Journal of Finance and Investment Analysis, vol. 4, no. 4, 2015, 23-35
ISSN: 2241-0998 (print version), 2241-0996(online)
Scienpress Ltd, 2015

A Study of the Allocative Efficiency of Quoted Manufacturing Companies in Nigeria

Ifuero Osad Osamwonyi[1] and Kennedy Imafidon[2]

Abstract

The objective of the study is to examine whether quoted manufacturing companies in Nigeria are allocating their available resources efficiently. In pursuance of this, the study adopted the output orientated DEA model with four input and output variables. The input variables are total asset, shareholder's equity, cost of goods sold and operating expenses while the output variables are sales/turnover, net profit, return on asset, and return on equity. An output orientated DEAP Version 2.1 package was employed for the analysis. The method assumes variable return to scale assumption using multi-stage DEA. The result revealed that there was inefficient allocation of resources with the presence of high slacks for the input variables: total asset (114%), shareholder's equity (77%), cost of goods sold (47%) and operating expenses (71%) in the production process of quoted manufacturing companies in Nigeria. Given their high input slack, it is recommended that total asset and shareholder's equity should be depleted from their current allocations, and such resources be shifted to alternative production activities.

JEL classification numbers: E23, D61, D24, C14
Keywords: Allocative Efficiency, Manufacturing, Data Envelopment Analysis

1 Introduction

Efficiency is a dynamic concept that involves a firm being able to operate with the minimum level of resources or inputs such as capital, labour, and materials to produce outputs and yet remain highly competitive over an extended period of time (Mostafa, 2007). Assessing efficiency levels has thus become an important issue for managers of businesses. Several methodologies have been employed for measuring and assessing business performance. These include scorecards, economic production function,

---

[1]Department of Banking and Finance, University of Benin, Benin City, Nigeria.
[2]Department of Business Administration, Ambrose Alli University, Ekpoma, Nigeria.

Article Info: *Received :* August 20, 2015. *Revised :* October 1, 2015.
Published online : December 1, 2015

econometric stochastic frontier analysis, multi-attribute decision making techniques and regression analysis. These measures are often inadequate due to the multiple inputs and outputs defined by different resources, activities and environmental factors, thus Data Envelopment Analysis (DEA) becomes a viable alternative.

The concept of frontier analysis which was introduced by Farrell (1957) forms the basis for DEA, but the linear programming formulation and extensions was triggered by the work of Charnes, Cooper, and Rhodes (1978).

Charnes et al (1978) describes DEA as a linear programming model applied to observational data that provide a new way of obtaining empirical estimates of relation such as the production functions and efficient production possibility surface that are cornerstones of modern economics. In DEA, neither specific functional relationship between production outputs and inputs nor any specific statistical distribution of the error terms is assumed. Thus DEA provides no statistical information on the goodness of fit and reliability of the result. However, its ability to handle production processes involving multiple inputs and multiple outputs makes it an appealing choice and outweighs its statistical shortcomings. It provides detailed information on the comparative performance of each DMU in the form of an efficiency score (1 for efficient DMU and less than 1 for inefficient DMUs). For inefficient DMU, DEA identifies its peers from a set of efficient units that it is compared with, as well as improvements in output and/or input levels required by the unit to be on the efficient frontier. In other words, DEA provides the inefficient unit with guidance or path to the frontier.

Numerous studies on allocative efficiency using DEA have been conducted and reported. In developing countries such as Nigeria it is scanty and almost absent. This study is therefore to determine the allocative efficiency of quoted manufacturing companies in Nigeria using Data Envelopment Analysis (DEA) approach. This paper is divided into five sections including this introductory part. Section two presents the literature review and theoretical foundation, section three presents the methodology, section four deals with the analysis of Data Envelopment results and discussion of findings, and section five presents the conclusion.

2 Preliminary Notes

2.1 Definitions

The Concept of Efficiency: Efficiency which is economic efficiency is made up of technical and allocative efficiency. Technical efficiency looks at the ability of the decision making units to combine minimum possible input to produce maximum possible output, allocative efficiency looks at cost minimization of the input used in production (Mainak, Meenakshi & Ray, 2009). Allocative efficiency implies the ability of the firm to optimize input at given prices and at available technology. The economic theory underlying efficiency analysis dates back to the works of Koopmans (1951), Debreu (1951), and Farrell (1957). The presence of inefficiency can be attributed to differences in production technology, differences in the scale of operation, differences in operating efficiency and differences in the operating environment in which production occurs (Fried, Lovell & Schmidt,1994). Leibenstein (1966) states production process may be influenced by economic factors internal to any firm and other factors not tightly under the control of the management.

