Determinants of Technical Inefficiency in Farm Production: The Case of NDE Farmers in Ondo State, Nigeria

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Abstract

The study estimates the determinants of technical inefficiency among the farmers that are participating in the Ondo State chapter of the National Directorate of Employment program in Nigeria. Using a tobit analysis, it was found that extension visits, higher education, land input and membership of farm association were significant factors influencing technical efficiency. This suggests that education, efficiency in supply of inputs and public awareness are key factors necessary for policy consideration.

1. Introduction

Many studies that have examined technical efficiency among farmers have generally reported gross inefficiency in farm production. In a recent parametric investigation of technical inefficiency among the farmers that are participating in the National Directorate of Employment (NDE) program in Ondo State of Nigeria, in which the stochastic frontier approach was used, it was found that technical efficiencies vary widely across farms, ranging between 21.7 and 87.8 percent with an average of 67 percent (Ajibefun and Abdulkadri, 1999). This indicates an average technical inefficiency of 33 percent.

The NDE, among others, was introduced in 1987 as a part of the modified Structural Adjustment Program (SAP) adopted by Nigeria, which was less severe in its initial effects on welfare than the full scale SAP originally suggested by the World Bank during the economic downturn of the early 1980s. The general objective of the NDE is to generate self-employment among the high school leavers and the graduates from colleges and universities especially that have been affected by the pervasive unemployment and underemployment

problems. In the farm sector, the goal is to simultaneously reverse the declining trend of local food supplies and save foreign exchange on food imports.

A number of the empirical analyses that have been conducted in the area of technical efficiency in Nigeria do not extend beyond the computation of the degree of efficiency. In order to effectively improve productivity, a detailed study of the factors that contribute to the inefficiencies across farms is indispensable. Education is usually suggested as an important ingredient to productivity enhancement. The fact that inefficiencies of such magnitude as above were discovered among college and university graduates necessitates a detailed investigation of the factors causing them.

The objectives of the study are therefore to: 1) Identify the factors contributing to technical inefficiency among crop farmers that are participating in the NDE program; 2) Quantify the effects of such factors identified above on technical efficiency and 3) Suggest ways of enhancing the efficiency measures.

Other factors aside from education could also have significant effects on technical efficiency. Unavailability of yield enhancing technology (fertilizer, pesticides, etc.), inadequate funding and other logistic problems could be possible culprits. Time consciousness in the supply of inputs, adequate commitment on part of the parties involved in ensuring good performance of the NDE farm business and adopting the recommendations suggested from this study would boost the effectiveness and success of the production plans and policy.

The rest of the paper is organized as follows. Section 2 presents some basic concepts of technical efficiency measurement and the literature review. The data used, their sources and analytical method are discussed in section 3. In section 4, we present and evaluate the results of the analysis. Section 5 contains the summary and conclusion.

2. Efficiency Concepts and Literature Review

2.1 Technical Efficiency

Technical efficiency, otherwise known as pure technical efficiency (PTE), like its counterparts (allocative, scale and scope efficiencies) (Färe, Grosskopf and Lovell, 1985; Farrell, 1957), is a major component of productivity, which itself is a measure of farm performance. PTE indicates whether a farm uses the best available technology. It reflects the ability of a farm to obtain maximum output from a given set of inputs (Coelli *et al.,* 1998). A technically efficient farm operates on the production frontier. A technically inefficient farm, i.e., one that operates below the frontier, could operate on the frontier either by increasing output with the same input bundle or using less inputs to produce the same output. The closer a farm gets to the frontier, the more technically efficient it becomes.

Figure 1 shows a graphical illustration of a production efficiency frontier. A farm, for example, at point X refers to the inefficient farm, while points Y and Z are both efficient because they are on the frontier. The farm at point X should therefore move upward to point Y or backward to point Z in order to be efficient. If its movement is toward Y, more output is obtained with the same amount of inputs or if it is toward Z, fewer amounts of inputs yield the same output. Both cases depict more technical efficiency than the initial position X.

