ECONOMIC ANALYSIS OF FISHERY IN THE NORTHERN PERSIAN GULF

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There are many fishing landing areas in southern Iran, distributed all along the northern Persian Gulf. Despite increasing effort, the total catch has fluctuated in recent years. Iran is facing with over capacity of vessels and too many fishers, yet simultaneously political, social and economical pressures exist for expansion of fishing effort. It is extremely difficult to make management and resource allocation among competing user groups. This study examines the technical efficiency and profitability of the fishing industry in order to select the best fishing vessels group. The results indicate that wooden vessels of medium size are more efficient than small fiberglass ones. The result of profitability analysis using internal rate of return, and benefit cost ratio indicate that big vessels are in critical stage. Although small and medium vessels are profitable, but medium vessels are more economically efficient than others.

Key words: Persian Gulf, Profitability, Efficiency, Fishery Management

Persian Gulf is a 600-mile-long body of water, which separates Iran from Iraq, Saudi Arabia, Bahrain, Kuwait, Qatar, and United Arab Emirates. Fisheries in the Persian Gulf play very important role for the local economy. There are three coastal provinces involving fisheries in Iranian side of the Gulf includes; Khozestan in the northwest, Hormozgan in the northeast and Boushehr in the middle of the Gulf. Many commercial species caught from Persian Gulf includes; demersial species (39%), big pelagic (38%), small pelagic (12%) and other species (11%). Hormozgan is the most important province for Iranian fisheries in the Gulf (Esmaeili, 2009). Around 30 percent of 380000 tones fish landings in Iran come from the Hormozgan province. This amount of fish is capture by 26900 fishermen and 3825 fishing vessels. The major problem facing the fisheries in the region is the uncertain availability of fish and non profitability of fishing vessels.

Towards decreasing trend in total fish landing and increasing trend in fish vessel, per capita catch decreased in recent years (Figure 1 & 2).

Figure 1. Relationship between fish catches and vessels (1991-2009)

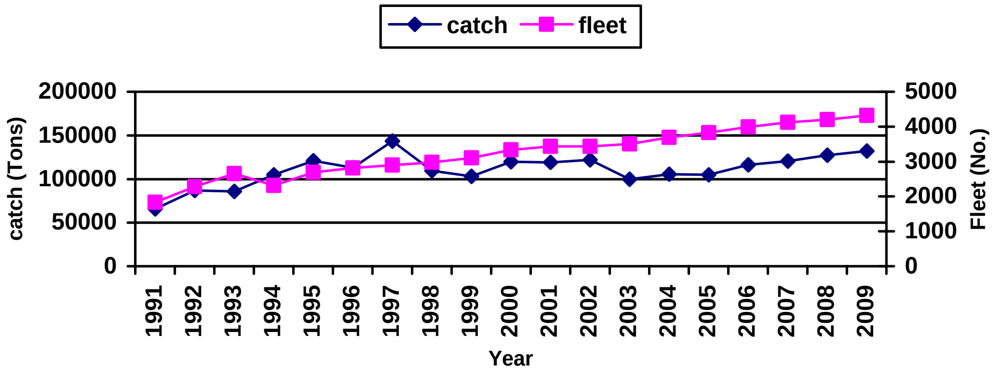
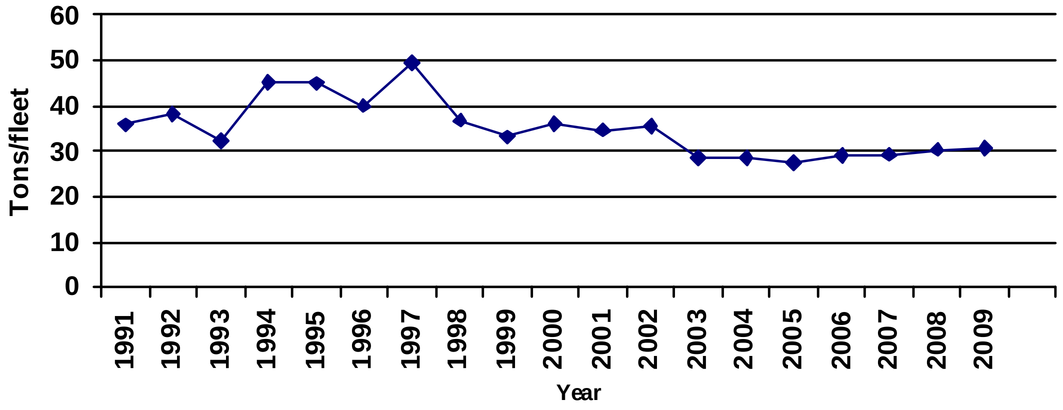


