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THE ROLE OF MICROECONOMIC STUDIES IN DECISION-MAKING OF FISHERY MANAGEMENT

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Abstract:

The need for fisheries management arises as the surplus production from fish stocks is overtaken by the catching capacity of fishing fleets. In general, terms the goals in fisheries management can be divided into four subsets: biological; ecological; economic and social, where social includes political and cultural goals. Identifying such goals is important in clarifying how the fish resources are to be used to benefit society, both at the economic and policy level. Without such goals, there is no guidance on how the fishery should be operated and managed. The study was yielded some microeconomic analysis results such as value of gross output, variable and fixed costs, gross and net profit, average fishing income, non-fishing income and household income.

This research aimed at computing the income level of the fishermen, fishing of the Northern part of Turkey in the Sea of Marmara and examining the cost-profit relationship with regard to vessel size. 231 vessels sorted with respect to size and grouped under four classes. Stratified random sampling method was used to determine survey sample size. 156 vessels from the first group, 46 from the second, 15 from the third, and 14 from the fourth group were included into the survey.

Keywords: Fishing economics, Cost, Profit

Introduction

Production is a process of combining various material inputs and immaterial inputs (plans, know-how) in order to make something for consumption (the output). Economics is defined as the study of how limited resources can best be used to fulfill unlimited human wants. In a production process, all economic activities aim directly or indirectly to satisfy human needs.

So, agricultural production economics is about how to use economic principles for making agricultural production decisions.

There are three ways to use economic principles for making agricultural production decisions efficiently:

1. Input-Input Relationship-Input optimisation (Which ınputs should be preffered?)
2. Output-Output Relationship-product optimisation (Which product should be produced?)
3. Input-Output Relationship-maksimum profit at optimum cost (How much/many product must be produced at optimum (where Marginal Revenue is equal to Marginal Cost)?).

Fish and fisheries are an integral part of most societies and make important contributions to economic and social health and well-being in many countries and areas. Some 58.3 million people were engaged in the primary sector of capture fisheries and aquaculture in 2012 all over the world. Of these, 37 percent were engaged full time. It has been estimated that approximately 163 million people are directly employed in fishery activities (47.000 in Turkey). “In recent years globally production from capture fisheries has tended to vary between approximately 85 and 90 million tonnes. The total number of fishing vessels was estimated at 4.72 million in 2012. Globally, 57 percent of fishing vessels were engine-powered, but the motorization ratio was much higher (70 percent). 79 percent of the world’s motorized fishing vessels were less than 12 m length overall. About 200 countries reported exports of fish and fishery products. Fishery exports reached a peak of US $129.8 billion in 2011, up 17 percent on 2010, but declined slightly to US $129.2 billion following downward pressure on international prices of selected fish and fishery products in 2012. The fishery trade is especially important for developing nations” (FAO, 2014) .

The need for fisheries management arises as the surplus production from fish stocks is overtaken by the catching capacity of fishing fleets. In general terms, as Cochrane stated in 2002, the goals in fisheries management can be divided into four subsets: biological; ecological; economic and social, where social includes political and cultural goals:

- to maintain the target species at or above the levels necessary to ensure their continued productivity (biological);
- to minimise the impacts of fishing on the physical environment and on non-target (by-catch), associated and dependent species (ecological);
- to maximise the net incomes of the participating fishers (economic); and
- to maximise employment opportunities for those dependent on the fishery for their livelihoods (social).

This research study aims at computing the income level of the fishermen in Turkey with the example of the Marmara Sea and examining the cost-profit relationship with regard to vessel size to maintain some contributions for more realistic fisheries management policies.

Identifying such goals is important in clarifying how the fish resources are to be used to benefit society, and they should be agreed upon and recorded, both at the policy level and for each fishery. Without such goals, there will be no guidance on how the fishery should be operated and managed. The study was yielded detailed analysis results of production economics such as value of gross output, variable and fixed costs, gross and net profit, average fishing income, non-fishing income and household income.

“The research area, Marmara Sea, is an important place in the fishing of especially pelagic fish that migrate, being the passage zone between the Black Sea and the Aegean through the Bosphorus and the Dardanelles straits in Turkey. It's known to be the spawning and feeding area of pelagic fish especially, due mainly to the low salinity of the surface waters flowing in through the straits and the nutrients they bring. The bluefish (*Pomatomus saltatrix* Linnaeus) is among the foremost pelagic fish species with regard to its economic

contribution and traditional fishing" (Akyol et al., 2006).

