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# An Analysis of the Production Efficiency of Broiler Firms in Ibadan Area of Oyo State, Nigeria

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**Target Audience:** Livestock farmers, Scientists and Policy Makers

Abstract

*The study applied the neoclassical theory involving stochastic frontier production and cost functions to broiler production in Oyo State Nigeria. Technical, allocative and economic efficiency measures were derived for sampled broiler firms. This was based on Kopp and Diewert's cost decomposition approach for estimating Farrell's efficiency measures. The data came from a sample survey of the area of study. A multistage random sampling procedure was employed in selecting the sample needed for the analysis. Evidence from the analysis suggested that the broiler firms attained only about 80.3 percent technical efficiency. The allocative efficiency is about 74.9 percent while the economic efficiency stood at 60.3 percent. Based on these results, by operating at the efficient frontier; the sampled broiler production firms would be able to reduce their costs by 39.7 percent by operating at technical and allocative efficiency levels. This resource savings has important implication for both policy formulation and firm management. The result obtained implies that the average firm is potentially capable of increasing production without increasing its use of inputs. There is the need for the firms to improve on their management practices. This is because it embraces both technical and allocative efficiencies. As incentives for producers, input provision at reduced prices are recommended especially for imported ones. Improvement in hatchery facilities and; introduction of labour saving technologies are also recommended.*

Keywords: Efficiency- measures, broiler firms, stochastic production/cost frontiers, Ibadan, Nigeria.

## Introduction

The importance of food in the socio-economic development of any country cannot be over emphasized. Increased domestic food supply has been the major food policy objective of successive Nigerian Governments since the 1970s. Such policy objective has been translated into many agricultural programmes and projects (1). The emphasis on increased domestic food production capability can be justified in view of the poor performance of the food sub-sector o the Nigerian economy. The consequences of food demand - supply gap are declining per capital production, high and rising food prices, increasing food import and a growing deterioration in the nutritional status of the average Nigerian (2).

It is well-known that Nigeria's per capita intake of high quality animal protein is too low (3,4,5). Th health hazards of protein malnutrition have been well documented (7). According to (8); there is an increasing evidence of high infant mortality, low resistance to diseases, poor growth and development, mental retardation which comes as a result of inadequate protein in the diets of most Nigerian. According to (6) the diets of the people of the tropical zone and Nigeria (9) are usually protein poor.

Apart from fishes, other source of animal protein in Nigeria are cattle, poultry, piggery, sheep and goats. Hence, livestock industry of which poultry is a subset provides protein for the populace (10). However, cattle, sheep and goats are poor candidates or not fast-growing species for rapid short-term increases in number and the provision of the much needed protein supply. This is due to their low fecundity, long gestation and long generation interval. Very rapid increases can be achieved with respect to piggery and poultry within a short-time (11). Unlike pork that has no national spread due to religious beliefs, there are virtually no taboo that hinders the consumption of poultry meat or eggs (12). Hence, poultry production has long been recognized as one of the quickest ways for a rapid increase in protein supply in the short-run. The need to met animal protein requirements from domestic sources, demands intensification of production of meat and eggs derived from prolific animals like poultry birds. Poultry has a shorter life-cycle and is much more prolific than larger livestock.

## The Problem Statement

Poultry farming units are the most common type of livestock production in Nigeria, (11). Before now, most of the poultry raised in the country was from their indigenous breeds. In recent years, commercial poultry farms using modern techniques and inputs such as improved breeds, better feeding methods and management practices have been established (13). Today, the poultry industry in Nigeria is suffering from being largely import dependent (14). It is believed that the rate of expansion of this sub sector of the economy has been substantially reduced (15). This is due to, among other factors, high feed cost; arising largely from increasing prices of ingredients, poor quality food and inefficiencies, in production and distribution (16).

