Economic Efficiency in the Coastal Small-scale Fisheries in Lagos State, Nigeria

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Abstract: This study was aimed at assessing how efficient the small - scale fishing units in Lagos State, Nigeria use the monetary inputs: costs of gear repairs, craft repairs, fuel, fishing losses, hired labor, and the residual costs of craft and gear. Between January and December, 113 mechanized and 43 non-mechanized fishing units in 21 purposively chosen coastal villages were surveyed bi-monthly through questionnaire administration. The input and output (earnings) data were analyzed using the linear regression and Cobb-Douglas technique in monetary terms and Ordinary Least Square methods to determine the elasticities of the fishing units in the wet and dry seasons. The regression output for the non-mechanized category produced good fits for the yield models with adjusted R^2 values range of 0.88 in the wet to 0.98 in the dry seasons. The mechanized category showed respective regression outputs of AR^2 of 0.94 and 0.62. The Durbin-Watson statistic showed moderate multicollinearity amongst the chosen variable inputs. The non-mechanized category had three significant explanatory variables in the dry season while five were significant in the wet season at the 0.05 level. The mechanized category had significant F-ratio values at the 0.05 level in the seasons. The seasonal technical efficiency evaluated using the chosen cost variables showed that there was inefficient combination of the inputs for optimal production

Keywords: small-scale, efficiency, multispecies, subsidy, optimality, elasticity

1. INTRODUCTION

Over the years different governments in Nigeria have recognized the relevance of the fisheries sub-sectors, which are composed of the marine, brackish and freshwater. Several attempts were made over the years to boost their productivity through institutional reforms and the various fiscal and economic measures. Some of these measures involved tax exemption and input subsidy schemes for distribution to fishermen to stimulate increased production. Despite all these forms of external intervention the development plans, the fisheries sector still showed a deficit in the supply and demand of fish to the populace. It was also thought that the sub-sector was a temporary phase of transition to the industrial sector, but today the small-scale fisheries have come to stay as a permanent feature in the fisheries of developing nations worldwide, Nigeria inclusive. For Nigeria to have a meaningful fisheries development policy, information is required on the allocation and utilization of all the input resources or the resource use efficiency in addition to other economic data. The availability of such knowledge will assist the policy makers in pointing the right direction of future development or management.

Fisheries workers in different parts of the globe have worked extensively on the problems facing the development and management of - the industrial and small-scale - fisheries and their failures are indicators of the limitations imposed on research by the complex nature of the sector, artificial and natural. There are problems of the resource base (common property nature, easy entry, finite and renewable nature and open access), heterogeneity and variations in technology of extraction, characterizations, operations (lack of alternative form of employment, profit maximizing behavior, inter and intra competition, and dualism) and definitions from one location to the other. Some studies by Firth (1946, 1966); Norbeck (1954); and Gulland (1974,1979) highlighted some of these constraining problems.

1.1 Definition and Attributes of Small-scale Fisheries

Tredten and Hersoug, (1992) attempted a traditional definition of artisanal, small-scale, peasant and subsistence fisheries and used Smith's, (1979) classical definition for the purpose of generalization. Haakonsen, (1992) noted the ambiguity of the terms used to define artisanal fisheries in West Africa which he asserted are simpler to categorize as they are assumed to be the equivalent of canoe or pirogue fisheries. These include planked versions such as the "Ghana boat" in Sierra Leone, and to a very minor extent, fiberglass duplicates of traditional vessels such as the Nigerian "banana boat"(Haakonsen, 1992). A potential source of problem according to Haakonsen, (1992) is the question of distinguishing professional from part-time fishermen because a large number of the half a million canoe fishermen in West Africa are actually occasional fishermen. They fish either for subsistence or to supplement incomes derivable from other economic activities. These part-timers are characterized by the utilization of low cost craft, usually one to three - man canoes, and the employment of gear requiring relatively moderate capital investments. It should also be noted that when cross border migrant fishermen are considered, vessels and fishing technology alone can be confusing as some rely on fishing as their only economic activity, for example the Kru fishermen in Liberia. Alternatively, many Serer and Nyomka of Senegal using quite large motorized canoes for cross border movements with nets of substantial investment, spend most of the year growing rice in their home villages in Sine-Saloum. It is also necessary to look primarily at the contribution of fishing to the fisherman's household income, secondly, how much time and effort is put into fishing; and thirdly how he and others perceive him or whether his status in the community is that of a fisherman. Haakonsen, (1992) further affirmed that this should be regardless of whether this may be "high" or "low" in his particular society and the above assertions are of course difficult to determine statistically but they are normally easily observable.

Thompson, (1983), successfully compared the attributes of the fisheries of the industrialized and developing countries and elaborated that most developing countries fisheries have very large artisanal sections and these constitute both social and economic problems. The FAO (1979) enumerated the attributes of the artisanal fisheries of developing nations like Nigeria. Thompson, (1983) asserted that all the drastic resource failures of more than 30 years ago may have been due to the pressure of commercial fleets on artisanal fishing grounds, and then over-exploitation may well occur.

