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Stochastic Frontier Estimation of Economic Efficiency of Small and Medium Scale Feed Processing Enterprises in Imo State, Nigeria; Using Translog Profit Function Model.

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Abstract:
Feed constitutes 70% of operating cost in livestock business in Nigeria. But the quality of the products from processing is very low. The method is very tedious resulting perhaps from inefficient use of technique and low management at enterprise level. To investigate in to the fact, the study was conducted at enterprises level in two Agricultural Zones in Imo State with a sample of 80 each of small and medium scale enterprises to ascertain the level of economic efficiency and determinants of economic efficiency using stochastic translog profit function. The result shows that both small and medium scale enterprises were not efficient. There was no significant difference in mean efficiency between the small and medium scale enterprises. The determinants of economic efficiency result shows that business experience, credit status and labour influenced efficiency for small scale enterprise while membership to cooperative organization, business experience, credit status and labour influenced efficiency in medium scale enterprise respectively. . The study observed that there was an opportunity for increase in enterprises' efficiency and concluded that policies that would directly affect these identified variables should be pursued vigorously.
Key words: stochastic frontier, economic efficiency, translog, profit function, small and medium scale, feed processing, enterprise, Imo State, Nigeria, profit function

1.0 Introduction

It is well recognized that feed represents the most significant cost of animal production. Even with sheep, which typically consume more forage (as a percentage of their diet) than do other domestic species, feed may represent 55% or more of total costs. For poultry at least 70% of the production costs estimates are feed costs(FAO,2000).The high demand for animal feed is derived from the demand for animal products as human food, and general pattern is that this demand rises in response to increase in income and population(ODNRI, 1988). The productivity of the existing small and medium scale feed processing enterprises are low and it is estimated to meet only about 60% of per capita demand for livestock products (Okumadewa, et al,2002 and Emesowum,.et al,2008). Oladejo, *et al* (2006) reports that poultry has the highest feed conversion rates and produces the cheapest, commonest and best source of animal protein.

Feed processing and the costs associated with processing include a wide range of unit operations including receiving, grinding, proportioning, mixing, pelleting, load out, and delivery. Nearly every one of these operations can have either a negative or positive influence on quantity and quality of feed produced and can certainly influence final profitability (Ojo, 2003). According to IFC, (2003) the small and medium processing employ four to fifty workers. The problem of economic efficiency in the utilization of resources has been the greatest concern of agribusiness entrepreneurs (Awoke and Okorji, 2003). Efficiency utilization of productive resources may be affected by factors such as; Government policies, customs and institutions or cultural configuration, cost

structures, resource management, ownership patterns, resources administration and services (Nweke and Winch 1979). According to Ogunfowara and Olayide (1981), resources are not efficiently utilized or allocated under small and medium scale processors which are mainly traditional in style. This depicts a big potential for increased output; however, the biggest challenge is limited knowledge on the causes of this inefficiency. Thus, this study therefore aimed at estimating economic efficiency of small and medium scale enterprises in Imo State and its determinants.

2.0 Methodology

2.1 Study Area; The study was conducted in Imo State, specifically, Orlu and Owerri agricultural zones. The area lies between latitude of 5.2^{o}N and 6.08^{0}N and longitude of 6.6^{0}E and 7.5^{0}E. The area has tropical climate characterized by high rainfall and temperature range of 1500mm-2000mm and 34^{0c}-37^{0c} respectively. Agriculture is the major occupation of people and the major arable crops cultivated in this area include cassava, yam, cocoyam, maize, pepper, and other vegetables. The plantation crops such as oil palms, coconuts, rubber, cocoa, plantain and bananas. Livestock reared in Imo State include poultry, goat and sheep. Two out of three agricultural zones were purposively selected for the study. They are Orlu and Owerri zones. A multistage sampling technique was adopted for the study. Four Local Government Areas were purposively selected from two zones and ten small and medium scale feed processing enterprises were purposively selected per LGA. 80 each of small and medium scale enterprises were selected for the study, making a total 160 enterprises. Data were analyzed using descriptive statistics such as frequencies, percentages, and means

