Efficiency of Insurance Industry in Nigeria: An Application of Data Envelopment Analysis

By

AIGBOVO-OMORUYI Osariemen
Department of Insurance,
University of Benin
Benin City, Edo State, Nigeria;
irabor.osariemen@uniben.edu
+2347037491449

And

OROBATOR Benecdita
Department of Insurance
University of Benin
Benin City, Edo State, Nigeria;
+234; @uniben.edu

Abstract

The study sought to establish whether listed insurance firms in Nigeria are technically and scale efficient. To achieve this goal, the study employed the Non-parametric Data Envelopment Analysis (DEA) with input variables that include total equity, fixed asset and number of staffs while the output variables are revenue, other income and profit before tax. The study period was 2015 - 2016. The STATA DEA software was used to calculate the efficiency score. Findings from the study indicates that in 2015; 5 insurance firms out of the 13 in our sample were efficient based on constant return to scale (CRS), while 6 are variable return to scale (VRS) efficient whereas, 6 insurance firms were scale efficient. Furthermore, in 2016 the result indicates that 3 insurance firms out of the 13 in our sample were efficient based on constant return to scale (CRS), while 5 are variable return to scale (VRS) efficient whereas, 9 insurance firms were scale efficient. This means that majority of the sampled insurance firms are not successful in converting their inputs to outputs. The study concludes that insurance firms in Nigeria are not optimally performing in terms of converting their inputs to outputs. It is therefore recommended that there is need for the insurance firms to scale down cost of production through appropriate strategy. Also the operation of the efficient insurance firms can be benchmark by the inefficient insurance firms.

Keywords: Data Envelopment Analysis, Technical Efficiency, Scale Efficiency, Insurance Industry, Nigeria.

Introduction

Insurance is one of the cornerstones of modern-day financial services sector. In addition to its traditional role of managing risk, insurance market activity, both as intermediary and as provider of risk transfer and indemnification, may promote growth by allowing different risks to be managed more efficiently, promoting long term savings and encouraging the accumulation of capital, serving as a conduit pipe to channel funds from policy holders to investment opportunities, thereby mobilizing domestic savings into productive investment (Skipper, 1997 & Arena, 1998). Analyzing the efficiency of insurance companies has been of interest to researchers in recent times, this is due to the crucial role that insurance sector play in the economy. According to Kubai (2011), the insurance industry provides financial security as well as financial intermediation to both individuals and businesses in the economy, hence, improving the nation's financial and economic development.

Evaluating the performance efficiency of insurance companies is highly important because it helps in determining how insurance companies respond to the various challenges and how many of them are likely to survive those challenges in the event of their occurrence (Berger & Humphrey, 1993). This study uses data envelopment analysis (DEA), a non-parametric statistical procedure, to assess the technical efficiency of insurance firms in Nigeria for the period 2015-2016. DEA is a procedure that tests whether decision-making units are operating on their efficient frontier, along which minimum input usage is required for a given level of output (Andersonet, Brockman, Giannikos & McLeod, 2004).

The review of empirical literature reveals that few studies have utilized the DEA approach to analyze the efficiency of listed insurance firms in Nigeria, this study attempt to fill this gap. Hence, this study will add to the limited empirical studies that have investigated the efficiency of listed insurance firms in Nigeria using DEA approach.

The study seeks to provide answers to the research questions.

(i) Are listed Insurance firms technically efficient in Nigeria?

(ii) Do listed Insurance firms in Nigeria have constant return to scale technical efficiency?

(iii)Is there variable return to scale technical efficiency among insurance firms in Nigeria?

The main objective of this paper is to measure performance efficiency of listed Insurance firms in Nigeria using Data Envelopment Analysis (DEA) Approach. In specific terms, the researcher seeks to:

(i) Determine whether listed Insurance firms are technically efficient in Nigeria;
(ii) Ascertain if listed Insurance firms in Nigeria have constant return to scale technical efficiency; and
(iii) Find out if there is variable return to scale technical efficiency among listed insurance firms in Nigeria.

The rest of the paper is structured as follows. Section 2 reviews the conceptual and empirical literature. Section 3 describes the methods and data sources. The results are presented in section 4 and section 5 concludes the paper.

Literature Review

Conceptual Literature

Concept of Efficiency

The efficiency concept is used to characterize the utilization of resources to produce outputs. The concept means different things to different people in different circumstances. As Lau and Yotopoulo (1971) put it economic efficiency is an elusive concept in which the policy maker, economist and the engineers all have great stakes. For example, the cost accountant uses the ratio of standard cost to actual cost percent to measure production efficiency (Horngren, 1972). An engineer describes the efficiency of his machine by the relation of output to theoretical capacity or output/ theoretical capacity percent. However the economist breakdown the economic efficiency of a firm or industry into two separate components: price efficiency and technical efficiency. The former measures a firm‘s success in choosing an optimal set of inputs, the latter its success in producing maximum output from a given set of input (Farrel, 1957). Furthermore, Farrell states that once the adjective economics is dropped efficiency becomes a rather nebulous concept meaning only success in achieving planned objectives whatever they maybe

Efficiency Measurement According To Farrell

The efficiency measurement discussion began with Farrell (1957) who, based on the work of Debreu (1951) and Koopmans (1951), defined a simple measure of firm efficiency that could account for multiple inputs. Farrell (1957) proposed that the efficiency of a firm consists of two components namely, technical and price efficiency (or allocation efficiency). The first component reflects the ability of a firm to obtain maximal output from a given set of inputs while the second reflects the ability of a firm to use the input in optimal propositions, given their respective prices and production technology. The combination of these two measures provides a measure of total economic efficiency (or overall efficiency). The production of the technical and allocative efficiency measures provides the measure of the overall economic efficiency. However, factor prices are often difficult to find, and Farrell recommends the technical efficiency concept.

Technical Efficiency

Technical efficiency, the most common of the efficiency measure, reflects the ability of the firm to obtain maximum output from a set of inputs. That is, it refers to the use of productive resources in the most technologically efficient manner (Worthington, 2004). In the context of bank services production, technical efficiency will refer to the physical relationship between the resources employed, for example, Deposit, labour, fixed assets and capital and some outputs like total loans extended and Investments. In microeconomic terms, a technically efficient production process is one that lies along the production possibilities frontier or isoquant.

Technical and Allocative (Price) Efficiency

Farrell proposed that the efficiency of a firm is of two parts: technical efficiency and allocative efficiency. Technical efficiency refers to the ability of a firm to produce maximal output from a given set of inputs over a certain time period. While allocative efficiency reflect the ability of a firm to use inputs in optimal proportion given their respective prices. It refers to whether inputs, for a given level of output and a set of input prices are chosen to minimize the cost of production, assuming that the organization being examined is already fully technically efficient (Steering Committee for the Review of Commonwealth/ State Services Provision, 1997).

