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Resource-Use Efficiency and Firm Performance in Nigeria's Manufacturing Industry

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Abstract

The study investigated the existence of technical efficiency among manufacturing firms and examine its effects on firm performance in Nigeria using firm level data between 2001 and 2017. Variables such as capital, labour, total overhead inputs, total firm output, competition, capital intensity, firm market share, technical efficiency scores and firm profitability were used in this study. Using the stochastic frontier analysis (SFA) to generate the technical efficiency scores, the study adopted System-GMM to examine the effects of technical efficiency on firm performance among quoted manufacturing firms operating in consumer (food beverages and tobacco), industrial and health (pharmaceutical) sectors in Nigeria. The findings revealed that 29% of the variation between the observed and optimal outputs is attributed to inefficiency among manufacturing firms. However, firm competitiveness significantly increases the efficient use of resources among manufacturing firms. This study further showed that technical efficiency variable has positive effects on manufacturing firm performance in Nigeria. The paper concluded that competition increases the efficient utilization of resources which positively improves firm performance in Nigeria's manufacturing industry. Finally, the paper recommended that industrial policies should be geared towards promoting healthy competition (and not collusion) among manufacturing firms to attain optimal economic efficiency of resources.

Keywords: Efficiency, Competitiveness, Capital intensity, Market share, Firm performance, Manufacturing firms.
JEL Classification: D22, L25, O14.

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Contents

Contribution of this paper to the literature
This study investigated the existence of technical efficiency among manufacturing firms and examine its effects on firm performance in Nigeria's manufacturing industry between 2001 and 2017. The study revealed that 29% of the variation between the observed and optimal outputs is attributed to inefficiency among manufacturing firms. The study also added that intense competition among manufacturing firms increases the efficient use of resources which positively improves firm performance in Nigeria's manufacturing industry.

1. Introduction

Manufacturing industry has been identified as a crucial driver of industrialization given its significant roles in the development of the contemporary developed and emerging economies. This could be attributed to the technological processes involved in the transformation of raw materials to finished goods as well as the accompanied technical efficiency generated from using factor inputs to achieve maximum outputs. The efficient use of both human and capital resources, therefore, has great potential for the production of differentiated goods, job creation, development of the industrial sector and firm performance. Firm performance expressed in terms of profitability, growth, market value and some other socioeconomic indicators (Selvam, Gayathri, Vasanth, Lingaraja, & Marxiaoli, 2016) can be achieved by improving on the efficient use of factor inputs that enhances competitiveness of manufacturing firms both locally and internationally.

Since independence in 1960, Nigeria has aimed at industrialization with the hope of changing the economy from an agricultural and import-dependent to a more dynamic and export-oriented economy, especially through the export of industrial outputs (import substitution strategies). However, Nigeria has continued to experience a concomitant decline in the manufacturing sector output. According to the National Bureau of Statistics (2014), manufacturing sector contributed 10% to Nigeria's outputs compared with the 70% contributed by the primary sector (agriculture) before crude oil exploration in the 1970s. With the windfall gain from crude oil, the manufacturing sector's contribution to the national outputs declined drastically to 7.83% in 1982. In a bid to increase the performance of the industrial sector, the Nigeria Enterprise Promotion Decree of 1977, the Structural Adjustment Programme (SAP) of 1986; and other industrial development policies were directed towards domestic production of previously imported consumer products and the promotion of Nigeria's industrial sector to attain sustainable growth. With continued dependence on revenue from crude oil exports, the manufacturing sector performance decline in growth and value-added, contributing minimally to economic growth despite the emphasis placed on science, technology and innovation (STI) as key drivers of the economic reform of the National Economic Empowerment and Development Strategy (NEEDS) between 1999 and 2007 and the economic policy blueprint of Vision 20:2020 in Nigeria Chete, Adeoti, Adeyinka, and Ogundele (2014).

