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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Determinants of economic efficiency: A case study of Rapa whelk (*Rapana venosa)* fisheries in the South Black Sea

Ekonomik etkinliğin belirlenmesi: Güney Karadeniz'deki deniz salyangozu (*Rapana venosa)* avcılığına (balıkçılığına) ilişkin bir çalışma

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Abstract: The inevitable increase in the numerical and technological capacity of fishing fleets in developed and developing countries has major implications for the management and distribution of limited natural resource capacity, as well as the ecological and socio-economic sustainability of fisheries. It is important to determine these effects to make the right decisions in fisheries management. This study aims to assess the fishing capacity, technical efficiency, scale efficiency, and capacity use in a specific subset of Rapa whelk fishers, those in Turkey's Black Sea. Economically efficient and inefficient boats were also compared in the study. The data obtained through face-to-face interviews with 452 boat owners constitute the main data of the study. Data were collected about the economic efficiency of the boats for one year. While economic efficiency ranged between 0.27 and 1, the average value was found to be 0.60. It was concluded that the age of the owner, the education period, and the length of the fishing boat positively affected economic efficiency ($p<0.05$). In the boats studied, technical efficiency scores were greater than economic efficiency scores. This suggests that rather than technical information, fishers require information on selecting the optimum input combination at the data cost level.

Keywords: *Rapana venosa,* economic efficiency, data envelopment analysis (DEA), Black Sea

Öz: Gelişmiş ve gelişmekte olan ülkelerde balıkçı filolarının sayısal ve teknolojik kapasitesindeki kaçınılmaz artış, sınırlı doğal kaynak kapasitesinin yönetimi ve dağıtımı ile balıkçılığın ekolojik ve sosyo-ekonomik sürdürülebilirliği üzerinde önemli etkilere sahiptir. Balıkçılık yönetiminde doğru kararların verilebilmesi için bu etkilerin belirlenmesi önemlidir. Bu çalışma, Türkiye'nin Karadeniz kıyılarında bulunan deniz salyangozu avlayan balıkçıların teknik etkinliği, ölçek etkinliğini ve kapasite kullanımını değerlendirmeyi amaçlamaktadır. Çalışmada ekonomik olarak verimli ve verimsiz tekneler de karşılaştırılmıştır. 452 tekne sahibi ile yüz yüze görüşülerek elde edilen veriler çalışmanın ana verilerini oluşturmaktadır. Teknelerin bir yıllık ekonomik etkinliğini belirlemeye ilişkin veriler toplandı. Ekonomik etkinlik 0,27 ile 1 arasında değişirken, ortalama değer 0,60 olarak bulunmuştur. Tekne sahibinin yaşı, eğitim düzeyi ve balıkçı teknesinin boyunun ekonomik verimliliği olumlu yönde etkilediği sonucuna varılmıştır. Teknelerde teknik etkinlik puanları ekonomik etkinlik puanlarından daha yüksek çıkmıştır. Bu, balıkçıların teknik bilgiden ziyade, veri maliyeti düzeyinde optimum girdi kombinasyonunu seçme konusunda bilgiye ihtiyaç duyduğunu göstermektedir.

Anahtar kelimeler: *Rapana venosa*, ekonomik etkinlik, veri zarflama analizi (VZA), Karadeniz

INTRODUCTION

One of the invasive marine gastropods, the rapa whelk, *Rapana venosa* (Valenciennes, 1846), was first seen in the Black Sea in the 1940s. Rapa whelk has been effective in colonizing the Black Sea ecosystem because of the lack of predators and competitor species (ICES, 2004). Rapa whelk with international demands to Turkey in the 1980s after the post in Bulgaria in the 1990s has also been a commercial species in Romania (STECF, 2015). Until now, Turkish fisheries mostly focused on marine fish and the Black Sea contributed a substantial proportion (80%) of the total fishery of Turkish seas (TURKSTAT, 2020). This implies that the Black Sea accounts for the majority of Turkey's marine fisheries (Dağtekin et al., 2017). Anchovy (*Engraulis encrasicolus*), sprat (*Spratus spratus*), Atlantic bonito (*Sarda sarda*), horse mackerel (*Trachurus mediterianus*), whiting (*Merlangius merlangus*), striped venus clam (*Chamelea gallina*), and rapa whelk (*Rapana venosa*) are the most important species (TURKSTAT, 2020).

