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Comparing government regulated and unregulated inland water fisheries of Plateau State, Nigeria: an economic productivity analysis

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Abstract:
The objectives of the research was to compares the economics of regulated and unregulated fisheries through the estimates of technical, allocative and economic efficiency of micro entrepreneur or artisanal fishers in the central Nigerian state of Plateau, with a view to examine the economic benefits and sustainability on inland water fisheries as renewable resource in developing economics. Stochastic frontier production and cost functions using the maximum likelihood estimation (MLE) technique was used to analysed data collected from, daily fishing observations made for 4 weeks, and through questionnaire from 20 micro entrepreneurs from unregulated lakes of Polmakat, Shimankar, Deben, Janta and 30 micro entrepreneurs from the only regulated Pandam Lake to give a sample size of 110 respondents selected in a multi-stage sampling technique. The mean technical, allocative and economic efficiency of unregulated fishers were 0.83, 0.56 and 0.68 respectively, while, the mean technical, allocative and economic efficiencies of the regulated fishers were 0.91, 0.68 and 0.72 respectively. This study shows higher potential for increase in fishing output at unregulated fisheries through better use of available resources, given the current state of technology. The MLE result suggested that extension contact, age and educational status were major determinants of efficiency in unregulated fishing, meaning that the transformation for effective and sustainable fisheries exploitation requires the involvement of educated fishers, extension education, and redefinition of property rights of unregulated fishery and constraining of inputs at regulated fishery.

Keywords: micro entrepreneurs, economic, efficiency, comparative, stochastic, renewable resource

1 Introduction

The diverse farming environments of Sub-Saharan Africa, among other factors, suggest an Asian-type Green Revolution is unlikely and there is a need for more localised innovation and solutions to enhance and sustain productivity of smallholder production systems centred on agriculture, forestry and fisheries (Madison, 2006). The global captured fishery is in a crisis with a majority of the world's fisheries being fully exploited and about one third of them being either depleted or over-exploited (FAO, 2003. This crisis has been deepen by both market and policy failures which manifest themselves through, among other things, improper management and inadequate property rights. The results of these are extinction of species, disturbances of delicate ecosystem, collapse of important fisheries, and destruction of natural environment, less dramatic, but of enormous importance, is the decrease in yield, income, and employment from fisheries. FAO (2004) also stated that deterioration of global fisheries is raising significant concern, mainly because an estimated one billion people, mostly in low-income countries, depend on fish as their primary source of protein and further stated that the industry, ranging from subsistence fishermen to large-scale mechanized fishing vessels, directly or indirectly employs some 200 million people worldwide.

Fisheries development plans in Nigeria have spanned for a period of 44 years however, the key objectives to make Nigeria self sufficient in fish production, conservation of the resource and other economic factors were considered targets of fisheries management remains unfulfilled((Azionu *et al.,* 2005). However, there is a growing consensus among ecologist, conservationist, biologist and fisheries managers that conventional season length and gear restriction management methods are bound to fail in the future, and that a new approach is therefore needed (Bohnsack, 1993). Plateau state government in the last eight years (2004) adopted a new management regulatory mechanism (henceforth called regulated fishery) at Pandam Wildlife Park lake fishery and the only of its kind in Nigeria. The main objective of the study was to compares the economics of regulated and open access systems (henceforth called unregulated fishery) inland water fisheries. Specific objective was to measure the technical efficiency (TE), allocative efficiency (AE), and economic efficiency (EE) of fishing micro entrepreneurs at both governments regulated and unregulated natural lakes in central Nigerian state of Plateau. This research seeks to test the null hypotheses that there was no difference in the economics of regulated and unregulated fisheries in the study area.

2 literature review

The stochastic frontier modelling is becoming increasingly popular because of its flexibility and ability to closely marry economic concepts with modelling reality. And, based on this, the model is employed in this paper to provide the basis for measuring household-level technical, allocative and efficiency as a basis for assessment of current property rights, management and exploitation levels for beneficial and sustainable fishery indicators. The modelling, estimation and application of stochastic frontier production function to economic analysis assumed prominence in econometrics and applied economic analysis following Farrell's (1957) seminar paper where he introduced a methodology to measure technical, allocative and economic efficiency of a firm.