Figure2. Catch per vessel (1991-2009)



Catch per vessel are falling, despite the fact that effort for catch increased in recent years. The problem is that too many vessels are chasing too limit fish resource. Due to decline profitability, inefficiency, and poor management, some fish stocks declined in recent years.

The main purpose of this study is to examine the profitability of fishery industry and determine selected vessel group.

Methods:

The data for this study came form the field study of fishery in Hormozgan province, south of Iran. Totally 144 fish vessels were selected using stratified random sampling method. The sample vessels were classified into four groups includes 0-3 ton, 3-20 ton, 21-50 ton, and above 50 ton capacity vessels. The information was collected through face-to- face interviews with skippers.

Efficiency methodology is used for measuring factor influence fishery profitability. Although fifty years ago, Farrell (1957) introduced a methodology for measuring efficiency, his methodology undergoing many refinements and improvements. The model used in this paper is based on Battese and Coelli (1995) approach. They introduce following stochastic frontier general model for estimation efficiency.

$$\ln(y_i) = \beta\chi_i + v_i - u_i \qquad (1)$$

Where y_i is output of the $_i$th vessel x_i is a vector of production inputs, β is vector of parameters, v_i are independent identically distributed random variables that measured errors and exogenous shocks beyond the control of the manager, finally v_i is distributed one side and measured efficiency.

The inefficiency determinants function also as following general form.

$$u_i = \delta_0 + \delta z_i + w_i \qquad (2)$$

Where z_i is vector of factors affecting efficiency level, δ is vector of parameters and w_i is error term.

Frontier efficiency model (Eq.1) and inefficiency model (Eq.2) are estimated together by maximum likelihood method.

Secondary method used in this study is financial analysis (engineering economy). Financial analysis is a decision criterion that prescribes how to select investment alternatives. Benefit cost ratio and internal rate of return criteria methods are used to analysis profitability of fishing vessels.

The role of economic analysis is to provide decision-makers (e.g. politicians, fishery managers, funding agencies) with information that will enable appropriate choices and trade-offs to be evaluated concerning the allocation of resources to capture fisheries. Profitability for the fishermen is the aim of government and it depends on the market price of fish and the unit cost of harvesting, price being a function of the quantity of fish landed and unit cost being a function of job opportunity and the prices of factor inputs to run fisheries.

In economic engineering study, the rate of return on investment is normally expressed as a percentage. The annual net profit divided by total initial investment represent the fraction which, when multiplied by hundred, is known as the percentage of return on investment. The usual procedure is to find the return on total original investment, with the value of the average net profit being the nominator.

