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Are Fishers Profit Maximizers? The Case of Gillnetters in Negros Occidental and Iloilo, Philippines

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Abstract

The translog profit function model was used to determine whether sampled Philippine gillnet boats or fishers were able to maximize profits from their fishing trips. The empirical results showed that the translog functional form was more appropriate than the Cobb-Douglas form. The sampled gillnet boats were not able to maximize profits. This nonprofit-maximizing behavior was found in each of the different gillnet types: drift gillnet, encircling gillnet and bottomset gillnet. The evident overfished condition of the fishery and the fishers' satisfaction from their work were cited as the major reasons why they opted to remain in the fishery despite its nonprofitability.

Introduction

The classical theory on the tragedy of the commons (Hardin 1968) alludes to the inevitability of misallocation of society's resources and nonprofit-maximizing use of an open access resource. This is due to the fact that unlimited entry to the use of the open-access resource invites overexploitation if not depletion of the resource.

The fisheries are good examples of an open-access resource where unlimited entry of competing users leads to overfishing or overexploitation and the inefficiency of resource use, i.e., fishers are not able to maximize profit as a result of applying fishing effort beyond the maximum economic yield level, and even beyond the maximum sustainable yield (Panayotou 1982; Anderson 1986).

Anderson (1986), amongst others, explains that fishers in an open-access fishery will choose to remain in the fishery as long as average cost equals average revenue (or total cost equals total revenue). This, however, contradicts the usual profit-maximizing behavior of firms and producers as explained in microeconomics theory, whereby firms and producers aim to equate marginal revenue to marginal costs.

This paper provides an example of such behavior and seeks to determine whether fishers are able to maximize profit from their fishing.

With the development of duality theory, alternative approaches to the classical production function are possible for analyzing production technologies and relationships in the fisheries, agriculture and other sectors. These approaches employ the cost function and the profit function. Young et al. (1985) stressed that these dual functions contain information about both optimal behavior and the structure of underlying technologies.

The profit function has the following advantages (Yotopoulos and Lau 1979; Kalirajan and Shand 1981):

(i) The firms' supply and factor demand functions can be derived directly from the profit function.
(ii) The profit, supply and derived input demand functions are functions of (normalized) input prices and the quantities of fixed inputs. The latter variables are normally considered to be independent of the firm's behavior.
(iii) The assumption of profit maximization can be tested because of the joint consideration of the variable factor demand functions and the profit function in the estimation.
(iv) Own- and cross-price elasticities of variable inputs, elasticity of output (or fish catch) with respect to its own price, the prices of variable inputs, and the magnitudes of fixed inputs can be readily obtained.

This paper examines how advantage (iii) above is put to use with a translog profit function to test for profit-maximizing behavior of sampled fishers/boats. This approach was used by Sidhu and Baanante (1981), Kalirajan et al. (1986) and others.

Methodology

Model Specification

The normalized restricted translog profit function for a single output, expressed as a second order approximation of the Taylor expansion, is discussed by Diewert (1974) and by Sidhu and Baanante (1981).

The normalized restricted translog profit function and the derived input demand functions, which can be written as share equations, are specified as:

$$\ln \pi^{*'} = a_0 + \sum_{i=1}^{3} a_i \ln P'_i + \sum_{j=1}^{2} b_j \ln Z_j$$

$$+ 0.5 \sum_{j=1}^{3} \sum_{h=1}^{3} a_{ih} \ln P'_i \ln P'_h$$

$$+ 0.5 \sum_{j=1}^{2} \sum_{k=1}^{2} b_{jk} \ln z_j z_k$$

$$+ \sum_{i=1}^{3} \sum_{j=1}^{2} c_{ij} \ln P'_i \ln Z_j,$$

$$i,h = 1, 2, 3$$
$$j,k = 1, 2 \qquad \ldots 1)$$

$$S_i = \frac{-P'_i X_i}{\pi} = \frac{d \ln \pi}{d \ln P'}$$

$$= a_i + \sum_{h=1}^{3} a_{ih} \ln P'_h + \sum_{j=1}^{2} c_{ij} \ln Z_j,$$

$$i, h = 1, 2, 3$$
$$j = 1, 2 \qquad \ldots 2)$$

where: $\pi^{*'}$ = normalized profit - total revenue less total cost of variable inputs divided by Py, the price of output; P'_1 = average money income of labor (average wage) per fishing trip normalized by the price of fish; P'_2 = price of fuel per fishing trip normalized by the price of fish; P'_3 = cost of crew provisions per fishing trip normalized by the price of fish; Z_1 = mesh size of fishing net (cm); Z_2 = gross tonnage of boat; D_1 = 1 if drift gillnet (DGN), D_1 = 0 if otherwise; $D_2 = 1$ if encircling gillnet (EGN), $D_2 = 0$ if otherwise; ln = natural logarithm; S_i = factor share, or share of factor cost to profit; a_o, a_i, a_{ih}, c_{ij}, b_j, b_{jk} = parameters.

