

Research paper

**TECHNICAL AND ECONOMIC EFFICIENCIES IN POULTRY PRODUCTION
IN IMO STATE, NIGERIA**

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ABSTRACT

This study estimated the technical and economic efficiencies of poultry farmers in Imo State, Nigeria. Data were collected with questionnaire from 140 proportionately and randomly selected poultry farmers. A stochastic frontier production function was estimated using the maximum likelihood estimation technique to obtain the technical and economic efficiencies of poultry farmers. The mean technical efficiency of poultry farmers was 75 percent, while their mean economic efficiency was 21 percent. The generalized likelihood test indicated that, the poultry farmers are not fully technically and economically efficient in resource use. There is enough allowance to increase economic efficiency of poultry farmers by improvement in technical efficiency.

Keywords: Efficiency, Stochastic Frontier, Poultry, Imo State.

INTRODUCTION

Poultry farming is an important agribusiness enterprise that has a great potential for providing additional income to our farming community and educated unemployed

persons of the rural areas through creating self employment opportunities (Ahmed and Hamid, 1992). Poultry production is one of the important sub-sectors in the Nigerian economy (Rahman and Yakubu, 2005). In addition to its contribution to the Gross Domestic Product (GDP) and provision of employment opportunities, poultry production is a major source of protein in the country. Poultry meat is found to be one of the most nutritious and most complete food known to man and it provides a means by which rapid transformation of animal protein intake can be achieved (Murtala *et.al.*, 2004).

Poultry products rank only with economically produced animal protein (Obioha, 1992). Despite the nutritive value of poultry meat its production in the country is grossly inadequate as reflected in the wide gap between demand and supply of the product. This could be attributed to numerous problems that poultry farmers in Nigeria are facing. These problems include low capital base, inefficient management, technical inefficiency, economic inefficiency, diseases and parasites and poor housing (Alabi and Isah, 2002), high cost of feeds, poor quality of day old chicks (DOC), inadequate extension and training facilities (Bamgbose *et.al.*, 1998).

The poultry production capacity of farms has to increase rapidly to be able to meet up with the increasing demand, and for this to be achieved, the present level of technical and economic efficiency must be improved upon. Presently, there are dearth of studies on efficiency of poultry farms (Ohajianya and Obasi, 2005; Ali, 1993). Particularly, there are limited information about the performance of poultry farms in terms of technical and economic efficiencies (Sarker *et.al.*, 1999).

Efficiency is defined as how effectively a production unit uses variable resources for the purpose of profit maximization given the best production technology available (Kebede, 2001). However, a number of empirical studies on poultry production in Nigeria have focused more on production constraints (Alabi and Isah, 2002; Bamabose *et.al.*, 1998), economic analysis (Ali, 1993; Islam, 1995), and profitability (Murtala *et.al.*, 2004; Sarker *et.al.*, 1999). For other studies that attempted to ascertain the resource use efficiency of poultry farmers in Nigeria, the ordinary least squares (OLS) estimation techniques were used.

These include works by Ohajianya and Obasi (2005), Mijindadi (1980), Sarker *et al.*, (1999), Nkasiobi (2009). The use of the ordinary least squares (OLS) estimating technique makes it difficult to determine farm level efficiency as it provides only an average function (Idiong *et.al.*, 2009; Bravo-Ureta and Pinheiro, 1997) though it provides consistent estimates of the parameters except the intercept (Kebebe, 2001). To overcome this shortcoming of the OLS, the stochastic frontier function was developed and has been used by several researchers to estimate efficiency in agricultural production. Its beauty lies in its ability to test and quantify the inefficiency of individual farmers in a sample because it allows for statistical noise rather than attributing all deviation to efficiency difference. It is also straight forward to implement and interpret (Xu and Jeffrey, 1995). A situation that is not possible with other partial measures of efficiency such as the OLS (Ajibefun and Aderinolea, 2003).

