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A Mediterranean Agreement for Tuna Conservation: The Political Benefit of an International ITQ Scheme

Mediterranean bluefin tuna have been increasingly overfished since the early 1990s, but the countries involved have so far been unable to reach an agreement on an ecologically and economically more efficient use of this shared resource. A system of individual transferable quotas could foster international agreement on reducing the total allowable catches. One condition for this, however, would be that fisheries be adequately compensated for the opportunity costs of decommissioning vessels.

Overfishing generally arises from a bad specification of the property rights to fish stocks. It is exacerbated when the resource is shared among several nations unable to coordinate a collective action that would be ecologically and economically more efficient.

This is the current situation of the Mediterranean bluefin tuna (MBT). This resource, highly valued in Japan, has been increasingly overfished since the early 1990s. Mediterranean countries have been unable to accept and/or to respect a tightening of their catches and, as a result, have produced two classic outcomes of a tragedy of commons: i) MBT stocks are threatened; ii) most of the resource rent has not been received by Mediterranean fisheries but captured downward in the sector.[1]

The resource rent is a surplus generated from resource harvesting above and beyond all extraction and exploration costs, including return on capital employed. Campbell and Haynes[2] define it as "a component of earnings from the exploitation of a resource and such that it is the amount that would be paid for the unexploited resource if an efficient market for the resource existed." Since Gordon[3], it has been shown that this rent is completely dissipated and lost for fishermen when the resource has a "common pool" characteristic and access to it is not regulated.

It is widely admitted and has been observed that the implementation of a system of individual transferable fishing quotas (ITQ) increases the revenue of fisheries, as a larger part of the resource rent accrues to the owners of the property rights. In such a system, the resource rent corresponds to the market value of ITQs.[4]

In theory, the market price of ITQs should be equal to the discounted value of all future and anticipated profits generated by the use of the fishing rights.[5] In other words, the value of all ITQs is equal to the expected earnings generated by the fishery. And as in the case of the shares of a company, this is also the market value of the fishery. According to Arnason[6], the total value of permanent ITQs in Iceland, concerning about 35 fisheries, exceeded US $4bn in 2005. In Australia, where southern bluefin tuna fishing is regulated by an ITQ scheme, the value of the ITQs, based on permanent transfers, was about AUS $850m in early 2008.

This paper considers the ability of ITQ systems to favour a political compromise, at either local or international lev-

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1 The cross-board production price paid to operative Mediterranean purse seiners for their MBT catches has been hardly covering their operating costs since 2000. For example, they received only 3 euros/kg in 2003, 2.90 euros/kg in 2004 and 2.60 euros/kg in 2005. This corresponds to 15-20% of the wholesale price for MBT in Japan, net of taxes, fees, transport and processing costs (see WWF: Race for the last bluefin: Capacities of the purse seine fleet targeting bluefin tuna in the Mediterranean Sea and estimated capacity reduction needs, 2008, http://assets.panda.org/downloads/med_tuna_overcapacity.pdf).

2 D. Campbell, J. Haynes: Resource Rent in Fisheries, ABARE discussion paper 90.10, Canberra 1990.

3 S. Gordon: Economic theory of a common property resource: The fishery, in: Journal of Political Economy, Vol. 62, No. 2, 1954, pp. 124-142.

4 R. Arnason: Iceland's ITQ system creates new wealth, in: The Electronic Journal of Sustainable Development, Vol. 1, No. 2, 2008, p. 26, http://www.ejsd.org/docs/ICELANDS_ITQ_SYSTEM_CREATES_NEW_WEALTH.pdf.

5 R. Newell, K. Papps, J. Sanchirico: Asset Pricing in Created Markets for Fishing Quotas, RFF discussion paper 05-46, Washington DC 2005.

6 R. Arnason, op. cit., p. 37.

els, for the conservation of a shared resource. The reduction in the total allowable catches (TAC) is likely to induce short-run costs for interest groups, explaining their opposition to the tightening of the environmental constraint, even if they may benefit from it in the longer run. For example, fisheries may lose in terms of profits and jobs during the early stage of the ecological reform. The initial allocation of quotas, which commands the redistribution of the resource rent, may be designed so as to compensate these costs and thus raise fisheries' acceptance of the environmental policy. This compensation mechanism would be an important means of consensus dynamics and favour an international environmental agreement for the conservation of a common resource.

Matulich and Sever[7] and Kerr[8] have underlined this principle and we apply it to the conservation of bluefin tuna in the Mediterranean Sea.[9] We show that it is possible to find an initial allocation of the ITQs that would leave the fisheries' constituents at least not worse off in the short run, following a cut in the TAC. In order to do so, we simulate the implementation of an international ITQ system, organised for purse seiners, with a global TAC set to 15,000 tonnes of bluefin tunas per year.