2.1.1 Model Specification

The normalized translog profit function model was used to analyze the economic efficiency in small and medium scale enterprises. This can be specified as follows

$$\Pi^{*} = \Pi/p = F^{*}_{i}(X_1; Z) \qquad 1$$

Where

Π= normalized profit of the ith enterprise

X_1 = vector of variable input prices

Z = vector of fixed input prices

Alternatively, the above equation can be written in transcendental logarithmic model form as stated below;

$$In\Pi_E = \beta_o + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + 0.5\beta_6 InX_1^2 + 0.5\beta_7 InX_2^2 + 0.5\beta_8 InX_3^2 + 0.5\beta_9 InX_4^2 + 0.5\beta_{10} InX_5^2 + 0.5\beta_{11} InX_1 InX_2 + 0.5\beta_{12} InX_1 InX_3 + 0.5\beta_{13} InX_1 InX_4 + 0.5\beta_{14} InX_1 InX_5 + 0.5\beta_{15} InX_2 InX_3 + 0.5\beta_{16} InX_2 InX_4 + 0.5\beta_{17} InX_2 InX_5 + 0.5\beta_{18} InX_3 InX_4 + 0.5\beta_{19} InX_3 InX_5 + 0.5\beta_{20} InX_4 InX_5 + V_i - U_i \qquad 2$$

Where

$\prod_E$ = normalized profit in Naira

X_1 = wage rate normalized by the price of output per enterprise

X_2 = price of other inputs normalized by the price of output per enterprise

X_3 = price of petroleum/fuel used normalized by the price of output per enterprise

X_4 = Unit cost of transportation normalized by the price of output per enterprise

X_5 = capital (interest rate) Naira per enterprise.

U_1=error term under the control of the enterprise

V_1 =error term not under the control of the enterprises

β_0=intercept

β_1-β_{20}= estimated coefficients

The determinants of economic efficiency, U_i is defined by

$$\text{Exp}(-U_i)] = b_o + b_1 Z_1 + b_2 Z_2 + b_3 Z_3 + b_4 Z_4 + b_5 Z_5 + b_6 Z_6 + b_7 Z_7 + \varepsilon \qquad 3$$

Where

Exp $(-U_i)]$ =Efficiency of the ith enterprise

Z_i = Age of the enterprise (in years)

Z_2 = Labour (in man-days)

Z_3 = credit status (Access = 1, No access = 0)

Z_4 = Business Experience (in years)

Z_5 = Membership of cooperative society (member = 1, non = 0)

Z_6 = Number of employees

Z_7 = Extension visit (number of times)

ε = Error terms

β and bs are scalar parameters that were estimated. To estimate the model and separate inefficiency (U_i) some assumption i.e. N (0, σ^2_v) while U_i has a half normal distribution i.e. U_i = (0, σ^2_v). The estimates for all the parameters of the stochastic frontier function and the inefficiency were simultaneously obtained, using the computer program frontier version 4.1(Coelli, 1996). Tests of null hypothesis on efficiency was carried out using the generalized likelihood ratio (LR) test statistic which is defined by

$$\lambda = -2 \ln [L(H_o)/2(H_1)] \quad 4$$

Where $L(H_o)$ is the value of the likelihood function for the frontier model, which the parameter restrictions specified by the null hypothesis, Ho, are imposed; and H_1 is the value of the likelihood function for the general frontier model. The test statistic LR (λ) has a chi-square (X^2) distribution which has a degree of freedom equal to q+1, where q is equal to the number of parameters involved in H_o and H_1 (Spilaimen and Lansink, 2005). If the null hypothesis is true then λ has approximately chi-square (or mixed square) distribution with degrees of freedom equal to the difference between the parameters under H_1 and H_o, respectively. The efficiency indices were compared using a t-test as stated below

$$t_{cal} = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad 5$$

Where

X_1 = the mean economic efficiency indices of small scale enterprises

$\mathbf{X_2}$ = **the** mean economic efficiency indices of medium scale enterprises

