Fishery Resources and Trade Openness: Evidence from Turkey

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Abstract

In this study, we investigate whether the trade in fish and fish products contributed to the decline of 57 fish species observed from 1996 to 2009 in Turkey. Our aim is to test the theoretical prediction that trade liberalization in the presence of open access resources can lead to a reduction in harvest at the long-run due to stock depletion. To this end, we carry out an instrumental variable estimation for a panel data model. Estimation results reveal that the harvest supply curve bends backward, i.e., the resource is overexploited, no matter if the fish is exported or not.

Keywords: openness to trade, fish harvest, fishery technology, biological factors, panel data model. JEL codes: C23, Q22, Q27, Q56.

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1 Introduction

Worldwide, fishery resources are under threat. Worm et al. (2009) report that 63% of assessed fish stocks worldwide require rebuilding. FAO (2011) reports that approximately 87 percent of the world fish stocks are fully exploited or overexploited. The underlying open-access problem 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. The waters of Turkey are relatively fish-abundant; however, over that same period, its fish stocks have come under threat (Turkish Marine Research Foundation). Turkey could be considered to have a (regulated) open-access regime in fisheries. The majority of management instruments are based on command-and-control instruments such as season and area closures, or gear restrictions. The current fishing fleet is still considered to have an excess capacity (FAO, 2008), despite the fact that the number of fishing licenses has been limited since 2002.

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 exports and imports of

[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).

Turkey increased in value between 1980 and 2000 (EarthTrends, 2003).[3] At the same time, several reports have emphasized a decline in Turkey's fishery resources. 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. 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. It is important to note that all of these threatened species are exported.[4] 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, in fish and fish products, on Turkey's fish harvests. We have constructed a 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. Fischer (2010) lists four reasons why this occurs. 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 rela-

[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 increased over time. Secondly, the deflated value of exports was higher than that of imports (see Figure 2).

[4] The Turkish Marine Research Foundation reports that the fish species under threat are bluefin tuna, swordfish, sturgeon, mackerel, and turbot. In our data base, we observe that all these species are exported. In exports (in value), bluefin tuna is the first, followed by mackerel (the 4th), turbot (the 8th), and swordfish (the 9th).

tion 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). This research, including among others, Chichilnisky (1994), Brander and Taylor (1997a,b, 1998), Hannesson (2000), Emami and Johnson (2000), Nielsen (2006), and Rus (2012) have shown that trade liberalization in the presence of open access resources might cause reduced fish stocks, a reduction in the steady state harvest, and in turn, a reduced steady-state welfare for the country with a comparative advantage in the resource good. The findings of this literature indicate that the effects of trade liberalization on the resource stock and the welfare are dependent on the comparative advantage of the country in fishing, the fisheries management regime, the size of the country in the world market, and whether marine resources are national or transboundary. The above-mentioned models assume that the regimes of property rights are exogenous. This assumption has been challenged, among others, by Hotte et 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 (1997a) 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.[5] 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[6] does indeed have a significant effect.[7] As concerns the trade-fisheries debate, Nielsen (2006) has investigated the effects of trade liberalization on the East Baltic cod fishery. The partial equilibrium model involves trade between countries sharing a common fish stock which is governed with a regulated open access regime (such as quotas, input limitations or mesh-size regulations). The case study shows that the welfare effect of trade liberalization is small for all sectors in all countries. To our knowledge, there is no existing empirical analysis of the effects of trade on fishery resources.[8]

In this investigation, we aim to test some of the theoretical predictions of Brander and Taylor (1997a) and related models[9] in the case of data reflecting the

[5] One exception is Taylor (2011) who provides the empirical evidence that the North American bison has been slaughtered because of the trade between the US and the Europe. For case studies, see for instance Lopez (1997, 2000).

[6] 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.

[7] 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).

[8] Nostbakken and Bjorndal (2003), 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.

[9] Related models are Brander and Taylor (1997b, 1998), Hannesson (2000), Emami and Johnson (2000), Nielsen (2006), and Rus (2012)

situation in Turkey. More specifically, our aim is to assess if, as they theorize, a small open economy exporting an open-access renewable resource experiences a greater decrease in fish harvests. To this end, we estimate a reduced-form of the harvest profile based on harvest data for a panel of fish species observed from 1996 to 2009 in Turkey. To address the endogeneity problem of the domestic fish price, we carry out an instrumental variable estimation for a panel data model. 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. Finally, we exploit the panel nature of the data by estimating a panel data model.

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 foundations of the empirical model. 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 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 (Earth Trends, 2003). Turkey is also rich in

[10] See the map in Appendix 1.

terms of inland water resources with a high potential for capture fishery and aquaculture (OECD, 2005). 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 (horse power) inboard diesel engine. FAO (2008) reports that there are 18,396 vessels in the Turkish marine fishing fleet, licensed by the Ministry of Agriculture and Rural Affairs, and 3,000 more in inland waters.

2.1 Fishery production

Turkey could be considered as a small open economy in terms of fish production. TurkStat 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 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 finfish and shellfish between 1996 and 2009 is represented in Figure 1. The figure shows that the variation of fish landings was around 4-500 thousand tons 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 finfish and shellfish 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, 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 abovementioned 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, 622 962 tons; export, 54 354 tons; import, 72 686 tons; domestic consumption, 545 368 tons; processed fish (fish meal and oil factories), 90 211 tons; not processed or consumed, 5 715 tons; consumption per capita, 7.569 kg (TurkStat, 2011). These statistics indicate that currently Turkish fish production is mainly dedicated to domestic consumption. It is important to note, however, that for some fish species the share of exports (in constant value) represents more than 30 % of the value of harvest (in constant terms). In our data set, this is the case for gilthead seabream, shore rockling, chup mackerel, tope shark, atlantic bluefin tuna, mackerel, spiny lobster, and european lobster.

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,

[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.

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).

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 instruments 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). There are no other measures such as individual transferable quotas (ITQs) or a system of total allowable catch (TAC) for the management of fish stocks, except the quota schemes for bluefin tuna and striped venus calm (Can and Demirci, 2012). Saglam and Duzgunes

[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.

(2010) explain the absence of TAC and quota systems is Turkey by the lack of fish stocks assessments.

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 (for the fishery as a whole), 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 licenses have been delivered, the current fishing fleet is still considered to have an excess capacity (FAO, 2008). This concern was also pointed out by the European Union in the context of membership talks with Turkey (Can and Demirci, 2012).