Given the role of industrialization in attaining economic growth and development, efficient use of resources in the manufacturing industry has substantial implications for firm performance. Efficient firms weed out less efficient ones because efficient firms tend to be competitive and, as a result, resources would be reallocated from inefficient firms to the efficient ones (Ahn, 2002; Obembe & Soetan, 2015; Soames, Brunker, & Talgaswatta, 2011). As the market becomes more competitive, efficient firms will increase their productivity and market share while inefficient firms lose their market share to the efficient ones, and either way firm profitability will be affected. Thus, the relationship between the efficient use of resources and firm profitability ultimately influence the overall firm performance. However, studies by Baten, Kamil, and Fatama (2009); Essmui, Berma, Shahadan, and Ramlee (2013); Helali and Kalai (2015) revealed that inefficiency exists in the use factor inputs among manufacturing firms, although, the effects of the inefficiency on firm performance is controversial (Addai-Asante & Sekyi, 2016; Din, Ghani, & Mahmood, 2007). Hence, this study estimates the resource utilization efficiency as well as examine the effects of the technical efficiency on firm performance in the Nigeria's manufacturing industry.

The technical efficiency measures the extent to which factor inputs are optimally utilized to produce outputs and this was achieved by separating inefficiency scores from random error (Battese & Coelli, 1995). This was estimated through the stochastic frontier analysis (SFA) as proposed by Aigner, Lovell, and Schmidt (1977) and Meeusen and van Den Broeck (1977) to estimate resources efficiency in applied economic research. The stochastic frontier analysis (SFA), a parametric approach, separates the deviations from the production frontier to white noise and technical inefficiency unlike the data envelopment analysis (DEA) which is non-parametric approach that allocates the deviation to technical efficiency/inefficiencies (Iinuma, Sharma, & Leung, 1999). Hence, the SFA technique reveals a general relationship between output and inputs and also accounts for random shocks (white noise) which are lacking in non-parametric DEA (Silva, Tabak, Cajueiro, & Dias, 2016). This study adopts the SFA approach because, in reality, the deviations from the production frontier in the manufacturing industry are not solely attributable to the inefficiency of manufacturers (Bolarinwa & Adegboye, 2020), certain deviations result from risk and uncertainty that surround the supply of materials and fluctuations in the market price of intermediate and finished goods of manufacturing firms.

Thus, this study generated a resource-use efficiency variable and examined its effects on firm performance among forty-three (43) quoted manufacturing firms operating in consumer (food beverages and tobacco), industrial and health (pharmaceutical) sectors by using stochastic frontier analysis. This was done in line with the Nigerian Economic Recovery and Growth Plan (ERGP) framework (2017-2020) that encourages STI to drive economic growth through the agro-processing sub-sector comprising firms operating in food, beverages, tobacco, and other manufacturing sub-sector.

2. Literature Review

Koh, Rahman, and Tan (2004) separated productivity growth into technical efficiency, technical progress and scale of economies effect and examined their contribution to productivity among 18 manufacturing industries between 1974 to 1998 in Singapore. Using the stochastic frontier analysis, it was revealed that the variation between the frontier and actual outputs resulted from technical inefficiency but the efficiency level tends to increase over time. The study further showed that technical progress contributed 1.5 per cent per annum, technical efficiency change contributed 0.5 per cent per annum and scale of economic efficiency contributed 0.8 per cent per annum to the productivity growth in the Singapore manufacturing industry. The study concluded that the Singapore manufacturing industry requires technology to improve on technology growth.

Din et al. (2007) studied the efficiency level of the large scale manufacturing sector in Pakistan. Stochastic frontier analysis and data envelopment analyses were employed to investigate efficiency level among 101 industries in Pakistan, the result of the stochastic frontier analysis showed that there is a small increase in the efficiency level of the large scale manufacturing firms. The result of the data envelopment analysis further supported that the efficiency level of the manufacturing sector has greatly improved and exert positive effects on firm performance as a result of economic reforms in the Pakistan manufacturing industry.

