TECHNICAL EFFICIENCY OF PIG FARMERS IN IMO STATE NIGERIA; A TRANSLOG STOCHASTIC FRONTIER PRODUCTION FUNCTION APPROACH

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ABSTRACT
This study was carried out in Imo State, Nigeria. It was necessitated by the need to estimate the technical efficiency of pig farmers in the area, since pig farming activities is rising recently in the state. The study used a multi stage stratified random sampling technique to select 60 pig farmers in the state. The stochastic frontier production function was employed to estimate the technical efficiency and simultaneously, its determinants using the maximum likelihood methods. The results show that the pig farmers had a mean technical efficiency of 0.59, with a maximum of 0.78 and a minimum of 0.23. Variables like level of education, years of experience in pig farming, environmental orientation, quantity of waste generated and waste management/related expenditures among others were positively related to technical efficiency while some variables like age, quantity of waste generated and conflict had an inverse relationship with technical efficiency. This implies that agricultural policies should aim at encouraging the youth to engage in pig production as a way of addressing the unemployment problem in the state. This study has revealed that ample opportunities exist for pig farmers to improve on their levels of technical efficiency in the study area.
Keywords: Pig Farmers, Technical Efficiency, Production, Stochastic, Frontier, Translog.

INTRODUCTION

Agriculture is one of the most important sectors of the Nigerian economy. This is because it contributes more than 30% of the total annual GDP, employs about 70% of the labour force, accounts for over 70% of the non oil exports and perhaps most importantly, provides over 80% of the food needs of the country (Adeboye, 2004). The advent of oil in the early 70's caused a sharp diversion from agriculture to oil, due to the huge amount of revenue generated by crude oil exploration and exportation. However, the long run effect is currently being observed in Nigeria today because most Nigerians live below the poverty line.

Protein deficiency has been observed to be a common phenomenon in the health status of many Nigerians especially children. Owolabi (1988) reported that protein deficiency is responsible for wide spread under nutrition and mal-nutrition among all ages in Nigeria. The Food and Agricultural Organization (FAO) recommended an average of 20g animal protein per day for developing countries (Adesehinwa *et al* 1999). For most Nigerians, consumption of animal protein is not common because of the high costs associated with it. This is so because they cannot conveniently afford the rather expensive sources of animal protein like beef, chicken, milk and egg.

However, pig production is gradually gaining prominence in Southeast Nigeria due to its high profit levels (Ewuziem, 2009), and the need for a substitute to beef and chicken which have become very costly to purchase. The pig industry is a very reliable industry due to certain attributes of the pig. The potentialities of pig as an effective provider of protein for human diet have well been recognized (Payne, 1990). The relative advantages of the pig in respect of this include; its high survival rate and ability to utilize a host of agro-industrial bye-products and crop residue (Ter Meuleen and El-harith 1985), with little or no processing and at minimal cost (Tewe and Adesehinwe 1995). Pigs are known to be prolific producers, realizing 20-30 piglets from 2 or 3 litters per year (Adesehinwa *et al.,* 2003), with short generation intervals. In recent times, pig production is fast becoming a dependable business because more people have realized these unique potentialities of the animal.

One of the ways to achieve the millennium development goals is by increasing the production of livestock, which is a veritable means of making protein available to the people. The question now is, since it is very clear that the production of animals to provide food (protein) for the people especially in Sub-Saharan Africa, is short of demand despite the great potentials envisaged in terms of income generation, are the resources employed in production efficiently utilized?, this calls for attention.

Since efficiency is a very important factor of productivity growth especially in developing agriculture where resources are meager and opportunities for developing and adopting better technologies have lately started dwindling. The sustainability, suitability and efficiency of piggery farming will be able to enhance greater productivity of resources used for the existing farms and attract investment. Productive efficiency means attainment of production goal without waste (Ajibefun and Daramola, 2003).

In recent times, the stochastic frontier production function is widely put into use to overcome the short coming of the ordinary least square estimation. The stochastic frontier function has the advantage of being able to list and quantify the efficiency of individual farmers in a sample (Ajibefun and Aderinola, 2004). Since Farrell's original work in 1957, the frontier methodology has become a widely used tool in applied production analysis due mainly to its consistency with the textbook definition of production, profit or cost function (i.e. with the notion of maximization and minimization) (Thiam *et al* 2001). This popularity is evidenced by the proliferation of methodological and empirical frontier studies over the last two decades (Anyaegbunam *et al.,* 2009).

