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INSTITUTION, GEOGRAPHIC REGIONS AND TECHNICAL EFFICIENCY: EVIDENCE FROM SMALL FARMS IN NIGERIA

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ABSTRACT

The agricultural sector in Nigeria has been plagued with challenges. One identified constraint is the limited knowledge on factors influencing efficiency of small farms by policy makers. In this context, we aggregate the determinants of technical efficiency into institutional and geographic factors. This paper adopts the Bayesian method to measures the impacts of these components on technical efficiency. Empirical measurement is demonstrated using 2010/2011 Household Survey dataset for Nigeria. The results show that the average crop output in value of per hectare is approximately ₦ 143,000 ($878.65). The sizes of farm were small with majority smaller than 2 hectares; which are predominantly cultivated using family labour. Further we found that all production variables considered were significant at 1 percent while farms were inefficient up to 16 percent on average. We find that selected institution variables (land ownership) and Geographic location variables significantly influenced the level of efficiency.

Keywords: Bayesian, Technical efficiency, Small farms, Nigeria.

INTRODUCTION

The agricultural sector worldwide has been the focus of economic growth for most economies. Notably, agriculture the world over has experienced fundamental changes in the past few decades with significant expansion in many developing countries in terms of capacities in agricultural research and innovation. The Nigeria agricultural sector however has suffered a couple of setbacks and fluctuation attributed to various reasons. Phillip, Nkonya, Pender & Oni, (2009) reported that over the last two decades, agricultural yields in Nigeria have remained the same or witnessed a declined. The documented rise in agricultural productivity in Nigeria over the last few years have been arguably attributed to expansion of the cultivated land area rather than an increase in yield (Okuneye, 2002; Phillip et al. 2009).

Although government has been investing in agriculture, this has remained far from being adequate and institutional development on the other hand is insufficient to attract the necessary growth in agriculture (Olatomide & Omowumi, (2014). Thus food production indices do not show sustainable patterns; and most farming households remain food insecure (Fakayode, Rahji, Oni & Adeyemi, 2009).

Typically, the bulk of farmers that dominate agriculture in Nigeria are smallholders (Nsikak-Abasi, Okon & Akpabio, 2011) who basically rely on their family as working units (Begho & Ogisi, 2014). This category of farmers has been reported to be inefficient in use of resources. The cause of inefficiency in small farms has been suggested in several literatures. However, empirical evidence using country level data still remains insufficient. Over the years, most studies on farm-level technical efficiency in Nigeria have been narrowed to specific states or zones; or selected crop or livestock (evident in the studies by Okozi & Okoaya, 2006;

Onyenweaku & Nwaru, 2009; O'raye, Chukwuji & Okeke, 2012) hence country-level information remains limited. This study therefore is a necessary progression on earlier studies in Nigeria as it adopts the Bayesian estimation method in the estimation of a much recent and reliable country-level data.

Since the efficient use of scarce resources is key to improving agricultural production it became imperative to investigate the extent and sources of efficiency differentials in small farms in Nigeria. In order to understand and possibly address this lingering problem, the following research questions were investigated:

- Are small farms in Nigeria technically inefficient?
- Does geographic location of small farms influence farm technical efficiency across Nigeria?
- Do institutional factors affect technical efficiency of small farms across Nigeria?

In spite of the challenges currently facing agriculture in Nigeria, benefits accrue when the extent and causes of technical inefficiency are appropriately identified hence the need for more studies of this nature.

LITERATURE REVIEW

The area in which this research was carried out is Nigeria. Nigeria is located in West Africa and lies between latitude 4^0N to 14^0N; and longitude 3^0E to 15^0E. Nigeria consists of 36 states and the federal capital territory. The country is bounded in the north by Niger, in the east by Chad and Cameroon, Republic of Benin in the west and the Atlantic Ocean on the coastline of the south. It has two main rivers: Niger and Benue; and a total land area of 923,768 sq. km out of which 745,000 sq. km is arable (World Bank Report, 2010).

