



Data Envelopment Analysis Technique (DEA) and Technical Efficiency Performance of Privatized and Non-Privatized Firms in Nigeria

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ABSTRACT

This study focused on assessing the impact of privatization on the technical efficiency of Nigeria's manufacturing sector, considering the unique economic, political, and organizational characteristics of Nigeria whether privatized firms perform better under private ownership compared to public ownership. The methodology employed for this assessment was Data Envelopment Analysis (DEA), specifically utilizing the Output-Oriented Variable Returns to Scale (VRS) model. The selection of this model was influenced by its appropriateness for situations where manufacturing firms are undergoing substantial structural changes, such as privatization. The findings suggest an overall positive impact of privatization on technical efficiency, with enhanced performance and resource utilization among privatized firms. The study emphasizes the need for tailored policies and a deep understanding of local conditions when pursuing privatization initiatives, contributing to the international discourse on privatization's implications for economic development and efficiency. The study recommended that given the improved output technical efficiency post-privatization, reducing the size of public enterprises and entrusting them to private management is advisable. This aims to enhance output efficiency, minimize economic resource wastage, alleviate financial burdens on the public sector treasury, and encourage fiscal discipline while removing the constraints hindering profit maximization, the Nigeria government should fight double taxation and unreliable power supply, to encourage industrialization to speed up development in Nigeria. In conclusion, Ultimately, the study aims to inform the Nigerian government's decision-making regarding privatization strategies and their potential impact on the country's manufacturing sector and overall economic well-being.

Key words: DEA, Privatization, Performance, Technical Efficiency.

1. Background to the study

One of the key economic shifts that has played a central role in the global push for economic liberalization and performance enhancement is the privatization of state-owned enterprises. This phenomenon is particularly noteworthy in Nigeria, where the privatization of public enterprises has become a focal point of efforts to liberalize the economy. This move towards privatization is driven by the belief that the public sector has not effectively managed these enterprises.

The roots of privatization in Nigeria can be traced back to 1970, a period when the country began grappling with economic difficulties. These challenges intensified in the early 1980s, characterized by a severe economic downturn marked by falling oil revenues, declining industrial output, challenges in financing imports, a weakened agricultural sector, growing trade arrears, and difficulties in addressing the burdensome external debt. This crisis was compounded by issues such as corruption, outdated production technology, inadequate capital structures, bureaucratic inefficiencies, internal conflicts, insufficient working capital, foreign exchange shortages, poor management, and a lack of technical support.

While some of the debt was resolved and forgiven by the Paris Club of creditors, a fundamental issue observed in public enterprises globally and in less-developed countries is inefficiency. Inefficiency results in the wastage of resources, slow economic growth, and an undue reliance on government support, even when these enterprises could be profitable. Some argue that government ownership tends to breed laziness, fraud, bureaucratic obstacles, and social problems.

Despite numerous empirical studies exploring the link between privatization and efficiency in developed countries, the findings may not directly apply to less-developed nations like Nigeria due to the unique characteristics of their political, economic, environmental, administrative, and organizational landscape.

The focus on Nigeria is significant for several reasons. Firstly, the Nigerian government actively seeks international connections through organizations like the Economic Community of West African States (ECOWAS), the African Growth and Opportunity Act (AGOA), and the World Trade Organization (WTO). Additionally, recent policies in Nigeria aim to diversify the economy and promote a private sector-driven approach. Secondly, studying the Nigerian experience could provide valuable insights into the effectiveness of privatization and the factors contributing to its success. There is a scarcity of empirical studies in the West African sub-region, particularly using Data Envelopment Analysis (DEA), which is crucial for analyzing multiple inputs and outputs in contexts like Nigeria.

This study specifically focuses on examining the impact of privatization on the technical efficiency of Nigeria's manufacturing sector. The privatization issue has attracted considerable attention from economists and policymakers in less-developed countries, sparking extensive international discussions. Through analysis and discussions, it becomes apparent that well-planned and executed privatization efforts can yield significant benefits, including enhanced efficiency, increased investments, budgetary savings, and additional resources to improve a nation's economic conditions. Furthermore, the excessive size of public firms, especially in Nigeria, has hindered the development of less-developed countries.