Furthermore, Baten et al. (2009) examined the effect of technical inefficiency on manufacturing industry performance among 279 industries in Bangladesh. The study employed stochastic frontier analysis and the ordinary least square method and showed the existence of technical inefficiency in the Bangladesh manufacturing sector, although, the inefficiency declines over the studied period. The study further revealed that the inefficiency of capital, labour (manual and non-manual) and raw material cost have significant effects on the manufacturing output level.

Similarly, Essmui et al. (2013) investigated the level of inefficiency and its effects on the performance of 207 firms in the Libya manufacturing industry. Stochastic frontier model was used and the study showed the existence of technical inefficiency in the Libya manufacturing industry as capital, labour and material inputs are not optimally utilized. The study concluded that outputs in Libya manufacturing industry can be increased without necessarily increase capital, labour and material inputs.

In a related vein, Helali and Kalai (2015) investigated technical, allocative and economic efficiencies and examined their effect on production output among 6 sectors in the Tunisian manufacturing industry between 1961 and 2010. The study adopted the stochastic and Bayesian model and found that technical inefficiency existed in the manufacturing industry and that output efficiency can be improved using the same inputs in production. It was also revealed that a lack of innovation and investment in technology in the manufacturing industry resulted in negative productivity growth.

Addai-Asante and Sekyi (2016) examined technical/resources efficiency in production among 39 Ghanaian Pharmaceutical firms. Using stochastic frontier analysis and the ordinary least square method, the study revealed that technical inefficiency exists in the pharmaceutical industry and resources inefficiency exerted a diverse impact on output level. It further showed that capital was more productive in the production of capsule compared to labour (skilled and unskilled). Although, skilled and unskilled labour was productive more than capital in the production of syrup. The study concluded that age and maintenance of plant, as well as the size of the professional labour, are technically efficient.

3. Stochastic Frontier Model

In stochastic frontier analysis (SFA), several functional forms are often used, however, the two most commonly used forms are Cobb-Douglas and transcendental logarithmic (trans-log) production functions. Following the study of Battese and Coelli (1995), this study adopted the Cobb-Douglas stochastic frontier production model rather than the trans-log production function given the likelihood ratio (LR) test statistics. The Cobb-Douglas production function is specified as;

$$Y_i = f(X_i;\beta) \tag{1}$$

Where Y_i is the optimum output obtainable; X_i is the vector of inputs and β represents unknown parameter. Stochastic frontier production function incorporates measurement error and unobservable shocks into the model as;

$$Y_i = X_i\beta + \varepsilon_i \qquad \text{for } i = 1,\dots,n \tag{2}$$

$$Y_i = \alpha_0 + X_i\beta + V_i - U_i \tag{3}$$

Where $\varepsilon_i = V_i - U_i$

Here, $V_i \sim i.i.d.\ \mathrm{N}(0,\sigma_v{}^2)$ and $U_i \sim i.i.d.\ \mathrm{N}(\mu,\sigma_\mu{}^2)$ are independently and identically distributed of each other and other explanatory variables. Following Battese and Coelli (1995) model which assumes truncated normal distribution, this study estimated the technical efficiency of firms in Nigeria's manufacturing industry through the Cobb-Douglas stochastic frontier model. The linear form of Equation 3 can be rewritten as:

$$lnY_{it} = ln(\alpha_0 + \sum_{j=1}^{n}\beta_j X_{j,it} + V_{it} - U_{it}) \qquad \text{for } i = 1,\dots,n, t = 1,\dots,T \tag{4}$$

$$lnY_{it} = \alpha_0 + \sum_{j=1}^{n}\beta_j lnX_{j,it} + V_{it} - U_{it} \tag{5}$$

$$Y_{it} = \exp(\alpha_0 + \sum_{j=1}^{n}\beta_j lnX_{j,it} + V_{it} - U_{it}) \tag{6}$$

Equation 6 can be rewritten as:

$$Y_{it} = \exp(\alpha_0 + \sum_{j=1}^{n}\beta_j lnX_{j,it}) * \exp(V_{it}) * \exp(-U_{it}) \tag{7}$$