Most of the previous studies that used the stochastic frontier production function in agriculture of developing countries limited their work to the determinants of technical efficiency. Studies such as those of Bagi and Haung (1983), Kalirajan and Shand (1980), Kalirajan (1991), Adesina and Djato (1997), Mochebelele and Nelson (2000), Amaza and Olayemi (2000) Udoh and Akintola (2001), Kebede (2001), Ajibefun and Aderinola (2003), Nwaru 2004), Onyenweaku *et.al.*, (2005) and Udoh (2005) estimated technical efficiency of crop farmers in developing countries, including Nigeria. There is a paucity of published empirical works carried out in Nigeria generally and Imo State specifically that have made use of the stochastic frontier production function to estimate technical and economic efficiency simultaneously in poultry production. This study is therefore, intended to use the stochastic frontier function to provide estimates of technical and economic efficiency in poultry production in Imo State, Nigeria.

METHODOLOGY

This study was conducted in the year 2012 in the three agricultural zones of Imo State. The State lies within latitudes $5^{\circ} 40^1$ and $7^{\circ} 05^1$ North and longitude $5^{\circ} 35^1$ and $8^{\circ} 30^1$ East. It had a population of about 3.92 million people in 2006 (NPC, 2006). Imo State is divided into three agricultural zones of Owerri, Orlu and Okigwe, and further subdivided into 27 Local Government Areas (LGAs). Farming is the major occupation of the people. The weather and environmental conditions of the state favour the production of poultry and other livestock such as sheep, goat, rabbit, pigs, etc. A pre-survey was initially carried out in each zone to identify poultry farmers through the assistance of Imo State Agricultural Development Programme (ADP) extension agents and officials of all farmers Association of Nigeria (AFAN). The number of poultry farmers identified varied among the LGAs in each agricultural zone. Two LGAs from each zone that had the highest number of poultry farmers were purposively selected, making a total of six LGAs. The sampling frame was the list of poultry farmers in each selected LGA. Proportionate sampling followed by random sampling techniques were employed in each LGA to selected the sample size of 140 poultry farmers. The study used mainly primary data which were collected with the aid of questionnaire. Data wee collected on variables such as socioeconomic characteristics of farmers, resource inputs and output in poultry production. Data were analyzed using descriptive statistics such as mean, frequency distribution and percentages, as well as stochastic frontier production function.

Analytical Framework

The stochastic frontier production function was specified as;

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

Where, Y is output of poultry, X_i is actual input vector, β is vector of production function parameters, V is random error term with zero mean, and U is non-negative one sided error term.

Given that the functional form for this study is self dual, i.e. Cobb-Douglas, the corresponding cost frontier can be derived and written as,

$$C = f(P,Y, \gamma) \dots\dots\dots(2)$$

120

121 Where, C is minimum cost associated with the production of poultry, P is vector of input
122 prices, Y is output of poultry, γ is vector of parameters.

123 Using Sheppard's Lemma we can obtain

$$124 \quad \frac{\partial C}{\partial P_i} = X_i(P, Y, \gamma) \dots \dots \dots (3)$$

126 This is the system of minimum cost input demand equations (Bravo-Ureta and Evernson,
127 1994; Xu and Jeffrey, 1995; Bravo-Ureta and Pinheiro, 1997). Substituting a farm's input
128 prices and quantity of output in equation (3) yields the economically efficient input
129 vector X_i . With observed levels of output given, the corresponding technically and
130 economically efficient costs of production will be equal to X_i , P and X_i , respectively,
131 while the actual operating input combination of the farm is X_i , P.