The efficiency of a production unit involves a comparison between observed and optimal value of its output and inputs. The comparison can take the form of the ratio of observed to maximum potential output obtainable from a given input or the ratio of minimum potential to observed input required to produce the given output or some combination of the two (Ajibefun and Aderinola, 2004). This is a typical technical efficiency since in both comparisons; the optimum is defined in terms of production possibilities. The idea is that, the closer the individual production plans are to the maximum levels, as defined by the frontier and given input levels, is the measure of technical efficiency for each farm. For example, the maximum output obtainable from the various input vectors (X_1, X_2… Xn) in producing a single output Y, the efficient transformation of inputs into the output, is characterized by the production function; f(x).

Several studies from both developing and developed countries have used the Cobb Douglas functional form to analyze farm efficiency despite its well known limitations (Battese, 1992,; Bravo Ureta and Pinheiro, 1997). Koop and Smith (1980) concluded that functional form has a discernable impact on estimated efficiency. Ahmed and Bravo – Ureta (1996) rejected the Cobb Douglas function form in favour of a simplified translog form. Onyenweaku and Okoye (2007) clearly pointed out in an efficiency study, that for the cost function to be Cobb Douglas, the coefficients of the second order terms should be zero. The rejection of this hypothesis in the translog function is a confirmation of the fact that the translog function is more suitable for the data and model specification than the Cobb Douglas function. The translog production function has the advantage of flexibility and allows analysis of interactions among variables. The use of the translog functions in efficiency studies have been on the increase in recent times. Anyaegbunam *et al* (2009) applied the translog cost function to estimate plot size and cost inefficiency among small holder cassava farmers in South East Agro-Ecological zone of Nigeria. Onyenweaku and Okoye (2007) used the translog function to estimate technical efficiency of small holder cocoyam farmers in Anambra state, Nigeria. Also, Amaefula *et al* (2009) employed the translog production function to estimate technical efficiency of fish farmers in Delta state, Nigeria. This study therefore employed the translog stochastic frontier analysis to estimate the technical efficiency and its determinants among pig farmers in Imo state Nigeria. The result will assist farmers in making production decisions and ensure optimal productivity of inputs to maximize output.

METHODOLOGY

The Data

The study was carried out in Imo State of Nigeria. The State is located in the Southeast agro-ecological zone of the country, characterized by humid tropical environment. This study used a multi stage stratified random sampling techniques. The state was stratified into the existing three agricultural zones. A random sampling technique was adopted in the selection of two local government areas from each zone and ten (10) pig farmers from each selected local government area, giving a total of 60 respondent pig farmers used for the study. However, in each selected local government area, the register of pig farmers from the LGA agricultural department and All Farmer Association of Nigeria formed the sample frame from which the random sampling technique was used to select the respondents. Data were collected by means of a well structured questionnaire on their production activities in terms of inputs, outputs and their prices for the year 2007.

The Econometric Model

The stochastic frontier production function is based on the composite error model (Aigner *et al,* 1977). Technical inefficiency of production is assumed present in the stochastic frontier production function. This function is defined by;

$Y_i = f(X_1, \beta) \exp(V_1 - U_1)$ i= 1, 2 ... N (1)

Where:

Y = represents the possible production output of □th farmer.

X = represents input vectors

F ( ) = represents the functional form (in this respect, the translog function)

β = represents the vector of unknown parameter to be estimated.

V'_s is a random error, which is associated with random factors not under the control of the farmer. The random errors, $V_{i's}$ are assumed to be independently and identically distributed as N (O, $O^{-2}{}_v$) random variables independent of the $U_{'s}$, having zero mean and constant variance.

$U_{'s}$ is technical inefficiency effects which are assumed to be independent of the $V_{'s}$ and a non negative truncation of the N (O, $O^{-2}{}_v$) distribution (i.e. half normal distribution) or have exponential distribution. $U_{'s}$ are assumed to be under the control of the farm operator. Technical efficiency of an individual farm is defined in terms of ratio of the observed output to the corresponding frontier output, given the available technology.

Technical efficiency (TE) = Y_i / Y* (Ajibefun and Adenirola 2003)

= f (X_i, β) exp ($V_1 – U_1$) / f (X_1, β) exp (V_1)

= exp ($-U_1$) ………………… (2)

Where:

Y_1 = observed output of the pig farmer

Y* = the frontier output.

Technically efficient farmers are those that operate on the production frontier and the level by which a farmer lies below its production frontier is regarded as the measure of technical inefficiency.