1.2 Relevance Of Models In Fisheries Development And Management And Their Limitations

Prediction models are necessary for fisheries administrators to foresee in advance the evolution of the resource abundance. This is necessary for development and management measures to be taken in time (Garcia and Le Reste, 1981). The production function model can be injected with the universal economic model, widely used in fisheries economics. The standard model assumes that there is an equilibrium point at which the development of the fishery will stop and where the economic profit will be nil. The existence, therefore, of natural variations in abundance involves the theoretical existence of a family of bio-economic models. The consequences will be fluctuations in profits and likely increases in overexploited fisheries (Garcia, 1984).

Caddy, (1983) noted differences between the multispecies tropical and steady state fisheries. The limitations of the use of stock assessment models that are geared towards the steady state fisheries for multispecies were observed by Pauly, (1979) using the Schaefer Growth model, for instance, takes care of virgin fishery expansion and the relationships or interactions are easy for single species fishery. Multispecies fishery on the other hand is a complex composition of fish species and technical interactions aside, when non-discriminatory gear is applied to such a fishery, total mortality that occurs is a function of stock abundance. One can get more than a hundred to two hundred species in a haul and changes in fishing intensity alter these ecological relationships of age, species, and overall biomass. This could lead to biological extinction of some species and expansion of some as exemplified in the Gulf of Thailand where flat fishes (Heterosomata sp) were kept in check by small prey fishes (Leiognathus equulus). Characterization, causes, symptoms and bio-socio-economic consequences of overfishing in multi-species fisheries have been defined by Pauly, (1984 and 1990). Pauly, (1987) characterized overfishing while Hardin, (1968), coined it the "tragedy of the commons" and this is when the lower bound of economic fishing is reached and fishermen will leave the fishery. McGoodwin, (1983) added that it is a happier state of affairs to maintain a fishery above the lower bounds of economic and biological overfishing. Aguero, (1987), asserted that in quantitative terms, overfishing or excessive effort is not new and is the "turning point" in the yield levels of an exploitable fishery resource. In management terms, it is the last signal calling for regulations or controlling measures. He believed that the theoretical foundations, manifestations, causes and effects are not yet fully or consistently defined for management purposes. Clark, (1976) and Waugh, (1984), have distinguished between biological and economic overfishing. Biological "overfishing" is any level of effort which prevents the stock from generating the maximum sustainable yield. Waugh, (1984), Bailey, (1987) and Pauly, (1987) believed that overfishing is essentially an economic problem with strong social and biological implications. Chumpol, (1987), McGoodwin, (1983) and Aguero, (1987), Bailey, (1983,1987), and Firth, (1966) are some of the workers who elucidated on some of the consequences of social overfishing. Since Gordon's first formalization of the economic theory of a 'common property' in 1954, (Clark, 1976, 1985), "economic overfishing" has generally been loosely defined and handled in empirical works without clear recognition or account of several important elements. Aguero (1987) added the inherent nature of fisheries as the causes of overfishing McGoodwin (1983) mentioned a high population while Pauly, (1987) blamed fish biologists or politicians. The fishery biologists advice on recommended and adopted levels of management techniques like total allowable catches, licenses, and quotas in fishery bulletins in steady state fisheries of the world.

Three examples were described where a number of models routinely used by fishery biologists to formulate management advice have the common feature of positing management goals that induce overfishing viz.:(1) Using erroneous techniques for fitting surplus yield models to time series of catch - and effort data e.g. production models by Schaefer, (1957) or Fox, (1970). These apply to single species fisheries but are applied to multispecies fisheries also. Gulland, (1969) also noticed that example. The use of Arithmetic mean (AM) or predictive regression for their catch per effort versus effort plots. This regression type assumes that the data on the abscissa scale i.e. effort is to be measured without error (Ricker, 1973) which is clearly unrealistic. Instead, Pauly (1987) suggested the use of Geometric mean (GM) or functional regression.

(2) Estimating optimum mesh sizes from length - per recruit analysis based on the assumption of knife-edge selection. Here, Beverton and Holt, (1957) assumed that a gear like trawl is knife - edged. This is not realistic in the small fish typical of tropical demersal stocks.

(3) Continuing the use of Gulland's equation for potential yield estimates. Gulland, (1970) proposed that the fishing mortality generating MSY (= F_{msy}) should be approximately equal to M. M is the rate of natural mortality in a stock, and based on this assumption used the proceeding equation

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MSY = 0.5 x M x unexploited biomass............ (1)

Where MSY = Maximum Sustainable Yield

M = the rate of natural mortality in a stock

The above equation (1) has been used to estimate (potential) MSY in a variety of tropical stocks. A mean value of M is extremely hard to define. Francis, (1974), Beddington and Cooke, (1983) have shown that it is grossly misleading, this model is still universally used. They showed that F_{msy} = M applies only in fishes with low values of M. such as North Sea plaice and F_{msy} is much smaller than M when the latter is high. This is because it occurs in the small short-lived species characteristic of tropical waters (Pauly, 1980).

Padilla and Charles (1994) defined bio-economic models as quantitative models characterized by the integration of the natural and human sides of the fisheries equation, linking the biological and economic elements. They identified the behavioral and optimization models and noted the challenges of bio-economic models in tropical capture fisheries, which are multiple gears and technological inter-relationships in the harvesting process with limited selectivity. From the failures of the past biological models it was affirmed that bio-economic models can address three complexities that characterize tropical fisheries where pervasive overexploitation is rife: the multispecies nature of the fisheries resource, the multi-objective nature of the exploitation and management, and the multifaceted independent nature of the fishery system as a whole.