3 Theoretical Foundations

For a (regulated) open-access fishery, increasing prices combined or not with improved technology would lead to supply along a backward bending supply curve as suggested by Copes (1970) (see also Clark (1990)). Backward bending supply curve is related to biological overfishing, i.e., the stock is driven below Maximum Sustainable Yield (hereafter denoted as MSY) level and long run equilibrium catches are reduced despite increasing effort.

In order to address the problem, we take predictions from the following single species fishery model under open access, and examine these empirically.

The "Resource" good (H) is produced from Labor (L) and the resource stock (S) with a Schaefer production function: $H = qSL$, with $q > 0$, 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: $\frac{\partial S}{\partial t} = G(S(t)) - H(t) = rS(1 - S/K) - qSL$, where $r > 0$ is the intrinsic growth parameter and $K > 0$ represents the carrying capacity of the resource. One can argue that Gordon-Schafer model is extremely simple and does not represent well pelagic fish because the latter usually do not reveal a pattern close to a uniform distribution (Bjorndal, 1998). "*It is, nevertheless, a model that is very familiar to resource managers and fisheries scientists and is widely used to discuss economic aspects of fisheries*" (FAO, 2003, p.15).[13]

The rent of a fisherman can be written as: $\pi = pH - wL$ where p represents the price of the resource good, and w is the opportunity cost of labor. Under open access, rents are dissipated so that $pH = wL$. This condition together with the steady-state condition for the fish stock, i.e., $\frac{\partial S}{\partial t} = 0$, give the expression of the harvest at the steady-state:

$$H = \frac{w}{p}\left(\frac{r(pqK - w)}{pq^2K}\right)$$

which is positive if $(pqK - w) > 0$. Comparative statics on the level of harvest show the following. An increase in the intrinsic growth rate of the stock (r) and the carrying capacity (K) increases the harvest at the long-run. The harvest curve bends backwards if ($2w < pqK$), i.e., when the price exceeds $\frac{2w}{qK}$. In that case, an increase in the opportunity cost of labor (w) increases the harvest at the steady-state, whereas higher catchability in fishing (q) reduces it. The reason for the former is as follows. When the cost of labor increases, there

[13] The Schaefer function could be considered as a good proxy to describe the harvest in Turkish data that we have at our disposal. Indeed, our data base is representative of both pelagic and benthic-demersal species. In a total of 49 marine fish species, 17 of them are pelagic, the other 34 are benthic-demersal (hereafter denoted as BD). In a total of 20 exported fish species, the half is pelagic and the remaining is BD. If we look at the ranking of exports in value, the top ten is made half by pelagic species (atlantic bluefin tuna, the first; chup mackerel, the second; anchovy, the third; mackerel, the fourth, and swordfish, the ninth), the other half by BD species (gilthead seabream, the fifth; tope shark, the sixth; whiting, the seventh; turbot, the eighth, and striped bream, the tenth).

is less fishermen who exploit the resource. This increases the fish stock, which, at the long-run raises the harvest level. In contrast, when the productivity in fishing increases, the fish stock is reduced, so is the harvest level at the long-run.

The harvest at equilibrium also depends on demand factors. The empirical strategy will account for this by including determinants of domestic demand such as the size of the population (POP) and the GDP. The increase in demand, triggered by a larger population size or a higher GDP, induces an increase in long-run harvest if the price is such that the fishery is on the upward-sloping part of the harvest supply curve. In contrast, this increase in demand reduces the harvest level if the price is such that the fishery operates in the region where the supply curve is downward-sloping (see Figure 3).

This theory provides the following reduced form structure for the empirical tests:

$$H = f(p, w, q, K, r, POP, GDP)$$

Brander and Taylor (1997a) and related models have shown for a small open economy that trade liberalization, by triggering the price increase of exported fish species (i.e., world price exceeds the domestic price), could enhance the biological overfishing. Fishermen would employ higher fishing effort resulting in a long run equilibrium with lower catches. Our aim is to test empirically this theoretical prediction that, **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 finfish and shellfish (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 finfish and shellfish.[14] 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 finfish and 8 shellfish species.[15] 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.

We do not dispose information on fish stocks specific to each species in the case of Turkish data. This problem has been also underlined in Can and Demirci (2012, p.49): "*However, existing state of stocks in Turkish waters was not assessed with comprehensive scientific research* ". 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, however, 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.

[14] 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). Another reason for excluding aquaculture is that property rights problem of marine fisheries is not present in aquaculture.

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

We use TurkStat data on price ($PRICE$) per kg of each fish species. TurkStat provides ex-vessel prices, that is, the prices that fishers receive when they sell their catch for the first time.[16] Since the data prior to 2005 are expressed in Turkish Lira (TL), we transformed them to Yeni 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.[17] For this reason, we use the data of Sea Around Us Project for Exclusive Economic Zone of Turkey: mean trophic level[18] (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.

The data provided by TurkStat on the fishery harvest technology can be described as follows. From 1996 to 2009, information on the fishery harvest technology is available for two variables[19]: the number of fishing vessels by group

[16] Can and Demirci (2012, p.53) provide more detailed information about the information system on fish price: " *Data on the "first hand sale" of fish is collected. An official document is used to identify the agents involved in the sale process, the quantities and prices for each species sold at the authorized sale centers*".

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

[18] 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 trophic 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/).

[19] 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

of horsepower (*POWER*) and the number of fishing vessels by group of tonnage (*TONNAGE*). For the variable POWER, we have information on the number of fishing vessels for five categories of horsepower in kw: 1 - 9.9, 10 - 19.9, 20 - 49.9, 50 - 99.9, and 100 - 199.9. Likewise, for the variable TONNAGE, we have at our disposal information on the number of fishing vessels for 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 they are one of the key indicators of capacity in fisheries. The use of capital, in turn, affects the pressure on fish stocks (FAO, 2003, p.6).

For the cost data in fishery, we use the agricultural value added per worker as a measure of the opportunity cost of labor (source: World Development Indicators). These data are expressed in constant YTL (base year 2003).[20] As concerns determinants of domestic demand, we use the size of the population (POP) and the GDP (source: World Development Indicators). These data are expressed in constant YTL (base year 2003).

The trade data on fish-specific export and import[21] (with positive fish exports and/or positive fish imports) are only available for some fish species. This reduces the size of the sample to 299. Table 1 represents the descriptive statistics of the sub-sample including only observations with positive fish exports (the sample size is equal to 217 in this case).[22] Table 2 represents the descriptive statistics of the sub-sample when fish exports are absent (the sample size is equal to 82 in this case).

