

Evaluation of the Technical Efficiency Performance of Privatized and None Privatized Manufacturing Firms in Nigeria: Two Stage Analytical Techniques

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A b s t r a c t

This study evaluated the technical efficiency performance of manufacturing firms in Nigeria over the 1995 to 2004 time period. Efficiency of the private sector in comparison to the public sector has been topical among economists and policy makers at all levels of government. This work is designed to empirically compare firms' performance before and after privatization using two stage analytical techniques, Data Envelopment Analysis (DEA) and ordinary least square regression (OLS) technique to analyze the data. Three critical input variables (Raw materials cost, labor and capital) and two output variables (output and profit) were used to evaluate the technical efficiency of ten manufacturing firms in Nigeria and the period of analysis is five years before and five years after privatization. The investigation revealed that all the ten sampled firms used for the study exhibited various levels of efficiencies in terms of output and profit. Seven firms lied on the efficiency frontier with an efficiency score of 1.00 each before privatization while the remaining three firms were not technically efficient in terms of output. After privatization. In the after privatization era, seven firms were also technically efficient while three firms were inefficient. In terms of profit, six firms lied on the efficiency frontier with an efficiency score of 1.00 each before privatization while the remaining four firms were inefficient. In the after privatization era, four lied on the efficiency frontier with an efficiency score of 1.000 each while the remaining six firms were inefficient in terms of profit. In the second stage regression analysis, concentration ratio, size and age of firm were considered as determinant of technical efficiency. None of these variables were found to be statistically significant before privatization but concentration ratio and size were statistically significant. It shows that privatization has had a positive technical efficiency on privatized firms considering their present growth potentials across the country.

Keywords: *Technical efficiency, Data envelopment analysis, Regression, Privatization of firms, Nigeria*

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Background to the Study

The issue of privatization has occupied the attention of economist and policy makers especially in less-developing countries and has generated wide international discuss. The discussion and analysis shows that privatization if properly articulated and implemented may result to substantial benefits, improved efficiency, renewed investment, budgetary savings and preservation of scarce resources for the improvement of a nation's economic conditions.

The historical background of Privatization dated back to 1970 when the Nigerian economy began to experience economic depression. The adverse impact of this Economic crisis became monumental in the early part of 1980, as the nation witnessed a dramatic decline in economic performance. In 1981, the Nigerian economy went into recession (an economic crisis marked by falling oil revenue, declining industrial output which was reflected in the inability of the Nigerian economy to finance imports, a weak agricultural sector, trade arrears worth billions of dollars and a statement in talks to reschedule the countries crippling external debt) until recently when the debts were settled and the remaining percentage written off by the Paris Club of creditors Despite the mixed market features of the Nigerian economy, the impact of the public sector is still high in terms of investment and infrastructure, high capital outlay, provision of sound financial structures, planning and control. But certain negative tendencies such as misappropriation of public funds and other fraudulent practices contributed to the failure of the public enterprises. However one basic feature of public enterprises the world over and in particular the less developing countries is inefficiency. Inefficiency leads to waste, slow growth and inordinate dependence on government support even when the activity is apparently a profitable one. This might be as a result of the already agreed fact in some quarters that there is a tendency for government ownership to bring about laziness, fraud, bureaucracy and social vices among others.

Most empirical studies analyzed the linkage between privatization and efficiency in developed countries. The results reported from these empirical studies may not hold true for less developing countries like Nigeria, for reasons mainly due to political, economic, environmental, administrative and organizational structure of the Nigeria economy. The focus on Nigeria is of interest for several reasons: firstly, the Nigerian government has been willing to develop international links through the Economic Community of West African State (ECOWAS), African Growth and opportunity act (AGOA), World Trade Organization (WTO) and its recent polices at diversifying the economy, attracting foreign direct investment (FDI) and the fight against corruption.

Statement of the Problem

In Nigeria, many commissions of inquiry and study groups were inaugurated to interrogate the problems of public enterprises. Such commissions and panels were headed by Ani, Adebo, Udoji and Onosode among others. All the commissions of inquiry agreed that private enterprises are better than the public enterprises. In 1985, profit losses went up from N96.44 million to about N3.7 billion in 1990's and was also reported that the amount of the joint investment in these parastatals was put at N23 billion. However government equity investment in them has only yielded paltry of 1.39 per cent returns on investments.

A review of Nigeria economic policy profile from 1986 to date has shown different policy shifts. First, she pursued import substitution industrialization (ISI) to protect the domestic industries from collapse. Secondly, she adopted export promotion as a development tool to encourage the utilization of Nigeria domestic raw materials for production. But unfortunately, she has never identified the key variables that define efficiency of privatized firms in Nigeria using two stage analyses.

Objectives of the Study

The major objectives of the study are;

1. To investigate the technical efficiency of some selected firms before and after privatization in terms of output and profit.
2. To draw a comparative analysis between these selected firms performance before and after privatization based on technical efficiency of output and profit.
3. To evaluate concentration ratio, size and age of firm as determinants of technical efficiency.

