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Fishery Resources and Trade Openness: Evidence from Turkey

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Abstract

There is an ongoing debate over the potential effects of international trade on fishery resources. In this study, we investigate whether the trade in fish and fish products contributed to the decline in a given number of fish species in Turkey. The overall purpose is to test the theoretical findings of Brander and Taylor (1997) who argue that trade openness decreases fish harvest in a small open economy characterized by a regime of open-access to fishery resources. To this end, we estimate a panel data model to measure the effects of trade openness on fish harvests in the case of 57 fish species observed from 1996 to

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2009 in Turkey. We estimate Turkish fish harvests in terms of the relative importance of openness to trade as well as in terms of biological characteristics, in addition to economic and technological factors. Estimation results reveal a backward-bending supply curve for the fish harvest. Furthermore, we find that the indicator of openness to trade has a significant and positive impact on the fish harvest. Our results suggest that further openness to trade would put additional pressure on Turkey's already declining fishery resources.

Keywords: openness to trade, fish harvest, fishery technology, biological factors, panel data model.

JEL: Q22, Q56, C33.

1 Introduction

Worldwide, fishery resources are under threat. It is recognized that most of the world's commercial fisheries could collapse within just a few decades (Costello et al., 2008, p.1678). FAO (2009) reports that approximately 80 percent of the world fish stocks are fully exploited or overexploited. The tragedy of the commons is characteristic of both domestic and international fisheries. This is due to the fact that property rights governing fishery resources are usually ill-defined. This is especially true for developing countries. The majority of these countries have also undertaken trade liberalization reforms over the last two decades (Ferreira, 2004). Turkey, which is considered as an upper-middle income country[1], has implemented a number of reforms to liberalize its economy since the '80s. Its waters are relatively fish-abundant; however, over that same period, its fish stocks have come under threat (Turkish Marine Research Foundation).

Numerous trade reforms were introduced between 1980 and 1985 in Turkey. They mainly focused on eliminating import quotas, and they reduced the stamp duty from 25 percent to 1 percent. To ease foreign trade with the European Union, Turkey joined the Custom Union in January 1995 (Guncavdi and Kucukcifci, 2005).[2] These trade reforms have also been undertaken in the fishery sector. In terms of fish and fish products, both the

[1] Turkey has experienced significant growth over the last two decades. GDP growth was 9.4% in 2004, 8.4 % in 2005, 6.9 % in 2006, 4.7 % in 2007, 0.7 % in 2008, and -4.7 % in 2009 (World Bank Development Indicators). TurkStat (Turkish Statistical Institute) reports that the growth rate for 2010 was 9 %.

[2] Moreover, in order to stimulate exports, Turkey provided tax rebates, subsidized credit and other such incentives which made the duty-free import of raw materials possible (Guncavdi and Kucukcifci, 2005, p.5).

exports and imports of Turkey increased in value (in millions of U.S. dollars) between 1980 and 2000 (EarthTrends, 2003).[3] At the same time, several reports have emphasized a decline in Turkey's fishery resources. The Turkish Marine Research Foundation stresses that the numbers of many species are dropping in all waters, even in the Black Sea, Turkey's most productive sea in terms of marine fish production. In 2008, OECD reported that the number of known fish species in Turkey was relatively high (450) and that 11.1% of them, that is to say 50 species, were threatened. These observations led us to ask the following question: has the international trade in fish and fish products contributed to the decline of some fish species in Turkey?

This paper attempts to shed light on the trade-fishery resources debate by using harvest data for a panel of fish species observed from 1996 to 2009 in Turkey. We estimate an econometric model to measure the effect of openness to trade[4], in fish and fish products, on Turkey's fish harvests. We have constructed a pertinent data set by bringing together TurkStat data on the yearly harvest of numerous fish species with other economic, technological, and biological information. These data, which come from a variety of sources, are the grounds to investigate Turkish fish harvests in terms of the relative importance of openness to trade as well as in terms of biological characteristics, in addition to economic and technological factors.

Trade impacts the dynamics of renewable resources. Indeed, four means

[3] This finding also holds for the period 1996-2009. Using the TurkStat data set for 1996-2009, we first note that the deflated values of both exports and imports (in YTL, New Turkish Lira) increased over time. Secondly, the deflated value of exports was higher than that of imports (see Figure 2).

[4] Rather than focusing on trade liberalization, this study focuses on trade intensity (or trade exposure, interchangeably).

have been pointed out (Fischer, 2010). First, trade induces changes in relative prices of resource-intensive products. This, in turn, modifies the incentives to harvest the resources. Second, trade may modify the level of national income (in relation with the demand for resource-intensive products). Third, trade can modify the way in which property rights covering fishery resources are managed. Finally, trade can induce a direct negative externality on fishery resources via the introduction of invasive species in water resources.

There has been a growing interest in theoretical research that investigates the link between trade and renewable resources (for a recent review of the literature see Fischer, 2010, and for a more technical focus, see Bulte and Barbier, 2005). Chichilnisky (1994) has shown that a "pollution haven" type of result could arise when two identical regions in technology, preferences, and endowments, but asymmetric in terms of institutional governance of renewable resources, open their economy to trade. The "North" with well-defined property rights on renewable resources over-imports resource-intensive products from the "South" which has an open-access regime on these resources. Brander and Taylor (1997) have also pointed out the negative effects of trade on renewable resources for a small open economy. In a dynamic model for renewable resources, they have shown that in a majority of cases the resource-exporting country is worse off under trade.[5] The above-mentioned models assume that the regimes of property rights are exogenous. This assumption has been challenged, among others, by Hotte et

[5] A large resource exporter may be much worse off under trade. See Brander and Taylor (1998).

al., 2000, and Copeland and Taylor, 2009. Copeland and Taylor (2009) have characterized three types of property rights regimes on renewable resources based on the basic parameters of the model (economic, technological and biological factors, as well as the enforcement power of a government). The model combines the Brander and Taylor (1997) renewable resource model with a model of asymmetric information in which harvesters are supposed to have an incentive to cheat on their harvest quotas. They show that trade liberalization may lead to a better management of resources in economies with enough enforcement power in a context with a high level of relative resource prices.

Although the link between trade and renewable resources has been extensively studied from a theoretical point of view, relatively little is known about the underlying empirical link.[6] As concerns the trade-deforestation debate, Ferreira (2004) has carried out an econometric analysis based on the theoretical model proposed by Chichilnisky (1994). The estimation involves a cross-section of countries. The results suggest that openness to trade on its own has no significant effect on deforestation rates; however, the interaction between the openness to trade and measures of institutional quality[7] does indeed have a significant effect.[8] To our knowledge, there is no exist-

[6] For case studies, see for instance Lopez (1997, 2000).

[7] Also see Deacon (1994), and Bohn and Deacon (2000) who have investigated the effects of institutions on natural resources. Their estimations indicate that weak property rights are an important cause of deforestation.

[8] It is worthwhile noting other empirical studies addressing the measurement of the effects of trade on overall emissions of a country. Antweiler et al. (2001) were the first to propose a theoretical model (and to test it) which makes it possible to separate the impact of trade on pollution into scale, technique and composition effects. They have estimated the determinants of SO2 pollution concentrations in the case of a panel of countries. Recently, Managi et al. (2009) have extended the work of Antweiler et al. (2001) to different pollutants (SO2, CO2 and BOD). From an econometric point of view,

ing empirical analysis of the effects of trade on fishery resources.[9] In this investigation, we aim to test some of the findings of the theoretical model of Brander and Taylor (1997) in the case of data reflecting the facts of the situation in Turkey. More specifically, our aim is to assess if, as they theorize, openness to trade decreases fish harvests in a small open economy characterized by a regime of open-access on fishery resources. Indeed, can we find evidence of the stock depletion effect which sumps up Brander and Taylor's findings about trade openness? To this end, we use an econometric model, based on harvest data for a panel of fish species observed from 1996 to 2009 in Turkey. We use the same model to estimate the effects of other economic, technological, and biological factors on fish harvests. This is carried out by constructing a unique data set for the Turkish fishery sector, using several sources of information. Compared to studies using purely cross-sectional data, our panel data model contains far more information than single cross-sections and thus allows for an increased precision in estimation.