Recently, rapa whelk has assumed increasing importance in small-scale fisheries as a crucial source of income, especially with the decrease in turbot, sturgeon, flounder, and other fish stocks (Dağtekin et al., 2021a). Small-scale fishers produced revenue of 5.7 million USD in 2019 (TURKSTAT, 2020). The number of workers involved in fishing, processing, and marketing of Rapa whelk is estimated to be about 5000 (Erik et al., 2020) and the processing industry contributes to local employment. Nowadays, rapa whelk is the most important commercial species in Turkey, Romania, Ukraine, and Bulgaria because all of the catch is exported. In recent years, the volume of catch landings has started to increase (Figure 1). Rapa whelk plays a significant role in terms of socio-economic change and has also led to changes in the benthic ecosystem in the Black Sea. As a result, it is now important to establish a conventional management model for all Black Sea countries that have significant rapa whelk fisheries (STECF, 2015).

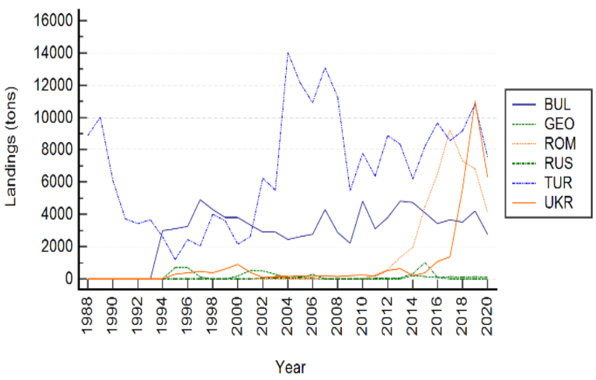

Figure 1. The volume of Rapa whelk in the Black Sea basin

Dredging and diving are two methods used for rapa whelk fishing. In Turkey, permission for rapa whelk fishing must be obtained annually from the Ministry of Agriculture and Forestry. Other fish species besides rapa whelk are also caught by boats. The number of boats licensed by the Ministry in 2018 was 793, of which 659 were dredgers and 134 were diving boats (Erik et al., 2020).

The inexorable rise of the numerical and technological capacity of fishing fleets in the developed and developing countries has brought serious problems regarding the management and share of the limited capacity of natural resources, as well as the ecological and socio-economic sustainability of fisheries (Eigaard et al. 2014; Kumar et al. 2019). This constant increase in fishing effort has resulted in decreased fish stocks decrease and sometimes, catch species population collapse. Therefore, to produce a sustainable management plan, policymakers have to first assess the extent of overcapacity in a fleet in order to regulate fishing capacity and eliminate excess capacity (Madau et al. 2009). The aim of this study was to determine the fishing capacity, technical efficiency, scale efficiency, and degree of capacity used in one sector of the Black Sea rapa whelk fishery, namely that based in Turkey. Economically efficient and inefficient enterprises were also compared.

MATERIAL AND METHODS

Data obtained from face-to-face interviews with Rapa whelk fishing boat owners were used for this study. Data were collected from 452 boat owners who agreed to interview and gave information about their boats (Figure 2). These boats operated along the coast lines of several cities, including Artvin, Rize, Trabzon, Giresun, Ordu, Samsun, Sinop, Kastamonu, Bartın, Zonguldak, Düzce, Sakarya, Kocaeli, Istanbul and Kırklareli all of which are located on Turkey's Black Sea coast.

