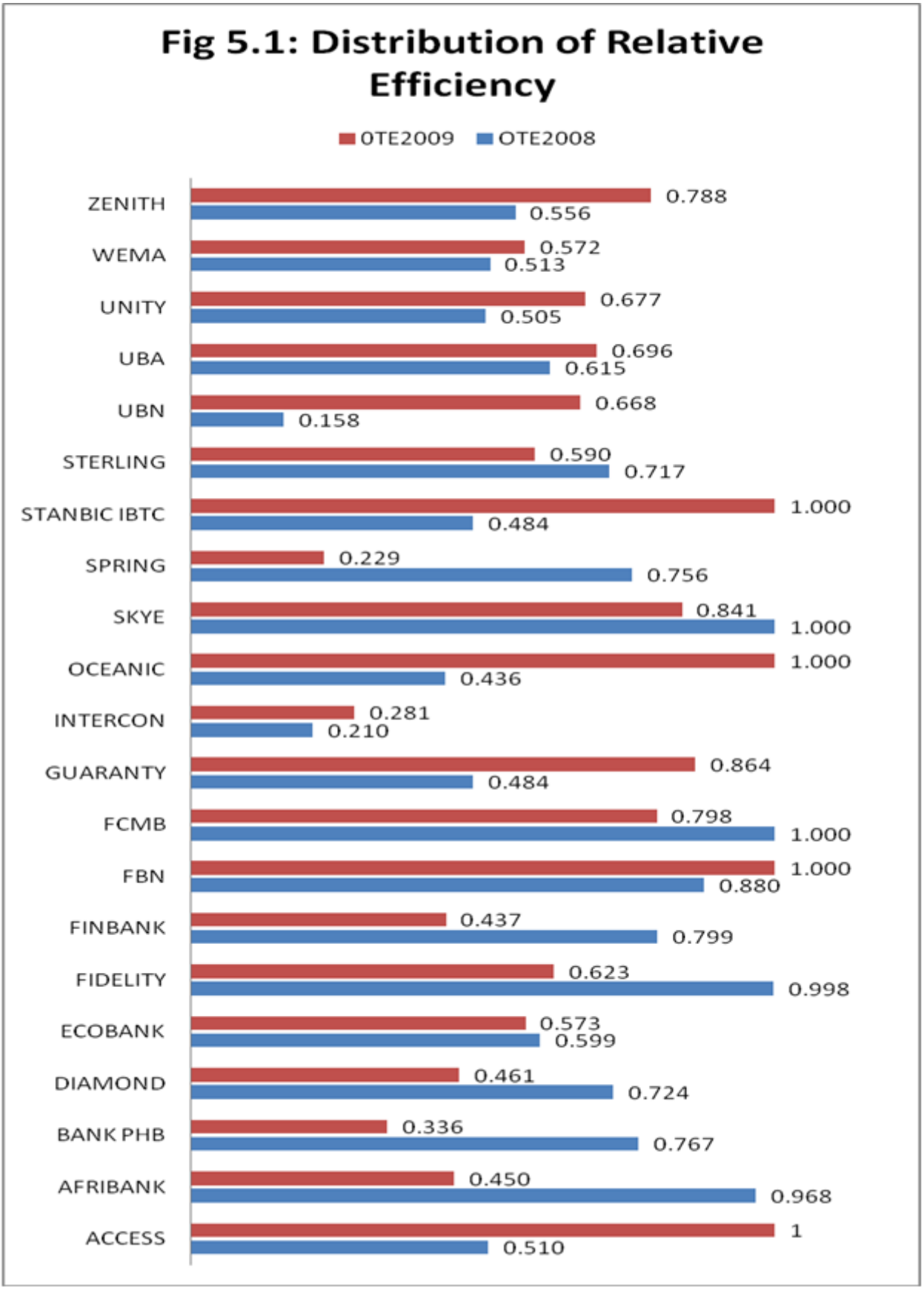


Fig 5.1: Distribution of Relative Efficiency
OTE2009
OTE2008
ZENITH
0.788
0.556
WEMA
0.572
0.513
UNITY
0.677
0.505
UBA
0.696
0.615
UBN
0.668
0.158
STERLING
0.590
0.717
STANBIC IBTC
1.000
0.484
SPRING
0.229
0.756
SKYE
0.841
1.000
OCEANIC
1.000
0.436
INTERCON
0.281
0.210
GUARANTY
0.864
0.484
FCMB
0.798
1.000
FBN
1.000
0.880
FINBANK
0.437
0.799
FIDELITY
0.623
0.998
ECOBANK
0.573
0.599
DIAMOND
0.461
0.724
BANK PHB
0.336
0.767
AFRIBANK
0.450
0.968
ACCESS
1
0.510

Table 5.6. Regression Results for Sources of Efficiency 2001

Dependent Variable: OTE				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	0.560255	0.221326	2.531362	0.0114
ROC	0.218503	0.194301	1.124558	0.2608
KAPAS	1.175112	0.464101	2.532019	0.0113
LADEP	0.102405	0.082210	1.245647	0.2129
OEXY	-0.084669	0.254125	-0.333180	0.7390
MKS	0.555302	0.739118	0.751304	0.4525
IDP	-0.807328	0.605712	-1.332858	0.1826
EA	-0.898206	0.595348	-1.508709	0.1314
LQTY	0.090887	0.080789	1.124997	0.2606

Table 5.7. Regression Results for Sources of Efficiency 2002

Dependent Variable: OTE				
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	-0.261963	0.198496	-1.319737	0.1869
ROC	0.630391	0.199782	3.155392	0.0016
LADEP	0.105552	0.153108	0.689399	0.4906
KAPAS	1.320007	0.414927	3.181298	0.0015
OEXY	0.151842	0.217961	0.696650	0.4860
MKS	3.291414	1.149734	2.862761	0.0042
IDP	-0.195044	0.787466	-0.247685	0.8044
EA	0.406589	0.731285	0.555992	0.5782
LQTY	0.206303	0.110324	1.869977	0.0615

Table 5.8. Regression Results for Sources of Efficiency 2008

Dependent Variable: ECE				
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.059260	0.149907	7.066103	0.0000
ROC	0.073830	0.021373	3.454445	0.0006
KAPAS	0.442959	0.243522	1.818970	0.0689
LADEP	-0.020572	0.109436	-0.187983	0.8509