This paper is organized as follows. In the following section, we describe the main characteristics of the Turkish fishery sector, in terms of fishery production, fish trade, and fishery management. In Section 3, we present the theoretical model of Brander and Taylor (1997). Section 4 describes the data set and the econometric methodology. In Section 5, we provide the estimation results. Section 6 offers concluding remarks in terms of fish harvest and openness to trade as well as in terms of economic, biological

they have considered trade and income as endogenous by using the instrumental variables technique.

[9] Costello et al. (2008) and McWhinnie (2009) have contributed to empirical fisheries research, basing their investigations on econometric methods. These studies do not take into account trade in fishery resources.

and technological factors.

2 Turkish Fishery Sector

Turkey has a favorable position in terms of marine capture fishery because it has access to the fish resources of four seas: the Black Sea in the north, the Mediterranean Sea in the south, the Sea of Marmara between the European and Asian landmasses, and the Aegean Sea in the west.[10] The length of the entire coastline is approximately 8,140 kilometers, and the claimed Exclusive Economic Zone is 176 643 km^2 long (Earth Trends, 2003). Turkey is also rich in terms of inland water resources with a high potential for capture fishery and aquaculture (OECD, 2005).

2.1 Fishery production

Turkey could be considered as a small open economy in terms of fish production. Turkstat (Sea Products Statistics) reports that from 2003 to 2007 Turkey provided on average 0.6 % of the total world production of fish. The harvest of pelagic species represents the majority of harvests. The main pelagic species are anchovy, bonito, horse mackerel, sardines, and bluefish. Around 60-70% of total landings (in volume) involve anchovies, and it is the most significant pelagic species in terms of harvest and in terms of tastes favored by the Turkish population (FAO, 2008). In the case of Turkey, the fishery sector's contribution to the national income is negligible. FAO (2008) reports that in 2006 the whole sector (including aquaculture, processing and

[10] See the map in Appendix 1.

support industries) represented a mere 0.4 percent of Turkish GDP.

The total marine production of Turkey increased steadily from 1975 up to 1988, reaching at that point in time 676,000 tons. The late 80s marked the collapse of the fishery stocks (especially anchovy stocks). Marine production fell to 300,000 tons. In 1995, it attained the level of 1988 (OECD, 2005). The evolution of total harvest of sea fish and other sea fish (crustaceans and molluscs) between 1996 and 2009 is represented in Figure 1. The figure clearly shows that fish landings slightly decreased during that period. The figure veils, however, the existing heterogeneity in fish harvests when it comes to fish species.

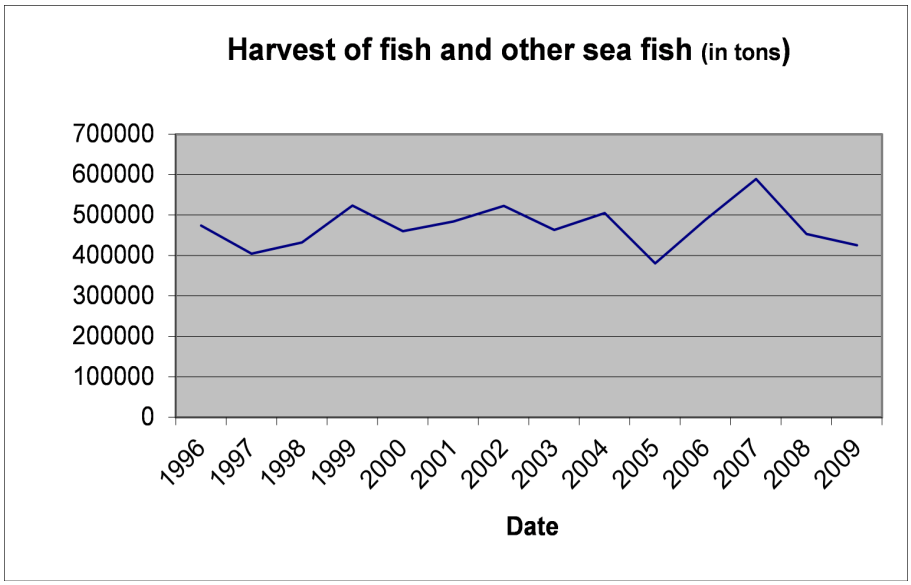

Figure 1: The evolution of harvest of fish and other sea fish in Turkey

Source: TurkStat, Agriculture, Sea Products Statistics

Several reports point out the increasing number of threatened fish species in Turkey. The Turkish Marine Research Foundation reports that the fish species under threat are bluefin tuna, swordfish, sturgeon, Atlantic mackerel, and turbot.[11] Figure 4 in Appendix 3 plots the harvest profile of some fish species included in our data set. In the period 1996-2009, we note that the harvest of the above-mentioned threatened species is effectively decreasing while that of sprat, silverside, thornback ray or common cuttlefish follows an increasing trend. This account of the situation once again stresses the importance of taking into account the heterogeneity of fish species in terms of harvest.

2.2 Fish trade

The Turkish fishery activity in 2009 can be summarized as follows: production, 623,191 tons; export, 54,354 tons; import, 72,86 tons; domestic consumption, 545,597 tons; processed fish, 90,211 tons; not used, 5,715 tons; consumption per capita, 7.5 kg (TurkStat). These statistics indicate that currently Turkish fish production is mainly dedicated to domestic consumption. Fresh and chilled products rank first on the list of total fish export products while bivalve and molluscs rank second. As regards 2009 fish trade statistics, the main markets for export opportunities, in terms of the value of exports, are Japan, Italy and the Netherlands. Among total fish import products, the first item is frozen fish. Turkey imports fish products mainly from Norway, France, and Iceland (TurkStat, 2009).

[11] The Sea Around Us Project (SAU) considers the following species as under threat in Turkey: shark, angel shark, dusky grouper, and common sea bream.

At this time, the fishery sector does not play a key role in Turkish exports. Nevertheless, over the last two decades the increasing trend in export values for the fishery sector (see Figure 2) reflects the high potential Turkey has for exporting fishery products and in turn, perhaps for exerting additional pressure on fish stocks.