Literature Review and Theoretical Framework

Privatization has long been seen as a major thesis in the global development literature. Thus, the study is cast within this context to provide clarity on the relevance of privatization of public enterprises and performance of selected firms in Nigeria. Several studies reviewed in the literature looked into two-stage DEA analysis and suggested alternative models for DEA in other to prove that the total technical efficiency ratings of two-stage procedure can also be analyzed as a weighted harmonic mean of the efficiencies of two separate stages and by extension to variable returns to scale (VRS) assumption. However, studies on DEA model are rather few in spite of the importance in handling multiple inputs and output analysis. For the purpose of economic Policies, government need to know the challenges faced by privatized manufacturing firms and speedup measures to catch up with the Asean Tigers of the world. It is on the account of this vacuum that the study has specified relevance by adopting two stage analyses.

Investigation revealed that different approaches had been adopted by researchers in determining the efficiency of firms using to bit regression analysis by few researchers and ordinary least squares (OLS) regression have been widely used to project the variation in calculated efficiencies. In addition, Favero and Papi (1995) investigated the determinants of efficiency using the DEA and ordinary least square and the study proved that the determinants of efficiency size and product specialization. Miller and Noulas (1996) adopted two stage analytical techniques: DEA and econometric programming to investigate the influence of size, profit and power of market on efficiency of firms and reported that size and profit are significant and are the determinants of efficiency. However, a study by Aggrey (2010) using ordinary least square method found a negative relationship between size and efficiency and a positive relationship between foreign ownership and efficiency. Technical efficiency rises until a firm size level is attained and technical efficiency lowered with an upward movement in the firm size as explained in the study.

Kao and Hwang (2008), carried out a study which looked into two-stage DEA analysis and suggested alternative DEA models for two-stages showing that the total efficiency of two-stage process can also be analyzed as a weighted mean of two separate stages and can be extended to variable return to scale model. Though the results were mixed in terms of labour income, employment and wage relativities.

In a more recent study conducted by Arul (2012) used three inputs variables and two output variables respectively (raw materials, staff expenses, plant/machinery and net sale and earnings after tax) were used to investigate the technical efficiency of 30 manufacturing companies in Kenya. The study adopted two techniques of analysis such as Pearson correlation to show correlation between input and output variables used. The study adopted input oriented approach DEA model. The findings showed that comparatively small firm has the highest efficiency level to medium and large firm. The study also indicated that one large firm, two medium-sized companies and three small-sized companies operate under the most efficient technical scale in the three-year period of analysis. The study made policy recommendations to increase market competition to achieve sustainable efficiency performance. Publicly firms crowded out private firms in accessing credit and created statutory barriers to protect the monopoly status of public firms. Net impact change in ownership from public to private would improve efficiency performance of these firms. The study identified that Privatisation would certainly diminish negative impact of crowding out and allocate more credit to the private enterprises and increases the chances for new investment.

Obafemi (2008) carried out a study on the efficiency of the Nigeria banking industry. She adopted a two stage analysis using data envelopment analysis and the ordinary least square (OLS) to determine the technical efficiency of 67 banks in Nigeria and concluded that public ownership of banks in Nigeria reduces the efficiency of banks. She further added that when banks are highly labor intensive the efficiency declines, thereby recommended that there is need to encourage huge bank size through mergers and acquisitions. The study also identified capital adequacy, ownership, capital labour ratio, Market share, liquidity ratio and quality of management as key determinants used in analyzing technical efficiency in the banking industry. But the study did not explain why some privately owned banks collapse despite being efficient from the result of the analysis.

Leachman (2005) examined the manufacturing performance of eight major automobile manufacturers using two stage DEA techniques and showed that there is a strong R&D commitment and ability to compress production time in manufacturing performance. Studies carried out to examine efficiency. In the first stage, the efficiency scores generated from the individual firms using DEA are used as the dependent variable.

DEA has been adopted widely to study the technical efficiency of firms while the second stage regression analysis has been used to explain variations in the calculated efficiencies to a set of independent variables. Amongst the determinants of the efficiency performance of firms, are liberalization, age of the firm, capital investment (size), ratio of equity to invested assets, number of employees, ownership, Foreign direct investment, R&D

intensity (ratio of expenditure on R&D and sales), export of goods, import of capital goods, patent regime and technology. All these are cited as some of the variables determining the level of efficiency of manufacturing performance. The private sector had challenges of economic fluctuations over the years under different government control. Performance can be measured by the levels of efficiency in the firm under consideration and this can be analyzed by a variety of methods, such as the stochastic frontier analysis and data envelopment analysis (Yang, 2006).