Where $\exp(\alpha_0 + \sum_{j=1}^{n}\beta_j lnX_{j,it})$ are the deterministic component and the composite error term, ε_{it}, which is decomposed into noise effect V_{it} and efficiency parameter U_{it}. Thus, technical efficiency (TE_i) is expressed as the ratio of observed output to optimum output. The technical efficiency (TE_i) for the *i*-th firm at time *t* is defined as:

$$TE_{it} = \frac{\exp(X_{it}\beta + V_{it} - U_{it})}{\exp(X_{it}\beta + V_{it})} \quad (8)$$

Equation 8 presents the technical efficiency model which measures the extent to which factor inputs are efficiently or optimally utilized to produce outputs and this is done by separating efficiency scores from random error.

Equation 8 can be rewritten as:

$$TE_{it} = \exp(-U_{it}) \quad (9)$$

Equation 9 argues that the expected value of the exponential ($-U_{it}$) is the technical efficiency.

Given the truncated-normal assumption in the stochastic frontier analysis, the technical efficiency model is specified thus;

$$U_{it} = \delta_i Z_{it} + W_{it} \quad (10)$$

Equation 10 represents the technical efficiency level with respect to firm competitiveness.

Z_{it} represents the exogenous variable which in this case is competition (COM), W_{it} represents the error term of the efficient model and δ is the estimated parameter. A negative coefficient of δ connotes an increase in technical efficiency or a reduction in technical inefficiency.

3.1. Effects of Resource-use Efficiency on Firm Performance

The system GMM estimator (S-GMM) theorized by Arellano and Bover (1995) which Blundell and Bond (1998) developed was adopted by the study as its estimation technique to examine the effect of resource-use efficiency on firm performance using secondary data obtained from forty-three (43) quoted manufacturing firms operating in consumer (food beverages and tobacco), industrial and health (pharmaceutical) sectors. The S-GMM is preferred to difference GMM (D-GMM) because the presence of a lagged dependent variable as an independent variable in the D-GMM violates the orthogonality assumption. This is because the lagged dependent variable PEF_{it-1} depends on ε_{it-1}. However, system GMM augments difference GMM under the assumption that the first difference of instrumental variables is not correlated with the level errors. Besides, the system GMM estimator is preferred to the OLS and the fixed effects techniques in that the OLS and the fixed effect results generally suffer from the problem of endogeneity (Obembe & Soetan, 2015). This study, therefore, adopted System GMM framework that accommodates the endogeneity problem inherent in the explanatory variables and it also gives consistent parameter estimates for a small period of time, t, and large cross-sectional dimension, N. To examine the effects of resource-use efficiency on manufacturing performance, this study employed the S-GMM model specified as follows;

$$PEF_{it} = \lambda PEF_{it-1} + \beta EFF_{it} + X'_{it}\delta + \varepsilon_{it} \quad (11)$$

In Equation 11, PEF_{it} represents performance for firm *i* over period *t*; PEF_{it-1} entails the lagged value of the dependent variable for firm *i* over period *t*, EFF_{it} represents resource-use efficiency, *X* represents other control variables included in the model such as capital intensity (CIN) and firm market share (FMS) for firm *i* over period *t*. To solve the problem of endogeneity inherent in the explanatory variables, this study examined the effects of resource-use efficiency on firm performance using the system generalized method of moment (S-GMM) estimator as propounded by Arellano and Bover (1995).

3.2. Sources of Data

Secondary data were sourced from annual reports of quoted manufacturing firms on the Nigerian Stock Exchange (NSE). The population of the quoted manufacturing firms is fifty-six (56) consisting of consumer (food, beverages and tobacco - 26); healthcare (10); industrial (20) firms as categorised by securities and exchange commission (SEC). Total sampling technique was employed by the study, however, only forty-three (43) firms consisting of 19 firm operating in consumer (food, beverages and tobacco); 18 firms in industrial and 6 firms in healthcare (pharmaceuticals) were used due to unavailability of data for most of the quoted manufacturing firms for the period under study. These firms were chosen because they have greater access to foreign and domestic funds and they also invest more in research and development compared with non-quoted manufacturing firms. Secondary data were specifically obtained from the published annual reports and financial statements of the manufacturing firms.