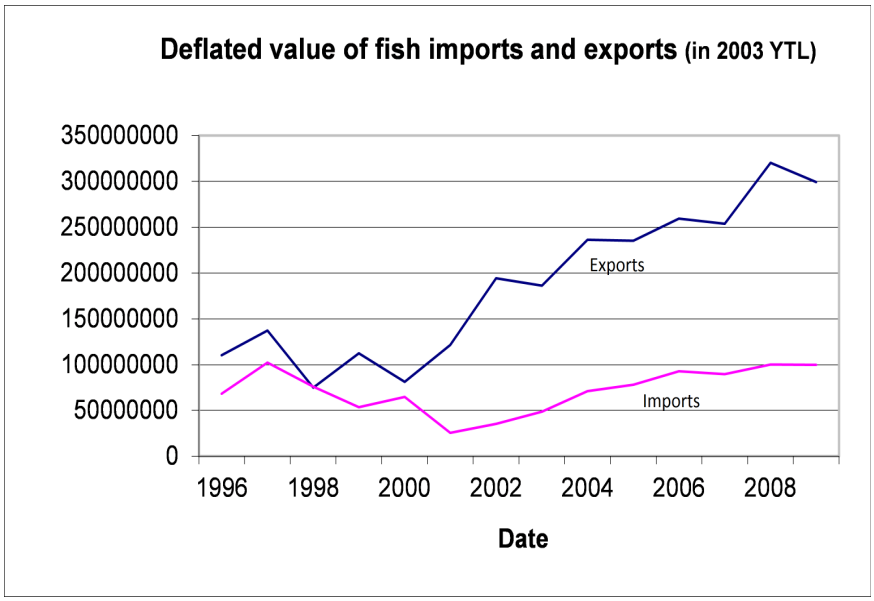

Figure 2: The evolution of the real values of fish imports and exports (*Source*: TurkStat)

2.3 Fishery management

Turkey lacks effective regulatory and market instruments for the management of property rights in fisheries. It mainly uses basic regulatory instru-

ments in fishery.[12] The majority of management instruments are based on regulations such as minimum mesh size, minimum fish size, closed area and terms for specified gears and /or vessels, closed season and area, a ban on catch (in the case of some species such as dolphin, seal, salmon, sea turtle, a kind of sponge, corals and sturgeons), wholly forbidden fishing techniques and nets, and gear restriction for identified species (OECD, 2005). In terms of output controls, there is no quota scheme for the management of fish stocks, except for bluefin tuna. Initially provided government subsidies for the development of the fishery sector lead to overcapacity with adverse effects on fish stocks. According to the subsidy categories of Sea Around Us Project, in 2000, beneficial subsidies, such as fishery research and development, were much lower (6,190 US$, inflation adjusted) than harmful subsidies which were estimated to be 59,594 US$. Some of these harmful subsidies are boat construction, renewal and modernization, tax exemption and fuel subsidies. Although since 2002 no additional vessel licences have been delivered, the current fishing fleet is still considered to have an excess capacity (FAO, 2008).

3 Theoretical Foundations

Our aim is to test the harvest profile proposed by Brander and Taylor (1997). We first summarize the main properties of this model.

The model is a two-sector general equilibrium model for a small open

[12] Copeland and Taylor (2009, p. 740, footnote 15) mention the work by Hannesson (2004) which stresses a progression in the use of policy instruments in fishery: initial instruments are usually season closures or age/size restrictions, followed by overall caps on the total allowable catch, entry restrictions, and sometimes individual quotas.

economy. The fishery resources are governed by an open-access regime.

The "Manufactures" (M) good (the numeraire with $p_M = 1$) is produced from Labor (L_M) with a one-for-one technology[13]: $M = L_M$. The conditions of perfect competition in the labor sector imply that the wage (w) is equal to one if the manufactures good is produced.[14]

The "Resource" good (H) is produced from Labor (L_H) and the resource stock (S) with a constant-returns-to-scale Schaefer production function: $H = \alpha S L_H$, with $\alpha > 0$, the catchability coefficient. This coefficient describes the implicit harvest technology. The evolution of the resource stock over time is dictated by the difference between the logistical biological growth function and the harvest: $\frac{\partial S}{\partial t} = G(S(t)) - H(t) = rS(1 - S/K) - \alpha S L_H$, where $r > 0$ is the intrinsic growth parameter and $K > 0$ represents the carrying capacity of the resource.

The representative consumer, which owes one unit of labor, has a Cobb-Douglas utility function made up of the consumptions of the manufactures good (m) and the resource good (h). Its programme is written as follows: $Max \quad u = h^{\beta} m^{1-\beta} \qquad s.t. \quad w = ph + m$, where p is the relative price of the harvest good.

The steady-state level of the harvest at autarky is written in the following way: $H_A = \alpha\beta LK(1 - \alpha\beta L/r)$.

Comparative statistics show that the steady-state harvest positively depends on r and K, and on α, β and L if $(r/L) > 2\alpha\beta$. This condition says

[13] Hannesson (2000) extends the model of Brander and Taylor (1997) by allowing diminishing returns to scale in the manufactures good sector.

[14] This condition is satisfied by the assumption of a Cobb-Douglas utility function, which implies that the two consumption goods are essential.

that the resource flow, measured by r, must be sufficiently high, in that the country could be considered as a "resource abundant" one. Furthermore, the relative autarky price of the resource decreases by an increase in the relative resource abundance of the country, measured by (r/L). In that case, this country has a comparative advantage in the production of the resource good.

We assume that the country is initially at the autarky steady state (equilibrium point E in Figure 3), and then it opens its self to trade. This temporary trading equilibrium is represented by point C. It can be easily shown that the economy specializes in and exports the resource good if the autarky price is lower than the exogenously given world price of the resource p^* (the case considered here). In this case, the country imports the manufactures good. The transition to a diversified-trading steady-state is described in the same figure. As long as the country exports the resource good, the harvest causes the depletion of the resource stock. Therefore, the marginal productivity of labor in the resource sector drops, which makes the vertical intercept of the production possibility frontier move down along the vertical axis. This induces a reduction in the harvest production as well as a decrease in the economy's free-trade budget line. In the end, exports of the resource good, imports of the manufactures good, and the gains from trade all decline. In this case, it is clear that the steady-state utility is reduced with international trade because the consumption possibility set with trade is dominated by the one at autarky.

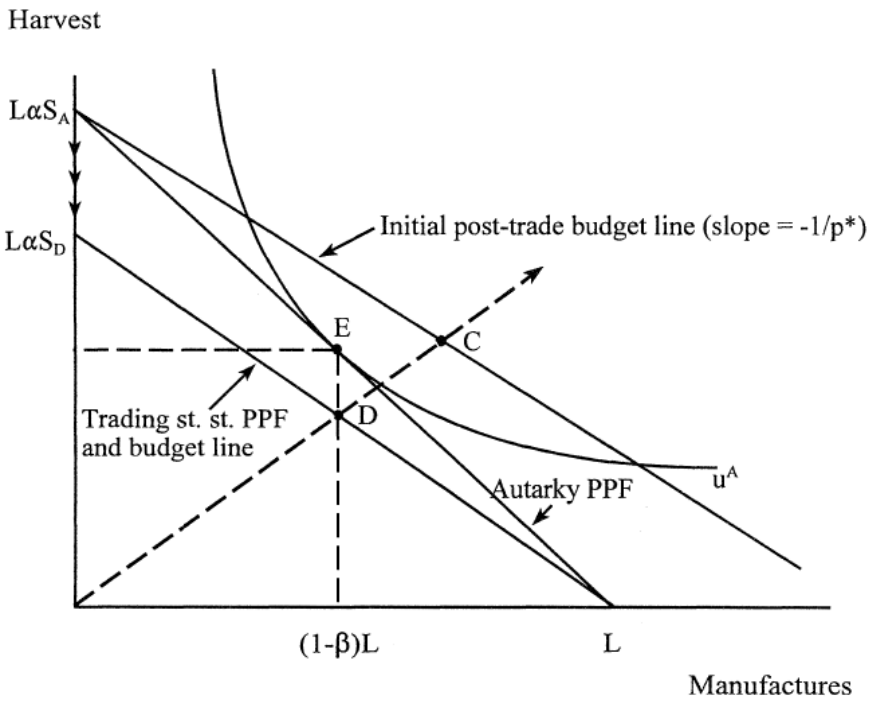

Figure 3: Transition to a diversified-trading steady state (taken from Brander and Taylor, 1997)

Brander and Taylor (p. 541) highlight that « *As production of the harvest falls along this transition path, so too does the economy's free-trade budget line* ». Our aim is to test empirically this finding, that is to say, **when the price of the resource good increases with trade openness, we should observe a fall in the production of the harvest in the case of the overexploitation of the resource**. This would mean that we fall into the decreasing part of the supply curve. This situation is due to the fact that property rights governing fishery resources are ill-defined.