We estimate the MBT resource rent, based on the value of ITQs, and we show that it would exceed the cost induced by the large decommissioning of tuna purse seiners necessary to comply with the new TAC. We analyse which initial allocation of quotas among countries would maximise the political acceptability of the conservation measure. Then, we compare it to the current distribution scheme as agreed in the International Convention for the Conservation of Atlantic Tuna (ICCAT). In order to do this, we develop a simple model to derive the equilibrium characteristics of ITQ schemes and, in particular, the redistribution of fishing efforts based on micro-level productivity. We show how the value of the ITQs may compensate the costs for the vessels' owners and due to the TAC reduction. This model is presented in the third section of this paper, whereas the second briefly describes the Australian ITQ system for bluefin tuna conservation.

In the fourth section, we simulate the equilibrium characteristics of a Mediterranean ITQ scheme for MBT, using micro-level data on the fishing efficiency and capacities of the vessels. We run two geographical scenarios; the first system is organised for Mediterranean European member states only. In the second scenario, all the main Mediterranean tuna fishing nations participate. The choice to set the TAC to 15,000 tonnes follows ICCAT experts' recommendations for 2009. Each of these scenarios will be presented and analysed according to the equilibrium redistribution of fishing efforts, the international "trade" in quotas and the reduction in the proportion of catch capacities and in the number of vessels.

In the final section, we estimate the value of MBT resource rent. For this, we transfer the 2008 ITQ prices from the Australian bluefin tuna fisheries to our Mediterranean case. This enables us to approximate the resource rent distribution that would result from an initial quota allocation based on the ICCAT 2007 agreement. We then propose an alternative rule that would maximise the political acceptability of cutting the TAC. Indeed, we find that with such a distribution, all Mediterranean fisheries could be at least compensated for their net opportunity costs induced by the new regulatory ecological constraint. We then discuss the results and conclude.

The Australian ITQ System for Southern Bluefin Tuna

Australia, Japan, and New Zealand agreed to limit their catches of southern bluefin tuna (SBT) in 1982. Two years later, the Australian authorities implemented a system of ITQs within their fishing zone and allocated the quotas to 136 individuals and companies. The initial allocation rule was the outcome of bargaining and stated that quotas would be granted for free to all significant participants in the fishery prior to the implementation of the system (those who caught at least 15 tonnes of SBT during the three preceding seasons), on a boat-by-boat basis.[10]

These ITQs, transferable both permanently and within the season, are rights to harvest a certain proportion of the TAC, which has been reduced almost yearly. The Australian fleet complied with the binding regulation and restructured quickly after 1984. After only one year, one-third of the boats had left the fishery, while by the end of 1986, two-thirds had left. These two-thirds were comprised of

7 S. Matulich, M. Sever: Reconsidering the initial allocation of ITQs: The search for a Pareto-safe allocation between fishing and processing sectors, in: Land Economics, Vol. 75, No. 2, 1999, pp. 203-219.

8 S. Kerr: The political economy of structural reform in natural resource use: observations from New Zealand, MOTU WP, 2006, http://www.oecd.org/dataoecd/28/50/36883151.pdf.

9 This way of using the initial allocation of property rights so as to ensure the political acceptability of the environmental policy has also been put forward by R. Stavins: What can we learn from the grand policy experiment? Lessons from SO_2 allowance trading, in: Journal of Economic Perspectives, Vol. 12, No. 3, 1998, pp. 69-88, but for the control of atmospheric pollution using emissions trading schemes.

10 See G. Geen, M. Nayar: Individual Transferable Quotas in the Southern Bluefin Tuna Fishery: An Economic Appraisal, in: Marine Resource Economics, 5, 1988, pp. 365-387; T. Meany: The introduction of individual transferable quotas into the Australian sector of the southern bluefin tuna fishery, in: R. Shotton (ed.): Case studies on the allocation of transferable quota rights in fisheries, FAO Fisheries Technical Paper 411, Rome 2001.

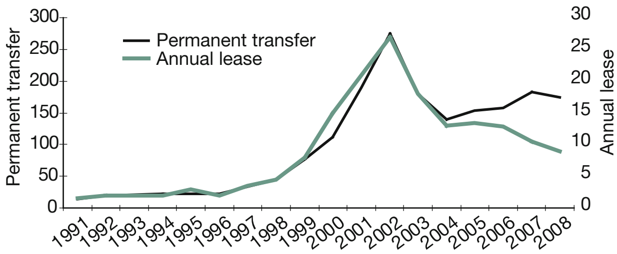
the smallest and oldest vessels and accounted altogether for one-third of the total quotas issued.[11] It was accompanied by a geographical concentration of the fleet in Port Lincoln, South Australia. The sector adopted new fishing equipment and techniques which led to an increase in the economic efficiency of the entire Australian SBT fishery.[12] Although it is restricted to Australian holders of fishing licenses, the system permitted the growing involvement of Japanese-operated vessels within Australian fishing zones through joint ventures. Japanese capital also contributed to the development of tuna ranching in Australian waters.