The measurement of economic efficiency has been intimately linked to the use of frontier functions. The modern literature in both fields begins with the work of Farrell (1957), Koopmans (1951), and Debreu (1951). Farrell (1957) characterized the different ways in which a productive unit can be inefficient either by obtaining less than the maximum output available from a determined group of inputs (technically inefficient) or by not purchasing the best package of inputs given their prices and marginal productivities (allocatively inefficient).
The analysis of efficiency carried out by Farrell (1957) can be explained in terms of Fig. 1 below. Assuming constant returns to scale (crs) as Farrell (1957) initially does in his work, the technical set is fully described by the unit isoquant YY' that captures the minimum combination of inputs per unit of output needed to produce a unit of output. Thus, under this framework, every package of inputs along the unit isoquant is considered as technically efficient while any point above and to the right of it, such as point P, defines a technically inefficient producer. Hence, the distance RP along the ray OP measures the technical inefficiency of producer located at point P.
This distance represents the amount by which all inputs can be divided without decreasing the amount of output. Geometrically, the technical inefficiency level associated with package P can be expressed by the ratio RP/OP, and therefore, the technical efficiency of the producer being analyzed (1-RP/OP) would be given by the ratio OR/OP.

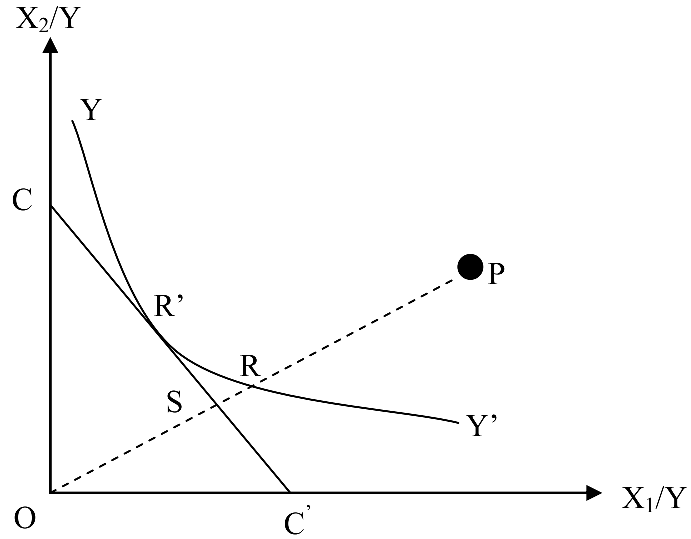


Figure 1: Technical and Allocative Efficiency Measures

If information on market prices is known and a particular behavioural objective such as cost minimization is assumed in such a way that the input price ratio is reflected by the slope of the isocost-line CC', allocative inefficiency can also be derived from the unit isoquant plotted in Figure 1. In this case, the relevant distance is given by the line segment SR, which in relative terms would be the ratio SR/OR. With respect to the least cost combination of inputs given by point R', the above ratio indicates the cost reduction that a producer would be able to reach if it moved from a technically but not allocatively efficient input package (R) to both technically and allocatively efficient one (R'). Therefore, the allocative efficiency that characterizes the producer at point P is given by the ratio OS/OR.

Together with the concepts of technical efficiency and allocative efficiency, Farrell (1957) describes a measure of what he termed overall efficiency which is also known as economic efficiency(EE). This measure comes from the multiplicative interaction of both technical (TE) and allocative (AE) components,EE = TE x AE = OR/OP x OS/OR = OS/OP. Where the distance involved in its definition (SP) can also be analyzed in terms of cost reduction. Fare and Lovell (1978) point out that, under crs, input orientated and output orientated measures of technical efficiency are equivalent. Such equivalence as Forsund and Hjalmarsson (1979) and Kopp (1981) state, ceases to apply in the presence of non-constant returns to scale. The analysis of allocative efficiency in an output orientated problem is also treated in Fare, Grosskopf and Lovell (1994 & 1995) and Lovell (1993) from a revenue maximization perspective. Kumbhakar (1996), Fare, Grosskopf and Lovell (1994) and Fare, Grosskopf and Weber (1997) approach the analysis of allocative efficiency on the basis of profit maximization, where both cost minimization (input orientated model) and revenue maximization (output orientated model) are assumed.