Fishes such as anchovies, horse-mackerel, bonito, sardines, shrimps, red mullet and striped red mullet, turbot, sole, European hake, picarel, twait shad, European horse mackerel and mullet are fishery products of primary economic significance, whereas seafoods such as sea robin, octopus, ray, shark, needlefish, sea snail and clam secondary economic significance in Marmara Sea. Looking at the management of the fishing activities in Turkish seas, including the Sea of Marmara, it is possible to assert that there are many aspects that do not run smoothly and that it lacks an effective resource management strategy. Because both large fishing boats and small coastal fishing boats display a highly dispersed structure. The fisheries rules are continually infringed and the investments in fishing capacity constantly increase without considering the existing resources (i.e. the stock of fish that can be caught), which causes the fishing fleet to grow constantly both in quality and quantity, creating excessive pressure on fish inventory.

Using stratified random sampling method, 156 vessels from the first group, 46 from the second, 15 from the third, and 14 from the fourth group have been included into the survey. The tables include detailed economic analysis results such as value of gross output, variable and fixed costs, gross and net profit, average fishing income, non-fishing income and household income. For instance, the net annual profits are calculated to be 7,403.3€, 19,072.9€, 188,814.2€ and 360,037.5€ respectively for the first, second, third and fourth groups.

Materials and Methods

Stratified random sampling method was used to determine survey sample size. Face-to-face interviews were held with the fishermen to compute the income level of the fishermen fishing in the Sea of Marmara and to examine the cost-return relationship with regard to vessel size. The number of vessels involved in fishing activities in the region and holding a fishing permit was determined to be 2523.

Table 1. shows the distribution of the vessels with fishing permits among size groups and prov- inces.

A total of 231 fishing vessels from 22 locations in 7 provinces, which pursued fishing activities in the Sea of Marmara during 2011-2012 fishing season were the main source of primary data. The vessels were sorted with respect to size and grouped under four classes as vessels under 8.9m; vessels ranging from 9m to 15.9m; from 16m to 25.9m; and over 26m in size, considering fishing methods and intensities.

Distribution of fishing vessels was taken from the official records of General Directorate of Fisheries and Aquaculture (BSÜGM). The vessels were sorted with respect to size in increasing order and grouped under four classes considering fishing methods and intensities. Table 2 shows number of samples by the size groups and provinces. 156 vessels from the first group, 46 from the second, 15 from the third, and 14 from the fourth group were included into the survey, according to sample size computations using the following formula (Yamane, 2001):

$$n = \frac{N \Sigma (Nh\, Sh^2)}{N^2 D^2 + \Sigma\, Nh\, Sh^2}$$

where;

n: Total sample size, N: Total number of enterprises, N_h: Number of enterprises in a given stratum, S_h: Standard deviation of the given stratum, S_h^2: Variance of the given stratum,

D^2: Margin of error of population mean

($D^2 = d^2/Z^2$, $d = 0.05 * X$)

Z: Z score, or standard normal deviate for 95% confidence interval (1.96)

The tables included economic analysis results such as value of gross output, variable and fixed costs, gross and net profit, average fishing income, non-fishing income and household income. The data were converted to Euro values using the offical Central Bank of Turkey exchange rate of 1€ =2.4TL on 1st January, 2012, pertaining to the fishing season where the survey was carried out.

Table 1. Fishing Vessels in Marmara Region by the Size Groups and Provinces (2012)

Provinces	1	2	3	4	Total	%
	<8.9 m	9-15.9 m	16-25.9 m	>26 m		
Çanakkale	472	87	12	4	**575**	**22.8**
Istanbul	432	103	15	12	**562**	**22.3**
Balıkesir	205	161	119	45	**530**	**21.0**
Kocaeli	335	8	3	2	**348**	**13.8**
Yalova	137	50	5	6	**198**	**7.8**
Tekirdağ	119	68	4	4	**194**	**7.7**
Bursa	71	28	9	7	**115**	**4.6**
TOTAL	**1770**	**506**	**167**	**80**	**2523**	**100.0**
%	**70.2**	**20.1**	**6.6**	**3.2**	**100.0**	**-**

Reference: TÜIK, 2013.