The success of a poultry enterprise, irrespective of the size, largely depends on the kind of care and attention the flock receives (17). This is reflected in the choice of source of birds, the choice of feed/feed materials and the operational diseases control programmes. These factors inter-play to determine the total well-being or health status of the flock and the enterprise. It has long been established that profitability in the poultry industry depends largely on the biological efficiency of the birds, efficiency of feed consumption and viability. The economic efficiency of chicken meat production depends on the growth rate of the birds as well as the feeding cost and finishing time. Efficiency measurement has received considerable attention from both theoretical and applied economist (18). Little of this research effort has been directed to the poultry industry and to the relative importance of the various components of poultry firms efficiency.

Yet in the last few years, a series of methods has been developed to determine the technical efficiency of production units (19). Moreso, measuring efficiency is important in the use of scarce resources in production. This is because it is a first step in a process that might lead to substantial resource savings (18). These resource savings have important implications for both policy formulation and firm management. This study contributes to the lieterature on firm level efficiency measurement by applying the stochastic formulation, which yields technical, allocative, and economic efficiency measures that are free from distortions arising/stemming from statistical noise, inherent in deterministic models to the Nigerian poultry industry. As far as this author knows, no specific investigations into the efficiency levels have, as yet been carried out on broiler production in Nigeria.

## Objectives of the Study

The general objective is to apply the stochastic efficiency decomposition model to broiler production in Ibadan area. The specific objectives include; estimate the technical, allocative and economic efficiency measures for broiler production; examine the firms' potentials for reducing cost through improved efficiency in production; make policy recommendations based on the findings of this study.

## *Methodology*

### *Area of Study*

The area of study in Ibadan zone of Oyo State, Nigeria. It is made up of eleven Local Government Areas. The five LGAs, making up the former Ibadan Municipal Government Area, are however excluded from the analysis. These are Ibadan Southwest, Ibadan, Northeast, Ibadan South, Ibadan Northwest and Ibadan

North. These area classified as strictly urban LGAs. The other six LGAs are Oluyole, Ona-ara, Egbeda, Lagelu, Akinyele and Iddo. They are denoted as strictly rural LGAs. The latter LGAs are used as the sampling frames for the current study. This is because mot of the firms are found in these area.. Ibadan is the largest city in West Africa. It has a population of about 2 million inhabitants (20) it is a densely populated area. The high population translates to ready market for most commodities.

## Method of Data Collection

A simple random sampling procedure was used in selecting the sample needed for this study. The six LGAs classified as strictly rural were used for this exercise. In each LGA, a random sample of 20 broiler firms was taken using the list of firms provided by the Poultry Association of Nigeria. The Random Number Process was applied. This gave a sample size of 120 firms. The completeness of information provided by the firms informed the decision to use them all in the subsequent analysis.

Data were collected on input - output relationships of the firms, costs of inputs, prices of outputs, labour utilization, veterinary services, drugs and other relevant information pertaining to the operation of the firms.

## *Method of Data Analysis*

(a) Stochastic Production Function

The analytical framework borrows from the work of (18) and (21). The methodology follows (22) cost decompotion procedure of estimating technical, allocative and economic efficiencies. The firm's technology is representd by a Cobb - Douglas production function and the stochastic production function is given as:

$$Q_i = f(X_i, b) + V_i - U_i \quad \ldots\ldots(1)$$

Where $Q_i$ denotes the weighted output of live birds (kg); $X_i$ is a vector of actual inputs used by the $i^{th}$ firm; b is a vector of parameters to be estimated; $V_i$ and $U_i$ are assumed to the independent of each other; $V_i$ is the two-sided, normally distributed random error. $V \sim N(\sigma, s^2)$ $U_i$ is the one-sided efficiency component with a half-normal distribution. $U \sim |N(0, \sigma^2)$; This is a non-negative random variable. It is assumed to account for the existence of technical inefficiency. The error terms is $V_i - U_i = e_i$. The ei represents traditional deterministic production function formulation.