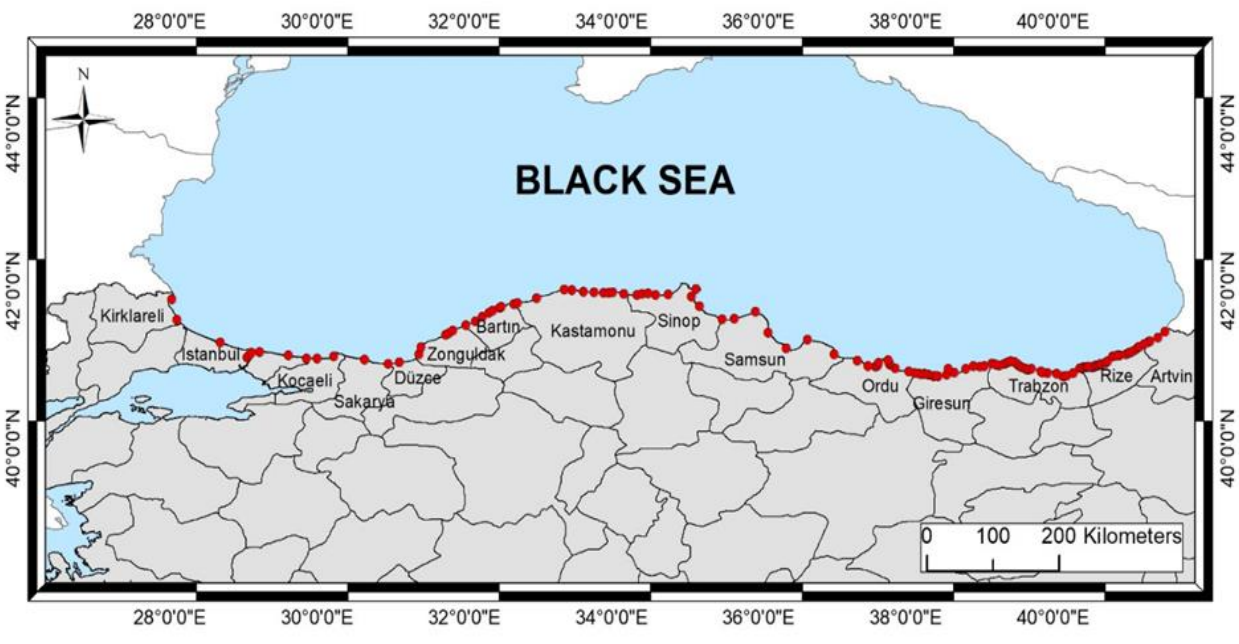

Figure 2. Location of fishing vessel ports/shelters where interviews were carried out

Data were analyzed by basic descriptive statistical methods. T-test was performed when two groups were compared while variance analysis was used when three or more groups were compared. "Two-step method" (two-stage approach) was used for efficiency analysis. This method is recommended as it does not require any prior assumption about the effect of the variables and can be used with more than one continuous or discrete variable. For this reason, this approach has been used in many efficiency analyses (Bravo-Ureta et al., 2007). In the first step of this approach, efficiency coefficients are obtained for each enterprise. In the second stage, the relationship between the variables that may affect the efficiency are assessed and efficiency is then estimated with the help of the appropriate regression model (Coelli et al., 2003).

The distribution of resources in decision-making units and differences in the current technology levels reveal economic efficiency. Economic efficiency, which is a measure of the efficiency of decision units in production, consists of two elements: technical efficiency and allocative efficiency. Technical efficiency indicates the ability to reach the maximum output with a certain amount of input. Allocation efficiency is an indicator of the ability of enterprises to distribute the inputs they use in production in proportion to their costs (Farrell, 1957). Data Envelopment Analysis (DEA), which is a non-parametric method, or stochastic frontier analysis (SFA), which is a parametric method, are widely used in efficiency analysis. However, there are three main reasons why DEA is preferred to SFA in the calculation of efficiency measurements. The first is that a special production function is not required when using DEA. Second, it is not necessary to determine in advance the type of distribution belonging to the error term, which is accepted as the measure of efficiency. The third reason is that DEA is more useful when there is more than one output (Coelli et al., 2003; Kumbhakar and Lovel, 2000).

In this study, Farrell's efficiency measures for input were preferred. Based on the suggestions of Charnes et al. (1978), each fishermen’s fuel expenses, labour expenses, boat maintenance and repair expenses and Rapa whelk, and all other target species (Yi) was assumed. That is, a single output model with three inputs was created. The economic efficiency for input for each boat owner was calculated with the following linear programming model:

$$Minimum_{\lambda, xi*} \quad w_i^T x_i^*$$

$$Limitations \qquad -y_i + Y\lambda \geq 0$$

$$x_i^* - X\lambda \geq 0$$

$$\lambda \geq 0$$

where: wi is the input cost for each fisher; T is the transpose of the function; and xi * is the given input cost, wi, and the output levels; Yi is the vector showing the lowest cost input quantities calculated using the linear programming method for each fishers.