However, a technically efficient firm could be inefficient in allocative efficiency if inputs are not being employed in proportions that minimize its costs, given their relative input prices (Coelli, 1996). The technical efficiency which evaluates the way the firm chooses the ratio of the different inputs compared to the market price that is supposed competitive (Ouattara, 2012).

The Return to Scale Concept

The return to scale concept reflects the degree to which a proportional increase in all inputs increases output, in the long- term. There are basically two types - constant return to scale (CRS) and variable return to scale (VRS). The constant return to scale occurs when a proportional increase in all inputs results in the same proportional increase in output. The variable return to scale can be an increasing return or deceasing return to scale. Increasing returns to scale occur when a proportional increase in all inputs results in more than a proportional increase in output, while decreasing returns to scale exists when a proportional increase in all inputs results in a less than proportional increase in output. Koulenti (2006) posit that there are many reasons why a particular firm may possess certain returns to scale properties. The most commonly used example relates to a small firm exhibiting increasing returns in particular tasks. One possible reason for decreasing returns to scale is the case where a firm has become so large that the management is not able to exercise close control over all the aspects of the production process. According to Benicio & Soares de Mello (2019) Return to scale is found when there is a standard performance in the verification of the return to scale in the production frontier

Concept of Data Envelopment Analysis (DEA)

DEA estimates and compares the relative efficiency of homogenous Decision Making Units (DMUs) which use similar multidimensional inputs to produce multiple outputs. The DMUs can be banks, bank branches, schools, hospitals, airlines, bank branches, mutual funds, utility companies etc. The technique measures efficiency relative to an unobserved true frontier by identifying a subset of efficient 'best-practice' DMUs that are used to construct the frontier which envelopes all observed DMUs. Then, the relative efficiency of each DMU is measured by the distance with respect to the boundary of the PPS by either increasing the outputs or reducing the inputs or both. The output-oriented efficiency estimate equals one for efficient DMUs and

greater than one for inefficient ones.

Reasons for Choosing DEA

There are a number of reasons for selecting this DEA frontier method above other approaches. First, unlike the SFA or other parametric approaches, DEA can capture the interaction among multiple inputs and multiple outputs simultaneously (Charnes et al., 1978). The banking industry employs several inputs such as employees, deposits, financial and physical capital, borrowings and interest expenses to produce several outputs including loans, investments, interest income, fees and commissions. For this reason, it may be difficult to use the parametric techniques as they only account for single-output technologies at a time.

Second, DEA can be used to easily decompose profit, cost, and revenue efficiencies into several components including overall technical, pure technical and scale efficiencies, in order to determine the specific sources of efficiencies in a particular industry, such as the banking industry.

Third, DEA avoids the need to specify a functional relationship between the input and output variables as reflected in the production function. It therefore considers the firm as a black box without the need to know the basics of the underlying technological process. In other words, DEA allows the 'data to speak for themselves'. DEA also circumvents the need to specify a distributional functional form for the inefficiency term. Such assumptions can create specification errors (Cummins, Weiss., Xie, X., & Zi, 2010) which make DEA very flexible as opposed to the parametric frontier models.

Drawbacks of DEA

The envelopment estimator is not without some limitations. DEA is "deterministic" in the sense that all the observations are considered as being feasible with probability one. In other words, DEA contains no statistical noise but assumes that all frontier deviations are due to inefficiency. The "deterministic" nature of DEA means that in the case of noisy data in the Data Generating Process (DGP), there is an identification problem (i.e. we are unable to identify the part of the production technology, which is due to random error, and the part, which is due to inefficiency). Still, developments are underway in terms of stochastic DEA (Simar, 2007; Kuosmanen &

Kortelainen, 2010), asymptotic results (Kneip., Simarand., & Wilson, 2008) or bootstrapping (Simar & Wilson, 1998; 2007).

Another drawback of DEA estimator is that it is sensitive to measurement error due to outliers or missing explanatory variables. This is because DEA, like FDH, envelopes all the data points. Even so, there are recent developments on partial frontiers such as the order - *m* estimator that provides a robust estimator of the efficiency scores, sharing the same asymptotic properties as the envelopment estimators but being less sensitive to outliers.

There is also the order - α estimator. It is argued that with the partial frontiers, the curse of dimensionality for the envelopment estimator may be overcome as they have root-*n* speed of convergence where *n* is the number of firms being evaluated (Daraio & Simar, 2007).

Note however that partial frontiers are conditional measures. That is, the efficiency score in an input (output) orientation depends on the output (input) levels of the DMU under evaluation. Also, the computation of partial frontier may be time-consuming particularly for large sample size. This is because finding a suitable value of *m* or α may require several tries.

Insurance Sector in Nigeria

The origin of modern insurance is intertwined with the advent of British trading companies in the region and the subsequent increased inter-regional trade. Increased trade and commerce led to increased activities in shipping and banking, and it soon became necessary for some of the foreign firms to handle some of their risks locally (Adeyemi, 2005). Trading companies were therefore subsequently granted insurance agency licenses by foreign insurance companies. Such licenses made it possible for such firms to issue covers and assist in claims supervision. The first of such agency in Nigeria came into force in 1918 when the Africa and East trade companies introduced the Royal Exchange Assurance Agency. Other agencies include Patterson Zochonis (PZ) Liverpool, London and Globe, BEWAC's Legal and General Assurance and the Law Union and Rock (Jegede, 2005).

There was an initial slow pace of the growth of the insurance industry in Nigeria, particularly between 1921 and 1949. This has been traced to adverse effect of the World War II on trading activities both in the United Kingdom and Nigeria. As soon as the war ended, business activities

gradually picked up again, and insurance industry in Nigeria began to record remarkable improvement in growth (Gbede, 2003). It was not until 1958 that the first indigenous insurance company, the African Insurance Company Limited, was established. At independence, only four (4) of the then twenty-five (25) firms in existence were indigenous. By 1976, the number of indigenous companies had far surpassed that of the foreign companies. As at September 2005, there were one hundred and four (104) insurance companies and four (4) reinsurance companies in existence before recapitalization.

Regulation of Nigeria insurance industry has become substantially intensified in the last two (2) decades. There are risks of potential abuse, low level awareness, poor market penetration, low operating capital, as well as low capacity for retention and acceptance of foreign risks (Ezekiel, 2005), all of which led to massive regulation of the insurance sector of Nigeria financial system. The first major step at regulating the activities of insurance business in Nigeria was the report of Obande Commission of 1961, which resulted in the establishment of department of Insurance in the Ministry of Trade and which was later transferred to the Ministry of Finance. The report also led to the enactment of Insurance Companies Act of 1961, which came into effect on 4th May, 1967. By the provisions of the Act, the office of the Registrar of Insurance was created to supervise insurance practice. Other provisions of the Act included minimum capital requirement and other conditions for registration, monitoring, and control of insurance operation generally. This was followed by a series of legislation which sought to further the cause of insurance regulation in the country.