Data envelopment analysis (DEA) concept was developed by Charnes, Cooper and Rhodes (1978) known as CCR model which gave the idea of constant return to scale and has been extended by Banker known as BCC model in 1984. The CCR and BCC models can be divided into two; input and output oriented models. The input model minimizes the use of inputs to produce a fixed quantity of output while the output oriented model maximizes the level of output for an acceptable level of inputs. The constant return to scale (CRS) shows that the manufacturing firms attained the best scale. While the increasing return to scale (IRS) assume that an upward movement in inputs will lead to a more than proportionate upward movement in output while decreasing return to scale (DRS) agrees that an upward movement in inputs will lead to a lower proportionate increase in certain quantity of output. The idea is to identify a frontier of most DMU's in the study that are efficient and then to assess how far from the frontiers some units are inefficient. In estimating the data and since our objective is to measure the Performance of the selected firms pre and post privatization in order to ascertain which period was better, the use of this method contrary to parametric methods of technical efficiency estimation, no *a priori* assumption to the analytical procedure of the production function is needed and the technique of analysis is the Data Envelopment Analysis (DEA).

In summary, the major literatures reviewed so far, have revealed some gaps that begs to be filled. One of such gap is that from the literature reviewed so far, nobody has adopted two stage analytical techniques (mathematical programming and econometric programming) with the combination of three inputs and two output variables respectively (such as raw materials, labour and capital) and (output and profit) to measure the performance of privatized firms in Nigeria. In the light of the above, there is need for stronger empirical findings to determine the impact of privatisation and the performance of firms in the Nigerian economy using two stage analytical techniques. The dearth of much empirical work done on privatized firm's performance in terms of their output and profit and the need to close this gap therefore claims the attention of this study. The study is anchored on the theory of the firm and the structure of objective function theories which predicted an improvement on other theories by examining the objective functions of private investment, change of ownership role in making resource allocation and product decisions in line with the existing theories mentioned and also supported efficiency improvement within the context of privatization.

Research Methodology and Model Specification

The study adopted the *ex-post facto* design because the design considers events that have already taken place. Thus, it is possible to draw a comparative analysis before and after

privatization. To evaluate the technical efficiency of these firms, three critical input variables (raw materials cost, labor and capital) and two output variables (output and profit) were used to evaluate the technical efficiency of ten manufacturing firms in Nigeria. The period of analysis is five years before and five years after privatization for each firm in the sample and the study employed two stage analysis procedures, Data envelopment analysis (DEA) and ordinary least square regression (OLS).

In the first stage of the analysis, a DEA model was constructed and used to generate efficiency scores for each of the firm in the sample. The efficiency scores are used as the dependent variable in the second stage regression analysis. In the second stage analysis, we constructed an econometric model whereby the efficiency scores are regressed against certain set of explanatory variables (size, age and concentration ratio). The Output oriented variable returns to scale (VRS) model was adopted in this study. This is because variables returns to scale is more appropriate when manufacturing firms have considerable evidence of ongoing structural changes like privatization and it also provide technical efficiency of DMU's under investigation without scale effect.

Data envelopment analysis (DEA) requires solving a linear programming problem for the DMU under investigation, one for each decision making unit h . While X_{ij} and Y_{ij} are the observed values for the DMU and are constants, u, v, w are the variables.

Following Nyong (2005), the study adopt the eclectic approach which is a variant of modern technique of manufacturing firms in selecting inputs and outputs. Thus, we assume that the production process consist of three inputs and two outputs. The inputs variables are raw materials (raw material cost- X_1), labor (number of employees- X_2) and capital (wages and salaries- X_3). The outputs variables are Output (Total value added - Y_1) and profit (net income- Y_2). The model is adapted from Nyong (2005) and Arul (2012).

DEA begins with fractional programming formulation. Consider that there are ten number decision making units (DMU) to be analyzed. Each decision making unit consumes different amounts of m different inputs (X) to produce k different outputs (Y). It is assumed that these inputs X_{ji} and outputs Y_{ji} are not negative and each DMU _{j} has one positive input at least and output. Mathematically, the DMU h consumes amount $X_{ih} > 0$ of input $I, I = 1, 2, 3, \dots, m$ and produces amount $Y_{rh} > 0$ of output $r = 1, 2, 3, \dots, k$.

DEA tends to ascertain which of the decision making units determine an efficient frontier. Units that are found on the surface are deemed to be efficient while those that are found below the surface are considered inefficient and the analysis provides assessment of their relative efficiency. Two types of envelopment surfaces are used in DEA. There are constant returns to scale (CRS) and the variable returns to scale (VRS). The Output oriented variable returns to scale (VRS) model will be adopted in this study. This is because variables returns to scale is more appropriate when manufacturing firms have considerable evidence of ongoing structural changes like privatization and it also provide technical efficiency of DMU's under investigation without scale effect. The manufacturing firms are:

- DMU 1. Golden Guinea Breweries Plc,
- DMU 2. Cement Company of Northern Nigeria
- DMU 3. Lafarge WapcoPlc (West African Portland cement)
- DMU 4. International Paints West Africa (Ipwa) Plc.
- DMU 5. Interlinked Technologies Plc.
- DMU 6. Flour Mills Plc.
- DMU 7. Aluminum Extrusion Industries Plc.
- DMU 8. Vono Products Plc.
- DMU 9. Beta (Delta) Glass Plc.
- DMU 10. Enpee Industries (Plc.)