This equation shows the lowest cost for the Constant Returns Scale (CRS) conditions. Economic efficiency for each fisherman was calculated using the formula (EE)=wiTxi*/wiTxi. In this equation, EE is the ratio of the lowest cost to the observed cost for the given input costs and under CRS conditions. The allocation efficiency was calculated with the formula AE=CE/TE (Coelli et al., 2003). Since the fisheries enterprises have insufficient capital and lack information about the market, a restrictor ($N1\lambda = 1$) that provides convexity was added to the CRS model, and the model was transformed into a variable returns to scale (VRS).

Since adding this restrictor to the model prevents the calculation of scale efficiency, the minimum cost in CRS conditions was calculated by proportioning the minimum cost in the VRS conditions when calculating the scale efficiency (Banker et al., 1984). The DEAP 2.1 package program, developed by Coelli (1996), was used for estimating efficiency measurements.

Since efficiency coefficients vary between 0 and 1, and the classical least squares method predicts the coefficients to be larger than necessary, "Tobit regression" was used in this study. The Tobit model is an econometric method proposed by James Tobin that describes the relationship between a non-negative-dependent variable and an independent variable or vector. The information of the dependent variable is known as the censored sampling model, where it is found only for some observations. It is a non-parametric alternative to least squares regression (Liao, 1994). For this reason, the Tobit model is also called the censored or discrete regression model.

RESULTS AND DISCUSSION

The Rapa whelk fishing sector includes fishers and their dependent employees, brokers, and processing plants. In 2018, beam trawlers and divers spent 147 days at sea on average and landed a total of 8,675.98 tonnes of Rapa whelk by 714 boats. Rapa whelk fishing was permitted for 793 boats but not all boats with permission performed Rapa whelk fishing. In the research area an average boat had an income of 16767.1 US$ from fishing activity and to achieve this income incurred the following costs: 4593.5 US$ labour; 565.1 US$ boat maintenance; and 1534.8 US$ for fuel. The technical efficiency coefficient with variable returns to the scale varies between 0.30 and 1, and the average was found to be 0.75. This value shows that inefficient firms can reduce their inputs by 25% without a reduction in output. It was calculated that 46.02% of the enterprises have a lower value than the average technical efficiency calculated. With a constant return to the scale, the technical efficiency coefficient was found 0.72 and the scale efficiency was calculated as 0.96. Scale effectiveness shows whether the enterprises are on optimal scale. We found that 27.43% of the enterprises have a lower value than the calculated average scale efficiency value. Resource allocation efficiency was between 0.34 and 1, with an average of 0.80 for the enterprises examined. This value indicates that boats spend 20% more than the minimum cost combination of inputs. In this area 42.26% of the enterprises have a lower value than the average resource allocation efficiency value calculated While economic efficiency ranged between 0.27 and 1, the average value was 0.60, which shows that economically inefficient enterprises would need to reduce their operating costs by 40% to reach the level of similar but economically efficient enterprises (Table 1).

Table 1. Descriptive statistics for efficiency scores

Efficiency measurements	Mean	Standard deviation	Lower	Upper
Technical efficiency	0.72	0.13	0.24	1.00
Pure technical efficiency	0.75	0.13	0.30	1.00
Scale effectiveness	0.96	0.07	0.31	1.00
Resource allocation efficiency	0.80	0.10	0.34	1.00
Economic efficiency	0.60	0.11	0.27	1.00

Scale effectiveness of present study was the same as the value found in this study (0.96). Dağtekin et al. (2021b) found that technical efficiency in pelagic trawl boats ranged from 0.413 to 0.998, with an average of 0.739. The frequency distribution of efficiency scores is given in Table 2. We found that technical efficiency scores and pure technical efficiency were mostly between 0.700-0.799. In addition, the scale effectiveness scores were mostly between 0.950-0.999 and that most enterprises were close to the appropriate scale level.