The first major attempt at regulating insurance in the country was the promulgation of the Nigerian Insurance Decree, 1976. The biggest development in the Nigerian insurance includes the National Insurance commission (NAICOM) seizing control of the largest insurer - NICON. National Insurance Commission (NAICOM) is a refurbished institution, established by the penultimate military administration in the country in 1997. The power of NAICOM under the prevailing legislation for the industry in the country, the Insurance Act 2003, is clearly comprehensive. Section 86 of the Act provides that subject to the provision of the Act, NAICOM shall be responsible for administration and enforcement of the provisions of the insurance Act. Criteria and standards for registration, policy provision, rates, expenses limitations, valuation of

asset and liabilities, investment funds, and the qualifications of sale representatives are set by NAICOM.

Empirical Literature

This section reviewed the previous studies that have investigated the efficiency of insurance firms. Rai (1996) examines the cost efficiency of insurance firms in 11 countries over 1988-1992 and found that X-inefficiencies not only vary by country but by size and specialization. Firms in Finland and France have the lowest, while firms in the United Kingdom have the highest X-inefficiency. On average, small firms are more cost efficient than large firms. Firms grouped into those offering single or specialized services also operate more cost efficiently than those offering a combination of life and nonlife services (combined firms).

Cummins and Zi (1996) analyzed the efficiency of insurance companies with 445 U.S. life insurance companies for five years (1988-1992) period using two different methodologies: Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH) mathematical programming. This study finds different result on the same sample while applying the different methodologies. They advised to use more than one methodology when analyzing the efficiency to ensure that the findings are not being driven by specification errors.

Bernier and Sedzro (2002) examined the efficiency of 69 Canadian insurance companies for the period of five years (1996-1999) and find that the efficiency scores in the industry vary significantly by insurers' size, i.e. larger firms are more efficient than smaller firms. The size has a significant impact on cost efficiency while size does not matter on revenue efficiency. The study suggests that many insurers seem to have a hard time choosing the cost-minimizing combination of inputs, the most efficient insurers are close to achieving the optimal choice of outputs, therefore maximizing revenues, and there is evidence of a lack of “scale” mostly among small insurers.

Jametti and Sternberg (2003) compared the cost efficiency of private and public property insurance providers in Switzerland including 18 years data (1981-1998) of 19 causality and property insurers based on claims to premium ratio. The study shows that the public insurance providers are about 20 percent more cost efficient than their private counterparts. Greene and Segal (2004) explored the relationship between cost inefficiency and profitability in the U.S. life

insurance industry using the Stochastic Frontier (SF) method. The study finds that cost inefficiency in the life insurance industry is substantially relative to earnings and that inefficiency is negatively associated with profitability (Return on equity) and stock (shareholder owned) companies are as efficient and profitable as mutual (policyholder-owned) companies.

Barros and Obijiaku (2007) studied the technical efficiency of ten Nigerian insurance companies from 2001 to 2005 using DEA. They used profit or loss for the year, net premiums, settled claims, outstanding claims and investment income as the outputs while total capital, total operative costs, total number of employees and total investment as their inputs. Their result show that some of the Nigerian insurance companies were inefficient, although there was a just a margin for them to upgrade their efficiency. They also argue that all the companies considered in their study did not display equivalent efficiencies.

Borges, Nektarios, and Barros (2008) used CCR and BCC models to evaluate the performance of Greek life insurance companies for the period 1994 to 2003, combining operational and financial variables. These models identify adequately the inefficient companies, but are weak in discriminating among those found to be efficient. The study further estimated an inefficiency gap of about 27% and found that large and quoted life insurance companies and involved in mergers and acquisition have higher efficiency. A major finding is that the local market is in great need of further consolidation.

Luhnen (2009) assessed the efficiency and productivity in German property-liability insurance industry covering the period from 1995 to 2006 using Data Envelopment Analysis. The study finds the improvement in efficiency about 15 percent in terms of technical and 45 percent in terms of cost efficiency during the study period. Furthermore, total factor productivity and efficiency growth are found to be low with growth rates of 1.3 percent (in 1995) and 0.6 percent (in 2006). Further, the study concludes that firm size, distribution channels, ownership of forms, product specialization, financial leverage, and premium growth are the major determinants of the efficiency of property-liability insurance company.

Asghar and Afza (2010) examined the efficiency of insurance companies in Pakistan over the period 2003 to 2007 selecting the gross premiums and investment incomes as outputs variables and labor, business services, equity capital and debt capital as input variables. It was found that

the insurance companies were on average 92.7 percent technical efficient, 81.12 percent allocative efficient and 75.44 percent cost efficient. Moreover, the study has also found that allocative and cost efficiencies are improved from 2003 to 2005 but significantly decreased in 2006 whereas; technical efficiency is increased over the study period.

Eling and Huang (2011) examined the efficiency of non-life insurance companies in fastest-growing markets of four emerging BRIC countries (Brazil, Russia, India, China) during the period of 2000–2008 using frontier efficiency method. They found that Brazil has the most efficient followed by Russia, China, and India.

Saad and Idris (2011) measured the efficiency of life insurance companies in Brunei and Malaysia for the year 2000-2005 using the Data Envelopment Analysis. Study showed that bigger the size of the company, higher the probability for the company to be more efficient in utilizing inputs to generate more outputs. Due to the positive impact of both efficiency and technical changes, the overall total productivity change for these firms within the period of study has been found higher than 1.

Bawa and Ruchita (2011) analyzed the efficiencies of health insurance business in India for ten general insurance companies and four public sector companies from 2003 to 2010 using DEA. The inputs of their study were equity capital and labour (including agent's fees, commission and other expenditure, while the output is net premium). They found that on average, the technical efficiency of the health insurance business was 73%, the scale efficiency was 78% and pure technical efficiency was 92%. They argued that public sector companies were becoming mature and now having the decrease return to scale because of the competition with the private sector companies given the improvement in the private sector.

Dalkılıç and Ada (2014) evaluate the efficiency of Life/Pension Insurance Industry in Turkey from 2010 to 2011 using DEA. There were 20 sample companies and the input used were operating expenses, shareholders' equity, number of agencies and number of staff employed by insurance companies while the output were net gross written premiums, net claims incurred and net technical provisions. There was a decrease in the average scale efficiency of 20 companies included in their study from 92% in 2010 to 87.7% in 2011. However, the life insurance companies average scale efficiency increased from 94.8% in 2010 to 98.6% in 2011.

