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A Data Envelopment Analysis Approach for Benchmarking of Manufacturing Efficiency in Nigeria.

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Abstract
This study aimed at benchmarking of manufacturing efficiency in Nigeria using Data Envelopment Analysis (DEA). This study was motivated due to the recurring challenges faced by manufacturing companies in Nigeria in terms of their efficiency. The sampled firms were 28 quoted manufacturing companies categorized under three sub sectors. Data were obtained through secondary sources from the published financial statements of the Nigerian Stock Exchange from 2015-2019 and analysed using Data Envelopment Analysis.The study revealed that only 4 companies representing just 14.29% are operating at increasing return to scale IRTS; while 2 representing about 7.14% companies are operating at constant return to scale (CRTS) and 22 companies comprising 78.57% are operating at decreasing return to scale (NIRS/DRS). This suggests that employing more inputs brings about less than proportional change in output largely due to diminishing marginal returns to scale.It was also found that, Johnholt PLC., Dangote Cement PLC. and Premier paints PLC. were leading companies with the best first three scale efficiencies of 100%, 100% and 99% respectively. The scale relative efficiencies showed that only three (3) companies are efficient in managing their assets and liabilities. While 25 companies are inefficient with respect to asset liability ratio. However, Honeywell PLC and Johnholt PLC have both exhibited 100% level of technical efficiencies over the years under study which makes them standout as the optimum benchmark target within the period under study.It is therefore recommended that, all other inefficient similar strategic companies should benchmark against these four outstanding companies.

Keywords: *Constant return to scale (CRS), Increasing return to scale, Variable return to scale, Data envelopment analysis (DEA), Manufacturing, Variable return to scale (VRS).*

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I. Background To The Study

Efficiency assessment of companies is a major concern by managers and stakeholders in the light of present-day global challenges in both developed and developing countries.It reveals how a company's resources are used productively and it also motivates firms to implement strategies for future improvements (Yu, Barros, Tsai & Liao, 2014). Manufacturing companies must be ready to meet and adapt to challenges emerging from these changes if they are to survive and remain in business as major players. One of the strategies is taking advantage of benchmarking and classifying the efficiency of companies in the relevant sector (Imafidon& Osamwonyi,2015).

One major motivation for this study is the fact that despite the level of acceptance of benchmarking in the last years, the efficiency of manufacturing companies is experiencing uncertainties. The Nigerian economy is known to be highly dependent on oil revenues and this displays its preference in terms of managing continuous revenue sources. This reliance on the oil sector is liable to have a great negative effect on the other sectors such as manufacturing (Ku, Mustapha & Goh, 2010).

Efficiency gives information about the attainment of an activity, a process or an organisation with a reasonable extension far from those directly associated with the calculated value of the parameter itself (Haziq, Mosameem, Muslim, Dost and Qani, 2019). Evaluating efficiency levels has significantly become an important issue for managers of companies in developing countries like Nigeria that is currently going through economic challenges (Fapohunda, Ogbeide, Igbinigie 2017).

Data Envelopment Analysis (DEA) has been found to ascertain the efficiency of firms with more accuracy and less enormity of inefficiency than other approaches (Eriki&Osifo, 2014; Yu, Hammond, Ling,

Zhou, Mortimer, Xu, 2014)). DEA has been applied in many sectors (education, health care, finance, utilities) and it is obvious that no researcher can meaningfully contribute to the body of knowledge these days in terms of efficiency analysis of companies and industries without the use of DEA (Fapohunda, Ogbeide, Igbinigie 2017). According to Qamruzzaman and Jianguo (2016), it is prominent that DEA has a strong appeal among researchers for assessing level of efficiency whether for financial institution or other business areas. Data Envelopment Analysis is used in identifying performance variables (outputs) that reflect the corporate objectives and strategies of the company and then determining the input variables that can be demonstrated to manifest themselves as outputs (Avkiran, 1999). However, efficiency is regarded as a strong performance indicator (Inua&Maduabum, 2014).

Historically, financial measures are the best measures to determine a company's performance (Ehimare, 2013), such as the values of sales and profits or percentage return on investments and assets. In line with this, we have adopted the financial measures suggested by Parmenter (2009), Alam& Nizamuddin (2013) and Zamfir, Manea& Ionescu (2016) such as total revenue and total liabilities as the performance measures for output and input variables such as total costs and total assets of manufacturing companies in Nigeria. DEA is used for efficiency evaluation and for benchmark target selection by providing a reference set of efficient peer units for each inefficient unit. These reference set serves as benchmarks for improvements (Saxena, 2017). Therefore, efficiency scores are used to benchmark organisations against the most efficient organisations operating under the same environment (Fagge, 2019).