Table 2. Frequency distribution of efficiency scores

Efficiency level	Technical efficiency	Variable returns to scale	Scale effectiveness	Resource allocation efficiency	Economic efficiency
0.200-0.299	3	1	0	0	2
0.300-0.399	3	2	1	6	20
0.400-0.499	24	21	1	3	47
0.500-0.599	38	23	3	14	161
0.600-0.699	97	87	2	29	154
0.700-0.799	183	161	6	139	44
0.800-0.899	69	97	47	201	17
0.900-0.949	12	18	50	44	3
0.950-0.999	6	4	311	12	0
1.000	17	38	31	4	4
Total	452	452	452	452	452

In terms of resource allocation efficiency, the efficiency scores were predominantly between 0.800-0.899. It was striking that the obtained score values were mostly between 0.500-0.599 and 0.600-0.699, and the economic efficiency of the enterprises was low. There were 38 fully technically efficient, four fully efficient in terms of resource allocation efficiency and economic efficiency, and 31 optimal scales operating enterprises.

A sizeable proportion of the enterprises examined (46.90%) had a decreasing return to scale, while a similar proportion (46.24%) had an increasing return to scale, and 6.86% have constant returns to scale (Table 3). It was found that the income of enterprises with increasing returns to scale is considerably lower than enterprises with a constant return to scale and in turn boats with decreasing returns to scale earned 1.18 times more income than enterprises with fixed returns to scale, but the labour cost, boat maintenance costs, and fuel costs were 1.31, 1.71, and 1.11 times higher, respectively. Variance analysis results identified significant differences by return group amongst the following variables: fishing income (F=18.444, p<0.001), labour wage (F=15.149, p<0.001), boat maintenance cost (F=10.330, p<0.001) and fuel cost (F=27.096, p<0.001).

The classification of boats according to their technical efficiency is given in Table 4. Only 8.41% of the enterprises worked technically fully effectively. In addition, 0.88% of the enterprises worked efficiently, 3.98% of them worked less effectively, and the majority (86.73%) were not technically efficient.

Analyses of the calculated resource allocation efficiency scores showed that 0.88% of the enterprises were fully efficient in resource allocation, 2.65% were efficient and 9.73% were less efficient. Once again, 86.73% did not allocate resources efficiently. Thus, when the current technology level and current input costs are taken into account, most of the enterprises produce with the wrong input combination. The present study found that only 0.88% of the enterprises worked economically fully effectively, that is, they continue their production with a minimum cost input combination. While 0.66% of the enterprises were found to work less effectively, it was shown that 98.52% of them did not work economically effectively. It was also determined that the average and optimum input levels and potential improvement rates of the enterprises were not economically efficient.

Table 3. Scale effectiveness analysis results

Return to scale	Frequency	%	Fishing income (US$)	Labour cost (US$)	Boat maintenance cost (US$)	Fuel cost (US$)
Decreasing return to scale	212	46.90	22296.4[a]	6228.5[a]	681.0[a]	1967.5[a]
Increased return to the scale	209	46.24	10841.0[b]	2911.9[b]	472.1[b]	1061.0[b]
The constant return to scale	31	6.86	18907.1[a]	4748.8[a]	399.0[b]	1770.0[a]

*The averages of the groups shown with different letters are different at a 5% significance level. (1 USD:6.88 TRY)

Table 4. Classification of boats according to their technical efficiency

Efficiency status	Technical efficiency		Variable returns to scale		Scale effectiveness	
	Frequency	%	Frequency	%	Frequency	%
Fully effective (TE = 1)	17	3.76	38	8.41	31	6.86
Effective (0.95 ≤ TE ≤ 1)	6	1.33	4	0.88	311	68.81
Slightly effective (0.90 ≤ TE ≤ 0.949)	12	2.65	18	3.98	50	11.06
Ineffective (TE ≤ 0.899)	417	92.26	392	86.73	60	13.27
Total	452	100.00	452	100.00	452	100.00

Descriptive statistics of the variables used in the Tobit model are given in Table 5. Findings included the average age of boat owners was 44.48 years, the average period of education was seven years, and the average family size was 4.45 individuals. The average income of boat owners from any activity other than fishing was 301.9 US$. The average length of boats was 8.74 m, and the engine power was 108.54 HP. Nearly one fifth (19%) of owners had a second profession other than fishing. In addition, most fishers used dredge (99.12%) and only a small proportion (0.88%) caught whelk by hand diving.

