TECHNICAL EFFICIENCY EVALUATION OF MARKET AGE AND ENTERPRISE SIZE FOR BROILER PRODUCTION IN IMO STATE, NIGERIA

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ABSTRACT
The study was on Technical Efficiency Evaluation in Broiler production involving Brooding and Rearing Enterprises on one hand and small-scale and large-scale brooding and small-scale and large-scale rearing enterprises on the other hand. Using multi-stage sampling technique, the study area was zoned into three, following the existing zoning arrangement of the Imo State Agricultural Development Programme (ADP). A total of nine L.G.As were randomly selected and a total of 180 broiler farmers (made up of 90 brooding and 90 rearing farmers) were selected. A set of structural questionnaire was administered on the producers to obtain required information. Data obtained were analyzed using simple statistical tools, and multiplicative dummy variable models. Results showed that broiler rearing farmers were more technically efficient than the brooding farmers. Small-scale rearing farmers were more technically efficient, while large-scale brooding farmers showed more technical efficiency in the use of resources than the small-scale ones. The implication is that technical efficiency may not increase in rearing broiler by increasing stock but in brooding business it can be increased by increasing stock. Since technical efficiency is greater in rearing broilers, it is recommended that producers should engage in both brooding and rearing birds.

Key words: **Broiler Production, Technical Efficiency and Scale of Operation**

INTRODUCTION
Efficiency in production is concerned with the relative performance of the processes used in transforming a set of inputs into output. The concept has been given various interpretations in efficiency literature. Farrel (1957) and Carlson (1972) in their pioneering work in efficiency studies distinguished between two types of efficiencies; technical and allocative. A third form of efficiency, economic, was described as the product of technical and allocative efficiencies. When they occur together, they create sufficient conditions for achieving economic efficiency(Yotopolous and Nuggent, 1976).An economically efficient input-output combination therefore, would be on both the frontier function and expansion path (Ogundari and Ojo, 2006). Technical efficiency is borne out of the techniques used. It is the producer's ability to use the "best practice" in the production process so that not more than the required or necessary inputs are used to produce "best" level of output (Timmer, 1970; Carlson, 1972). It is considered as the maximization of the ratio of physical output to physical input without taking into account factor input and output prices (Arene and Okpukpara, 2006). In other words, a method of production that uses more of physical input resources than an alternative in the production of a unit of output is said to be technically inefficient (Chukwuji, *et al*., 2006). The measurement of firm's specific technical efficiency is based on observed output from the best production (Okoruwa and Ogundele, 2008). Firm's technical efficiency is based on deviation of observed output to the best or ideal production. Technical inefficient will therefore arise when actual or observed output from a given mix is less than the maximum possible output (Omotesho *et al*., 2008).

Allocative efficiency deals with the choice of optimum combination of inputs consistent with relative factor prices. A farmer is therefore considered allocatively efficient in the use of a resource if he is capable of equating marginal value product (MVP) of the production to its factor price. That is, allocative inefficiency arises when the input mix is not consistent with cost minimization (Fan, 1999).

In this study, market age in broiler production is taken as the age at which a particular producer offers his birds for sale. There are therefore three distinct market ages that can be observed in boiler market; 4 weeks brooded; 8-12 weeks reared and above twelve weeks reared, popularly called over-aged. On this, Oluyemi and Roberts (1979) pointed out that the exact time for marketing broilers depended on different marketing situations involving the relative costs of chicks and feeds and market preferences.

Size of enterprise is considered important as it may influence resource use efficiency. There are controversies in efficiency literature between size of operation and efficiency of resource use (Kydd and Christiansen, 1982; Lele and Agarwal, 1989; Deininger and Binswangar, 1995; and Awoke, 2003).The definition of farm size or scale of operation has however varied in efficiency literature, as what is considered large or small-scale is relative depending on the agricultural system setting (Ohajianya, 2002). May be the most useful economic definition of small-scale business is the one that emphasized those characteristics which might be expected to make their performances and their problems different from large-scale business (Adebusuyi, 1977). The definition according to Okafor (2000) is contextual as each country or public agency tends to adopt a definition criterion which accommodates the peculiar needs of public policy or which most appropriate for the intended policy objective of the agency concerned. Important operational variables like capital investment, turnover, employment level and relative size of a firm within any industry are common features in most definitions. In Nigeria, enterprise size classification is based on a composite criterion of sales volume, capital or asset base and employment level (Udechukwu, 2002).

