# ESTIMATION OF EFFICIENCY IN SMALL SCALE PIG PRODUCTION

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**Abstract**
*A study was conducted in rural areas of Itu and Uyo to estimate the efficiency of resource use by small scale pig producers. With the aid of questionnaire, 70 swine farmers were selected through the random sampling procedure. Using the stochastic production frontier function, the maximum likelihood estimation method was employed to obtain asymptotic parameters which describe the efficiency determinants. Results revealed that none of the pig farmers reached the frontier threshold as the inefficiency gap in resource use was 0.35. The most critical inputs in pig production were hired labour, feed and stocking density.*

**Keywords:** Pig, resources, production, efficiency.

## Introduction

Swine production in Nigeria has been growing in recent years and has contributed immensely to the improvement of the nutritional plane of many Nigerians (Ajuogu and Aniebo, 2011) and its production represents an important segment in the food animal industry throughout the world (Ladokun *et al* 2011). Pig production represents a fast way of increasing animal protein consumption because pigs grow fast and are more prolific than cattle, sheep and goats (Sokunbi *et al* 2010; Shehu and Buba, 2011). Nigeria is reported to rank second in pig population in Africa and pig meat contributes about 4.5 percent of meat consumption in the country (Dafwang and Adesehinwa, 2010). Despite existing religious and cultural taboos that have put pig at a disadvantage, pig production and consumption are becoming increasingly popular among Nigerians (Dafwang and Adesehinwa, 2010). To achieve optimum production and increased availability of pork to the growing market, pig farmers have to transform resources into output as efficiently as possible. Earlier and empirical studies by Etim *et al.,* 2005, Udoh and Etim (2006) Etim *et al.,* (2013) posit that for farmers to optimize agricultural production, available resources used in production must be used as efficiently as possible, and as managers of land, farmers need to solve problems arising from deteriorating natural resources (Rosegrant *et al.,* 2005, Udoh and Etim, 2011; Etim and Udoh, 2014).

The term efficiency of a firm can be defined as its ability to provide the largest possible amount of output from a given set of inputs. The modern theory of efficiency dates back to the pioneering work of Farrell (1957) who proposed that the efficiency of a firm consist of technical and allocative components and the combination of these two components provide a measure of total economic efficiency (overall efficiency). As noted by Farrell (1957) technical efficiency, which is the main focus of this study, is the ability to produce a given level of output with a minimum quantity of inputs and can be measured either as input conserving oriented technical efficiency or output-expanding oriented technical efficiency. Output-expanding oriented technical efficiency is the ratio of observed to maximum feasible output, conditional on technical and observed input usage (Jondrow *et al.,* 1982; Ali, 1996). This study aims at using output-expanding orientation to measure technical efficiency effects. The term frontier involves the concept of maximality in which the function sets a limit to the range of possible observations (Forsund *et al.,* 1980). It is therefore, possible to observe points below the production frontier for firms producing below the maximum possible output, but there cannot be any point above the production frontier, given the available technology. Deviations from the frontier are attributed to inefficiency. The need to measure inefficiency effects is the major motivation for the study of frontiers. Frontier studies are classified according to the method of estimation. Kalaitzandonakes *et al.* (1992) grouped these methods into two broad categories-parametric and non-parametric methods. For the parametric methods, it can be deterministic, programming and stochastic depending on how the frontier model is specified. Many researchers, including Schmidt (1976) have argued that efficiency measures from deterministic models are affected by statistical noise. This however, led to the alternative methodology involving the use of the stochastic production frontier models. Aigner *et al.* (1977) and Meeusen and Vander Broek (1977) independently proposed the idea of stochastic measurement.

The major feature of the stochastic production frontier is that the disturbance term is a composite error consisting of two components, one symmetric and the other one-sided. The symmetric component, $V_i$, captures the random effects due to measurement error, statistical noise and other influences outside the control of the firm and it is assumed to be normally distributed. The one-sided component $U_i$, captures randomness under the control of the firm. It gives the derivation from the frontier attributed or exponential. The major weakness of the stochastic frontier model is its failure to provide an explicit distribution assumption for the inefficiency term (Sharma *et al.,* 1999).
By definition, stochastic frontier production function is

$$Yi = F(X_i; \beta) \exp(V_i - U_i) \quad I = 1, 2, \ldots, N \qquad (1)$$

Where $Y_i$ is the output of the ith farm; $X_i$ is the corresponding (MX2) vector of conventional physical inputs; β is a vector of unknown parameter to be estimated; F(.) denotes an appropriate functional form, $V_i$ is the symmetric error component that accounts for random effects and exogenous shock; while, $U_i<0$ is a one sided error component that measures technical inefficiency.
In recent times, econometric modeling of stochastic frontier methodology associated with efficiency estimation has been important aspect of economics research. both time varying and cross-sectional data have been used in studies based mostly on Cobb-Douglas function and transcendental logarithmic functions that are specified either as production function or cost function to estimate individual firm efficiency (Bagi and

Hunag, 1983; Bagi, 1984; Ali, 1996; Apeziteguia and Garate, 1997; Yao and Liu, 1998; Udoh and Akintola, 2001; Etim *et al.,* 2005; Udoh and Etim, 2006). However, this study uses a Cobb-Douglas production function to estimate technical efficiency effect of pig farms.