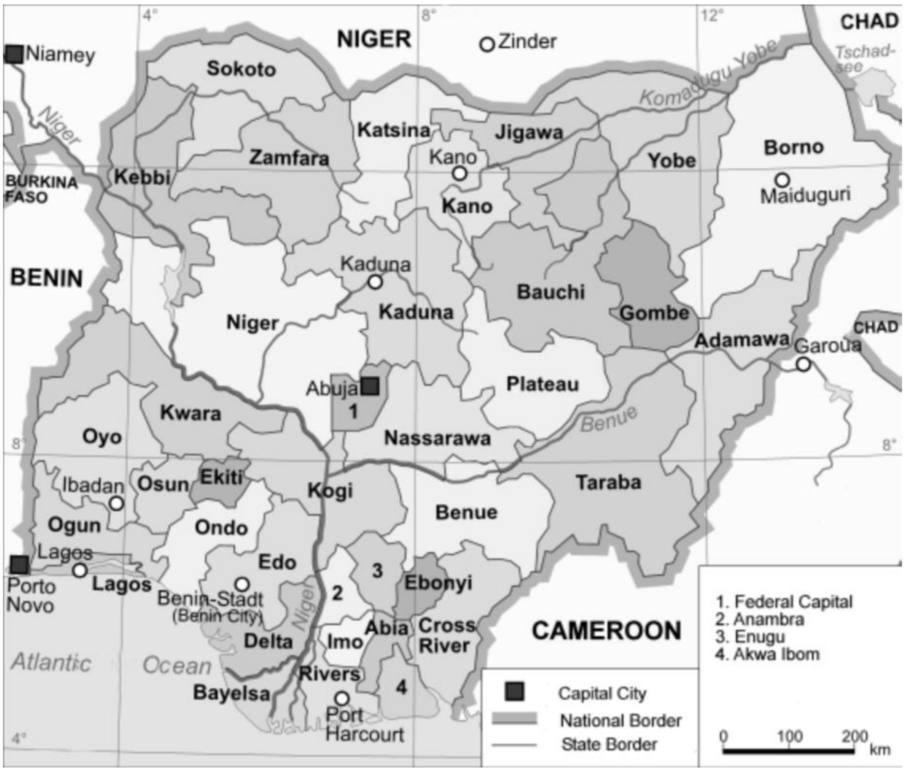

Fig 1: Map of Nigeria
Source: https://en.wikipedia.org/wiki/Nigeria

Although Nigeria lies within the tropics, there is variation in its climate from the coast further inland - from equatorial in the south, tropical in the middle-belt and semi-arid in north. It has two main seasons - rainy and dry seasons; with the north having about three to four months of rainfall (of about 1600mm to less than 400mm) and a mean temperature of about 40^0C. In the south about 6 to 7 months of rainfall between 2000mm and 3000mm is recorded annually with a temperature of between 26^0C and 28^0C (Federal Ministry of Environment of Nigeria, 2001). Owing to the notable differences between north and south both in physical landscape, climate, vegetation as well as social organisations; Nigeria is split into six geopolitical zones. These zones include North Central, North-East, North-West, South-East, South-South and South-West.

Aigner, Lovell & Schmidt (1977) and Meeusen, & Van Den Broeck (1977) developed the stochastic frontier model which was designed to estimate efficiency for each production unit based on certain distributional assumptions on technical and allocative inefficiency in addition to a statistical noise component (Kumbhakar, 2001). This model accommodates statistical noise by including a composed error structure which comprise of a two-sided symmetric term and a one-sided component (Bravo-Ureta et. al, 2007). The two-sided error captures the random effects which are beyond the control of production decision while the one-sided component portrays actual inefficiency. Basically, the two approaches to the stochastic frontier model are: the Classical and Bayesian approach. Although there are similarities in the basis of estimation, there have been extensions and combinations of techniques.