In Nigeria, numerous commissions of inquiry and study groups were established to examine the challenges faced by public enterprises. These commissions and panels were led by individuals such as Ani, Adebo, Udoji, & Onosode, among others. All of these inquiry commissions reached a consensus that private enterprises outperformed their public counterparts. The rationale behind the decision to privatize state-owned firms stemmed from the widely held perception of poor performance by public entities. The underlying belief was that transferring these state-owned enterprises to private management would improve efficiency, increase production, and better meet the high demand for their services.

Despite the implementation of various policies aimed at advancing privatization in Nigeria, the study aims to address the existing research gap by specifically investigating the impact of privatization on the technical efficiency of Nigeria's manufacturing sector using Data Envelopment Analysis (DEA). While there are studies examining privatization and efficiency across various industries and countries, there is a notable absence of such research in the West African sub-region, particularly employing DEA in Nigeria, which enables the analysis of multiple inputs and outputs. This research endeavours to close this void by presenting empirical evidence on how privatization influences the technical efficiency of manufacturing firms in Nigeria, considering the distinctive economic, political, and organizational features of the Nigerian context. The primary goal of this study is to evaluate the technical efficiency performance of manufacturing firms both before and after privatization in Nigeria and to provide recommendations for appropriate policies that the Nigerian government should consider adopting.

2. LITERATURE REVIEW

Numerous studies referenced in the literature have presented diverse findings regarding the impact of privatization on the technical efficiency of privatized companies. Some studies have indicated improved performance in firms after privatization, while others have observed only marginal enhancements. However, most empirical studies do not align with either of these extreme perspectives; instead, they generally report mixed results concerning the effects of privatization.

Traditional performance analysis methods, such as financial ratios, have been utilized in various studies, but these methods have limitations in assessing single input-output scenarios. In contrast, this study adopts an alternative approach introduced by Charnes et al. (1978), known as "constant return to scale (CRS) Data Envelopment Analysis." This model facilitates the analysis of multiple input-output data, and Banker et al. (1984) further extended it to incorporate variable return to scale. Since then, this approach has been widely employed by researchers in various fields, including the analysis of manufacturing firms. Performance, in this context, is typically measured by the efficiency levels of the firm under examination and can be analyzed using various methods, such as stochastic frontier analysis and data envelopment analysis (Yang, 2006). Hamdy (2006) has emphasized that technical efficiency, a specific type of technology, is crucial for transforming inputs into outputs.

Abokareh & Kamaruddin (2011) conducted a study on the impact of privatization on the efficiency of 21 Libyan manufacturing firms, both before and after privatization (from 2000 to 2008). The analysis revealed no significant difference in their technical efficiencies before and after privatization. The average technical efficiency of all firms stood at 49.5% before privatization and increased to 62.3% after privatization. Interestingly, public firms improved by 9.3% post-privatization, while private firms exhibited a more substantial improvement of 15.3%.

Qiang & Cai (2009) analyzed the efficiency of high-tech industries in China, using two input and two output variables. They employed an output-oriented DEA model under the CCR model for a six-year period, with R&D expenditure and R&D personnel as input variables and patent and sales revenue as output variables. Their findings indicated a decrease in average technical efficiency from 2002 to 2007. Private firms achieved 100% efficiency five times during this period, while computer industries achieved a 100% efficiency rating four times. When using the VRS model, three companies exhibited decreasing variation from 2002 to 2007, and only five efficient companies in 2007 displayed a decreasing trend using the VRS model.

Martin & Parker (1997) examined the impact of privatization on ten major firms in the UK that were privatized in the 1980s. They employed several performance indicators, including labor productivity growth, total factor productivity growth, data envelopment analysis (DEA), growth in value-added per employee, and the rate of profit. The study concluded that economic reforms and restructuring contributed to improvements in productive efficiency. Additionally, they assessed the impact of privatization on other variables such as employment and income distribution in the business. The results suggested that the transfer of state holdings was associated with high profitability, although outcomes varied regarding labor income, employment, and wage relativities.