**Methodology**

The study was conducted in Itu and Uyo Local Government Areas of Akwa Ibom State. A farm-level survey was conducted in 2012 to provide demographic data. A total of 70 pig farmers were randomly selected. Information on resource use, unit prices, output levels and socio-economic characteristics of the producers were obtained.

Multiple regression analysis based on a stochastic production frontier model was employed. The model incorporates efficiency determinants into the inefficiency error components as hypothesized by coelli and Battese (1996) to estimate the efficiency of resource use among producers. This model describes the best and most efficient outcome possible based on the various parameters studied.

By definition, a stochastic frontier production function is:

$$Yi = F(X_i; \beta) \exp(V_i - U_i) \quad 1 = 1, 2, \ldots, N \quad - \quad - \quad - \quad - \quad - \qquad (1)$$

Yi is the output of ith pg farm; $X_i$ is the corresponding (m x 2) vector of inputs; β is a vector of unknown parameter to be estimated; F (.) denotes an appropriate functional form; Vi is a symmetric error component that accounts for random effects and exogenous shock; while $Ui \leq O$ is a one sided-error component that measures technical inefficiency.

To develop a model that is flexible which can include the data, a power production function known as Cobb-Douglas production function was specified. This is expressed as:

$$L_n Y = \beta_o + \beta_1 L_n X_i + \beta_2 L_n X_2 + \beta_3 L_n X_3 + \beta_4 L_n X_4 + \beta_5 Ln X_5 + V_i - U_i \quad - \qquad (2)$$

Where Y is the total quantity of pigs produced in kg; Xi is Hired labour in mandays; $X_2$ is quantity of feed in kg; $X_3$ is value of drugs in naira; $X_4$ is value of all farm implements used in naira; $X_5$ is stocking density.

While $V_i \sim N(O, \sigma v^2)$; and

$$e^{-ui} = \rho_o + \rho_1 (X_6) + \rho_2 (X_2) + \rho_3 (X_8) + \rho_4 (X_9) + \rho_5 (X_{10}) + Z_i \quad - \qquad (3)$$

where $X_6$ is age of the farmers; $X_7$ is access to credit (dummy); $X_8$ is access to market (dummy); $X_9$ is households size measured as number of persons in a household who share the same meal; $X_{10}$ is technical assistance by extension personnel (dummy) and $Z_i$ is an error term assumed to be randomly and normally distributed. The values of the unknown coefficients in equation (2) and (3) are jointly estimated by maximizing the likelihood function (Yao and Lui, 1998; Udoh and Akintola 2001b).

**RESULTS AND DISCUSSION**

**Results of Maximum Likelihood and Inefficiency Estimates**

The model specified is estimated by the maximum likelihood estimation technique using FRONTIER 4.1. The value of sigma square indicates goodness of fit and the correctness of the specified distribution assumption of the composite error term. The variance ratio is high as 70.06 percent suggesting that the systematic influences that are not explained by the production function, are relatively dominant sources of random errors. Result implies that the existence of inefficiency of resource use among the pig farmers accounts for about 70 percent of the variation in the output level of pigs produced. The presence of one-sided error component in the specified model is thus confirmed implying that the ordinary least square estimation would be inadequate representation of the data. Result confirms the relevance of the specified production function and maximum likelihood estimation.

The production function estimate is an indication of the importance of resources in pig production. Except for value of drugs and capital, the coefficients of other inputs have the expected signs and magnitude and are statistically significant at different levels. Hired labour, stocking density and quantity of feed seem to be the most critical inputs based on the magnitude of their coefficients. The large elasticity (0.6254) of hired labour is an indication that pig production is highly laborious. Similar finding was reported in earlier study of Udoh and Etim (2008).

The coefficient of quantity of feed is 0.4017 and is positively significant at ($P<.10$). This result suggests the importance of concentrate in pig production. The elasticity of stocking density is 0.3856 and is negatively significant at ($P<.05$). Result is in conformity with similar empirical study by Lundval and Battese (2000) and Aye and Mungatana (2010) who found a varied relationship between the size of farm and inefficiency using the frontier production function. Stocking density capture the effect of scale of production on the technical efficiency of the farm. Result implies that increasing the stock of animals tend to diminish the timeliness of resource use thus leading to decline in technical efficiency.