Technical efficiency is defined (Kumbhakar and Lovell, 2000) as the ability of a decision-making unit (DMU) to obtain the maximum output from a set of inputs. However, over the years, Farrell's methodology had been applied widely, while undergoing many refinement and improvements. And of such improvement is the development of stochastic frontier model which enables one to, measure firm level technical and economic efficiency using maximum likelihood estimate (a corrected form of ordinary least square –COLS).Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977) were first to proposed stochastic frontier production function and since then many modifications had been made to stochastic frontier analysis. Aigner et al. (1977) applied the stochastic frontier production function in the analysis of the U.S agricultural data. Battese and Corra (1977) applied the technique to the pastoral zone of eastern Australia.

In the fisheries context, there is a growing interest in the measurement of technical and cost efficiency under different fishing management scenarios. In this context, knowledge of the technical and cost efficiency at fleet level and its determinant factors would be valuable information not only to obtain the maximum output from a set of inputs or to produce an output using the lowest possible value of inputs, but also for a decommissioning program (Idda *et al*., 2009; Lindebo *et al*., 2007; Maravelias & Tsitsika, 2008) In fact, the success of a decommission program depends both on the variation and the level of efficiency within the fishing fleets. The actual reduction in fleet capacity will be less than expected if fleets with lower than average efficiency levels are decommissioned. Further, if the remaining fleets improve their technical efficiency it may even further offset the effects of the decommissioning program (Lindebo *et al*., 2007). Due to the key role of efficiency and its determinant factors in fishing management and a decommissioning program, there is a growing interest in the measurement of technical efficiency and the factors determining it at fishing fleet level (Esmaeili, 2006; Garcia del Hoyo *et al*., 2004; Hjalmarsson *et al*., 1996; Huang & Wang, 2002; Idda *et al*., 2009; Kirkley & Squires, 1999; Kirkley *et al*., 2002; Lindebo *et al*., 2007; Maravelias & Tsitsika, 2008; Pascoe *et al*., 2001; Reid *et al*., 2003; Reinhard *et al*., 2000; Squires *et al*., 2003; Tingley *et al*., 2005; Vestergaard *et al*., 2003).

All of the aforementioned studies measure the technical efficiency of fleets within the similar management system based on the stochastic frontier production function. Different fisheries differ from each other in management, natural endowment and level of economic development, therefore ignoring the variation in management systems may lead to biased estimates of efficiency scores, and hence misleading policy implications. However, for making efficiency comparisons across management systems was done by measuring economic efficiency of the two systems found on the plateau state in central region of Nigeria.

3 Materials and Methods

3.1 *Study area*

Plateau State is located in the middle belt region of Nigeria and lies between latitude 8^{o}30′ and 10^{o}30′N, longitude 7^{o}30′ and 3^{o}37′E with a land mass covering 53,585 square metres, the state has an estimated population 3.9 million (projected 2012 population, NPC, 2006). The Shimankar, Polmakar, Deben, and Janta Lakes and Pandam Lake (is about 200 hectares located within the Pandam wildlife Park) all lies within the Northern guinea Savannah.

3.2 *Data Collection*

Primary data were employed for the research and collected using questionnaires and a catch assessment record logbook. The questionnaires were administered to the 30 micro entrepreneurs or artisanal fishers of Pandam Lake (regulated fishery) while, another 20 micro entrepreneurs or artisanal fishers each from the unregulated fishery at Shimankar, Polmakar, Deben, and Janta Lakes. Furthermore, daily fishing observations of selected fishers was carried out through a catch assessment survey (CAS), to capture the lean months (July/September) and peak months (Nov/Jan) of fishing for period of two weeks each at unregulated, while, the lean months (April/May) and peak months (Dec/Jan) for the regulated fishery. The total observations of one thousand five hundred and forty in twenty weeks from one hundred and ten fishers (observations: 1540; 4wks; 110 samples).

4 Theoretical Frameworks

4.1 *Stochastic Frontier Production and Cost Function Models.*

The basic method for measuring fishery vessel level efficiency is to estimate a stochastic frontier production and cost functions that envelop all the input-output data. The efficiency comparisons of the different types of management systems (e.g., comparing efficiency levels of government regulated fishery vessels with efficiency levels of unregulated fishery vessels) in this study was done by measuring both technical and allocative efficiency of individual household. The estimate of efficiency can be done using data envelopment analysis