Udejaja (2001) conducted a study to determine the technical efficiency of seven wholly privatized firms in Nigeria and its distributional consequences on income and wealth. The study revealed mixed results for the privatized firms but indicated technical efficiency gains in terms of profitability after privatization. The study employed efficiency and ownership theories, as well as public choice theories, and used data envelopment analysis (DEA) to analyze the technical efficiency of the seven privatized firms. It concluded that privatization had a positive impact on technical efficiency and wealth distribution but did not delve into the reasons for the failure of some privatized enterprises to achieve their objectives.

Obafemi (2008) conducted a study on the technical efficiency of the Nigerian banking industry, using a two-stage analysis approach involving data envelopment analysis and ordinary least squares (OLS). The study encompassed 67 banks in Nigeria and suggested that public ownership of banks reduced their efficiency. It also noted that highly labor-intensive banks experienced decreased efficiency and recommended encouraging larger bank sizes through mergers and acquisitions. The study identified key determinants for analyzing technical efficiency in the banking industry, including capital adequacy, ownership, capital-labor ratio, market share, liquidity ratio, and quality of management. However, it did not provide an explanation for the collapse of some privately-owned banks despite their efficiency.

Kao & Hwang (2008) conducted a study that explored two-stage DEA analysis and proposed alternative DEA models for two-stage processes. They demonstrated that the total efficiency of a two-stage process can be analyzed as a weighted mean of two separate stages and extended this analysis to the variable return to scale model.

Overall, these studies are grounded in theories related to firms and objective functions, aiming to enhance our comprehension of the role of privatization in resource allocation, decision-making, and efficiency improvement within the context of various industries.

3. METHODOLOGY

To evaluate the technical efficiency of these companies, an investigation was carried out on ten manufacturing firms in Nigeria. This assessment incorporated three essential input factors namely, the costs of raw materials, labor, and capital along with two output factors: production and profit. The study spanned a decade, covering a period of five years before and five years after privatization for each company in the sample. The methodology employed for this assessment was Data Envelopment Analysis (DEA), specifically utilizing the Output-Oriented Variable Returns to Scale (VRS) model. The selection of this model was influenced by its appropriateness for situations where manufacturing firms are undergoing substantial structural changes, such as privatization. Furthermore, it enables the evaluation of the technical efficiency of the firms under scrutiny while disregarding scale effects. The manufacturing firms are :

DMU 1. Golden Guinea Breweries Plc,

DMU 2. Cement Company of Northern Nigeria

DMU 3. Lafarge Wapco Plc (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.)

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_{rj} are the observed values for the DMU and are constants, u , v , w are the variables.

In compact form, the VRS model is given as

$VRS_m (X_j, Y_j)$

$$\max h_0(u, v) = \frac{\sum_{r=1}^s v_r y_{r0}}{\sum_{i=1}^m u_i x_{i0}}$$

$$\frac{\sum_{r=1}^s v_r y_{rj}}{\sum_{i=1}^m u_i x_{ij}} \leq 1; j = 1, 2, \dots, n$$

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

$$v_r \geq 0; r = 1, 2, \dots, s$$

Following the ideology of Charnes-Cooper transformation (1962), we can pick a representative solution (u, v) given as

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

Where: X_{ij} = the quantity of input i to be used by the j th DMU Y_{rj} = the quantity of output r to be used by the j th DMU U_i = strength assigned to the input i .

Inputs (X_{ij}) = raw materials cost, labor and capital Output (Y_{ij}) = output and profit.

The values u , v and w have been interpreted as multipliers as indicated above while the linear programming problem; VRS_m has been referred to as the multiplier side.

The data utilized in this study primarily comprises information from secondary sources gathered from various channels. These sources include the annual reports and offer prospectuses of the firms under scrutiny, information sourced from the internet, and data provided by Analyst Data Services and Resources Ltd (ADSRL), specifically pertaining to the manufacturing firms.