The estimating equation for the stochastic function is given as

$$\text{Ln } Q = \beta_0 + \beta_1 \text{ In } X_i + \beta_2 \text{ In } X_2 + \beta_3 \text{ In } X_3 + \ldots \beta_5 \text{ In } X_5 + V_i - U_2 \ldots\ldots(2)$$

The maximum likelihood estimated of (2) provides estimators for b's variance parameters ($\sigma^2 = \sigma_u^2 + \sigma_v^2$), gamma (g), which is equal to $\sigma_u^2 / \sigma^2$, and lambda (1) = $\sigma_u / \sigma_v$. The parameter gamma (g) has a value between zero and one (23). According to (24), gamma (g) measures the technical efficiency. Similarly (1-g) measurers the technical inefficiency of the firms. The parameter lambda (l) is expected to be greater that one. Such a result accordiing to (25) indicates a good fit for the model and the correctness of the specified distributional assumptions for $V_i$ and $U_i$.

## Cost Frontier Function

Following (26) the analytically derived dual cost function can be represented as

$$C = f(P_1, P_2, P_3, P_4, P_5, Q^*) \ldots\ldots(3)$$

Where P's are the average prices of the inputs and Q* is the observed output of the $i^{th}$ firm adjusted for the stochastic noise capture by $V_i(Q^* = Q_i - V_i)$.

$$C = KP_1^{a1} \; P_2^{a2} \; P_3^{a3} \; P_4^{a4} \; P_5^{a5} \; Q^{*r} \ldots\ldots(4)$$

Where $\text{In } C = \text{Ink} + a_1 + \text{In } P_i + a_2 \text{ In } P_2 + a_3 \text{ In } P_3 + a_4 \text{ In } P_4 + a_5 \text{ In } P_5 + r \text{ In } Q^* \ldots\ldots(5)$

This means that C is the minimum cost associated with the production of Q*. All the parameters of (4) can be derived from those of the estimated equation(2) for the derivation see (26). According to (22), equation (3) can be used to estimate technical and allocative efficiency of production.

## The Efficiency Indexes

The technically efficient input vector ($X_t$) for a given output level (Q) is derived by solving simultaneously $Q=f(X_\sigma)$ and the input ratios $X_1 / X_i = K_i (I>1)$ where $K_i$ is the ratio of th observed inputs (X1) and input at output $Q^*(X_i)$

The application of Shephard's lemma to (3) gives a system of minimum cost input demand equations.

$\partial C/\partial P_i = X_i$ (P, Q) ..............................................(6)

A firm's input prices and output are substituted into this system to obtain the economically efficient input vector ($X_e$). Hence, $X_iP$ and $X_e^1P$ repesent the cost of the technically efficient and economically efficient input combinations associated with the firm's observed output respectively. Similarly, the cost of the firms actual operating input combination is $X^1_aP$. The efficiency indexes are derived form these measures as

Technical Efficiency (TE) = $(X^1P)/X^1_aP)$
Economic Efficiency (EE) = $(X^1_eP)/X^1_aP)$
Allocative Efficiency (AE) = $(X^1_eP)/(X^1_tP)$
i.e AE= EE/TE

These are equivalent to the efficiency indexes derivable from directly using the fortier production function (26,27).

Explanatory Variables

There are so many economic factors that affect the cost of production in a poultry enterprise. These include feeds, labour, cost of medication, depreciation cost. The cost of feed accounts for 70-80percent of the total running cost (28,8), Feeds of interest in this case are broiler starter for broiler chicks and broiler finisher for broilers. The seasonal nature of some feed components particularly energy sources introduces seasonal patterns into the price of feed (15). Hence, knowledge of the seasonal price of feed is of great importance in the poultry industry (29) According to (13) the poultry industry is characterized by high cost of production. Labour occupies a significant position in the cost of production in any poultry enterprises. Efficient use of labour has a great bearing on the unit cost of production. Thus efficiency can be achieved by increasing the scale of operation (flock size), improving the layout of the farm houses, staff training, employment of experienced staff on the management side, the application of works-study to increase the efficiency of labour utilization, reducing the amount of labour required for a certain flock size or increasing the size of flock that can be handled by a unit of labour(28)

It is hypothesized in this study that cost of feed (X1), cost of labour (X2), cost of medication or veterinary services (X3), cost of starting stock (X4) and cost of fixed inputs (X5) will have significant impact on the output of broiler by weight in this study. The selection of these variables is based on economic theory as well as suggestions from the literature based on previous/similar studies.