OEXY	-0.177354	0.054405	-3.259910	0.0011
MKS	2.524503	0.972042	2.597114	0.0094
IDP	-1.644545	0.547348	-3.004568	0.0027
EA	0.147299	0.048690	3.025213	0.0025

Table 5.9. Regression Results for Sources of Efficiency 2009

Dependent Variable: OTE				
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.719979	0.218663	-3.292645	0.0010
ROC	-0.026421	0.029279	-0.902410	0.3668
KAPAS	-0.057415	0.075262	-0.762860	0.4455
LADEP	1.002130	0.135968	7.370314	0.0000
OEXY	0.038932	0.037186	1.046953	0.2951
MKS	1.903540	0.629009	3.026251	0.0025
IDP	0.047233	0.294647	0.160303	0.8726
EA	1.717654	0.533157	3.221666	0.0013
LQTY	0.592407	0.146979	4.030560	0.0001

Figure 5.1 indicates the pictorial representation of the overall technical efficiency in 2008 and 2009 and shows clearly that efficiency improved moderately in 2009.

Tables 5.6, 5.7, 5.8 and 5.9 present the sources of efficiency among the banks. The result show that their capital to asset ratio in 2001, return on equity, capital to asset ratio, market share and liquidity in 2002 were the dominant challenges the bank faced which impacted on their efficiency. In 2008 high overhead expenses to total income and interest paid to total deposit impacted negatively on bank efficiency while return on equity(ROC), capital-asset ratio, market share and earning-asset ratio were positively related to efficiency. The results also show that in 2009 the sources of bank efficiency with positive impact were loan-deposit ratio, market share, earning–asset ratio or asset quality. The results show that capital risk ratio is the only factor which may be considered to be consistently critical to bank efficiency. Consequently, consolidation policy is a step in the right direction in promoting efficiency and should be encouraged.