Osamwonyi and Imafidon (2016) studied the technical efficiency of manufacturing companies in Nigeria using data envelopment analysis and found out that quoted manufacturing companies in Nigeria are relatively efficient with thirty-one companies operating on the production possibility frontiers and twenty-seven not operating on it. The results show an average variable returns to scale mean score of 85% and scale efficiency mean score of 76%. They recommended that companies operating in the region of decreasing returns to scale should scale down their inputs while those that are in the region of increasing return to scale should scale up their inputs.

Ogieva and Omoregbe (2017) analyzed the efficiency and performance of quoted insurance companies in Nigeria. Specifically, it determines the extent to which quoted insurance companies in Nigeria are efficient (technical, allocative and scale) in terms of their resource utilization and the performance (total factor productivity growth rate) of quoted insurance companies in Nigeria. In pursuance of the above, the study employs the input oriented data envelopment analysis (DEA) model with four input and output variables. The input variables are management expenses, net premium, shareholders fund and total asset while the output variables are investment income, net claims, profit after tax and market share. The result revealed that quoted insurance companies in Nigeria are relatively inefficient. Only seven companies are technically efficient as the result indicates a mean variable returns to scale technical efficiency score of 59%. On the other hand, we observed that twenty-six companies were scale efficient with a mean scale efficiency score of 87% showing that quoted insurance companies are relatively efficient in their choice of scale or size of operations and that Standard Trust Assurance Company (STACO) has the highest peer count. They also discovered the presence of high slacks for management expenses, net profit, shareholders fund and total asset and this shows the degree of inefficient allocation of resources in the Nigerian quoted insurance companies. On the other hand, the output fall (slack) mean of investment income, net claims, profit after tax and market share indicate what the companies would have achieved if the input variables were properly allocated. Finally, weobserved that there is no total factor productivity increase in Nigerian quoted insurance companies as only 7 (seven) firms out of thirty-four recorded varying degrees of productivity progress.

Grmanová and Strunz (2017) examined the relationship between technical efficiency and profitability of insurance companies. The profitability of insurance companies was expressed by

such indicators as ROA, ROE and the size of assets. We analysed 15 commercial insurance companies in Slovakia in the period of 2013-2015. Technical efficiency scores were expressed using DEA models. The relationship between the technical efficiency score and the indicators of profitability was expressed using censored regression, i.e. the Tobit regression model and the Mann-Whitney U-test. The relationship between the technical efficiency score in the CCR and BCC models and all the groups formed on the basis of the return on assets and the group formed basing on the return on equity was not confirmed. Statistically significant difference between average technical efficiency score in the CCR model in the group of insurance companies with ROA <1%,2%) and technical efficiency score in the CCR model in the group of insurance companies with ROA equal or higher than 2 was confirmed.

Aigbovo and Igbbinoba (2019) evaluate the efficiency of listed banks in selected Sub-Saharan African countries for the 2014/2015 fiscal year. The study employed the Non-parametric Data Envelopment Analysis (DEA) with input variables as interest expenses, operating expenses, customer deposit, and total asset while the output variables are interest income, profit after tax and loans and advances to customers. The finding of the study reveals that11 banks out of the 20 in our sample within the period under study were efficient based on constant return to scale (CRS), while 13 are variable return to scale (VRS) efficient whereas, 11 banks were scale efficient. This means that majority of the banks in the banking industry in the selected Sub-Saharan African countries are being successful in converting their inputs to outputs.

Jaloudi (2019) evaluate the technical efficiency in the Jordan insurance market, and examine the internal and external determinants that appear to affect the technical efficiency of the insurance companies. The study used panel data for 22 insurance companies operating inside Jordan over the period 2000-2016. Data Envelopment Analysis used to evaluate the technical Efficiency Scores, Slacks based and Logit models to examine the efficiency determinants. The study found that there is a slight development of technical efficiency for the Jordanian insurance companies during the study period. In addition, there is a substantial efficiency difference between insurance companies each year, and there is a variation at the level of efficiency for each company in each year. The results also showed that owners' equity is among the most important internal determinants of companies' efficiency, and there is a significant correlation between type, size, and return on assets of the insurer and its efficiency.

Methodology

Data envelopment analysis

This paper adopts the DEA methodology to investigate the efficiency of insurance firms in Nigeria. DEA is a non-parametric method that measures the relationship between produced outputs and consumed inputs and determines an efficiency score. It uses a linear programming technique to construct an efficient cost frontier from which the deviations of individual insurance firms are measured. These deviations represent the inefficiency of each individual insurance firm. Besides using a cost frontier as the basis for inefficiency measures, the primary advantage of the DEA methodology is that it allows efficiency estimations to be made without the need to specify a functional form while handling a multiple-input, multiple-output production process (Anderson *et al*., 2002). The DEA approach is suitable for this study, as it allows the use of a smaller sample size, and the number of insurance firms in Nigeria is relatively low. Essentially, DEA constructs an efficient frontier which consists of a linear combination of the perfectly efficient insurance firms from a sample and determines deviations from that frontier. These deviations from the efficient frontier signify performance inefficiencies that are a function of the failure to minimize inputs and maximize outputs (Douglas, 2006).

Technical efficiency exists when a insurance firms cannot reduce its input usage (costs) without decreasing its output. Technical efficiency can be decomposed into pure technical efficiency and scale efficiency (SE) measures. Technical efficiency (constant returns to scale efficiency–TE_{CRS}) is the product of pure technical efficiency (variable returns to scale efficiency–PTE_{VRS}) and SE:

$TE_{CRS} = PTE_{VRS}$ x SE

Pure technical efficiency (PTE_{VRS}) refers to deviations from the efficient frontier that results from the failure to utilize the used resources efficiently, allowing variable returns to scale (VRS). SEs are losses due to the failure to operate at the long-run optimal scale (CRS). A value of unity implies that the firm is on the industry frontier in the associated year, whereas values less than unity implies that the firm is below the frontier or, in other words, technically inefficient. Thus, the further the value is from unity, the more inefficient the firm is.

Source of Data

Three inputs and three outputs are used to analyze data over a two-year period. The inputs utilized are total equity, fixed asset and number of staffs. The three outputs are revenue, other

income and profit before tax. The data for all variables for the years 2015 to 2016 were obtained from the audited annual reports of thirteen (13) selected insurance firms.