(DEA) or stochastic frontier analysis (SFA). The SFA models have the advantage of separation of impact of weather and luck from contribution of variations. DEA, however, does not account for random variation (a common feature in fishery) in the output. Apart from measuring efficiency, applications using SFA have been recommended by FAO (1998) to also measure fishing capacity (Garcia del Hoyo *et al*., 2004; Kirkley & Squires, 1999; Kirkley *et al*., 2002; Pascoe *et al*., 2001; Reid *et al*., 2003; Vestergaard *et al*., 2003). A frontier model with output-oriented technical inefficiency is specified as follows:

$Y_i = E_i \beta + (\varepsilon_i = V_i - U_i)$ -- - - - - - - -- - - - - - - (1)

Where Yi is output in kg of individual i (i= 1, 2 ... N) E_i is the corresponding matrix of K inputs and β is a k x 1 vector of unknown parameter to be estimated. The disturbance term is made up of two independent components, $\varepsilon i = V_i - U_i$ where $V_i \sim N(0, \sigma_v^2)$, and U_i is a one-side error term. The estimated frontier is stochastic since fishing is sensitive to random factors (Kirkley et al., 1995). The first-best option is to consider a translog flexible functional form, because it represents a second-order approximation of any arbitrarily chosen function as well as being theoretically possible (Berndt and Christensen, 1973); it is specified as follows:

$\text{In } Y_j = \beta_o + \beta_1 \text{In}E_1 + \beta_2 \text{In}E_2 + \beta_3 \text{In}E_3 + \beta_{12} \text{In}E_1 \text{In}E_2 + \beta_{13} \text{In}E_1 \text{In}E_3 + \beta_{23} \text{In}E_2 \text{In}E_3 + ½ (\beta_{11} \text{In}E_1 + \beta_{22} \text{In}E_2 + \beta_{33} \text{In}E_3)^2 + (V_i - \mu_i)$ - - - - - - - - -- - - - (2)

Where; subscript j refers to the jth fisher in the sample.

$E_1 =$ is the length of fishing gears measured in meters.

$E_2 =$ the time taken for passive gears to remain active in water (hours) per fishing trip as a proxy for hours fished (Kirkley et al, 1998).

$E_3 =$ the number of fishing gears owned by the individual fishers active during survey period.

In = the natural logarithm (base e).

In Equation (2), the symmetry restriction is imposed a priori to be able to identify the coefficients (βij=βji). The corresponding cost frontier of Cobb-Douglas functional form which is the basis of estimating the allocative efficiencies of the fishers is specified as follows:

$C_i = g (P_i; \alpha) \exp (V_i + U_i); = 1, 2….n$ - - - - - - - - - - - - - - (3)

a_1 = cost of gillnet used by fishers

a_2 = Cost of malia trap used by fishers

a_3 = Cost of hook line used by fishers

a_4 = Cost of gura trap used by fisher

a_5 = Cost of repairs/maintenance

a_6 = Cost of depreciation on equipment

Where C_i represents the total input cost of the i-th fisher; g is a suitable function such as the Cobb-Douglas function; P_i represents input prices employed by the i-th fisher and measured in naira; α is the parameter to be Estimated, V_is and U_is are random errors and assumed to be independent and identically distributed truncations (at zero) of the N (μ, σ^2) distribution. U_i provides information on the level of allocative efficiency of the i-th fisher. The allocative efficiency of individual fishers is defined in terms of the ratio of the predicted minimum cost (C_i*) to observed cost (C_i).That is: AEi= C_i^*/C_i = exp (U_i) Hence, allocative efficiency ranges between zero and one.

4.2 *Technical inefficiency model*

In the Battese and Coelli (1995) inefficiency effect model, the one-sided error term is specified as:

$$U_i = \delta_0 + \sum_{j=1}^{4} \delta j\, Zj + \omega \qquad (4)$$

Where Zs are socioeconomics variables used to explain efficiency differentials among fishers, δ's are unknown parameters to be estimated and ω_i is an iid random variable with zero mean and variance defined by the truncation of the normal distribution. The specific Z-variables the above model can be specified as follows:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \omega \qquad (5)$$

Where Ui is individual fishers' technical inefficiency measure in production and allocative efficiency in stochastic cost function and Z1, Z2, Z3 and Z4 represents age of fishers, family size, extension contact and level of formal education respectively. The inefficiency equation (5) can be estimated if the technical inefficiency and allocative inefficiency effects, Ui are stochastic and have particular distributional properties (Battese, et al, 1996).