6. Concluding Remarks

In this paper we made an attempt to analyze the relative efficiency of domestic commercial banks in Nigeria during the four year periods 2001, 2002 before bank consolidation and 2008, 2009 after banking consolidation. We use non parametric mathematical optimisation technique rooted in Data envelopment analysis (DEA) to evaluate bank efficiency and Tobit regression to determine the sources of inefficiency. We first began by emphasizing the crucial role of banks in promoting and sustaining economic growth and stability and that banks can play that role effectively if they are efficient. Next we presented some developments and behavioural characteristics of Nigerian banks by examining their structure, conduct and performance. We also presented a brief review of the empirical literature focusing on studies on bank efficiency in America, Latin America, Europe, the Middle East, Asia and Africa including Nigeria. The review of the empirical literature reveals the applicability of DEA in various sectors of the economy including banking. We provided empirical results of the overall technical efficiency among Nigeria's commercial banks and its decomposition into pure technical and scale efficiency.

The empirical results showed that:

- The average technical efficiency of the banks was about 0.638 for overall technical efficiency (OTE), 0.721 for pure technical efficiency (PTE) and 0.902 for scale efficiency(SCE) in 2001. In 2002 the results were 0.552 (OTE), 0.787(PTE) and 0.690 (SCE). In 2008 OTE, PTE and SCE were respectively 0.651, 0.793 and 0.812. In 2009 the banks recorded slight improvement in their efficiency level at 0.661 (OTE), 0.747 (PTE) and 0.883 (SCE).
- The results suggest that on average commercial banks have some degree of inefficiency (i.e 36% in 2001 and 34% in 2009 for OTE) which is more so due to pure technical rather than scale effects. Thus, Nigerian banks could gain more from reducing the input quantities used without sacrificing the output or increasing the output (bank credit and earnings) produced with more efficient input. Banks should not worry too much about not choosing the optimal scale for production though the paper found evidence of economies of scale that have not been exhausted.
- Only 4 banks namely COOPT, Nigerian American, Trans International and IBTC were found to be efficient in 2001; 6 banks Access, Centre Point, Citibank, FBN, Nigerian American, and Union were efficient in 2002; 2 banks FCMB, and Skye banks in 2008; and 4 banks Access, FBN, Oceanic and Stanbic IBTC were found to be efficient in 2009.
- The efficient banks were found to have lower overhead costs relative to total income, use resources better, have higher quality portfolios, and have higher earnings (e.g. return on equity – ROE) than inefficient ones.
- The dynamics of banking efficiency suggests that banks that were efficient in one period were not necessarily those that were efficient in the next period.
- The sources of inefficiency include low capital adequacy ratio (KAPAS) in 2001, low return on equity (ROC), low market share and liquidity ratio in 2002.
- In 2008 the sources of inefficiency include low return on equity, low capital adequacy ratio, high overhead/total earning ratio, low market share, high interest expense/total deposit ratio, and low earning ability (earning/asset ratio).
- In 2009 the sources of inefficiency were low loan-deposit ratio, low market share, earning ability, and low liquidity ratio.

Overall the results of our study revealed that low capital risk ratio appears to be the only consistent factor determining bank inefficiency in Nigeria. Thus, banks with higher capital adequacy ratios are less risky, manage safer and higher earning portfolios and are more efficient. The paper further revealed that more banks could still join the industry without compromising the industry earnings since most of the

existing commercial banks are operating under increasing returns to scale. The results indicate bright opportunities for further expansion in loans and earnings. The results of the study particularly pure technical efficiency (PTE) could be used by banks, deposit Insurance Corporation and central banks to monitor the quality of management, minimize distress in the banking industry and avert bank failure.

