MEASUREMENT AND SOURCES OF ECONOMIC EFFICIENCY IN RABBIT PRODUCTION IN AKWA IBOM STATE, NIGERIA (A stochastic Frontier Profit Function Approach)

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ABSTRACT

The study estimated the economic efficiency of production for rabbit enterprise in Akwa Ibom State of Nigeria employing a stochastic profit function approach. Sixty (60) rabbit farmers were purposively selected in the six (6) agricultural zones of the state. The stochastic frontier profit function was used to analyze economic efficiency levels in the area of study for analysis. The analysis of data revealed that labour costs (wage), price of feeds/feed supplements, farm size and to some extent price of drugs/medication determined profit level in the enterprise. Furthermore, level of education, farming experience, extension contact and gender were shown as major factors influencing economic efficiency of the enterprise. The Mean Economic Efficiency (MEE) was 68.00% implying that efficiency level could be increased by 32.00% through better use of available resources. In essence, the enterprise did not achieve maximum economic efficiency.

KEYWORDS: Economic Efficiency, Stochastic Frontier, Rabbit Production,.

INTRODUCTION

The concept of efficiency in farm resource usage is concerned with the relative performance of processes in transforming given inputs into outputs. Odii *et al* (1996) however stressed that the productivity of any resource can be defined either in terms of a combination of resources or the individual resource used. In essence, the efficient utilization of resources in the production process implies optimal productivity of resources.

A lot of effort has been made by eminent scholars to define economic efficiency and to measure it in an empirical sense. Farrel (1984) has defined economic efficiency in a more appreciable form even though with some limitations as it defies precise measurement. His definition is coughed as the simple product of Technical Efficiency (TE) and Allocative Efficiency (AE). It is possible for a farm to have either technical or allocative efficiency without having economic efficiency. Yotopoulous *et al* (1972) however stressed that technical and allocative efficiency are necessary conditions but when they occur together are sufficient conditions for achieving economic efficiency. Economic efficiency however depends on market forces which in turn are influenced by sectoral and marketing polices of the country. Ali *et al* (1996) however measured economic efficiency based on the estimation of trans-log profit function in which certain restrictions were imposed.

Efficiency of production could be measured from a production function or a profit function approach. The profit function is much more helpful when individual or sole enterprise is considered. Nigerian livestock family predominantly consists of cattle, goats, sheep, pigs, poultry, rabbit and camels. Livestock plays a key role in the Nigeria economy as it contributes about 5.0% of GDP and 20.0% of total agricultural output. Mustapha *et al* (1999). In essence, rabbit farmers in Akwa Ibom State are mostly small-farm holders which however make them to be poor resource managers because of their limitations in many respects. Onyenweaku (1987) identified these limitations to include labour constraints arising from increasing scarcity and high cost of labour and technical constraints including inadequate infrastructures, dependence on unimproved inputs and rudimentary technology. This is essence affects productivity and efficiency of these farmers in question.

However, the study objectives would be to estimate the economic efficiency score and also identify factors determining efficiency levels in rabbit enterprise in the study area.

Theoretical Framework and Literature Review

Coelli (1995) emphasized that globally there is a wide body of empirical research on the economic efficiency of farmers both in the developed and developing countries but it is more in developed countries. Using Cobb-Douglas stochastic profit functions, Weir (1999) and Weir and Kumbhakar *et al* (2001) emphasized the impact of education on economic efficiency in Ethiopia and found that household education positively influenced the level of efficiency both technically and economically in cereal crop farmers. Owens *et al* (2000) found that access to extension services improved the value of farm production by 15 percent in Zimbabwe. Wang *et al* (1996) using a profit model examined the productive efficiency of Chinese agriculture and found that household educational levels, family size and per-capita income were positively related to production efficiency but off-farm employment was negatively related to efficiency.