4.3 *Description of the Fisheries*

The Pandam lake reserve *regulated* fishery is the only natural lake reserve inland water body in Nigeria that employs three major activities; *limit entry, mesh size restriction and a close season*. Current regulation requires mesh size to be at least 3.5 inches in diameter and a full closure is in effect from 1st June to 31st October every year and only 30 licensed fishers to fish every day for the period of open season in the fishery. The *unregulated* other natural lakes in the state have; no direct government control, the number of people going to fish at the lakes are unlimited, mesh size are not regulated, fishery is expose to poisonous fishing and fishing is done throughout the year.

5.0 Results and Discussion

5.1 *Descriptive Statistic*

The descriptive statistics of variables for the stochastic frontier estimations for both fisheries are presented in Table 1 and 2. The Results revealed that the average total value of fish caught by regulated fishers (obtained by adding cash receipt from selling of fish and those consumed by family and given as gifts) was ₦60,889.49 with a standard deviation of ₦24, 324.30, while the unregulated fishers had ₦56, 820.49 with a standard deviation of ₦13,650.80. The large value of standard deviation implies that the fishers were operating at different levels of exploitation which was confirm by the minimum value of ₦11,376.00 and maximum value of ₦131, 328.09 for regulated and the minimum value of ₦3,640 and maximum value of ₦87,360 for unregulated fishery, this tend to affect their output levels. For the regulated fishers, the minimum value of length of gears owned was 45.72

metres and maximum was 5943.60 metres. The mean length of gear owned was 1341.63 metres with a standard deviation of 1328.57 metres, while mean length of gear owned was 1821.05 metres with a standard deviation of 1633.25 metres for unregulated fishers. The variability in length of gears measured by the minimum, maximum values and confirm by standard deviation may be due to the high cost of fishing gears as was reported by fishers during the oral interview.

Table 1: Descriptive statistics of regulated micro entrepreneurs or artisanal fishers used in the analysis

Variable	Notation	Mean	S ± D	MIN	MAX
Average Total Catch (kg)		3815.94	1621.62	758.40	8755.20
Total value of catch (₦)	Y	60889.49	24324.30	11376.00	131328.09
Length of fishing gears (M)	E1	1341.63	1328.57	45.72	5943.60
Time of passive gears in water	E2	1046.77	1001.21	48.00	4920.00
Number of gears owned/fisher	E3	46.24	38.24	14.00	210.00
Age of the sampled fishers	Z1	38.51	11.61	20.00	75.00
Family size of fishers	Z2	6.51	4.26	03.00	15.00
Extension contact	Z3	18.57	11.68	02.00	55.00
Cost of malia trap used	c_2	8.05	6.27	00.00	13.00
		16062.71	1456.57	1200	60000
Cost of hook line used	c_3	9016.66	9371.66	1000	60000
Cost of gura trap used	c_4	7088.74	10132.40	70	50000
Cost of repairs/maintenance	c_5	7715.80	10139,8	90	55000
Cost of dep. on equipment	c_6	1503.55	3186.82	352	30000
Total cost of investment	c_t	46910	21452.81	14344	214528.10

Table 2: Descriptive statistics of unregulated micro entrepreneurs or artisanal fishers used in the analysis

Variable	Notation	Mean	S ± D	MIN	MAX
Average Total Catch (kg)		2841.52	687.54	1820	4368
Total value of catch (₦)	Y	56820	13650	3640	87360
Length of fishing gears (M)	E1	1821.05	1633.25	45.72	5943.60
Time of passive gears in water	E2	1072	878.29	288	3840
Number of gears owned/fisher	E3	53.8	39.81	15	160
Age of the sampled fishers	Z1	45.167	14.66	23	72
Family size of fishers	Z2	6.167	4.73	03.00	12.00
Extension contact	Z3	27.20	12.80	10.00	55.00
Formal educational status	Z4	8.05	6.27	00.00	13.00
Cost of malia trap used	c_2	4,997	5349	1000	24000
Cost of hook line used	c_3	4,663	2992	1500	15000
Cost of gura trap used	c_4	15,970	13832	2000	50000
Cost of repairs/maintenance	c_5	717	365	200	1500
Cost of dep. on equipment	c_6	7,042	11541	1210	66825
Total cost of investment	c_t	56,642	26546	22340	120225