References

Aikaeli, J. (2008). Commercial bank efficiency in Tanzania. A paper presented at a CSAE Conference on Economic Development in Africa, held at St. Catherine's College, Oxford, 16th – 18th. *Banking Finance, 20(3): 495-509*.

Alam, I. M. S. (2001). A nonparametric approach for assessing productivity dynamics of large U.S. banks. *Journal of Money, Credit and Banking, 33(1): 121-39*.

Ali, A. I. and Seiford, L. M. (1994). *The mathematical programming approach to efficiency analysis.* Oxford University Press:

Ali, A. I., Cook, W. D. and Seiford, L. M. (1991). Strict vs weak ordinary relations for multipliers in data envelopment analysis. *Management Science, 37(6): 733-38*.

Almumani, A. (2003). The relative efficiency of Saudi banks: Data envelopment analysis models. *International Journal of Academic Research in Accounting, Finance and Management Sciences, 3(3): 152-61*.

Altunbas, Y., Liu, M., Molyneux, P. and Seth, R. (2000). Efficiency and risk in Japanese banking. *Journal of Banking and Finance, 24(10): 1605-28*.

Anyanwu, M. C. (2010). An overview of current banking sector reforms and the real sector of the Nigerian economy. *Central Bank of Nigeria (CBN) Economic and Financial Review, 48(4): 31-56*.

Avkiran, N. K. (1999a). The evidence on efficiency gains: The role of mergers and the benefits to the public. *Journal of Banking and Finance, 23(7): 991-1013*.

Avkiran, N. K. (1999b). An application reference for data envelopment analysis: Helping the novice researcher. *International Journal of Bank Marketing, 17(5): 206-20*.

Banker, R. D., Charnes, A. and Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30(9): 1078-92*.

Benston, G. J. (1965). Branch banking and economies of scale. *Journal of Finance, 20(2): 312-31*.

Berger, A. N. and Humphry, D. B. (1991). The dominance of inefficiencies over scale and product mix economies in Banking. *Journal of Monetary Economies, 28(1): 117-48*.

Berger, A. N. and Humphrey, D. B. (1997). Efficiency of financial institutions: International survey directions for future research. *European Journal of Operational Research, 98(2): 175-212*.

Berger, A. N., Hunter, W. C. and Timme, S. G. (1993). The efficiency of financial institutions: A review and preview of research past, present and future. *Journal of Banking and Finance, 17(2-3): 221-49*.

Berger, A. N., Leusner, J. and Mingo, J. (1996). The Efficiency of Bank branches. Working paper, Board of governors of the Federal Reserve System, Washington D.C.:

Bonin, J. P., Hasan, I. and Wachtel, P. (2005). Bank performance, efficiency and ownership in transition countries. *Journal of Banking & Finance, 29(1): 31-53*.

Casu, B. and Girardone, C. (2002). A comparative study of the cost efficiency of italian bank conglomerates. *Managerial Finance, 28(9): 3-23*.

Casu, B. and Molyneux, P. (2003). A comparative study of efficiency in European banking. *Applied Economics, 35(17): 1865-76*.

Central Bank of Nigeria (2010). Annual report and statement of accounts for the year ended 31st december 2010. Abuja.

Central Bank of Nigeria (1985). Annual report and statement of accounts 2010, Abuja.

Central Bank of Nigeria (1991). Annual report and statement of accounts 2010, Abuja.

Central Bank of Nigeria (1992). Annual report and statement of accounts 2010, Abuja.

Central Bank of Nigeria (2006). Statistical bulletin december 2006. Abuja.

Central Bank of Nigeria (2008). Banking supervision annual report 2008.

Central Bank of Nigeria (2010a). Annual report and statement of accounts 2010, Abuja.

Central Bank of Nigeria (2010b). Statistical bulletin december 2010. Abuja.

Charnes, A., Cooper, W. W. and Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operations Research, 2(60): 429-44*.