The variable age could either positively or negatively affect technical efficiency. Older farmers are more experienced and would be more technically efficient than younger farmers. However, regarding innovations and agricultural methods, older farmers are less likely to adopt new ideas and would hence be less technically efficient than younger farmers. In this study, however, age is positively signed and impacts significantly on technical efficiency and thus, the variable age indexes experiences and serves as a proxy for human capital suggesting that pig farmers with more years of farming experience will have more technical skills in management and thus higher efficiency than younger pig farmers. According to a recent study by Etim and Edet (2014), increased experience in agricultural production may also enhance critical evaluation of the relevance of better production decisions including efficient utilization of productive resources. The statistical significance of the coefficient suggest that specialization is developed overtime leading to improved production methods and higher efficiency. Finding agree with studies by Parikh *et al* (1995); Khai *et al* (2008); Aye and Mungatana, (2010) and Etim and Okon (2013). This result supports the hypothesis by Chianu and Tesji (2004) that human capital plays a positive role in the acquisition and evaluation of new ideas. Besides, programme and materials promoting technological change typically favour literate farmers.

The variable credit has a coefficient 0.1704 and is positively significant ($P<.01$) implying that accessibility and availability of credit loosens the production constraints and make for timely purchase of resources thereby increasing productivity through efficiency. Result is in conformity with earlier findings by Etim and Okon (2013) but contrast with results of Haji (2006) who found a negative impact of credit on technical efficiency.

**Table 1:** Maximum Likelihood Estimates and Inefficiency Function

| Variables | Coefficient | Asymptotic t-value |
|---|---|---|
| **Production Function** | | |
| Constant term $\beta_0$ | 0.2031 | 2.2102** |
| Hired Labour $\beta_1$ | 0.6254 | 3.1315*** |
| Quantity of feed $\beta_2$ | 0.4017 | 1.9567* |
| Value of drugs $\beta_3$ | 0.3091 | 1.0112 |
| Capital $\beta_4$ | 0.1053 | 1.4776 |
| Stocking density $\beta_5$ | -0.3856 | -2.0967* |
| **Explainers of Inefficiency** | | |
| Intercept $\rho_o$ | 0.4100 | 1.0920 |
| Age $\rho_1$ | 0.1665 | 2.0092** |
| Credit $\rho_2$ | 0.1704 | 2.8511*** |
| Market $\rho_3$ | 0.1566 | 1.3622 |
| Household size $\rho_4$ | 0.0882 | 1.0227 |
| Extension contact $\rho_5$ | 0.4251 | 3.0911*** |
| **Diagnosis statistics** | | |
| Sigma-Square $\delta s^2$ | 0.6441 | 2.4511** |
| Gamma $\lambda$ | 0.7006 | 3.1862*** |

**Resource-Use Efficiency**

One important feature of the stochastic production frontier is its ability to estimate individual, farm-specific technical, allocative and economic efficiencies.

Figure 1 revealed variation in efficiency indices across the sampled pig farms. The distribution spreads from left to right at different intervals thus validating the assumption of normal distribution of inefficiency effects (-Ui) in equation (2). The average resource-use efficiency is 0.65 leaving an inefficiency gap of 0.35, meaning that about 35% increase in pig production could be accomplished using the same input combination. According to a recent study by Etim and Edet (2014), this is an indication of product wastage due to inefficiency of resource use by the pig producers. From the graph, the least and most efficient producer had efficiency indices of 0.04 and 0.92 respectively. Result revealed that none of the pig farmers reached the frontier threshold implying that producers must have encountered some production and environmental constraints they were unable to completely surmount. According to Ali (1996), in small scale farming, resources are mostly allocated to various uses on the basis of their shadow values, which is the amount by which the contribution could be raised if an additional unit of the input was utilized, thereby preventing the producers from maximizing production efficiency.

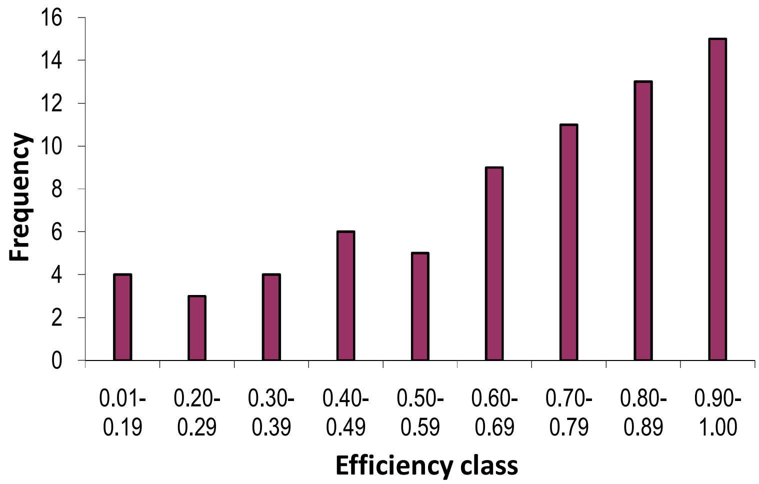


**Figure 1: Farm specific technical efficiency**

**Conclusion**

This study was conducted to measure the efficiency of resource use among small scale pig producers in Uyo and Itu. Although pig production is on small scale, producers have utilized resources for production. Results showed that pig production was highly labourious given the magnitude of elasticity. Feed and stocking density were important factors determining efficiency among the farmers. Findings of this study also revealed that all the farmers operated below the frontier threshold. Results further underscores the need to increase labour, credit capital availability to farmers.

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