Waters, (1991) reviewed the incentives of the open access to overfish using the earlier arguments of Hardin, (1968) and defined the different types of externalities based on studies by Gordon (1954); Scott, (1955); Cheung, (1970); Bell, (1978); Christy, (1978); and Anderson (1986). Complete and detailed studies on the economic inefficiencies of open access regulations were done by Crutchfield and Zellner, (1963): Crutchfield and Pontecorvo (1969); Bell, (1978); Christy, (1978); Anderson (1986) and Hanneson (1989). Different forms of restricting access to a fishery have been discussed in details by Rettig and Ginter, (1978); Rettig, (1984); Mollet (1986); Huppert (1987); Clark et al, (1988); Geen and Nayar, (1988); and Townsend (1990). Other less frequently mentioned alternatives include territorial use right (TURF) by Christy, (1982), Smith and Panayotou, (1984) and sole ownership (Scott, 1955 and Keen 1988).

Much has been written locally about the Nigerian fisheries by Longhurst, (1960a, 1960b, 1962,1963 and 1964a); Bayagbona (1965); Fagade, (1969); and Bayagbona (1973); Tobor (1973, 1990, and 1993); Troadec, (1982); Kusemiju (1981, 1991 and 1993); Nsetip (1983); Ajayi and Talabi (1984); Akinyemi et al (1986); and Elliot (1993). These workers concentrated mainly on the inter-relationships between the biological characteristics of the various fish species and their abundance and hence catchability. Mabawonku (1979, 1981 and 1986) however placed attention on the economics of fishing as a business concern and, the public policies (interventions) that affect returns to the fishing operators. The goal of this study was to determine the economic efficiency through the variable cost components, the impacts of seasonality and outboard engine mechanization and the policy implications of the findings in the small-scale fishing operations of Lagos State, Nigeria.

2. AREA OF STUDY

Lagos State lies to the southwestern part of Nigeria and has boundaries with Ogun State both in the north and east. It is bordered on the west by the Republic of Benin and in the south and stretches for 180 km. along the coast of the Atlantic Ocean. It therefore has 22.5% of Nigeria's coastline and occupies an area of 3,577 sq. km. landmass with 786.94 sq. km. (22%) of it being lagoons and creeks in Lagos, Ikorodu, Badagry and Epe. The State is endowed with marine; brackish and fresh water ecological zones with varying fish species that provide productive fishing opportunity for fishermen. FAO (1967 - 1971) survey showed that at the inception of the State's creation, there were about 30,000 actively engaged fishermen with manual gears and crafts. Of the many policies inherited from the old Western Region, the canoe mechanization subsidy scheme was continued with at a period when catches were poor and morale and income very low.

A survey by the Lagos State's Ministry of Agriculture and Natural Resources (MANR) in 1985 showed that glass reinforced boats was yet to be adopted in the State but three types of craft were in use. These were:(1) Ghanaian dugout canoes with planked free boards (2) smaller local dugout canoes (3) local planked canoes. The outboard engines used were of numerous brands with a range of horsepowers from 5 to 55 HP. The gears in use were:-(1) gill nets which could be surface or bottom, set, drifting and/or encircling, (2) beach seines could be of 200 to 800 meters length, (3) cast nets, (4) hooks and lines, (5) stream weirs and, (6) traps (Udolisa and Solarin, 1979).

The Ghanaian dugout canoes ranged from 8 - 12 meters length over-all (LOA) with beach seine as fishing gears. The canoes were made from silk samba trees (Triplochiton scleroxylon) in the western zone. The local dugout canoes had LOA range of 6.1 - 8 meters from silk cotton trees of Ceiba penitandra and ironwood (Lophira alata) used by marine and inland gill net operators. Planked canoes of 5.5 - 8.5 meter LOA were also being used for gill netting, long lining and shark fisheries in the eastern zone. Woods used were Terminalia sp (white or black afara), Mahogany (Khaya ivorensis) or silk cotton tree of ceiba. The nettings were of mesh sizes with ranges of 9 to 38 and 38 to 51 mm. In the codend, bunt and wings of beach seines; 24 to 52 mm. for encircling gill nets; 41 to 305 mm. for set gill nets and 300 mm. for shark nets. The crew of the marine encircling net was made up of seven to fifteen while for the beach seine net crew it was 20 to 50.

3. METHODOLOGY.

The traditional fishing operations used for this study were in the coastal and brackish water fisheries and the survey was carried out through questionnaire administration between January and December 1991 in 21 predominantly fishing villages. Since the fishing population is made up of indefinite strata with differing characteristics and each stratum has a proportionate ratio in terms of number of fishing units to every other stratum the villages were purposively chosen for being active fishing locations. The multispecies nature limited our choice and preference for certain economically viable and targeted fish families therefore the landings chosen for the survey were from the families of Sciaenidae (croakers), Polynemidae (threadfins), Carangidae (bumpers), Ariidae (sea catfishes) and the Clupeidae (sardines). The choice of these fish families was based on past studies by Nsetip (1983); Ajayi and Talabi (1984); FDF (1985, 1988 and 1990) and Akinyemi et al (1986) who observed the predominance of these fish families in artisanal landings.