132 The three cost measures can then be used to compute the technical efficiency (TE)
133 and economic efficiency (EE) indices as follows;

$$134 \quad TE = (X_i, P)/(X_i, P) \dots \dots \dots (4)$$

$$135 \quad EE = (X_i, P)/(X_i, P) \dots \dots \dots (5)$$

136 Note however that, efficient production is represented by an index of 1.0 while the lower
137 values indicate a greater degree of inefficiency. Using the method by Bravo-Ureta and
138 Pinheiro (1997) and Idiong *et.al.*, (2009) which was based on the work of Jondrow *et.al.*,
139 1982), efficiency can then be measured using the adjusted output as shown in equation
140 (6).

$$141 \quad Y^* = f(X_i, \delta) - U \dots \dots \dots (6)$$

142 Where, U can be estimated as;

$$143 \quad E(U_i/\epsilon_i) = \frac{\delta \delta}{1 + \delta^2} = f \frac{(\epsilon_i \lambda/\delta)}{1 - F^*(\epsilon_i \delta/\delta)} - \frac{\epsilon \delta}{\delta} \dots \dots \dots (7)$$

146 Where, $f(.)$ and $F^*(.)$ are standard normal density and cumulative distribution functions
147 respectively, $\delta = \delta/\delta_v$, $\epsilon_i = V - U$ and $\delta^2 = \delta_u + \delta_v^2$

148

Y^* is the observed output adjusted for statistical noise. When ε_i and δ estimates, are replaced in equations (6) and (7), it will provide estimates for U and V.

In this study, a Cobb-Douglas function was fitted to the stochastic production frontier of the poultry farmers using the Maximum Likelihood method. This functional form has been used in many empirical studies particularly those relating to developing countries' agriculture (Xu and Jeffrey, 1995; Idiong *et.al.*, 2009). It has been useful in estimating economic efficiency because it's self-dual. However, Idiong *et.al.*, 2009) had opined that functional form has limited effect on empirical efficiency measurement. The production function model is specified as follows;

$$\ln Y = \ln \delta_0 + \delta_1 \ln X_1 + \delta_2 \ln X_2 + \delta_3 \ln X_3 + \delta_4 \ln X_4 + \delta_5 \ln X_5 + \delta_6 \ln X_6 + \delta_7 \ln X_7 + \varepsilon_i \dots (8)$$

Where, Y is output of poultry (kg), X_1 is quantity of feed (kg), X_2 is flock size (number of birds), X_3 is labour input (mandays), X_4 is cost of drugs and medication (₦), X_5 is capital (₦), X_6 is cost of management (₦), and X_7 is other inputs (₦), Ln is natural logarithm, $\delta_0 - \delta_7$ are coefficients to be estimated, ε_i is composed error term which is also defined as $V - U$. the use of single equation model is justified by the assumption that farmers maximize expected profits as it is often assumed in similar studies (Bravo-Ureta and Pinheiro, 1997; Idiong *et.al.*, (2009). It is expected a priori that the coefficients of $X_1, X_2, X_3, X_4, X_5, X_6, X_7$, will be positive. The cost frontier function is also specified thus;

$$\ln C = \ln a_0 + a_1 \ln P_{X_1} + a_2 \ln P_{X_2} + a_3 \ln P_{X_3} + a_4 \ln P_{X_4} + a_5 \ln P_{X_5} + a_6 \ln P_{X_6} + a_7 \ln P_{X_7} + a_8 Y^* + \varepsilon_i \dots (9)$$

Where, C is cost of production per poultry farmer, P_1 is cost of feed, P_2 is cost of birds (₦/bird), p_3 is cost of labour (₦/manday), p_4 is cost of drugs and medication (₦/bird), p_5 is cost capital (₦), p_6 is cost of management (₦/manday), p_7 is other costs (₦/bird), Y^* is output of matured bird in kg adjusted for statistical noise, $a_1 - a_7$ are parameters to be estimated, a_0 is the y – intercept, and ε_i is the composed error term. It is expected a priori that the coefficients of $P_{X_1}, P_{X_2}, P_{X_3}, P_{X_4}, P_{X_5}, P_{X_6}$ and P_{X_7} will be positive.

RESULTS AND DISCUSSION

Socio-economic characteristics of farmers.