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sector are only available from 2006 to 2009. TurkStat does not provide any information about the number of licensed fishing vessels.

[20] The initial data expressed in constant 2000 US dollars are first transformed to 2000 YTL using the exchange rate statistics of the Central Bank of the Republic of Turkey (http://evds.tcmb.gov.tr/cbt.html). Afterwards, these data are transformed to 2003 YTL using the CPI (base year 2003).

[21] TurkStat provides data on the value of exports and imports of fish and fish products.

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

Table 1: Summary Statistics of the Sample with Positive Exports

Variable	Unit	Obs.	Mean	Std.Dev.	Min.	Max.
H	kg	217	2.11e+07	7.12e+07	6000	3.85e+08
POP	individuals	217	6.87e+07	3905721	6.23e+07	7.48e+07
COST	real YTL	217	728.9167	88.7598	610.6173	878.751
GDP	real YTL	217	4.97e+11	7.79e+10	3.63e+11	6.11e+11
POWER1	number of vessels	217	5403.871	2109.603	2439	9197
TONNAGE1	number of vessels	217	9999.949	5291.002	406	14477
PRICE	real TYL	217	7.266729	5.896447	.5640158	33.69405
TL	-	217	3.595438	.6021373	2.6	4.5
SLMax	cm	217	112.9124	134.9787	12	458

Table 2: Summary Statistics of the Sample without Exports

Variable	Unit	Obs.	Mean	Std.Dev.	Min.	Max.
H	kg	82	5967963	8288737	8000	2.70e+07
POP	individuals	82	6.77e+07	2947439	6.23e+07	7.48e+07
COST	real YTL	82	701.6551	67.11862	610.6173	878.751
GDP	real YTL	82	4.64e+11	5.84e+10	3.63e+11	6.01e+11
POWER1	number of vessels	82	5790.768	2403.031	2439	9197
TONNAGE1	number of vessels	82	10317.79	5297.574	406	14477
PRICE	real TYL	82	7.092513	5.881814	.599994	28.3817
TL	-	82	3.497195	.6100461	2.1	4.5
SLMax	cm	82	65.68293	32.4657	7	135

We note that the mean of the variables (H), (PRICE) and (SLMax) are higher in the sub-sample with positive exports than in the sub-sample when exports are absent. This means that the levels of harvest and price, and the size of fish are higher for the observations with positive exports.

4.2 Econometric methodology

In order to test for the harvest profile proposed by Brander and Taylor (1997a) and related models, we use the following reduced form of harvest level of fish (i) at time (t):

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

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 fish species subscript and $t = 1, ..., T$ is time subscript, $j = 6, ...10$ and $k = 11, ...15$ refer respectively to different POWER and TONNAGE variables.

We choose a log-log specification for the harvest equation that allows us to interpret the estimated coefficients as the elasticity with respect to the explanatory variable under consideration. Here, parameters β_l represent the elasticity of the harvest with respect to exogenous variables.

In line with the theoretical predictions described in Section 3, 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) contribute to the decline in 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. We expect that all of the technological variables, POWER and TONNAGE, have a negative effect on harvest if the price is such that the fishery operates in the region where its harvest supply curve is downward-sloping, i.e., if the coefficient on PRICE is negative and significant. Under the same configuration, we expect that the variable COST has a positive effect on harvest, whereas the variables POP and GDP have a negative effect on harvest at the long-run.

We use the Hausman test to check 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 $P - value = 0.4788$ that suggests that the null hypothesis is accepted and that the random effects model is more appropriate to fit the data. 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.

We suspected that the log of the fish price $ln(PRICE_{it})$ is endogenous since it may be correlated with the time varying component of the error term (ε_{it}) (Cameron and Trivedi, 2009). In that case, the OLS estimator would become inconsistent and we would need to instrument $ln(PRICE_{it})$. 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. Indeed, we note that the correlation between the log of fish price and the log of 2-year lagged fish price ($PRICEL2_{it}$) is equal to 0.92 at the 1%

significance level. Hence, we have computed an instrumental variable estimate of the harvest level, using the log of fish price as a potentially endogenous variable, instrumented by the log of ($PRICEL2_{it}$). The test result indicates that the null hypothesis of exogeneity is rejected ($P - value = 0.01423$). Thus, the price variable is endogenous. We have carried out several tests to check the relevance of the chosen instrument. These test results indicate that the null hypothesis of underidentification and weak identification are rejected.[23] Therefore, we run an instrumental variable estimate of the log of harvest with the fish price being instrumented by the 2-year lagged fish price. To ensure that the results are robust, we will also consider other instruments. A generalized two-stage least squares (G2SLS) estimator for random effects models is used for estimations.

4.3 Identification strategy

Our aim is to test empirically the theoretical prediction that, 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. In this empirical work, we also consider the case where the world fish price exceeds the autarky price because it is the relevant one for the Turkish fishery sector. Indeed, fish prices grew faster than the consumer price index between 1982 and 2004 in Turkey.[24] Turkey has implemented a number of reforms to liberalize its economy since the '80s. The period 1982-2004 corresponds to that marked by increased trade exposure in the fishery sector, especially after Turkey joined the customs union of the EU in 1996. Hence, our data set which covers the period

[23] The underidentification test is a Lagrange Multiplier test of whether the equation is identified, i.e., whether the instrument is correlated with the endogenous regressor. The test results indicate that the null hypothesis of underidentification is rejected ($P - value = 0.0000$). The weak identification test is a F version of Cragg-Donald Wald statistic of whether the instrument is only weakly correlated with the endogenous regressor (Stock and Yogo, 2005).

[24] More precisely, as concerns fishery products, the wholesale price index of 1994 (*resp.* 2004) was 582 (*resp.* 59) times higher than that of 1982 (*resp.* 1994). As concerns the consumer price index, its level in 1994 (*resp.* 2004) was 263 (*resp.* 51) times higher than that of 1982 (*resp.* 1994) (TurkStat, 1996).

1996-2009 corresponds to the period with the most important liberalization, after Turkey signed the free trade agreement with the EU.

In order to isolate the effects of openness to trade on harvests, we adopt the following strategy.[25] We carry out estimations based on two different samples: when the fish exports are positive (with the implied number of observations $N = 185$) and when they are absent (with the implied number of observations $N = 70$).[26] Does the effect of fish price on harvests differ depending on whether or not the fish is exported?