Model Specification

The DEA model used is derived as follow:

$$maxh_0(u,v) = \frac{\sum_{r=1}^{z} v_r y_{r0}}{\sum_{i=1}^{m} u_i x_{i0}}$$

Subject to

$$\frac{\sum_{r=1}^{z} v_r y_{r0}}{\sum_{i=1}^{m} u_i x_{i0}} \leq 1; j = 1, 2, \dots\dots, n$$

$$u_i \geq 0 : i = 1,2, \dots\dots, m$$

$$v_i \leq 0 : r = 1,2, \dots\dots, s$$

Where

x_{ji} = the amount of input i utilized by the jth DMU

y_{rj} = the amount of output r produced by the jth DMU

u_i = weight given to input i

v_i = weight given to input r

Following the Charnes Cooper transformation (1962), one can select a representative solution (u, v) for which

$$\sum_{i=1}^{m} u_i x_{i0} = 1$$

Hence, the denominator in the efficiency score h0 shown above is set equal to one, the transformed linear programming model for DMU0 can be written as follow

$$max\ z_0 \sum_{r=1}^{z} v_r y_{r0}$$

Subject to

$$\sum_{r=1}^{z} v_r y_{rj} - \sum_{r=1}^{m} u_i x_{ij} \leq; j = 1,2, \ldots\ldots, n$$

$$\sum_{r=1}^{m} u_i x_{i0} = 1$$

$$u_i \ \geq \ 0 : i = 1,2, \ldots\ldots, m$$

$$v_i \ \leq \ 0 : r = 1,2, \ldots\ldots, s$$

The linear programming mode shown above will be run n times in identifying the relative efficiency scores of all the DMUs. Each DMU selects input and output weights that maximize its efficiency score. Generally, a DMU is considered efficient if it obtain a score of 1.00, implying 100% efficiency; whereas a score of less than 1.00 implies that it is inefficient. Maximizing the fraction can be accomplished by minimizing the denominator of the fraction and normalizing the denominator to one (Lehman et al., 2004).

$$Min \sum_{r=1}^{m} u_i\ , x$$

Subject to:

$$\sum_{r=1}^{s} v_i y_r = 1$$

$$\sum_{r=1}^{s} v_i y_{rj} + \sum_{r=1}^{m} u_i, x \geq = 0, \qquad j = 1, 2 \ldots n$$

$$v_i \ \geq 0 \qquad r = 1,2, \ldots s$$

$$u_i \ \geq 0 \qquad r = 1,2, \ldots s$$

The duality theory from linear programming suggests that there is a dual program for each original linear program and the solution are always equal (Gale et al., 1951).

4. Analysis and Discussion of results

In this section, we evaluate the relative efficiency in thirteen (13) listed insurance firms in Nigeria for the period 2015 - 2016. Before conducting the DEA, we first carry out descriptive

statistics in order to explain the behavioural patterns of the individual time series data used in the study. In the DEA model, we utilized three inputs and three outputs in evaluating the relative performance efficiency of the selected insurance firms in Nigeria. In this regard, the data set used for the input and output variables is presented in Table 1 below.

Table 1

Input and Output Variables used in the Analysis

INPUT	**OUTPUT**
Total Equity (EQUIT)	Revenue (REV)
Fixed Asset (FASST)	Other Revenue (INVC)
Number of Staff (STAFF)	Profit Before Tax (PBT)

Source: Author's Computations (2018)

The input and output adopted in this study clearly shows that our focus is on the relative performance efficiency of selected Nigerian insurance firms in terms of how well the insurance firms can convert total equity, fixed asset, number of staff (input) into revenue, other revenue and profit before tax (output).

Descriptive Statistics

Table 2 provides the descriptive statistics (including mean, standard deviation, minimum and maximum) of the selected insurance firms output and input variables and the descriptive statistics show the summary of data and other basic characteristics within the series.

Table 2

Descriptive Statistics for DEA Input and Output Variables

Year		INPUT			OUTPUT		
2015		EQUIT	FASST	STAFF	REV	INVC	PBT
	Mean	11063417	1904346.	227.5385	9228839.	1627862.	1404705.
	Median	9365339.	1327844.	210.0000	6148778.	746237.0	704911.0
	Maximum	26071459	5353657.	557.0000	23600989	5864828.	5731738.
	Minimum	4267812.	479301.0	74.00000	2434614.	258866.0	20544.00
2016	Mean	12179497	2226433.	217.3846	11902902	1508779.	2631445.
	Median	8702978.	1620472.	198.0000	6763129.	476513.0	1142880.
	Maximum	30094669	5915891.	506.0000	30029334	7249662.	11835236
	Minimum	4402800.	569572.0	74.00000	2197357.	281288.0	44975.00

Source: Author's Computations from DEA STATA Software (2020)

The descriptive statistics in table 2, shows that the sampled mean of the 13 insurance firms for the period of 2015 fiscal year, on the input side, total equity was N11,063,417 million, fixed asset was N1,904,346 million while staff salary was N227.5385 million. From the total fixed asset mean result, it shows that insurance firms like Aiico had a total fixed asset of N5,353,657 million, AxaMansard N1,932823 million, Custodian & Allied Insurance N2,761,272 million, Nem Insurance N2,694,001million, Unitykapital N2,518,219million and Wapic Insurance N2,374,524 million which were far above the sampled peer insurance average of N1,904,346 million. Furthermore, the table shows the mean total salary paid to staff to be N227.5385 million, while insurance firms like Aiico, AxaMansard, Consolidated Hallmark, Custodian and allied Insurance, Nem Insurance and Unitykapitalwithin the selected sampled insurance firms had staff salary higher than the mean of all the sampled insurance firms valued at N557 million, N267 million, N243 million, N268 million, 235 million and 283 million respectively. While the insurance firm with the maximum staff salary was Aiico valued at N557 million and the minimum staff salary was for continental Reinsurance valued at N74 million. On the output side, the average revenue of the sampled 13 insurance firms stood at N9,228,839 million while insurance firms like Aiico, AxaMansard, continental Reinsurance, Custodian & Allied Insurance and Nem Insurance had revenue income N10,410,650 million, N16,891,241 million, N20,679,772 million, N23,600,989 million and N10,700,505 million above the average

respectively while the bank that recorded the revenue was Prestige Assuranceat N2,434,414 million and Custodian & Allied Insurance had maximum at a value of N23,600,988 million.

The descriptive statistics in table 2, shows that the sampled mean of the 13 insurance firms for the period of 2016 fiscal year, on the input side, total equity was N12,179,497 million, fixed asset was N2,226,433 million while staff salary was N217.5846 million. From the total fixed asset mean result, it shows that insurance firms like Aiico had a total fixed asset of N5,915,891 million, Custodian & Allied Insurance N3,039,638 million, Nem Insurance N2,819,986million, Unitykapital N3,293,545million and Wapic Insurance N4,025,510 million which were far above the sampled peer insurance average of N2,226,433 million. Furthermore, the table shows the mean total salary paid to staff to be N217.3846 million, while insurance firms like Aiico, AxaMansard, Consolidated Hallmark, Custodian & allied Insurance and Unitykapital within the selected sampled insurance firms had staff salary higher than the mean of all the sampled insurance firms valued at N506 million, N310 million, N241 million, N277 million and 242 million respectively. While the insurance firm with the maximum staff salary was Aiico valued at N506 million and the minimum staff salary was for Prestige Assurance valued at N74 million. On the output side, the average revenue of the sampled 13 insurance firms stood at N11,902,902 million while insurance firms like Aiico, AxaMansard, continental Reinsurance and Custodian & Allied Insurance had revenue income N30,029,334 million, N20,676,584 million, N25,312,994 million and N10,700,505 million above the average respectively while the bank that recorded the revenue was Prestige Assurance at N2,434,414 million and Custodian & Allied Insurance had maximum at a value of N28,368,403 million.