The Empirical Model

For this study the production technology of pig farmers is specified by the translog production function defined by;

$I_n\, Y_1 = \alpha_0 + \square\, \alpha_i\, I_n\, X_1 + {}^1/_2 + \square\, b_i\, I_n\, X_i^2 + \square\, b_{ij}\, I_n\, X_i\, X_j + V_i – U_i$ ……….. (3)

Where:

I_n = the Natural logarithm

i = $\square^{th}$ respondent pig farmer

Y = output of the farmer (value of output ₦)

X_i to X_j = Inputs (defined below)

α_o, α_i, b_i, b_{ij} are parameters to be estimated.

V_i are assumed to be independently and identically distributed normal random errors, having zero mean and unknown variance ($Ó^2V_1$).

U_s are non-negative random variables; technical inefficiency effects which are under the control of the pig farmer.

The translog production function is alternatively defined as follows;

$In\, Y_i = b_o + b_1\, I_n\, X_1 + b_2\, In\, X_2 + b_3\, I_n\, X_3 + b_4\, I_n\, X_4 + b_5\, I_n\, X_5 + b_6\, I_n\, X_6 + b_7\, I_n\, X_7 + {}^1/_2 b_8\, I_n\, X_1{}^2 + {}^1/_2 b_9\, I_n\, X^2{}_2 + {}^1/_2 b_{10}\, I_n\, X_3{}^2 + {}^1/_2 b_{11}\, I_n\, X_4{}^2 + {}^1/_2 b_{12}\, I_n\, X_5{}^2 + {}^1/_2\, b_{13}\, I_n\, X_6{}^2 + {}^1/_2\, b_{14}\, I_n\, X_7{}^2 + b_{15}\, I_n\, X_1\, I_n\, X_2 + b_{16}\, I_n\, X_1\, I_n\, X_3 + b_{17}\, I_n\, X_1\, I_n\, X_4 + b_{18}\, I_n\, X_1\, I_n\, X_5 + b_{19}\, I_n\, X_1\, I_n\, X_6 + b_{20}\, I_n\, X_1\, I_n\, X_7 + b_{21}\, I_n\, X_2\, I_n\, X_3 + b_{22}\, I_n\, X_2\, I_n\, X_4 + b_{23}\, I_n\, X_2\, I_n\, X_5 + b_{24}\, I_n\, X_2\, I_n\, X_6 + b_{25}\, I_n\, X_2\, I_n\, X_7 + b_{26}\, I_n\, X_3\, I_n\, X_4 + b_{27}\, I_n\, X_3\, I_n\, X_5 + b_{28}\, I_n\, X_3\, I_n\, X_6 + b_{29}\, I_n\, X_3\, I_n\, X_7 + b_{30}\, I_n\, X_4\, I_n\, X_5 + b_{31}\, I_n\, X_4\, I_n\, X_6 + b_{32}\, I_n\, X_4\, I_n\, X_7 + b_{33}\, I_n\, X_5\, I_n\, X_6 + b_{34}\, I_n\, X_5\, I_n\, X_7 + b_{35}\, I_n\, X_6\, I_n\, X_7 + e$ …………(4)

Where:

X_1 = feed consumed (kg)

X_2 = labour (man days)

X_3 = stock (no of pigs)

X_4 = medication (₦)

X_5 = water used (liters)

X_6 = rent (₦)

X_7 = depreciated cost of farm structures and tools (₦)

The variance ratio Gamma (Y) explaining the total variations in input from the frontier level of output attributed to technical efficiencies was computed as;

$Y = Ó^2{}_u / Ó^2{}_v$

Technical efficiency measures are bounded by zero and one. Hence technical efficiency estimates would range between 0 and 1.

The determinants of technical efficiency were modeled in terms of the under stated variables. The technical efficiency was simultaneously estimated with the determinants of technical efficiency (D_i) defined by;

$D_i = d_i\, Z_{1i} + d_2\, Z_{2i} + d_3\, Z_{3i} + d_4\, Z_{4i} + d_5\, Z_{5i} + d_6\, Z_{6i} + d_7\, Z_{7i} + d_8\, Z_{8i} + d_9\, Z_{9i} + d_{10}\, Z_{10i}$ …………………. (5)

Where:

D_i = Technical efficiency of 1th farmer

d_s = Unknown scalar parameters to be estimated.

Z_i = Age (years)

Z_2 = Level of Education (years).

Z_3 = Pig farming experience (years)
Z_4 = Environmental consciousness (1 for environmentally conscious farmers; those that willing apply pollution abatement measures and zero otherwise)
Z_5 = Waste management system (1 for waste disposal, while 0 for waste utilization)
Z_6 = Quantity of waste produced (kg / yr)
Z_7 = Waste management / related expenditures (naira)
Z_8 = credit access (a dummy variable which takes the value of unity if the farmer has access to credit and zero otherwise.
Z_9 = Conflict (1 is for farms where conflict is existing between the farmers and his neighbor s while 0 is for farms where there are no existing conflicts).
Z_{10} = membership of farmers associations/ cooperative societies (a dummy variable which takes the value of unity for member and zero otherwise).