4 Data and Econometric Methodology

4.1 Data

The data have been drawn from a variety of publicly available sources of information. The dependent variable, fish harvest (H), has been garnered from TurkStat data available from 1996 to 2009. TurkStat reports information on catch statistics for each region (East Black Sea, West Black Sea, the Sea of Marmara, the Aegean Sea, and the Mediterranean Sea) as well as for the total of caught sea fish and other sea fish (crustaceans and molluscs) in Turkey. We use the latter information as we are interested in describing the whole Turkish fishery sector. The information on catch is also available for inland fisheries and aquaculture. In this study, we focus on the capture of sea fish and other sea fish.[15] We have limited our investigation to the species for which we have complete harvest information from 1996 to 2009. In all, we have 49 marine fish species and 8 other sea fish.[16] The initial information on caught fish are given in tons. We have transformed it to kg in order to have a comparable data set as a whole.

The data on the fishery harvest technology can be described as follows. The Turkish fishery sector is considered to be a small-scale one (FAO, 2008). The majority of the Turkish fleet is composed of small boats under 10 m in length, with a 10-25 hp inboard diesel engine. FAO (2008) reports that there are 18,396 vessels in the Turkish marine fishing fleet, licensed by the Ministry

[15] This choice is explained by the fact that marine fisheries are the first source of overall fish production in Turkey. For instance, in 2006, the share of fishery production between capture sources was as follows: marine fisheries (62%), aquaculture (20%), inland fisheries (11%), and other marine products, such as crustaceans and molluscs (7%) (FAO, 2008).

[16] The list of fish species can be found in Appendix 2.

of Agriculture and Rural Affairs, and 3,000 more in inland waters. From 1996 to 2009, information is available for two variables[17]: the number of fishing vessels by group of horsepower (*POWER*) and the number of fishing vessels by group of tonnage (*TONNAGE*). For the variable POWER, we have taken into account five categories of horsepower in kw: 1 - 9.9, 10 - 19.9, 20 - 49.9, 50 - 99.9, and 100 - 199.9. Likewise, TONNAGE have been defined by five categories of groston: 1 - 4, 5 - 9, 10 - 29, 30 - 49, and 50 - 99. Hence, five different variables are constructed for POWER and TONNAGE. These two variables remain very useful in that "*Tonnage and power are one of the main factors in determining the fishing capacity of a fleet and thus also the pressure which is exerted on fish stock*" (Schare, 2006, p. 59).

Let us now describe fish-specific data. We use TurkStat data on price (*PRICE*) per kg of each fish species. Since the data prior to 2005 are expressed in Turkish Lira (TL), we transformed them to New Turkish Lira (YTL). Finally, to obtain a constant price (YTL 2003) of fish per kg, these data were deflated by a Consumer Price Index (CPI, base year 2003) constructed from inflation statistics for Turkey provided by IMF (2010).

Along with economic data on individual fish species, we wanted to include data on their biological characteristics. Unfortunately, we do not have at our disposal information for the intrinsic growth rate and the carrying capacity of each fish species included in our data set.[18] For this rea-

[17] TurkStat provides some information about fishing vessels by qualities, but they are not all complete in terms of time series. Moreover, the statistics on the labor force in the fishery sector are only available from 2006 to 2009. TurkStat does not provide any information about the number of licensed fishing vessels.

[18] McWhinnie (2008) faces a similar problem. To overcome it, she uses discrete categorical data taken from FishBase and constructs dummy variables based on these categories. We do not follow the same strategy because the continuous data on mean maximum length

son, we use the data of Sea Around Us Project for Exclusive Economic Zone of Turkey: mean trophic level[19] (TL) and mean maximum length ($SLMax$) in cm. Where data are lacking, we complete them with FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org) data. To this end, we have searched for information according to the scientific names of fish species included in TurkStat data and found the corresponding biological characteristics in these three data sets.

In order to replicate the structure of the theoretical model of Brander and Taylor (1997), we would need two more variables: the parameter of taste for fish consumption and the fish stock. As concerns the former, we would need a parameter which either varies among fish species or over time. Unfortunately, this data is lacking in the case of Turkey. In terms of the fish stock, FAO reports data on the exploitation status of fish stock in 15 regions of the world from 1994 to 2002. This data set does not provide information on all of the fish species of our data set nor does it provide information for each year from 1996 to 2009. We use the size of the population (Pop) (source: World Development Indicators) as a proxy for the labor force.

In the period under consideration, 1996-2009, fish price dynamics were affected by both the domestic demand and trade flows. To be able to identify the sole effect of trade on harvest, we include an indicator of openness to trade as a regressor. The indicator of openness to trade ($OPEN$) is calcu-

and mean trophic level provide richer information for each fish species.

[19] To monitor the evolution of biological diversity, the Conference of the Parties to the Convention on Biological Diversity (CBD) uses this indicator, or equivalently the marine trophix index. Declining trends in TL, observed worldwide, are interpreted as declining abundance of larger fishes on top of marine food webs (Sea Around Us Project, http://www.seaaroundus.org/).

Table 1: Summary Statistics

Variable	**Unit**	**Obs.**	**Mean**	**Std.Dev.**	**Min.**	**Max.**
H	kg	798	7383489	3.83e+07	3000	3.85e+08
POP	number	798	6.87e+07	3871049	6.23e+07	7.48e+07
OPEN	real YTL/kg	299	0.0130957	0.039992	2.07e-07	0.3306997
POWER 1	number	798	5448.571	2108.089	2439	9197
TONNAGE 1	number	798	10082.93	5220.603	406	14477
PRICE	real YTL/kg	798	6.212027	4.76402	0.1095404	33.69405
TL	–	798	3.59	0.6176163	2.01	4.5
SLMax	cm	798	84.80702	88.43051	6	458

lated by the sum of exports in constant value (YTL New Turkish Lira, 2003) for each fish and imports in constant value (YTL 2003) for each fish divided by the total harvest for all species.[20] TurkStat provides data on trade in fish and fish products in current dollars. We have first transformed these data to YTL using the exchange rate statistics of the Central Bank of the Republic of Turkey (http://evds.tcmb.gov.tr/cbt.html).[21] Afterwards, we have deflated these data by a Consumer Price Index (CPI, base year 2003) constructed from inflation statistics for Turkey provided by IMF (2010).

We have a sample made up of a balanced panel of 57 fish and other sea fish observed between 1996 and 2009 in Turkish seas. This leads to 798 observations. The trade data on fish-specific export and import flows are only available for some fish species. This reduces the size of the sample from 798 to 299. Table 1 represents the descriptive statistics of our sample.[22]

[20] Usually, the indicator of openness to trade is represented by the sum of the value of exports and imports divided by the GDP. In our case, because the numerator is very small compared to the GDP, we do not adopt this definition.

[21] In 2003, 1 $ was equal to 1.49307 YTL.

[22] For the sake of space, we have only reported descriptive statistics for the technical variables POWER 1 and TONNAGE 1.