Input Orientated Measures: Farrell (1957) illustrated his ideas using a simple example involving firms that use two inputs *(*x_1 and x_2) to produce a single output (*y*), under the assumption of constant returns to scale. Knowledge of the unit isoquant of the fully efficient firm represented by SS' in Figure 2 permits the measurement of technical efficiency. If a given firm uses quantities of inputs, defined by the point P, to produce a unit of output, the technical inefficiency of that firm could be the distance QP, which is the amount by which all inputs could be proportionally reduced without a reduction in output. This is the ratio QP/OP, which is the percentage by which all inputs could be reduced.

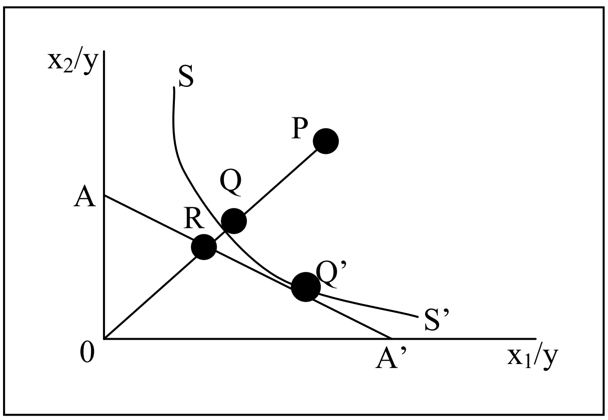


Figure 2: Technical and allocative efficiencies from input orientated measures

The technical efficiency of a firm is most commonly measured by the ratio TE_1=OQ/OP, which is equal to one minus QP/OP. It will take a value between zero and one, and hence provides an indicator of the degree of technical inefficiency of the firm. A value of one indicates that the firm is fully technically efficient. For example, the point Q is technically efficient because it lies on the efficient isoquant. If the input price ratio, represented by the line AA' in Figure 2, is also known, allocative efficiency may also be calculated. The allocative efficiency of the firm operating at P is defined to be the ratio AE_1 = OR/OQ, since the distance RQ represents the reduction in production costs that would occur if production were to occur at the allocative (and technically) efficient point Q', instead of the technically efficient, but allocative inefficient, point Q. The total economic efficiency is defined to be the ratio EE_1 = OR/OP where the distance RP can also be interpreted in terms of a cost reduction. Note that the product of technical and allocative efficiency provides the overall economic efficiency TE_1 x AE_1 = (OQ/OP) x (OR/OQ) = (OR/OP) = EE_1. Note that all three measures are bounded by zero and one. The mathematical representation of input orientated measures in a linear form is shown as

$$MaxQ_0 = \sum_{r=1}^{s} u_r y_{r0} \qquad 2.1$$

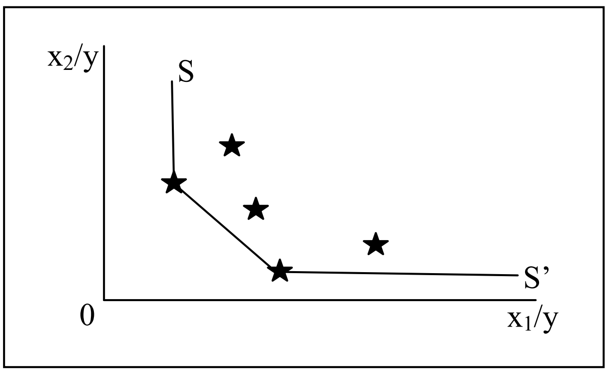
Subject to

$$\sum_{i=1}^{m} v_i x_{i0} = 1 \qquad 2.2$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij}; \quad j=1\ldots n \quad r=1\ldots s$$

$i = 1\ldots m$
$u_r, v_i \geq 0$

where Q_0 = the efficiency score of the DMU that is under consideration. Its value ranges between 0% - 100%. n = number of DMUs in the data set; s=number of outputs; m=number of inputs; y_{rj}, xij = known outputs and inputs of the *j*-th DMU and they are all positive. u_r, v_i ≥ 0 = variables' (outputs' and inputs') weights to be determined by the solution of the optimization problem.



These efficiency measures assume that production function of the fully efficiency firm is known. In practice this is not the case, and the efficient isoquant must be estimated from the sample data. Farrell (1957) suggested the use of either (a) a non-parametric piecewise-linear convex isoquant constructed such that no observed point should lie to the left or below it (refer to Figure 3), or (b) a parametric function be fitted to the data, again such that no observed point should lie to the left or below it.