The position of individual farms relative to the frontier, whether on the frontier or below the frontier, would be influenced by factors such as environmental, structural and farm characteristics. These characteristics include the share of production, size of farms, tenure, specialization, degree of mechanization, operator's characteristics, geographical location,

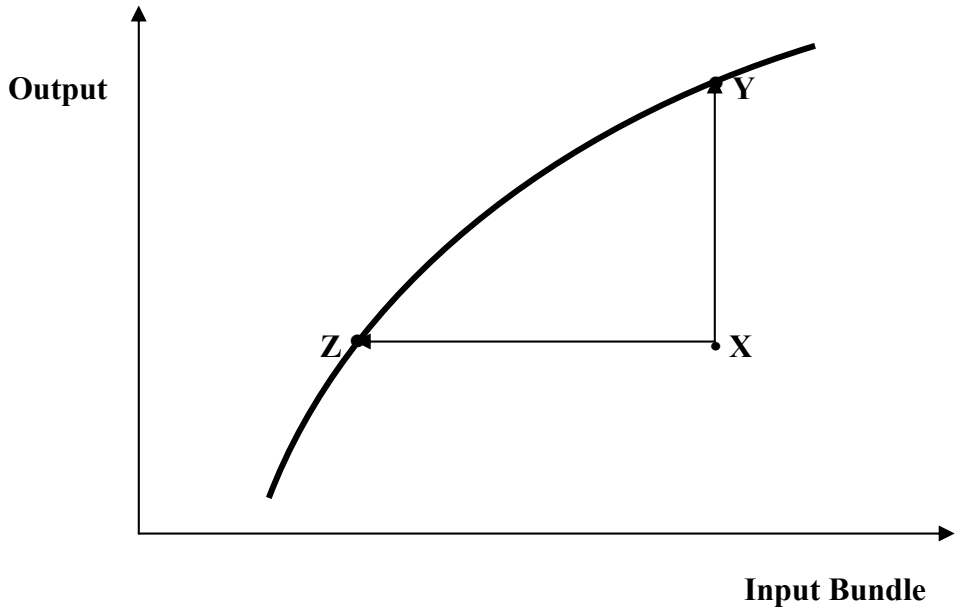

Figure 1: Production Frontier

management practices and strategies as well as business organization and arrangement of farms (Sall, 1997; Hoppe *et al.,* 1996, Hoppe *et al.*, 2001).

2.2 Literature Review

On average, the farms have not been behaving badly in terms of technically efficiency unlike other efficiency measures like allocative and scale efficiencies especially in the developing countries. Despite the rampant use of traditional or less advanced agricultural technology in some low and middle income countries like Argentina, Bangladesh, Nigeria, Philippines, Zaire and Malaysia, the mean technical efficiency indices between 1964 and 1993 have been 1.00, meaning that they are technically efficient but others like China, Iran, Ireland, South Africa, Zimbabwe etc., experience very low levels of efficiency. The United States, Japan, Israel and The Netherlands are examples of technologically advanced countries that are efficient over the same period (Arnade, 1998).

Although the technical efficiency indices are of great importance in examining farm performance, a determination of the factors influencing those indices is equally important. A part of the study conducted by Featherstone *et al.* (1997) on Kansas beef cow farms focused on the determinants of technical inefficiency. Using a tobit regression model, they found that seed, labor, utilities and fuel, veterinary services and miscellaneous costs are significant factors that are associated with technical inefficiency with feed cost being the most important among them. A similar study by Sall (1997) on Senegal found significance only on the ratio of on-farm income to total income.

In his work on international agricultural efficiency and productivity, Arnade (1998) found that fertilizer/land and tractor/labor ratios - both depicting movements away from traditional endowments, the impact of international research institutes such as the Consultative Group for International Agricultural Research (CGIAR) especially in seed variety improvement, agricultural research expenditure/agricultural output ratio, extension agents/farmers ratio, and average level of education are significant factors that jointly affect efficiency and productivity.

Other authors that have attempted the regression of the efficiency and productivity indices from nonparametric methods on explanatory variables such as discussed above are Schuh and Norton (1991), Schimmelpfennig and Thirtle (1994), Thirtle et al. (1997), etc.