Literature has shown that agricultural productivity could be improved through two major ways, namely; introducing new technology and improving on a technique. That is, improving the methods of input application for a given technology (Mario, 2006). In Nigeria efforts are focused on introducing new technology with less attention to improving on the existing ones. Whereas, it is believed that unless the potential of an existing technology is fully exploited, benefits from new ones may not be realized. In fact, little policy attention is paid on efficiency use of the chosen technology in Nigerian agriculture (Yusuf and Adenega, 2008).

Efforts of governments to raise animal protein intake have not yielded required results because there are still high cost of meat, increase animal product import bills and general inadequacy of animal protein in the diets of majority of our rural dwellers. The importance of animal protein cannot be over emphasized. It is recommended that more than one third of the minimum protein intake for an adult per day should be of animal origin. This is because animal protein contains the essential amino-acids which are more balanced and readily available to meet nutritional needs than plant protein (Onyenuga, 1971; Ojo, 2003). However, animal products contributed only about 15-20% of the protein intake of the nation (FRN, 1997). This is against the fact that Nigeria is endowed with abundant livestock production facilities (Abubakar, 1998). Since efficiency improvement is necessary for increasing productivity and achieving production growth, an analysis of technical efficiency of resource use among broiler farmers in Imo State would therefore provide empirical evidence of gaps that may exist in the farmers' current level of technology. These gaps would serve as intervention points for relevant stake-holders for arresting any difference that may precipitate animal protein crisis in the study area, as inefficiency directly translates to low productivity and profitability. Hence the study sets to discover technical efficiency of resources use among the market ages in broiler production, otherwise called broiler brooding and rearing enterprises as well as large-scale and small-scale outfits in the two broiler enterprises. It is hoped to provide better information about the variables of variations in technical efficiency of resources use among the group of farms. It will also try to formulate policy measures that will reduce the difference if any.

METHODOLOGY

The study area was divided into three clusters based on the existing three agricultural zones of Imo state, namely, Orlu, Owerri and Okigwe zones following the zoning arrangement of Imo Agricultural Development Project (IADP). Each zone is made up of several local government areas. Nine Local Government Areas, three from each zone were randomly selected. Then the broiler production was broadly stratified into brooding and rearing enterprises. Each stratum was further stratified into small and large scale outfits. In each of the enterprises, random samples of five small-scale and five large-scale farms were selected in a Local Government Area. This gave a total of twenty (20) farms of ten (10) from each enterprise in a local government area. In all therefore, a sample size of 180 farms were selected for study.

A set of structured questionnaire was used to obtain primary information from the respondents. Data collected were analyzed using Additive Multiplicative Dummy Variable Model approach following the works (Baggi, 1981; Benwo, 1986; Onyenweaku, 1994; Nwaru, 2003; Nwaru and Nnadozie, 2006). This model is used in place of traditional method of fitting separate models and testing the equality of coefficients between them. It is used to discover technical efficiency differences and similarities of group of farms in a production system. The main aim of the model is to establish whether any group of farms under consideration is characterized by neutral production function or non-neutral /factor-biased production function or same production function. Achieving neutral production function means that the production functions of the two farms under consideration differ only in their intercepts while their slope coefficients are the same. This implies that none of the slope coefficient of parameters is statistically significant at a chosen level of probability. A situation of non-neutral or factor-biased production function arises when one or more of the slope coefficients of the two functions are statistically significant. This means that they differ statistically in one or more of their slope coefficients, though their intercepts may differ or not. If there is however no significant difference in both the intercepts and slope coefficients of the two production functions, the farmers are said to face the same production function showing equal performance in technical efficiency. Implicitly, the model is given thus: $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, D, X_1D, X_2D, X_3D, X_4D, X_5D, X_6D) + e_i$

Explicitly, the log linear Cobb-Douglas functional form is thus:
$In\ Y = InAo + BoD + A_1InX_1 + B_1DInX_1 + A_2InX_2 + B_2DInX_2 + A_3InX_3 + B_3DInX_3 + A_4InX_4 + B_4DInX_4 + A_5InX_5 + B_5DInX_5 + A_6InX_6 + B_6DInX_6 + e_i$

Where: In = the natural logarithm, Y = Value of output (#) Ao = the intercept, Bo = Coefficient of intercept shift dummy or neutral technical efficiency parameter, D = dummy variable which takes value of unity for brooding enterprise and large-scale outfit on one hand and value of zero for rearing enterprise and small-scale outfit on the other hand, X_1 = Labour outlay (Mondays), X_2 = Quantity of feed (Bags), X_3 = Farm size (number of birds), X_4 = Value of medication and veterinary services(#), X_5 = Value of other inputs (transport, marketing expenses, repairs and miscellaneous expenses), X_6 = Value of capital inputs (Interest, depreciation, rent etc.), Ai (i = 1,2….6) = coefficient of the ith, B_1D_1, B_2D_2 etc = coefficients of slope shift dummies. E_i = stochastic error term which is assumed to fulfill all the assumptions of classical linear regression model.