Table 2. Number of Samples by the Size Groups and Provinces

Provinces	1	2	3	4	Total
	<8.9 m	9-15.9 m	16-25.9 m	>26 m	
Çanakkale	34	10	3	3	51
Istanbul	36	10	3	3	53
Balıkesir	33	10	3	3	49
Kocaeli	22	6	2	2	32
Yalova	12	4	1	1	18
Tekirdağ	12	4	1	1	18
Bursa	7	2	1	1	11
TOTAL	156	46	15	14	231

Reference: TÜIK, 2013.

Results and Discussion

It is important for the management authority to consider the broad economic context of fishery, including relevant macroeconomic factors. Realistic goals and objectives must be established across ecosystems, so as to manage for species and fisheries interactions. The potential yield and profits acording to vessel size needs to be estimated to maximise the net incomes of the participating fishers. The ability of fishery economics to provide a consistent framework for the analysis of policy problems thus enables it to make a key contribution to development of fishing people. Development of fishing people is very important for sustainability and scarcity of naturel resources.

It is possible to group professional fishing in Turkey under two main categories:

1. Coastal fishing (small size vessels ranging between 10 to 29 meters)
2. Long-range fishing (vessels larger than 30 meters; (sweep-nets, trawls and sweep-trawls)

Table 3 shows, number of fishing vessels by size groups in Turkey. According to the statistics, there are currently about 14.500 vessels in Turkey. 24% of which are active in the research area. 82% of the vessels consist of small fishing boats under the size of 10 meters same as in Turkey (Table 4). The vessels shorter than 20 m are income tax free in Turkey according to general support policy for agricultural products. So then total income level directly increases at least 20-25% yearly. Because the income tax rates are between 15-35% according to income level.

Costs of Fishery Products

All the costs faced by companies can be divided into two main categories: fixed costs and variable costs. These categorisation is also true for fishery activities. Variable costs are costs that vary with output while fixed costs are costs that are independent of output. Variable costs are also the sum of marginal costs over all units produced. Variab-

le and fix costs can be defined for fishery activities as:

Variable costs are costs that change in proportion to the fish amount that caught by a vessel. But fixed costs are independent of seafood amount caught. Fixed costs and variable costs make up the two components of total cost.

The distribution of fishery costs in Turkey announced by the Turkish Statistical Institute showed in table 6. As it could be seen in the table, the biggest cost item is fuel and the second one is crew costs. The second support policy for fishermen is tax free fuel oil application. In 2012, 5513 recorded fishermen benefited this support in Turkey (Ubak 2016).

Finally, the distribution of fishery costs in research region was shown in table 5. As it could be seen the differences between the table 5 and 6. The middlemen and marketing costs determined approximately 23% in Marmara Sea while about 5% in General. Therefore, the fishery managers could be aware of the differences and reasons of this difference among regions and between the vessels sizes.

Total Gross Product of Fishery Activities

Coastal fishing vessels, are those that usually exploit local areas in nearshore waters for daily fishing trips using various fishing instruments such as lines, setlines, seines (pelagic seine-nets), drive-in nets, beam trawls, and dredges in Marmara Sea. These vessels are smaller than 12 meters in size generally.

A variety of pelagic, demersal and benthic fish and marine species such as bonito, bluefish, turbot, whiting, red mullet, twait shad, grey mullet, needlefish, horse mackerel, hake, sole, shrimps, sea snail, and mussels can be caught with these nets.

Table 7 shows a hypothetical sample for calculating net profit of a vessel. At the table; the amounts caught and prices obtained for different fish species are given to calculate gross product or profit of vessels.

At last, economic indicators calculated for the vessel groups showed at the table 8. The values of gross product (Value of Gross Output-Variable Costs) with regard to fish species for different vessel groups were calculated as €8.065, €20.849, €205.975 and €401.211 for Groups 1, 2, 3, and 4 respectively.

As it can be seen on the table 9, a satisfactory net profit is realized by fishermen especially 3 and 4th groups. Total household income was calculated by adding fishery income from other activities than fishing (net repair, retail fish sales on stalls, fish restaurants etc.) and non-fishery income (retirement salary, income from rented properties, wages for other jobs, agricultural production income, etc.) to net profit. Total monthly household income is seen to be €831.3, €1.780, €16.241, and €30.515 for Groups 1, 2, 3, 4 respectively, which makes fisheries a more lucrative business segment compared to other agricultural segments, although it is also riskier and more intensive.