Charnes, A., Cooper, W. W., Lewin, A. Y. and Seiford, L. M. (1995). *Data envelopment analysis: Theory, methodology and applications.* Norwell, M.A.: Kluwer Academic Publishers.

Coelli, T., Rao, D. S. P. and Battese, G. (2005). *An introduction to efficiency and productivy analysis. 2nd ed*nSpringer Science Business Media, LLC.

Coelli, T. J. (1996). Centre for efficiency and productivity analysis (CEPA) Working Papers. A guide to DEAP Version 2.1: Data Envelopment Analysis (Computer) program No. 8/96. Available: http//www.une.edu.au/econometrics/cepawp.htm

Cooper, W. W., Seiford, L. M. and Tone, K. (2000). *Data envelopment analysis: A comparative test with methods, applications, references, and DEA-solver software.* Boston: Kluwer Academic.

Cooper, W. W., Seiford, L. M. and Tone, K. (2007). *Data envelopment analysis: A comprehensive text with models, applications, references and dea-solver software. 2nd edn*: New York: Springer Science Business Media.

Debreu, G. (1951). The coefficient of resource utilization. *Econometrica, 19(3): 273-92*.

Erkoc, T. E. (2012). Estimation methodology of economic efficiency: Stochastic frontier analysis vs data envelopment analysis. *International Journal of Academic Research in Economics and Management Sciences, 1(1): 1-23*. Available: www.hrmars.com/journals

Evanroff, D. D. and Israilevich, P. R. (1991). Productive efficiency in banking. *Econometric Perspectives, 15(4): 11-32*.

Färe, R., Grosskopf, S. and Lovell, C. A. K. (1983). The structure of technical efficiency. *Scandinavian Journal of Economics, 185(2): 181-90*.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General), 120(3): 253-90*.

Favero, C. and Papi, L. (1995). Technical efficiency and scale efficiency in the italian banking sector: A non-parametric approach. *Applied Economics, 27(4): 385-95*.

Ferrier, G. and Lovell, C. A. K. (1990). Measuring cost efficiency in banking: Econometric and linear programming evidence. *Journal of Econometrics, 46(1-2): 229-45*.

Fried, H. O., Lovell, C. A. K. and Schmidt, S. S. (2008). *The measurement of of productive efficiency and productivity growth (eds).* Oxford University Press:

Goncalves, R. P. (2006). Management quality measurement: Using data envelopment analysis (DEA) estimation approach for banks in Brazil. MPRA paper 11143. Available: http://mpra.ub.uni-muenchen.de/11143/

Gonzalez-Hermosillos, B. (1999). Determinants of ex-ante banking system distress: a macro-micro empirical exploration of some recent episodes. IMF Working papers 99/33.

Green, C. J., Murinde, V. and Nikolov, I. (2003). Are foreign banks in Central and Eastern Europe more efficient than domestic banks?, 24th SUERF colloquium on stability and efficiency of financial markets in Central and Eastern Europe.

Greene, W. H. (2007). *Econometric analysis. 6th edn*: New Jersey: Prentice Hall.

Greene, W. M. (1980). Maximum likelihood estimation of econometric frontier functions. *Journal of Econometrics, 13(1): 27-56.*

Gwahula, R. (2012). Commercial banks efficiency in Tanzania: a non parametric approach. *European Journal of Business and Management, 4(21): 55-67*. Available: www.iiste.org

Hicks, J. R. (1935). Annual survey of economic theory: The theory of monopoly. *Econometrica, 3(1): 1-20*.

Hjalmarsson, L., Andersson, I. and Mlima, A. (2000). Swedish banking efficiency and produc-tivity in an international perspective. Estocolmo: Supplement Number 28 to the Government Inquiry on the International Competitiveness of the Swedish Financial Sector.

Humphrey, D. B. (1985). *Costs and scale economies in bank intermediation, in aspinwall, R. C. & Eisenbeis, R. A. (Ed.), Handbook for Banking Strategy.* New York: John Wiley and Sons. 745-83.

