Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension
Volume 9 Number 1 January 2010 pp. 1-7
ISSN 1119-7455

COBB DOUGLAS PRODUCTION FUNCTION WITH COMPOSITE ERROR TERM IN EGG LAYING ENTERPRISE IN AKWA IBOM STATE, NIGERIA.

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ABSTRACT

The study tried to estimate the profit efficiency and the relevant indices determining efficiency levels for egg-laying industry in Akwa Ibom State, Nigeria utilizing Cobb-Douglas production function based on stochastic profit frontier. Sixty poultry farms were randomly selected across the six agricultural zones of the state. Primary data were collected with the aid of a structured questionnaire. Empirical results revealed the mean economic efficiency of 65.00% implying the need for increased resource use efficiency The results further showed that variable inputs such as price of feeds, price of drugs and medication were statistically significant (p<0.05) thus indicating that profit decreased with increase in input prices while fixed inputs such as capital inputs and farm size were statistically significant and had the right sign a-priori indicating that profit increased with increase in the level of its utilization. The maximum economic efficiency level attained by an individual farmer was 88.00% indicating that there was room for improvement. The study therefore suggests that policy that would enhance extension services, encourage membership in cooperative farming and enhanced good and adequate utilization of improved livestock inputs should be put in place.

Key words: Egg, Cobb- Douglas, profit function, egg laying enterprise, Nigeria.

INTRODUCTION

Farm production which is an organization of resources to produce output involves different operations with varying technical and managerial requirements. Structural and resource constraints however limit the growth of the livestock sub-sector. Adegeye (1987) emphasized that subsistence oriented production especially among small scale farmers, poorly developed inputs and product markets, policy reversals, low investment in livestock enterprises, weakened extension services, poor utilization of superior varieties of poultry birds are some of the constraints which influence efficiency of resource use. Idachaba (2006) also tried to classify neglect of agriculture in Nigeria into severe, mild, chronic and transient and noted that Nigerian Agriculture continues to be neglected because of persistent dumping of cheap subsidized food imports from developed agriculture, weak agricultural stake-holders capacity, prolonged political instability and what he called 'Dutch Disease' (i.e discovery of petroleum and gas).

He however enunciated the consequence of these neglect to include food insecurity, food import tendency, rural unemployment, endemic poverty and stunted agro-industrialization.

Based on the constraints to resource use efficiency, it is ideal to lay emphasis on allocating and distributing adequate resource inputs, investment in research and eliminating the bottlenecks to efficient resource use and utilization at the farm level (Bagi,1993). It is important to stress that in Akwa Ibom State, small scale farmers dominate most of the poultry farming enterprises but are regarded as major contributors to the growth of the sector in the state. It is important to note that continued scarcity of egg products in the state and inability to invest meaningfully in the sector would continue to depress socio-economic and developmental aspirations of the state and the country in general. It is imperative for government and other stake holders to work tirelessly towards purposeful and honest investments in the sector and also study their demand as well. This we hope would help to contribute to the effectiveness and efficient planning of the enterprise.

Farrel (1984) defined economic efficiency as a simple product of the technical and allocative efficiencies. It is possible for a farm to have either technical or allocative efficiency without having economic efficiency. Globally, there is a wide body of empirical research on the economic efficiency of farmers in the developed and developing countries, (Battese, 1992). Economic efficiency however depends on market forces which in turn are influenced by sectoral and marketing policies of the country. (Bravo-Ureta and Rieger (2002) however measured economic efficiency based on the estimation of a trans-log profit function in which certain restrictions were imposed. Empirical literature suggests several alternative approaches to measuring economic efficiency which may be grouped into non-parametric frontiers and parametric frontiers. Non-parametric frontiers do not impose a functional form in the production frontiers and do not make assumptions about the error term and the most popular is the Data Envelopment Analysis (DEA) while parametric frontiers impose a functional form on the production function and make assumptions about the error term. The most common functional forms include the Cobb-Douglas, Constant Elasticity of Substitution (CES) and Trans-log production function.