5 Estimation Results

Table 3 presents our initial regression results when the fish exports are positive. In specification (1), we regress the log of harvest on the fish price, the opportunity cost of labor, the population size, the GDP, the mean trophic level and the size of fish species, and the technological factors such as the tonnage and power of fishing fleets. Technological variables TONNAGE 4 and 5 are excluded in this case because of the presence of collinearity. In specification (2), we estimate the previous relation by adding a dummy variable (*FISH)* for the type of marine fish: it is equal to 1 for finfish and equal to 0 for shellfish. In specification (3), instead of *FISH*, we use another dummy variable *SIZEREG*: it is equal to 1 for fish species under the size regulation[27] and equal to 0 for others.[28] Finally,

[25] Another option for isolating the effects of openness to trade would be to carry out separate estimations for the species which are only exported versus only imported. We cannot use this option because in our data set, the fish species are usually imported and exported simultaenously. For instance, there is no species which is purely exported, and we have only three species which are purely imported.

[26] The number of observations has decreased because we use a 2-year lagged fish price to instrument the current fish price.

[27] 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).

[28] 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 highly migratory species as they were never significant. As concerns the list of threatened species, we have included the

in specification (4), we use multiple instruments for the fish price: the 2-year lagged fish price (PRICEL2) and an interaction term of PRICEL2 with the fish size (SLMax). The latter variable provides an interesting information because it appears, in our data set, that larger fish are more expensive per kilogram than smaller ones. In Table 4, the estimation results when the exports are null are presented for the same set of specifications. In this case, technological variables TONNAGE 3, 4 and 5 are excluded because of the presence of collinearity.

In specifications (1)-(4), the case of positive exports (Table 3), we find strong evidence that harvest is negatively correlated with fish prices. The coefficient on the fish price is negative and significant. In specification (3), we estimate that increasing fish price by 1% is associated with a 2.3% decrease in harvest level.[29] As concerns the estimation results based on the sample without fish exports (Table 4), in specifications 1-4, the fish price has a negative effect on fish harvest. This effect is significant in specifications 3 and 4.

These overall results on the fish price tend to indicate that harvest decreases with an increase in fish price no matter if the fish species are exported or only consumed domestically. Estimation results thus reveal that we fall into the decreasing part of the supply curve in both samples (when the fish exports are positive and when they are absent). This means that the fish stock is overexploited, in average, for all the fish species included in our data set. This result is explained by the presence of open-access regime on fishery resources, which also characterizes the fishery sector of Turkey. These overall results are illustrated in Figure 3.

Figure 3: The backward-bending supply curve of fish harvest

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.

[29] Table 9 in the Appendix provides the first-stage estimation results of the instrumental variable model based on specification (3).

Table 3: Estimation results of G2SLS random effects regression of fish harvest with positive exports

	(1)	(2)	(3)	(4)
	lnharvest	lnharvest	lnharvest	lnharvest
lnprice	-2.122***	-1.991***	-2.312***	-2.127***
	(-4.18)	(-4.55)	(-5.15)	(-4.60)
lncost	20.20	18.83	21.77*	20.39*
	(1.91)	(1.79)	(2.04)	(1.96)
lngdp	0.947	0.993	0.968	0.865
	(0.27)	(0.28)	(0.27)	(0.25)
lnpop	-64.34*	-59.57*	-69.16*	-64.89*
	(-2.13)	(-2.00)	(-2.29)	(-2.20)
lnslmax	0.434	0.372	-0.358	-0.466
	(0.68)	(0.68)	(-0.66)	(-0.82)
lntl	0.525	-0.572	3.717	4.034
	(0.18)	(-0.23)	(1.52)	(1.56)
lnpower1	4.577*	4.317*	4.947**	4.573*
	(2.38)	(2.30)	(2.61)	(2.46)
lnpower2	14.10*	13.31*	15.25*	14.20*
	(2.31)	(2.23)	(2.52)	(2.40)
lnpower3	-15.79*	-14.96*	-17.06*	-15.91*
	(-2.17)	(-2.09)	(-2.35)	(-2.25)
lnpower4	13.02*	12.17	14.07*	13.15*
	(2.02)	(1.90)	(2.17)	(2.08)
lnpower5	-6.289	-5.841	-6.778*	-6.368*
	(-1.94)	(-1.81)	(-2.08)	(-2.00)
lntonnage1	-3.896*	-3.668*	-4.205*	-3.914*
	(-2.08)	(-1.98)	(-2.24)	(-2.14)
lntonnage2	-2.872	-2.678	-3.101*	-2.889
	(-1.89)	(-1.78)	(-2.03)	(-1.94)
lntonnage3	-4.460*	-4.212*	-4.810*	-4.484*
	(-2.08)	(-1.98)	(-2.24)	(-2.14)
lntonnage4	.	.	.	.
	.	.	.	.
lntonnage5	.	.	.	.
	.	.	.	.
other		1.422*		
		(2.13)		
sizereg			2.487***	2.402***
			(3.86)	(3.52)
_cons	1031.5	953.0	1106.4*	1040.6
	(1.85)	(1.72)	(1.97)	(1.91)
N	185	185	185	185
R^2	0.48	0.56	0.61	0.61

t statistics in parentheses

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

We could be tempted to interpret the negative relationship between price and harvest differently. For instance, over the studied period, fish prices and particularly the prices of exported species, could have increased, while the regulatory regime in Turkey could have gradually improved. We rule out this explanation because the regulatory regime continued to be (regulated) open access in Turkish fishery industry over the studied period. As Can and Demirci (2012) stress, there is no use of instruments which directly control output such as TACs nor market-based instruments such as harvest taxes or ITQs. FAO (2008) also considers that the current Turkish fishing fleet has still an excess capacity.

In specification (3), the case of positive exports (Table 3), we find that an increase in the opportunity cost of labor has a positive and significant effect on fish harvest. As expected, an increase in fishing cost induces an increase in steady-state harvest when we fall into the decreasing part of the supply curve. The reason is that there is less fishermen who exploit the resource in this case. We also find that that the population size has a negative and significant effect on harvest. In line with the underlying theory, an increase in demand, triggered by a larger population size decreases fish harvest when the fishery operates in the region where its harvest supply curve is downward-sloping. The other demand factor, that is, the GDP has a positive effect on harvest, but this effect is not significant. As expected, we find that the marine trophic index (TL) and the fish size (SLMax) are positively correlated with the harvest, but their effect is not significant. In addition, our empirical results show that all of the technological variables have significant effects. In line with the underlying theory, the following variables POWER3, POWER5, TONNAGE 1,2 and 3 are negatively correlated with the harvest. This means that an increase in the number of vessels belonging to these power and tonnage groups decrease fish harvest when we fall into the decreasing part of the supply curve. Finally, in specification (3), 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 level of fishermen.