In this study, it was founded that there was a positive economic return to fishermen in Marmara Region. According to data from the Federation of European Employers, Minimum wage is 310.92 monthly in Turkey. Compared to the minimum wage, the first group's vessels gained almost twice monthly (€831). The profits tend to increase because of scarcity of resources and seasonal increases in fish prices. But there are considerable variations in activities, revenues and costs among regions and vessels in terms of vessel size. Politicians and fishery managers have to take into considiration these variations for more effective and realistic management.

Some suggestions was given below in determining an appropriate fishery management strategy to achieve specified operational objectives.

However, the income of the fishermen in Marmara region fails to create the expected level of welfare, mainly due to the fact that the fishermen have long been economically dependent on loans and middlemen systems. They borrow money during the closed season and at the beginning of the fishing season from the fishermen to whom they will be selling their catch (for instance, it's estimated that it takes around €62.500 to prepare a 25 meter purse-seine vessel to the season) (Uras, 2014). Therefore the fishermen sail under the pressure of heavy debts in the fist place; and in a market dominated by middlemen rather than by cooperatives, they have to settle for low prices while the consumers will have to accept to pay high prices.

Table 3. Number of Fishing Vessels in Turkey by Size Groups (m) (TUIK, 2014)

Years	(5 - 7.9)	(8 - 9.9)	(10-11.9)	(12-14.9)	(15-19.9)	(20-29.9)	(30-49.9)	(50+)	Total
2010	9196	4871	728	603	420	609	215	8	**16650**
2011	7293	4512	662	607	400	593	223	10	**14300**
2012	7377	4409	680	633	396	595	225	9	**14324**
2013	7166	4264	632	534	358	534	230	9	**13727**
2014	9508	3064	621	392	286	489	227	8	**14595**

Table 4. Some Characteristics of Fishery in Turkey (TUIK, 2014)

Years	Shorter than 10 m		Shorter than 20 m (Tax Free)	
	Number	%	Number	%
2010	14067	84.5	15818	95.0
2011	11805	82.6	13474	94.2
2012	11786	82.3	13495	94.2
2013	11430	83.3	12954	94.4
2014	12572	86,1	13871	95.0

Table 5. Variable and Fixed Cost Items of the Fishing Activities

Total Costs=TVC+TFC	
Variable Cost Items	**Fixed Cost Items**
Fuel	General Administrative Expenses (VC*%3)
Temporary Crew costs	Interest of debts/loans (annual)
Victuals	Labour (wages of permanent labourers)
Apparel (boots, raincoats)	Mooring fees
Packaging, crates etc.	Telephone bills (annual)
Ice	Vessel insurance (annual)
Marketing	Labor insurance (annual)
Cleaning	Vessel depreciation+interest
Fines	Other depreciation+interest
Vessel lease/rent	Warehouse/Vessel refuge rent (annual)
Ves. repair and maintenance	Vessel tax (annual)
Net maintenance+Purchasing	Diesel fuel card (annual)
Middleman share	Certificate of seaworthiness
Variable Costs (VC)	Green licence (semi-annual)
Interest on operating capital (VC*0.7)	Fishing licences (annual)
	Cooperative fees (annual)
Total Variable Costs (TVC)	**Total Fixed Costs (TFC)**

Table 6. The Distribution of Fishery Costs in Turkey During 2010-2014 Fishing Season (%) (TUIK, 2014)

Cost Items	2010	2011	2012	2013	2014
Fuel	46.9	49.8	49.3	47.5	45.3
Crew costs	26.6	24.9	25.6	26.8	26.6
Victuals	8.0	6.4	6.2	6.1	8.0
Middleman share, payments in fish markets, taxes etc.	5.1	5.0	5.5	5.4	5.1
İnterests	3.2	2.8	2.1	2.5	3.2
Net maintenance+Purchasing	1.7	1.7	1.5	1.2	1.7
Apparel (boots, raincoats)	0.9	0.7	0.8	0.9	0.9
Vessel, frozen deposit lease/rent	0.8	1.0	1.0	0.8	0.8
Packaging, crates, ıce etc.	1.0	0.8	5.4	5.5	5.5
Other costs (water, electricity, telephone etc.)	5.8	6.9	0.6	3.3	2.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 7. The Distribution of Fishery Costs Due to the Various Items in Marmara Sea (%) (TUIK, 2014)

Cost Items	**2011-2012**
Fuel	32,7
Crew costs	24,4
Middleman share and marketing	22,6
Vessel repair and maintenance	5,8
Net maintenance+Purchasing	5,8
Victuals	4,4
Packaging, crates etc.	2,5
Apparel (boots, raincoats)	0,9
Ice	0,6
Vessel lease/rent	0,1
Cleaning	0,1
Total	**100**