Firms' total value of output (TVO) was measured by total annual sales of sampled manufacturing firms (Battese & Coelli, 1995). The labour input (LAB) was measured by the labour-to-revenue ratio. It is calculated as total labour cost divided by revenue. The labour-revenue ratio measures the efficiency of the labour force in generating revenue and it is estimated to be positively related to output. The capital input (CIP) was measured by the asset turnover ratio. The total asset turnover is calculated as revenue divided by average total assets which should be positively related to total output. The total overhead input (TOH) was measured by the operating expenses ratio. It is calculated as total overhead expenses divided by revenue. The operating expenses ratio showed how efficiently an organization is being managed and it is expected to be positively related to output (Edwards, Allen, & Shaik, 2006). YEAR is the year of the observation involved.

Technical efficiency scores (EFF) was derived by generating inefficiency from maximum output obtainable using stochastic frontier analysis (Battese & Coelli, 1995). Firm performance (PEF) was measured as the ratio of profit (profit before tax) to total asset. This shows the ability of a firm to generate profits by using all its asset (Ti & Chi, 2016). Capital intensity was measured by the ratio of tangible assets (fixed assets) to the total number of employees (Halpern & Muraközy, 2015). Firm market share which is the share of the market that each firm can capture was measured by the ratio of each firm's revenue to the industry revenue (Edwards et al., 2006). Competition (COM) was measured by the Price–Cost Margin (PCM). Intense competition in a market stimulates efficiency among incumbent firms (forces inefficient firms out), thereby increasing the average PCM among firms (Cranfield, 2002).

$$PCM = \frac{Revenue + \Delta Inventories - LabourCost - CostOf.Materials}{Revenue + \Delta Inventories}.$$

4. Results and Discussions

This study examined the effects of resource-use efficiency on firm performance in Nigeria's manufacturing industry. In a bid to achieve this, the study generated a resource-use efficiency variable for all sampled firms through the stochastic frontier analysis (SFA) technique. Following Battese and Coelli (1995) in estimating technical efficiency, the Cobb-Douglas and trans-log production functions were estimated and the appropriate production frontier between the two production functions was selected using the likelihood ratio test. The existence of inefficiency effects was also tested and analyzed using maximum likelihood statistics. This is because, manufacturing firms will not be able to achieve optimum technical efficiency until we can identify the sources of inefficiency (Tingum & Ofeh, 2017). Finally, the technical efficiency scores (EFF) of sampled manufacturing firms in Nigeria were generated using 43 Nigeria's manufacturing firms operating in consumer (food, beverages and tobacco), industrial; and healthcare (pharmaceutical) sectors between 2001 and 2017. The stochastic frontier production function consisted of labour input, capital input, overhead expenditure and total revenue.

4.1. Descriptive Statistics of Inputs and Output Data

In estimating the stochastic frontier analysis, labour, capital, overhead expenditure and total revenue from the selected manufacturing firms were sourced for the period between 2001 and 2017 in Nigeria. The dependent variable (total value of output) of the model is total revenue while labour input, capital input and overhead expenditure are the independent variables.

The descriptive statistics results in Table 1 reveal that the mean and median are in between their maximum and minimum values for all the inputs and output variables which show a high consistency level. The skewness statistics reveals that all the variables are negatively skewed. The kurtosis of all the variables exceeds 3 implying that the series is peaked (leptokurtic) compared to the normal distribution.

Table 1. Descriptive statistics.