4.2 Econometric methodology

In order to test the implication of Brander and Taylor (1997) who argue that the overexploitation of fish, triggered by trade openness, is characterized by a negative correlation between fish price and harvest, we use the following reduced form of harvest level of fish (i) at time (t):

$$\begin{aligned} ln(H_{it}) &= cons + \beta_1 * ln(PRICE_{it}) + \beta_2 * ln(POP_t) + \beta_3 * ln(OPEN_{it}) \\ &\quad + \beta_4 * ln(TL_i) + \beta_5 * ln(SLMax_i) \\ &\quad + \sum_{j=6}^{10} \beta_j * ln(POWER_{jt}) + \sum_{k=11}^{15} \beta_k * ln(TONNAGE_{kt}) + \mu_i + \varepsilon_{it} \end{aligned}$$

where β_l $(l = 1, ..., 15)$ are parameters to be estimated, μ_i are individual fish effects and ε_{it} are errors terms that are assumed *iid*, $i = 1, ..., N$ is individual subscript and $t = 1, ..., T$ is time subscript.

We choose a log-log specification for the harvest equation that allows us to interpret the estimate of a coefficient as the estimate of elasticity with respect to the explanatory variable under consideration. Here, parameters $\beta' s$ represent the elasticity of the harvest with respect to exogenous variables.

In line with the result of Brander and Taylor (1997), we expect the price of fish, PRICE, to be negatively correlated with the fish harvest as export opportunities (and the related context of high fish prices) deplete the fish stock. Furthermore, we expect that the variables TL (mean trophic level) and SLMax (mean maximum length) have a positive effect on harvest as fishermen have an incentive to catch larger fishes at the top of marine food

webs. As concerns the technological variables, we know that a typical two-man boat has a 10-25 hp inboard diesel engine. Thus, an engine with more than 25 hp could be considered to be a larger-scale operation. This would correspond to variables POWER 3, 4 and 5. Thus, we could expect that an increase in the number of vessels belonging to these power categories have a positive effect on harvest. We expect that the size of the population, POP, increases the demand for harvest goods, and thus the harvest level. In a similar way, we expect that an increased trade intensity, OPEN, tends to increase the harvest.

We use the Hausman test to determine whether a random effect or a fixed effect specification is appropriate. This test evaluates the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. The Hausman test results show a $\chi^2(15) = 2.73$ with a $P - value = 0.9998$ that suggests that the null hypothesis be maintained and that the random effects model results be retained. In the random effects model, the variation across entities (fish species here) is assumed to be random and uncorrelated with the regressors. This allows us to include as regressors time invariant variables such as the biological factors of fish species, TL and SLMax in our case.

Since we use a random effect model, we have to decide between a random effects regression and a simple OLS regression. The Breusch-Pagan Lagrange Multiplier test helps us to do so, testing the null hypothesis that variances across entities are zero. The test results show a $\bar{\chi}^2(01) = 963.30$ with a $P - value = 0.0000$ that suggests that the null hypothesis be rejected and

that the regression be run with a random effects model.

We have tested for autocorrelation of errors. Using standard error estimates which ignore serial autocorrelation in errors would lead to an invalid statistical inference because it would be based on biased estimates of standard errors. The test proposed by Wooldridge (2002) for autocorrelation in panel data was therefore carried out. These test results suggested we reject the null hypothesis of "no first-order autocorrelation" at 1% significance level ($P = 0.0000$). We have used a method which fits panel regression models when the disturbance term is first-order autoregressive.[23] A generalized least squares (GLS) estimator for random effects models is used for estimations.

We suspected that the log of the fish price $ln(PRICE_{it})$ is endogenous since it may be correlated with the error term. In order to decide whether it is necessary to use instrumental variable estimation methods to deal such endogeneity, we use the Davidson and MacKinnon (1993) exogeneity test. An instrumental variables estimate of the harvest level is computed, using the log of fish price as a potentially endogenous variable, instrumented by the lagged of the log of fish price. The test results indicate that the null hypothesis of exogeneity is not rejected ($P - value = 0.44$).

5 Estimation Results

In order to isolate the effects of openness to trade on harvests, we adopt the following strategy. We carry out estimations based on two different

[23] The corresponding command in Stata 12 is "xtregar" which implements the methods derived in Baltagi and Wu (1999).

samples: when the fish exports are positive (with the implied number of observations $N = 217$) and when they are absent (with the implied number of observations $N = 82$). The question is to know if the effect of fish price on harvests differs depending on whether or not the fish is exported.

Table 2 presents our initial regression results when the fish exports are positive. In specification (1), we regress the log of harvest on the population size, the fish price, and the trade intensity indicator. Specification (2) also accounts for the biological characteristics of fish species, the mean trophic level and the mean maximum length. Specification (3) takes into account, in addition to the previous regressors, the technological factors such as the tonnage and power of fishing fleets. In specification (4), we estimate the previous relation by adding a dummy variable (*FISH)* for the type of marine fish: it is equal to 1 for sea fish and equal to 0 for other sea fish (such as crustaceans and molluscs). In specification (5), instead of *FISH*, we use another dummy variable *SIZEREG*: it is equal to 1 for fish species under the size regulation[24] and equal to 0 for others.[25] In all specifications, the estimation results when the exports are null are also presented.

We note that the explanatory power of the model increases from specification (1) to specifications (3)-(5). We find strong evidence that harvest

[24] We refer to the regulation set by the Circular 2002 (article 6) of the Ministry of the Agriculture which implements minimum size (cm) restrictions for some species for which catches are limited (Turkish Marine Research Foundation).

[25] We omit other dummy variables from our regressions. The dummy variables corresponding to the different years of the data set are excluded because of the problem of collinearity. We have also excluded the dummy variables on threatened species and on higly migratory species as they were never significant. As concerns the list of threatened species, we have included the ones reported by the Turkish Marine Research Foundation and the Sea Around Us Project. As concerns the list of highly migratory species, we have referred to Annex I of the United Nations Convention on the Law of the Sea.

Table 2: Estimation results of GLS random effects regression of fish harvest with positive exports

	(1)	(2)	(3)	(4)	(5)
	lnharvest	lnharvest	lnharvest	lnharvest	lnharvest
lnpop	-3.256**	-2.999*	10.80	11.01*	12.63*
	(-2.70)	(-2.49)	(1.95)	(1.97)	(2.24)
lnprice	-0.383*	-0.297	-0.585**	-0.613**	-0.798***
	(-2.43)	(-1.83)	(-2.93)	(-3.12)	(-4.13)
lnopen5	0.0685*	0.0662*	0.0574*	0.0626*	0.0668*
	(2.49)	(2.42)	(2.11)	(2.30)	(2.44)
lntl		4.478	3.674	1.995	6.229**
		(1.82)	(1.44)	(0.82)	(2.83)
lnslmax		-1.003*	-0.794	-0.713	-1.367**
		(-2.09)	(-1.58)	(-1.54)	(-3.04)
lnpower1			1.979	2.049	2.526*
			(1.63)	(1.68)	(2.05)
lnpower2			3.757**	3.859**	4.494**
			(2.58)	(2.64)	(3.06)
lnpower3			1.771	1.863	2.514
			(1.02)	(1.06)	(1.42)
lnpower4			0.586	0.603	0.645
			(1.56)	(1.59)	(1.67)
lnpower5			1.422	1.465	1.830*
			(1.58)	(1.62)	(2.01)
lntonnage1			-1.892*	-1.943*	-2.320*
			(-2.02)	(-2.07)	(-2.45)
lntonnage2			-0.822	-0.857	-1.092
			(-1.40)	(-1.45)	(-1.84)
lntonnage3			-2.025*	-2.071*	-2.453*
			(-2.03)	(-2.06)	(-2.42)
lntonnage4			5.123*	5.266*	6.361*
			(2.01)	(2.06)	(2.46)
lntonnage5			-1.785	-1.827	-2.272*
			(-1.59)	(-1.62)	(-2.00)
other				1.594*	
				(2.30)	
sizereg					1.960***
					(3.52)
_cons	73.73***	67.43**	-240.0	-245.3	-290.2*
	(3.37)	(3.07)	(-1.87)	(-1.90)	(-2.23)
N	217	217	217	217	217
R^2	0.46	0.41	0.49	0.60	0.63