Table 8. Hypothetical Sample For Calculating Profit of Each Vessels

Fish Species	**Amount**				**Prices (€)**			
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 1**	**Group 2**	**Group 3**	**Group 4**
Anchovies (kg)	0	0	29250	47500	0.0	0.0	1.1	1.0
Small Bluefish (kg)	284	1220	17750	28750	3.5	4.3	3.4	3.3
Horse Mackerel (kg)	934	1627	48750	61250	1.8	1.8	1.6	1.5
Picarel (kg)	25	0	0	0	2.9	0.0	0.0	0.0
Grey Mullet (kg)	0	0	0	3750	0.0	0.0	0.0	3.0
Chub Mackerel (kg)	0	0	0	650	0.0	0.0	0.0	1.5
Seabass (nr)	14	0	0	1750	0.0	0.0	0.0	6.5
Bluefish (nr)	349	805	30225	55750	3.8	4.1	3.8	3.7
Bonito (nr)	646	2880	24330	53375	2.6	2.8	2.6	2.6
Sardines (kg)	792	1180	0	0	1.4	1.1	1.3	1.1
Garfish (kg)	21	50	0	0	3.6	3.4	0.0	0.0
Red Mullet (kg)	104	517	0	0	6.1	6.0	0.0	0.0
Sole (kg)	25	0	0	0	8.0	8.3	0.0	0.0
Turbot (kg)	54	230	0	0	11.1	12.0	0.0	0.0
Red Mullet (kg)	22	0	0	0	6.4	0.0	0.0	0.0
Whiting+hake (kg)	144	240	0	0	4.4	4.3	0.0	0.0
Red Gurnard(kg)	31	0	0	5270	2.8	0.0	0.0	3.3
Shrimps (kg)	1110	2770	0	0	1.8	2.0	0.0	0.0

Table 9. Calculation of Gross and Net Profit for Each Vessels (€)

Indıcators	Group 1	Group 2	Group 3	Group 4
Gross Output	**11310.8**	**33215.8**	**351868.3**	**623355.8**
Varıable Costs	3246.3	12367.1	145893.3	222145.0
Fıxed Costs	661.1	1776.0	15858.5	35641.4
Income Tax	0.0	0.0	1302.1	5531.7
Gross Profit	8064.6	20848.8	205975.0	401210.8
Net Profit	**7403.3**	**19072.9**	**188814.2**	**360037.5**
Other Fishing İncome	293.8	1052.1	2552.1	1320.8
Total (Annual)	**7697.1**	**20125.0**	**191366.3**	**361358.3**
Total (Monthly)	**641.3**	**1677.1**	**15947.1**	**30113.3**
Non-fishery income	2279.2	1229.2	3530.0	5142.9
Total Household Income (Annual)	9976.3	21354.2	194896.3	366501.3
Total Household Income (Monthly)	831.3	1779.6	16241.3	30541.7
Minimum Wage in Turkey (Monthly) (2012)			€311	

Table 10. Some Suggestions in Determining an Appropriate Fishery management

Strategy Steps	Importance of Microeconomic Information
1. While determining fisheries policy	- Guides to managers critical information on cost and profit items of fisheries, social and economic characteristics and importance of sector.
2. While setting goals	- Draws an historical performance view including costs, yields, economic and social contribution. - Considers a lot of existing problems as living conditions/quality of fishermen and crews - May give some idea for decision-making techniques and policy opportunities.
3. While determining operational objectives and setting reference points	- Gives opportunity to test, refine and quantify the objectives and models used. - Requires iterative consultation between decision-makers and scientists.
4. While determining management strategy	- Uses analyses, models, and expert knowledge of interested areas to test performance of management measures against operational objectives. - Determines suite of management measures best able to achieve operational objectives. - Considers realities of fishing operations in main and the sub-sectors at the same time.

The issues determine these requirements and operational objectives the manager needs to consid- er. They have to benefit the biological, ecologi- cal, economic, social and institutional infor- mation as a chain.

Conclusion

Different perspectives will give some chances by finding easy and more realistic answers for the following simple questions:

- Are current catches in the fishery sustainable and making good use of the resource?
- Is the fishery being conducted in an economically responsible and efficient manner consistent with the economic goals and priorities of the country or local area?
- Are those dependent on the fishery for income and livelihoods receiving appro-

priate, beneficial returns from their fish- ery-related activities?

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