The variable return to scale multiplier problem formulation takes the form

$$VRS_M(Y_k, X_h) \quad 5.1$$

$$\text{Max } Z = y_{1h}u_1 + y_{2h}u_2 + y_{3h}u_3 \dots y_{sh}u_s - X_{jh}V_i - X_{2h}V_2 - X_{3h}V_3 - \dots - X_{mh}V_m + wu, v, w \quad 5.2$$

Subject to:

$$y_{11}u_1 + y_{21}u_2 + y_{31}u_3 \dots y_{k1}u_s - x_{i1}v_1 - x_{21}v_2 - x_{31}v_3 - \dots - x_{m1}v_m + w \leq 0 \text{DMU1} \quad 5.3$$

$$y_{12}u_1 + y_{22}u_2 + y_{32}u_3 \dots y_{k2}u_s - x_{i2}v_1 - x_{22}v_2 - x_{32}v_3 - \dots - x_{m2}v_m + w \leq 0 \text{DMU2} \quad 5.4$$

$$y_{13}u_1 + y_{23}u_2 + y_{33}u_3 \dots y_{k3}u_s - x_{i3}v_1 - x_{23}v_2 - x_{33}v_3 - \dots - x_{m3}v_m + w \leq 0 \text{DMU3} \quad 5.5$$

$$y_{14}u_1 + y_{24}u_2 + y_{34}u_3 \dots y_{k4}u_s - x_{i4}v_1 - x_{24}v_2 - x_{34}v_3 - \dots - x_{m4}v_m + w \leq 0 \text{DMU3} \quad 5.6$$

$$y_{15}u_1 + y_{25}u_2 + y_{35}u_3 \dots y_{k5}u_s - x_{i5}v_1 - x_{25}v_2 - x_{35}v_3 - \dots - x_{m5}v_m + w \leq 0 \text{DMU4} \quad 5.7$$

$$y_{16}u_1 + y_{26}u_2 + y_{36}u_3 \dots y_{k6}u_s - x_{i6}v_1 - x_{26}v_2 - x_{36}v_3 - \dots - x_{m6}v_m + w \leq 0 \text{DMU5} \quad 5.8$$

$$y_{17}u_1 + y_{27}u_2 + y_{37}u_3 \dots y_{k6}u_s - x_{i7}v_1 - x_{27}v_2 - x_{37}v_3 - \dots - x_{m7}v_m + w \leq 0 \text{DMU6} \quad 5.9$$

$$y_{18}u_1 + y_{28}u_2 + y_{38}u_3 \dots y_{k6}u_s - x_{i8}v_1 - x_{28}v_2 - x_{38}v_3 - \dots - x_{m8}v_m + w \leq 0 \text{DMU7} \quad 5.10$$

$$y_{19}u_1 + y_{29}u_2 + y_{39}u_3 \dots y_{k6}u_s - x_{i9}v_1 - x_{29}v_2 - x_{39}v_3 - \dots - x_{m9}v_m + w \leq 0 \text{DMU8} \quad 5.11$$

$$y_{20}u_1 + y_{30}u_2 + y_{40}u_3 \dots y_{k6}u_s - x_{i0}v_1 - x_{30}v_2 - x_{40}v_3 - \dots - x_{m10}v_m + w \leq 0 \text{DMU9} \quad 5.12$$

$$y_{1n}u_1 + y_{2n}u_2 + y_{3n}u_3 \dots y_{kn}u_s - x_{in}v_1 - x_{2n}v_2 - x_{3n}v_3 - \dots - x_{mn}v_m + w \leq 0 \text{DMU10} \quad 5.13$$

$$u_1 \geq 1 \quad y_{16}u_1 + y_{26}u_2 + y_{36}u_3 \dots y_{k6}u_s - x_{i5}v_1 - x_{26}v_2 - x_{36}v_3 - \dots - x_{m6}v_m + w \leq 0 \text{DMUn} \quad 5.14$$

$$u_2 \geq 1$$

$$u_3 \geq 1$$

$$u > 0$$

Second Stage Regression Model

Using the efficiency scores as dependent variable, we use the following as explanatory variable.

Output Function

In specifying this equation, three variables are included, namely concentration ratio, age of the firm and size of the firm. The efficiency scores obtained from the output technical efficiency are used as the dependent variables in order to establish the functional relationship between the output efficiency scores and the explanatory variables. Concentration ratio is measured as the log of total assets, age of the firm is determined as the number of years of incorporation to date while size of the firm is measured as the ratio of equity to invested assets. In line with the theory of Cobb Douglas production function, these three variables are some of the determinants of technical efficiency and several empirical studies have identified and adopted concentration ratio,

age of the firm, size of the firm, export propensity, patent, liberalization among others as determinants of efficiency and we expect the output function to be positively related to the variables.

$$\text{Efficiency}_{\text{output}} = f(\text{conr}, \text{age}, \text{size}) \quad 1$$

Where:

Conr = concentration ratio

Age = age of firm

Size = size of firm

Profit Function

In specifying this equation, three variables are also included, namely concentration ratio, age of the firm and size of the firm. The scores obtained from the profit technical efficiency are used as the dependent variables in order to establish the functional relationship between the profit efficiency scores and the explanatory variables. Profit is one of the determinants of manufacturing firm performance (efficiency) but the second stage regression analysis is used to explain variations in the calculated efficiencies from DEA to a set of independent variables. Reasons justifying the inclusion of the variables had already been discussed in the literature review. In line with the theory of Cobb Douglas production function, these three variables are some of the determinants of technical efficiency and several empirical studies have identified and adopted concentration ratio, age of the firm, size of the firm, export propensity, patent, liberalization among others as determinants of efficiency and we expect the profit function to be positively related to the explanatory variables.

$$\text{Efficiency}_{\text{Profit}} = f(\text{conr}, \text{age}, \text{size}) \quad 2$$

Where:

Conr = concentration ratio

Age = age of firm

Size = size of firm

The general model linking these sources of efficiency is hereby presented.

Linearizing the two equations we have:

$$\text{Eff}_{\text{output}} = \alpha_0 + \alpha_1 \text{conr}_i + \alpha_2 \text{age}_i + \alpha_3 \text{size}_i + v_i \quad 5.17$$

$$\text{Apriori} = \alpha_0 > 0; \alpha_1 > 0; \alpha_2 > 0; \alpha_3 > 0$$

$$\text{Eff}_{\text{profit}} = b_0 + b_1 \text{conr}_i + b_2 \text{age}_i + b_3 \text{size}_i + \varepsilon_i \quad 3$$

$$\text{Apriori} = b_0 > 0; b_1 > 0; b_2 > 0; b_3 > 0$$

Where the α, b are to be estimated.

Method of Data Collection and Sources of Data

The data for this study is basically secondary in nature and were obtained from various sources. Annual reports of the firms, offer prospectus of the firms, the internet and the Analyst Data Services and Resources Ltd (ADSRL) provided additional data for the manufacturing firms.

Estimation Techniques

In estimating the data, Data envelopment analysis (DEA) and ordinary least square (OLS) were adopted. DEA is a linear programming methodology used to measure the efficiency of multiple decision-making units (DMUs) when the production process presents a structure of multiple inputs and outputs. DEA is also used to determine which DMU lie on the efficiency frontier. DEA identifies all the inputs and outputs of each privatized firm to obtain efficiency of the firms and the results assume a value between zero and one. The higher the value, the greater the efficiency. A value of one indicates that the firm is technically efficient. It provides the analysis of efficiencies for multiple inputs and outputs, by evaluating each DMU and comparing its performance with the best performing unit. The best performing unit should lie on the efficiency frontier. If the unit is not on the efficiency frontier, it is considered inefficient. The concept of DEA is useful because in calculating efficiency, it takes into consideration returns to scale, allowing for the concept of increasing or decreasing efficiency based on size and output levels. DEA is superior to other econometric approach because it has the following advantages:

1. DEA doesn't require explicit specification of the mathematical model.
2. DEA has proved to be important in discovering association that cannot be discovered by the use of other methods.
3. DEA has the capacity of handling multiple inputs and outputs.
4. DEA has the capacity of being used to measure with any input and output.
5. DEA identifies any sources of inefficiency that can be evaluated, analyzed and quantified.

Data Presentation and Analysis

Descriptive Statistics of Output and Profit Variables Used.

Table 1 presents the descriptive statistics of the variables used in the study. As shown in the Table, the mean value of output in the pre and post privatization period is N 702.61 and N1361 respectively. It is concluded that output in the post privatization period is significantly higher than the one in the pre privatization period.

Table 1: Descriptive statistics of Variables in the study

Variables	Period	Mean (N'000)	Std. Deviation
Output	Pre privatization	702.61	1088.83
	Post privatization	1361.97	2343.26
Profit	Pre privatization	477991.14	3372835.71
	Post privatization	62093.04	427558.24

Source: Author's computation from underlying data (2016)

Firm's Average Technical Efficiency Based on Output

The average efficiencies of the ten firms for the study on output are shown in Table 2. The table shows that the average efficiencies for the firms are below one indicating that all fell below the efficiency level. The result further shows that the highest level of average efficiency was before privatization in 1998 while the lowest level was in 1999 with average efficiency score of 27.5 per cent. This was probably due to undue political pressure arising from electioneering campaign, shortfall in the demand for the products and the socio economic challenges facing the Nigeria economy at that time. After privatization in 2000, 2001 and 2004 the average efficiencies of firms rose to 73.8 per cent, 70.5 per cent, 72.1 per cent and 63.0 per cent respectively. The improved performance was attributed to the smooth transition to civil rule that created enabling environment for investors.