In essence, the objectives intended to be achieved in this study include :- to determine profit efficiency for egg industry in the study area, identify factors influencing profit efficiency levels and make policy recommendations towards improving economic efficiency levels in the state.

MATERIALS AND METHODS

Pitt and Lee (1994) estimated stochastic 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 and others in attempt to identify some of the reasons for differences in predicted efficiencies between farms. This has long been recognized as a useful exercise, but the two stage estimation procedure has long been recognized as one which is inconsistent in its assumptions regarding the independence of the inefficiency effects in the two estimation stages. The two-stage estimation procedure is unlikely to provide estimates which are as efficient as those that could be obtained using a single –stage estimation procedure.

These issues were addressed by Kumbhakar *et al;* 1999 and Reifschneider and Stevenson (1998) who proposed stochastic frontier models in which the inefficiency effects (Ui) were expressed as explicit function of a vector of farm – specific variables and a random error. Battese and Coelli, (1995) proposed a model which was equivalent to Kumbhakar *et al* (1999) 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 may be specified as follows:

Πj = f(Pij,Zki) exp (Vi –Ui) ----------- (eqn 1.0)

Where Πj is the normalized profit of the jth farm defined as gross revenue less variable costs divided by the farm specific price of egg output per farmer, f represents an appropriate function (e.g Cobb-Douglas, Trans-log etc),Pij is the price of the ith variable input faced by the jth farm divided by the price of egg layers, Zkj is the level of the kth fixed factor on the jth farm, Vi is a random variable which is assumed to be N(0,σv^2), and independent of the Uj which are non-negative random variables which are assumed to be N(0,σu^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. The stochastic frontier model was independently propsed by Aigner, Lovell and Schimdt (1977) and Meeusen and Van den Broeck (1977).

Profit Efficiency = Π / Π^*= f(PijZkj) exp (Vi – Ui)/f(PijZkj)exp Vj = exp (-Uj)------- (eqn 1.1)

Where :

Π is the observed profit and Π^* is the frontier profit. Profit efficiency of an individual farmer is defined in terms of the ratio of the observed profit to the corresponding frontier profit given the prices and the levels of fixed factors of production of that farmer. Recent development have used the Data Envelopment Analysis (DEA) otherwise known as deterministic frontier analysis. This is a non-parametric method of frontier analysis which according to Battese (1992) defined the deterministic frontier model as:

Y1 = f (X1;β) exp (-Ui) i—1,2—n----(eqn 1.2)

Where:

Y1 is the possible production level for the ith sample farm; X_1 is the vector of inputs for the ith farm, β is a vector of parameters to be estimated; Ui is a non-negative random variable associated with farm specific factors that contribute to the ith farm not attaining maximum efficiency in resource use while n is the sample size in a cross sectional survey of the industry. The non-negative variable Ui in this model is associated with the technical inefficiency of the farm and implies that the random variable exp (Vi) has values between zero and one. Okike and Jabbar (2000) however emphasized that the main weakness of DEA is its inability to allow for stochastic shocks to the frontier. It is arguable that this characteristic of the DEA renders it an unsuitable instrument for investigating production frontiers in noisy environment where measurement error, missing pieces of information, weather and other causes of distortion to the shape and position of the estimated frontier play significant roles. Addressing this unsuitable position opened the way for the numerous ways of the stochastic profit function analysis.

The Empirical Model.

(i) Stochastic Profit Function:

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

$$In\pi Ly^* = InA^* + \Phi_1{}^*InW + \Phi_2{}^*\ Inp_1 + \Phi_3{}^*InP_2 + \Phi_4{}^*InP_3 + ß_1{}^*InX_1 + ß2^*InX_2 + Vi - Ui \text{ -----------(eqn.1.3)}$$

Where:

$In\pi Ly^*$ = Normalized profit in naira per egg laying enterprise defined as revenue less variable cost normalized by the price of egg output per farmer.

A* = Intercept or Constant term. W = Wage rate normalized by the price of egg output per farmer.