To evaluate the performance of the selected manufacturing firms concerning technical efficiency of output and profit before and after privatization, we employed a methodology known as data envelopment analysis (DEA). DEA is a linear programming technique used to assess the efficiency of multiple decision-making units (DMUs) in scenarios where the production process involves multiple inputs and outputs. This method is instrumental in identifying which DMUs lie on the efficiency frontier. DEA involves a comprehensive evaluation of the inputs and outputs of each privatized firm, resulting in efficiency scores that range from zero to one. A higher score indicates greater efficiency, with a score of one denoting technical efficiency. DEA provides an in-depth analysis of efficiency, considering multiple inputs and outputs, and compares each DMU's performance to the best-performing unit, ideally situated on the efficiency frontier. Any deviation from the efficiency frontier is considered an indication of inefficiency.

The concept of DEA is valuable because it incorporates returns to scale, allowing for the assessment of efficiency changes based on size and output levels. DEA holds advantages over other econometric approaches for several reasons:

1. DEA doesn't require explicit specification of the mathematical model.
2. DEA has proven to be important in discovering associations that other methods may not uncover.
3. DEA can handle multiple inputs and outputs.
4. DEA is versatile and can be used to measure efficiency with any input and output.
5. DEA identifies sources of inefficiency that can be evaluated, analyzed, and quantified.

5. DATA PRESENTATION AND ANALYSIS

5.1 Descriptive Statistics of output and profit variables used.

Table 5.1 displays the descriptive statistics for the variables employed in the investigation. According to the table, the mean value of output during the pre-privatization period is N 702.61, while in the post-privatization period, it is N1361. It is inferred that the output during the post-privatization period is notably higher than that in the pre-privatization period.

Table 5.1 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 (2023)

Nevertheless, the null hypothesis asserting no difference between the pre and post-privatization periods is rejected concerning profit. Consequently, it is deduced that the profit during the pre and post-privatization periods remains the same.

5.2 Evaluation of Firm’s Average Technical Efficiency Based on Output

Table 5.2 showcases the mean efficiencies of the ten firms investigated in the output-focused analysis. The table indicates that the average efficiencies of these firms consistently fell below one, signifying that they all operated below the desired efficiency level. Notably, the data reveals that the highest average efficiency was observed in the year before privatization, specifically in 1998, while the lowest point was reached in 1999, with an average efficiency score of 27.5 percent. The decrease in efficiency during 1999 can be attributed to various factors such as political pressures arising from election campaigns, a decrease in product demand, and the socioeconomic challenges prevalent in the Nigerian economy during that period.

However, a positive trend emerged after the initiation of the privatization process in 2000. Average efficiencies for the years 2000, 2001, 2004 stood at 73.8 percent, 70.5 percent, 72.1 percent, and 63.0 percent, respectively. This enhancement in performance was largely credited to the smooth transition to a civilian government, creating a conducive environment for investors and businesses to prosper.

Table 5.2 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 (2023)

The notable increase in the average efficiency of these companies can be ascribed to the fundamental shift represented by privatization. This shift replaces the singular focus on profit maximization with a broader set of objectives aimed at enhancing overall performance. Significantly, the government's withdrawal of its guarantee for the parastatals' debts following privatization exposes them to financial instability and the risk of potential liquidation.

When comparing the average efficiency of the ten selected firms for the two distinct periods, it becomes apparent that before privatization, the overall average efficiency stood at 1.394. However, after privatization, this figure increased to a higher score of 1.469. This implies that in both periods, these firms operated within the efficiency frontier, indicating a positive impact on their performance.

In summary, it can be concluded that the firms experienced improvements in their output after privatization.

5.3 Evaluation of Firm’s Average Technical Efficiency Based on Profit

Table 5.3 presents the mean efficiencies of the ten firms analyzed in the profit-focused study. The findings reveal that the average efficiencies of these firms consistently fall below 1, indicating that they all operate below the desired efficiency threshold. Furthermore, the results indicate that prior to privatization, the highest average efficiency level was recorded in 1998, with a mean score of 0.626, but it subsequently declined to 0.580 in 1999. In contrast, the lowest point was reached in 1995, with an average efficiency score of 40.5 percent. This drop in average efficiency during those years can be attributed to factors such as reduced product demand and the socioeconomic challenges prevalent in the Nigerian economy at that time.