To interpret the result of the model estimated, attention is focused on the intercept shift dummy (BoD). If the value of coefficient estimate (B_o) of the dummy 'D' is positive and significant, it means that the production function for the farm with value of unity in the binary dummy has larger intercept implying higher level of technical efficiency. If however it is negative and significant, it means that the production function of the farm has lower intercept implying lower level of technical efficiency.

The farmer groups are facing neutral production function if none of the slope coefficients is different from zero (i.e. statistically significant). But if at least one or two of the slope coefficients of the production functions are different from zero, it shows that the groups are facing factor-biased or non-neutral production function. This implies differences in technical efficiency. A case of same production function for the groups arises when the values of intercept coefficient and slope coefficients are both not different from zero. Such groups of farms are having the same level of technical efficiency.

RESULTS AND DISCUSSION

The technical efficiency comparison between the brooding and rearing enterprises are shown in table I. The table contains the result of fitted numerical data to the additive multiplicative dummy variable models. Based on statistical and econometric positions, linear function was chosen as lead equation for analysis. In this model, the coefficient of multiple determination (R^2) was 0.934, which was higher than that of other functional forms. The value of coefficient of multiple determination being 0.934 shows that up to 93% variations in the output of the farmers were jointly explained by the set of explanatory variables of the model. Also, in the linear model, farm size measured in number of birds was positive and statistically significant at 1% level of probability. Being significant and positive shows that increase in number of bird increased income of the farmers. Equally, feed input was positive and highly significant and therefore had influenced output positively. Increased feed consumption, increased body weight of birds which therefore increased farmers' income. Capital was significant at 5%level indicating that investment in fixed assets, such as expansion of poultry building, increased income of the farmers. These slope shift coefficients being statistically significant shows that the farmers had factor-biased production functions. In other words, they had different functions and technologies.

Table I: Estimated pooled production function for brooding and rearing enterprises. D = 1 for brooding and 0 for rearing enterprises

Variable	Linear	Exponential	Semi-log	Double-log
Intercept	33609	10.50717	-1896463	4.10451
	(1.98)*	(65.66)***	(6.54)***	(5.70)***
Labour	63.14551	0.00690	-53356	0.05787
	(0.28)	(3.29)**	(-1.57)	(0.69)
Feed	1.7147	0.00000361	248936	0.42982
	(8.50)***	(1.90)*	(5.28)***	(3.67)**
Farm size	325.7307	0.00119	-32141	0.4502
	(4.92)***	(1.90)*	-(0.65)	(3.74)**
Medication	2.39855	-0.00001975	35195	-0.01945
	(0.74)	(-0.65)	(1.26)	(-0.28)
Other inputs	-0.51238	0.00004152	-63782	0.07533
	-(0.20)	(1.72)*	(-2.60)**	(1.24)
Capital	3.89949	0.00003683	24783	0.04954
	(2.49)**	(2.49)	(1.07)	(0.86)
Intercept dummy	-14595	-0.12405	1307439	0.06812
	(-0.52)	(-0.47)	(2.98)**	(0.06)
(Labour) D	-233.665	-0.00572	48840	-0.14724
	(-0.41)	(-1.07)	(0.79)	(-0.96)
(Feed) D	-1.3598	0.000000480	-24002	-0.28518
	(-2.63)**	(0.99)	4.42)***	-(2.04)**
(Farm size) D	-316.5578	-0.0008877	56060	-0.02253
	(-4.42)***	(-1.31)	(6.90)	(-0.15)
(Medication)D	2.30218	0.000046	-27322	-0.07300
	(0.51)	(1.11)	(0.76)	(-0.82)
(Input) D	23.9025	0.000123	124369	0.31541
(Capital) D	5.41215	0.0000473	-15006	0.00303
	(0.67)	(0.62)	(-0.43)	(0.03)
R^2	0.9347	0.65	0.770	0.915
R^{-2}	0.9290	0.6211	0.750	0.9084
F – ratio	164.02***	21.76***	38.38***	124.57***

