AN APPLICATION OF STOCHASTIC FRONTIER PRODUCTION FUNCTION TO AGRIBUSINESS FIRMS IN LAGOS AND OGUN STATES, NIGERIA

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ABSTRACT

The Nigerian manufacturing sector has been characterized by relatively low productivity and slow growth, a situation that could be attributed to inefficiency. The need for efficient-allocation of productive resources cannot be overemphasized. Every factor of production-should be efficiently and effectively mobilized to close the gap between actual and-potential national outputs. This study evaluates the technical efficiency level of Agribusiness firms in Lagos and Ogun States, Nigeria. Specifically, the objectives were to identify socio-economic characteristics that influence technical efficiency; to determine levels of technical efficiency; and to identify and analyse the determinants of efficiency. Primary data used for this study were obtained from a representative sample of 120 Agribusiness firms and were selected using purposive and simple random sampling techniques.

Frequency table and Maximum Likelihood Estimates (MLE) were obtained using Cob-Douglas Stochastic Production Frontier model to estimate the technical efficiency variables. Technical efficiency estimates of the Agribusiness firms showed that majority of the firms were operating above 70% level. Age of the business operator-was a major determinant that influenced technical efficiency at 5%; educational level of business operator and level of investment were significant at 1% and 10% respectively, while Total worth of investment was negatively significant. The study revealed that the Agribusiness firms were technically inefficient and therefore, there is room for efficiency growth. It also recommended that the Federal Government of Nigeria should develop and implement policies that would encourage investment through the reduction of interest rate and collateral demands by commercial banks.

KEYWORDS: Agribusiness, Technical Efficiency, Firms, Stochastic Frontier, Maximum Likelihood Estimation

INTRODUCTION

The word 'Agribusiness' has been defined to include not only those that farm the land but also the people and firms that provide the inputs, process the output, manufacture the food products, and transport and sell the food products to the consumers-(Baruah, 2017). Agribusiness was also defined as the total output arising from farm production and product processing at both pre- and post farm gate levels (Acharya, 2007). The term 'Agribusiness' was first introduced by Davis and Goldberg (1957). According to them, it is a three part system made up of the agricultural input sector, the production sector and the processing-manufacturing sector.

In Nigeria, Agribusiness firms are scattered all over the country but are concentrated in three main industrial clusters in Nigeria namely; Kano, Kaduna and Jos in the North; Lagos, Otta, and Ibadan in the South West and Port Harcourt, Aba, Nnewi, Onitsha in the South East. In general, the Lagos-Otta-Ibadan axis accounts for 44 percent of the registered firms and roughly 52 percent of the total employment figures for these companies. The largest firms are also located in the Lagos area. About 60 percent of the firms are small-scale enterprises (between 20 and 49 employees),-accounting for 12% of employment figures. With a few exceptions, firms with more than 500 employees provide the

bulk of sectoral employment accounting for 53%-of total employment in the manufacturing sector (Marchet *et al.*, 2001).

Agribusiness enterprises in Nigeria can be classified into four major groups namely; farming input supply companies, producing farm firms, food processing agribusiness firms, and food marketing and distribution agribusiness organizations. These four groups can be found in both formal and informal sectors of the economy. The formal agribusiness sector is defined as any Agriculture-based manufacturing firm registered with the National Directory of Establishments published by the National Bureau of Statistics. This includes those that are registered with the Manufacturers Association of Nigeria (MAN) and the National Association of Small and Medium Scale Enterprises (NASME).

The informal sector is not registered with these umbrella bodies but may or may not be organized into localised associations. Examples include food processors, private food stores, farmers' cooperative societies and wholesalers scattered all over the country.

In Nigeria, Agribusiness firms have developed over the years from small-scale to large-scale but lack of high efficiency and productivity are still major challenges faced by these firms. Therefore, any attempt to identify determinants of efficiency of productive resources would help in achieving firm growth at macro level. Besides, economic difficulties in most developing countries today, including Nigeria, make the financing of inputs/capital accumulation infeasible. Hence, the focus on industrial growth is shifting to issues of efficiency in the use of the available quantum of productive inputs.

Efficiency is a measurable concept, quantitatively determined by the ratio of output to input. Efficiency in general, describes the extent to which time or effort is well used for the intended task or purpose. It is often used with the specific purpose of relaying the capability of a specific application of effort to produce a specific outcome effectively with a minimum amount or quantity of waste, expense, or unnecessary effort. The measurement of the level of efficiency and the identification of its sources are essential to improving the economic performance and can be a useful decision tool for adopting management strategies and policies that would induce firms to become more productive (Theodoridis *et al.*2017). The need for the efficient allocation of productive resources cannot be overemphasized and the importance of measuring efficiency is discussed in Ajibefun and Daramola (2003). The concept of efficiency is divided into three namely; Technical, Allocative and Productive Efficiencies (Okoruwa *et al.* 2014)

Therefore, the purpose of this study is to evaluate the Technical Efficiency (TE) of Agribusiness firms in Lagos and Ogun States of Nigeria.