Ikhide, S. I. (2008). Measuring operational efficiency of commercial banks in Namibia. *South African Journal of Economics, 76(4): 586-95*.

Izah, M. T., Bakar, N. M. A. and Haron, S. (2009). Evaluating efficiency of Malaysian banks using data envelopment analysis. *International Journal of Business and Management, 4(8): 96-106.*

Kamau, A. (2011). Intermediation efficiency and productivity of the banking sector in Kenya. *Interdisciplinary Journal of Research in Business, 1(9): 12-26*.

Kiyota (2009).*Efficiency of commercial banks in Sub Sahara: A comparative analysis Domestic and Foreign bank, Paper presented at the CSAE conference 2009 on "Economic Development in Africa"*.

Koopmans, T. C. (1951). *An analysis of production as an efficient combination of activities,' in Koopmans, T.C. (ed), Activity analysis of production and allocation, cowles commission for research in economics, monograph no. 13.* New York: John Wiley and Sons.

Leibenstein, H. (1966). Allocative efficiency vs X-efficiency. *American Economic Review, 56(3): 392-415*.

Maudos, J. and Pastor, J. (2001). Cost and profit efficiency in banking: An international comparison of Europe, Japan and the USA. *Applied Economics Letters, 8: 383-87*.

Maudos, J., Pastor, J. M. and Quesadaa, J. (2002). Cost and profit efficiency in European banks. *Journal of International Financial Markets Institutions and Money, 12: 33-58*.

Mckinnon, R. (1973). Money and capital in economic development Washington DC, Brooklyn‟s Institution.

Murinde, V. and Moses, T. (2002). A foreign affair? How far does Africa need a foreign bank? Insight issue No 40 communicating development research.

Musonda (2008).*An investigation into the determinant of cost efficiency in the Zambian Banking system*. Paper presented at the 13h Annual African Econometrics Society (AES) conference. South Africa.

Naaborg, I., Scholtens, B., Haan, J., Bol, H. and Haas, R. (2003). How important are foreign banks in the financial development of European transition countries?, CESIFO Working Paper, No 1100.

Nasieku, T., George, K. and Joseph, O. (2013). Intermediation efficiency and productivity of commercial banks in Kenya: A data envelopment and Malmquist productivity index analysis. *Economics and Finance Review, 30(1): 1-13*. Available: http://www.businessjournalz.org/efr

Ncube (2009).*Efficiency of banking sector in South Africa*. African Economic Conference. Addis Ababa, Ethiopia.

Nigeria Deposit Insurance Corporation (2005). Annual report and statement of accounts. Abuja.

Nigeria Stock Exchange (2010-2011). The nigeria stock exchange factbook. Abuja.

Nunamaker, T. R. (1985). Using data envelopment analysis to measure the efficiency of non-profit organisations: a critical evaluation. *Managerial and Decision Economics, 6(1): 50-58*.

Nyong, M. (1987). Joint production and economies of Scale in Nigerian banking. *Nigerian Journal of Economics and Social Studies, 2(2): 195-206*.

Nyong, M. (1989). The effect of quality of management on the profitability of commercial banks: A comparative analysis based on Nigerian banking experience. *Developing Economies: 286-303*.

Nyong, M. (2005). *Management science: an operations research emphasis in economics and business.* Calabar: Clearlines Publication.

Obafemi, F. (2012). Technical efficiency of nigerian banks. *Asian Economic and Financial Review, 2(2): 407-20*.

Onour, I. A. and Abdalla, A. M. A. (2011). Technical efficiency analysis of banks in major oil exporting middle east countries. Available: http://mpra.ub.uni-muenchen.de/29884/

Pastor, J., Perez, F. and Quesada, J. (1997). Efficiency analysis in banking firms: An international comparison. *European Journal of Operational Research, 98(2): 395-407*.