Table 2: Average technical efficiency of selected firms based on output

Before privatization		After privatization	
Period	Average efficiency	Period	Average efficiency
1995	0.695	2000	0.705
1996	0.51	2001	0.721
1997	0.57	2002	0.522
1998	0.738	2003	0.36
1999	0.275	2004	0.63

Source: Authors computation (2016)

The high increase of the average efficiency of the firms is attributed to the fact that Privatization is meant to replace the objective of profit maximization for the other goals of the firms in order to enhance performance. Government removal of its guarantee of the parastatals debt after privatization exposes them to bankruptcy and may likely lead to liquidation. Comparatively, the average efficiency of the ten selected firms for the two periods shows that before privatization the total average efficiency was 1.394 while after privatization it was higher with 1.469 score, implying that the firms in the both periods fell within the efficiency frontier. In a nutshell, the firms were better after privatization in terms of output.

Firm's average technical efficiency based on profit

The average efficiencies of the ten firms for the study on profit are shown in Table 3. The result shows that the average efficiencies for the firms are below 1 implying that they all fall below the efficiency level. The result further shows that before privatization, the highest level of average efficiency was in 1998 with average score of 0.626 and later dropped to 0.580 in 1999 while the lowest level was in 1995 with average efficiency score of 40.5 per cent. The low level of average efficiency of the firms could be attributed to the shortfall in the demand for the products and the socio economic challenges facing the Nigeria economy at that time. After privatization, the highest value was in 2002 and 2000 with average efficiency scores of 62.6 per cent, 73.1 per cent and 74.1 per cent

respectively. The improved performance was attributed to the smooth transition to civil rule that created enabling environment for investors.

Table 3: Average technical efficiency of selected firms based on Profit

Before privatization		After privatization	
Period	Average efficiency	Period	Average efficiency
1995	0.405	2000	0.731
1996	0.4	2001	0.627
1997	0.501	2002	0.741
1998	0.626	2003	0.563

Source: Author's Computation (2016)

The high increase of the average efficiency of the firms is attributed to the fact that Privatization is meant to replace the objective of profit maximization for the other goals of the firms in order to enhance performance. Lack of functional economic infrastructures and decay in the existing infrastructures in the economy such as poor and epileptic power supply, bad road network, inefficient telecommunication system, double taxation, foreign exchange scarcity and inefficient banking system. All these have constituted an impediment on the wheel of progress for most manufacturing firms in Nigeria and have adversely affected their performance. Comparatively, the average efficiency of the ten selected firms for the two periods shows that before privatization the total average efficiency was 1.256 while after privatization it was higher with 1.6 score, implying that the firms in the both periods fell within the efficiency frontier. In a nutshell, the firms were better after privatization in terms of profit.

Firms output technical efficiency.

Output technical efficiency was investigated as shown in Table 4. The analysis was based on five years before and five years after privatization and the findings agreed with the studies reviewed in the literature.

Table 4: Result of output technical efficiency before and after privatization 1995-2004

Efficiency Scores, five years before Privatization					Efficiency Scores, five years after Privatization				
1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0.38	1	1	1	1	0.45	0.5	0.47	0.48	0.49
1	1	1	1	1	0.48	1	1	1	1
1	0.54	1	0.44	0.45	1	1	1	1	1
0.58	0.1	0.27	0.19	0.1	0.23	0.36	0.45	0.28	0.08
1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
0.11	0.55	0.48	0.45	0.42	0.36	0.16	0.47	0.45	0.11
1	0.48	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	0.46	1	1	1	1	1	1	1	1

Source: Authors computation (2016)

The result indicates that all the ten sampled firms used for the study exhibited various levels of efficiencies in terms of output. Seven firms (Golden Guinea Breweries Plc, Cement Company of Northern Nigeria, Interlinked Technologies Plc, Flour Mills Plc, Vono Products Plc, Beta (Delta) Glass Plc and Enpee Industries Plc) lie on the efficiency frontier with an efficiency score of 1.00 each before privatization while the remaining three firms (Lafarge Plc, IPWA Plc and Aluminum Extrusion Plc) were not technically efficient.

In the after privatization era, seven firms were also technically efficient. Cement Company of Northern Nigeria, Lafarge Wapcopl, Interlinked Technologies Plc, Flour Mills Plc, Vono Products Plc, Beta (Delta) Glass Plc and Enpee Industries Plc lie on the efficiency frontier with an efficiency score of 1.00 each while the remaining three firms (Golden Guinea Plc, IPWA Plc and Aluminum Extrusion Plc) were inefficient. The reduction in performance of some firms could also be attributed to the shortfall in demand for the products and the socio economic development facing the Nigeria economy. Privatization if correctly conceived should improve efficiency and stimulate investment and therefore new growth.

Firms profit technical efficiency

Profit technical efficiency was investigated as shown in Table 5. The analysis was based on five years before and five years after privatization and the analysis also agreed with the studies reviewed in the literature. The result below indicates that all the ten sampled firms used for the study exhibited various levels of efficiencies in terms of profit. This means that six firms (Golden Guinea Breweries Plc, Lafarge Wapcopl (West African Portland Cement), Interlinked Technologies plc, Vono Products Plc, Enpee Industries Plc and Beta (Delta) Glass Co. Plc) lie on the efficiency frontier with an efficiency score of 1.00 each before privatization in terms of profit while the remaining four firms were inefficient.