Pitt and Lee (1981) have estimated stochastic profit frontiers and predicted farm level efficiencies using estimated functions, and then regressed the predicted efficiencies upon farm-specific variables (such as managerial experience, ownership characteristics etc) in an attempt to identify some of the reasons for differences in predicted efficiencies between farms. This has long been recognized as a useful exercise. These issues were addressed by Kumbhakar *et al* (2000) and Reischneider and Stevenson (2000) which proposed that stochastic frontier models in which the inefficiency effects (Ui) were expressed was explicit function of a vector of farm specific variables and a random error. Battese and Coelli (1995) proposed a model equivalent to the Kumbhakar *et al* (2000) specification with the exception that allocative efficiency was imposed, the first order profit maximizing conditions removed and panel data was permitted.

A stochastic frontier profit function model according to Battese and Coelli (1995) is expressed as

$$\Pi j = f(Pij_i\, Zk_i) \exp(V_1\ U_1 \text{ -------------- (eqn 1.0)}$$

Where Πj is the normalized profit of the j^{th} farm defined as gross revenue less variable cost divided by the farm specific rabbit price.

F(f) represent an appropriate function (e.g Cobb-Douglas, Trans log etc), Pij is the price in the Ith variable input faced by the jth farm divided by the price of rabbit,

Zkj is the level of the Kth fixed factor on the jth farm. Vj is a random variable which is assumed to be $N(O, 6_v^2)$ and independent of the Uj which are non-negative random variables which are assumed to be $N(0, 6_u^2)$ i.e half normal distribution or have exponential distribution.

If Uj = 0, the farm lies on the profit frontier obtaining maximum profit given the prices it faces and levels of fixed factors. If Uj>0, the farm is inefficient and loses profit because of inefficiency. Profit efficiency of an individual farmer is defined in terms of the ratio of the observed profit to the corresponding frontier profit given the price and the levels of fixed factors of production of that farmer.

A profit function relates maximized profits to the prices of product(s) and input(s) so also to other exogenous variables such as fixed inputs or agro-climatic and social variables. It should be made clear that the parameters of a profit function contain all the information about the underlying production functions. Researchers have developed a modified form of this profit function called the Normalized profit function which proved handy from the theoretical and econometrical point of view. This is because it reduces the number of explanatory variables by one and provides a wider choice of the functional form. The Normalized profit function is related to relative price unlike the profit function which is related to the actual prices of inputs and the price of output.

METHODOLOGY

Study Area: The study area is in the Southern Area of Nigeria in which Akwa Ibom State inhibits. The state is located on the South Eastern part and on the rain forest zone of Nigeria. It lies between $4^0 33'$ and $5^0 33'$ North and longitudes $7^0 25'$ and $8^0 25'$ East. It comprises thirty one Local Government Areas, Six (6) Agricultural zones namely Oron, Eket, Etinan, Abak, Ikot Ekpene and Uyo respectively. The ecological condition in the state are conducive for an impressive diversity of livestock such as goat, cattle, sheep, pork, fish, rabbit, poultry etc. Agriculture is the major occupation of the people (Policon 2001).

Data Sources: Primary data were collected to achieve the objectives of this study and complemented with secondary data. Structured questionnaire were administered to collect data on household rabbit production activities and price information during 2003/2004 production year. The secondary data were obtained from Akwa-Ibom State Agricultural Development Programme (AKADEP) and the State Ministry of Agriculture and Natural Resources (MANR).

Sampling Procedure: The six agricultural zones of the state which reflect the demarcation structure were involved. From each zone, at least one Local Government Area (LGA) was purposively selected based on the type of livestock activities and the preponderance of rabbit animals in the area. Sixty (60) rabbit farmers were contacted implying that at least ten (10) rabbit farmers were chosen from each zone of the state for a detailed study. Resident agricultural extension agents of the Agricultural Development Programme (ADP) and other key informants within the area were contacted to provide the list of rabbit farmers which formed the sampling frame for the study.

Analytical Technique

The data from the study were analyzed using a Normalized Stochastic Profit Function modelled after Yotopoulous and Lau (1972) for economy efficiency for rabbit production. The Cobb-Douglas functional form was used to fit the stochastic frontier profit function using Maximum Likelihood Estimation Procedure. Despite its limitations, the Cobb-Douglas was chosen because the methodology required that the production function be self-dual. It is worth stating that this functional form has been widely used in farm efficiency analysis for both developing and developed countries with greater success.