Benchmarking has gained global significance over the years and various programs were initiated by government in different countries (Costa, Kagioglou, Formoso and Alarcon, 2006), for instance: Benchmarking and Metrics initiative from the United States, the Performance Measurement for Benchmarking in the Brazilian Construction Industry Project, the National Benchmarking System which was developed by the Chilean Chamber and the Program for Excellence in Production Management, (Grillo and Garcia 2003). Malaysia's Third Outline Perspective Plan has given special importance to the development of world-class Malaysian companies using benchmarking for international best practices. Bain & Company's Biannual Management tools and trends survey shows that the popularity of benchmarking has remained on the increase and remained the top ten over some time (Rigby & Bilodeau, 2015).

Benchmarking is basically used not only for development but also for improving the efficiency of organisations (Saxena 2017). It examines the resources and processes by comparing them with other organisations or defined standards (Ceric, D'Alessandro, Soutar& Johnson, 2016). It was first discovered by Xerox in 1983 as an activity which examines business practices and processes by comparing one firm against another (Francis & Holloway 2007). Studies have proved that benchmarking contributes to improving performance in public and private sector organisations through the identification of process efficiencies (Francis & Holloway 2007) and by targeting key business processes for sustainable improvement (Ceric et al. 2016; Zairi&Whymark 2000). Benchmarking is used to point out mistakes of inefficient departments to become efficient and to learn better managerial practice (Rayeni& Saljooghi,2010).

However, despite the policy reforms initiated by government in Nigeria such as indigenization policy, structural adjustment programmes, etc in order to reverse the downward trend in the manufacturing sector by providing the basic infrastructure for the production of raw materials and machinery needed in the manufacturing companies, manufacturing firms across the globe are faced with the challenges of managing and sustaining the efficiency of their system (Amos, Adebola, Asikhia& Abiodun, 2018). Openda (2013) asserted that the efficiency of the manufacturing sector is greatly affected by the manufacturing practices adopted which can either result in strategic gain or strategic loss for the firm. Bamidele (2005) identified that manufacturing performance in Nigeria remain unimpressive. The annual performance rate of the manufacturing sector in Nigeria is very low as compared to what is obtained in many countries, even countries like Singapore, Malaysia, Indonesia, and South Korea which were at the same level of development with Nigeria in the 1960s and the early 1970s (Ekpo, 2005). The implementation of performance programmes in Nigeria has commonly not been given the sort of genuine consideration it merits (Ekpo, 2014).

Previous studies of benchmarking with DEA have identified numerous sources of inefficiency in some of the most profitable firms. These are firms that had served as benchmarks to others and this has provided a vehicle for identifying better benchmarks in many applied studies (Aparicio, Lopez-Espin, Martinez-Moreno, and Pastor, 2014). DEA is chosen for this study simply because it is considered a nonparametric and deterministic technique. As such, it does not produce standard errors and makes hypothesis testing extremely difficult (Goodheart,2017).). In view of this, the present study is designed as a first step toward demonstrating the applicability of DEA in benchmarking the efficiency of quoted manufacturing companies in Nigeria. As brought up in Cooper, Seiford& Tone (2000).

However, various studies that applied data envelopment analysis (DEA) in assessing the efficiency of companies were foreign studies. These studies among others include; Odeck and Alkadi (2001) in Norway, Cowie and Asenova (1999) in Britain, Pradhan (2018) in India, Erasmus and Makina (2014) in South Africa. In Nigeria, there are very scanty studies that have empirically examined the efficiency of quoted manufacturing

companies using Data Envelopment Analysis such as Osamwonyi and Imafidon (2016), Fapohunda, Ogbeide&Igbinigie (2017). While the majority of these studies were done in developed and advanced economies, however, it is very clear that only a few studies were conducted on benchmarking and efficiency in the developing countries and particularly in the manufacturing sectorin Nigeria using Data Envelopment Analysis. Also, to the best of the researcher's knowledge, no previous study was conducted using the variables in question and the years under consideration. Hence, the need for this research, and yet another strong motivation for this study.

The Research Problem

As today's business environment becomes increasingly competitive, business organisations are becoming more aggressive and dynamic in identifying strategies that will add value to their existence. Hall (2002) describes that an understanding of benchmarking that drives performance is very essential. Performance drivers need to be organised in such a way that those that have the highest impact can be identified, where this is not done, there is a tendency of low- efficiency. For the sake of achieving this goal, the investor needs some instruments to benchmark each investment opportunity (Mahmoud, Meysam&Amirreza, 2012). Despite the emphasis placed on benchmarking in the management of the manufacturing sector, Nigerian economy is yet to come on the path of sound efficiency because of low output in the manufacturing sector to the economy (GDP).

Certain negative tendencies such as inability of manufacturing companies to develop an efficiency frontier to serve as a benchmark and to suggest acceptable performance levels based on a company's selected indicators as defined in the Data Envelopment Analysis model is a great challenge in the manufacturing industry. However, one basic feature of public enterprises the world over and in particular the less developing countries like Nigeria is inefficiency (Ogbonna, 2017). This by implication leads to waste, slow growth and inordinate dependence on government support even when the activity is apparently a profitable one.