Descriptive Statistics	LAB	CIP	TOH	TVO
Mean	-2.40	-0.45	-1.65	15.7
Median	-2.34	0.57	-1.54	15.9
Standard Dev.	0.80	0.91	0.81	2.07
Minimum	-6.89	-5.56	-5.22	8.39
Maximum	0.16	2.59	0.64	20.5
Skewness	-1.15	-1.78	-0.98	-0.37
Kurtosis	7.43	10.8	5.40	3.05
Observations	610	647	577	658

Note: LAB, CIP, TOH and TVO represent the natural logarithm of Labour input, Capital input, Total overhead expenditure and Total value of output (Sales).

4.2 Stochastic Frontier Analysis Results

The maximum likelihood estimates of the time-invariant inefficiency model for the Cobb-Douglas production function (assuming a truncated-normal distribution) was obtained and reported in Table 2. The Cobb-Douglas and the transcendental logarithmic (trans-log) production models were estimated, however, the Cobb-Douglas model was presented rather than the trans-log production function following the likelihood ratio (LR) estimates. The probability value of the likelihood ratio (14.42) is not significant at a 5% significant level, thus the rejection of the null hypothesis that the Cobb-Douglas production function is nested in full in the trans-log production function. This study accepts the alternative hypothesis that the Cobb-Douglas production function is not nested in full in the trans-log production function, hence, the Cobb-Douglas production function was presented.

The results showed that the coefficients of labour (LAB) and overhead (TOH) inputs from the Cobb-Douglas model are negative and statistically significant at a 5% level except for capital input (CIP) which is positive at a 5% significant level. The negative coefficient of labour (LAB) input could be as a result of incessant activities of labour unions (such as strike actions), low wage rate and unfavourable working conditions of workers. These will, in turn, affect labour efficiency and reduce firm performance (Tingum & Ofeh, 2017). The MLE further explains the concepts of elasticity and returns to scale. The output elasticity is explained by the estimated coefficients of input variables (labour, capital and overhead) from the MLE.

The results revealed that the elasticity coefficients of labour input (-0.6084) and total overhead input (-0.5361) are negative which implies that labour input (LAB) and total overhead expenditure (TOH) had significant negative effects on the outputs level in Nigeria's manufacturing industry. By implication, a percentage increase in all the input variables will result in less than a proportionate increase in firms' outputs and revenue level. Conversely, the elasticity coefficient of capital input (0.2114) is significantly positive, thus, capital input (CIP) has a significant positive effect on outputs level among manufacturing firms in Nigeria. Succinctly, the summation of all elasticity coefficients (-0.9331) shows that Nigeria's manufacturing firms operate on a decreasing return to scale.

4.2.1. The Inefficiency Effects

Table 2 also reveal the existence of inefficiency in the Cobb-Douglas model. According to Ahmadzai (2017), the coefficient of gamma implies that the variance between the observed outputs and optimum level of outputs is attributable to technical inefficiency. The coefficient (γ=0.29) from the model shows that about 29% of the difference between the observed output and maximum outputs comes from inefficiency on the part of the manufacturer/production team. By implication, about 29% of the difference between the observed output and the frontier outputs results from inefficiencies among manufacturing firms. This shows reductions in the frontier outputs using capital input, labour input and total overhead expenditure. However, 71% of the variation is attributable to random effects such as risk and uncertainty that surround the supply of raw materials as well as fluctuations in the market price of intermediate and finished goods of manufacturing firms. Thus, the null hypothesis which states that the variation in production is not attributable to technical inefficiency is rejected. This finding is consistent with the study of Helali and Kalai (2015) which showed that the variation in production output is attributable to technical inefficiency and random effects.