$$\frac{B}{C} = \frac{EUAB}{EUAC}$$

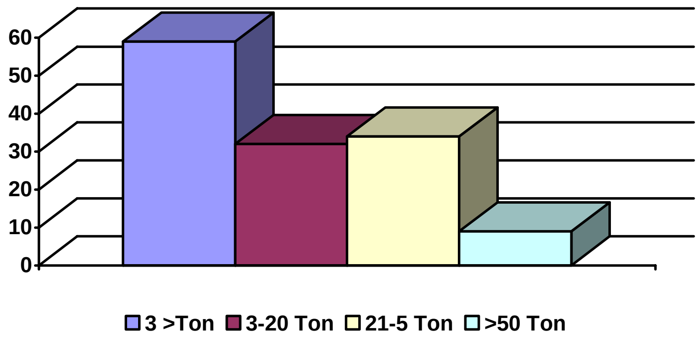
EUAB: Equivalent Uniform Annual Benefit

EUAC: Equivalent Uniform Annual Cost

Result

The study focuses on the Hormozgan province in Northern Persian Gulf. The vessels of this province consist of small fibreglass and medium wooden vessels. These vessels making short trips close to the costal-land in the region. Revenue and cost determine the profit of fishing operations. Revenue is depending on quantities caught and price obtained for fish. The main cost factors are operational cost, which can be divided in fuel cost, labor, food and ice cost, gear repair, vessel maintenance expenses and insurance.Totally 144 fish vessels were selected and sample was classified into four groups includes 0-3 ton, 3-20 ton, 21-50 ton, and above 50 ton capacity vessels (Figure 3). The information was collected through face-to- face interviews with skippers.

Figure 3. Number of vessels in selected groups



Descriptive statistics of annual profit and vessel characteristics are presented in Table 1. The table also presents socio-economics characteristics of the skippers.

Table 1. Descriptive statistics of vessel characteristics and socio-economics of skippers

Parameter	**0-3 ton**	**4-20 ton**	**21-50 ton**	**50< ton**
General Characteristics				
Labor	3.6	7.7	9.5	15.9
Engine Power (HP)	52.7	131.2	258.3	329.4
Fuel Cost	15,973,085	23,594,074	38,238,578	63,143,167
Two-way Radio	6.9%	96.9%	94.1%	100%
Total Cost (Rials)	7,205,727	29,393,676	54,495,108	68,208,333
Investment Vessel (Rials)	30,507,458	307,656,250	575,738,235	1,182,222,222
Investment nets (Rials)	16,043,277	56,732,823	82,822,309	144,572,067
Income (Rials)	77,325,424	206,749,387	363,874,412	537,777,778
Profit (Rials)	54,107,927	77,893,075	100,603,883	120,841,314