Specifically, the objectives are to: identify socio-economic characteristics that influence TE of the Agribusiness firms; determine the levels of their TEs; analyse the determinants of efficiency; and estimate TE of the Agribusiness firms;

Hypothesis

H_0: Selected Agribusiness firms are efficient and have no room for efficiency growth

H_1:Selected Agribusiness firms are not efficient and have room for efficiency growth

Theoretical Framework

Technical efficiency (TE) is a term used to describe the way through which natural resources are transformed into goods and services without waste. There is no waste of material inputs. There are no workers standing idly around waiting for spare parts. The maximum amount of physical production is obtained from the given resource inputs. In essence, production is achieved at the lowest possible opportunity cost. Technical efficiency refers to the ability of a firm to produce maximum output given its inputs (Badunenko *et al.* 2005). So many research works have been conducted on TE. These include the works of Awoyemi *et al.* (2014), Otekunrin (2011), Ogundari and Ojo (2007), Okoruwa *et al.* (2014), Rezitis *et al.* (2003) among others.

METHODOLOGY

The research was carried out in Lagos and Ogun States. Both States are situated in the South-Western Zone of Nigeria and they are selected due to their prominence in Agriculture and Agribusiness-related activities.

Sampling Technique

Purposive and Random Sampling techniques were used to select the respondents. Lagos and Ogun States were purposively selected. Lagos State was selected because it is the commercial nerve centre of Nigeria while Ogun State was selected because of its nearness to Lagos State and the large number of Agribusiness firms located in the State. A list of Agribusiness firms in Nigeria was provided by the Manufacturers Association of Nigeria (MAN). Simple Random Sampling (SRS) technique was used to select 60 Agribusiness firms each from the two States making a total sample size of one hundred and twenty (120) firms.

Analytical Techniques

Descriptive statistics (such as frequency distribution and percentages), MLE and Stochastic Frontier (SF) were used to analyse the data collected.

Model Specification

Technical Efficiency estimation

The Cobb–Douglas (1928) SF production function specifies the technology of the enterprises. The model was defined by:

$$lnY_i = f(X_i, \beta)exp(V_i - U_i), i = 1, 2, \ldots, n \ldots\ldots(1)$$

Where *ln* represents the natural logarithm; the subscript i represents the i*th*enterprise; and Y represents the value of output, which is measured in monetary unit (naira). X represents the quantity of inputs used in production by i*th*enterprise, and varies between *1*and n inputs.

The $V_i's$ are assumed to be independent and identically distributed random errors, having$N(0, \sigma_v^2)$distribution, independent of the$U_i s$. The $U_i s$ are technical inefficiency effects, which were assumed to be non-negative random variables.

This SF model was also independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977).

Determinants of TE

Some of the factors that influence the TE were determined quantitatively by using the Ordinary Least Square multiple regression analysis (OLS) under the assumption that data collected fulfilled the assumptions of multiple regression model.

Technical Efficiencies were assumed to be determined by firm specific variables, and was expressed as: $\mu_{ii} = \delta 0 + \Sigma \delta_{iz}$ .....(3)

Where δs are unknown parameters to be estimated and the z_s represent the factors that could influence efficiency of the enterprises.

The empirical model of the Stochastic Frontier model applied in the analysis is as stated in equation (1) and the variables estimated were:

Output (Y) measured in Naira;

X_1: Quantity of Agricultural raw materials in (Kg); X_2: Quantity of other materials used (Kg);

X_3: Quantity of water (in Litres); X_4: Working hours (in man-days);

X_5: Total material cost (in Naira); X_6: Depreciation on equipment (in Naira);

X_7: Age of business operator/decision maker (in years); X_8: Level of education of business operator/decision maker (in years); X_9: Number of employees; X_{10}: Total worth of investment (in Naira)

RESULTS AND DISCUSSION

Socio-Economic Characteristics

Table 1 presents the distribution of the years of business operation of the Companies considered. Thirty-seven (37) companies out of the one hundred and twenty (120) companies have been in

existence for about 11-15 years accounting for 30.83% of all. Other companies considered have been in existence for between 6-10 years, 16-20years, 21-25years, over 25 years representing 17.50%, 16.67%, 15.83%, 19.17% respectively of the total number of companies (120).

Table 1: Distribution of *Ages of Business (Years of Operation)*

Age of Business (years of operation)	Frequency	Percentage
6-10	21	17.5
11-15	37	30.83
16-20	20	16.67
21-25	19	15.83
> 25 years	23	19.17
Total	120	100
Mean Value	1.548073	

Table 2 shows the distribution of the educational status of the Business Owners. 72.50% of the owners have Master's degree while 27.50% have first degrees.