5.2 *Productivity Analysis*

5.2.1 Technical efficiency

The maximum likelihood estimates of the stochastic frontier Production functions for regulated and unregulated fishers in the study area are presented in Table 3. The estimated coefficients of all the parameters of stochastic production function using translog specification is not necessarily meaningful in fisheries economics, however, the return to scale (RTS) from both estimates shows that the estimated elasticity's of the explanatory variables of the model shows that all the variables have decreasing function to the factors. The regulated and unregulated fisheries returns to scale (RTS) were 2.020 and 0.964 respectively, the decreasing return to scale at unregulated fishery points to the fact that fishing exploitation at the fishery was at the stage of economic optimum (in stage II) in the production surface. For the regulated fishers, an increasing rate of return, suggests that fishing at regulated site was not at the stage of economic or technical optimum. This shows the existence of a potential for expansion of the present scope of production/ harvesting to actualise the full economic potential of fishers which could result to the attainment of more output in regulated fishery. Furthermore, at unregulated fishery, the result shows that about 68% of variation in output of fish was due to their difference in technical efficiency.

The results of inefficiency model estimate suggested that there was no technical inefficiency existing in the regulated fishery, while educational level and extension contact were factors influencing fishers' technical efficiency at the unregulated fishery. Educational level and extension contact were significant and positive; indicating that increasing a unit of these factors can lead to decrease in technical inefficiency of fishers in an unregulated fishery. Specifically, educational status was statistically significant at 5% ($p>0.001$), suggesting that for an increase in one year of formal education there will be 14.4 % probability or chance of the micro entrepreneur or fisher being technically efficient. Also, extension contact was statistically significant at 5% ($p>0.01$), indicating that for a unit increase in extension contact there will be about 9% probability or chance of being technically efficient.

Table 3: Technical Efficiency estimate Using Translog Specification for both fisheries

Variable	Description of variables	Unregulated MLE		Regulated MLE	
		Coefficient	t-ratio	Coefficient	t-atio
E_0	Constant	5.560	5.27*	1.30	0.87
InE_1	Length of fishing gears (M)	0.290	1.72	0.820	4.9*
InE_2	Time of passive gears in water	0.470	1.21	0.520	1.3
InE_3	Number of gears owned/fisher	-0.150	-0.23	0.820	0.84
InE_1 InE_2	Length of fishing gears (M) x Time of passive gears in water	-0.022	-0.23	-0.098	-7.2*
InE_1InE_3	Length of fishing gears (M) x Number of gears owned/fisher	-0.034	-0.22	-0.270	-1.1
InE_2 InE_3	Time of passive gears in water x Number of gears owned/fisher	0.057	0.65	0.016	0.39
InE_1^2	Length of fishing gears (M) squared	-0.047	-0.31	0.089	0.32
InE_2^{-2}	Time of passive gears in water squared	0.100	0.55	0.120	0.599
InE_3^{-2}	Number of gears owned/fisher squared	-0.120	-0.75	-0.003	-0.0014
	Inefficiency model				
Z_0	Contant	1.85	-1.01	-0.220	-0.97
Z^1	Age of fishers	0.0097	0.35	0.050	-0.48
Z_2	Family size	0.083	1.27	-0.0023	-0.48
Z_3	Extension contact	0.092	-1.73**	0.058	-1.33
Z_4	Level of formal education	0.144	2.05**	-0.220	0.91
δ^2	Sigma square	0.340	2.81*	0.840	1.41
γ	gamma	0.680	4.48*	0.990	3962*
Log likelihood		-34.55		31.92	
LR test			16.84	23.5047	

(DF; 6, 095 = 12.59) *and ** significant at 1% and 5% respectively

5.2.2 Allocative efficiency

The allocative efficiency refers to the estimates of the parameters of cost functions model showing the cost minimisation abilities or otherwise of the fishers in both regulated and unregulated systems and presented in Table 4. The result of unregulated fishery suggested that about 78% variation in total cost incurred by micro entrepreneurs or artisanal fishers were as a result of the differences in their minimisation abilities, while, at regulated fishery about 99% variation in the total costs were incurred because of the differences in the cost minimisation abilities of micro entrepreneurs. The estimate of stochastic cost function using Cob-Douglass point to constant return to scale as expected.