EMPIRICAL MODEL FOR ECONOMIC EFFICIENCY IN RABBIT ENTERPRISE

The Cobb-Douglas functional form was fitted for the rabbit enterprise embracing the stochastic frontier profit function equation given as:

$$\text{In}\prod{}^*p = \text{In}A^* + \theta_1{}^*\text{In}W + \theta_2{}^*\text{In}Fe + \theta_3{}^*\text{In}Dg + \theta_4{}^*\text{In}FL + {}_1{}^*\text{In}X1 + {}_2{}^*\text{In}X_2 + V_i - U_i \text{------------------(eqn. 1.2)}$$

Where:

$\prod p^*$	=	Normalized profit in Naira per rabbit enterprise defined as revenue less variable cost normalized by the price of rabbit output.
A*	=	Intercept or Constant term.
W	=	Wage rate normalized by the price of rabbit output per farmer.
Fe	=	Price of feed and feed supplements normalized by the price of rabbit output per farmer.
Dg	=	Price of drugs and medication normalized by the price of rabbit output per farmer.
FL	=	Price of feeder livestock normalized by the price of rabbit output per farmer.
X_1	=	Capital inputs measured in Naira including depreciation charges on machinery, equipment, implement, cost of machine hire, transportation, interest charges on loans.
X_2	=	Farm size measured in total number of herd size housed during the production period per farmer.

$\theta_1{}^*, \theta_2{}^*, \theta_3{}^*, \theta_4{}^*, {}_1{}^*, {}_2{}^*$; A* are the regression parameters to be estimated.

V_i	=	Normal random errors which are assumed to be independent and identically distributed having $N(0, \delta^2)$
U_i	=	Non-negative random variables associated with the economic efficiency of the enterprise. It accounts for inefficiency and are also under the farmers control.

RESULTS AND DISCUSSION

The results of the estimated equation are presented in Table 1 below. All the coefficients have the expected theoretical signs. As is theoretically consistent, the coefficients of the prices of labour, feeds and feed supplements, drugs and medication, feeder livestock are negatively signed as expected.

Table 1. Economic Efficiency of the Stochastic Frontier Profit Function for Rabbit Enterprise.

Production factors	Parameters	Estimated coefficients	Standard errors	t-values
Constant	A^*	2.433	2.284	1.065
Wage rate	θ_1*	-0.180	0.253	-0.711
Price of feeds (Fe)	θ_2*	-0.566	0.259	-2.184**
Price of drugs/Medication	θ_3*	-0.058	0.131	-0.441
Price of feeder livestock	θ_4*	-0.214	0.148	-1.441
Capital inputs (X_1)	β_1*	0.117	0.156	0.748
Farm size (X_2)	β_2*	1.043	0.287	3.630***
Efficiency factors				
Constant	∂o	-37.811	17.051	-2.217**
Age	$\partial 1$	5.796	2.159	2.684**
Level of Education	$\partial 2$	2.994	0.825	3.625***
Farming Experience	$\partial 3$	1.568	0.989	1.584
Membership of cooperative society	$\partial 4$	1.712	1.059	1.663
Farm size	$\partial 5$	3.843	1.141	3.367***
Access to credit	$\partial 6$	-1.965	1.121	-1.753
Extension contact	$\partial 7$	4.841	1.233	3.925***
Gender	$\partial 8$	2.990	2.054	1.455
Household size	$\partial 9$	6.761	2.285	2.958***
Diagnostic Statistics				
Sigma –squared	δ^2	3.195	0.598	5.342***
Gamma	Ý	0.975	0.011	84.344***
Log likelihood function		-38.998		

LR Test 58.949

Note ***,**,* are statistically significant at 1%, 5% and 10% levels respectively.

Source: Computed from MLE Results/Field survey, 2004.

The coefficient for price of labour (wage rate) was 0.180. The negatively signed conformed to a- priori expectation which implies that it has an inverse relationship with profit level of the enterprise. A unit increase in wage rate reduces profit level by 0.180.