Source: Field Survey, data 2010

NB: Values in Parenthesis are t-values

***** Significant at 10%

** Significant at 5%

*** Significant at 1%

The intercept shift dummy was negatively signed and statistically insignificant. This implies that the brooding farmers achieved lower output than their counterparts in rearing business. The slope shift dummy for farm size and other inputs were statistically significant at 1% and the slope shift dummy for feed was significant at 5% level indicating that both the brooding farmers and rearing farmers were characterized by factor-biased production functions. They had different levels of technologies and resource use efficiencies. In addition, the slope shift dummies for feed and farm size were negatively signed suggesting lower use intensities for these resources by the brooding farmers. The slope shift dummy for other inputs was positively signed suggesting higher use intensities for these resources. Higher or lower use intensities are attributes of resource use inefficiencies

Comparison of technical efficiency was carried out in large and small-scale outfits in boiler rearing enterprise. Table II contains results of fitted numerical data to equations of additive multiplicative dummy variables. Based on statistical and econometric criteria, the Double-log equation was chosen as lead equation. The estimated model showed that the coefficient of multiple determinations (R^2) was 0.967. This indicated that up to 97% of variations in output were explained by the explanatory variables of the model. The farm size was statistically significant at 1% level, other inputs was significant at 5%, intercept shift dummy was significant at 1% and other inputs shift dummy was significant at 10% level. The farm size and other inputs being significant and positive showed that they influenced income of the farmers so much. They were the major determinants of the income of the farmers. It also indicated that the farmers had factor-biased functions and different production technologies. The intercept shift dummy was highly significant and negatively signed suggesting that there was a shift in neutral technical efficiency parameter to a lower level. In other words, large-scale farmers were less technically efficient than the small-scale rearing farmers.

Feed shift dummy was significant and positive showing higher use intensity by the large-scale farmers. Farm size shift dummy and other inputs were negatively signed showing their lower use intensities. The higher or lower use intensities in the use of the resources by the large-scale farmers suggest that the farmers inefficiently employed some of the resources. In other words, they achieved lower technology while their counterparts small-scale producers, used high technology in the use of the resources. They were therefore technically more efficient than the large-scale producers in the industry.

Table II: Estimated production function for large-scale and small scale rearing enterprises Large D = 1 Small D = 0

Variables	***Linear***	***Exponential***	***Semi-log***	**Double-log**
Intercept	-6506.274	9.513	-443366	6.39339
	(0.24)	(65.46)***	(-1.31)	(5.91)***
Labour	252.088	0.004	6780.79	0.0594
	(0.51)	(1.59)	(0.20)	(0.55)
Feed	1.345	0.00001	40599	0.0604
	(0.91)	(1.42)	(0.82)	(0.38)
Farm size	637.600	0.008	43511	0.9407
	(1.27)	(3.05)**	(0.80)	(5.44)***
Medication	-7.599	0.00003	-14212	-0.083
	(-0.65)	(0.57)	-(0.70)	(-1.27)
Other inputs	2.840	0.00005	1253.66	0.1537
	(0.45)	(1.67)*	(0.06)	(2.29)**
Capital	11.777	0.00003	8025.398	-0.0613
	(0.64)	(0.34)	(0.37)	(-0.88)
Intercept dummy	136076	3.005	-2.937	-4.727
	(2.32)**	(9.71)***	(1.80)*	(-9.29)***
(Labour) D	-630.31	-0.005	-33902	-0.1201
	(1.02)	(-1.58)	(-0.74)	(-0.82)
(Feed) D	0.364	-0.0000075	305321	+0.6343
	(0.24)	(0.96)	(4.40)**	(+2.86)**
Farm size	-381.018	-0.00833	222274	-0.880
	(-0.75)	(-3.09)**	(3.11)**	(-385)***
(Medication) D	12.713	0.000020	40141	0.1692
	(1.02)	(-0.31)	(0.82)	(1.08)
(Other Input) D	-5.944	0.00056	-30118	-0.1954
	(-0.80)	(-1.44)	(0.86)	(-1.75)*
(Capital) D	-9.351	-0.000024	6396.426	0.1617
	(-0.51)	-(0.25)	(0.20)	(1.59)
R^2	0.946	0.904	0.950	0.967
R^{-2}	0.934	0.884	0.940	0.9608
F-ratio	83.76***	45.06***	91.47***	142.56***