Nigeria's manufacturing sector has been operating under very unfavourable conditions and has not been contributing to the nation's GDP as expected which led to the closure of many firms and performance is greatly affected (Saidu& Gidado, 2018).

The Nigerian Stock Exchange (2015) shows that about a third of businesses were shut down, a little over half of ventures delegated weak and just 10% named working at supportable level. All these demonstrate that the efficiency of the Nigerian quoted manufacturing companies is in question (Osamwonyi and Imafidon, 2016). Additionally, a diminishing presentation to close the year 2014 has been recorded, a normal month to month loss of 0. 27%, 17.36% misfortune in 2015 and loss 6.17% in 2016 were recorded (NSE Facts Book, 2016).

Some manufacturing companies recorded very low performance, for instance; Cadbury Nigeria Plc, Champion Brew. Plc, Multi-Trex Integrated Foods Plc, First Aluminium Plc, among others (NSE, 2019). Notwithstanding, DEA enables us to compare several units with each other and determine their relative efficiency.

RESEARCH QUESTIONS

Based on the research problem, the study is set out to provide answers to these research questions:

1. How can the efficient and inefficient units of quoted Manufacturing Companies in Nigeria be identified using Data Envelopment Analysis (DEA).
2. What is the optimum benchmark target for the inefficient quoted Manufacturing Companies in Nigeria using Data Envelopment Analysis.

OBJECTIVES OF THE STUDY

The broad objective of this research is to examine the effects of applying Data Envelopment Analysis in benchmarking the technical and allocative efficiency of Manufacturing Companies in similar strategic groups in Nigeria, while the specific objectives are to:

1.Identify the efficient and inefficient units of quoted Manufacturing Companies in Nigeria using Data Envelopment Analysis (DEA).

2. Identify the optimum benchmark target for the inefficient units of quoted Manufacturing Companies in Nigeria using Data Envelopment Analysis

COPE OF THE STUDY

This study examines how DEA can be applied to benchmark the efficiency of quoted manufacturing companies in Nigeria from 2015 to 2019.The manufacturing sector was chosen because they are better organized with full financial data needed for this study and it remains the most powerful engine for the economic development of countries (Jide, 2010). It is known as the largest exchange in Africa as it renders services to the largest economy in the continent. A period of five years (from 2015 to 2019) has been chosen since the performance of manufacturing companies in Nigeria within these periods has not been satisfactory.

Also, throughout the 2000s, the Nigeria government gave more attention to benchmarking in the oil sector allowing the manufacturing sector to suffer. During these periods, manufacturing companies need proficiency and viability which is vital to their development.

II. Review Of Relevant Literature

2.1 The Nature of a Benchmark/Benchmarking

Benchmarks are a set of indicators which represent an organisation's agreed minimum standard relative to best practice organisations at a particular year level. In this context, 'minimum agreed standard' means a critical level of numeracy or value without which an organisation will have difficulty making sufficient progress in its operations. Ishola (2011) characterizes a benchmark as a regiment test or set of tests utilized for contrasting choices in an association. As indicated by Carlos and Rosana (2013), benchmarks are manners by which an association can promptly distinguish areas needing improvement, which helps an organisation in planning and they are valuable for surveying representatives.Benchmarking allows companies to compare their key performance measures internally or externally. An organisation can study practices and decide to measure performance from within itself, or against its industry peers (Bogan& English, 1994).

Benchmarking is part of the concept of total quality management. It is a concept that has been in use for a long time and is now being practiced in divers' areas (White, 2002). It entails learning the best and putting it into practice and not copycatting. Watson (1993) says that the benchmarking concept should be viewed as a process of organisational adaptation, not adoption, not simply a question of copying others, but learning how to improve by putting heads together. The ability of an organisation to adapt to best practices makes everything suitable to the organisation and its environment but the inability of an organisation to adapt to best practices will prove an obstacle on the road to success and will hinder the organisation from reaching good benchmarks. Organisations do not become world-class overnight. It is a moderate and conscious cycle of setting targets and moving in the direction of accomplishing them(Lema& Price, 1995).

Jackson and Lund (2000) defined benchmarking as a process of learning formulated by organisations to compare their services, activities, and products to identify their areas of strengths and weaknesses as a background for self-improvement, control, and regulation. Benchmarking has been accepted as an effective and efficient tool for continuous improvement of organisational performance, through the learning of best practices in one's area or across industries (Tseng, Tan, Lim, Lin &Geng, 2014). It minimizes the idea of trial and error and provides room for the efficiency of developing new products. It also aims at comparing some identified areas of organisational performance to identify gaps and weaknesses to take appropriate actions (Maire, Bronet& France, 2005).