The knowledge of technical efficiency will not be useful if we do not understand the source of the efficiency. Table 2 shows that the coefficient (δ) of competition (-1.1840) in the inefficiency effects section of the production function is negative and significant at a 5% level. The negative coefficient of competition showed a reduction in technical inefficiency or an increase in technical efficiency. This indicates that in manufacturing industry, firm competitiveness motivates the resource-use efficiency of manufacturing firms. This is in line with Esquivias and Harianto (2020) who found that competition (in terms of export and import activities) has positive impact on firms' technical efficiency level. This implies that a higher level of efficiency will be attained by competitive firms (firms that are export-oriented as well as firms that have access to imported raw materials) compared with less competitive firms with no export and/or import activities which face the risk of being driven out of the market by competitive firms. Hence, this study revealed that the source of technical efficiency among Nigerian manufacturing firms is dependent on the level of industrial competitiveness.

Table 2. Cobb-Douglas maximum likelihood estimates.

Method	Variable	Coefficient	Std. Error	t-value	Prob.
Production Frontier	Constant	331	284	1.17	0.24
	LAB	-0.61	0.12	-5.22	0.00***
	CIP	0.21	0.11	1.96	0.05**
	TOH	-0.54	0.11	-5.10	0.00***
	YEAR	-41.7	37.4	-1.11	0.27
Inefficiency Effects	σ_u^2	0.49	0.30	1.63	0.10
	σ_v^2	1.69	0.73	23.2	0.00***
	γ`	0.29	0.36	0.82	0.41
	Constant	0.87	0.42	2.07	0.04**
	COM (δ)	-1.18	0.21	-5.54	0.00***
	Log-Likelihood	-1088			
	Wald Chi²	112			
	Prob.	0.00			
	Likelihood-ratio LR Chi²	14.4			
	Prob.	0.08			

Note: LAB, CIP, TOH and YEAR represent the natural logarithm of Labour input, Capital input, Total overhead expenditure and Year of observation involved.
***, ** significance at 1% and 5% respectively.

4.2.2. Estimation of Technical Inefficiency Scores

Table 3 reveals the existence of technical inefficiency with a sample mean of 19.15% in the selected sample of quoted manufacturing firms. This reveals that there are technical inefficiencies in Nigeria's manufacturing industry. By implication, manufacturing firms operating in consumer (food, beverages and tobacco); industrial; and healthcare (pharmaceutical) sectors obtained 80.85% outputs from utilizing available capital, labour and total overhead inputs. Put differently, the sampled manufacturing firms only produced 80.85% outputs which were below the maximum obtainable output while the rest of their output (19.15%) is attributed to inefficiency. The analysis of technical inefficiency scores of sampled firms is also presented in Table 3.

Table 3. Technical inefficiency statistics.

Mean	Median	Maximum	Minimum	Std. Dev.
19.15812	18.9	22.5	17.3	1.07

4.3. Effects of Resource-use Efficiency on Firm Performance

Under normal market conditions, resource-use/technical efficiency results in higher firm performance in terms of high profitability. However, when markets are characterized with imperfections and asymmetric information, resource-use efficiency together with other performance-related factors may negatively affect firm performance. The study had established that inefficiency existed in the resource utilization among Nigeria's manufacturing firms for the period between 2001 and 2017 (see Table 2). Given the existence of inefficiency in the use of factor inputs by manufacturing firms in Table 3, the resource-use efficiency variable (EFF) was derived by generating firms' inefficiency scores from the maximum output obtainable to examine the effect of resource-use efficiency on firm performance in Nigeria's manufacturing industry.

Table 4 shows the effects of resource-use efficiency (EFF) on firm performance in Nigeria's manufacturing industry using the generalized method of moments approach. The results indicated that the effect of resource-use efficiency (0.087%) is positive on firm performance, though not statistically significant at 5% level. By implication, the efficient utilization of factor inputs in the manufacturing industry has positive effects on profitability and subsequently on firm performance.

Besides, the results showed that firm performance in the previous period (PEF(-1)) has a significant positive effect (0.1155) on the current firm performance at a 5% significant level. This means that a unit increase in the last period performance leads to an 11.55% increase in the current period performance. Similarly, firm market share (FMS) exhibits a positive effect (1.3738) on firm performance at a 5% level of significance, meaning that a unit increase in the firm market share results in 137% increases in firm performance.