3. Data and Methodology

In this paper, the data used include measures of technical efficiency and farm characteristics. The estimated measures of technical efficiency were obtained from Ajibefun and Abdulkadri (1999). Others including observations on inputs used (hectares of land, man-

days of labor, tractor hours, fertilizer per kilogram and naira of credit) and farm characteristics (such as age of farmers, years of education and experience, number of extension visits, and membership of farm management association) were sourced directly from the farmers in 1997 by the use of questionnaires as well as from the databank of the Ondo State Ministry of Agriculture, Akure, Nigeria.

We followed Featherstone et al's (1997) method to compute the technical inefficiency indices by subtracting the technical efficiency estimates from 1 after converting them from percentages to decimals and we model the technical inefficiency in a tobit regression (Tobin, 1958, Greene, 1995) stated as follows:

$$\left.\begin{aligned} TIE_i &= \sum_{i=1}^{n} \beta_i X_i + u_i \;\; if \;\; L_i < \sum_{i=1}^{n} \beta_i X_i + u_i < U_i, \\ &= 0 \qquad\qquad\qquad\qquad otherwise, \end{aligned}\right\} \tag{1}$$

where TIE_i is the technical inefficiency measure for each farm, X_i is a $k\ x\ 1$ vector of explanatory variable for the ith farm, β_i is a $k\ x\ 1$ vector of unknown parameters to be estimated, u_i are residuals that are independently and normally distributed, with mean zero and a common variance σ^2, and L_i and U_i are the distribution's lower and upper censoring points, respectively. The explanatory variables are the inputs and farm characteristics discussed above. Education was categorized into years of high school, college and university attendance by the operators. Profession of operator, i.e., whether agricultural and non-agricultural, would have been a vital variable but was not available. The observations on age were omitted from the analysis because they are suspect to multicollinearity problem in the model especially with experience since the older farmers have prior experience before the commencement of the NDE program unlike the younger farmers. We recorded more significance on the estimates without the age variable.

We chose the tobit analysis by assuming that the concentration of the dependent variable clusters toward the left limit (i.e., zero) and because it does not only explain the value of the dependent variable or the probability of limit (e.g. point of technical efficiency) and non-limit (e.g. points of technical inefficiency) responses, but also the size (i.e., value) of non-limit responses (Tobin, 1958). These reasons give the tobit model added advantage over probit or multiple regression analyses which disregard some important information. In addition, we regard the sample as truncated-censured since NDE focuses mainly on relatively large farms with carefully mapped-out strategy in terms of farm characteristics like size, credit, type of farms as well as categories of farmers.

The coefficients obtained from using tobit have been decomposed by McDonald and Moffitt (1980) into two parts: effects on the probability of being above the limit and effects conditional upon being above the limit. In this paper, all observations have positive (non-zero) technical inefficiency estimates. The cumulative distribution function is presumed to be evaluated at the mean of the explanatory variables and hence facilitates the computation of percentage of the total change in technical inefficiency resulting from a change in the explanatory variables that would be generated by marginal changes in the value of technical inefficiency. Deducting this from one will result in the percentage that would be generated by changes in the probability of being technically efficient.

4. Results and Discussion

4.1 Summary Statistics for a Sample of NDE Farms

The summary statistics of all the variables used are presented in Table 1. The average inefficiency is 39 percent, by which the farmers should increase output in order to produce on

Table 1: Summary Statistics for a Sample of NDE Farms

Variables	Mean	Std. Dev	Minimum	Maximum	# Obs
Inefficiency	0.39	0.11	0.21	0.68	67
Land (hectares)	2.36	0.85	0.80	4.10	67
Labor (man-days)	165.94	71.14	69.00	400.00	67
Tractor Hours	8.69	4.10	1.00	20.00	67
Fertilizer (kg)	791.19	1364.38	0.00	8000.00	67
Amount of Credit (N)	6326.87	7096.19	1000.00	44000.00	67
Extension Visits (#)	3.30	1.23	1.00	6.00	67
Age of Farmer	45.12	7.31	25.00	57.00	67
Education (years)	8.16	3.72	0.00	15.00	67
Experience (years)	8.87	3.97	2.00	20.00	67
Membership (dummy)	0.61	0.49	0.00	1.00	67