In Table 1, the socioeconomic characteristics of the poultry farmers are presented. The table indicates that an average poultry farmer spent about 9 years in formal education, had 8 persons in their household, acquired 13.6 years experience in poultry farming, had 727 birds, received 0.81 extension visit, and was aged about 45 years old. Also, 86.4% of them are married, only 30.7% of them had access to credit, and 65.7% of them belong to farmers associations.

Table 1. Distribution of Poultry Farmers According to Socioeconomic Characteristics

Variable	Frequency	Percentage	Mean
Marital status			
Married	121	86.4	
Single	19	13.6	
Total	140	100	
Level of education (years)			
0 (No formal education)	6	4.3	
1 – 6	34	24.3	
7 – 12	75	53.6	
13 – 18	23	16.4	
19 and above	2	1.4	
Total	140	100	8.8 years
Household size (No. of persons)			
2 – 4	11	7.9	
5 – 7	39	27.9	
8 – 10	52	37.1	
11 and above	38	27.1	
Total	140	100	8 persons
Farming experience (years)			
≤ 10	26	18.6	
11 – 15	64	45.7	
16 – 20	37	26.4	

206	21 and above	13	9.3	
207	Total	140	100	13.6 years
208	Flock size (No. of birds)			
209	≤ 500	31	22.1	
210	501 – 700	41	29.3	
211	701 – 900	15	10.7	
212	901 – 1100	34	24.2	
213	1101 – 1300	13	9.3	
214	1301 and above	6	4.3	
215	Total	140	100	727 birds
216	Extension contact (No. of visits)			
217	0 (No. of visits)	79	56.5	
218	1 – 2	52	37.1	
219	3 – 4	7	5.0	
220	5 – 6	2	1.4	
221	Total	140	100	0.81 visits
222	Access to credit			
223	Access	43	30.7	
224	No access	97	69.3	
225	Total	140	100	
226	Farmers associations membership			
227	Member	92	65.7	
228	Non – member	48	34.3	
229	Total	140	100	
230	Age (years)			
231	≤ 30	8	5.7	
232	31 – 40	37	26.5	
233	41 – 50	54	38.6	
234	51 – 60	24	17.1	

235	61 – 70	14	10.0	
236	71 and above	3	2.1	
237	Total	140	100	45.4 years

238 Sources: survey data 2012

239 Statistics of Output and Input Variables

240 Table 2 presents the summary statistics of output and input variables in poultry
 241 production in Imo State, Nigeria. The table shows that mean output per poultry farmer
 242 was 2181 kg, quantity of feed was 4813 kg, flock size was 772 birds, labour input was
 243 604 mandays, expenditure on drugs and medication was ₦3105, capital was ₦103465,
 244 cost of management was ₦81500, other inputs was ₦3655. The total cost of production
 245 per farmer was ₦136495.64, feed cost per 50kg bag was ₦6016, cost of one bird was
 246 ₦143.30, labour cost per manday was ₦1540, cost of drugs and medication per bird was
 247 ₦13.54, cost of capital was ₦125413, cost of management was ₦ 2013, while cost of
 248 other inputs was ₦14.34 per bird.

249 Table 2. summary statistic of output and input variables in poultry production

250	Variable	Unit	Mean
251	Output (Y)	kg	2181
252	Feed (X ₁)	kg	4813
253	Flock size (X ₂)	Number of Birds	772
254	Labour (X ₃)	Mandays	604
255	Drugs and medication (X ₄)	₦	3105
256	Capital (X ₅)	₦	103465
257	Management (X ₆)	₦	81500
258	Other inputs (X ₇)	₦	3655
259	Total cost (C)	₦/farmer	136495.64
260	Feed cost (P ₁)	₦/50kg	6016
261	Cost of birds (P ₂)	₦/bird	143.30
262	Labour cost (P ₃)	₦/manday	1540
263	Cost of drugs and		
264	Medication (P ₄)	₦/bird	1354