Output Orientated Measures: The above input orientated technical efficiency measure addresses the question; "By how much can input quantities be proportionally reduced without changing the output quantities produced"? This is an output orientated measure as opposed to the input orientated measure discussed earlier. The difference between the output and input orientated measures can be illustrated using a simple example involving one input and one output. This is depicted in Figure 4a where we have decreasing returns to scale technology represented by $f(x)$, and an inefficient firm operating at point P. The Farrell input orientated measure of technical efficiency would be equal to the ratio AB/AP, while the output orientated measure of technical efficiency would be CP/CD. The output and input orientated measures will only provide equivalent measures of technical efficiency when constant returns to scale exist, but will be unequal when increasing or decreasing returns to scale are present (Fare & Lovell 1978). The constant returns to scale case is depicted in Figure 4b where we observe that AB/AP=CP/CD, for any inefficiency point P we care to choose.

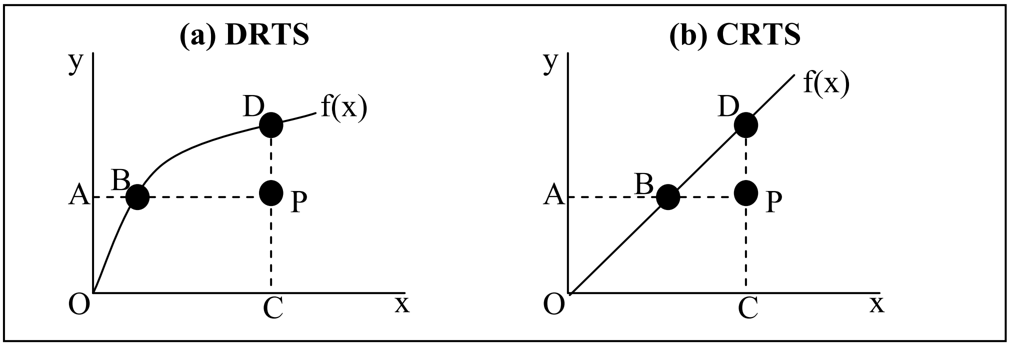


Figure 4: Input and Output Orientated Technical Efficiency Measures and Returns to Scale

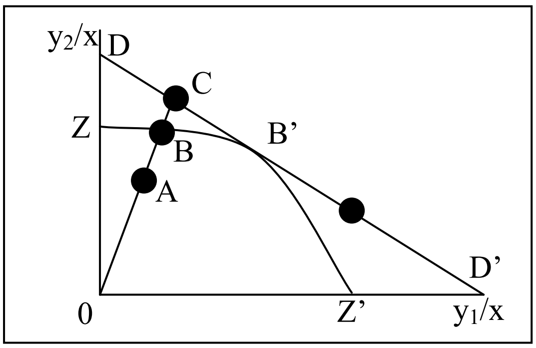


Figure 5: Technical and Allocative Efficiencies from Output Orientated

One can consider output orientated measures further by considering the case where production involves two outputs (y_i and y) and a single input (x). Again, if we assume constant returns to scale, we can represent the technology by a unit production possibility curve in two dimensions. This example is depicted in Figure 5 where the line ZZ' is the unit production possibility curve and the point A corresponds to an inefficient firm. Note that the inefficient point, A, lies below the curve in this case because ZZ' represents the upper bound of production possibilities. The Farrell output orientated efficiency measures would be defined as follows. In Figure 5, the distance AB represents technical inefficiency.

Hence a measure of output orientated technical efficiency is the ratio TE_0 = OA/OB. If we have price information then we can draw the isorevenue line DD', and define the allocative efficiency to be AE_0 = OB/OC which has a revenue increasing interpretation (similar to the cost reducing interpretation of allocative inefficiency in the input orientated case).

Furthermore, one can define overall economic efficiency as the product of these two measures EE_0 = (OA/OC) = (OA/OB) x (OB/OC) = TE_0 x AE_0. Again, all of these three measures are bounded by zero and one. The mathematical representation of output orientated measures in a linear form is shown as;

$$Min H_0 \sum_{i=1}^{m} v_i x_{i0}$$

Subject to

$$\sum_{r=1}^{s} u_r y_{r0} = 1$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij}; \quad j = 1 \ldots \text{n} \quad r = 1 \ldots s$$

i = 1… m

$u_r,\ v_i \geq 0$

where H_0 = weighted sum of the inputs of the DMU that is under consideration; n-number of DMUs in the data set; s = number of outputs; m = number of inputs; y_{rj},x_{ij} = known outputs and inputs of the j-th DMU and they are all positive. $u_r,v_i \geq 0$ = the variables' (outputs' and inputs') weights to be determined by the solution of the optimization problem.