For both samples, the estimation results of specification (4) are very similar to those of specification (3). This means that the estimation results associated with our base specification are not altered with the addition of new instruments for fish price.

5.1 Other specifications

To check the robustness of our estimation results with specification (3) (Table 3), Table 5 (*resp.* Table 6) presents the estimation results run with three alternative econometric models, when the fish exports are positive (*resp.* when fish exports are absent). In specification (5), we estimate the base model with a standard OLS model. Specification (6) estimates the base model with random effects model. Here, we do not employ an instrumental variable estimate. Specification (7) removes all the time-invariant regressors from the base specification, and runs the estimation with a fixed-effects model (without employing an instrumental variable estimate).

In all specifications, the sign of the fish price keeps to be significantly negative. In the case of the sample without exports, the sign of the fish price is also significantly negative, except in the fixed-effects model.

5.2 Robustness checks

Table 7 (*resp.* Table 8) reports coefficients for three sensitivity tests of our base econometric specification (3), when the fish exports are positive (*resp.* when

Table 4: Estimation results of G2SLS random effects regression of fish harvest without exports

	(1)	(2)	(3)	(4)
	lnharvest	lnharvest	lnharvest	lnharvest
lnprice	-0.722	-0.669	-1.740***	-1.795***
	(-1.17)	(-1.04)	(-3.79)	(-3.97)
lncost	3.639	4.609	-3.467	-4.485
	(0.15)	(0.18)	(-0.39)	(-1.01)
lngdp	1.288	0.918	5.857	5.930
	(0.16)	(0.11)	(1.30)	(1.61)
lnpop	-17.88	-19.95	-8.149	-5.637
	(-0.24)	(-0.25)	(-0.33)	(-0.98)
lnslmax	-0.350	-0.431	-0.0989	-0.0595
	(-0.38)	(-0.45)	(-0.16)	(-0.10)
lntl	0.182	0.0235	1.966	1.930
	(0.06)	(0.01)	(0.82)	(0.82)
lnpower1	-0.459	-0.269	-1.186	-1.550
	(-0.11)	(-0.06)	(-0.31)	(-0.42)
lnpower2	-0.997	-0.580	-4.046	-4.665
	(-0.14)	(-0.07)	(-0.65)	(-0.78)
lnpower3	0.517	-0.276	6.043	7.279
	(0.04)	(-0.02)	(0.45)	(0.55)
lnpower4	0.688	1.505	-5.318	-6.268
	(0.05)	(0.09)	(-0.62)	(-0.82)
lnpower5	-1.377	-1.485	-0.597	-0.584
	(-0.31)	(-0.32)	(-0.26)	(-0.31)
lntonnage1	-0.0836	-0.161	0.332	0.405
	(-0.05)	(-0.08)	(0.37)	(0.55)
lntonnage2	0.242	-0.147	2.582	3.134
	(0.03)	(-0.02)	(0.51)	(0.67)
lntonnage3	.	.	.	.
	.	.	.	.
lntonnage4	.	.	.	.
	.	.	.	.
lntonnage5	.	.	.	.
	.	.	.	.
other		0.345		
		(0.34)		
sizereg			2.414***	2.449***
			(3.82)	(3.95)
_cons	292.2	333.3	40.45	.
	(0.22)	(0.23)	(0.09)	.
N	70	70	70	70
R^2	0.22	0.23	0.60	0.60

t statistics in parentheses

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

Table 5: Estimation results with other specifications (the case of positive exports)

	(5) lnharvest	(6) lnharvest	(7) lnharvest
lnprice	-1.899***	-1.048***	-0.694**
	(-13.44)	(-5.00)	(-2.90)
lnslmax	-1.107***	-1.129*	
	(-5.55)	(-2.23)	
lntl	4.981***	5.418*	
	(4.97)	(2.19)	
lncost	4.987	3.145	2.554
	(1.14)	(1.83)	(1.52)
lngdp	1.401	1.671	1.474
	(0.43)	(1.32)	(1.20)
lnpop	2.357	-2.582	-3.846
	(0.07)	(-0.20)	(-0.31)
sizereg	1.910***	1.967**	
	(8.78)	(3.15)	
lnpower1	5.041	3.075	2.064
	(0.84)	(1.29)	(0.88)
lnpower2	7.445	3.857	2.640
	(0.96)	(1.26)	(0.88)
lnpower3	6.030	3.933	2.596
	(1.05)	(1.64)	(1.09)
lnpower4	1.357	0.382	0.281
	(0.68)	(0.50)	(0.38)
lnpower5	3.240	1.852	1.176
	(0.77)	(1.11)	(0.72)
lntonnage1	-3.647	-2.290	-1.570
	(-0.74)	(-1.18)	(-0.83)
lntonnage2	-3.775	-1.989	-1.374
	(-1.41)	(-1.82)	(-1.28)
lntonnage3	-3.202	-2.255	-1.583
	(-0.59)	(-1.06)	(-0.76)
lntonnage4	10.20	6.390	4.392
	(0.90)	(1.40)	(0.98)
lntonnage5	-2.793	-2.299	-1.595
	(-0.51)	(-1.07)	(-0.76)
_cons	-245.1	-85.57	-23.74
	(-0.38)	(-0.34)	(-0.10)
N	217	217	217
R^2	0.66	0.61	0.14