S_1^2 = the variance economic efficiency indices of small scale enterprises

S_2^2 = the variance of economic efficiency indices of medium scale Enterprises

n_1 = the number of sampled small scale enterprises

n_2 = **the** number of sampled medium scale enterprise

3.0 Results and Discussion

3.1 Features of Small and Medium Scale Feed Processing Enterprises

The results in table 1 indicate that majority (71.25%) of small scale feed processing enterprises fell within the age bracket of 1-10 years while 58.75% of medium scale feed processing fell with the age bracket of 11-20 years. About 36.25% of small scale processing enterprise had between 6-10 years of business experience while 35% had between 11-16 years of experience for medium scale enterprise. The percentage of small scale processing enterprise that employed between 1 and 10 people were 81.25% while medium scale enterprise that employed between 21 to 30 people were 52.5%.

3.2 Estimation of Economic Efficiency

Table 2 depicts the maximum likelihood estimates of profit frontier translog function of small scale feed processing enterprises in Imo State. The result shows that the sigma (δ^2 = 0.320) and the gamma (γ = 0.999) are quite high and significant at 1.0% level of probability respectively. The high and significant value of sigma square (δ^2) indicates the goodness of fit and the correctness of the specified assumption of the composite error term distribution (Nwachukwu, 2006). The gamma shows that 99.9% variation in the total profit is due to inefficiency and one-sided error. The coefficients of wage, transportation and interest rate were significant but wage rate is with desired positive sign, which agrees with a priori expectations while transportation and interest rate were negatively signed. This implies that increased price of labour should be encouraged since the factor is underutilized. Most of the second order coefficients were statistically significant at the conventional significance levels imply the suitability of the translog function (Emesowum,et al 2008). Among the second order terms, the coefficients of the square term for price of feed, cost of transportation, interest rate and those of interactions of wage rate and unit cost of transportation, wage rate and interest rate, fuel and cost of transportation, fuel and interest rate, price of feed and interest rate and unit cost of transportation were significant at 1% probability level showing a direct relationship with profit of the enterprise.

The result in table 3 shows that sigma (δ^2 = 0.168) and the gamma (γ = 0.99) are quite high and significant at 1% level of probability respectively. The high and significant value of sigma square (δ^2) indicates the goodness of fit. The gamma shows 99.7% variation in the total profit is due to inefficiency and one-sided error as obtained in small scale feed processing enterprise. All the first order coefficients are significant at 1% probability level, except interest rate which is not significant. The only coefficient of wage rate carried the expected positive sign, implying that wage rate increases with profit. An increase in price of labour would lead to an increase in profit by 34.292%. The price of feed components, petrol and transportation are significant. This implies that increasing price of feed

components, petrol and cost of transportation by 1% would decrease total profit by 36.972, 8.771 and 18.081 respectively.

A comparative analysis was equally carried out to ascertain the difference in economic efficiency between small and medium scale feed enterprises. The result showed that there was no significant difference in the mean of economic efficiency between the two enterprises in the state. This implies that the SMEs share similar features and use almost the same kind of production. The only difference might be the amount of capital employed.