Measurement of Variables

The dependent variable(Q represents a weighted output of live birds produced and sold during the survey period in kilograms. Feed cost (X1) donates the total quantity of broiler feed (mash) and other grain-based feeds in kilograms multiplied by the average price per unit of this input. Labour variable (X2) is the sum of the family and hired labour used in broiler production and multiplied by the average wage rate in the are of study. In this instance, family and hired labour are taken to be perfect substitutes. Hence, the opportunity cost of family labour in terms hired labour is used as the imputed cost for family labour. Veterinary/ Medication r health management cost (X3): This variable is necessary because there are known diseases many of which are better prevented. Some may be very fatal in poultry. This often informs the establishment of vaccination schedule which serve as a health guide for veterinarians. These specialists also advise on management of both the birds and human resources o the farm. The cost embraces all expenses on flock health management and medications. This is calculated on per bird basis.

The cost of starting stock (X4) is the unit price of the stock multiplied by the number of day-old broilers or cockerels. It is believed that the number of birds purchased has influence on the total cost because of this consideration. The fixed input variable(X5) represents the total costs of fixed inputs. This may include insurance where applicable, taxes, depreciation on housing machinery and other equipment. The price for this is obtained per sold-bird, which is the estimated cost divided by the number of birds that got to the market wieght and finally sold. This simple-manipulation of the data was needed in order to derive the average input prices required for estimating the efficiency indices.

## Empirical Analysis

Table 1: Maximum likelihood (MLE) Estimates of Cobb-Douglas based Stochastic Production Frontier

| | | | |
|---|---|---|---|
| Feed ($X_1$) | 0.5432*** | (0.1967) | 0.7616 |
| Labour ($X_2$) | 0.2560** | (0.1277) | 2.0047 |
| Medics($X_3$) | 0.2894** | (0.1218) | 2.3760 |
| Stocks ($X_4$) | 0.4537*** | (0.1551) | 2.9252 |
| Fixed Inputs ($X_5$) | 0.1205* | (0.0726) | 1.6598 |
| Constant | 3.2146 | | |
| $\lambda$ | 2.0183 | | |
| $\gamma$ | 0.8029 | | |

Log likelihood function = 106.4325
N = 120
$\sigma_u^2$ = 0.1472
$\sigma_u$ = 0.3837
$\sigma_v^2$ = 0.0362
$\sigma_v$ = 0.1901
$\sigma^2$ = 0.1834

Source: Data Analysis, 2002 Standard errors are in brackets.

### Results and Discussions

Table 1 presents the result of the estimated stochastic production. The lambda ($\lambda$) with value of 2.0183, which is greater than one signifies a good fit for the estimated model and the appropriateness of the required distributional assumptions for the decomposed terms of the error term. The parameter estimates for $X_1$ and $X_4$ are significant at the 10% level. The coefficients of $X_2$ and $X_3$ are significant at the 5% level while that for $X_5$ is significant at the 10% level. Hence, all parameter estimates are statistically significant at different levels. The gamma ($\gamma$) value of 0.8029 implies that the firms attained about 80 percent technical efficiency level in their operation. The estimate of technical inefficiency is 0.1971. It means that the firms are about 20 percent technically inefficient. This represents the largest proportional reduction in inputs that can be achieved in the production of broiler without the output being affected/ reduced.

The dual cost frontier derived analytically from the estimated production frontier is:

$$\ln C = 0.65 + 0.3267 \ln P_1 + 0.15401 \ln P_2 + 0.1741 \ln P_3 + 0.2729 \ln P_4 + 0.0725 \ln P_5 + 0.614 \ln Q^*$$

Where $P_1$, $P_2$, $P_3$, $P_4$, and $P_5$ are the average prices of the inputs and $Q^*$ is the weighted output per firm adjusted for any statistical noise as specified in equation (3). The use of average prices is reasonable if the geographical area where the firms are located and the competitive nature of the input markets are considered.