t statistics in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

is negatively correlated with higher fish prices when these fish are exported. The coefficient on the fish price is negative and significant (except in specification (2)). In specification (5), with the highest explanatory power, we estimate that increasing fish price by 1% is associated with a 0.8% decrease in harvest level. As concerns the estimation results based on the sample without fish exports (Table 3), we find little evidence that the fish price has a significant effect on harvests. One exception is specification (5) in which harvest is negatively and significantly linked to fish price. These overall results on the fish price tend to indicate that harvest decreases with an increase in fish price when the fish species are exported. Our estimation results therefore confirm the theoretical implication of Brander and Taylor (1997) who hold that trade openness, which induces an increase in fish price compared to its price at autarky, causes a decline in the production of the harvest in the case of the overexploitation of the resource. This would mean that we fall into the decreasing part of the supply curve, that is to say, the fish stock is depleted. This result is explained by the presence of open-access regime on fishery resources, which also characterizes the fishery sector of Turkey. In all specifications with positive exports, we find that trade intensity has a positive and significant effect on harvest (a positive coefficient for OPEN). This means that increasing trade value induces fishermen to catch more fish to increase exports. The trade intensity increases the pressure on fish stocks since it creates an additional demand for these harvest goods. As concerns the estimation results based on the sample without fish exports (Table 3), contrary to the previous results, the OPEN5 variable is not significant. This indicates that imports do not play a key role in determining the harvest level

at home.

In specification (2) with positive exports, we note that the introduction of the biological factors as regressors reduces the power of the model. While the mean maximum length (SLMax) has a significant and negative effect on harvest, we find that the marine trophic index (TL) is positively and significantly linked with harvest. This latter result confirms our intuition that fishermen have an incentive to harvest larger fish species. We also find that the harvest is significantly and positively correlated with population size. As expected, an increase in population size raises the domestic demand for harvest goods, and thus the harvest level. In specification (5), we estimate that increasing population size by 1% is associated with a 12.6% increase in harvest level, which is quite high. This result is expected given that the fish production is mainly dedicated to domestic consumption in Turkey. In addition, our empirical results show that some of the technological variables are significant. The following variables have a positive impact on harvest, POWER1, POWER2, POWER5 and TONNAGE4, whereas others have a negative effect, TONNAGE1, TONNAGE3 and TONNAGE 5.

In specification (4), the case of positive exports, we find that the dummy variable FISH corresponding to the type of fish ("sea fish" vs. "other sea fish") has a significant and positive effect on fish harvest. This suggests that fishermen tend to catch more marine fish than other sea fish, such as crustaceans or molluscs. In specification (5), we find that the dummy variable SIZEREG, which indicates the fish species under the minimum size regulation, has a significant and positive effect on fish harvest. This suggests that the current regulation is not effective in reducing the harvest effort of

fishermen.

5.1 Other specifications

To ensure that the results are robust in terms of our base econometric specification (5), Table 4 presents the estimation results run with four alternative econometric models, when the fish exports are positive. In specification (6), we remove all the time-invariant regressors. Specification (7) considers the previous equation and runs the regression with an Arellano-Bond (1991) linear dynamic panel data model. Specification (8) considers the equation without time-invariant regressors and runs the regression with an HAC (heteroskedasticity-autocorrelation) robust fixed-effects model. In specification (9), we run the same equation with a standard OLS model.

To correct for serial correlation in standard errors, in specification (7) we use the Arellano-Bond linear dynamic panel data model which includes lags of the dependent variable as covariates and unobserved panel level effects. Arellano and Bond (1991) derived a consistent generalized method of moments (GMM) estimator for the parameters of this model.[26] This method does not allow the use of time-invariant regressors (and dummies). Hence, the comparison of estimation results is to be made with Specification (6) in Table (4). Indeed, the estimation results with the Arellano-Bond model are not satisfactory given that none of the regressors is significant.

The explanatory power of the model in (6) is lower than that in (5) be-

[26] In Stata 12, "xtabond" command implements this estimator. We use a two-step estimator which produces an estimated VCE (variance component estimation) that is robust to heteroskedasticity. We specify 1 lag of the dependent variable (harvest) as covariate, and maximum 1 lag of the dependent variable for use as instruments.

Table 3: Estimation results of GLS random effects regression of fish harvest without exports

	(1)	(2)	(3)	(4)	(5)
	lnharvest	lnharvest	lnharvest	lnharvest	lnharvest
lnpop	-1.536	-1.022	-5.010	-4.258	-11.61
	(-0.60)	(-0.40)	(-0.21)	(-0.17)	(-0.46)
lnprice	-0.119	0.0485	-0.492	-0.504	-0.900*
	(-0.50)	(0.19)	(-1.22)	(-1.25)	(-2.28)
lnopen5	0.0589	0.0569	0.0697	0.0773	0.0704
	(1.29)	(1.25)	(1.37)	(1.47)	(1.37)
lntl		1.382	0.517	-0.0871	2.633
		(0.44)	(0.15)	(-0.03)	(0.87)
lnslmax		-0.972	-0.453	-0.458	-0.665
		(-1.34)	(-0.55)	(-0.57)	(-0.91)
lnpower1			-1.605	-1.411	-3.578
			(-0.24)	(-0.21)	(-0.52)
lnpower2			-0.103	0.0572	-0.853
			(-0.02)	(0.01)	(-0.15)
lnpower3			7.463	7.465	11.79
			(1.03)	(1.02)	(1.61)
lnpower4			-2.672	-2.593	-4.735
			(-0.58)	(-0.55)	(-1.00)
lnpower5			-2.549	-2.374	-4.990
			(-0.37)	(-0.34)	(-0.70)
lntonnage1			-0.932	-1.058	-0.661
			(-0.30)	(-0.33)	(-0.20)
lntonnage2			3.514	3.404	5.907
			(0.61)	(0.58)	(0.99)
lntonnage3			-1.514	-1.643	-1.612
			(-0.55)	(-0.59)	(-0.57)
lntonnage4			1.376	1.674	0.763
			(0.17)	(0.20)	(0.09)
lntonnage5			0.388	0.190	2.040
			(0.06)	(0.03)	(0.31)
other				0.686	
				(0.71)	
sizereg					1.844*
					(2.44)
_cons	42.15	34.71	81.81	66.00	194.4
	(0.92)	(0.75)	(0.16)	(0.13)	(0.37)
N	82	82	82	82	82
R^2	0.29	0.08	0.25	0.32	0.49

t statistics in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 4: Estimation results with other specifications