3.3 Determinants of Economic Efficiency

From the result, the seven efficiency factors are contained in table 4. labour, access to credit; business experience and number of employees were significant and are evidenced to be related to economic efficiency. Labour and number of employees are negatively signed and significant at 5% probability level. The implication is that labour and number of employees are decreasing with efficiency and any 1% increase in these inputs would decrease efficiency to the tune of 0.00007 and 1.215% respectively. The coefficients of credit status and business experience are 2.322 and 0.023%, indicating access to credit and business experience has positive relationship with efficiency and they are increasing with economic efficiency. These findings agreed with Nwachukwu, (2006).
From the result, the seven efficiency factors as contained in table 5, labour, access to credit, business experience and membership to cooperative organizations are positive and statistically significant at 1% probability level except credit status that is significant at 10% respectively. This implies that variables are increasing with economic efficiency and 1.0% increase would lead to 0.002, 0.98, 0.024 and 0.379 increases in efficiency levels.

4.0 Conclusion

The study examined the Economic Efficiency of Small and Medium Scale Feed Enterprises in Imo State. The study observed that the small and medium scale feed processing enterprises were not efficient .This shows that there is a great opportunity for the enterprises to increase their level of efficiency in feed processing. Business experience, credit status and labour were observed to influence efficiency in small scale enterprise while membership to cooperative organization, business experience, credit status and labour influenced efficiency in medium scale enterprise respectively. Since more access to credit, membership to cooperative organization and business experience increase efficiency. The processors should adopt cost reducing strategy like vertical integration and form more cooperative organization to attract more incentives from government and private sectors.

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TABLES

Table 1: Distribution of Small and Medium Scale feed -processing Enterprises in Imo State by Age, Business Experience, Number of Employees, membership to cooperative organization and credit status

	Feed processing E			
	Small		Medium	
Age of the enterprise (yr)	Freq	%	Freq	%
1-10	57	71.25	24	30
11-20	17	21.24	47	58.75
21-30	4	5.00	5	6.25
31-40	1	1.25	2	2.5
41-50	1	1.25	2	2.5
Total	80	100	80	100
Mean	9.34		12.95	
Business experience (yr)				
1-5	26	32.5	17	21.25
6-10	29	36.25	20	25
11-16	15	18.75	28	35
17-22	6	7.5	10	12.5
23-28	4	5	5	6.25
Total	80	100	80	100
Mean	9.93		12.95	
No of employees				
1-10	65	81.25	0	0
11-20	13	16.25	5	6.25
21-30	2	25	42	52.5
31-40	0	0	21	26.25
41-50	0	0	7	8.75
51-60	80	100	80	100
Total	80	100	80	100
Mean	8.45		30.90	

Table 2 Maximum likelihood estimates of the stochastic profit function model (Translog) for small scale feed processing enterprise in Imo state.

Production factors	Parameters	Coefficient	Standard	t-value
Constant term	β_0	-41.490	03.248	-12.776***
Wage rate	β_1	26.272	10.315	2.547***
Price of feed components	β_2	10.105	18.000	0.561
Price of petrol	β_3	-1.043	24.482	-0.043
Unit of transportation	β_4	-14.084	1.722	-8.174***
Interest rate	β_5	-1.238	0.681	-1.818*
Wage rate^2	β_6	7.096	8.705	0.815
Price of feed components^2	β_7	-19.020	4.153	-4.580***
Price of petrol^2	β_8	0.469	0.272	1.720
Unit cost of transportation^2	β_9	2.220	0.480	4.628***
Interest rate^2	β_{10}	0 115	0.065	1.782*
Wage ratexprice of feed component	β_{11}	0.265	6.811	0.039
Wage ratex price of petrol	β_{12}	-9.965	8.041	-1.239
Wage cost x unit cost of transport	β_{13}	-4.941	2.160	-2.288**
Wage rate x interest rate	β_{14}	1.613	0.342	4.718***
Price of feed compoxprice of petrol	β_{15}	10.318	0.918	11.242.***
Price of feed compoxunit cost of transport	β_{16}	-7.388	1.675	4.412***
Price of feed compo x interest rate	β_{17}	-0.165	0.323	-0.510
Price of petrolxunit cost of trans	β_{18}	1.840	0.375	4.912***
Price of petrolxinterest rate	β_{19}	1.657	0.281	5.895***
Unit cost of transportxinterest rate	β_{20}	-0.128	0.212	-0.604
Diagnostic statistics				
Log-likelihood function		-62.435		
Total variance	δ^2	0.320	0.050	6.462***
Variance ratio	γ	0.999	0.0146	68.272***
LR test		38.875		

***,**,* are significant levels at 1.0%, 5% and 10% respectively.

Table 3 Maximum likelihood estimates of the stochastic profit function model (Translog) for medium scale feed processing enterprise in Imo state.