In 1984, quotas permanently transferred were traded for AUS $800-1,200 per tonne.[13] Their price increased sharply, to AUS $14,500 per tonne in 1991, and peaked at AUS $250-300,000 in 2002, as shown in Figure 1. By mid-2008 they were worth AUS $175,000 per tonne.[14] The second curve presents the evolution of ITQ prices based on annual leasing. The exchange of ITQs takes place directly within industry, without brokers[15], and the price of the quotas contributes to the observed increased revenue for those who left the fishery or remained in it.[16]

Figure 1

ITQ Prices for Australian Bluefin Tuna

AUS $1000, current prices per tonne



Source: Industry source.

Equilibrium of an International ITQ System

A fishery is constituted of N tuna purse seiners, i, with a production technology characterised by a fishing efficiency indicator θ_i. It indicates the catches per unit of effort (CPUE), given the technology of the vessel and the fishing techniques employed by the crew, for a given resource abundance. In the static perspective of the model, we assume that θ_i varies among vessels but is constant in levels of activity and in the total TAC.

For computational simplicity and given the static perspective of our analysis, we assume that the model is linear in harvest levels and independent of biomass. In addition, individual boat fishing capacities are considered as fixed. Relaxing these assumptions would not change our results and conclusions.

If c is the unit cost of effort and q_i the level of catches of vessel i, then its operating costs are $\frac{cq_i}{\theta_i}$. To simplify, we assume that c is constant among vessels, which is not the reality of the Mediterranean purse seine fleets, given differences among countries in the prices of fuel, labour costs and taxes. The fishing activity is regulated with the efficient organisation and implementation of an international ITQ system, and such that $\sum_{i=1}^{n} q_i = T$, with T the annual TAC. Each vessel i is a price-taker and can only catch q_i during a fixed period if it holds enough ITQs. Let Z be the permanent value of a quota. Using it during a period costs $z = rZ$, which is its rental value.[17] Quotas are initially granted for free, and each vessel receiving a quantity a_i may buy extra quotas at a price z. If the fisherman uses the quotas received for free, he will nonetheless consider an opportunity cost z, as these quotas could alternatively be sold on the market. Vessel owners support an additional cost rK_i which is the annual payback of the initial capital investment (amortisation cost of the fully equipped vessel). Vessel owners must make large enough margins (above operating costs) so as to cover this capital cost. If they decide to leave the sector, they still have to support this cost, in particular if the market value of the vessel is lower than the residual capital cost.[18] To simplify, we assume that decommissioning tuna fishing boats induces an annual net cost rK_i for their owners. For a given market price P of fish, rational vessel owners choose the level of activity q_i that maximises their profit π_i and such that:

$$\max_{q_i} \pi_i = Pq_i - \frac{cq_i}{\theta_i} - z\,(q_i - a_i) - rK_i \qquad (1)$$

From the first order condition, one gets:

$$z^d = P - \frac{c}{\theta_i} \qquad (2)$$

11 D. Campbell: Change in the fleet capacity and ownership of harvesting rights in the Australian southern bluefin tuna fishery, FAO Fisheries technical paper 412, Rome 2001.

12 R. Arnason: A review of international experiences with ITQs, CEMARE report 58, University of Portsmouth, Portsmouth 2002.

13 P. Newton, R. Wood, D. Galeano, S. Viera, R. Perry: Fishery economic status report, ABARE research report 07.19, Canberra 2007.

14 Clean Seas Tuna Limited: Business Update, October 2008, http://www.cleanseas.com.au/.

15 R. Arnason: A review of…, op. cit.

16 G. Geen, M. Nayar: Individual transferable quotas and the Southern bluefin tuna fishery: economic impact, ABARE Occasional Paper 105 AGPS, Canberra 1989; D. Campell, op. cit.

17 This simple relationship between the rental price and purchase price of quota holds under the simplifying assumption that expected lease prices and discount rates remain constant in the future. See R. Newel, K. Papps, J. Sanchirico, op. cit., p. 2.

18 This is likely the case. As more and more fish stocks are overfished, transfers of fishing capacities across fisheries are limited, thus reducing boats' residual values.