Table 5: Result of profit technical efficiency before and after privatization (1995-2004)

Efficiency Scores, five years before Privatization					Efficiency Scores, five years after Privatization				
1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	1	1	1	1	0.06	0.11	0.11	0.12	0.23
0.23	0.09	0.03	0.06	0.89	0.39	0.36	0.29	0.04	0.02
1	1	1	1	1	1	1	1	1	1
0.39	1	0.36	0.3	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
0.03	0.4	0.3	0.51	0.4	0.12	0.13	0.36	0.45	0.03
0.4	0.18	1	0.03	0.4	0.14	0.22	0.14	0.28	0.16
1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	0.43	0.03	0.4	0.38	0.42
1	1	1	1	1	0.03	0.4	0.12	0.46	0.19

Source: Authors computation (2016)

In the after privatization era, four firms (Lafarge Wapcoplc, International Paints West Africa (Ipwa) Plc, Interlinked Technologies plc and Vono Products plc) lie on the efficiency frontier with an efficiency score of 1.00 each while the remaining six firms were inefficient. In a nutshell, the overall picture indicates an improvement in performance after privatization. It can also be observed that some of the firms were performing well before privatization. Privatization is meant to replace the objective of profit maximization for the other objectives of the firms. Comparatively, Golden Guinea Plc had better performance between 1996 and 1999 but fell below the efficiency frontier from 2000 to date in terms of profit. Cement Company of Northern Nigeria fell below the efficient frontier before and after privatization. Lafarge Plc posted better performance before and after privatization. IPWA was efficient after privatization and fell within the efficiency frontier. Interlink Technologies Plc maintained steady performance before and after privatization. Flour Mills Plc with the high demand for flour and its other products did not fare better in performance before and after privatization in terms of profit. Aluminum Extrusion Plc even with high competition in aluminum profiles could not post a better performance before and after Privatization in terms of profit. Vono Products Plc was better before and after privatization while Beta and EnpeePlc respectively.

Descriptive statistics of the output and profit technical efficiency

Table 6 presents some descriptive statistics on the variables used in the second stage of this study. As shown in Table 6, the result of the data envelopment analysis (DEA) investigating significant difference in the pre and post privatization period based on the technical efficiency obtained from output and profit function shows that the mean efficiency value for the output in the pre and post privatization is 0.5046 and 0.5642 respectively. This shows that the mean value of output after privatization was higher while the mean efficiency value from profit is 0.4805 and 0.3950 respectively. The mean value for profit was higher before privatization.

Table 6: Descriptive statistics of the technical efficiency

Variables	Period	Mean	Std. Deviation
Output Technical efficiency	Pre Privatization	0.5046	0.31241
	Post Privatization	0.5642	0.30408
Profit Technical efficiency	Pre Privatization	0.4805	0.38465
	Post Privatization	0.395	0.31962

Source: Author's computation from data (2016)

In this section, we attempt to analyze the regression results to enable us know the determinants of technical efficiency of the manufacturing firms. The result shows that the determinants of technical efficiency in the manufacturing firms are concentration ratio, age of the firm and size of the firms among others.

Analysis of the Regression Result

In the previous section, we discovered that there is a differential in the technical efficiency of the manufacturing firms with some firms operating below the efficiency frontier. In this section, we attempt to analyze the regression results to enable us know the determinants of technical efficiency of the manufacturing firms. The result shows that the determinants of technical efficiency in the manufacturing firms are concentration ratio, age of the firm and size of the firms among others.

Regression Analysis for Output

Table 7 presents regression result for the second stage analysis that relates technical efficiency based on the output function to concentration ratio, age and size of the firm in the pre privatization periods. In the pre privatization, none of the explanatory variables significantly explain technical efficiency while after privatization only size of the firm had a significant difference.

Table 7: Result of output regression

Variables	Pre privatization			Post privatization		
	coefficient	t- statistic	P- value	coefficient	t- statistic	P- value
(Constant)	0.56 (-0.527)	1.063	0.294	-0.781 (-0.287)	-2.725	0.009
Concentration ratio	-0.465 (-0.811)	-0.573	0.57	-0.697 (-0.414)	-1.683	0.099
Age	0.007 (-0.008)	0.96	0.342	-0.003 (-0.005)	-0.617	0.541
Size	-0.019 (-0.056)	-0.342	0.734	0.103 (-0.029)	3.543	0.001
R-square						
F-statistic	0.06			0.363		
F(P-value)	0.944			8.347		
	0.427			0		

Source: Author's computation using Eview(2016)

Note: Standard error of coefficient is in parenthesis

The result shows that concentration ratio and size are statistically significant after privatization. The coefficient of the log of concentration ratio before privatization is negative (-0.465) while after privatization the coefficient is also negative (-0.697). The coefficient of age of the firm before privatization is positive (0.007) and after privatization it was negative (-0.003) while the coefficient of the size of the firm before privatization is negative (-0.019) and after privatization is positive (0.103) and was statistically significant. This is an indication that large public firms were problems to the less developing countries.