Socio-economics characteristics				
Skipper is Owner	86%	62.5%	66.7%	88.9%
Private Ownership	88.9%	58.1%	39.4%	11.1%
Education	74.6%	81.3%	79.4%	66.7%
Experience (Year)	17.4	17.7	21.2	16.2
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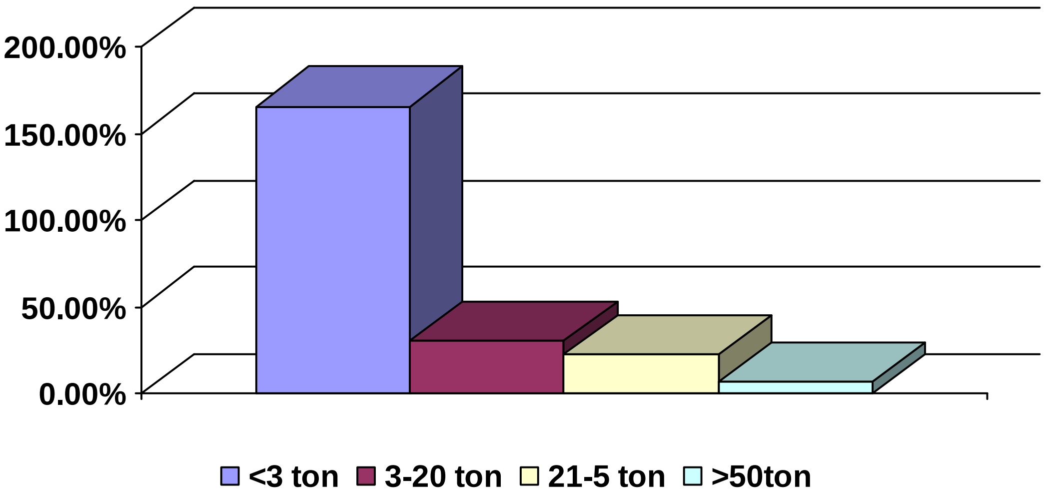
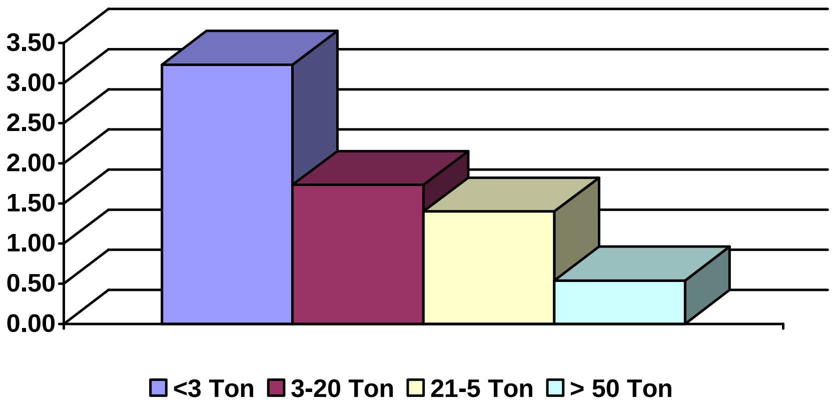
The fiberglass vessels are small with an average of 52.7 HP engine power, 30,507,458 and 16,043,277 Iranian Rials investment in vessel and equipment, respectively. 4-20 ton vessels, relatively small with an average of 131.2 HP engine power, 307,656,250 and 56,732,823 Iranian Rials investment in vessel and equipment, respectively. 21-50 ton capacity vessels, relatively big with an average of 258.3 HP engine power, 575,738,235 and 82,822,309 Iranian Rials investment in vessel and equipment, respectively. 51< ton vessels are big with an average of 329.4 HP engine power, 1,182,222,222 and 144,572,067 Iranian Rials investment in vessel and equipment, respectively. Annual income, cost and profit for four mentioned vessels groups are presents in table 1. Although big vessels income and profit is higher than small and medium vessels, the rate of return is relatively low for big vessels (figure 4).

Figure 4. Rate of return for selected vessels groups



The annual rate of return for <3ton, 3-20 ton, 21-50 ton, and >50ton vessels groups are calculated 165, 30, 23, and 7 percent respectively. The rate of return relatively low for big vessels compare to interest rate in agriculture sector (14%), industrial sector (17%) and annual inflation rate (17.5%). It means >50 ton vessels group is non profitable. Another alternative method for select the most profitable vessels group is benefit cost ratio. For any vessels group to remain under consideration, its benefit-cost ratio must exceed one. The benefit cost ratio for <3ton, 3-20 ton, 21-50 ton, and >50ton vessels groups are calculated 3.23, 1.73, 1.4 and 0.54, respectively (Figure 5).

Figure 5. Benefit cost ratio for selected vessels groups



It could be conclude that three smaller vessel groups remain under consideration. The correct alternative (the most profitable vessels group) can be selected by applying the principle of incremental analysis. In incremental analysis for comparing one alternative to another, first determine the cash flow representing the difference between the two cash flows. Then the decision whether to select a particular alternative rests on the determination of the economic desirability of the additional increment of investment required by one alternative over the other (Thuesen and Fabrycky 1993). The incremental investment is considered to be desirable if it yield a return that exceeds the minimum attractive rate of return or the benefit-cost ratio exceed one.

The calculation of incremental investment for both methods (rate of return and benefit cost ratio) are indicated that 21-50 ton vessels are the most profitable vessels. In other worlds, although rate of return and benefit-cost ratio are higher for <3ton vessels, but the incremental rate of return and incremental benefit-cost ratio are exceed minimum attractive rate of return (MARR) and one, respectively. Comparing 3-20 ton and 21-50 ton indicated that incremental investment is less than one in benefit-cost ratio method.

Productivity of labor and capital are different among vessels groups. Although labor productivity is higher for large vessels, but capital productivity is larger for small vessels (table 2). On the whole, medium vessels are more efficient than small and large vessels in the region.