P1 = Price of feeds and feed supplements normalized by the price of egg output in naira per farmer.

P2 = Price of drugs and medication normalized by the price of egg output in naira per farmer.

P3 = Price of day old chicks normalized by the price of egg output in naira per farmer.

X1=Capital inputs measured in naira including Depreciation charges machinery, equipment, implements, cost of machine hire, transportation, interest, charges on loan.

X2 = Farm size measured by total number of birds housed.

Φ1*, Φ2*,Φ3*,Φ4*,ß1*,ß2*, A* are the regression parameters estimated.

Vi = Normal random errors which are assumed to be independent and identically distributed having zero mean and constant variance.

Ui = Non- negative random variables associated with the profit efficiency of the enterprise. It accounts for inefficiency and are also under the farmers control.

The model was analyzed using a normalized stochastic profit function modelled after (Yotopoulous and Lau, 1972). The Cobb-Douglas functional form was used to fit separate stochastic frontier profit functions using Maximum Likelihood Estimation (MLE) procedure. This functional form has been widely used in farm efficiency analysis for both developing and developed countries with greater success (Chavas and Alibe,1998). Furthermore, in one of the few studies examining the impact of functional form on efficiency, Russel and Young (1993) concluded that functional specification has a discernable but rather small impact on estimated efficiency.

(ii) Profit Efficiency Function: The model specified in equation 1.4 below was formulated and estimated jointly with the stochastic frontier profit model in a single stage maximum likelihood estimation procedure using the computer software frontier version 4.1(Battese and Coelli,1995) to determine factors influencing observed profit efficiency.

$$PE = bo + b_1x_1j + b_2x_2j + b_3x_3j + b_4x_4j + b_5x_{5j} + b_6x_6j + b_7x_7j + b_8x_8j + b_9x_9j \text{ -------------------------- (eqn. 1.4)}$$

Where:

PE is profit efficiency, x_1j is farmers age in years, x_2j is farmers level of education measured by number of years of schooling, x_3j is farming experience measured in years, x_4j is membership of cooperative society, a dummy variable which takes the value of unity for members and zero otherwise, x_5j is farm size measured by the total number of birds housed, x_6j is access to credit, a dummy variable with value of unity for credit access and zero otherwise, x_7j is number of extension visits /contacts made by the farmer in the production year, x_8j is farmers gender, a dummy variable with value of unity for male egg farmers and zero otherwise, x_9j is farmers household size while b_0, b_1,b_2,b_3--------b_9 are the regression parameters to be estimated.

The Data: The study was conducted in Akwa Ibom State, Nigeria which is located on the south eastern part and on the rain forest zone of Nigeria. The state comprises thirty one (31) local government areas and six (6) agricultural zones. The ecological condition of the state favours impressive distribution of livestock such as goats, sheep, pigs, rabbit, fish, poultry etc. The state has a population of 3,927,19,602 people.(NPC,2006). Agriculture is the major occupation of the people. A sample frame which denotes the list of egg farmers in the state was obtained from the state Ministry of Agriculture and Natural Resources, Uyo. Resident agricultural extension agents of the Agricultural Development Programme (ADP) were contacted and recruited in each zone on the procedure for data collection. Primary data were collected with the aid of a structured questionnaire with emphasis on socio-economic features and other quantitative variables of interest, price information during the 2004 production period. In each agricultural zone, ten (10) egg poultry farmers were randomly selected giving a total sample size of sixty (60) egg poultry farmers in the state for the study

RESULTS AND DISCUSSION

The estimated coefficient for labour cost is -0.295 which is negatively signed as expected. This inelastic nature indicates that the industry is operating in stage two of the production function.

It however indicates that a unit increase in the cost of hired labour reduces profit level by 0.295 unit. The negative coefficient however confirms the cost implication of hired labour to profit levels of farms. (Clayton, 1997) pointed out that labour constitute about 12 percent of the total production cost and its efficient use is an important source to the growth of our economy.