DEA Analysis

The performance efficiency scores that were generated from the DEA methodology is based on the three efficiency measures; (1) **DEA Overall technical efficiency score (CRS):** This is obtained when we assume a constant return to scale for all the sampled insurance firms. This implies increase in insurance firms input (equity, total fixed assets and staff salary) by 1% would lead to a 1% increase in its output (revenue, other revenue and loans and profit before tax). These neglect management skills in converting small inputs to large outputs. (2) **DEA Pure technical efficiency score (VRS):** This is obtained when we assume a variable return to scale for all the sampled insurance firms. This implies that increase in insurance firms input (equity, total fixed

assets and staff salary) by 1% would lead to more than 1% increase in its revenue, other revenue and loans and profit before tax (output). This focuses on measuring the extent to which management skills was relevant in converting small inputs to large outputs and (3) **Scale efficiency score (SCALE):** This is the ratio of constant return to scale to variable return to scale (CRSE/VRSE).

Constant Return to Scale (CRS) Technical Efficiency DEA Results

The DEA models involved in assessing the performance of the selected 13 insurance firms were solved using STATA DEA software. The "overall" technical efficiency score (i.e. technical efficiency relative to the CRS DEA model) for each of the 13 insurance firms is presented in table 4. Also presented in the table are the referenced efficient insurance firms (peer) sets for inefficient insurance firms as well as frequency with which a particular insurance firm appears in the efficient sets of other insurance firms. The CRS DEA model is based on the assumption of constant return to scale for all the sampled insurance firms.

In the table 3.1, we found that on the basis of CRS Technical efficiency scores (**TEcrs)** for 2015, 5 out of the 13 selected insurance firms were efficient. This means that majority of the sampled insurance firms in Nigeria are not technically efficient in 2015. This implies that they were unable to use their input (equity, total fixed assets and staff salary) to generate better outputs (revenue, other revenue and loans and profit before tax).

Table 3.1

Technical efficiency scores of the 13 sampled listed insurance firms in Nigeria based on CRS DEA model 2015

DMU NO	COMPANIES	TEcrs	RANK
1	Aiico	1.00	1
2	AxaMansard	1.00	1
3	Consolidated Hallmark	0.98	7
4	Contiental Reinsurance	1.00	1
5	Custodian & Allied Insurance	1.00	6
6	Lasasco Assurance	0.98	9
7	Linkage Assurance	0.62	11
8	Nem Insurance	1.00	1
9	Prestige Assurance	0.49	12
10	Regency Aliance Ins	0.68	10
11	Sovereign Trust	0.97	8
12	Unitykapital Assurance	0.24	13
13	Wapic Insurance	1.00	1

Source: Author's Computations from DEA STATA Software (2020)

In the table 3.2, we found that on the basis of CRS Technical efficiency scores (**TEcrs)** for 2016, 3 out of the 13 selected insurance firms were efficient. This means that majority of the sampled insurance firms in Nigeria in 2016 are not technically efficient. This implies that they were unable to use their input (equity, total fixed assets and staff salary) to generate better outputs (revenue, other revenue and loans and profit before tax) in 2016.

Table 3.2

Technical efficiency scores of the 13 sampled listed insurance firms in Nigeria based on CRS DEA model for 2016

DMU NO	COMPANIES	TEcrs	RANK
1	Aiico	1.00	1
2	AxaMansard	1.00	3
3	Consolidated Hallmark	0.71	5
4	Contiental Reinsurance	1.00	1
5	Custodian & Allied Insurance	0.82	4
6	Lasasco Assurance	0.61	7
7	Linkage Assurance	0.25	12
8	Nem Insurance	0.63	6
9	Prestige Assurance	0.37	10
10	Regency Aliance Ins	0.54	9
11	Sovereign Trust	0.60	8
12	Unitykapital Assurance	0.13	13
13	Wapic Insurance	0.36	11

Source: Author's Computations from DEA STATA Software (2020).

Variable Return to Scale (VRS) Technical Efficiency DEA Results

The "pure" technical efficiency score (i.e. technical efficiency relative to the VRS DEA model) for each of the 13 insurance firms is presented in Table 5. Also presented in the table are the referenced efficient insurance firms (peer) sets for inefficient insurance firms. The VRS DEA model is based on the assumption of variable return to scale for all the sampled insurance firms. This implies increases in insurance firms input by 1% can lead to a more than 1% increases in its output. This implies that management skills in converting small inputs to large outputs are captured by the VRS DEA model. The VRS DEA results are presented in Table 4.1 and 4.2 and discuss below;

In the Table 4.1, we found that on the basis of VRS Technical efficiency scores (**TEvrs)** for 2015, six (6) insurance firms out of the 13 sampled insurance firms were efficient while 7 insurance firms were found to be inefficient. The six (6) efficient insurance firms that were able to use their equity, total fixed assets and staff salary(input) to generate better output (revenue, other revenue and loans and profit before tax) are Aiico, AxaMansard, Consolidated Hallmark,

Contiental Reinsurance, Custodian & Allied Insurance and Lasaco Assurance. This implies that these insurance firms used fewer inputs to produce relative better output compared to other sampled insurance firms. This implies that management of these banks was successful in using their relatively small input resources to generate better. In the same results we also observed that other insurance firms (Linkage Assurance, Nem Insurance, Prestige Assurance, Regency Alliance Insurance, Sovereign Trust, Unitykapital and Wapic Insurance) in the sample on the VRS DEA model were inefficient in converting their input to better output as compared to some of their peers, thus creating slacks or under-utilization.