The assumptions of profit maximization and price taking behavior of fishers require that the parameters of equation (2) must be equal to corresponding parameters in equation (1). Moreover, the symmetry restriction must be met (i.e., $a_{ih} = a_{hi}$). This provides the principle for testing the hypothesis of profit maximization. To test if the function is of Cobb-Douglas form rather than a translog one, the restriction was imposed that all second order terms of equation (1) were equal to zero.

Estimation Procedure and Technique

Equations (1) and (2) could be estimated separately using the Ordinary Least Squares method (OLS), but would result in inefficient estimates. This is because of cross equation restrictions; the presence of a_i (as well as a_{ih} and c_{jk}) in both equations would be ignored (Lau and Yotopoulos 1972). Moreover, because factor share equation (2) was derived from the profit function (1), this necessitates that the equations be jointly estimated to obtain more consistent and efficient estimates.

Estimation using Zellner's (1962) asymptotically efficient method of estimation, or the seemingly unrelated regressions (SUR) method for equations (1) and (2) provide further efficiency in parameter estimation.

Data and Study Area

The respondents for this study consisted of 121 gillnet (drift [DGN], encircling [EGN] and bottomset [BGN]) boats from six coastal towns of Iloilo and Negros Occidental Provinces which are located along the Guimaras Strait and adjacent waters, Western Visayas, Philippines.

The area forms part of the most productive fishing region (out of six) in the Philippines. It is adjacent to another rich fishing ground, the Visayan Sea. Fish production from Guimaras Strait predominantly consists of small pelagics mostly caught by small-scale fishing gears such as gillnets (23%), hooks and lines (20%), beach seines (12%) and others (BFAR 1989).

For each of the six fishing zones in the two provinces, one coastal town or landing site was chosen for survey and data collection: Himamaylan, Silay City and Cadiz City from Negros Occidental; Guimbal, Banate and Himamaylan from Iloilo. A survey was carried out in these towns to enumerate as much as possible, within budget constraints, the different types of boats/gears that catch predominantly small pelagic species. This survey provided the sampling frame based on which the second stage of the sampling was done. The latter involved the random selection of boats which were monitored for a 12-month period (November 1988 to October 1989). The monitoring was done every other week to record fishing trips. Weekly fish sampling was done for the biological component of the research.

Results

The estimates of the translog model for all gillnets in Guimaras Strait and adjacent waters showed that the SUR estimates were more efficient than the OLS estimates (Table 1). In general, the estimated profit function fits the data well as indicated by R^2 values of more than 0.60. In the restricted SUR regression, eight parameters were significant, seven of which were at the one per cent level of significance, compared with seven significant parameters in the OLS regression, most of which were at the 10 per cent level. With profit maximization imposed, the restricted SUR results showed that the variable input prices have the expected (negative) signs implying that profit is a decreasing function of variable input prices. This means that increase in variable input prices cause a decrease in the average gillnet boat's profits from its fishing operation.

The restricted SUR results for all gillnets also showed that the dummy variable for EGN was significant, with a positive value coefficient (1.432) indicating that the operation of EGN was more profitable than the other two gear types. Fixed factor variables, net mesh size and boat gross tonnage did not obtain significant coefficient estimates, which means that they did not influence profitability of fishing operations across different gillnets.

Test on Cobb-Douglas Form

To determine what kind of functional form best fitted the data, a test on the functional form of the profit function model was

Table 1. Parameter estimates of the translog profit function for gillnets in Guimaras Strait and adjacent waters.