Table1: Distribution of the Respondent Fishing Units

Villages	No.	%	Gear Types	Fishing Gears
1) Okunfolu	22	14.1	Gillnet	Plank canoe
2) Okegelu	3	1.92	Gillnet	Plank canoe
3) Okun Ise	9	5.77	Gillnet	Plank canoe
4) Imedu	1	0.64	Gillnet	Plank canoe
5) Akodo	5	3.22	Gillnet	Plank canoe
6) Idasho	10	6.44	Gillnet	Plank canoe
7) Lekki	9	5.77	Gillnet	Plank canoe
8) Igbekodo	5	3.22	Gillnet	Plank canoe
9) Apakin	6	3.85	Gillnet	Plank canoe
10)Osoroko	10	6.44	Gillnet	Plank canoe
11) Otolu	10	6.44	Gillnet	Plank canoe
12) Oringanrigan	5	3.22	Gillnet	Plank canoe
13) Olomowewe	5	3.22	Gillnet	Plank canoe
14) Ikare	1	0.64	Beach Seine	Local dugout
15) Ibeshe	1	0.64	Beach seine	Local dugout
16) Liverpool*	4	2.6	Setnet	Plank canoe
17) Ashikpa	12	7.69	Beach Seine	Ghanain type
18) Agbonrin	7	4.49	Beach Seine	Ghanain type
19) Sakpo-Beach	13	8.33	Beach Seine & Gillnet	Ghanain type
20) Sakpo-Falola	1	0.64	Beach Seine	Ghanain type
21) Gbagi-Aivoji	3	1.92	Beach Seine Gillnet	Local dugout
22) Ajido-Vivi	14	9.0	Beach Seine Setnet	All above types
Total : 160				

* Omitted from the study

The primary data were collected using a purposive sample of one hundred and fifty six (156) respondent fishing units with considerations given to the common problem of seasonal redeployment of craft and gear types. A "fishing unit" herein is defined as one particular combination of type of craft, gear and the crew. Initial samples were collected on the stock of the fishing units with the cooperation of the Lagos State Agricultural Development (LSADP) agents in the villages. Information gathered were fishing inputs' sizes, life span, (yrs.) and types viz: length of boat, (m.), area and types of net (m^2), outboard engine, ownership, capacity and types. Based on the ownership of outboard engines, the respondent fishing units were categorized into two with 113 mechanized and 43 non-mechanized. Table1 shows the distribution of the respondent units during the survey period.

The data collection was done on a fortnightly basis by the field enumerators who made actual observations of the fish sales transactions at the landing jetties. This enabled them to record the prices, quantities and types of fish landed and the general marketing situation. They additionally extracted information from the fishermen about the conditions at the fishing grounds, weights of the different species/families of interest to the study frame. Thereafter at a time most appropriate and convenient to the sample unit owner(s), the enumerators visited the household(s) and canvassed for details relating to the costs and earnings of the fishing trip(s). The data collected were directly entered into the schedules. After the monthly data were collected, the enumerators added the figures and entered them as the monthly totals. All the input data collected during the survey were standardized and processed using two weeks (14 days) of good fishing period as the yardstick of a monthly operation. The extrapolated monthly data were averaged and thereafter multiplied using the above factor of fourteen (14). Data processing on the variable costs (gear repairs, craft repairs, fuel, losses incurred during fishing, hired labor), earnings and total fishing effort, actual fishing time, voyage time, number of non-owners fishing were analyzed. The findings to be presented later are the results of analysis of the data in their highest state of consolidation at the monthly and seasonal levels.

3.1 Theoretical Consideration

Ogunmoroti (1989) quoting Smith (1982) asserted that the choice of the explanatory variables to include and the appropriate functions depends largely on the assumption underlying the biological relationships in the production process. Frederick et al (1985), and Panayotou (1985) described the stock and fishing effort as the two major variables of relevance in the consideration of the production function. A production function can therefore be specified on the basis of these two variables as follows;

$Q = f(s, e, E_i)$………………………… (2)

Where Q = catch

s = fish stock

e = fishing effort

E_i = error term

Khaled (1985) and Panayotou (1985) added that a fish stock could be assumed fixed for a given fishing season. The variation in catch will therefore be solely due to the variation in effort applied. This is implied in the above specification of equation (1). The fishing effort is however a composite input which could be broken into its component elements of capital, labor, time spent at sea, actual fishing time, length of craft, area of gear, depth of fishing, weather conditions at sea and on land. The capital item in particular can be broken down into costs of gear and craft, maintenance and repair of gear and craft types, depreciation, insurance, taxes, hired labor, fuel and other miscellaneous expenses. The present paper however concentrated on costs of labor, maintenance and repairs, fuel, losses (to craft and gears) during fishing; and the residual costs of craft and gears. In addition, length and area of craft and gears, actual fishing time, number of hired hands fishing and total voyage time were considered in explaining the variations in output of the fishing units whether mechanized or not. This can be stated implicitly as:

$Q = f(X_1, X_2, \ldots Xn, E_i)$ ……. (3)

Where

Q = an index of catch from summation of quantities of individual species caught in kg. and weighted by their prices.