The estimated coefficient for feed cost is rightly signed and positively statistically significant at 0.05 probability level. The largest item of cost in the production of eggs is feed which make up 65 to 70 percent of the total cost. Chavas and Alibe (1998) stressed that the most profitable use of feed required ad-libitum feeding for maximum egg production at all levels of cost and prices, so long as egg revenue exceeds total feed costs. It is important to emphasize that the aim of commercial egg producers is to maximize egg revenue over and above total fed costs. Ekaete (2001) found out that feed cost constitute about 82.8 percent of the total variable cost of egg production. From this assertion, feed cost appears to be the most important variable input that determines profit levels in the egg enterprise.

The estimated coefficient for drugs and medication has the expected theoretical negative sign and is statistically significant at 0.01 probability level. This indicates that profit decrease with increases in input prices. Studies by Helfand (2003) and Effiong (2005) revealed that medication cost constitute the least proportion of operating cost and various reports puts its proportion at between two and five percent. Also, the quantity of these drug used by a farmer determine the success and the profitability in the enterprise. (Ekpenyong, 2002) found that drug cost constituted 5.34% of total variable cost in egg-laying poultry industry.

The coefficient of capital inputs is found to be positive and significant at 0.10 probability level. This shows that profit increases in the levels of capital inputs. It is possible that farmers invest on capital inputs since the amount of capital inputs per farm determines the level of investment. High level of investment positively translates to higher returns.

Table 1. Estimated Stochastic Frontier Profit Function for Egg-Laying Industry in Akwa Ibom State, Nigeria, 2004.

Production factors	Parameters	Estimated coefficients	t-ratios
Constant term	Φ_0*	4.304	1.962*
Wage rate (W)	Φ_1*	-0.295	-0.764
Price of feeds (P_1)	Φ_2*	-0.074	-2.411**
Price of drugs/medication(P_2)	Φ_3*	-0.804	-5.121***
Price of day old chicks(P_3)	Φ_4*	-0.142	-0.665
Capital inputs(X_1)	β_1*	0.300	1.965*
Farm size (X_2)	β_2*	1.166	2.230**
Diagnostic statistics			
Sigma-squared (σ^2)		2.993	3.424***
Gamma (γ)		0.812	8.014***
Log-likelihood function		-8.008	
LR-Test		8.949	
Number of observations = 60			

*= significant at 10%, ** = significant at 5%, *** = significant at 1%.

Source: Computer print out of Frontier Version 4.1/Field survey.

The coefficient of farm size is positive with a value of 1.166 and statistically significant. Bhasin and Akpalu (2001) stressed that large scale farmers seem to be more efficient in resource use and utilization than the small scale farmers. Awuja (2000) also stressed that increase in size is bound to bring further cost reduction since capacity is bound to increase fast. This is to say that as more layers are housed together, the more economic the operation becomes. This is in line with this study.

From the study, the estimate of sigma-squared is statistically significant and different from zero at one percent (0.01) level. This indicates a good fit and the correctness of the specified distribution assumption of the composite error term. More so, the gamma is estimated to be 81.3 percent. This implies that the presence of economic inefficiency among the sample farmers explained about 81.3 percent variation in the profit level of the egg – laying industry. Thus, it is important to infer that the influence of these factors can enhance profit efficiency of the egg industry in the study area.

The estimated coefficient of farming experience is positive and statistically significant at the 0.05 probability level. This indicates that farmers with longer years of farming experience in egg production are more efficient. Nwaru (2004) stressed that the number of years a farmer spent in farming may give an indication of the practical knowledge he acquired on how to cope with the inherent farm production, processing and marketing problems leading to higher levels of efficiency.

Membership of cooperative society is positively signed and the estimated coefficient is statistically significant at 0.10 probability level. Clayton (1997) stressed that if farmers are properly mobilized and focused, membership of farm associations would have great potentials for making positive contributions in enhancing their economic fortune.