Podpiera, A. and Jiri, P. (2005). Deteriorating cost efficiency in commercial banks signals an increasing risk failure. Working Paper 6, Czech National Bank.

Ramanathan, R. (2007). Performance of banks in countries of the Gulf Cooperation Council. *International Journal of productivity and Performance Management, 56(2): 137-54*.

Sanchez, B., Kabir, H. M. and James, R. B. (2013). Efficiency determinants and dynamic efficiency changes in Latin American banking industries. *The Business and Economics Research Journal, 6(1): 27-52*.

Sathye, M. (2003). Efficiency of banks in a developing economy: The case of india. *European Journal of Operational Research, 148(3): 662-71*.

Sealey, C. W. J. and Lindley, J. T. (1977). Inputs, outputs, and a theory of production and cost at depository financial at depository financial institutions. *Journal of Finance, 32(4): 1251-66.*

Seiford, L. M. and Thrall, R. M. (1990). Recent developments in DEA: The mathematical programming approach to frontier analysis. *Journal of Econometrics, 46(1-2): 7-38*.

Seiford, L. M. and Zhu, J. (1999). An Investigation of Returns-to-scale in Data Envelopment analysis. *Omega, 27(1): 1-11*.

Shaw, E. (1973). *Financial Deepening in Economic Development.* New York: Oxford University Press.

Shirvani, H., Shahram, T. and Bahman, M. (2011). A new approach to data envelopment analysis with an application to bank efficiency in Turkey. *Bank and Bank Systems, 6(1): 5-10*.

Sobodu, O. S., Olankunle, A. P. and Akiedo, A. P. (1998). Bank performance and supervision in Nigeria: Analysing the transition to a deregulated economy, African Economic Research Consortium Nairobi.

Stevenson, R. (1980). Likelihood functions for generalized stochastic frontier estimation. *Journal of Econometrics, 13(1): 58-66.*

Stigler, G. J. (1976). Xistence of X-efficiency. *American Economic Review, 66(1): 213-16*.

Supachet, C. C. (2008). Relative efficiency of commercial banks in Thailand, DEA approach. *Internatinal journal of Finance and Economics*:

Survita, J., Xiaofeng, H. and Baiqing, S. (2013). Commercial banking efficiency in Nepal: An Application of DEA and Tobit model. *Information Technology Journal, 12(2): 306-14*.

Tabaki, B. M., Giovana, L. C. and Daniel, O. C. (2011). Bank efficiency and default in Brazil: Causality tests. Working Paper 253. Banco Central Do Brazil.

Wahidudin, A. N. (2010). Technical efficiency of commercial banks in Malaysia: An application of window data envelopment analysis. MPRA No. 45136. Available: http://mpra.ub.uni.muenchen.de/45136

Wheelock, D. C. and Paul, W. W. (1995). Why do banks disappear: the determinants of u.s. bank failures and acquisitions. Working Paper 1995-013B Also found in Review of Economics and Statistics, February 2000, pp. 127-38. Available: http://research.stlouisfed.org/wp/1995/95-013.pdf

Yıldırım (2002). Evolution of banking efficiency within an unstable macroeconomic environment: The case of Turkish commercial banks. *Applied Economics, 34: 2289-301*.

Yıldırım, H. and Philippatos, G. (2007). Efficiency in banks: Recent evidence from the transition economies of Europe, 1993-2000. *The European Journal of Finance, 13: 123-43*.

Yudistira, D. (2003). Efficiency in Islamic banking: An empirical analysis of 18 banks. Working paper, Department of Economics, Loughborough University, UK.

Zaim, O. (1995). The effect of financial liberalization on the efficiency of Turkish commercial banks. *Applied Financial Economics, 5: 257-64*.

Zeitun, R. and Benjelloun, H. (2013). The efficiency of banks and the financial crisis in a developing economy: The case of Jordan. *Journal of Finance, Accounting and Management, 4(1): 1-20*. Available: http://www.gsmi-ijgb.com/Documen