Conversely, the results show that capital intensity (CIN) has significant negative effects (-0.0258) on manufacturing firm performance but insignificant at a 5% level. The adverse effect of capital intensity on firm performance is not unconnected with the existence of technical inefficiency among manufacturing firms as reported in Table 3.

The generalized method of moments diagnostic test was also reported in Table 4 and it revealed the validity of instruments employed as well as the absence of auto-correlation in the model. Hansen statistics explains the validity of instruments. The overall validity of instruments holds since the null hypothesis (p-value > 0.05) that supports the choice of the instruments at a 5% level of significance cannot be rejected. Similarly, auto-correlation of the error term was carried out to test the null hypothesis that the error term is auto-correlated. The probability value of the AR(2) in Table 4 which is 0.601 shows that the null hypothesis of no serial correlation cannot be rejected, rather, the results imply that the original error term is not correlated at 5% significant level, moment conditions are correctly specified and the model does not suffer from second-order auto-correlation.

Table 4. System GMM.

Variables	Coefficient	Std. Error	t-Statistic	Prob.
PEF (-1)	0.11	0.04	2.71	0.01***
EFF	0.00	0.02	0.04	0.97
FMS	1.37	0.44	3.08	0.00***
CIN	-0.03	0.15	-1.69	0.09**
C	0.23	1.77	0.13	0.89
No. of Obs.				688
F statistic				4.89
Group/Instruments				43/21
AR (2)				0.60
Hansen Statistic				0.99

Notes: ***, ** represent significance at 1% and 5% respectively.

In addition, the study showed in Table 5 that younger manufacturing firms between 0 – 20 years are the most inefficient (21%) compared with much older firms between 51 – 60 years (18.70%), suggesting that younger firms are likely to perform poorly compared to older firms in Nigeria's manufacturing industry. As reported by Krusinskas, Norvaisiene, Lakstutiene, and Vaitkevicius (2015) this can be attributed to the fact that small and medium-tech firms lagged behind the high-tech firm in innovation. According to Soames et al. (2011) who opined that small and medium firms are not likely to survive if they are inefficient unlike large firms which can profitably remain in business even at sub-optimal production levels. This might be attributed to the fact that younger firms between 0 - 20 years, at the beginning of business operations, will have large sunk cost and are competing with large existing firms who have been in operation for 51 – 60 years.

However, the high inefficiency scores of firms that are 61 years and above could be attributed to the technology employed in their production. Many of these technologies are considered archaic and outdated compared to the types of technologies employed by younger firms. By implication, firms that are 61 years and above usually operate below production frontier level compared with younger firms.

Table 5. Mean technical inefficiency by firm age.

Variable	Years	Inefficiency
Firm Age	0-20 years	21.00%
	21-30 years	20.60%
	31-40 years	20.00%
	41-50 years	19.50%
	51-60 years	18.70%
	61 and above	19.00%

5. Conclusion

The study identified the existence of inefficiency in the use of resources among manufacturing firms in Nigeria. However, it was observed that competition significantly increases the efficient utilization of resources among manufacturing firms. This study further showed that resource-use efficiency has positive effects on manufacturing firm performance. The study concluded that intense competition increases efficient utilization of resources and resource-use efficiency subsequently improves firm performance in Nigeria manufacturing industry.

6. Policy Recommendations

The study revealed the existence of technical inefficiency (reduction in the optimum/frontier output) arising from capital input, labour input and total overhead expenditure among manufacturing firms. Therefore, policies on the efficient utilization of resources (capital input, labour input and total overhead expenditure) that will bridge the gap between actual output and potential output should be developed to achieve optimal production efficiency and prevent voluntary winding up or outright relocation of Nigerian firms to neighbouring countries. The study also showed that firm competitiveness enhances resource-use efficiency, as a result, the study recommends industrial policy that will promote healthy competition (and not collusion) among manufacturing firms to attain optimal economic efficiency of resources that will enable the economy to compete effectively with the developed and newly industrialized countries of the world.

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