t statistics in parentheses

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

Table 6: Estimation results with other specifications without exports

	(5)	(6)	(7)
	lnharvest	lnharvest	lnharvest
lnprice	-2.293***	-1.083**	0.231
	(-7.38)	(-2.75)	(0.45)
lnslmax	0.573	-0.605	
	(1.25)	(-0.87)	
lntl	-0.154	2.741	
	(-0.09)	(0.96)	
lncost	3.873	-3.981	2.743
	(0.31)	(-0.45)	(0.62)
lngdp	5.451	-9.422	-2.442
	(0.64)	(-0.70)	(-0.78)
lnpop	-41.06	9.776	40.81
	(-0.49)	(0.58)	(1.39)
sizereg	2.701***	2.059**	
	(6.28)	(2.87)	
lnpower1	5.697	-19.14	8.744
	(0.25)	(-0.77)	(1.10)
lnpower2	-1.788	-0.452	8.151
	(-0.08)	(-0.13)	(1.02)
lnpower3	.	43.13	.
	.	(0.92)	.
lnpower4	-2.587	-19.99	3.951
	(-0.27)	(-0.87)	(1.18)
lnpower5	1.603	-22.75	8.825
	(0.08)	(-0.79)	(1.23)
lntonnage1	-3.087	-0.548	-6.108
	(-0.21)	(-0.18)	(-1.17)
lntonnage2	-1.488	26.77	-5.127
	(-0.10)	(0.83)	(-0.99)
lntonnage3	-2.833	-5.391	-5.907
	(-0.19)	(-1.00)	(-1.13)
lntonnage4	-0.114	0.390	13.74
	(-0.00)	(0.07)	(1.23)
lntonnage5	-4.662	15.26	-9.418
	(-0.21)	(0.69)	(-1.20)
_cons	642.7	0	-801.1
	(0.38)	.	(-1.35)
N	82	82	82
R^2	0.64	0.49	0.25

t statistics in parentheses

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

fish exports are absent).

In specification (8), we use different instruments for the fish price: the 3-year lagged fish price (PRICEL3) and an interaction term of PRICEL3 with the fish size (SLMax). In specification (9), instead of the opportunity cost of labor (COST), we use the price of crude oil (PriceOil) as a proxy for the fuel cost in Turkish fishery industry. Finally, in specification (10), we use the GDP per capita instead of the GDP. In all these specifications, the fish price has a negative and significant effect on harvest. This result also holds for the sample without fish exports (see Table 8). These findings confirm our previous empirical result that the fish stocks are overexploited, no matter if the fish species are exported or only consumed domestically.

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 licenses 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 whether there is a significant difference before and after the policy change, we create a dummy variable D2002 to account for the years after 2002 and also interaction terms of the existing regressors with this dummy. The equation to estimate now includes as regressors the interaction terms together with the isolate terms.[30] We run an instrumental variable estimate of the log of harvest with the fish price being instrumented by both the 2-year lagged fish price (PRICEL2) and an interaction term of PRICEL2 with the dummy D2002. A generalized two-stage least squares (G2SLS) estimator for random effects models is used for

[30] These estimation results are provided in Table 10 in the Appendix.

Table 7: Estimation results with positive exports: robustness check

	(8)	(9)	(10)
	lnharvest	lnharvest	lnharvest
lnprice	-2.142***	-1.986***	-2.313***
	(-9.19)	(-4.86)	(-5.15)
lncost	-18.52		21.81*
	(-1.22)		(2.04)
lngdp	7.424	7.269***	
	(1.80)	(3.59)	
lnpop	27.96	-10.00**	-68.32*
	(0.65)	(-3.16)	(-2.06)
lnslmax	-0.680*	-0.548	-0.358
	(-2.30)	(-1.05)	(-0.66)
lntl	4.509**	4.214	3.716
	(3.25)	(1.77)	(1.52)
sizereg	2.241***	2.318***	2.488***
	(6.85)	(3.72)	(3.86)
lnpower1	-21.26	1.871*	4.952**
	(-1.48)	(2.47)	(2.61)
lnpower2	-7.567	4.578*	15.27*
	(-1.15)	(1.97)	(2.52)
lnpower3	-11.55	-5.587	-17.07*
	(-1.69)	(-1.88)	(-2.35)
lnpower4	-8.025	1.216	14.09*
	(-1.18)	(0.87)	(2.17)
lnpower5	-0.385	-0.221	-6.790*
	(-0.15)	(-0.24)	(-2.08)
lntonnage1	46.18	-0.751	-4.210*
	(1.55)	(-0.87)	(-2.24)
lntonnage2	10.73	-0.240	-3.107*
	(1.42)	(-0.32)	(-2.03)
lntonnage3	.	-1.340	-4.816*
	.	(-1.14)	(-2.24)
lntonnage4	.	.	.
	.	.	.
lntonnage5	.	.	.
	.	.	.
lnPriceOil		-0.0454	
		(-0.10)	
lngdphab			0.956
			(0.27)
_cons	-685.4	.	1108.6*
	(-0.86)	.	(1.98)
N	169	185	185
R^2	0.64	0.62	0.61

t statistics in parentheses

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

Table 8: Estimation results without exports: robustness check

	(8)	(9)	(10)
	lnharvest	lnharvest	lnharvest
lnprice	-1.852***	-1.787***	-1.729***
	(-3.68)	(-3.90)	(-3.78)
lncost	32.98		-1.042
	(1.06)		(-0.08)
lngdp	-11.30	7.454	
	(-0.67)	(1.94)	
lnpop	-135.9	-9.298	-11.85
	(-1.19)	(-1.60)	(-0.28)
lnslmax	-0.0206	-0.0673	-0.108
	(-0.03)	(-0.11)	(-0.17)
lntl	1.965	1.943	1.966
	(0.76)	(0.81)	(0.82)
sizereg	2.482***	2.439***	2.408***
	(3.61)	(3.89)	(3.82)
lnpower1	-15.72	-0.105	-1.429
	(-0.90)	(-0.04)	(-0.39)
lnpower2	-1.488	-2.410	-4.261
	(-0.55)	(-0.50)	(-0.70)
lnpower3	-14.09	2.384	7.202
	(-0.66)	(0.23)	(0.55)
lnpower4	15.81	-3.243	-4.778
	(0.92)	(-0.55)	(-0.53)
lnpower5	-11.46	-0.286	-1.278
	(-1.11)	(-0.17)	(-0.41)
lntonnage1	35.44	0.323	0.183
	(0.87)	(0.47)	(0.17)
lntonnage2	.	0.931	2.520
	.	(0.29)	(0.49)
lntonnage3	.	.	.
	.	.	.
lntonnage4	.	.	.
	.	.	.
lntonnage5	.	.	.
	.	.	.
lnPriceOil		-0.817	
		(-1.01)	
lngdphab			4.468
			(0.78)
_cons	2452.4	.	206.9
	(1.13)	.	(0.28)
N	65	70	70
R^2	0.58	0.60	0.60

t statistics in parentheses

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

estimations for the whole sample (N=684).[31]

The estimation results show that fish price has continued to have a (significant) negative effect on fish harvest despite the implementation of the 2002 policy. These empirical findings indicate that the 2002 policy does not appear to be effective in terms of its initial objective to reduce the pressure on fish stocks. 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 empirically assessed the effect of trade openness on the Turkish fishing industry. We investigated whether or not the trade in fish and fish products contributed to the decline of 57 fish species observed from 1996 to 2009 in Turkey. More specifically, we tested the theoretical prediction that a small open economy exporting an open-access renewable resource will experience increased resource depletion, and a reduction in the steady state harvest. To this end, we carried out an instrumental variable estimation for a panel data model to estimate the relationship between fish harvest and fish price. 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.