Table 4.1

Technical efficiency scores of the 13 sampled listed insurance firms in Nigeria based on VRS DEA model for 2015

DMU NO	COMPANIES	TEvrs	RANK
1	Aiico	1.00	1
2	AxaMansard	1.00	1
3	Consolidated Hallmark	1.00	7
4	Contiental Reinsurance	1.00	1
5	Custodian & Allied Insurance	1.00	1
6	Lasasco Assurance	1.00	9
7	Linkage Assurance	0.65	11
8	Nem Insurance	1.00	1
9	Prestige Assurance	0.51	12
10	Regency Aliance Ins	0.70	10
11	Sovereign Trust	0.97	8
12	Unitykapital Assurance	1.00	13
13	Wapic Insurance	0.24	1

Source: Author's Computations from DEA STATA Software (2020)

In the Table 4.2, we found that on the basis of VRS Technical efficiency scores (**TEvrs)** for 2015, five (5) insurance firms out of the 13 sampled insurance firms for 2015 were efficient while 8 insurance firms were found to be inefficient. The five (5) efficient insurance firms that were able to use their equity, total fixed assets and staff salary (input) to generate better output (revenue, other revenue and loans and profit before tax) are Aiico, AxaMansard, Consolidated

Hallmark, Contiental Reinsurance and Custodian & Allied Insurance. This implies that these insurance firms used fewer inputs to produce relative better output compared to other sampled insurance firms. The implication of this is that management of these insurance firms was successful in using their relatively small input resources to generate better income. In the same results we also observed that other insurance firms (Lassaco Assurance, Linkage Assurance, Nem Insurance, Prestige Assurance, Regency Alliance Insurance, Sovereign Trust, Unitykapital and Wapic Insurance) in the sample on the VRS DEA model for 2015 were inefficient in converting their input to better output as compared to some of their peers, thereby creating slacks or under-utilization.

Table 4.2

Technical efficiency scores of the 13 sampled listed insurance firms in Nigeria based on VRS DEA model for 2015

DMU NO	COMPANIES	TEvrs	RANK
1	Aiico	1.00	1
2	AxaMansard	1.00	1
3	Consolidated Hallmark	1.00	4
4	Contiental Reinsurance	1.00	1
5	Custodian & Allied Insurance	1.00	5
6	Lasasco Assurance	0.61	9
7	Linkage Assurance	0.25	12
8	Nem Insurance	0.63	7
9	Prestige Assurance	0.37	10
10	Regency Aliance Ins	0.63	8
11	Sovereign Trust	0.64	6
12	Unitykapital Assurance	0.13	13
13	Wapic Insurance	0.36	11

Source: Author's Computations from DEA STATA Software (2020)

Scale Efficiency DEA Results

Following the above, we learned that overall technical efficiency (CRS DEA model) is based on relative efficiency in terms of using the right scale of operation combined with managerial skill while also the pure technical efficiency (VRS DEA model) shows the success of insurance firms

management at input to output "conversion". The scale efficiency which is the ratio of overall technical efficiency (TEcrs) to pure technical efficiency (TEvrs) measures how much an insurance firms can improve its efficiency by being projected from VRS to CRS, that is the ability to further increase its outputs. This reflects the efficiency of the insurance firms irrespective of whether it operates at the right returns to scale or not. For an insurance firm to become scale efficient it should increase its output further to reach the most productive scale size. The results of the scale efficiency for 2015 and 2016 are presented in Table 5.1 and 5.2

In table 5.1, we found out that on the basis of scale efficiency scores (**TEcrs/TEvrs)** for 2015, six (6) of the sampled insurance firms were scale efficient. This means that majority of the insurance firms were unable to use their input to generate better outputs under both VRS and CRS DEA assumptions.

Table 5.1

Scale efficiency scores of the 13 sampled Insurance firms based on DEA model 2015

DMU NO	COMPANIES	TEcrs	TEvrs	Scale
1	Aiico	1.00	1.00	1.00
2	AxaMansard	1.00	1.00	1.00
3	Consolidated Hallmark	0.98	1.00	0.98
4	Contiental Reinsurance	1.00	1.00	1.00
5	Custodian & Allied Insurance	1.00	1.00	1.00
6	Lasasco Assurance	0.98	1.00	0.94
7	Linkage Assurance	0.62	0.65	0.95
8	Nem Insurance	1.00	1.00	1.00
9	Prestige Assurance	0.49	0.51	0.98
10	Regency Aliance Ins	0.68	0.70	0.96
11	Sovereign Trust	0.97	0.97	0.97
12	Unitykapital Assurance	0.24	1.00	0.99
13	Wapic Insurance	1.00	0.24	1.00

Source: Author's Computations from DEA STATA Software (2020)

In Table 5.2, we found out that on the basis of scale efficiency scores (**TEcrs/TEvrs)** for 2016, nine (9) of the sampled insurance firms were scale efficient. This means that majority of the

insurance firms were able to use their input to generate better outputs under both VRS and CRS DEA assumptions. The results of the scale efficiency are presented in Table 6.

Table 5.2

Scale efficiency scores of the 13 sampled Insurance firms based on DEA model for 2016

DMU NO	COMPANIES	TEcrs	TEvrs	Scale
1	Aiico	1.00	1.00	1.00
2	AxaMansard	1.00	1.00	1.00
3	Consolidated Hallmark	0.71	1.00	0.71
4	Contiental Reinsurance	1.00	1.00	1.00
5	Custodian & Allied Insurance	0.82	1.00	0.82
6	Lasasco Assurance	0.61	0.61	1.00
7	Linkage Assurance	0.25	0.25	1.00
8	Nem Insurance	0.63	0.63	1.00
9	Prestige Assurance	0.37	0.37	1.00
10	Regency Aliance Ins	0.54	0.63	0.86
11	Sovereign Trust	0.60	0.64	0.95
12	Unitykapital Assurance	0.13	0.13	1.00
13	Wapic Insurance	0.36	0.36	1.00

Source: Author's Computations from DEA STATA Software (2020).

Conclusion and Recommendations

Conclusion

This study examines the technical efficiency of listed insurance firms in Nigeria. The Non-parametric methodology known as Data Envelopment Analysis (DEA) was employed to evaluate the relative efficiency of these sampled insurance firms under the assumptions of constant return to scale (CRS), variable return to scale (VRS) and scale efficiency (SE) score. An insurance firm with a score of 1 is efficient, while a score below 1 means the insurance company is inefficient. Efficiency analysis of firms is one of the main concerns of stakeholders given the present economic challenges in Nigeria. Only firms that are efficient in resources utilization and maintain production frontier curve can survive the challenges in the corporate world. A sample of thirteen quoted insurance firms for the fiscal year 2015-2016 was examined. Findings from the study indicates that in 2015; 5 insurance firms out of the 13 in our sample were efficient

based on constant return to scale (CRS), while 6 are variable return to scale (VRS) efficient whereas, 6 insurance companies were scale efficient. Furthermore, in 2016 the result indicates that 3 insurance firms out of the 13 in our sample were efficient based on constant return to scale (CRS), while 5 are variable return to scale (VRS) efficient whereas, 9 insurance companies were scale efficient. This means that majority of the insurance firms in the Insurance industry in Nigeria are not successful in converting their inputs to outputs. The study concludes that insurance firms in Nigeria are not optimally performing in terms of converting their inputs to outputs. This means that majority of the sampled insurance firms are not successful in converting their inputs to outputs.

Recommendations

Based on the empirical findings of this study, the following policy recommendations are suggested for policy action:

(i) The insurance firms that are inefficient should strengthen their operations so that they can be efficient.