2.2 Methodology

The population of the study comprises of all quoted manufacturing companies on the Nigerian Stock Exchange. As at December 31st 2010, two hundred and seventeen companies were quoted on the Nigerian Stock Exchange, but the study focuses on the eighty-six companies which are into manufacturing.

The study adopted stratified random sampling to ensure that the same proportion was represented by each sector in the desired sample size. The sample size of fifty-eight companies was chosen with Yaro Yamane formula at 5% level of significance:

$$n = \frac{N}{1 + N(e)^2}$$

where

n = sample size

N = population

e = level of significance

The study was based on secondary data obtained from Nigerian Stock Exchange Factbooks, Annual reports and financial statements of the companies under study. Specifically, the data collected are the input variables of the companies which are total asset, shareholder's equity, cost of goods sold and operating expenses while the output variables are sales/turnover, net profit, return on asset and return on equity. For data availability, the values of these variables were collected between 2004 and 2010 for the analysis. The data was analyzed with the aid of output orientated DEAP Version 2.1 (Coelli,1996).

3 Main Results

Data Envelopment Analysis Results: The input and output slack scores of quoted manufacturing companies in Nigeria are shown in table 1 below. The many 0.000 in table 1 did not affect the empirical analysis.

Table 1: Input and Output Slack Scores of Quoted Manufacturing Companies in Nigeria

Summary of output slacks Output						Summary of input slacks Input			
S/N	**Companies**	**Sales/ turnover**	**Net profit**	**Return on asset**	**Return on equity**	**Total asset**	**Shareholder's equity**	**Cost of goods sold**	**Operating expenses**
1	LIVESTOCK	0.000	108.575	34.661	32.969	12.331	0.000	838.326	0.000
2	FTN COCOA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	PRESCO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	OKOMU	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	GUINNESS	0.000	0.000	0.000	401.232	392.743	471.792	0.000	0.000
6	NIG. BREW	0.000	0.000	131.949	33.567	0.000	61.068	0.000	0.000
7	INT. BREW	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	ASHAKA	0.000	0.000	0.000	83.172	597.159	404.749	25.510	0.000
9	CEMENT CO.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	LARFARGE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	NIG. ROPES	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	AFRI. PAINTS	412.669	0.000	0.000	0.000	0.000	68.980	263.708	65.527
13	BERG. PAINTS	32.350	0.000	333.863	0.000	321.031	0.000	0.000	123.967
14	CAPL	1.701	44.567	0.000	77.197	608.000	10.406	24.424	681.000
15	IPWA	26.535	0.000	177.560	21.498	0.000	0.000	254.040	0.000
16	PREM. PAINT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	NCR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	THOMAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	TRIP GEE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	LEVENTIS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	CHELLARMS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	P.Z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	SCOA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	UNILEVER	0.000	193.131	0.000	389.222	45.906	45.906	24.647	12.162
25	CUTIX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	NIG. WIRE	0.000	0.000	382.050	99.315	0.000	0.000	5099.597	188.013
27	7-UP	9.446	0.000	0.000	139.369	152.635	152.635	13.135	0.000
28	CADBURY	0.000	698.006	0.000	390.271	271.666	271.666	9.272	297.683
29	FLOUR	0.000	0.000	433.52	323.07	196.01	196.019	0.000	0.000

	MILL			9	9	9			
30	NAT. SALT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	NORTH FLOUR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	NESTLE	29.130	0.000	515.294	130.923	0.000	143.365	0.000	0.000
33	NIG. BOTLING	0.000	247.068	0.000	404.258	47.879	558.555	1.292	0.000
34	P.S. MAND	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	UTC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	GLAXO	0.000	181.490	476.663	190.252	0.000	607.997	0.000	0.000
37	M & BAKER	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	MORISON	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	NEIMETH	164.253	578.401	272.501	0.000	0.000	0.000	0.000	833.925
40	PHARMA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	ALUM. EXTR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42	BOCGAS	10.085	763.273	506.233	0.000	0.000	11.785	0.000	603.469
43	NIG. ENAL	18.709	0.000	0.000	339.177	320.233	9.100	14.446	119.268
44	VITAFOAM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	AVON	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
46	BETA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
47	NAMPAK	81.689	0.000	534.420	0.000	540.612	0.000	0.000	352.662
48	NIG. BAG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
49	GREIF	6.821	0.000	0.000	0.000	0.000	149.525	0.000	7.422
50	POLY	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
51	MRS OIL	0.000	192.773	0.000	411.215	16.218	412.368	12.637	7.731
52	CONOIL	0.000	711.022	182.544	265.419	0.000	372.521	0.000	0.000
53	ETERNA	0.000	0.000	30.783	289.334	0.000	0.000	478.817	0.000
54	MOBIL	0.000	198.129	0.000	404.838	680.565	458.857	18.313	89.982
55	ACADEMY	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
56	LONGMAN	1.920	594.940	0.000	282.164	360.000	6.991	20.116	309.000
57	UNIPRESS	0.000	0.000	0.000	0.000	0.000	2.013	238.087	447.407
58	UNT.TEXT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	MEAN	**15.496**	**77.782**	**69.518**	**81.181**	**113.955**	**76.660**	**47.351**	**71.366**