Table 5. Descriptive statistics of variables used in the Tobit model

Tobit model	Average	Standard deviation	Lower	Upper
Business owner age (year)	44.48	10.99	21.00	84.00
Education period of the owner (years)	7.01	2.84	0.00	15.00
Family size (person)	4.45	1.66	1.00	11.00
Non-fishing income (US$)	301.9	1238.2	0.00	19767.4
Boat length (m)	8.74	1.76	4.70	20.00
Boat engine power (HP)	108.54	76.26	6.00	480.00
Occupation other than fishing[1]	0.00			
Way of fishing[2]	1.00			

As a measure of central tendency, the arithmetic means in the data at interval and ratio level, the median in the rank data and the model in the classified data were used.
[1] No: 0, yes: 1 is included in the model.
[2] Dredge:1, diving:2
(1 USD:6.88 TRY)

The results of the Tobit model created for determining the factors affecting economic efficiency are given in Table 6. Thepositive or negative effect of most of the variables included in the model was as expected, with the income from non-fishing and the engine power of the boat having a positive effect on economic efficiency, but the fishing style and the need for a professional other than fishing, a negative affect. However, these variables were not statistically significant (p>0.10).

Table 6. Tobit analysis results: Factors affecting economic efficiency

Variable	Coefficient	Standard error	P
Boat owner's age (years)	0.000920*	0.000519	0.0760
Business owner's education period (years)	0.004475**	0.001953	0.0219
Family size (person)	-0.006218*	0.003201	0.0521
Non-fishing income (US$)	0.0000047	0.000006	0.4641
Boat length (m)	0.008207*	0.004276	0.0550
Boat engine power (HP)	0.000009	0.000009	0.3450
Way of fishing	-0.007666	0.010300	0.4567
Professional other than fishing	-0.008652	0.014308	0.5454
Likelihood ratio	30.06660***		

*Important at the 10% probability level
**Important at the 5% probability level
***Important at the 1% probability level

The age of the owner of the boat affected the economic efficiency positively (p=0.0760). As owners got older, the economic efficiency increased. This might be expected as more experienced older people take advantage of their greater experience and knowledge. More experienced boat owners made more accurate decisions in terms of both the level of input use and application of production techniques compared to younger, less experienced operators. The boat owner's education period also positively affected economic efficiency, as the duration increased, the economic efficiency increased (p=0.0219). This situation be defined as producers with a high education level were more conscious and therefore earned more income. Family size negatively affected economic efficiency (p=0.0521). As family size increased, economic efficiency decreased. The size of the fishing boat positively affected the economic efficiency (p=0.0550). As the length of the boat increased, fishing becomes more efficient, the amount of fish caught increased, and thus larger boat size increased income and thus economic efficiency. A comparison has been made between economically fully efficient and inefficient enterprises, and the results obtained are given in Table 7.

Table 7. Socio-economic characteristics of active and ineffective boats

Variables	Effective boats	Ineffective boats
Demographic variables		
Boat owner's age (years)	48.50 (11.90)	44.44 (10.99)
Boat owner's education period (years)	14.00 (2.00)***	6.95 (2.77)***
Family size (person)	3.75 (1.50)	4.46 (1.67)
The number of fishers in the household (number)	0.75 (0.96)	0.46 (0.91)
Profession outside fishing[1]	0.00	0.00
Non-fishing income (US$)	0.00 (0.00)***	2095.85 (8554.42)***
General characteristics of boats and activity results		
Boat length (m)	10.33 (4.58)*	8.73 (1.72)*
Boat engine power (HP)	224.50 (196.29)***	107.50 (74.08)***
Boat value (US$)	26162.79 (23496.81)**	12712.35 (11020.10)**
Value of equipment (US$)	5069.04 (6415.79)	3818.65 (4418.72)
Fishing pattern[2] (median)	2.00**	1.00**
Fishing income (US$)	85356.10 (153573.80)***	16154.73 (14515.84)***
Costs		
Labour cost (US$)	25423.93 (50041.71)***	4407.50 (4502.74)***
Boat maintenance cost (US$)	1061.05 (927.96)*	560.64 (521.83)*
Fuel cost (US$)	2925.15 (3954.08)**	1522.39 (1308.53)**