Based on the cost frontier function obtained the average technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE) indexes computed for the firms are contiained in Table 2.

Table 2: Frequency Distribution of Efficiency Indexes/Estimates

| Efficiency Level | Technical Efficiency | Allocative Efficiency | Economic Efficiency |
|---|---|---|---|
| 51 - 60 | 0 | 4 | 80 |
| 61 - 65 | 2 | 10 | 32 |
| 66 - 70 | 6 | 12 | 4 |
| 71 - 75 | 12 | 59 | 2 |
| 76 - 80 | 25 | 9 | 1 |
| 81 - 85 | 65 | 10 | 1 |
| 86 - 90 | 10 | 6 | 0 |
| 91 - 95 | 0 | 8 | 0 |
| 96 - 100 | 0 | 2 | 0 |
| Total | 120 | 12 | 120 |
| Mean | 80.29 | 74.88 | 60.30 |
| Standard Deviation | 5.72 | 8.57 | 4.13 |
| Minimum | 63.5 | 59.3 | 57.2 |
| Maximum | 84.2 | 96.7 | 85.4 |

Source: Data Analysis, 2002.

Table 2 shows that the average technical efficiency of the firms is 80.29 percent or 0.8029. This is exactly equal to that obtained from the production frontier function stimated. This confirms the assertion that one can obtain equivalent measures of technical and allocative efficiency using either the frontier production function and associated first order conditions or the dual frontier cost function (26). The mean allocative and economic efficiency estimates are 74.88 and 60.30 percent respectively. These results give a technical inefficiency level of 0.1971, allocative inefficiency of 0.2512 and economic inefficiency of 0.3970. The majority of the broiler firms fall within the ranges of 81-85 percent, 71 - 75 percent and 56 - 60 of technical, allocative and economic efficiency indices respectively.

The technical efficiency level of 80.29 gives a gamma (g) value of 0.8029 from this the lambda (1) value of 2.0183 is obtained which is also equal to the one from the production frontier function. In both methods, lambda (1) is greater than one. This implies that the one sided error Ui dominates the symmetric error Vi indicating a good fit and correctness of the specified distrubutional assumptions for them (25).

Since, output is treated as exogenous in the cost-minimizing framework of the cost frontier, the measure of technical inefficiency is input - saving (3). This gives the maximum rate at which the use of all inputs can be reduced without reducing output (31). The gamma (g) value of 0.8029 with technical inefficiency of 0.1971, implies that about 19.7 percent of the cost incurred by the broiler firms can be avoided without any loss in output. Similarly, for allocative efficiency, with gamma (g) of 0.7488, about 25.1 percent of cost can be reduced without output being affected to reach the most allocatively efficient level.

The average economic efficiency value of 0.6030 indicates that if an average broiler firm is to reach the EE level of its most efficient counterpart, then it could experience a cost savings of about 39.7 percent by operating at full technical and allocative efficiency levels. It is evident from these results that EE can be substantially improved. In addition to this, it seems that allocative inefficiency 25.1 percent constitutes a more serious problem than technical inefficiency (19.7 percent). The overall results, however, indicate that there are considerable inefficiencies in broiler production in the area of study. This is evident from the ranges of technical, allocative and economic efficiency indices that the firms fall into.

## Policy Recommendations

Most of the variables in the stochastic production function are significant at different levels. Out of this feeds, medicines and stocks are of policy relevance. Feed is directly related to output. The more feed that is used the more output that is made. Given a total cost outlay on feed, a reduction on the unit price of feed will lead to more feed being used. This translates into more output at reduced cost. Feed review is thus recommended so as to bring down the cost of production and the unit price of the output. The same analysis is plausible for the relevant medicines and the breeding or starting stock in production especially in the provision of efficient hatcheries by the government. It is recommended that inputs be provided at reduced prices, improvement in hatchery facilitates and the provision of labour saving technologies for large scale operations are also recommended.

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