Parameters	Unrestricted OLS estimates	Unrestricted SUR estimates	Restricted SUR estimates
$\ln P_1$ (price of labor)	0.622	0.692[b]	-0.459[a]
	(0.499)	(0.338)	(0.126)
$\ln P_2$ (price of fuel)	0.556[c]	0.386[c]	-0.311[a]
	(0.324)	(0.219)	(0.099)
$\ln P_3$ (av. cost of crew provision)	0.361	0.259	-0.599
	(0.361)	(0.210)	(0.052)
D_1 (dummy for DGN)	-0.969	-0.618	-0.180
	(0.446)	(0.301)	(0.274)
D_2 (dummy for EGN)	2.114[a]	1.707[a]	1.432[a]
	(0.541)	(0.365)	(0.324)
$\ln P_1 \ln P_2$	0.027[c]	0.041[a]	-0.015[a]
	(0.016)	(0.011)	(0.005)
$\ln P_2 \ln P_2$	0.077[b]	0.051[b]	-0.035[a]
	(0.036)	(0.024)	(0.006)
$\ln P_3 \ln P_3$	-0.021[c]	-0.008	-0.023[a]
	(0.012)	(0.008)	(0.003)
$\ln P_1 \ln P_2$	0.045	0.046[b]	0.004
	(0.031)	(0.021)	(0.006)
$\ln P_1 \ln P_3$	-0.039	-0.028	0.014[a]
	(0.041)	(0.028)	(0.004)
$\ln P_2 \ln P_3$	-0.024	-0.016	0.003
	(0.021)	(0.014)	(0.003)
$\ln P_1 \ln Z_1$	-0.361	-0.308	0.201[c]
	(0.405)	(0.273)	(0.111)
$\ln P_1 \ln Z_2$	-0.133	-0.144[b]	-0.017
	(0.101)	(0.068)	(0.033)
$\ln P_2 \ln Z_1$	0.168	0.117	0.013
	(0.133)	(0.090)	(0.083)
$\ln P_2 \ln Z_2$	0.019	0.038	0.007
	(0.053)	(0.036)	(0.031)
$\ln P_3 \ln Z_1$	-0.500	-0.266	-0.0005
	(0.289)	(0.195)	(0.047)
$\ln P_3 \ln Z_2$	-0.013	-0.028	0.017
	(0.085)	(0.057)	(0.015)
$\ln Z_1$ (net mesh size)	-3.230	0.295	-1.289
	(5.167)	(3.497)	(3.855)
$\ln Z_2$ (boat gross tonnage)	-0.400	-0.008	-0.312
	(0.828)	(0.564)	(0.505)
$\ln Z_1 \ln Z_1$	1.583	0.371	0.738
	(1.974)	(1.333)	(1.476)
$\ln Z_2 \ln Z_2$	0.026	-0.053	0.001
	(0.150)	(0.101)	(0.103)
$\ln Z_1 \ln Z_2$	0.433	0.189	0.370
	(0.788)	(0.532)	(0.447)
Constant/Intercept	4.050	1.812	2.724
	(3.335)	(2.267)	(2.477)
R^2	0.71	0.69	0.62

Figures in parentheses are asymptotic standard errors. a - significant at 1%; b - significant at 5%; c - significant at 10%

conducted wherein the null hypothesis stated that all interaction or second order terms are equal to zero (a_{ii}, a_{ih}, b_{ii}, b_{ih}, c_{ii}, c_{ih} = 0). If the null hypothesis is rejected, the translog form appears to be more appropriate for the profit function model. However, if it is not rejected, it would imply that the Cobb-Douglas form is superior. To test the above hypothesis, the F statistic, defined as follows, was used:

$$F = \frac{\dfrac{\left(e_r^2 - e_u^2\right)}{s}}{\dfrac{\left(e_u^2\right)}{N-k}}$$

where: e_r^2 = sum of restricted squared residuals; e_u^2 = sum of unrestricted squared residuals; N = number of observations across the system of equations; k = number of parameter estimates across the system of equations; and s = number of restrictions imposed.

The computed F statistic for the all-gillnet model is 5.85, while the critical F values at five per cent and at one per cent levels of significance are 1.67 and 2.04, respectively. This means that the null hypothesis is rejected at both levels (Table 2). Thus, the functional form which is deemed suited for the data analyzed in this study is the translog form.

A similar test was conducted for different gear types. The findings showed that the translog form of the profit function model was more appropriate for each gillnet group. For drift gillnets (DGN),

Table 2. Hypotheses testing on the translog profit function model for all gillnets.