From the estimated results, extension contact contributed positively to the enhancement of profit efficiency in the study area as it conformed to a-priori expectations. Extension contact is a very important tool to livestock farmers as it enhances opportunity to learn improved technologies and acquisition of needed inputs and services. Russell and Young (1993) showed that hours of extension contact exhibited the greatest number of significant relationships with profit efficiency. Owens *et al* (2000) stressed the impact of agricultural extension in farm production and agreed that extension contact improved the value of farm production by 15 percent in Zimbabwe.

From this study, household size coefficient is positively signed and statistically significant at 0.1 probability level. This suggests that large household size which comprise active work force increases profit efficiency. Mustapha and Tunde (1999) emphasized that traditional rural households count more on t/heir family members than hired workers as sources of farm labour which is one good reason for rising household size in the rural economy.

The coefficient for gender is negative but statistically significant at 0.05 probability level. This suggests that female farmers are economically more efficient than male farmers. However, the male farmers were more in numerical strength than their female counterparts. Due to this fact, they were mostly favoured in terms of access to extension programme service, credit and training schemes, farm supplies and services of new technology.

From table 3, the maximum profit efficiency value is 88.0% while the minimum or worst farmer had a value of 16.0%. These however show a wide gap between the most economically efficient farmer and the worst farmer. The average profit efficiency value is 65.0%. There is room for vast improvement because of inefficiency in the resource use and utilization in the study area to maximize profit. The frequency distribution of profit efficiency of the farmers reveals that less than 2.0 percent of the farmers have profit efficiency of about 60 percent.

Table 2: Estimated Determinants of Profit Efficiency in Egg- Laying Production in Akwa Ibom State, Nigeria, 2004.

Variables	Parameters	Estimated coefficients	t-ratios
Age (X_1)	b1	0.720	0.596
Level of education (X_2)	b2	-0.278	-0.205
Farming experience (X_3)	b3	2.443	2.099**
Membership of coop- Erative society(X_4)	b4	1.926	1.964*
Farm size (X_5)	b5	0.790	0.840
Access to credit(X_6)	b6	0.390	0.392
Extension contact (X_7)	b7	5.574	2.072**
Gender (X_8)	b8	-3.411	-2.375**
Household size (X_9)	b9	7.300	1.951*

*Significant at 10%, ** Significant at 5%, ***Significant at 1%.
Source: Computed from computer software, Frontier 4.1/Field survey, **2004.**

Table 3: Frequency Distribution of Profit Efficiency in Egg- Laying Production in Akwa Ibom State, Nigeria, 2004.

Profit Efficiency	Frequency	Percentage
0.10 – 0.20	1	1.67
0.21 - 0.40	1	1.67
0.41 – 0.60	14	23.33
0.61 – 0.80	32	53.33
0.81 – 0.90	12	20.00
0.91 - 1.00	0	0.00
Total	60	100.00

Maximum value = 0.88
Minimum value = 0.16
Mean Profit Efficiency = 0.65
Source: Field survey, 2004.

CONCLUSION

The estimated stochastic frontier profit function for egg-laying industry showed that wage rate, prices of feeds and feed supplements, prices of drugs and medication, farm size, capital inputs were theoretically signed and conformed to a-priori expectations indicating their significant effects on profit level of the industry. The factors that influenced the level of profit efficiency were farming experience, membership of cooperative society, extension contact, gender and household size, all of which conformed to a-priori expectations. The mean profit efficiency value was 65.0%. This however was not too low but showed that an additional profit could be achieved through efficient use of productive resources which could move the egg farmers to their profit frontier. The results however confirmed that an increase in the use of these variable inputs would reduce profit levels while increased use of fixed inputs such as farm size and capital inputs would lead to expansion thus enhancing profit level in the industry. From the results, policies and programmes should embrace access to extension services, encouraged cooperative society and experienced farmers to remain in farming. Farm policies that should encouraged farm production through equal or even more access to credit, extension services and inputs such as day-old chicks, feeds and feed supplements, drugs and vaccine, utilities from producers and distributors should be put in place.

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