At both fisheries, the coefficients of cost of repairs/maintenance of fishing crafts/gears E5, although insignificant were negative, suggesting excess use of variable. Furthermore, the estimated coefficients of all other parameters of the cost functions at both fisheries were positive. This implies that the variables (E1= cost of gillnets, E2=cost of malia trap, E3=cost of gura trap, E4=cost of hook line, E6 = depreciation on fishing crafts) used in cost analysis have direct relationship with total cost of fishing used for output realised. In other words, cost of fishing increases by the value of each positive coefficient as the quantity of each variable is increased by one. At the both fishery, the cost of hook line and cost of gillnets were positive and statistically significant at 1% ($p>0.001$); suggesting that increase in a unit of quantity of output could result in the probability of increasing cost of hook line by 24% and 3% for regulated and unregulated fishers respectively. Also, the result indicates that the variables of depreciation on fishing crafts (E6) were statistically significant at 5% in both fisheries.

The inefficiency estimated for unregulated fishery the coefficients of Age of fishers and extension contact were statistically significant at 5%, this is suggesting that as the fishers become older and as they make more extension contact their cost minimising efficiency increases. Furthermore, for regulated fishery, educational status also shows statistically significant at 5% level of significance, suggesting that for a one year increase in formal education, there will be a 4% probability increase in the fishers cost minimisation efficiency.

Table 4: Allocative efficiency estimate using Cob-Douglass specification for both fisheries

Variable	**Description of variables**	**REGULATED**		**UNREGULATED**	
		MLE		**MLE**	
		Coefficient	**t-ratio**	**Coefficient**	**t-ratio**
E_0	Constant	4.6	4.70*	7.08	13.99*
InE_1	Cost of gillnets,	0.06	3.72*	0.058	3.0*
InE_2	Cost of malia trap,	0.62	1.60	0.400	0.57
InE_3	Cost of gura trap,	0.22	0.02	0.102	0.16
lnE_4	Cost of hook line	0.24	3.02*	0.090	2.92*
lnE_5	Cost of Repairs/mainte.on gears	-0.46	-0.56	-0.06	-1.59
lnE_6	Depreciation on fishing crafts	0.32	1.9**	0.410	2.80*
	Inefficiency model				
Z_0	Constant	-0.03	-0.29	0.77	1.66
Z^1	Age of fishers	-0.27	-7.55*	0.044	-2.57**
Z_2	Family size	0.03	1.23	0.018	-0.37
Z_3	Extension contact	0.13	0.55	0.040	2.24**
Z_4	Level of formal education	0.06	2.74*	0.013	1.01
δ^2	Sigma square	0.20	0.63	0.14	3.03*
γ	gamma	0.99	138*	0.78	3.12*
log likelihood			42.88		25.89
LR test			129.1		29.50

df;6,095= 12.59 *and ** significant at 1% and 5% respectively

4.2.3 *Efficiency Score Distribution of Micro entrepreneurs*

4.2.3.1 Regulated Fishery

The regulated distribution of fishers according to deciles ranges and frequency distributions of technical, allocative and economic efficiency are presented in Table 5 shows that there was no fisher operating below 50%

technical efficiency level. Similarly, all the fishers were operating at 60% or more technical efficiency levels. The result further indicated that 76.67% of fishers were operating at 90% or more efficiency level. The mean technical efficiency score of fishers of regulated Pandam lake fishery was 92.50%. Allocative efficiency ranges between 40.21% -97.30% with a mean of 72.17% and economic efficiencies ranges from 40.11% - 96.42% with a mean of 68.12%. This result suggests that there exist a potential of 27.83% chance of improvement in the cost minimising abilities of regulated micro entrepreneurs.

The arithmetic means of the individual technical efficiency scores of 0.92 and allocative efficiency of 72.17% for regulated Pandam Lake fisheries can compare well with Lokina (2008) for Lake Victoria artisanal fisheries and Squires et al (2003) also found similar result, for the Malaysian gillnet fleets of artisan fishers. But these figures are comparatively higher than those found in Kuperan et al (2001) in Malaysian trawl fishery. These comparatively high efficiency scores are consistent with Schultz's (1964) thesis of "Poor and efficient" smallholders and peasant farmers in developing country agriculture.