In order to test the effects of trade openness, we carried out estimations based on two different samples: when the fish is exported and when it is not. Our estimation results indicate that fish harvest decreases with an increase in

[31] The interaction terms with the variables POWER 1-5, TONNAGE 4-5, COST, GDP and POP are omitted because of collinearity.

fish price in both cases. These results thus reveal that the fishery operates in the region where its harvest supply curve is downward-sloping, no matter if the fish species are exported or only consumed domestically. This means that the fish stock is overexploited, in average, for all the fish species included in our data set. This result is explained by the presence of open-access regime on fishery resources, which also characterizes the fishery sector of Turkey. In order to strengthen private property right regime on fishery resources, Turkish authorities could implement market-based instruments such as individual transferable quotas. They 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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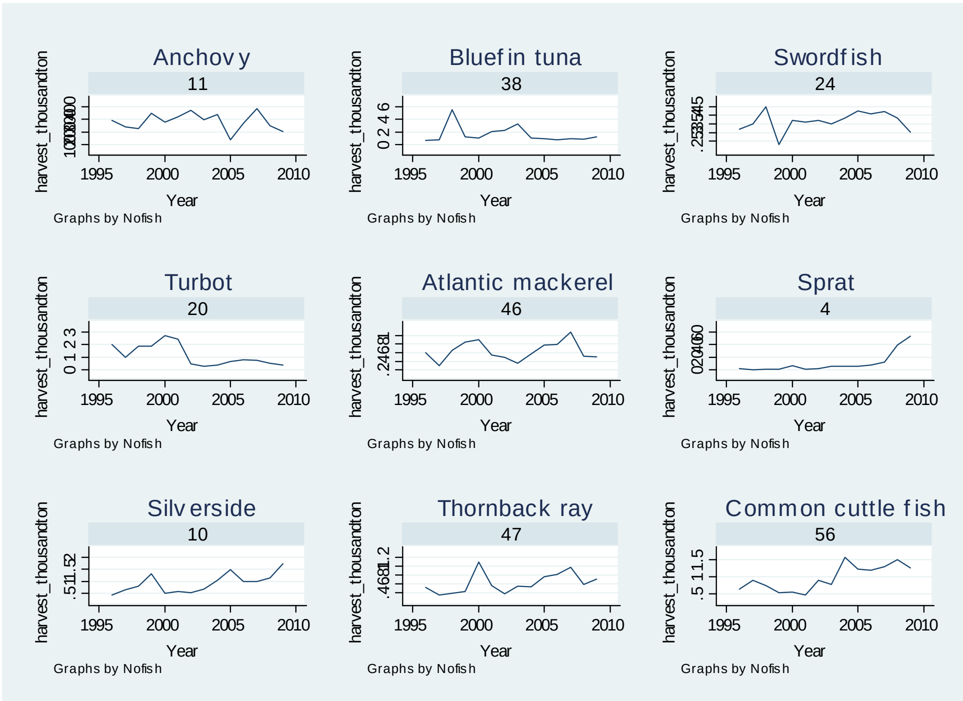
APPENDIX 1: MAP OF TURKEY

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 barracuda
Iskorpit	14	black scorpion fish
Isparoz	15	annular bream
Istavrit(Kraca)	16	horse mackerel
Istavrit(Karagoz)	17	jack mackerel
Iskine	18	brown meagre
Izmarit	19	picarel
Kalkan	20	turbot
Karagoz	21	two-banded 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

Fish name in Turkish	No	Corresponding fish name in English
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	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 SOME FISH SPECIES

Table 9:

	1st stage G2SLS regression			Number of obs =	185
				Wald chi(16) =	396
				Prob > chi2 =	0.0000
lnprice	Coef.	Std. Err.	z	P>z	[95% Conf.Interval]
lncost	11.93725	2.830016	4.22	0.000	6.390524 17.48398
lngdp	-1.204623	1.008162	-1.19	0.232	-3.180584 0.7713391
lnpop	-31.6744	7.754133	-4.08	0.000	-46.87222 -16.47658
lnslmax	.2930779	0.1366973	2.14	0.032	0.0251561 0.5609996
lntl	-0.7232536	0.6633455	-1.09	0.276	-2.023387 0.5768798
sizereg	0.2669082	0.1716857	1.55	0.120	-0.0695895 0.603406
lnpower1	3.047084	0.4814403	6.33	0.000	2.103478 3.990689
lnpower2	8.1627	1.560724	5.23	0.000	5.103737 11.22166
lnpower3	-8.177395	1.890959	-4.32	0.000	-11.88361 -4.471185
lnpower4	7.360325	1.699982	4.33	0.000	4.028423 10.69223
lnpower5	-3.310124	0.8617036	-3.84	0.000	-4.999031 -1.621216
lntonnage1	-2.552727	0.4977297	-5.13	0.000	-3.528259 -1.577195
lntonnage2	-1.670219	0.4003797	-4.17	0.000	-2.454949 -0.8854896
lntonnage3	-2.729462	0.5705712	-4.78	0.000	-3.847761 -1.611163
lnpriceL2	0.5241909	0.0658837	7.96	0.000	0.3950613 0.6533206
Cons	525.2835	147.9225	3.55	0.000	235.3608 815.2062