As evident in several studies; the Bayesian approach has been employed in the estimation of productivity and efficiency in agriculture. Combining both Bayesian and Classical stochastic frontier, Balcombe, Fraser & Kim, (2006) estimated technical efficiency of Australian dairy farms. Balcombe, Fraser, Rahman & Smith, (2007) in their study employed the Bayesian methods to the estimation of technical efficiency of rice farmers in Bangladesh. Similarly, Kurkalova & Carriquiry, (2002) used the Bayesian methodology in the estimation of grain production in Ukraine. Koop, Steel & Osiewalski, (1992) showed empirically the application of the Gibbs sampling methods in drawing posterior inferences in composed error stochastic frontier models. Chen & Deely, (1996) adopted the Bayesian estimation technique for a constrained linear multiple regression problem for predicting the new crop of apples. In line with existing literature, this paper adopts the Bayesian methodology in estimating technical efficiency of small farms in Nigeria.

METHODOLOGY

This study uses 2010/2011 Nigerian General Household Survey (NGHS-Panel) dataset which encompasses data from all six regions (North Central, North-East, North-West, South-East, South-South and South-West) of Nigeria. To achieve the aim of this research, all necessary data relevant to estimating the technical efficiency of small farms was collated.

We split the error term into two components; the random component (v) and the non-negative component (u) which we specify as:

$Y_{it} = f(X_i\text{b} + v_i - u_i)$ ………………..*eqn (i)*

And we obtained Y_i (output) from a vector of inputs

Our estimation was made by formulating a prior probability density function (pdf) $f(\theta)$ and combining the prior with the likelihood function $f(y|\theta)$. Where θ is unobserved parameters and y is a set of observable data.

We examine technical efficiency by specifying the equation as a cobb-Douglas function similar to Hofler & Payne (1993); Piesse, Thirtle, & Turk (1996); Mathij & Swinnen (2001) and Tomberlin & Holloway, (2007).

$lnY_i = b_0 + b_1 lnX_1 i + \ldots + b_n lnX_n i + v_i - u_i$ ………………..*eqn (ii)*

Y_i = value of output $X_1 - X_n$ = variables and bi's are the parameters to be estimated
The cobb-Douglas function is estimated for a truncated normal distribution $f^{TN}(z_{ij}|\mu\omega^2)$ in which z_{ij} is assumed to have an independent and identical distribution; and the sampling error has an independent and identical distribution $f^N(u_{ij}|0\sigma^2)$ from the normal. Using MATLAB computer application we adopt the Markov Chain Monte Carlo method of Gibbs sampling to estimate. 10000 Gibbs samples were drawn and the first 2000 were discarded as burn-ins.

The assumptions that were made in this study were that each farming household decision is to maximize expected output despite any uncertainties. In addition, it was assumed that in other to produce any single output, an N x 1 input is employed; which holds true under the assumption of output separability (O'Donnell, Shumway & Ball, 1999). Finally, the assumptions that input-output combinations which are feasible exist; and production is not impeded by extra inputs were made.

RESULTS

Table 1: Stochastic Production Frontier Results

Variables	Parameters	Coefficient	t-value
Stochastic frontier			
Farm size	β_1	1.53***	27.75
Fertilizer	β_2	0.73***	20.61
Other inputs	β_3	0.03***	2.96
Hired labour	β_4	0.60***	6.81
Family labour	β_5	1.24***	38.83
Inefficiency function			
Age	Z_1	-0.66*	-1.92
Gender	Z_2	-5.89***	-6.29
Education	Z_3	-0.74***	-2.66
Marital Status	Z_4	4.71***	5.54
Institution Variables			
Freq. of Ext. visit	Z_5	-1.12	-1.56
Savings	Z_6	1.58	1.07
Credit	Z_7	-0.64	-0.63
Land ownership	Z_8	2.28**	2.02
Off-farm activities	Z_9	-2.33	-1.57
Geographic Location			
North-Central	Z_{10}	-4.58***	-3.98
North-East	Z_{11}	-5.13**	-2.12
North-West	Z_{12}	-4.35***	-2.90
South-East	Z_{13}	-0.51	-0.80
South-South	Z_{14}	3.46***	3.40
R-Square	R^2	0.75	
Sigma statistics		1.60***	9.45
Omega statistics		2.91***	3.10

*Significant at 10%, **Significant at 5%, ***Significant at 1%

DISCUSSION

In line with economic theory, the estimated output elasticity of farm size, fertilizer, labour (family and hired), and other production inputs were positive and significant at 1percent. This implies that farm output increases with increase in farm size, fertilizer, cost of other input, hired and family labour increases. This corroborates the findings of Okon, Enete & Bassey (2010) and Simonyan, Umoren & Okoye, (2011);

The importance of farm size and family labour was evident with a significant coefficient of 1.53 and 1.24 respectively. An R^2 of 0.75 was obtained implying that the model explains 75 percent of the variability of the response data around its mean. The results also show a statistically significant sigma thus implying a correct distributional form for the composite error term.