The price of feeds/feed supplements appeared to be the most important variable input that determines profit levels in rabbit enterprise in the study area. It was rightly signed and statistically significant ($P \leq 0.05$) with a coefficient of 0.566. This showed the indispensable nature of feeds in rabbit production. This, however, implied that a 10 percent increase in price of feeds would depress profit level of the enterprise by 5.6 percent. Mustapha *et al* (1999) in his study on economics of rabbit production in Abeokuta, Ogun State in Nigeria showed that feed cost accounted for as much as 65.7% of total cost (excluding imputed cost of family labour). Pitt *et al* (1998) observed that availability of feeds at economic price was the most salient condition for profitable rabbit production. Weir (1999) reported that cost-return relationship in rabbit enterprise require a closer look and identified feed as the dominant cost of production in which efficient utilization was of utmost importance to profitable rabbit production.

The coefficient for price of drugs and medication was 0.0581 though carried right sign a-priori. This coefficient which was inelastic in nature appeared not to be a major determinant of profit level of rabbit enterprise in the study area. The high cost of veterinary drugs might have cut off most farmers. Effiong (2005) stressed that the cost of drugs had gradually assumed a significant proportion of the total variable cost in the industry.

The coefficient of farm size was found to be positively signed which conformed to a- priori expectation. Farm size was statistically significant at 0.01 level with coefficient of 0.287 implying that it was a major determinant of profit level in the enterprise. The positive sign and inelastic nature of the coefficient explains the importance of farm size as a fixed asset on rabbit production. The results however showed that a 10 percent increase in farm size would lead to increase in profit level by 2.87 percent which is less than proportionate increase.

The coefficient for capital input was 0.117 though carried right sign was statistically not significant. The coefficient was highly inelastic and did not play a major role in profit level of the enterprise.

The sigma square estimate was 3.19 and statistically significant at 0.01 probability level. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. The gamma estimate was 0.975 which was relatively high. Its value implies that only 97.5% of the total variation in farm profit was as a result of profit inefficiency.

DETERMINANTS OF ECONOMIC EFFICIENCY IN RABBIT ENTERPRISE

From the estimated results on efficiency factors in Table 1, age of the farmer, level of education, farm size, extension contact and household size were found to be statistically significant at different levels even though some were wrongly signed theoretically.

Age variable had a positive sign with a coefficient of 5.796. These results are consistent with the findings of Pitt *et al* (1998) and Bravo-Ureta and Rieger (1990). According to Mustapha *et al* (1999), older farmers are less willing to adopt new practices and modern inputs. Furthermore younger farmers are likely to have some formal education, and therefore might be more successful in gathering information and understanding new practices, which in turn will improve the economic efficiency through higher levels of technical efficiency and/or allocative efficiency.

Formal education commonly measured in years of schooling is the farmer attitude that seems to have received most of the attention in the frontier function efficiency literatures. Various studies have found a positive connection (Russel and Young, 1998), while several others have reported no statistically significant relationship between these two variables (Weir 1999). The results presented in Table 1 reveals a positive and statistically significant correlation between level of education and economic efficiency. Therefore these results indicate that farmers with some form of formal education exhibit higher levels of economic efficiency in the study area.

The positive and statistically relationship between farm size and economic efficiency from the estimated results support the notion that medium to large size farms have an efficiency advantage over small farms. Effiong (2005) stressed that the link between efficiency and farm size had been the subject of much discussion in the literature. Ali *et al* (2000) have stressed that only a few studies using frontier function methodology have investigated this issue in agriculture developing countries , but most have found no statistically significant correlation between farm size and economic efficiency. By contrast Onyenweaku (1987) found that large farm size had higher economic efficiency than small farms. This is in line with this study.

The estimated coefficient for extension contact was positive and highly statistically significant implying that it has contributed positively to economic efficiency of the farmer in the study area, Stevenson (2000) stressed that there was a positive and significant relationship between economic efficiency and extension contact. Owen *et al* (1995) in Pakistani agriculture found that the number of extension visits significantly influenced efficiency of farmers both technically and economically. From this assertion, extension contact variable is a major determinant of economic efficiency considering the higher coefficient values it commands.