However, following the privatization process, the highest average efficiency values were observed in 2000 and 2002, with average scores of 73.1 percent and 74.1 percent, respectively. This improved performance can be attributed to the smooth transition to civilian rule, creating a conducive environment for investors.

In summary, the firms demonstrated enhanced performance in terms of profit after the privatization period.

Table 5.3 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
1999	0.58	2004	0.538 0.627
1996	0.4	2001	0.741
1997	0.501	2002	
1998	0.626	2003	0.563

Source: Author’s Computation (2023)

The notable increase in the average efficiency of these firms can be linked to the core objective of privatization, which seeks to shift from the sole pursuit of profit maximization to broader organizational goals aimed at enhancing overall performance. Additionally, the challenges arising from the state of economic infrastructure and its deterioration have adversely affected companies in Nigeria. Factors such as unreliable power supply, inadequate road networks, inefficient telecommunications systems, double taxation, foreign exchange shortages, and an inefficient banking system collectively impede the progress of most manufacturing firms.

When comparing the average efficiency of the ten selected firms for both periods, it becomes evident that before privatization, the overall average efficiency stood at 1.256. However, after privatization, this figure significantly increased to 1.6, indicating that during both periods, these firms operated efficiently, falling within the efficiency frontier. In summary, the firms displayed improved profitability after undergoing privatization.

5.4 Evaluation of Firms' Output Technical Efficiency

Output technical efficiency was examined, as depicted in Table 5.4. The analysis was based on five years before and five years after privatization, and the findings align with the studies reviewed in the literature.

Table 5.4 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 (2023)

The findings reveal that all ten sampled firms included in the study demonstrated diverse levels of efficiency in terms of output. Before privatization, 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) operated on the efficiency frontier, each scoring 1.00, while the remaining three firms (Lafarge Plc, IPWA Plc, and Aluminum Extrusion Plc) were not technically efficient.

In the post-privatization era, seven firms also exhibited technical efficiency. Cement Company of Northern Nigeria, Lafarge Wapco Plc, Interlinked Technologies Plc, Flour Mills Plc, Vono Products Plc, Beta (Delta) Glass Plc, and Enpee Industries Plc operated on the efficiency frontier, each scoring 1.00, while the remaining three firms (Golden Guinea Plc, IPWA Plc, and Aluminum Extrusion Plc) were inefficient. The decline in performance of some firms could also be attributed to a decrease in product demand and the socio-economic challenges facing the Nigerian economy. Correctly conceived privatization should enhance efficiency and stimulate investment, thereby fostering new growth.

5.5 Evaluation of Firms' Profit Technical Efficiency

Profit technical efficiency was examined, as indicated in Table 5.5. The analysis was based on five years before and five years after privatization, and the results align with the studies reviewed in the literature. The findings below indicate that all ten sampled firms in the study demonstrated various levels of efficiency in terms of profit. This implies that six firms (Golden Guinea Breweries Plc, Lafarge Wapco Plc, Interlinked Technologies Plc, Vono Products Plc, Enpee Industries Plc, and Beta (Delta) Glass Co. Plc) operated on the efficiency frontier with a perfect efficiency score of 1.00 each before privatization in terms of profit, while the remaining four firms were inefficient.

Table 5.5 Result of profit technical efficiency before and after privatization (1995-2004)

Efficiency scores of privatization, five years before privatization					Efficiency scores of privatizations, 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 (2023)

After the privatization period, four firms—Lafarge Wapco Plc, International Paints West Africa (IPWA) Plc, Interlinked Technologies Plc, and Vono Products Plc—achieved a perfect efficiency score of 1.00, while the remaining six firms were found to be inefficient. In summary, this comprehensive evaluation indicates an improvement in performance following privatization. It's important to note that some firms were already performing well prior to privatization, and the aim of privatization is to replace the sole objective of profit maximization with a broader set of objectives for these firms.