Source: DEA print out

Allocative efficiency of a firm could be assessed on the basis of its input mix technique and its input-output ratio yield. The input and output slack scores can also be used to assess the efficient utilization of resources by a firm. A slack could be input or output oriented. An input slack oriented is the proportion by which input could be reduced and will still be able to produce at the same level of output while the output slack oriented is the proportion by which output could be increased at current level of input.

The inefficient companies showed input slacks of various proportions. The companies are; Livestock, Guinness, Ashaka, Berg.paints, CAPL, Unilever, Nig. Wire, 7-Up, Cadbury, Flour Mill, Nig. Bottling, Nig.Enal, Nampak, MRS Oil, Conoil, Mobil, & Longman could still produce her current level of output with approximately 12%, 393%, 597%, 321%, 608%, 651% 633%, 385%, 534% 493%, 48%, 320%, 541%, 16%, 17%, 681% & 360% less of her present usage of total asset input respectively.

Companies such as Guinness, Nig.Brew, Ashaka, Afri.Paints, CAPL, Unilever, 7-Up, Cadbury, Flour Mill, Nestle, Nig.Bottling, Glaxo, Bocgas, Nig.Enal, Greif, MRS oil, Conoil, Mobil, Longman, and Unipress would operate at their current level of technical efficiency of shareholder's equity with approximately 472%, 61%, 405%, 69%, 10%, 46%, 152%, 272%, 196%, 143%, 589%, 608%, 12%, 9%, 150%, 412%, 373%, 459%, 7% and 2%. Companies like Livestock, Ashaka, Afri.paints, CAPL, IPWA, Unilever, Nig.Wire, 7-Up, Cadbury, Nig.Bottling, Nig.Enal, MRS oil, Eterna, Mobil, Longman, and Unipress would also be able to remain on their production possibility frontier if they reduce their current cost of goods sold by approximately 838%, 26%, 264%, 24%, 254%, 25%, 510%, 13%, 9%, 1%, 14%, 13%, 479%, 18%, 20% and 238% respectively. Finally, companies such as Afri.Paints, Berg.Paints, CAPL, Unilever, Nig.Wire, Cadbury, Neimeth, Bocgas, Nig.Enal, Nampak, Greif, MRS oil, Mobil, Longman, and Unipress would be on their current level of production if they reduce their current level of operating expenses by 66%, 124%, 681%, 12%, 188%, 298%, 834%, 603%, 199%, 352%, 7%, 8%, 90%,309%, and 447% respectively. This analysis amounted to a mean input slacks for input; total asset, shareholder's equity, cost of goods sold, and operating expenses of 114%, 77%, 47% and 71% respectively. This result shows a clear evidence of inefficiency in resources allocation, thus under utilization of input resources.