Benchmarking relies upon measurements (Homaid, Al-Sulaihi, Ibrahim 2016). It is the process of comparing and assessing operations including services in line with the best practices adopted in one's sphere of contact (Rameshwar, Angappa, Stephen, Thanos, Benjamin, Mihalis& David, 2017).From benchmarking an organisation finds out where it can improve; what quality can make a positive or negative effect on cost; and what is the best of breed achieved so that the organisation can set its target. Occurrences in the past prove that many ideas originate not just outside one's own company but also one's industry (Kelessidis, 2000). Omorogie 2019, went further to buttress that benchmarking has to do with gap identifications which provide practitioners with some new insights on approaches and tools for benchmarking as a way of improving corporate performance measurably.

In this study therefore, Benchmarking can be characterized as a method by which organisationsdo an intensive investigation of their functions and processes, constantly distinguish their areas of strengths and weaknesses within their organisations, look for standard habits of lead, move in the direction of the accomplishment of a superior upper hand by gaining from others and utilizing their experience to go further to investigate thoughts on the best way to look for productivity. This is upheld by Slack (1998) who says a benchmark is a norm of greatness against which to gauge and look at something. This suggests proficient and successful organisations are the individuals who grasp consistent enhancements to accomplish principles at least expenses. One of the most significant management principles is a nonstop estimating which is a base for persistent enhancements of organisational performances (Besic and Djordjevic, 2007).

2.2 Using DEAfor Benchmarking

Data envelopment analysis studies efficiency in the best of circumstances. And as such, it is therefore possible to consider an improvement in units that are inefficient by DEA which gives room for establishing a benchmark unit for inefficient units. This will go a long way in stimulating motivation as well as competitiveness and a continual efficiency. In other words, there is no guarantee that the efficient unit of a particular period can prove to be as efficient as it was before. However, continuous improvement is essential in carrying out benchmarking activities in a contemporary competitiveorganisation. And thus, if strongly efficient

units are introduced as some of the most efficient units in a group of homogeneous ones, they will still need to have help and advice in achieving a high level of efficiency.

Benchmark target selection has been recognized as essential to inefficient organisations which is referred to as efficiency improvements. Several studies relevant to DEA-based benchmarking have been conducted in the field of business management (Tata, Prasad & Motwani,2000). A benchmarking cycle by and large comprises of three stages: first, identifying the company acknowledged to be the best performer; second, setting the benchmarking goals; third, implementing the best practices (Donthu, Hershberger &Osmonbekov, 2004). Identification of the best performer, which is the most important task in the benchmarking process, entails evaluation of the relative efficiencies of competitors according to multiple input and output factors. For this purpose, Data Envelopment Analysis (DEA) is the appropriate methodology for measurement of the relative efficiencies among homogeneous decision-making units (DMUs) in this study. An inefficient company generally should establish benchmarking strategies and implementation plans on how to improve efficiency after selecting its benchmarking targets (Park & Sung, 2016). Data Envelopment Analysis (DEA) appoints a score to every production unit considered in the analysis. Such score shows whether the unit is efficient or not, for inefficient units, it distinguishes a hypothetical unit as the target and consequently recommends enhancements to their efficiency. Nonetheless, for efficient units, no further improvement can be shown dependent on a DEA analysis (Hoseid, Farhad and Soheil, 2019).

DEA provides two important sets of information. The first has to do with the efficiency scores of units or companies, and the second is related to benchmarking information. As such, the score for one unit is determined according to its distance from the reference units. The estimated efficiency of any decision-making unit is the ratio of the distance from the origin to the unit under evaluation and the distance from the origin to the composite unit on the efficiency frontier (Barros &Dieke, 2008).

Data Envelopment Analysis (DEA) has been supported as a unique tool for analyzing efficiencies and benchmarking organisations and operational processes, especially when market prices are not available (Rayeni& Saljooghi,2010). For each inefficient company, DEA provides a lot of progress targets and efficient benchmarks permitting management to distinguish best practices in endeavoring to improve the performance of the inefficient units, and in defining improvement objectives. It can likewise deal with various inputs and outputs simultaneously all the while and does not need detail of a production function for the model's variables (Cooper, Seiford and Tone, 2000).

2.3 The Concept of Efficiency

According to Farrell (1957), overall economic efficiency is composed of twocomponents, i.e. technicalefficiency and allocative efficiency.Technical efficiency in a production unit refers to the achievement of the maximum potential output from givenamounts of factor inputs taking into account physical production relationships (Farrell, 1957). It also refers to a process of performing a job in the cheapest possible way that is capable of producing a certain level of output from thelowest available combination of inputs. Itreflects the ability of a firm or decision-making unit to attain the maximum output from a given set of input. This is to say that,a technically efficient organisation is capable of producing the same output with less input. It is simply the use of thesame input to produce more output (Green, 1993).