In making comparisons, it's noteworthy that Golden Guinea Plc exhibited stronger performance between 1996 and 1999 but subsequently fell below the efficiency frontier from 2000 onwards in terms of profit. Cement Company of Northern Nigeria showed inefficiency both before and after privatization. Lafarge Plc demonstrated improved performance both before and after privatization. IPWA achieved efficiency after privatization and remained within the efficiency frontier. Interlink Technologies Plc maintained consistent performance levels before and after privatization. Flour Mills Plc, despite high demand for its products including flour, did not significantly improve in terms of profit before and after privatization. Even in the face of intense competition in the aluminum profiles market, Aluminum Extrusion Plc did not exhibit superior performance before or after privatization in terms of profit. On the other hand, Vono Products Plc displayed strong performance both before and after privatization, while Beta and Enpee Plc had their respective performance characteristics.

5.6 Evaluation of Efficiency Ratings Under Variable Returns to Scale Output Model

Table 5.6 presents the efficiency ratings under the variable returns to scale output model, serving as the baseline model. The findings reveal varying levels of efficiency ratings, expressed as percentages, for the ten sampled firms. Comparatively, Golden Guinea Breweries Plc achieved a perfect 100% rating in both 1995 and 1996, marking the highest performance during those years. However, it failed to surpass this level of excellence from 1998 onwards.

Cement Company of Northern Nigeria maintained efficiency levels above the industrial average, exceeding 50% efficiency from 1995 to 1998 but dipped to 49% in 1996. There was a notable improvement in the technical efficiency of the firm after transitioning to private ownership.

Lafarge Wapco also experienced an enhancement in its efficiency ratings from 1998, ultimately reaching 100% in 2004. International Paints West Africa Plc consistently demonstrated outstanding efficiency, achieving 100% resource utilization efficiency between 1995 and 2003.

Interlinked Technologies Plc initially posted a 43% efficiency rating but saw significant improvements in subsequent years, consistently exceeding the industrial average and thus being deemed technically efficient. Flour Mills Plc made remarkable strides in efficiency ratings, exceeding 50%.

Aluminum Extrusion Industries Plc recorded its highest efficiency rating in 2004, having initially struggled with poor efficiency in 1995 and 1996. Nevertheless, it managed to rise to over 65.1% in 2004. Vono Products Plc began with a low efficiency rating of 42.5% in 1997 but later achieved a remarkable 100% efficiency rating in 2004, signifying technical efficiency in resource usage.

Beta (Delta) Glass Plc displayed a mixed performance, reaching 100% efficiency in 2003 and 2004 but falling below the industrial average of 50% in profit. Enpee Industries Plc consistently met or exceeded the industrial average from 1998, maintaining a 100% efficiency rating with minor fluctuations.

In summary, there was an overall improvement in the technical efficiency of the seven firms in terms of resource utilization.

Table 5.6 Technical efficiency rating (under VRS model) in percentages (output)

Year	Golden Guinea	Cement Company	Lafarge	IPWA	Interlink Technology	Flour Mills	Aluminum	Vono	Beta Glass	Enpee
1995	100	50	40	94.5	42.9	72.1	67.9	50	75.2	60
1996	100	49	49	91.1	55.1	82.4	74.5	44.2	55.6	72.5
1997	35	42.5	42.5	100	52.1	67.2	56.8	42.5	67.5	70.2
1998	30.1	50	50	100	60.1	57.6	88	48.5	50	66
1999	0.07	65	55	100	50	100	80.5	65	65	79
2000	0.06	60	59	100	72.9	100	82.5	65	60	79.5
2001	0.06	89.1	89.1	100	88.3	100	89	89.1	89.1	80.2
2002	0	95.5	100	63.2	87	60.7	90.5	95.5	95.5	89
2003	0	100	100	66.2	89.5	70	92	100	100	85.8
2004	0	80	75	70.1	90.2	69	92.9	80	100	88

Source: Authors computation (2023)

5.7 Evaluation of Efficiency Ratings Under Variable Returns to Scale Profit Model

Table 5.7 focuses on the efficiency ratings under the variable returns to scale profit model, serving as the baseline model. These results unveil diverse efficiency ratings among the ten sampled firms, reflecting their performance in terms of profitability.