Table 10: 2002 Policy	Estimation results of G2SLS RE regression of fish harvest
	lnharvest
lnprice	-1.525^{***}
	(-6.04)
lncost	18.18^{*}
	(2.22)
lngdp	-0.762
	(-0.37)
lnpop	-68.69^{***}
	(-3.60)
lnslmax	-0.117
	(-0.33)
lntl	0.251
	(0.15)
sizereg	1.808^{***}
	(3.92)
lnpower1	2.007
	(0.93)
lnpower2	7.828
	(1.44)
lnpower3	-7.010
	(-1.04)
lnpower4	9.889
	(1.94)
lnpower5	-5.906^{*}
	(-2.38)
lntonnage1	-2.387
	(-1.33)
lntonnage2	-2.299^{*}
	(-2.06)
lntonnage3	-2.227
	(-1.03)
lnslmax2002	-0.189^{**}
	(-2.66)
lntl2002	0.643
	(1.88)
_cons	1158.1^{***}
	(3.35)
N	684
R^2	0.43

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

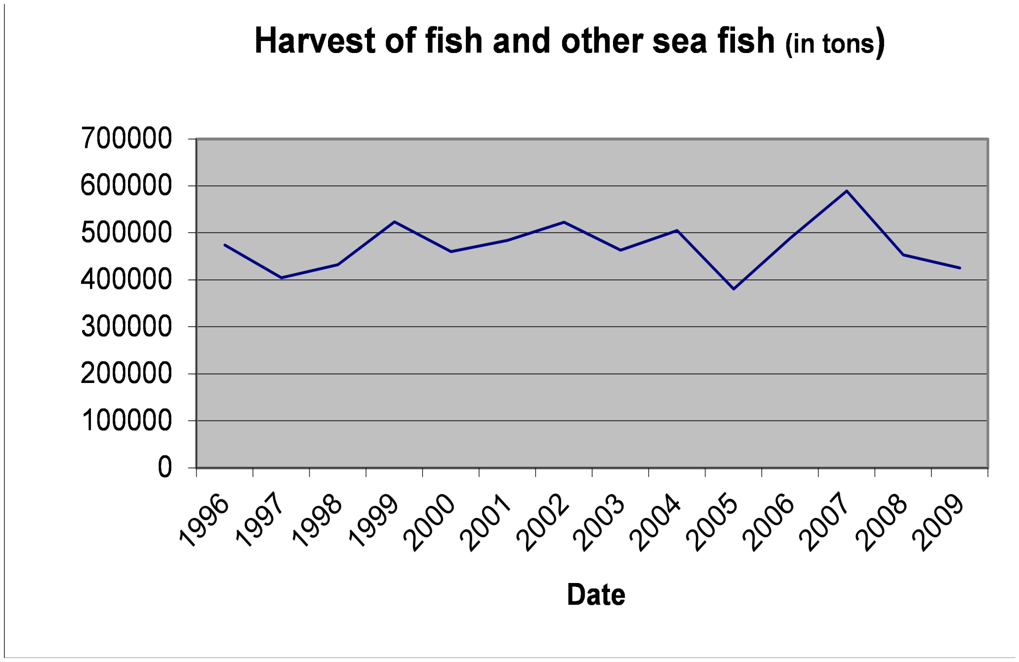

Harvest of fish and other sea fish (in tons)
700000
600000
500000
400000
300000
200000
100000
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Date

Figure 1

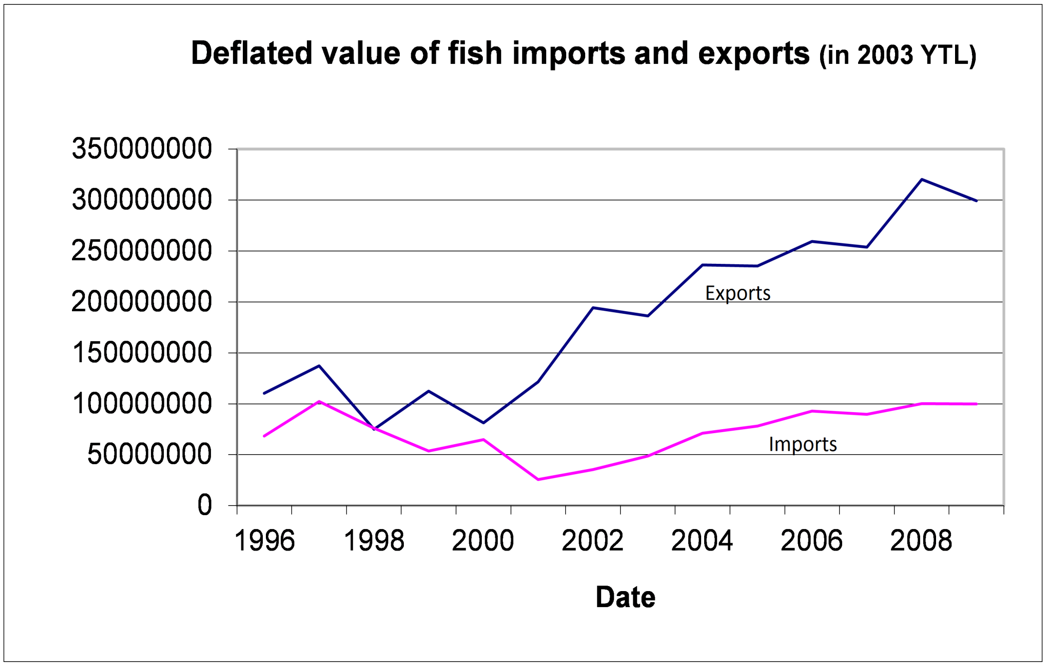
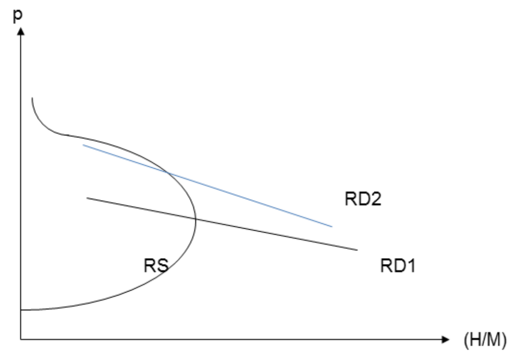

Deflated value of fish imports and exports (in 2003 YTL)
350000000
300000000
250000000
200000000
150000000
100000000
50000000
0
1996
1998
2000
2002
2004
2006
2008
Date
Exports
Imports

Figure 2

3



Note: (RD1) and (RD2) are the relative demand curves of fish at the absence of exports and in the presence of exports respectively. (RS) represents the backward-bending relative supply curve of fish (with respect to manufactures). In the case of positive exports, the relative demand of fish increases thanks to foreign demand, which induces an increases in relative fish price (p).

$_5.pdf$

Figure 3