Inefficiency Estimates

As presented in Table 4, Gender, Education and Marital Status are significant at 1 percent while Age is significant at 10 percent. In line with the a-priori, the coefficient of age is negative implying that the younger farmers are more technical efficient. This makes sense as these categories of farmers are expected to be more energetic and may more readily accept technological changes. Our finding buttresses the results of Ajibefun & Aderinola, (2004) and Okoye, Onyenweaku & Asumugha (2007).

Gender is significant and negative technical efficiency increases with more participation of men which justifies why more males are involved in farming than females. Okezie & Okoye, (2006) and Yusuf & Malomo, (2007) obtained similar results. This may be attributed to the drudgery of traditional farming practices predominant among small farmers in Nigeria thus males are more poised to perform better.

We found the coefficient of education to be negative and significant. This implication is that the higher the level of education attained the farmers' technical efficiency increases. This could be due to the fact that educated farmers are better positioned to embrace new knowledge and adopt technologies that help increase technical efficiency. Educated farmers are very likely to be less risk-averse and therefore more willing to try out modern technologies. This is similar to the results obtained from studies carried out by Kumbhakar, Ghosh & McGuckin, (1991), Bravo-Ureta & Pinheiro, (1997); Asogwa, Umeh & Penda, (2011) and Oladeebo & Masuku, (2013).

Similar to the findings of Simonyan, Umoren & Okoye, (2011); Okezie & Okoye, (2006), the coefficient of marital status is positive and significant. This implies that a single farmer is less efficient than a married farmer. This may be attributed to farm input support in terms of increased household labour.

Institutional Factors and Technical Efficiency

Of all institutional variables analysed, only land ownership is significant and positive implying that farmers who own the land in which they farm are less technically efficient that tenant farmers. Frequency of Extension visit, Personal Savings, Credit and Access to credit, Participation in off-farm activity were insignificant.

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Geographic Regions and Technical Efficiency

The estimated parameters for North-Central, North-West is significant and negative at 1 percent implying that farming in that zone significantly increases the possibility of technical efficiency while South-South is significant and positive at 1 percent which implies that farming in that zone significantly reduces technical efficiency . The estimated parameters of North-East is however significant at 5 percent. Finally, the significant coefficient of farming household in the North-Central, North-Eastern, North-Western, South-South regions of Nigeria confirms that regional location of farm influences technical efficiency. This finding is in consonance with Onoja, Ibrahim & Achike (2009) who reported that variation among zones is attributed to the predominant farming practices as well as soil and climatic factors.

From the results of the estimated model, we found that farmers operated inefficiently. And the current level of technical efficiency can be increased with 16 percent without employing new technology or use of additional inputs. Our finding corroborates Oladeebo (2012) who estimated technical efficiency among male and female farmers in south-western Nigeria.

CONCLUSIONS

This paper examines technical efficiency of small farms in Nigeria. The procedures employed by this study is gradually becoming popular in estimating the stochastic frontier as it has the capacity of providing precise small-sample inference on efficiencies in addition to the possibility of including a prior without much restrictions. The results show that the average crop output in value of per hectare is approximately ₦ 143,000 ($878.65). The sizes of farm were small with most being less than 2.2 hectare and are predominantly cultivated using family labour. Further we found that farm size, fertilizer, cost of other input, hired and family labour were significant at 1 percent while farms were inefficient up to 16 percent on average. We find that institution variables (frequency of extension visits, off-farm employment) and Geographic variables significantly and positively influenced the level of efficiency.

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