X_1 = cost of gear repairs
X_2 = cost of craft repairs
X_3 = fuel cost (where applicable)
X_4 = cost of losses incurred during fishing trips
X_5 = hired labor cost
X_6 = residual cost of craft
X_7 = residual cost of gear
X_8 = actual time spent fishing (hrs.)
X_9 = boat length
X_{10} = area of gear
X_{11} = total voyage time
X_{12} = numbers of non-owners fishing
X_{13} = outboard mechanization (where applicable)

This relationship can be quantified by making equation (3) explicit and the ordinary least squares technique can then be employed to estimate the functions. The power function (Cobb-Douglas) had however been used in Asia (Thailand) for capture fisheries production by Panayotou (1987) and Rungrai et al (1987). In Nigeria Okiya and Oguru, (1991) related catch to the components of fishing effort with specifications of the variables in monetary terms for their study of artisanal fisheries while Olomola (1992) used the production function for the mechanized and non-mechanized small- scale fisheries in Ondo State, Nigeria. They estimated the Cobb-Douglas function as

$LnQ = Lna1 + LnX1 + a2\, LnX2 \ldots + LnXn$ … (4)

The ease of estimation of the physical marginal product (MP) of the fishing inputs, production elasticities, returns to scale/economies of scale, technical and economic efficiencies are some of its advantages (Panayotou et al., 1982). Ogunmoroti, (1989) however enumerated some of the disadvantages of the power function as constraining the elasticity of substitution between inputs to be always equal to one. This study made use of this power function in spite of this demerit alongside the linear function. Using the ordinary least squares techniques (OLS), equations (3) and (4) were estimated for the two fishing categories and seasonality. The results obtained from equations (3) and (4) were used to achieve the objective of economic efficiency with respect to the variations in the categories of mechanized and non-mechanized in the seasons. The choices of the variables included in the above models were based on the exploitative technology of fish production among the small-scale fishermen in Lagos State, Nigeria. The resultant adjusted R^2 determined which model fitted the analysis closely, that is, the one that gave the best fit with the higher adjusted R^2.

The outputs of regression analyses for either the mechanized or non-mechanized fishing units in the seasons (wet and dry) were further tested for multicollinearity due to the number of the variables used. Kane (1969) asserted that multicollinearity arises whenever, either in the population or in the sample, several of the explanatory variables stand in an exact or almost exact relation to each other. The greater the degree of multicollinearity that obtains, the more arbitrarily and unreliably does least squares allocate the sum of explained variation among the individual explanatory variables. It is regarded as a black mark that reduces our confidence in conventional tests of the significance of the various coefficients. To solve this problem a Durbin Watson statistic was employed.

Based on the formula of Harcourt, (1972), rental value of the cost of fishing, k, was calculated as:

$$k = \frac{n + rk}{1-(1+r)} \text{ .... (4)}$$

where

k = acquisition cost of fishing inputs (canoe, fishing gear).

n = life span of boat and gear.

r = interest rate (at 30% per annum).

4. RESULTS AND DISCUSSION

Efficiency is defined within the context of this study as the success of a firm (fishing unit in this case) to produce as large an output as possible from given sets of inputs. Three forms of efficiencies, which are (i) technical, (ii) price and (iii) over-all efficiencies can be described. Technical efficiency is the ratio that measures the firm's success in terms of the choice of the level of inputs that will ensure maximum output through elasticity of inputs, returns to scale (economies of scale) and the marginal physical products (MPPs). Price efficiency is the part played by the relative prices of the different inputs in the productions of units of outputs. This is the relationship between the value of the marginal product (VMP) of the various inputs and the individual input prices. Rungrai et al, (1987) asserted that price efficiency is also a necessary condition of profit maximization. Over-all efficiency however, indicates the cost per unit of output for perfectly efficient firm both technically and economically and this in other words is dealing with the productivity of the firm. Maximum profit is obtained when input is used at the level that gives rise to equality between the value of its marginal product (VMP) and its price. If this equality were not satisfied, an increase in those inputs for which VMP is greater than price and a decrease for those, which VMP is less than price, would increase profits. The performance of the firm is viewed as an input-output system and this makes the measures of efficiency easy as a ratio of output to input.

The extent of input interaction was investigated by attempting to explain variations in Total Divisible Earnings (TDE) through aggregate linear and functional equations specified above. Distinctions were made between the wet and dry seasons for the mechanized and non-mechanized. In addition, it was possible to calculate the value of the marginal product of inputs without observable prices such as actual time spent fishing, number of non-owners engaged in fishing, voyage time, boat length and area of gear. The mechanized category responded to the Cobb-Douglas function while the linear regression technique was employed for the non-mechanized category. To use the linear regression technique for the determination of the value of the marginal product (VMP) for the non-mechanized category, each of the partial regression coefficients from the linear regression output was treated with a partial differentiation. This involved using the formula below (Koutsoyiannis, 1979) viz. ;

$$Bi = bi \, {}^{sx}/_{sy} \qquad (5)$$

$$bi = {}^{dy}/_{dx} \, . \, {}^{x}/_{y} \qquad (5i)$$

$$= bi \, {}^{x}/_{y} \qquad (5ii)$$

where Bi = partial regression coefficient

bi = beta regression coefficient

x = mean of variable input X e.g. cost of labor.

y=mean of dependent variable (Total divisible earnings).

The resultant output is devoid of the test of multicollinearity in the case of linear regression technique. The output of the partial coefficients is presented in Table 2.