Allocative efficiency on the other hand, measures the skills involved in obtaining thebest combination of inputs by taking into consideration their respective prices and provides the actual combination of outputs giventhe set of prices (Kumhaker and Hevell, 2000). An organisation is cost efficient if it is able to realize both technical and allocative efficiency. Allocative efficiency is referred to as the ability of a firm to utilize the optimal combination of inputs when their respective prices and production technologies are specified (Farrell, 1957).

Scale Efficiency focuses on technical efficiency which has to do with achieving maximal output from a particular set of inputs over a stipulated period of time (Adongo, Christoph & Elisa, 2005). Return to scale is an important factor in efficiency determination. It refers to increasing or decreasing level of efficiency based on size of production at a particular point in time (Karimzadeh, 2012).

III. Methodology

This study uses the descriptive research design. The population of the study is the entire manufacturing firms listedon the floor of the Nigerian Stock Exchange as at 31st December, 2019. For the purpose of this study, only 3 sectors (consumer goods, conglomerates and industrial goods sectors) which have strategic similarity were used for this study which made up 28 companies. Primarily, thisstudy analyzes the technical and allocative efficiency of the selected manufacturing companies for the period 2015-2019 using dataenvelopment analysis (DEA).

The study analyzed both the technical and allocative efficiencies across twenty-eight (28) sampled manufacturing companies listed on the floor of the Nigerian Stock Exchange NSE for the period of five years

(2015 to 2019). A non-parametric model of input and output-oriented Data Envelopment Analysis (DEA) has been deployed for measuring the relative efficiencies of these decision-making units. This was adopted because of its robustness, flexibility and consistency in estimating efficiency over the decades.

Four Key Performance Indicators KPIs namely, the total revenues, total costs, total assets and total liabilities of all the twenty-eight (28) companies were used. Total revenue and total cost are the respective output and input variables for model I. While total assets and total liabilities are the respective output and input variables for model II.

IV. Data Analysis And Discussion Of Findings

4.1 Analysis of DEA Model I using the Total Revenues and Total Costs:

Since the central objective of every company is to maximize profit (output) given a certain level of constraint variables (input). The study deployed the output-oriented DEA approach. Table 1 and 2 below present the level of variable return to scale VRT frontier and estimates of relative efficiency scores respectively.

Table 1: Variable Return to Scale VRT Frontier (-1:drs, 0:crs, 1:irs) Using Total Revenue and Cost

	CRS_TE	VRS_TE	NIRS_TE	SCALE	RTS
dmu:CADBURY	0.513250	0.778534	0.778534	0.659252	-1.000000
dmu:CHAMPION	0.527069	0.735733	0.735733	0.716386	-1.000000
dmu:DANSUGAR	0.624647	0.959038	0.959038	0.651327	-1.000000
dmu:FLOURMILL	0.601526	0.952844	0.952844	0.631295	-1.000000
dmu:GUINESS	0.526774	0.804013	0.804013	0.655181	-1.000000
dmu:HONYFLOUR	0.491668	0.494237	0.491668	0.994802	1.000000
dmu:INTBREW	0.508635	0.777861	0.777861	0.653890	-1.000000
dmu:MCNICHOLS	0.527498	1.000000	1.000000	0.527498	-1.000000
dmu:NNFM	0.055682	0.075905	0.075905	0.733574	1.000000
dmu:NASCON	0.648616	0.970740	0.970740	0.668166	-1.000000
dmu:NESTLE	0.650512	1.000000	1.000000	0.650512	-1.000000
dmu:NB	0.587786	0.980674	0.980674	0.599370	-1.000000
dmu:ENAMELWA	0.557525	0.708195	0.708195	0.787247	-1.000000
dmu:UNILEVER	0.493755	0.756006	0.756006	0.653109	-1.000000
dmu:VITAFOAM	0.576954	0.856997	0.856997	0.673227	-1.000000
dmu:CHELLARAMS	0.499043	0.702651	0.702651	0.710228	-1.000000
dmu:JOHNHOLT	0.449896	0.449896	0.449896	1.000000	0.000000
dmu:TRANSCORP	0.562638	0.783354	0.783354	0.718242	-1.000000
dmu:UACN	0.226783	0.305059	0.305059	0.743407	-1.000000
dmu:AUSTINLAZ	0.350317	0.390983	0.390983	0.895989	1.000000
dmu:BERGER	0.434152	0.602368	0.602368	0.720742	-1.000000
dmu:BETAGLASS	0.602729	0.903545	0.903545	0.667071	-1.000000
dmu:CAP	0.713761	1.000000	1.000000	0.713761	-1.000000
dmu:CUTIX	0.580735	0.787821	0.787821	0.737141	-1.000000
dmu:DANGCEM	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:VANLEER	0.433894	0.550978	0.550978	0.787498	-1.000000
dmu:PORTPAINT	0.453981	0.621320	0.621320	0.730672	-1.000000
dmu:PREMPAINTS	0.436032	0.436119	0.436032	0.999799	1.000000

Source: Computed by the Researcher Using STATA 14.