The output slack shows that companies such as Ashaka, Afri.Paints, Berg.Paints, CAPL, IPWA, 7-UP, Nestle, Neimeth, Bocgas, Nig.Enal, Nampak, Greif, & Longman could extend her output frontier in sales/turnover by approximately 3%, 413%, 132%, 2%, 27%, 9%,29%, 164%, 10%, 19%, 82%, 7% and 2% respectively with their current level of inputs. Companies like Livestock, CAPL, Unilever, Cadbury, Nig.Bottling, Glaxo, Neimeth, Bocgas, MRS oil, Conoil, Mobil, and Longman could extend their output on net profit by 109%, 45%, 193%, 698%, 247%, 181%, 578%, 763%, 193%, 711%, 198% and 594% respectively with their current level of inputs. Livestock, Nig.Brew, Berg.Paints, IPWA, Nig.Wire, Flour mill, Nestle, Glaxo, Neimeth, Bocgas, Nampak, Conoil and Eterna could also extend their output on return on assets by approximately 35%, 132%, 334%, 178%, 382%, 434%, 515%, 477%, 273%, 506%, 554%, 183% and 31% respectively with their current level of inputs while Livestock, Guinness, Nig.Brew, Ashaka, CAPL, IPWA, Unilever, Nig.Wire, 7-Up, Cadbury, Flour mill, Nestle, Nig.Bottling, Glaxo, Nig.Enal, MRS oil, Conoil, Eterna, Mobil ,and Longman could extend their output on return on equity by approximately 33%, 401%, 34%, 83%, 77%, 21%, 389%, 99%, 139%, 390% 323%, 131%, 404%, 190%, 339%, 411%, 265%, 289%, 405% and 282% respectively with their current level of input. This analysis amounted to a mean output slack of 15% for sales/turnover, 78% for net profit, 70% for return on asset, and 81% for return on equity.

Discussion of Findings: Allocative efficiency refers to whether inputs for a given level of output and set of input prices are chosen to minimize the cost of production. Allocation efficiency is determined by the slacks in DEA which is used to established whether the decision making units is able to utilizes its resources efficiently. From the slacks result, the mean slack for input variables is 114% for total asset, 77% for shareholder's equity, 47% for cost of goods sold and 71% for operating expenses. The input excess of the study means that the companies cannot dispose-off these inputs but will have to scale them down. This input excess occurs in twenty-seven companies. This confirms the study by Al-shammari (1999) that the inefficient companies are associated with the underutilization of some of the inputs. This finding also confirms the study by Majumder (1994) and Burki and Khan (2005) which revealed allocative inefficiency leading to over or under utilization of resources and high cost of production. On the other hand, the output fall (slack) mean are; 15% of sales/turnover, 78% of net profit, 70% of return on asset and 81% of return on equity. The output fall occurs in twenty-six companies while five companies which operated on the efficient frontier did not experience output fall. The implication of this analysis is that these are what the companies supposed to have achieved if the input variables were properly allocated.

Policy Implications of the Study: The inputs slacks of total asset, shareholder's equity, cost of goods sold and operating expenses show that the inefficiency of quoted manufacturing companies in Nigeria are attributable to underutilization of input factors. Input waste was identified in total asset, shareholder's equity, cost of goods sold and operating expenses of the companies. In a capital scarce economy, the companies cannot afford to have these input resources wasted. The companies should therefore rationalize their input resources such as operating expenses by engaging in staff rationalization or downsizing. Disengaged staff of the companies can be deployed to their subsidiaries to generate additional revenues. The reference ratio of workers inputs to output should be established to address the problem of overstaffing in some organizations. If member of staff have to be disengaged, the companies should be ready to fund the gratuities and pension outstanding of the staff concerned. The companies operating in the region of decreasing return to scale should engaged in rationalization of resources by reallocating some of the resources to other areas of their operations while those operating in the region of increasing return to scale should embarked on outsourcing of resources. The total asset, shareholder's equity, should be eroded or scale down.

It is recommended that manufacturing standards and information banks should be created for the availability and the use of resource inputs at all stages of manufacturing in Nigeria. These manufacturing standards should include the quantity and the quality of resource inputs as well as that of outputs within the scarce resources. It is recommended that allocation of funds and resource inputs should be based on the sales/turnover, net profit, and return on equity of the companies.

4 Conclusion

The study adopted the output orientated DEA methodology to examine the allocative efficiency of quoted manufacturing companies in Nigeria under the assumption of variable return to scale. The result revealed that there was inefficient allocation of resources with the presence of high slacks for the input variables in quoted manufacturing companies in Nigeria. This may explain the weak contribution of the manufacturing sector to economic growth in Nigeria. The study thus provides a method for the Nigerian Stock Exchange to identify and classify the efficient and inefficient quoted companies, monitor and supervise their operational activities, and shift the industrial efficiency frontier.

References

[1] Al- Shammari M. Optimization modeling for estimating and enhancing relative efficiency with application to industrial companies. *European Journal of Operational Research,* **115** (3), (1999), 488 – 496.

[2] Burki, A.A., & Mahmood ul Hassan, K. Effects of allocative inefficiency on resources allocation and energy substitution in Pakistan's manufacturing. Lahore University of Management Sciences. *CMER Working Paper* No. **04-03**. (2005). Central Bank of Nigeria Statistical Bulletin, 2010 Issues.