Table 2: Result of the Linear Regression technique for the Non-mechanized Category in Lagos State, Nigeria. (1991)

Variables/ Seasons	Dry	Wet
Constant	na.	na.
	(14809.4)	(1239.27)
X_1 – Gear repairs cost	0.03	-0.44
	(2.00)	(1.15)
X_2 – Craft repairs cost	0.03	0.47
	(1.87)	(1.41)
X_3 – Fuel cost	-	-
X_4 – Cost of fishing losses	0.03	0.36
	(0.99)	(0.91)
X_5 – Hired labor cost	0.33	0.08
	(0.65)	(0.65)
X_6 – Residual cost of craft	0.04	-0.03
	(53.64)	(31.01)
X_7 – Residual cost of gear	0.08	-0.37
	(130.75)	(48.05)
X_8 – Actual time spent fishing	0.11	0.25
	(91.49)	(64.13)
X_9 – Boat length	-1.84	0.61
	(12401.54)	(1018.81)
X_{10} – Area of gear	0.04	0.02
	(0.52)	(0.28)
R^2	0.98	0.91
Adjusted R^2	0.97	0.88
Durbin Watson Statistic	-	-
F – Ratio Calculated	109.22	35.37
df	9	9
N	43	43

( ) Figures for the standard errors of the b- coefficients
Source: Survey Data

4.1 Efficiency Of Resource Use - Technical Efficiency
4.11 Non-mechanized Category

The non-mechanized category in the dry season in Table 2 shows that the eight explanatory variables with positive coefficient values ranged from 0.04 to 0.11. This implies that if the units of these explanatory variables were individually increased by 1%, earnings of the non-mechanized category in the dry season would expectedly increase by a range of 0.04 to 0.11%. The explanatory variables jointly combined to 97% of the adjusted variability observed in total output during the dry season.

Six explanatory variables with positive coefficient values in the wet season ranged from 0.02 to 0.61. The implication for these variable inputs is that if these explanatory variables are individually increased by 1%, it is expected that the output or earnings of the non-mechanized fishing operators will increase within a range of 0.02 to 0.61%. This means that for optimal output, all the variables with the positive coefficients could still increase the units of their individual contribution to the production of the fishing units because the variable cost inputs were underutilized (Table 2).

The only explanatory variable with negative coefficient in the dry season was the boat length with a value of -1.84 and this meant that for a unit change in the utilization of this variable input by 1%, it was expected that earnings of the fishing units in this category would decrease by 1.84%. The three variable inputs with negative coefficients in the dry season were between - 0.03 to - 0.44 (Table 2). This means that for a unit increase in the individual explanatory variables by 1%, it is expected that the three explanatory variables will decrease earnings of the respondent units within a range of 0.03 to 0.44%. The implication of this is that each of the three explanatory variables have been individually overutilised in the harvesting of yield by the non-mechanized operators and they therefore need to cut down on the individual contribution of the input variables for optimality in their fishing operations.

The linear regression output for the wet season gave an estimated adjusted R^2 value of 0.88 while that of the dry was 0.97. The F - calculated values at the 0.05 and the 0.01 levels showed that there were significant and highly significant differences at both levels of probability during the two seasons. This implies that the chosen regression model had a very good fit (Table 2).

Table 3: Result of the test of significance from the linear Regression technique of the Non-mechanized category in Lagos State, Nigeria. (1991)

Variables/ Seasons	Dry	Wet
Constant	1.71	0.8
X_1 – Gear repairs cost	0.52	2.65**
X_2 – Craft repairs cost	1.54	7.03**
X_3 – Fuel cost	-	-
X_4 – Cost of fishing losses	0.52	0.2.4*
X_5 – Hired labor cost	15.55**	0.85
X_6 – Residual cost of craft	1.03	-0.31
X_7 – Residual cost of gear	0.87	-1.7*
X_8 – Actual time spent fishing	-1.27*	0.82
X_9 – Boat length	-0.43	2.35*
X_{10} – Area of gear	2.9	0.45
Table t-values at 5%	1.681	
Table t-values at 1%	2.42	

- (*) Significant at 5%
- (**) Significant at %
- Source: Survey Data

Results of the t – test in Table 3 show that three variables were significant at the 5% level while hired labor cost and area of gear were highly significant at the 1% level in the dry season. In the wet season, the costs of gear repairs and craft repairs were highly significant at1% level while the cost of losses incurred during fishing, residual cost of gear and boat length were also significant at the 5% level.

Table 4: Result of Cobb-Douglas Technique of the Mechanized category in Lagos State, Nigeria. (1991)

Variables/ Seasons	Dry	Wet
Constant	11.67	6.52
	(4.3)	(1.27)
X_1 – Gear repairs cost	0.06	-0.00284
	(0.13)	(0.04)
X_2 – Craft repairs cost	-0.31	0.1
	(0.19)	(0.13)
X_3 – Fuel cost	-0.0057	-0.16
X_4 – Cost of fishing losses	0.09	0.14
	(0.09)	(0.07)
X_5 – Hired labor cost	0.55	0.45
	(0.09)	(0.06)
X_6 – Residual cost of craft	-0.06	-0.1
	(0.26)	(0.08)
X_7 – Residual cost of gear	0.05	0.04
	(0.31)	(0.17)
X_8 – Actual time spent fishing	-0.21	- 0.1
	(0.12)	(0.09)
X_9 – Boat length	-1.1	0.01
	(0.33)	(0.02)
X_{10} – Area of gear	0.38	- 0.04
	(0.18)	(0.05)
X_{11} – Total voyage time	-0.37	-0.05
	(0.33)	(0.09)
X_{12} – No. of non-owners fishing	–0.53	0.09
	(0.34)	(0.08)
R^2	0.71	0.95
Adjusted R^2	0.62	0.94
Durbin Watson Statistic	2.19	2.21
F – Ratio Calculated	7.26	106.22
df	11	11
N	113	113