The household size was found to be positive and statistically significant. This however suggests that larger households might utilize family labour which could help to reduce labour cost and create avenue for improved economic efficiency. More adults in farmers' households may imply more workforce and savings in labour force.

Table 2. Frequency Distribution of Economic Efficiency Estimates of Rabbit Farmers.

In Table 2, the economic efficiency frequency distribution of respondents are estimated.

Economic Efficiency	Number of Respondents	% Distribution
0.10 0.20	3	5.00
0.21-0.40	4	6.67
0.41-0.60	8	13.33
0.61-0.80	26	43.33
0.81 0.90	18	30.00
0.91-1.00	1	1.67
Total	60	100.00

Maximum value = 0.94
Minimum value = 0.14
Mean Economic value= 0.67
Mean of worst 10 = 0.32
Mean of best 10 = 0.88
Source: Computed from field survey, 2004.

The estimated economic efficiencies differ substantially among the rabbit farmers ranging between 15.0% and 94.0% with a mean economic efficiency of 68.0%. The mean economic efficiency estimate of 68.0 percent is an indication of efficiency in resource use by the farmers. More so, there exist a wide gap between the efficiency of best economically efficient farmer and that of the worst farmer. The average best farmer from the best 10 would require a cost saving of (1-0.67/0.94) x 100 which equals 28.20% to become the best economically efficient farmer in the sampled group while the worst farmer in the worst 10 would need a cost saving of (1-0.14/0.94) x 100 which equals 84.5% to become the best efficient farmer in their group. The results however are in line with those of Odii *et al* (1996) who found that the economic efficiencies of rabbit farmers in Western Nigeria differs substantially ranging between 7.0% and 85.0% with a mean economic efficiency of 61.0%.

Hypothesis Testing

The hypotheses were carried out using the Generalized Likelihood Ratio Test Statistics. The hypothesis (H_1) which states that farmers are fully economically efficient in rabbit production was rejected. This implies that economic inefficiency existed in the enterprise in the study area.

Table 3: Farmers are fully economically efficient:

Enterprise	Log-likelihood Function	Chi-square statistics	Critical value	Decision
Rabbit	-33.988	90.53	15.51	Reject

Source: Computed from survey data, 2004.

SUMMARY AND CONCLUSION

The economic efficiency estimates for rabbit enterprise revealed that labour cost was rightly and negatively signed with a value of 0.181. The results also showed that price of feeds and feed supplements, farm size were statistically significant and rightly signed as well. Other variables such as prices of drugs and medication, price of feeder livestock and capital inputs were rightly signed theoretically but statistically insignificant. The result of the efficiency model indicated that age, level of education, farm size, extension contact and household size had positive values. These however signify that they contributed by increasing the level of economic efficiency. The frequency distribution of farmers showed that the estimated economic efficiency differed substantially ranging between 15.0% and 94.0% with a mean economic efficiency value of 68.0%. This indicates inefficiency in resource use which might be due to poor capital base and low farming experience.

The results of the test of hypotheses showed that the explanatory variables in the model contributes significantly in explaining economic efficiency in rabbit enterprise in the study area. In essence, the results suggest that substantial gains could be enhanced through good and adequate utilization of improved livestock inputs and recommended livestock production technologies. Although the prices of variable inputs were on the increase, effective management of the available resources could lead to an improvement in the profit margin of the enterprise.

Policy options identified for improving the current level of economic efficiency of rabbit farmers include those that would attract educated and young people into rabbit farming, encourage experienced farmers to remain in farming, provide equal opportunities to women farmers in terms of access to credit to increase their farm size as well as encourage farmers to belong to cooperative societies. These policies should be seen to focus on cost effectiveness as well as quality improvement research for the enterprise. If the recommendations based on the policy options are considered, it is hoped that these livestock enterprise would be enhanced which in turn could help to improve the state economy for a meaningful economic development.

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