Production factors	Parameters	Coefficient	Standard	t-value
Constant term	β_0	-101.440	0.993	-102.122***
Wage rate	β_1	34.292	0.943	36.360***
Price of feed components	β_2	-36.972	0.960	-38.512***
Price of petrol	β_3	-8.771	0.941	-9.317***
Unit of transportation	β_4	-18.081	0.892	-20.270***
Interest rate	β_5	.0.416	0.989	-0.849
Wage rate^2	β_6	-0.101	0.879	-0.115
Price of feed components^2	β_7	37.230	0.915	40.767***
Price of petrol^2	β_8	10.126	0.759	13.349***
Unit cost of transportation^2	β_9	-0.458	0.401	-1.143
Interest rate^2	β_{10}	0.101	2.874	3.520***
Wage ratexprice of feed component	β_{11}	-8.028	0.737	-10.890***
Wage ratex price of petrol	β_{12}	-2.258	0.710	-3.180***
Wage cost x unit cost of transport	β_{13}	2.355	0.589	3.997***
Wage rate x interest rate	β_{14}	-0.254	0.164	-1.547
Price of feed compoxprice of petrol	β_{15}	-9.153	0.850	-10.765.***
Price of feed compoxunit cost of transport	β_{16}	-4.476	0.663	-6.750***
Price of feed compo x interest rate	β_{17}	-0.151	0.188	0.802
Price of petrolxunit cost of trans	β_{18}	-1.449	0.106	-2.181**
Price of petrolxinterest rate	β_{19}	0.158	0.126	1.483

Unit cost of transportxinterest rate	β_{20}	0.024	0.039	-0.620
Diagnostic statistics				
Log-likelihood function		-102.911		
Total variance	δ^2	0.168	3.281	5.107***
Variance ratio	γ	0.997	0.051	19.619***
LR test		18.528		

***,**,* are significant levels at 1.0%, 5% and 10% respectively.

Table 4: Maximum likelihood estimates of the determinants of economic efficiency of small scale Feed processing enterprise.

Variable	Parameter	Coefficient	Standard error	t-value
Constant	Z_0	0.552	3.644	0.151
Age of enterprise	Z_1	0.101	0.118	0.861
Labour	Z_2	-0.000	0.010	-2.083**
Credit status	Z_3	2.322	0.726	3.200***
Business experience	Z_4	0.023	0.005	4.420***
Membership to cooperative organization	Z_5	0.126	1.474	0.086
Number of employees	Z_6	-1.215	0.551	-2.204**
Extension visit	Z_7	-0.503	0.507	-0.992

***,**,* are significant levels at 1.0%, 5% and 10% respectively.

Table 5 Maximum likelihood estimates of the determinants of economic efficiency of medium scale feed efficiency scale feed processing enterprise

Variable	Parameter	Coefficient	Standard error	t-value
Constant	Z_0	-1.518	0.974	-1.558
Age of enterprise	Z_1	-0.016	0.018	-0.883
Labour	Z_2	0.002	0.000	11.431***
Credit status	Z_3	0.986	0.574	1.919*
Business experience	Z_4	0.024	0.003	9.522***
Membership to cooperative organization	Z_5	0.379	0.173	2.187***
Number of employees	Z_6	0.030	0.046	0.660
Extension visit	Z_7	0.007	0.005	1.537

.***,**,* are significant levels at 1.0%, 5% and 10% respectively.

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