( ) Figures for the standard errors of the b- coefficients
Source: Survey Data

4.12. Mechanized category

In the dry season five explanatory variables with positive coefficients ranged from 0.05 to 0.55 (Table 4). The implication of these positive coefficients is that if the five variable cost inputs were individually underutilized and in order to optimize catches of the fishing operators, there is need to increase them individually for efficiency of resource use. The explanatory variables in the dry season with negative coefficients are seven and they were (i) cost of craft repairs, (ii) fuel cost, (iii) residual cost of craft, (iv) actual time spent fishing (hrs), (v) boat length, (vi) total voyage time (hrs), and (vii) the number of non-owners engaged in fishing with a range from -0.0057 to -1.1 (Table 4). This means that if any of the above seven variable coefficients was individually increased by a unit change of 1%, it is expected that the earnings of the fishing operators will decrease by a range of 0.0057 to 1.1%. The implication of these decreases in expected earnings with respect to elasticity is that the above seven explanatory variables have been exhausted and for efficiency of resource use, these variable inputs will need to be reduced.

There were six positive coefficients from the regression output in the wet season. The implication of the positive explanatory variable coefficient values is that the six were individually underutilized and in order to maximize earnings of the fishing operators the six explanatory variables needed to be increased. The Cobb-Douglas output gave an adjusted R^2 value of 0.62 while the higher F-calculated of 7.26 was higher than the table value implies that there were significant differences at the 0.05 level and that the chosen regression model had a good fit. The test of multicollinearity showed that there was slight or moderate overlapping or disturbances amongst the explanatory variables with the Durbin Watson statistic value of 2.19 (Table 4).

In the wet season, six explanatory variables with positive coefficients were (i) cost of craft repairs, (ii) cost of losses incurred during fishing, (iii) cost of hired labor, (iv) residual cost of gear, (v) boat length (m.), and (vi) number of non-owners engaged in fishing. The values of these coefficients ranged from 0.01 to 0.45 (Table 4). This range of values means that if the six explanatory variables enumerated above were individually increased by a unit change of 1%, they are individually expected to increase earnings of the mechanized units within a range of 0.01 to 0.45%. Six explanatory variables with negative coefficients were (i) cost of gear repairs, (ii) fuel cost, (iii) residual cost of craft, (iv) actual time spent fishing (hrs.), (v) area of gear (m^2), and (vi) total voyage time (hrs.). The negative coefficients ranged from -0.0028 to -0.16 and this range of values means that if the six negative explanatory variables were individually increased by a unit change of 1%, they were individually expected to decrease the earnings of the fishing units by their respective coefficients within a range of 0.0028 to 0.16%. The implication of these negative coefficient values of the six variable inputs is that they have been overutilised and in order to optimize the fishing operations, these explanatory variables' units need to be reduced for efficiency of resource use (Table 4).

The regression result in Table 4 shows an adjusted R^2 value of 0.94 and we may therefore conclude that we have been able to explain 94% of all variations in the value of earnings amongst the mechanized fishing units. The overall F - ratio is significant at the 0.05 level and, additionally, highly significant at the 0.01 level of probability and this is means that the chosen regression model had a good fit. The Durbin Watson statistic value is 2.21 and this implies that there is limited or moderate multicollinearity amongst the chosen explanatory variable inputs (Table 4). In Table 5, the t-test shows that the actual time spent fishing and area of gear are statistically significant explanatory variables at the 0.05 level while hired labor cost and boat length are in addition highly significant at the 0.01 level in the dry season. In the wet season, the costs of fuel and losses incurred during fishing were statistically significant at the 0.05 level while the cost of hired labor was, in addition, highly statistically significant at the 0.01 level.

Table 5: Result of the test of significance (t-test) from the Cobb-Douglas technique of the Mechanized category in Lagos State, Nigeria. (1991).

Variables/ Seasons	**Dry**	**Wet**
Constant	2.71	5.16
X_1 – Gear repairs cost	0.43	-0.07
X_2 – Craft repairs cost	-1.62	0.79
X_3 – Fuel cost	-0.02	2.23*
X_4 – Cost of fishing losses	0.97	1.87*
X_5 – Hired labor cost	6.17**	7.55**
X_6 – Residual cost of craft	-0.24	-1.28
X_7 – Residual cost of gear	0.17*	0.23
X_8 – Actual time spent fishing	-1.71*	-1.06
X_9 – Boat length	-3.37**	0.80*
X_{10} – Area of gear	2.17*	-0.91
X_{11} – Total voyage time	-1.12	-0.61
X_{12} – No. of non-owners fishing	-1.54	1.13
Table t-values at 5%	1.66	
Table t-values at 1%	2.3622	

- (*) Significant at 5%
- (**) Significant at %
- Source: Survey Data

5. CONCLUSION AND POLICY IMPLICATIONS

The fisheries resources are renewable if given time to recover from overexploitation. This ability of the water body to rejuvenate its stock is feasible but difficult because of societal needs derived from the resources like food, security and income generation. The difficulty of development and management is not only artificial but, additionally natural because water bodies have inherent factors - though controllable - which can induce pressure on the resources and therefore increase the risk of overfishing. This trend does not augur well considering the fact that fishing is a way of life in the respective communities either for income generation at one end of the spectrum to the other extreme of food security. Additional complications are the number and disparity of priorities and objectives choices for fisheries development and management. Nigeria with a large rural population that is dependent on the resource for subsistence, income earnings and employment therefore pursues management options of increased access contrary to rational biological or economic principles.