265	Cost of capital (P_5)	₦/farmer	125413
266	Cost of management (P_6)	₦/manday	2015
267	Cost of other inputs (P_7)	₦/bird	14.34

268 Source: survey data 2012

269 Estimation of stochastic production and cost Frontier Functions

270 The estimates of the stochastic production frontier function (Table 3) indicate that, all the
 271 coefficients carried the expected positive signs. The coefficients of feed (X_1), flock size
 272 (X_2), labour (X_3), and capital (X_5) were significant at 1% level, while the coefficients of
 273 drugs and medication (X_4), management (X_6), and other inputs (X_7) were significant at
 274 5% level. The sum of the elasticities was 1.958, indicating that, the poultry farmers were
 275 operating in the region of increasing returns to scale. The gamma (γ) was 0.783 which
 276 was high enough and significant at 1% level. It gives an indication that the unexplained
 277 variations in output are the major sources of random errors. It also shows that about 78
 278 percent of the variations in output of poultry farmers are caused by technical inefficiency.

279 Table 3. MLE of the Stochastic Production Frontier Function in Poultry Production
 280 in Imo State.

281	Variable	Coefficient	t-ratio
282	Constant	5.297	4.392**
283	Feed (X_1)	0.493	3.011**
284	Flock size (X_2)	0.378	2.813**
285	Labour (X_3)	0.512	3.016**
286	Drugs and medication (X_4)	0.067	2.512**
287	Capital (X_5)	0.281	3.157**
288	Management (X_6)	0.146	2.341*
289	Other inputs (X_7)	0.081	2.339*
290	Diagnostic statistics		
291	Gamma (γ)	0.783	2.544**
292	Sigma square (δ^2)	0.531	2.493**
293	Log likelihood function	-106.39	
294	LR test	22.73	

295 *significant at 5%

296 ** significant at 1%

297 Source: output of Frontier 4.1 by Coelli (1996)

298 It also confirms the presence of the one-sided error component in the model and hence,
 299 the use of the OLS in estimating the function, becomes inadequate in representing the
 300 data. The sigma square (δ^2) estimate was 0.531 and significant at 1%, and therefore,
 301 assures us of the goodness of fit and correctness of the distributional assumptions of the
 302 composite error. The generalized likelihood test gave a value of 22.73 which indicates
 303 that the farmers are not fully technically efficient. Xu and Jeffrey (1995), Kebede (2001),
 304 Ajibetun and Aderinola (2003), and Idwin *et.al.*, (2009), obtained similar results in their
 305 different studies.

306

307 Table 4. MLE of the stochastic cost Frontier in Poultry Production in Imo State, Nigeria.

308	Variable	Coefficient	t-ratio
309	Constant	6.094	4.106**
310	Feed cost (Px1)	0.409	3.115**
311	Cost of birds (P x2)	0.312	3.044**
312	Labour cost (P x3)	0.503	3.152**
313	Cost of drugs and		
314	Medication (P x4)	0.092	1.643
315	Cost of capital (P x 5)	0.056	1.814
316	Cost of management (Px6)	0.115	2.522*
317	Cost of other inputs (Px7)	0.058	1.549
318	Output (Y*)	1.731	4.037**
319	Diagnostic statistics		
320	Gamma (X)	0.98	3.918**
321	Sigma square (δ^2)	0.65	3.433**
322	Log likelihood function	-96.03	
323	LR test	67.25	

*Significant at 5%

**Significant at 1%

Source: Output of Frontier 4.1 by Coelli (1996)

In the cost frontier function (Table 4), all the variables carried the expected positive signs. The coefficients of feed cost (Px_1), cost of birds (Px_2), labour cost (Px_3), and output (Y^*) adjusted for statistical noise were significant at 1%, while the coefficients of cost of management (Px_6), was significant at 5%. The coefficients of cost of drugs and medication (Px_4), cost of capital (Px_5), and cost of other inputs (Px_7) were not significant even at 5% level.