In the R^2 only about six per cent variation was reported in the study before privatization while after privatization about four per cent explained variations in the variables used. The F statistics before privatization was nine per cent while after while privatization it was only 8.4 per cent. The p-value before privatization is 0.427 and after privatization it was 0.000.

Regression Analysis for Profit

Table 8 presents regression result for the second stage analysis that relates technical efficiency based on the profit function to concentration ratio, age and size of the firm. In the pre privatization period, concentration ratio and age are statistically significant. In the post privatization period, concentration ratio, age and size of the firm significantly explain technical efficiency at one per cent level of significance. All the firms are making profit. The R-square from this result shows that 36.3 per cent of the variation in post privatization technical efficiency can be explained by these variables. This shows that, the higher the concentration ratio, the monopoly power will be high, with age, firms gain experience and with size, firms gain more strength to control or have a larger share of the market.

Table 8: Result of profit regression

Variables	Pre privatization			Post privatization		
	coefficient	t- statistic	P- value	coefficient	t- statistic	P- value
(Constant)	3.433 (-0.686)	5.005	0	1.106 (-0.333)	3.322	0.002
Concentration ratio	3.603 (-1.057)	3.409	0.001	0.592 (-0.48)	1.232	0.224
Age	0.031 (-0.01)	3.154	0.003	0.021 (-0.006)	3.513	0.001
Size	-0.31 (-0.073)	-4.248	0	-0.106 (-0.034)	-3.125	0.003
R-square						
F-statistic	0.296			0.232		
F(P-value)	6.175 0.001			4.431 0.008		

Source: Author's computation using Eview (2015)

Note: Standard error of coefficient is in parenthesis

The F statistics shows that before privatization 6 per cent while after privatization it was 4.4 per cent.

Summary of Findings

Our analysis from the average efficiency scores of the firms using output and profit functions as shown in Table 2 and Table 3 shows that the average efficiency for the privatized firms was higher after privatization with average efficiency score of 73.8 per cent and 74.1 per cent respectively. The result from the output technical efficiency as shown in Table 4 indicates that all the ten sampled firms used for the study exhibited various levels of efficiencies in terms of output. Seven firms lie on the efficiency frontier with an efficiency score of 1.00 each before privatization while the remaining three firms were not technically efficient. In the after privatization era, seven firms were also technically efficient lie on the efficiency frontier with an efficiency score of 1.00 each while the remaining three firms were inefficient.

Table 5 shows that six firms lied on the efficiency frontier with an efficiency score of 1.00 each before privatization in terms of profit while the remaining four firms were inefficient. In the after privatization era, four firms lied on the efficiency frontier with an efficiency score of 1.000 each while the remaining six firms were inefficient in terms of profit. In a nutshell, the overall picture shows an improvement in performance after privatization. It shows that privatization has had a positive technical efficiency on privatized firms.

Table 6 relates technical efficiency based on the output function to concentration ratio, age and size of the firm indicates that in the pre privatization period, none of the explanatory variables significantly explain technical efficiency while after privatization only size of the firm had a significant difference in terms of output. Result from table 7 shows the second stage analysis that relates technical efficiency based on the profit function to concentration ratio, age and size of the firm in the pre privatization period, only concentration ratio and age are statistically significant. In the post privatization period, age and size of the firm significantly explain technical efficiency at one per cent level of significance. All the firms are making profit. The R-square from this result shows that 36.3 per cent of the variation in post privatization technical efficiency can be explained by these variables. This shows that, the higher the concentration ratio, the monopoly power will be high, with age, firms gain experience and with size, firms gain more strength to control or have a larger share of the market.

Conclusion

The study indicates that privatization has a positive impact on the technical efficiency of privatized firms in Nigeria. It shows that privatization has had a positive technical efficiency on privatized firms. In the second stage analysis, since concentration ratio, age and size of the firm significantly explain technical efficiency. Government should note that with concentration ratio, monopoly power is still very strong and may likely affect efficiency.

Recommendations

1. Since the output technical efficiency is better after privatization, it is recommended that the size of the public enterprises should be reduced and such enterprises should be offered to the private managers to manage in order to enhance output efficiency, reduce

waste of economic resources and the drain public enterprises have on the dwindling treasury of the public sector and ensure financial discipline. It will open doors for new investment opportunities and create new responsibilities for the private sector. This will enhance the provision of more basic and essential services to the citizens and improve output production of the privatized firms. This may also reinforce the process of the acquisition of new knowledge, skills and technology for expanded output to meet local and foreign demand for the effectiveness of privatization.

2. Since the profit technical efficiency is better after privatization. It is recommended that any constraints affecting profit maximization should be removed, such as double taxation, epileptic power supply etc.

3. In the second stage regression analysis, in the pre privatization period none of the explanatory variables significantly explain technical efficiency before privatization in output but in post privatization period concentration ratio and size of the firm respectively significantly explain technical efficiency in both output and profit. While in terms of profit concentration ratio and age significantly explain technical efficiency before and after privatization. It is recommended that there should be market competition with liberalization of entry conditions, in order to terminate monopoly and allow for new entrants to make operations competitive for production. This will be in line with the industrialization policy.

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