Source: Field survey data, 2010

Values in parenthesis are t-values

*** significant at 1% level

** significant at 5% level

* significant at 10% level

This shows that the farmers had different functions and technologies because they were facing factor-biased production functions. The comparison of technical efficiency in the small-scale and large-scale business in broiler brooding are contained in Table III. The table contains estimated production function in four functional forms. The double-log form was chosen as lead equation following statistical and econometric reasons. In the model, the coefficient of multiple determinations (R^2) was 0.927 showing that close to 93% of the variations in the output were explained by the exogenous variables of the model. The rest of 7% were taken care off by variables not included in the model. The F-value was statistically significant at 1% level showing that the model was adequate for use in further analysis. The intercept was highly significant, farm size was significant at 5%; other inputs was highly significant; intercept shift dummy was highly significant; farm size shift dummy was highly significant and other inputs shift dummy was statistically significant at 5% level. This therefore implies that the farmers were facing factor-biased production functions. The coefficient of intercept shift dummy being negative and significant indicates that there was a shift in technology to lower level among the small-scale brooding farmers. They were less technically efficient than the large-scale brooding farmers.

The slope shift dummies coefficients for farm size and other inputs being highly significant indicated that large-scale and small-scale brooding farmers were faced with factor-biased or different production functions, or technologies, the slope shift dummy of farm size being positively related to output showed its high level use intensity by the small-scale farmers. The negative sign for the slope shift dummy for other inputs suggested that the factor was less intensively use by the small-scale farmers.

Table III: Estimated production function for large and small scale brooding enterprises

Variable	Linear	Exponential	Semi-log	Double log
Intercept	160449	11.927	126428	11.975
	(6.45)***	(87.27)***	(0.65)	(12.43)***
Labour	-332.488	-0.00171	4516.341	0.02414
	-(1.04)	(0.98)	(0.25)	(0.27)
Feed	-0.5285	-0.0000032	-8899.95	0.0707
	(-1.74)*	(-1.94)*	(-0.76)	(1.23)
Bird(farm size)	-33.405	-0.00015320	-50733	0.253
	(-2.01)**	(-1.68)*	(-3.17)**	(3.21)**
Medication	3.5019	-0.00001070	22084	0.0764
	(1.94)*	(-1.08)	(2.35)**	(1.65)
Other inputs	*17.950	0.00009052	58549	0.3096
	(6.86)***	(6.30)***	(6.05)***	(6.49)***
Capital	-5.108	-0.000204	-26388	-0.1125
	(-0.80)	(-0.58)	(-1.86)*	(-1.61)*
Intercept dummy	-162934	-2.3766	-260226	-5.808
	(-3.54)**	(-9.41)***	(-0.89)	(-4.04)***
(Labour) D	492.417	-0.00444	6601.562	0.0835
	(0.35)	(0.58)	(0.15)	(0.38)
(Feed) D	0.1723	0.00000785	-4957.665	10.0258
	(0.08)	(0.63)	(-0.15)	(-0.16)
(Bird) D	433.520	0.00761	110927	1.3601
	(1.85)*	(5.91)***	(2.57)**	(6.40)***
(Medication) D	-3.27	0.000045	-26888	-0.0965
	(0.30)	(0.76)	(-1.78)*	(-1.30)
(Other Inputs) D	-17.165	-0.000101	-54005	0.2822
	(-1.20)	(-1.30)	(-2.44)**	(-2.58)**
(Capital) D	3.220	0.00002193	24698	0.0712
	(0.31)	(0.39)	(1.37)	(0.80)
R^2	0.753	0.910	0.7501	0.927
R^2	0.709	0.894	0.7056	0.9914
F – ratio	17.13**	57.33***	16.85***	71.35***

Source: Computed from 2010 survey data

NB: Figures in parenthesis are the T-values

*** - Significant at 1%

** - Significant 5%

* - Significant at 10%

The farm size and other inputs were statistically significant at 1% level and positive, while capital input was significant at 5% level. Their being significant and positive shows that they exerted positive influence on revenue of the farmers. Increases in them were expected to increase revenue of the farmers. The F-ratio was significant showing the over all significance of the model. All the parameters of the model had the expected signs. Labour was negatively signed showing that increased use of labour in form of man-hour decreased revenue.

CONCLUSION

This study revealed that in the study area, where brooding and rearing of broiler birds are two distinct enterprises, broiler rearing farmers were more technically efficient in the use of production resources than the broiler brooding farmers. Examination of size operation revealed that small-scale broiler rearing farmers were more technically efficient than the large scale ones. However, in broiler brooding business large-scale producers performed better than small-scale ones technically. It implies therefore that in broiler rearing, one needs not be a large-scale producer to maximize profit since he can use less of the required inputs to achieve the required output. In brooding business, one needs to increase stock in order to perform better. Operating at small-scale may mean a waste of some resources like fixed assets of building and feeding devices

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