	(1)	(2)	(3)	(4)
	lnharvest	lnharvest	lnharvest	lnharvest
lnpop	11.68*	3.488	9.659	20.12
	(2.11)	(0.07)	(1.95)	(1.03)
lnprice	-0.680***	-0.222	-0.508	-1.910***
	(-3.57)	(-0.23)	(-1.67)	(-13.83)
lnopen5	0.0590*	0.0381	0.0482	0.130**
	(2.17)	(0.37)	(1.14)	(2.95)
lnpower1	2.251	0.504	2.074	5.259
	(1.87)	(0.06)	(1.84)	(1.22)
lnpower2	4.124**	1.555	3.791**	8.844
	(2.87)	(0.18)	(2.88)	(1.90)
lnpower3	2.117	-0.419	2.214	6.708
	(1.22)	(-0.13)	(0.88)	(1.08)
lnpower4	0.614	0.394	0.596	1.494
	(1.63)	(0.22)	(1.45)	(0.82)
lnpower5	1.622	0.576	1.506	3.896
	(1.82)	(0.08)	(1.57)	(1.20)
lntonnage1	-2.101*	-0.725	-2.058*	-4.353
	(-2.26)	(-0.13)	(-2.23)	(-1.38)
lntonnage2	-0.947	0.0900	-0.781	-2.796
	(-1.63)	(0.03)	(-1.47)	(-1.24)
lntonnage3	-2.229*	-0.759	-2.239*	-3.691
	(-2.25)	(-0.14)	(-2.32)	(-1.07)
lntonnage4	5.695*	1.106	5.310	10.77
	(2.25)	(0.11)	(1.92)	(1.28)
lntonnage5	-2.022	-0.794	-2.199	-3.090
	(-1.82)	(-0.17)	(-1.96)	(-0.76)
L.lnharvest		-0.0448		
		(-0.03)		
_cons	-261.9*	-59.39	-219.4	-515.4
	(-2.05)	(-0.06)	(-1.80)	(-1.17)
N	217	178	217	217
R^2	0.51		0.50	0.54

t statistics in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

cause individual characteristics which do not vary over time are omitted. In all specifications, the sign of the fish price keeps to be negative. Except for the Arellano-Bond (7) and FE (8) models, the coefficient is significant at the 1% level. Furthermore, the sign of the indicator of openness is significantly positive in specifications (6) and (9). Finally, the comparison of the estimation results between specifications (5) and (9) show that the coefficients are overestimated with the OLS model.

5.2 Robustness checks

Table 5 reports coefficients for a number of sensitivity tests of our base econometric specification (5), when the fish exports are positive. In all these specifications, the fish price has a negative and significant effect on harvest. In addition, the indicator of openness to trade always has a significant and positive effect on harvest, except in specification (14) where the 3-year lagged price is used as a regressor instead of the current fish price.

To ensure that the results are not driven by particular observations, in Specification (10) we exclude the top and bottom 1% tails of the variables of interest, harvest and price, thereby reducing the number of observations to 205. In this case, the technological variables POWER 1, POWER 5 and TONNAGE 5 are no longer significant. The explanatory power of the model drops from 0.63 to 0.53. In specification (11), we add as a regressor the GDP per capita (*GDPhab*). We find that the associated (positive) coefficient is not significant. In this case, the population size and all the technological variables are no longer significant. Finally, we investigate whether fishermen harvest decisions depend on past fish prices, rather than the current ones.

Table 5: Estimation results: robustness check

	(1) lnharvest	(2) lnharvest	(3) lnharvest	(4) lnharvest	(5) lnharvest
lntl	6.579**	6.040**	6.140**	5.806*	5.958*
	(2.96)	(2.72)	(2.80)	(2.50)	(2.45)
lnslmax	-1.439**	-1.313**	-1.389**	-1.194*	-1.178*
	(-3.16)	(-2.88)	(-3.07)	(-2.49)	(-2.36)
sizereg	1.898***	1.991***	1.817***	1.790**	2.012**
	(3.38)	(3.55)	(3.29)	(2.98)	(3.18)
lnpop	12.28*	5.402	10.40	-4.361	-6.894
	(2.12)	(0.71)	(1.19)	(-0.46)	(-1.18)
lnprice	-0.693***	-0.865***			
	(-3.48)	(-4.32)			
lnopen5	0.0543*	0.0620*	0.0635*	0.0623*	0.0345
	(1.97)	(2.26)	(2.20)	(2.16)	(1.26)
lnpower1	2.127	1.738	1.438	-0.951	-2.085
	(1.70)	(1.29)	(0.89)	(-0.58)	(-0.87)
lnpower2	4.076**	2.907	3.171*	-2.540	-0.361
	(2.72)	(1.58)	(2.03)	(-0.87)	(-0.16)
lnpower3	2.076	2.783	2.491	7.834	-4.116
	(1.15)	(1.57)	(1.02)	(1.33)	(-0.74)
lnpower4	0.532	0.226	0.390	-1.739	1.385
	(1.36)	(0.46)	(0.48)	(-0.97)	(0.88)
lnpower5	1.548	1.316	1.183	0.909	-1.523
	(1.67)	(1.35)	(0.81)	(0.58)	(-1.30)
lntonnage1	-1.986*	-1.532	-1.748	0.456	1.902
	(-2.06)	(-1.40)	(-1.46)	(0.37)	(0.36)
lntonnage2	-0.975	-0.964	-0.540	-0.986	0.985
	(-1.63)	(-1.61)	(-0.77)	(-1.11)	(0.74)
lntonnage3	-2.169*	-1.549	-1.954	0.957	-0.0223
	(-2.10)	(-1.30)	(-1.51)	(0.61)	(-0.02)
lntonnage4	5.814*	4.940	5.075	3.981	-1.010
	(2.21)	(1.79)	(1.57)	(1.21)	(-0.58)
lntonnage5	-1.950	-1.582	-1.629	-0.242	.
	(-1.69)	(-1.29)	(-1.13)	(-0.18)	.
lngdphab		1.254			
		(1.40)			
lnpriceL1			-0.711**		
			(-3.20)		
lnpriceL2				-0.908***	
				(-3.79)	
lnpriceL3					-1.157***
					(-4.84)
_cons	-275.6*	-156.6	-231.9	37.03	173.1
	(-2.06)	(-0.98)	(-1.21)	(0.19)	(1.62)
N	205	217	202	185	169
R^2	0.53	0.63	0.62	0.63	0.63

t statistics in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Hence we have run estimations with up to 3-year lags on fish prices. In this case also, the population size and the majority[27] of technological variables are no longer significant.

5.3 Estimating the effect of 2002 policy

Here, we attempt to test the effect of a major fishery policy that was implemented in 2002 in Turkey. Indeed, after this date, no additional vessel licences have been delivered in the Turkish fishery sector. A new vessel can become part of the fleet only if an existing vessel is removed. In this case, a maximum 20% increase in length is permitted (Duzgunes and Erdogan, 2008). In order to test the implications of this policy, we carry out two separate estimations before 2003 (1996-2002) and after 2003 (2003-2009).[28] Our objective is to compare the estimations results based on these two different sub-samples.

The post-2002 estimation results show that the fish harvest is significantly and negatively correlated with higher fish prices (the associated elasticity is 1.15).[29] In this case, the coefficient is larger than the one in specification (5) which is based on the whole sample. Furthermore, the fish harvest is significantly and positively correlated with higher trade intensity. The technological variables are no longer significant[30]. The explanatory power of the model is better than that for the whole period, in spite of a smaller sized sample. We obtain similar conclusions for the estimations concerning

[27] The variable POWER 2 is significant in specification (12) where the one-year lagged price is used as a regressor instead of current fish prices.

[28] These estimation results are provided at the end of the appendix.

[29] This result is also confirmed using the Arellano-Bond estimator.

[30] The variables TONNAGE 1-5 are omitted because of collinearity.

the period before 2003, except that the indicator of openness to trade is not significant. The latter result tends to indicate that the pressure of trade flows on fish harvest comes into play in the more recent period covering 2003 to 2009.

These empirical findings indicate that the 2002 policy does not appear to be effective in terms of its initial objective to reduce the fishing effort. Fish prices continue to have an adverse pressure on fish stocks after the implementation of the policy. This fact could be explained by the fact that fishermen could avoid policy constraints by increasing the engine power or tonnage of vessels. Duzgunes and Erdogan (2008, p.191) have also highlighted this point, stressing that in terms of the 2002 policy, "*both in case of modification and replacement of vessels, engine power or tonnage are disregarded*".