Table 2: Distribution of *Educational Status of Business Operators*

Educational Status	Frequency	Percentages
First Degree	38	27.50
Masters Degree	87	72.50
Total	120	100

Table 3 shows the distribution of the ages of the Business Operators. Forty-seven and a half percent (47.50%) of the Business Operators are in the age range of 41-45years. 10% and 19.17%of the respondents are in the age range of 35-40years and 46-50years respectively while 12.50% and 10.83% of the respondents are in the age range of 51-60years and over 60years respectively.

Table 3: Distribution of *Ages of Business Operators*

Age of Business Operator (years)	Frequency	Percentage
35-40	12	10
41-45	57	47.5
46-50	23	19.17
51-55	15	12.50
> 55	13	10.83
Total	120	100
Mean Value	5.35579	

Table 4 shows the Gender distribution of the Business Operators. 70% of the respondents were Males while 30% were Females.

Table 4: Gender Distribution of Business Operators

Gender	Frequency	Percentage
Female	36	30
Male	84	70
Total	120	100

Technical Efficiency Estimate

The Maximum Likelihood Estimate for the variables was obtained after transforming the variables into log form and then running a Stochastic Frontier Production Function. Table 5 shows the MLE result which indicates that age *of business operator* was significant at 5%, while *Level of Investment* was negatively significant at 10%.

Table 5: Maximum Likelihood Estimates (MLE) result

Variables	Coefficient	Standard deviation	Z values
Constant	22.475	5.121	4.39
Quantity of Agric. raw materials (X_1)	-0.045	0.0507	-0.90
Quantity of other materials used (X_2)	0.117	0.117	1.0
Quantity of water (X_3)	-0.051	0.131	-0.39
Working hours (X_4)	-0.231	0.517	-0.45
Total material cost (X_5)	0.007	0.061	0.12
Depreciation on equipment (X_6)	-0.396	0.516	-0.77
Age of Business Operator (X_7)	3.632	1.327	2.74**
Level of education of Business Operator (X_8)	-0.010	1.356	-0.01
Number of employees (X_9)	-0.022	0.441	-0.05
Total worth of investment (X_{10})	-0.580	0.432	-1.34***
$\ln\sigma_v^2$	-9.576	2.487	-3.85
$\ln\sigma_u^2$	1.109	0.193	5.75
Sigmaσ_v	0.008	0.010	
Sigmaσ_u	1.741	0.168	
Sigmaσ^2	3.031	0.584	
Lamda λ	209.065	0.168	
Log likelihood	-110.727		

Source: *Field Survey 2013* **5%, ***10% significance level

Determinants of Efficiency

Table 6 shows the determinants of efficiency. *Educational level* and a*ge of business operator* were significant at 1% and 5% respectively. This result indicates that with access to more business knowledge and decision making skills, firms will be more technically efficient. The significance of a*ge of business operator* simply implies that younger people are better equipped and make better use of technology in their production process.

Table 6: Determinants of Technical Efficiency

Variable	Coefficient	Standard error	T values
Constant	-0.303	0.093	-3.26
Age of Business Operator (M1)	0.126	0.061	2.07**
Educational level of Business Operator (M2)	0.112	0.019	6.02*
Number of employees (M3)	0.333	2.97	0.11
Total worth of investment (M4)	-380.6517	10236.3	-0.04
Age of business (M5)	-0.990	0.823	-1.20
R^2	0.2467		
R^{-2}	0.2137		
F value	7.47		

Source*: Field Survey 2013* *1%, **5% significance level

Technical Efficiency Level

Table 7 indicates that technical efficiency (*TE*) indices range from *30* to *100* percent for the firms in the sample, with an average of 71 per cent. This shows that the firms still have room for efficiency growth.

Table 7: Technical Efficiency Level

Technical Efficiency Level	Percentage
90-100	4
80-89	29
70-79	58
60-69	0
50-59	5
40-49	17
30-39	7
Below 30	0
Mean value	**71**

Hypothesis Test

In Table 8, Likelihood-ratio test of sigma_u=0 was 69.80, the null hypothesis of technical efficiency and no room for further efficiency growth was therefore rejected. This was ascertained by the result of average TE level of the firms at 71% (Table 7), Agribusiness firms in the study areas still has 29% room for efficiency growth.

Table 8: Hypothesis Testing

Null Hypothesis	Calculated value	Df	P-value	Decision
H0;u=0	69.80	13	0.0000	Rejected

CONCLUSION AND RECOMMENDATIONS

This study has established the fact that the Agribusiness firms in the sampled data are not technically efficient and therefore have room for further efficiency growth as evidenced in the average Technical Efficiency level of 71%. However, level of investment, age and educational level of business operators were significant at 10%, 5% and 1% respectively.

Age of business operators was found to be a vital and sensitive factor influencing Technical Efficiency coupled with operators' level of education which exposes them to business information for better economic decision making to improve on the firms' production and Technical Efficiency (TE) level.

Firms should encourage young and brilliant minds to manage Agribusiness enterprises as they are better in embracing and managing technology for better performance. Business managers should also pursue more knowledge in their line of business as this will ensure they get the right business information and knowledge to make them better decision makers.

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