Table 5 Deciles Range of frequency distribution of TE, AE and EE of regulated fishers

	TE		A.E		E.E	
Range	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
0.00-0.19	-	-	-	-	-	-
0.20-0.29	-	-	-	-	-	-
0.30-0.39	-	-		-	-	-
0.40-0.49	-	-	2	6.67	2	6.67
0-50-0.59	-	-	6	20	2	6.67
0.06-0.69	2	8	5	16.67	4	13.33
0.70-0.79	2	10	4	13.33	7	23.33
0.80-0.89	3	16	6	20	4	13.33
0.90-0.99	23	20	7	23.33	11	36.67
TOTAL	30	100	30	100	30	100
Min	6.74		40.21		40.11	
Max	98.32		97.30		96.42	
Mean	**91.52**		**72.17**		**68.12**	
St.D	18.11		11.18		8.91	

Return to scale	S. P.F		S.C.F
Variable	**Elasticity**	**Variable**	**Elasticity**
LnE1	1.300	LnE1	0.058
LnE2	0.520	LnE2	0.400
LnE3	0.820	LnE3	0.102
LnE1E2	-0.098	LnE4	0.090
LnE1E3	-0.270	LnE5	-0.06
LnE2E3	0.016	LnE6	0.410
LnE1	0.089		
LnE2	0.120		
LnE3	0.003		
RTS	2.020		1.00

5.2.3.2 Unregulated

The unregulated distribution of fishers according to deciles ranges and frequency distributions of technical, allocative and economic efficiency are presented in Table 6. And the result shows that there was no fisher operating below 30% technical efficiency level. Similarly, all the fishers were operating at 40% or more technical, allocative and economic efficiency levels. The result further indicated that about 71.25% of fishers were operating between 40-59% of allocative efficiency level. Their mean technical, allocative and economic efficiency score of fishers were 83.12%, 56.34% and 68.12% respectively. This result implies capacity of fishers to fished/harvest a predetermined quantity of output at a minimum cost is relatively low and that TE was contributing more to EE for the study area. It is therefore, pointing to the fact that there is higher potential for cost minimization among unregulated fishers than the regulated fishers in the study area.

Table 6 Deciles Range of frequency distribution of TE, AE and EE of unregulated fishers

	TE		**A.E**		**E.E**	
Range	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
0.00-0.19	-	-	-	-	-	-
0.20-0.29	-	-	-	-	-	-
0.30-0.39	-	-		-	-	-
0.40-0.49	2	02.50	37	46.25	10	12.50
0-50-0.59	10	12.50	20	25.00	25	31.25
0.06-0.69	21	26.25	15	18.75	30	37.50
0.70-0.79	37	46.25	6	07.50	10	12.50
0.80-0.89	10	12.50	1	01.25	5	06.25
0.90-0.99	2	02.50	-	-	-	-
TOTAL	80	100	80	100	80	100
Min	6.74		40.21		40.11	
Max	98.32		97.30		96.42	
Mean	**83.12**		**56.34**		**68.12**	
St.D	18.11		11.18		8.91	
Return to scale			SPF		SCF	
Variable			**Elasticity**	**Variable**	**Elasticity**	
LnE1			0.290	LnE1	0.058	
LnE2			0.470	LnE2	0.400	
LnE3			-0.150	LnE3	0.102	
LnE1E2			-0.022	LnE4	0.090	
LnE1E3			-0.034	LnE5	-0.06	
LnE2E3			0.057	LnE6	0.410	
LnE^1			-0.047			
LnE^2			0.100			
LnE^3			-0.120			
RTS			0.964		1.00	

6.0 Conclusion and Policy Implications

There is a possibility for improving economic performance through expansion using the present technology and existing resources at both the unregulated and regulated fishery. At unregulated fishery, from the perspective of equity and distribution improving efficiency is desirable; but improving efficiency at the unregulated at the moment when neither effort nor catch is limited could lead to further depletion of stock. One potential policy option would be the retirement of a number of individuals preferably those with efficiency scores of less, than 50%. Improving efficiency would then lead to similar catch levels with a smaller number of fishers. However, such a prescription may be problematic for two reasons firstly, it presupposes control at the state level, which are currently lacking. Secondly, it requires the decommissioning of a number of fishers and the unemployment of a number of fishers. In the absence of aggregate control of effort and exit of less efficient or part time fishers. The situation may be resolve by taking measures that properly redefine the property right of the fisheries. With such reforms, the government of Plateau state could potentially carry out a limited entry, which would provide efficiency improvements and sustainability on all lakes in the state. Furthermore, improving allocative efficiency by 42% is possible at regulated site, when fishers are educated. Finally, at regulated fishery, managers should take steps that will constraint fishing effort not to go beyond acceptable level.

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