Hypotheses	Computed F-ratio	Degrees of freedom	Critical F-value 10	5%	1%	Remarks
Cobb-Douglas (H_o: a_{ij} =0, b_{ij} =0, c_{ij} =0)	5.85	v_1=15, v_2=435	1.49	1.67	2.04	Reject H_o
Profit maximization (H_o: $a_i' = a_i^*$, $a_{ih}' = a_{ih}^*$, $b_{ih}' = b_{ih}^*$)	5.29	v_1=18, v_2=435	1.45	1.61	1.94	Reject H_o

with degrees of freedom v_1=15, v_2=109, the computed F was 2.70. The critical F values were 1.77 and 2.22 at five per cent and one per cent level of significance, respectively. The null hypothesis was rejected for both levels of significance.

For encircling gillnets (EGN), the computed F (v_1=15, v_2=73 degrees of freedom) was 7.57, which was greater than the critical F values, 1.82 at five per cent and 2.31 at one per cent, respectively. For bottomset gillnets (BGN), the computed F was 6.24, which was greater than the tabulated F values at one per cent and five per cent levels of significance. Hence, the null hypothesis was rejected in both cases.

Test on Profit Maximization

Production economics explains that a firm usually produces output such as goods and/or services with two major objectives: to maximize profit and to minimize costs.

The theory of profit maximizing behavior of the firm or producer was tested for gillnet fishers by testing the null hypothesis of equality of the same parameters for the profit function and the factor share equations. These restrictions were imposed on the system of profit and share equations which were then jointly estimated.

For all gillnets, the computed F statistic was 5.29, while the critical F values at five per cent and one per cent were 1.61 and 1.94, respectively (Table 2). The null hypothesis that all gillnet fishers were able to maximize profit was therefore rejected. Table 3 shows the same result of hypothesis testing on profit maximization for each gear group.

The nonprofit-maximizing behavior of gillnet fishers may mean that resources were not efficiently used in the fishing operations. In fisheries economics theory, this means that total fishing effort of the gillnet fishing industry is operating at a level beyond the maximum economic yield or beyond the maximum sustainable yield of the fish stock and that marginal revenue is not equal to marginal cost (Hartwick and Oliwiler 1986, p. 255-261). This finding conforms to the theoretical expectation in the use of an open-access resource that as long as average revenue equals average variable cost, fishers would remain in the fishing industry.

From previous studies and catch statistics on Guimaras strait and adjacent waters, it was found that the pelagic fish stocks in

Table 3. Hypothesis testing on profit maximization for different gillnet types.

Analysis	Gillnet type		
	DGN	EGN	BGN
Null hypothesis:	Similar parameters in share equations and profit function have equal coefficients		
Computed F	1.521	6.33	4.39
Critical F			
- at 10%	1.518	1.55	1.49
- at 5%	1.71	1.77	1.67
- at 1%	2.12	2.20	2.05
Degrees of freedom	$v_1=18$ $v_2=109$	$v_1=18$ $v_2=73$	$v_1=18$ $v_2=177$
Decision	Reject H_o at 10%	Reject H_o	Reject H_o

these fishing grounds were overexploited (Silvestre 1987; Padilla et al. 1990). Hence, it is probable that the level of effort was beyond that for maximum sustainable yield.

Conclusions and Implications

Despite the nonprofitability of fishing activities, fishers still chose to remain in the fishery, probably because of the low opportunity costs of their labor. Panayotou (1985) mentioned that fishers chose to remain in a fishery because of their "preference for a particular way of life." In this case we can say that fishers prefer the satisfaction they derived from their work, rather than being purely profit-motivated.

Since fishers were not able to maximize profit under the present resource condition, some adjustments need to be made on the current pattern of input use. Additional fishing efforts have to be strictly curtailed and enforcement needs to be improved to ensure proper utilization of the already overexploited fish stock. These measures will not only increase fishers' catch per unit of effort and hence their income, but also ensure fish stock regeneration for future sustained use. If this suggestion is to be implemented, alternative employment has to be provided to the displaced fishers. An alternative to fishing could be farming or aquaculture as well as some other semi-skilled jobs in which the fishers could be given skills and vocational training. Another alternative would be to possibly include fishers as beneficiaries of the land reform program so that they will be able to have farmland of their own. Also the displaced fishers could be absorbed into the planned regional industrialization programs, but skills training would be required.

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