Table 2. Labor and capital productivity in vessels groups

	<3ton	3-20 ton	21-50 ton	>50ton
Vessel capital productivity	3.03	0.81	0.72	0.46
Equipment capital productivity	6.27	5.55	5.22	3.74
Total capital productivity	2.04	0.71	0.63	0.41
Labor productivity	2.61	3.03	4.06	3.38

Efficiency technique is used to analyze profitability of fishery vessels. For the profitability investigation, assuming Coob-Daglass functional form, the profit function mentioned in equation 1 can be written as,

$$Ln\Pi_i = \beta_0 + \sum_{j=1}^{5} \beta_j LnX_{ji} + v_i - u_i \qquad (3)$$

Where *i* represents the *ith* vessel for *i*=1, 2…141. Π_i is the profit of *ith* vessel and X_{ji} represents the amount of input j used by the *ith* vessel. The dependent variables are defined as follows.

X_{1i} represents the average maintenance cost used in *ith* vessel, measured in US$.

X_{2i} denotes per capita catch for *ith* vessel, measured in kg.

X_{3i} represents the average gear cost used in *ith* vessel, measured in US$.

X_{4i} represents the average fuel cost used in *ith* vessel, measured in US$.

X_{5i} represents the average food & ice cost used in *ith* vessel, measured in US$.

The inefficiency model in this study as following form.

$$u_i = \delta_0 + \sum_{k=r}^{6} \delta_k Z_{ki} + w_i \qquad (4)$$

Where u_i is the inefficiency of *ith* vessel and dependent variables as follows.

Z_{1i} represents port existence, Z_{1i} =1 if vessel fishing region have port, otherwise Z_{1i} =0.

Z_{2i} denote tow-way radio existence, Z_{2i} =1 if the vessel have two-way radio, otherwise Z_{2i} =0.

Z_{3i} denotes education, Z_{3i} =1 if skippers educated, otherwise Z_{3i} =0.

Z_{4i} denotes property right regime, Z_{4i} =1 if the owner is one person and Z_{4i} =0 if common property.

Z_{5i} denotes skippers age, measured in year.

Z_{6i} represents cooperative activity, Z_{6i} =1 vessel fishing region cooperative evaluated do not have good activity, otherwise Z_{6i} =0.

The stochastic frontier model and inefficiency model are estimated in one-stage by the econometric package FRONTIER 4.1 (Coelli 1996). The parameter estimated with corresponding standard errors is presented in Table 2.

The frontier model of the profit function coefficients is used to investigate economic efficiency and profitability. Estimates of the parameters of the frontier and inefficiency models are presented in Table 3. Parameters estimated have expected impacts on profitability and efficiency in both models. In the frontier model, the coefficients pertaining maintenance cost, gear cost, fuel cost are significant and have the expected negative signs, implying that an increase in the mentioned costs causes a decrease in profitability. The sign of food & ice coefficient is according to the expectation but not significant. The positive sign of per capita catch variable suggests that increase in catch leads to higher profitability.

Table3. The parameter estimated for frontier and inefficiency model

Parameter	Estimation	Standard Error
Frontier Model		
β_0	25.76***	0.83
β_1	-1.54***	0.32
β_2	0.17*	0.087
β_3	-3.26***	0.41
β_4	-2.05***	0.36
β_5	-0.042	0.285
Inefficiency Model		
δ_0	0.79***	0.233
δ_1	-0.69***	0.11
δ_2	-0.082	0.083
δ_3	-0.044	0.0612
δ_4	0.015	0.0611
δ_5	0.0012	0.003
δ_6	0.39***	0.089
γ	0.34*	0.25
σ^2	0.082***	0.11

*, **, *** statistically significant at the 10%, 5%, 1% levels, respectively.

The coefficients of inefficiency model have expected signs. Positive sign of parameters in the inefficiency model imply negative effects on the economic efficiency and the contrary. Although the coefficient of port existence and cooperative activity are significant, the other parameters (two-way radio, education, property regime and age) are non-significant. The value of γ suggests that the variance of profit inefficiency effects accounts 34 percent of total profit variance. Although this amount relatively low, but higher than that found by Fousekis et al. (2003).