RESULTS AND DISCUSSION

Estimated Production Function

The stochastic translog frontier production function was used to estimate the production parameters of pig farmers in Imo State Nigeria. The Maximum Likelihood Estimates (MLE) on per farmers bases are presented in table 1. The sigma-squared (♂^{2}) was derived as 0.84 which is shown to be significantly different from zero at 1% level this gives credence to the goodness of fit of the model and the correctness of the specified distribution assumptions of the composite error term. The variance ratio parameter λ (gamma) (♂^2_v / ♂^2_u) is estimated at 0.5903 and is statistically significant at 1% indicating that 59.03% of the total variations in pig output is due to technical inefficiency. This implies that variations in actual output from maximum output between farms mainly arose from differences in farmer practices rather than random variability. The presence of one sided error component is indicated by the log likelihood ratio which is significant at 1% level.

Table 1: Maximum Likelihood Estimate (MLE) of Stochastic Translog Frontier Production Function for pig Farmers in Imo State.

Production factors	**Parameter**	**Coefficient**	**t-ratio**
Constant term	b_0	11.3904	2.3889***
L_nX_1	b_1	0.5092	2.7719***
L_nX_2	b_2	0.7244	3.5479***
L_nX_3	b_3	0.6313	2.7246***
L_nX_4	b_4	0.3798	3.5763***
L_nX_5	b_5	0.1043	2.5254**
L_nX_6	b_6	0.3148	3.1261***
L_nX_7	b_7	0.4962	4.3565***
$^1/_2\ (L_nX_1^2)$	b_8	0.0398	3.8641***
$^1/_2\ (L_nX_2^2)$	b_9	0.0712	3.2963***
$^1/_2\ (L_nX_3^2)$	b_{10}	0.0603	2.8178***
$^1/_2\ (L_nX_4^2)$	b_{11}	0.0241	1.1157
$^1/_2\ (L_nX_5^2)$	b_{12}	0.0339	1.0971
$^1/_2\ (L_nX_6^2)$	b_{13}	0.0182	1.4444
$^1/_2\ (L_nX_7^2)$	b_{14}	0.0709	3.3131***
$L_nX_1\ L_nX_2$	b_{15}	0.0513	3.0353***
$L_nX_1\ L_nX_3$	b_{16}	0.0546	2.6897***
$L_nX_1\ L_nX_4$	b_{17}	0.0779	1.2708
$L_nX_1\ L_nX_5$	b_{18}	0.0613	1.2070
$L_nX_1\ L_nX_6$	b_{19}	0.0502	1.2184
$L_nX_1\ L_nX_7$	b_{20}	0.0714	3.1593***
$L_nX_2\ L_nX_3$	b_{21}	0.0609	2.8592***
$L_nX_2\ L_nX_4$	b_{22}	0.0238	1.1442
$L_nX_2\ L_nX_5$	b_{23}	0.0772	1.2573
$L_nX_2\ L_nX_6$	b_{24}	0.0168	1.2263
$L_nX_2\ L_nX_7$	b_{25}	0.0491	3.5324***
$L_nX_3\ L_nX_4$	b_{26}	0.0317	1.1486
$L_nX_3\ L_nX_5$	b_{27}	0.0428	1.0621
$L_nX_3\ L_nX_6$	b_{28}	0.0521	1.0621
$L_nX_3\ L_nX_7$	b_{29}	0.0503	1.0611
$L_nX_4\ L_nX_5$	b_{30}	0.0227	2.7917***
$L_nX_4\ L_nX_6$	b_{31}	0.0153	1.0657
$L_nX_4\ L_nX_7$	b_{32}	0.0446	1.0408
$L_nX_5\ L_nX_6$	b_{33}	0.0294	1.4025
$L_nX_5\ L_nX_7$	b_{34}	0.0308	1.2951
$L_nX_6\ L_nX_7$	b_{35}	0.0473	2.6522***
Diagnostic Statistic			
Sigma-squared		0.8413	5.8889***
Variance ratio		0.5902	3.7259**
Log Likelihood		-103.1509***	65.0538***
LR test		48.96***	

***** Significant at 1% level ** significant at 5% level**

Source: completed from survey data 2007

The coefficients of the estimated parameters for the variables, feed, labour, stock size, medication, water, rent and depreciation have the desired positive signs and are significant at 1% level, while the coefficient for water is significant at 5% level, implying that these seven variables are important factors influencing the output levels of pig farmers in the study area. The results obtained for the interactions between feed and labour, feed and stock size, feed and depreciation, labour and depreciation, stock size and depreciation, water and depreciation, rent and depreciation, shows that there exist a significant positive interactions between these inputs and quantities, suggesting that increases in quantities of these inputs used in pig production will increase the level of pig output in the study area.