The gamma (γ) estimate was 0.98 and was significant at 1% level indicating that 98% of the variation in output were caused by economic inefficiency. The sigma square (δ^2) was 0.65 and was significant at 1% level, and indicated the goodness of fit and correctness of the specified assumptions of the distribution of the compound error term (Bravo-Ureta and Pinheiro, 1997). The generalized likelihood test gave a value of 67.25 which indicates that the farmers are not fully such economically efficient.

Estimates of Technical and Economic Efficiency in Poultry Production

The estimates of Technical Efficiency of poultry farmers are presented in Table 5. Results show that technical efficiency ranged from 0.36 to 0.97 with mean technical efficiency as 0.75. This suggests that there are about 25% chance of increasing output without additional resources in poultry production. This result also indicates that, for the average poultry farmer to achieve the technical efficiency level of his/her most efficient partner, he would realize about 23 percent (i.e. $1 - (95/97)$) cost savings. On the other hand, the least technically efficient poultry farmers, will have about 64 percent (i.e. $1 - (36/99)$) cost savings.

The efficiency distribution, show that, about 4.3 percent of poultry farmers attained between 0.91 – 1.00 technical efficiency levels. About 38 percent of the poultry farmers

attained technical efficiency of between 0.71 – 0.80, while only 2.86% of the poultry farmers attained technical efficiency below 0.51.

The high mean technical efficiency is suggestive of the fact that only a small fraction of the output of the output is attributed to resource wastage. The technical efficiency distribution agrees with that obtained by Idiong *et.al.*, (2009), Ajibefun and Aderinola (2003), and Kebede (2001).

Table 5. Frequency Distribution of Technical Efficiency of Poultry Farmers in Imo State, Nigeria

Technical Efficiency	Frequency	Percentage
≤ 0.50	4	2.86
0.51 – 0.60	13	9.29
0.61 – 0.70	20	14.29
0.71 – 0.80	53	37.86
0.81 – 0.90	44	31.42
0.91 – 1.00	6	4.28
Total	140	100
Mean Technical Efficiency		0.75
Minimum Technical Efficiency		0.36
Maximum Technical Efficiency		0.97

Source: Derived from output of computer programme, frontier 4.1 by Coelli (1996)

The Economic Efficiency estimates are presented in Table 6. It shows a range from 0.14 to 0.56. The mean economic efficiency in poultry production in the study area was 21%. The estimates also show that for the average poultry farmer to attain the level of the most economically efficiency farmer in the sample, he/she would experience a cost saving of 62.5 percent (i.e, $1 - 21/56$) in poultry production.

However, the least economically efficient poultry farmer will experience efficiency gain of about 25 percent (i.e., $1 - 14/56$) in poultry production to attain the level of the most economically efficient farmer in the sample. The results are also lower than that obtained by Idiong *et.al.*, (2009) and Xu and Jeffrey (1995).

Table 6. Frequency Distribution of Economic Efficiency of Poultry Farmers in Imo State Nigeria.

Economic Efficiency	Frequency	Percentage
≤ 0.20	65	46.41
0.21 – 0.30	42	30.00
0.31 – 0.40	20	14.29
0.41 and above	13	9.3-
Total	140	100

Mean Economic Efficiency 0.21

Minimum Economic Efficiency 0.14

Maximum Economic Efficiency 0.56

Source: Derived from output of computer programme, Frontier 4.1 Coelli (1996)

CONCLUSION

This study estimated technical and economic efficiencies of poultry farmers in Imo State, Nigeria. The study found that poultry farmers in the state are not fully technically and economically efficient in their use of resources and therefore, there is enough allowance to increase their efficiencies if some important policy variables are addressed. It has also shown that the major efficiency problem of the poultry farmers is not so much of technical. Therefore, the farmers with their current resource base and technology, if technical efficiency is improved can substantially improve economical efficiency.

409

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