[3] Coelli, T. A guide to DEAP version 2.1: A data envelopment analysis (computer) program. *CEPA Working Paper 96/08*, University of New England, Australia. (1996).

[4] Charnes A., Cooper W., & Rhodes, E. Measuring the efficiency of decision making units. *European Journal of Operational Research, **2*** (6), (1978), 429-444.

[5] Debreu, G. The inefficiency of resource utilization. *Dan Econometrical **19***, (1951), 273 – 292.

[6] Fried, H., Lovell, C.A.K., & Schmidt, S.E. (1994). *The measurement of productive efficiency: Techniques and applications.* London: Oxford University Press.

[7] Forsund, F.R., & Hjalmarsson, L. (1979). Generalized Farrell measures of efficiency: An application to milk processing in Swedish dairy plants. *The Economic Journal, 89*, 294-315.

[8] Fare, R. Grosskopf, S., & Margarittis. Productivity in trend in Australian and New Zealand manufacturing. *Australian Economic Review,* **34**(2), (2001), 125-134.

[9] Farrell M.J. The measurement of productivity efficiency. *Journal of Royal Statistical Society, Series A, General,* **120** (3), (1957), 253 – 281.

[10] Fare, R., & Lovell, C.A.K , Measuring the technical efficiency of production. *Journal of Economic Theory,* **19**, (1978), 150-162.

[11] Fare R, S. Grosskopf, M. Norris &., Z. Zhang (1994). Productivity growth, technical progress and efficiency changes in industrialized countries. *American Economic Review, 8,* 66-83.

[12] Fare R.S., Grosskopf, S., M. Norris., & Zhang,Z. Productivity growth, technical progress and efficiency change in industrial countries united states. *Agency for International Development*, Jakarta, Indonesia, (1995).

[13] Fare, R., Grosskopf, S., & Weber, W. The effect of risk-based capital requirement on profit efficiency in banking. *Discussion Paper Series No.* **97-12***,* Department of Economics, Southern Illinois University at Carbondale, (1997).

[14] Imafidon, K. Assessing the efficiency of quoted manufacturing companies in Nigeria: Data envelopment analysis approach. A Ph.D thesis submitted to the Department of Business Administration, University of Benin, Benin City, (2012).

[15] Jide, A. The structure of the Nigerian manufacturing industry, A Paper presented at the National Workshop on Strengthening Innovation and Capacity Building in the Nigerian Manufacturing Sector, (2010).

[16] Koopmans T.C. (Ed) *Activity analysis of production and allocation.* New York: Wiley, (1951).

[17] Koopmans, T.C. *Analysis of production as an efficient combination of activities* in T.C. Koopmans, (ed). New York: Wikley, (1951).

[18] Kumbhakar, S.C. Efficiency measurement with multiple outputs and multiple Inputs. *Journal of Productivity Analysis,* **7**,(1996), 225-255.

[19] Kumbhakar S.C., & Lovell, C.A.K . *Stochastic frontier analysis.* Cambridge: University Press Cambridge, (2000).
[20] Kumbhakar S.C., & Lovell, C.A.K. *Stochastic frontier analysis.* Cambridge: University Press Cambridge, (2002).
[21] Kopp, R.J. The measurement of productivity efficiency: A reconsideration. *Quarterly Journal of Economics*, **96**, (1981), 477-503.
[22] Lovell, C.A.K. Production frontiers and productive efficiency, in *The measurement of productivity efficiency: Techniques and applications*, Harold O. Fried, Lovell, C.A.K., Schmidt, S.S (Eds,) Oxford: Oxford University Press, (1993).
[23] Longenecker, C.O., & Fink, L.S. Improving management performance in rapidly changing organizations. *Journal of Management Development,* **20** (1), (2001), 7-18.
[24] Leibenstein, H. Allocation efficiency vs. x-efficiency. *American Economic Review,* ***56*** (3), (1966), 392-415.
[25] Majumdar, S.K. (1994). Assessing firms capabilities – theory and measurement: A study of Indian pharmaceutical-industry. *Economic and Political Weekly, 29* (22), 83-89.
[26] Mainak, M, Meenakshi, R., & Ray, S.C. Output and input efficiency of manufacturing firm in India: A case of the Indian pharmaceutical sector. *Institute for Social & Economic Change*, Banglove, (2009).
[27] Mostafa, M. Evaluating the comparative market efficiency of top listed companies in Egypt. *Journal of Economics Studies,* ***34*** (5), (2007), 430 – 452. Nigerian stock exchange factbooks, 2010 issues, (2007).