The individual technical efficiencies of the pig farmers obtained using the stochastic translog frontier production function is presented in table 2. It shows that most (41.17%) of the pig farmers had technical efficiencies of 0.56 – 0.66, while 25% of the farmers had technical efficiencies of 0.67 – 0.77. Also, 15%, 13.33%, 3.33% and 1.67% of the farmers had technical efficiency ranges of 0.45 – 0.55, 0.34 – 0.44, 0.23 – 0.33 and 0.78 and above respectively. The minimum technical efficiency of the pig farmers was 0.23 while the maximum technical efficiency of the pig farmers was 0.78. The mean technical efficiency of the pig farmers was found to be 0.59, indicating that the pig farmers are not fully technically efficient showing that their actual output lies 41% below the frontier output, this is their level of inefficiency in resource use.

Table 2: Frequency Distribution of Technical Efficiency of Pig Farmers.

Technical Efficiency	Frequency	Percentage
0.23 – 0.33	2	3.33
0.34 – 0.44	8	13.33
0.45 – 0.55	9	15
0.56 – 0.66	25	41.67
0.67 – 0.77	15	25
0.78 – 0.88	1	1.67
Total	60	100
Minimum technical efficiency 0.23		
Maximum technical efficiency 0.78		
Mean technical efficiency 0.59		

Source: Survey data, 2007.

Determinants of Technical Efficiency

The maximum likelihood estimate of the determinants of technical efficiency of pig farmers is presented in table 3. The table shows that the estimated parameters of education, farming experience, environmental orientation, Waste management expenditures, credit access, and membership of farmer's associations/cooperative societies had a direct and significant effect on technical efficiency, which agrees with *a priori* expectation at both 1% and 5% levels of probability respectively. This confirms Amaza and Oluyemi (2000) who found out that education have a positive and significant effect on technical efficiency of food crop farmers in Gombe State Nigeria. According to Chukwu (1990), educated business persons are more responsive to positive changes in business trends and risk aversion. Also, Anyaegbunam *et al* (2009) reported that members of farmers' associations or cooperative societies have more access to agricultural information and other production inputs. Farmers who have long years of farming experience tend to combine their resources better in an optimal manner. On the other hand, the coefficients for age, quantity of waste generated and conflict had a negative and significant effect on efficiency. This implies that increase in age, quantity of waste and conflict will lead to technical inefficiency. This is in line with the findings of Amaechi (2007) that as the age of an entrepreneur increases, his technical efficiency reduces. Generally, these factors are important determinants of technical efficiency of pig farmers in Imo State. The coefficient for waste management system was positive but insignificant, implying that it is not an important determinant of technical efficiency in pig farming.

Table 3: Determinants of Technical Efficiency of Pig Farmers in Imo state.

Variables	Coefficient	t-ratio
Constant	18.3019	7.2196***
Age (Z_1)	-1.1141	-2.9614***
Education (Z_2)	0.4031	3.5362***
Experience (Z_3)	0.4691	3.0418***
Environmental orientation (Z_4)	0.1379	2.4620**
Waste management system (Z_5)	0.0989	1.1856
Quantity of waste generated (Z_6)	-1.2748	-4.1769***
Waste management/ related exp. (Z_7)	0.3654	3.436***
Credit access (Z_8)	0.3391	2.9381***
Conflict (Z_9)	-0.0713	3.3378***
Membership of Assoc./coop (Z_{10})	0.2044	2.3114**

***** Significant at 1%, ** Significant at 5%. Source: computed from survey data, 2007**

CONCLUSION

From the results of this study, the pig farmers in the study were 41% inefficient in their resource use. The farmers were 59% efficient. This implies a wide variation below their production frontiers and suggests existence of opportunities for increasing productivity and income through improved efficiency in resource use. Important factors directly related to technical efficiency are level of education, farming experience, credit access and membership of associations / cooperative societies. Age, quantity of waste generated and conflict have an inverse relationship with technical efficiency. These results call for policies aimed at encouraging the youths to engage in pig farming as a way of creating employment and alleviating poverty. Again the experienced ones should be supported to remain in farming by providing environmental safety standards for pig rearing to avoid conflicts with their neigbours.

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