Note: dmu= decision making unit; CRS_TE= Constant Return to Scale; VRS_TE= Variable Return to Scale; NIRS_TE= Not Increasing Return to Scale/Decreasing Return to Scale; and RTS = Rate of Transformation to Scale.

Table 2: Outcome Result showing the Efficiency Scores of all the Sampled Companies Using Total Revenue and Cost

	dmuo_qi_x	CRS_TE	VRS_TE	SCALE	RTS	
1.	CADBURY	1.662e+08	1.620e+08	0.513250	0.778534	0.659252 drs
2.	CHAMPION	23835035	22625207	0.527069	0.735733	0.716386 drs
3.	DANSUGAR	7.703e+08	6.170e+08	0.624647	0.959038	0.651327 drs
4.	FLOURMILL	1.188e+09	9.880e+08	0.601526	0.952844	0.631295 drs
5.	GUINESS	2.746e+08	2.608e+08	0.526774	0.804013	0.655181 drs
6.	HONYFLOUR	298852	304108	0.491668	0.494237	0.994802 irs
7.	INTBREW	3.287e+08	3.233e+08	0.508635	0.777861	0.653890 drs
8.	MCNICHOLS	4.194e+09	3.978e+09	0.527498	1.000000	0.527498 drs
9.	NNFM	1262181	11340960	0.055682	0.075905	0.733574 irs
10.	NASCON	1.148e+08	88545395	0.648616	0.970740	0.668166 drs
11.	NESTLE	1.128e+09	8.673e+08	0.650512	1.000000	0.650512 drs
12.	NB	1.510e+09	1.285e+09	0.587786	0.980674	0.599370 drs
13.	ENAMELWA	4941588	4434518	0.557525	0.708195	0.787247 drs
14.	UNILEVER	3.732e+08	3.781e+08	0.493755	0.756006	0.653109 drs
15.	VITAFOAM	81208013	70420952	0.576954	0.856997	0.673227 drs
16.	CHELLARAMS	28133763	28205519	0.499043	0.702651	0.710228 drs
17.	JOHNHOLT	3364	3741	0.449896	0.449896	1.000000 -
18.	TRANSCORP	22975303	20430378	0.562638	0.783354	0.718242 drs
19.	UACN	3999468	8823378	0.226783	0.305059	0.743407 drs
20.	AUSTINLAZ	1390008	1985181	0.350317	0.390983	0.895989 irs
21.	BERGER	15679560	18069090	0.434152	0.602368	0.720742 drs
22.	BETAGLASS	1.130e+08	93769509	0.602729	0.903545	0.667071 drs
23.	CAP	38059994	26678389	0.713761	1.000000	0.713761 drs
24.	CUTIX	11929125	10277188	0.580735	0.787821	0.737141 drs
25.	DANGCEM	2596256	1298947	1.000000	1.000000	1.000000 -
26.	VANLEER	3834866	4421914	0.433894	0.550978	0.787498 drs
27.	PORTPAINT	11236988	12383869	0.453981	0.621320	0.730672 drs
28.	PREMPAINTS	1005090	1153270	0.436032	0.436119	0.999799 irs

Source: Computed by the Researcher Using STATA 14

Note: dmu= decision making unit; o_q= Output orientation; i_x = Input orientation; CRS_TE= Constant Return to Scale; VRS_TE= Variable Return to Scale; and RTS = Rate of Transformation to Scale.

Findings arising from the above table 1 and 2 indicate that 57.14% of the quoted sampled manufacturing companies in Nigeria were highly scale efficient with their relative efficiency scores greater than or equal to (≥) 0.70 (70%). While 42.86% were moderately scale efficient with their respective relative efficiency scores ranging between ≥ 0.50 < 0.70 during the period under consideration. In summary, the overall average efficiency score for the twenty-eight companies was estimated to be 0.71 (71%)**.** This by implication suggests that manufacturing companies in Nigeria are highly (71%) efficient in their operations.

Interestingly, Johnholt Nigeria PLC., Dangote Cement PLC. and Premier paints PLC.were leading companies with the best first three scale efficiencies of 100%, 100% and 99% respectively.

In spite of this outstanding performance indicator, yet it is worrying to note that the findings however established only 4 companies representing just 14.29% are operating at increasing return to scale IRTS; while 2 representing about 7.14% of the sampled companies and 22 companies comprising 78.57% are operating at constant return to scale (CRTS) and decreasing return to scale (NIRS/DRS). This suggests that employing more inputs brings about less than proportional change in output largely due to diminishing marginal returns to scale.

This poses a potential threat for most of these companies since some of the factors employed are not being utilized at the maximum level but more costs are being incurred in the process.In general, there are no significant differences between the scale efficiencies and Variable Return to Scale Technical Efficiency (VRS-TE).