As a measure of central tendency, the arithmetic means in the data at interval and ratio level, the median in the rank data and the model in the classified data were used. (1 USD: 6.88 TRY)
1 Boat with a profession other than fisheries are included in the model with a value of 1, and boats with a value of 0.
2 The type of catch is included in the model with a value of 1 dredge, and 2 with a diver.
**The difference between economically efficient and non-economically efficient enterprises is statistically significant at the 10% probability level.*
***The difference between economically efficient and non-economically efficient enterprises is statistically significant at the 5% probability level.*
****The difference between economically efficient and non-economically efficient enterprises is statistically significant at the 1% probability level.*

The average age of economically efficient boat owners and the number of people fishing together in their households tended to be slightly higher than in ineffective boats, while the family size was lower. The proportion of owners having a profession other than fishing in effective and ineffective enterprises was similar. The value of the equipment owned by effective boats also tended to be greater than for inefficient boats. However, these variables were not significant (p>0.10).

The education period of owners of effective enterprises were considerably higher than inefficient enterprises (t=-6.994, *p*=0.005), suggesting that education level plays an important role in efficiency. While inefficient boats earned income from sources other than fishing, efficient boats had no income other than fishing (t=5.186, *p*<0.001). The length of the boat (t=-1.814, *p*=0.070), the engine power of the boat (t=-3.083, *p*=0.002) and the value of the boat (t=-2.402, *p*=0.017) owned by effective enterprises were higher than for inefficient enterprises. This shows that higher quality tools and equipment have a positive effect on efficiency. The income of the effective enterprises from fishing activities was considerably higher than the inefficient enterprises (t=-7.197, *p*=0.001). Labour costs (t=-6.895, *p*=0.09), boat maintenance costs (t=-1.896, *p*=0.059) and fuel costs (t=-2.079, *p*=0.038) of effective enterprises were higher than ineffective enterprises. Thus, the costs of effective enterprises were higher, but their income earned from fishing was approximately fivefold higher.

An large proportion of Rapa whelk landing occurs in the Samsun shelf area. However, the length of the boats and engine power is greater than in other regions. Therefore, the unit costs increased and will have an effect on efficiency scores. Tingley et al. (2005) determined the average technical activity as 0.56, 0.76, and 0.79 according to three different fishing activity categories in England for the period 1993–2000. Esmaili, (2006) calculated the average technical efficiency for fishing activity as 0.78, in Iran. In another study conducted in Portugal (Oliveira et al., 2010), with the same study, the technical efficiency and pure technical efficiency values for the local fleet and coastal fleet in 2005, 2006 and 2007 were calculated using a single methodology to be 0.74, 0.66, 0.58 and 0.81, 0.91, 0.79 respectively. Thean et al. (2011) found the average technical efficiency value to be 0.57 for trawlers in Malaysia. Ceyhan and Gene (2014), found that the average efficiency value was 0.667 when using trawl and purse-seine together, but 0.535 for those only using trawl in Samsun province. Kaygısız and Evren (2014) calculated the production efficiency of fishing operations in Turkey and the technical efficiency calculated value (CRS) was found to be 0.66. According to this study results, it was determined that, to become economically efficient, enterprises should make a 63.37% decrease in the labor wage, 1.39% decrease in fuel costs, and an increase of 84.01% in boat maintenance costs. Kaygısız and Evren (2014) reported that if fuel costs were reduced by 59.27%, enterprises would become fully effective. Zhaoqun et al. (2016) determined that 92.90% of fishing enterprises were not technically efficient, and only 7.10% showed technical efficiency scores above 0.90. It was calculated that 6.86% of enterprises work at the optimal scale, that is, their scale effectiveness scores were equal to 1. Besides, it was concluded that approximately 2/3 (68.81%) of the enterprises work close to the optimal scale.

According to the present study, the technical efficiency amongst fishing enterprises in Rapa whelk fishing was found to be 0.75. The technical efficiency was at a good level but was not at the optimum level. The lower pure technical efficiency scores than the scale efficiency scores indicate that the low technical efficiency was due to the ineffectiveness of the scale rather than the ineffectiveness of input use.