Golden Guinea Breweries Plc attained a perfect 100% efficiency rating from 1995 to 1996 but later fell below the efficient frontier from 1997 onwards. Cement Company of Northern Nigeria initially struggled with efficiency in 1995 but experienced a substantial increase from 1996 onwards. Lafarge Wapco exhibited improved efficiency ratings, particularly after privatization, reaching 100% in 2004. International Paints West Africa Plc consistently demonstrated efficiency in profit, surpassing the industrial average and reaching 100% in 2004.

Interlinked Technologies Plc maintained efficiency ratings above 70.5% to 100% in 2004, establishing it as technically efficient. Flour Mills Plc initially faced inefficiency from 1995 to 1997, with efficiency ratings ranging from 46.2% to 49.2%. However, it later achieved 100% efficiency in 2004. Aluminum Extrusion Industries Plc experienced inefficiency in 1995 and 1996 but improved to over 65.1% in 2004.

Vono Products Plc started with a low efficiency rating of 40% in 1995 but exhibited a remarkable 100% efficiency rating in 2004, indicating technical efficiency in profit. Beta (Delta) Glass Plc reached its highest efficiency rating of 60.5% in 2004 but remained below the industrial average of 50% in profit. Enpee Industries Plc consistently met the industrial average from 1998, maintaining a 100% efficiency rating with minor fluctuations.

Table 5.7 Technical efficiency rating (under VRS model) in percentages (profit)

Year	Golden Guinea	Cement Company	Lafarge	IPWA	Interlink Technology	Flour Mills	Aluminum	Vono	Beta Glass	Enpee
1996	100	70.3	72.4	57.3	70.4	40.7	47.3	54.5	55.9	40
1997	30	83.3	89.2	59	72.9	49.2	52.9	52.9	50	45

1998	35	76.2	88.5	85.2	100	50.3	65.1	48.5	60	100
1999	0.07	80.4	100	94.5	100	67.8	52.1	65.9	60	95.5
2000	0.06	96.3	100	91.1	100	88.3	50.1	65	46.7	100
2001	0.06	95	100	100	100	76.4	50	100	48.9	80
2002	0	100	100	100	89	82.5	60	100	50	67
2003	0	100	100	100	95.2	100	65.9	100	55	68
2004	0	100	100	100	100	100	70.1	100	60.5	60

Source: Authors computation (2023)

The above analysis demonstrates that the impact of privatization on individual firms' efficiency was mixed. While some firms experienced an increase in their efficiency scores, others witnessed a decline and fluctuation in their efficiency scores. Confirming the technical efficiency of firms appearing efficient in Tables 5.6 and Table 5.7, it is evident that there exists an efficiency differential among manufacturing firms, indicating an improvement in efficiency ratings after privatization.

6. SUMMARY OF FINDINGS

This study focused on assessing the impact of privatization on the technical efficiency of Nigeria's manufacturing sector, considering the unique economic, political, and organizational characteristics of Nigeria. The findings suggest an overall positive impact of privatization on technical efficiency, with enhanced performance and resource utilization among privatized firms. The study emphasizes the need for tailored policies and a deep understanding of local conditions when pursuing privatization initiatives, contributing to the international discourse on privatization's implications for economic development and efficiency. The analysis of average efficiency scores for companies using output and profit functions reveals an overall increase in average efficiency among privatized firms following privatization. The average efficiency scores were 73.8 percent and 74.1 percent before and after privatization, respectively. Regarding output and profit technical efficiency, all ten sampled firms exhibited varying levels of efficiency, with a majority achieving maximum efficiency scores post-privatization.

7. POLICY RECOMMENDATION

1. *Output Technical Efficiency:* Given the improved output technical efficiency post-privatization, reducing the size of public enterprises and entrusting them to private management is advisable. This aims to enhance output efficiency, minimize economic resource wastage, alleviate financial burdens on the public sector treasury, and encourage fiscal discipline.
2. *Profit Technical Efficiency:* To address constraints hindering profit maximization, the Nigeria government should fight double taxation and unreliable power supply, to encourage industrialization to speed up development in Nigeria.

8. CONCLUSION

Ultimately, the study aims to inform the Nigerian government's decision-making regarding privatization strategies and their potential impact on the country's manufacturing sector and overall economic well-being.

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