4.2 Analysis of Results based on Total Asset as Output and Total Liability as Input for the DEA Model II

Drawing a conclusion from the model I above could be misleading since it was based on only two indicators. Model II explored the use of total assets and liabilities of the companies as their respective outputs

and inputs variables to seeing if the efficiency score would be consistent. The results of the estimates are presented on tables 3 and 4 below.

Table 3: Variable Return to Scale VRT Frontier (-1:drs, 0:crs, 1:irs) Using Total Assets and Liability

	CRS_TE	VRS_TE	NIRS_TE	SCALE	RTS
dmu:CADBURY	0.006813	0.580809	0.580809	0.011730	-1.000000
dmu:CHAMPION	0.013234	0.376923	0.376923	0.035110	1.000000
dmu:DANSUGAR	0.007256	1.000000	1.000000	0.007256	-1.000000
dmu:FLOURMILL	0.005431	0.825378	0.825378	0.006580	-1.000000
dmu:GUINESS	0.005317	0.757168	0.757168	0.007023	-1.000000
dmu:HONYFLOUR	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:INTBREW	0.003716	0.562905	0.562905	0.006602	-1.000000
dmu:MCNICHOLS	0.006354	1.000000	1.000000	0.006354	-1.000000
dmu:NNFM	0.004541	0.148308	0.148308	0.030620	1.000000
dmu:NASCON	0.005124	0.491222	0.491222	0.010431	-1.000000
dmu:NESTLE	0.005440	0.791611	0.791611	0.006872	-1.000000
dmu:NB	0.006033	0.923524	0.923524	0.006532	-1.000000
dmu:ENAMELWA	0.004384	0.169873	0.169873	0.025807	1.000000
dmu:UNILEVER	0.006761	0.856860	0.856860	0.007891	-1.000000
dmu:VITAFOAM	0.001629	0.178675	0.178675	0.009116	1.000000
dmu:CHELLARAMS	0.004023	0.281876	0.281876	0.014272	1.000000
dmu:JOHNHOLT	0.003913	0.003913	0.003913	1.000000	0.000000
dmu:TRANSCORP	0.007575	0.831005	0.831005	0.009116	-1.000000
dmu:UACN	0.015467	0.990085	0.990085	0.015622	-1.000000
dmu:AUSTINLAZ	0.074043	0.111402	0.111402	0.664648	1.000000
dmu:BERGER	0.011627	0.174321	0.174321	0.066696	1.000000
dmu:BETAGLASS	0.009516	0.809301	0.809301	0.011758	-1.000000
dmu:CAP	0.005828	0.186586	0.186586	0.031235	1.000000
dmu:CUTIX	0.006873	0.098858	0.098858	0.069529	1.000000
dmu:DANGCEM	0.010016	0.065872	0.065872	0.152048	1.000000
dmu:VANLEER	0.004864	0.024649	0.024649	0.197319	1.000000
dmu:PORTPAINT	0.007773	0.084622	0.084622	0.091859	1.000000
dmu:PREMPAINTS	0.002705	0.012440	0.012440	0.217439	1.000000

Source: Computed by the Researcher Using STATA 14

dmu= decision making unit; CRS_TE= Constant Return to Scale; VRS_TE= Variable Return to Scale; NIRS_TE= Not Increasing Return to Scale/Decreasing Return to Scale; and RTS = Rate of Transformation to Scale.

Table 2: Outcome Result showing the Efficiency Scores of all the Sampled Companies Using Total Asset and Liability of the Sampled Companies