The overall technical efficiency is calculated from the model, for the entire sample, is 56 percent. It is important to note that capital opportunity cost was not included into the model. With respect to higher investment in big vessel compare to the smaller fiberglass one, the efficiency would be change if capital cost included into to the model.

Discussion:

In this study a frontier profit model and engineering economy were used to assess the economic efficiency and profitability among fishery vessels in the south of Iran. The socio-economic, infrastructure and institution factors had significant impact on profitability. Overcoming these constraints would contribute to increase in profitability of fishery and decrease in overfishing.

The result also shows that, on the whole, medium vessels are more efficient than small and large vessels in the region. In addition, the large vessels are non-profitable. The mean economic efficiency for the sample vessels is low. This means that there is potential for increasing profitability of fishing vessels.

Although food & ice coefficient was not significant, all other coefficients in the frontier model were significant and had expected signs. Cooperative activity and port existence are two important variables in inefficiency model. Vessels profitability also depends on others soci-economic factors, local development and provision of infrastructure, which affect the skipper's access to inputs and technologies. It would be interesting to identify the mentioned factors and use in the time series-cross section (pooled data) Fortier model.

Based on the fact that cross section data was used in the study, it was impossible to use fish price in the frontier model. This is one of the limitations of the research; therefore, it could be recommended that researcher use time series data in the future studies.

References

Battese, G., T. Coelli, 1992, Frontier production functions, technical inefficiency and panel data: with application to paddy farmers in India, *J. Prod. Analysis*, 3, 153-169.

Battese, G., T. Coelli, 1993, A stochastic frontier production function incorporating a model for technical inefficiency affects working Papers in Econometrics and Applied Statistics, No. 69. Department of Econometrics, *University of New England*, Armidale.

Battese, G., T. Coelli, 1995, A model for technical inefficiency effects in a stochastic frontier production function for panel data, *Empirical Economics*, 20, 325-332.

Coelli, T., 1996, A guide to frontier, version 4.1. A computer program for frontier production function. CEPA working paper 96/07, Department of Econometrics, *University of New England*, Armidale.

Esmaeili, A., 2009, Environmental change and fishery management in the northern Persian Gulf, *Journal of Environmental Planning and Management*, 52, 1071–1081

Farrell, M. J., 1957, The Measurement of production efficiency, .*Journal of Royal Statistical Society*, 120, 253-90.

Forsund, F. R., C. A. K. Lovell, and P. Schmidt, 1980, A survey of frontier production function and of their relationship to efficiency measurement, *Journal of Econometric*, 13, 5-25.

Fousekis, P., S. Kolonaris, 2003, Technical efficiency determination for fisheries: a study of trammel netters in Greece, *Fisheries Research*, 63, 85-95.

Kirkley, J., D. Squires, and I. Strand, 1995, Assessing technical efficiency in commercial fisheries: the mid-Atlantic sea scallop fishery, *American Journal of Agricultural Economicn*, 77, 686-697.

Pascoe, S., J. Andersen, and J. De Wilde, 2001, The impact of management regulation on technical efficiency of vellels in Dutch beam trawler fishery, European Review of Agricultural Economics, 28, 187-206.

Pomeroy R. S., 1992, Economic studies of small-scale fisheries: A comparison of methodologies. *Asian Fisheries Science*, 5, 63-72.

Sharma, K., P. Leung, 1999, Technical efficiency of the long-line fishery in Hawaii: an application of a stochastic production frontier, *Marine Resource Economics*, 13, 259-274.

Squires, D., 1987, Fishing effort: it's testing specification and internal structure in fisheries economics and management, *Journal of Environmental Economics Management*, 14, 269-282.

Thuesen G J., W. J. Fabrycky, 1993, Engineering Economy, *Prentice-Hall, Inc*. New Jersey.