CONCLUSIONS

The average resource allocation efficiency was 0.80 for the enterprises examined. Considering the current technology level and input costs, this situation can be explained by production using the wrong input combination by some enterprises. These enterprises spent 20% more than the minimum cost input combination. The average economic efficiency was 0.60 in the study area. Enterprises with economic inefficiency would need to reduce their operating costs by 40% to reach the level of their peers with similar and economically efficient enterprises. Technical efficiency scores were higher than the economic efficiency scores in the enterprises examined. This indicates that producers need information on choosing the appropriate input combination at the data cost level rather than technical information. Analysis revealed the positive effect of older age and better education levels of the owner, and also of larger boat sizes. Comparative analysis revealed that efficient boats were more successful than inefficient boats in all respects. To move the efficiency measures of poorly performing enterprises towards those of their efficient peers, first, access to information resources should be facilitated with well-organized dissemination studies. More effective operation of institutions and organizations that conduct extension services and the emphasis on the technical aspect of fisheries in their studies increased the efficiency in the field of examination. It does not appear that production can be increased because Rapa whelk supplies are being utilized to their maximum capacity. As catch cannot be increased further, research in Rapa whelk fisheries should focus on identifying strategies to optimize profit.

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APPENDIX
QUESTIONNAIRE ON DETERMINING THE EFFECTIVENESS OF RAPA WHELK FISHING

A-SOCIAL PROFILS OF BOATS OWNERS

1- How many people live in the household?............................ (male: age 0-14…….,, 15-64 years:……., 65+ years:………. Woman:……. 0-14 years.……,, 15-64 years:……., 65+ age:……….)
2- Number of children (If there is polygamy, the total number of children from both spouses will be taken into account): ………… (Male:……, Female:…….)
3- The number of people you fish with in your household: Male:………….., Female:………….
4- Age: …………………..
5- Educaiton level:……………….
6- Second job, if any………………… and income:………….
7- What are your reasons for starting/preferring the fishing profession? (Indicate the degree of importance numerically)
   1. ( ) Because it is a family profession
   2. ( ) Because I have no other profession
   3. ( ) Because I couldn't find a job in another field
   4. ( ) Interest/love towards the sea
   5. ( ) To work after retirement (additional income)

8- Are you satisfied with fishing?	
Satisfaction level Rationale	**Reason**
a. Satisfied	( ) My main source of income ( ) Love of the sea ( ) Other (specify):……………………..
b. Not satisfied	( ) Low income ( ) Heavy working conditions ( ) Income instability ( ) Other (specify): ……………………..

B-BOATS INFORMATION

Region where the boat is licensed		
Boats	Name and Number	
	Length of overall (m)	
	Engine power (HP)	
Equipment	Communication gear	
	Radar	
	Other…..	
Fishing method	( ) Diving ( ) Dredge	

C-Rapa whelk fishing periods

	Month											
	Jan	Fab	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fishing area												
Fishing gear												
Active fishing days												
Rapa whelk catch (kg)												
Daily operation time (hour)												
Number of fishing operaitons												
Each operation time (minute)												
Depth (m)												

D-INFORMATION ABOUT GILLNET FISHING

GILLNET FISHING PERIOD	Month											
	Jan	Fab	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number of days												
Landings (kg)												
Target fish species												
Turbot (kg)												
Whiting (kg)												
Horse mackerel (kg)												
Atlantic bonito (kg)												
Red mullet (kg)												
Bluefish (kg)												
Other (specify)……….												
Other (specify)……….												
Other (specify)……….												
Other (specify)……….												

E- INCOME-COST STATUS OF BOATS

COSTS	VALUE (TURKISH LIRA)
Crew	
Maintenince	
Fuel costs	
Technical device purchase	
Gears	
Commercial costs	
Other …..	
Other……	
Value of boats	
Value of equipments	

INCOME	VALUE (TURKISH LIRA)
Rapa whelk	
Turbot	
Whiting	
Horse mackerel	
Atlantic bonito	
Red mullet	
Bluefish	
Other……..	
Other……	
Other…..	
Other……..	

NON FISHING INCOME OF THE BOAT OWNER	VALUE (TURKISH LIRA)
Retirement	
Farming	
Small business	
Other	
Name and surname of fishers	
Tel	