(ii) Regulatory and supervisory authorities in Nigeria should formulate and implement monetary policies that are effective in helping the insurance firms to improve their operations, thereby leading to efficiency in resource allocation and utilization.

(iii) For the insurance firms that are inefficient, the management need to reallocate their resource input.

References

Adeyemi, M. (2005). An overview of the insurance Act 2003. *Issues in Merger and Acquisition for the Insurance Industry*. 3(1), 61-78.

Aigbovo, O., & Igbinoba, N. O. (2019). Efficiency of listed banks in selected Sub-Saharan African Countries: A data envelopment analysis approach. *DUTSE Journal of Economics and Development Studies, 8*(2), 242 - 257

Anderson, R. I., Brockman, C. M., Giannikos, C. & McLeod, R.W. (2004). A non-parametric examination of real estate mutual fund efficiency. *International Journal of Business and Economics,* 3 (3), 225-238.

Asghar, M.J.K.A. &Afza, T. (2010). Efficiency of the insurance industry in Pakistan: An Application of Non-Parametric Approach. *Interdisciplinary Journal of Contemporary Research in Business*, 2(8), 84-98

Barros, C., & Obijiaku, E. (2007).Technical efficiency of Nigerian insurance companies. Retrieved from https://www.researchgate.net/publication/288642612TechnicalEfficiencyofNigerian.Insurance.Com

Bawa, S., & Ruchita, R. (2011). Efficiencies of health insurance business in India: An application of DEA. *American Journal of Social and Management Sciences*, *4*(2), 237–247. http//:doi:10.5251/ajsms.2011.2.2.237.247.

Benicio, J., & Soares de Mello, J. C. (2019). Different types of return to scale in DEA. *Pesquisa Operacional, 39*(2), 245 – 260.

Berger, A. N., Cummins, J. D., Weiss, M. A., (1997). The coexistence of multiple distribution systems for financial services: The Case of Property-Liability Insurance *Journal of Business, 70* (4), 515–546.

Bernier, G., & Sedzro, K. (2002). Efficiency in the Canadian Life Insurance Industry: Some Preliminary Results Using DEA. Proceedings of ARIA Meeting, University of Québec at Montréal.

Borges, M. R., Nektarios, M., & Barros, C. P. (2008). Analyzing the efficiency of the Greek life insurance industry. *European Research Studies*, *11*(3), 35 – 52.

Charnes, A., & Neralic, L. (1990). Sensitivity analysis of the additive model in data envelopment analysis. *European Journal of Operations Research, 48*(2), 332-341

Charnes, A., Cooper, W., Lewin, A.Y., Morey, R.C. & Rousseau, J. (1985). Sensitivity and stability analysis in data envelopment analysis. *European Journal of Operation Research, 2*(1), 139 - 156.

Charnes, A., Cooper, W.W. & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operation Research*. 5(2), 429 – 444.

Charnes, A., Cooper, W.W., Seiford, L. & Stutz, J. (1982). A multiplicative model for efficiency analysis. *Socio-Economic Planning Sciences*, *16*(5), 223-228

Coelli T. (1996). A Guide to DEAP Version 2.1: A Data Envelopment Analysis (computer) program, *Australia CEPA Working Paper* 96/08

Cummins, J. D. & Zi, H. (1998). Comparison of frontier efficiency methods: An Application to the US life insurance industry. *Journal of Productivity Analysis*, *10*(2), 131–152.

Cummins, J. D., Weiss, M. A., Xie, X., & Zi, H. (1998). Economies of Scope in Financial Services: A DEA Efficiency Analysis of the US Insurance Industry. *Journal of Banking & Finance 34*(7), 1525 – 1539.

Dalkılıç, N., & Ada, A. (2014). Efficiencies of life/pension insurance industry in Turkey: An application of data envelopment analysis. *Journal of Applied Finance & Banking*, 4(1), 181–191.

Douglas, N. B. (2006). Ownership and technical efficiency analysis in the Spanish real estate sector, Universitat Autònoma de Barcelona, Barcelona

Eling, M., & Huang, W. (2011). An efficiency comparison of the nonlife insurance industry in the BRIC countries. Working papers on Risk Management and Insurance No. 94.University of St. Gallen. Institute of Insurance Economics.

Ezekiel O. C. (2005). The Nigerian insurance market in the context of the insurance Act 2003. Issues In Merger and Acquisition for the Insurance Industry. pp. 61-78 (ED) Ezekiel. O.C. Being Proceeding of the 2003 NIA Workshop on Insurance ACT 2003. Nigeria Insurance Association.

Farrel, M. J. (1957). The measurement of production efficiency. *Journal of the Royal Statistical Society, 1*(2), 253 - 281.

Gbede, G.O. (2003). *Marketing insurance services*. Westbourne Business School.

Grmanová, E., & Strunz, H. (2017). Efficiency of insurance companies: Application of DEA and Tobit analyses. *Journal of International Studies, 10*(3), 250 - 263.

Jaloudi, M. (2019). The efficiency of Jordan insurance companies and its determinants using DEA, Slacks, and logit models. *Journal of Business Management and Economic Research, 3*(2), 1 – 15.

Kneip, A. L., Simarand, P. W., & Wilson, A. (2008). Asymptotics for DEA estimators in nonparametric frontier models, Discussion paper 0317, Institut de Statistique, UCL.

Kubai, P. (2011). X-efficiency of insurance companies in Kenya *University of Nairob*. Retrieved from http://ggamanufacturing.com/handle/ 123456789/10972

Lau L. J., & Yotopoulos P. A. (1971). A test for relative efficiency and application to india agriculture‖. *The America Economic Review*, *61*(1) 94-109

Luhnen, M. (2009). Efficiency and competition in insurance markets. (Doctoral Thesis). University of St. Gallen.

Lutkepohl H., & Kratzig M. (2009). Structural Vector Autoregressive Modelling and Impulse Responses. Applied Time Series Economics. European University Institute .

Ogieva, F. O., & Omoregbe, O. (2017). Measuring the efficiency and performance of quoted insurance companies in Nigeria: Data envelopment analysis (DEA) approach. *Annals of the University of Petroşani, Economics, 17*(1), 187 – 208.

Osamwonyi, I.O., & Imafidon, K. (2016). The technical efficiency of manufacturing companies on the Nigerian Stock Exchange, *Journal of Applied Finance & Banking, 6*(1), 127-138

Ouattara, W. (2012). Economic efficiency analysis in Côte d'Ivoire. *American Journal of Economics 2*(1), 37- 46.

Rai, A. (1996). Cost efficiency of international insurance firms. *Journal of Financial Services Research*, *10*(2), 213-233.

Saad, N. M. (2012). An analysis on the efficiency of takaful and insurance companies in malaysia: A non-parametric approach. *Review of Integrative Business & Economics*, *1*(1), 33 –56.