6 Conclusion

In this study, we investigated whether or not the trade in fish and fish products contributed to the decline of some fish species in Turkey. More specifically, we tested the theoretical implication of Brander and Taylor (1997) who hold that trade openness decreases fish harvest in a small open economy characterized by a regime of open-access on fishery resources. To this end, we estimated a panel data model to measure the effects of trade openness on fish harvests. We focused on the case of 57 fish species observed from 1996 to 2009 in Turkey. To construct a pertinent data set, we brought together TurkStat data on the harvest of multiple fish species with other economic, technological, and biological information.

Our estimation results indicate that harvest decreases with an increase in fish price when the fish species are exported. These results therefore confirm the theoretical implication of Brander and Taylor (1997) who hold that trade openness, which induces an increase in fish price compared to its price at autarky, causes a decline in the production of the harvest in the case of the overexploitation of the resource. This would mean that we fall into the decreasing part of the supply curve, that is to say, the fish stock is depleted. Furthermore, we find that the indicator of openness to trade has a significant and positive impact on fish harvest. These findings suggest that further openness to trade, which is the current trend in Turkish fishery, would put more pressure on Turkey's already declining fishery resources. One way to alleviate this potential pressure is to strengthen private property right regime on fishery resources. This could be done through the implementation of individual transferable quotas. Turkish authorities should also take all measures necessary to ensure the respect of these rights.

These overall results could contribute to the ongoing debate over the potential effects of international trade on fishery resources. The method employed in this paper could be easily applied to other countries, taking into account as it does variations in fishery technology, fish biodiversity, fishery management and trade intensity.

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APPENDIX 1: MAP OF TURKEY

APPENDIX 2: LIST OF FISH SPECIES

Fish name in Turkish	No	Corresponding fish name in English
Akya	1	leerfish
Avci	2	greater amberjack
Barbunya	3	red mullet
Caca	4	european sprat
Cipura	5	gilthead seabream
Dulger	6	john dory
Fangri	7	red porgy
Gelincik	8	shore rockling
Grenyuz	9	meagre
Gumus	10	silverside
Hamsi	11	anchovy
Hani	12	painted comber
Iskarmoz	13	european barracude
Iskorpit	14	black scorpion fish
Isparoz	15	annular bream
Istavrit(Kraca)	16	mediterranean horse mackerel
Istavrit(Karagoz)	17	atlantic horse mackerel
Iskine	18	brown meagre
Izmarit	19	picarel
Kalkan	20	turbot
Karagoz	21	two-baded seabream
Kefal	22	goldon grey mullet
Keler	23	angelshark
Kilic	24	swordfish
Kirlangic	25	east atlantic red gurnard
Kolyoz	26	chup mackerel
Kopek	27	tope shark
Kupez	28	bogue
Levrek	29	european seabass
Lipsoz	30	red scorpion fish
Lufer	31	blue fish
Melanurya	32	saddled seabream
Mercan	33	striped bream
Mezgit	34	whiting
Mirmir	35	european conger
Minekop	36	croaker
Orfoz	37	dusky grouper
Orkinoz	38	atlantic bluefin tuna
Sardalya	39	european pilchard
Sarigoz	40	black seabream
Sarpa	41	saupe salema
Sinagrit	42	common dentex
Tekir	43	striped red mullet
Tirsi	44	twaite shad
Tranca	45	blue-spotted seabream
Uskumru	46	atlantic mackerel
Vatoz	47	thornback ray
Zargana	48	garfish
Zurna	49	atlantic saury
Ahtapot	50	common octopus
Akivades(Kum midyesi)	51	pullet carpet shell
Bocek	52	spiny lobster
Deniz salyangozu	53	sea snail
Istakoz	54	european lobster
Kalamerya	55	cape hope squid
Murekkepbaligi	56	common cuttle fish
Pavurya	57	green crab

APPENDIX 3: HARVEST PROFILE OF FISH SPECIES

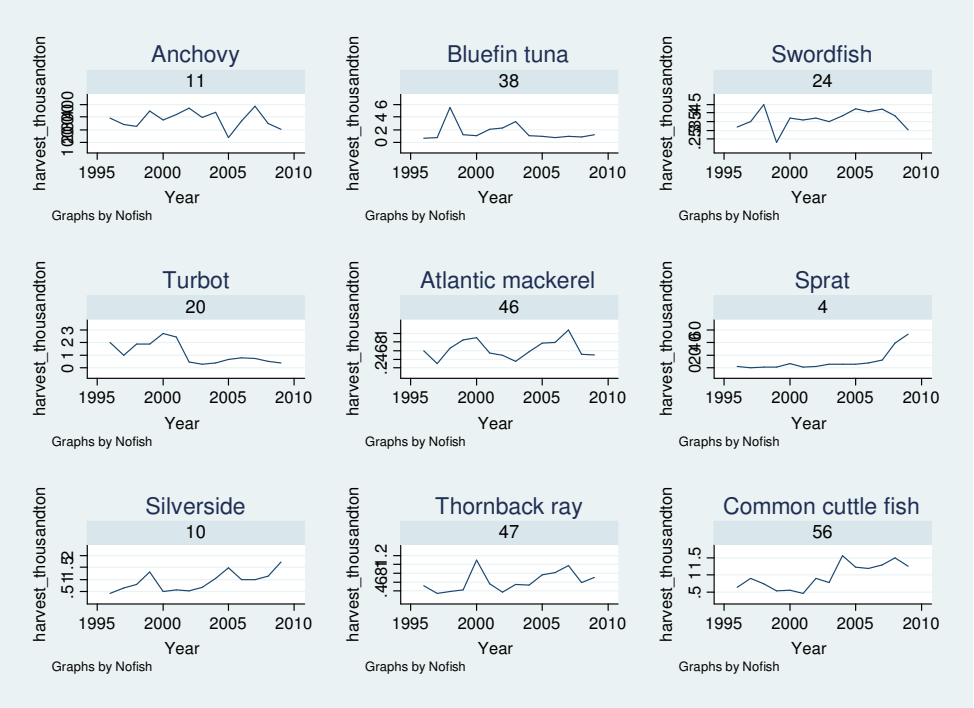

Table 6: Pre-2002 estimation results of GLS random effects regression of fish harvest with positive exports

	(1)
	lnharvest
lnpop	125.0
	(0.64)
lnprice	-1.099***
	(-3.91)
lnopen5	0.0825
	(1.69)
lntl	5.507*
	(2.42)
lnslmax	-1.170*
	(-2.36)
lnpower1	-3.180
	(-0.71)
lnpower2	-33.16
	(-0.66)
lnpower3	3.454
	(0.44)
lnpower4	1.812
	(1.06)
lnpower5	-3.447
	(-0.62)
sizereg	2.143***
	(3.80)
_cons	-1959.7
	(-0.63)
N	106
R^2	

t statistics in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 7: Post-2002 estimation results of GLS random effects regression of fish harvest with positive exports

	(1) lnharvest
lnpop	45.91
	(0.15)
lnprice	-1.146***
	(-5.21)
lnopen5	0.0676*
	(2.05)
lntl	7.133***
	(3.36)
lnslmax	-1.351**
	(-3.10)
lnpower1	6.960
	(0.15)
lnpower2	7.578
	(0.24)
lnpower3	-1.512
	(-1.28)
lnpower4	3.039
	(0.30)
lnpower5	2.791
	(0.15)
sizereg	1.819***
	(3.30)
_cons	-972.3
	(-0.15)
N	111
R^2	

t statistics in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$