	dmu	B	o_q	D	i_x	CRS_TE	VRS_TE	SCALE	RTS
1.	CADBURY	.	1.416e+08	.	68701903	0.006813	0.580809	0.011730	drs
2.	CHAMPION	.	51847654	.	12952369	0.013234	0.376923	0.035110	irs
3.	DANSUGAR	.	8.550e+08	.	3.895e+08	0.007256	1.000000	0.007256	drs
4.	FLOURMILL	.	1.528e+09	.	9.302e+08	0.005431	0.825378	0.006580	drs
5.	GUINESS	.	7.838e+08	.	4.873e+08	0.005317	0.757168	0.007023	drs
6.	HONYFLOUR	.	1.136e+08	.	375549	1.000000	1.000000	1.000000	-
7.	INTBREW	.	9.998e+08	.	8.894e+08	0.003716	0.562905	0.006602	drs
8.	MCNICHOLS	.	3.333e+09	.	1.734e+09	0.006354	1.000000	0.006354	drs
9.	NNFM	.	21076206	.	15343737	0.004541	0.148308	0.030620	irs
10.	NASCON	.	1.400e+08	.	90308124	0.005124	0.491222	0.010431	drs
11.	NESTLE	.	9.573e+08	.	5.818e+08	0.005440	0.791611	0.006872	drs
12.	NB	.	1.882e+09	.	1.031e+09	0.006033	0.923524	0.006532	drs
13.	ENAMELWA	.	25365811	.	19129146	0.004384	0.169873	0.025807	irs
14.	UNILEVER	.	4.793e+08	.	2.343e+08	0.006761	0.856860	0.007891	drs
15.	VITAFOAM	.	65246975	.	1.324e+08	0.001629	0.178676	0.009116	irs
16.	CHELLARAMS	.	56948633	.	46798324	0.004023	0.281876	0.014272	irs
17.	JOHNHOLT	.	43770	.	36984	0.003913	0.003913	1.000000	-
18.	TRANSCORP	.	3.035e+08	.	1.325e+08	0.007575	0.831005	0.009116	drs
19.	UACN	.	1.873e+08	.	40026397	0.015467	0.990085	0.015622	drs
20.	AUSTINLAZ	.	12695363	.	566847	0.074043	0.111402	0.664648	irs
21.	BERGER	.	21729307	.	6178721	0.011627	0.174321	0.066696	irs
22.	BETAGLASS	.	1.967e+08	.	68349565	0.009516	0.809301	0.011758	drs
23.	CAP	.	26381317	.	14964926	0.005828	0.186586	0.031235	irs
24.	CUTIX	.	12270621	.	5901960	0.006873	0.098858	0.069529	irs
25.	DANGCEM	.	7756961	.	2560437	0.010016	0.065872	0.152048	irs
26.	VANLEER	.	2874140	.	1953632	0.004864	0.024649	0.197319	irs
27.	PORTPAINT	.	10255232	.	4361633	0.007773	0.084622	0.091859	irs
28.	PREMPAINTS	.	1446086	.	1767464	0.002705	0.012440	0.217439	irs

Source: Computed by the Researcher Using STATA 14

Note: dmu= decision making unit; o_q= Output orientation; i_x = Input orientation; CRS_TE= Constant Return to Scale; VRS_TE= Variable Return to Scale; and RTS = Rate of Transformation to Scale.

Outcome of results from tables 3 and 4 above are not consistent with the ones presented on table 1 and 2. The scale relative efficiencies show that only three (3) companies representing 10.72% are efficient in managing their assets and liability. While as 89.28% are inefficient with respect to asset liability ratio. Interestingly Honeywell PLC. and Johnholt PLC. have both exhibited 100% level of technical efficiencies over the years.

It is evident that most companies listed on the NSE floor are exposed to risk of high liability which invariably affects the value of their total assets. On the contrary, there is a slide difference between VRS and the scale efficiencies. The VRS reveals that about 28.57% of the sampled companies are assets to ratio technical combination very efficient while as 71.43% are inefficient.

The findings of this study are in agreement with the work of Osamwonyi and Imafidon (2015) who carried out a research on benchmarking and ranking of quoted manufacturing companies in Nigeria using Data Envelopment Analysis.

The ultimate benchmark target however, inculcates companies with the highest technical efficiencies using DEA. However, Honeywell Nig. PLC. under the consumer goods sector as well as Johnholt PLC. which is under the conglomerate sector serve as the ultimate benchmark for other inefficient companies

V. Conclusion And Recommendation

The study utilized the output orientated DEA approach to measure the technical and allocative efficiency of quoted manufacturing companies in Nigeria. The results revealed that out of twenty-eight companies, only 4 companies are operating at increasing return to scale IRTS; while 2 of the sampled companies and 22 of the sampled companies are operating at constant return to scale (CRTS) and decreasing return to scale (NIRS/DRS) respectively. This suggests that using more inputs brings about less than proportional change in output largely due to diminishing marginal returns to scale. However, Johnholt PLC., Dangote Cement PLC. and Premier paints PLC.wereleading companies with the best first three scale efficiencies of 100%, 100% and 99% respectively. The scale relative efficiencies show that only three (3) companies are efficient in managing their assets and liability. While 25 companies are inefficient with respect to asset liability ratio. Interestingly Honeywell and Johnholt have both exhibited 100% level of technical efficiencies over the years.

It is however recommended that, all other inefficient similar strategic companies should establish benchmarking strategies and implementation plans on how to improve efficiency by learning best practices from Honeywell Flour mill PLC., Johnholt PLC., Dangote Cement PLC. and Premier paints in order to achieve high level of efficiency.

Furthermore, the management of these four companies must take the issue of consistent benchmarking seriously. They should also go further to learn from other best practiced firms in different parastatals in order to maintain their current position in the sectors.

The policy significance of this study is thatit will give room for the government of Nigeria to expand its control over the manufacturing sector especially the Consumer goods, Conglomerates and Industrial goods sectors by levying taxes and subsidies, favoring investment in key sectors which in turn allows the manufacturing sector to have access to government in the area of effective contribution to aid adequate taxation and other regulatory requirements in the country.

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