Nigeria including Lagos State had a developmental policy with long run implications for management of subsidy on inputs, outboard engines for small-scale fishing units for instance. The argument for and against this policy raged on while the subsidy scheme was implemented but due to the present state of the national economy, it has been discontinued. Non-economic arguments lie on the premise that the fishing industry is a peculiar one and that the attributes of fishermen are mostly unquantifiable and therefore makes non-economic issues crucial in addition to the considerable negative consequences for fishermen. The regression output in most cases could be rationally explained, for instance, the over-utilization of variables like fuel cost, actual fishing time and total voyage time in the dry season by the mechanized category of fishing units. It could be adduced that conditions of fishing during this season were more favorable unlike in the wet season when the fishing units expectedly had to face adverse weather conditions and had to cut back on the hired hands for their operations or the unwillingness of hired hands to participate during this adverse season.

5.1 Findings And Their Policy Implications

From the above results and discussions, there were eight underutilized explanatory variables in the operation of the non-mechanized category while the mechanized units had five underutilized explanatory variables in the dry season. The only over-utilized variable for the same season by the non-mechanized units had three over-utilized variables and the mechanized had six over-utilized explanatory variables. This trend shows that only one variable boat length was over-utilized by the non-mechanized category while the mechanized category, had seven which were the costs of craft repairs, fuel cost and the residual cost of craft, actual time spent fishing, boat length, total voyage time and the number of non-owners fishing. In the wet season, the non-mechanized and the mechanized categories had six underutilized variables each and the fishing operators were not efficiently combining the variable inputs for optimal production but the mechanized category of fishing units showed a relative advantage with respect to their ability to use their variable inputs more efficiently than the non-mechanized in either of the seasons.

The cost of losses during fishing was significant for both categories of operators in the wet season. To forestall this immense losses in cost terms in the wet season, an insurance scheme could be initiated at the community level by either the State Government or innovative private insurance companies in order to augment these losses apart from the adoption of the reinforced glass fiber boats for easier beach launching where surf conditions are heavy and dangerous. The variable costs of gear and craft repairs were significant during the wet season for the non mechanized category of operators and to alleviate the burden of these explanatory variable costs, it is suggested that the Lagos State Fisheries administration could rejuvenate the training workshop on a consistent basis on knowledge, skill and practice of boat building, repairs and outboard engine parts fabrication so that the fishing operators could actualize the repairs themselves. In the dry season, the mechanized category had six significant cost components like hired labor, cost of craft repairs, cost of losses during fishing, the residual costs of craft and gear in addition to two variable inputs without observable prices. In the wet season, seven important cost variable inputs were significant apart from the residual cost of craft, which was the only insignificant cost component.

The mechanized category showed that hired labor cost as a variable input was highly significant in the dry, and wet seasons. It was only in the dry season that the cost of losses incurred during fishing did not have significance while fuel cost was significant only in the wet season. As has been shown earlier, the economic regression output showed cases where important variables were not significant in either the seasons. The conclusion for these anomalies could be the unseen effects of unquantifiable elements, which control the harvesting production of fishing operations.

If ultimately we are to achieve some of the laid down objective of fisheries in Lagos State like to encourage gainful employment, as a way of life and for income generation, preferential pricing system could be given to small-scale fisheries operators as it is done for the more capital-intensive industrial sector. The disbursement of essential inputs through subsidization could motivate the morale of the non-mechanized operations to expand or shift their level of operations to outboard mechanization. This further buttresses the need by the Lagos State Government to resuscitate the defunct subsidy or canoe outboard mechanization scheme, which should be implemented with the known variations in the fishing intensity in the respective villages. Advantages of outboard mechanization have been shown by the disparity between the differences in resource extraction capabilities through greater range of fishing locations, higher maneuverability when fishing and the possibility of multiple fishing operations in a single day. This trend confirms the need by the Lagos State fisheries authorities to initiate fisheries policies that can induce new investments and by an awareness of the possible higher returns for the fishing operators through an improved and re-organized extension services programs which could recharge the verve of the past with possible new formations of cooperative societies which were prevalent in the days of subsidization scheme.

It can be concluded that the operating units in the State are in the stage of development and the government should look for ways and means to assist the operators in the sector so that the laid down objectives of fisheries could be achieved in the near future. The scrapped subsidy scheme could be rejuvenated under a new name. It is easy and possible to judge the success of subsidy input scheme successful if the trend in output or catches is monitored or assessed alongside the impact of the powered craft in the small-scale fisheries. If the subsidy scheme is rejuvenated and operated in phases, it could only serve on the long run to optimize the catches vis-a-vis the earnings of the non-mechanized units and improve the worsening economic situation of the rural fishermen.

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