Note: Statistics constructed from the data mentioned in section 3.

the frontier. The average size of land is 2.36 hectares. This is an indication that NDE members are large scale producers, although the minimum land size of 0.85 hectares would have been influenced by the amount of credit allowed for that particular farmer. The large difference between labor and tractor inputs' averages indicates that the farmers have either relied more on abundant labor resource than the use of tractors which is relatively expensive or engaged in minimum tillage practice proposed by experts in recent years.

The averages for fertilizer, credit and number of extension visits are 791kg, N6326.87 and three visits, respectively. The low level of credit could mean that most of the farmers under investigation have high school education, upon which the minimum amount of credit is usually based. Others are age, education and experience in years which are 45.1, 8.2 and 8.9, respectively.

4.2 Relationship among Technical Inefficiency, Inputs Used and Farm Characteristics

The estimates of marginal effects of the explanatory variables on technical inefficiency, shown in Table 2, were derived after correcting for heteroscedasticity before which none of the estimated marginal effects, apart from the constant, is significant. The final results show that the extension visit, university education, land input and farm association's membership (with values of 4.88%, 9.28%, 3.07% and 7.49%) are significant factors influencing technical efficiency, with only extension visit having a negative influence, while others have the expected positive influence. It might be surprising that extension visits have negative impact on inefficiency. This result could be justified by the fact that most of the farmers did not actually utilize extension messages timely or correctly or that the messages are inappropriate for the current dispensation. A technology packaged in the 1960s to early 1980s when agriculture was heavily protected by the government may impact negatively on farm production under liberalization regime. In addition, the extension messages might not be appropriate to a specific crop enterprise or location. The associated logistic problem especially of timely availability of inputs may force farmers to adopt inappropriate solution. Hence, extension visits might not have expected impact on efficiency.

Education and membership of farm association that are the most important among the significant marginal effects would reduce inefficiency by 9.28% and 7.49% if they increase 100%, respectively. We do not have sufficient statistical evidence to show that experience, labor and tractor use, the amount of credit available to individual farmers and other classes of education are relevant in this analysis. The likelihood ratio test, however, shows that all the explanatory variables are jointly significant.

Table 2: Relationship among Technical Inefficiency, Inputs and Farm Characteristics

Independent Variable	Marginal Effects	Std. Error	T-Ratio	P-Value
Constant	0.4680***	0.0834	5.6128	0.0000
Extension Visit	0.0488***	0.0134	3.6524	0.0003
High School Education (1-5 years)	-0.0564	0.0612	-0.9210	0.3571
College Education (6-9 years)	-0.0936	0.0567	-1.6523	0.0985
University Education (> 9 years)	-0.0928*	0.0518	-1.7925	0.0731
Years of Farming Experience	0.0015	0.0087	0.1704	0.8647
Land Use	-0.0307**	0.0132	-2.3175	0.0205
Labor man-days	0.0000	0.0001	0.3097	0.7568
Tractor Hours	-0.0059	0.0073	-0.8031	0.4219
Fertilizer	0.0000	0.0000	0.6235	0.5330
Credit	0.0000	0.0000	-1.3155	0.1883
Membership of Farm Association	-0.0749***	0.0204	-3.6629	0.0002
Likelihood Ratio Test	30.0533***			

Notes: Single, double and triple asterisks (*) denote significance at 10%, 5% and 1% level, respectively.

5. Summary and Conclusion

Within the limitation of the data availability, we have been able to identify and estimate the factors determining technical efficiency among the farmers that participate in the National Directorate of Employment program. Among those factors that have significant impacts on technical efficiency are extension visit, university education, land input and farm association's membership. This outcome thus suggests that education and awareness are vital variables to be considered seriously when policy-makers deliberate on ways to reduce inefficiency among farmers. Most important are the extension services and the existing technological packages that need to be overhauled.

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