This is vessel i's optimal demand for quotas, expressed in terms of prices. It represents the willingness of the vessel owner to pay for using a quota and is a function of fishing efficiency. The vessel owner decides to fish (using quotas) as long as $z^d \geq z$. Using this condition and rearranging (2), we have:

$$\theta_i \geq \frac{P - z}{c} = \hat{\theta} \qquad (3)$$

Vessel owners use quotas if their fishing efficiency is superior or equal to a threshold $\hat{\theta}$. Otherwise, they sell them and quit the fishery. This is a standard result which explains the economic efficiency of tradable property rights.

On the market, fishing firms demand or supply ITQs according to their willingness to pay, based on their productivities. The most efficient will be ready to pay a higher price than less efficient ones, and the latter will sell quotas to the former.

The ITQ price that balances supply and demand also equalises the marginal productivities of the remaining fishing firms. These firms are the most efficient and share the TAC, whereas the least efficient have left the fishery. This virtuous mechanism contributes to the higher efficiency of the whole fishery, which has been empirically confirmed in the case of Iceland fisheries[19] and, more relevant for our purposes, in the case of the Australian southern bluefin tuna fishery, as described above.

Fishermen $j \in N$, deciding to leave the fishery and to lease their quotas to other firms $i \neq j$, will receive the following periodical profit:

$$\pi_j = z_j^a - rK_j \qquad (4)$$

The discounted value of all their future profit flows is

$$\Pi_j = Z_j^a - K_j \qquad (5)$$

The terms z_j^a and Z_j^a are the shares of the annual and permanent resource rents accruing to the vessel owners which are raised due to the implementation of an ITQ system. Assuming a perfectly competitive fishery, there would be no profit, except the resource rent. In the situation of a common pool resource, the rent is likely to disappear due to a collective action problem. Thus, the annual and permanent costs of decommissioning a vessel are reduced to rK_j and K_j, the second terms on the right-hand side of equations (4) and (5). These costs could be compensated thanks to the initial allocation of ITQs if it is such that in equations (4) and (5), i.e. for fishermen leaving the sector, we have

$$z_j^a \geq rK_j \qquad (6)$$

and

$$Z_j^a \geq K_j \qquad (7)$$

Conditions (6) and (7) could then be a political objective in the negotiations for an agreement on marine resources conservation. Following Matulich and Sever[20] and Kerr[21], we may assume that this would ensure a minimum level of political acceptability for the ecological constraint.

In order for condition (7) to be satisfied, one must have $Z \geq \sum_j K_j$. The resource rent to be allocated is greater than the total cost endured by all the fishermen having to leave the sector because of the TAC reduction.

An International ITQ System for MBT Conservation

Methodology

In order to simulate the equilibrium of an international ITQ system, we assume that the equilibrium characteristics derived in the previous section hold: only the most efficient vessels remain in the fishery and share the TAC, whereas the less efficient boats sell their quotas and leave. In addition, we assume that each MBT purse seiner i holds enough quotas to harvest its real catch potential (RCP) α_i. We can easily replicate this equilibrium characteristic using boat-level data on efficiency and on RCP. Through a simple data management procedure using Excel, we solve the following equation[22]:

$$\max \sum_i \theta_i$$

$$\text{s.t.} \quad \sum_i \alpha_i = T \qquad (8)$$

Our data for θ_i and α_i relies heavily on a report by WWF.[23] From it we take estimates of Mediterranean purse seiners' best average yearly catch potential as a proxy for their real

19 D. James: Environmental incentives: Australian experience with economic instruments for environmental management, Environmental Economics Research Paper 5, Australian government, Department of the environment, Canberra 1997, http://www.environment.gov.au/archive/about/publications/economics/incentives/index.html; R. Arnason: Iceland's ITQ system…, op. cit.

20 S. Matulich, M. Sever, op. cit.

21 S. Kerr, op. cit.

22 We select the most efficient vessels and such that the sum of their real catching capacities is equal to the TAC.

23 WWF: Race for the last bluefin: Capacities of the purse seine fleet targeting bluefin tuna in the Mediterranean Sea and estimated capacity reduction needs, 2008, http://www.assets.panda.org/downloads/med_tuna_overcapacity.pdf.

catch potential. Taking these estimates is justified given that Mediterranean countries usually underreport their catches. Data is given per country and per length of purse seiners. Their length overall (LOA) is:

- 20m ≤ LOA < 28.6m
- 28.6m ≤ LOA ≤ 38.5m
- 38.5m < LOA.

To measure fishing efficiency, we take the ratio between vessel i's real catch potential and its gross fishing capacities (GFC) f_i:

$$\theta_i = \frac{\alpha_i}{f_i} \quad (9)$$

f_i is the product of a vessel's gross reported tonnage (GRT, in tonnes), its length (LOA, in metres) and its installed horsepower (IHP, in horsepower), such that

$$f_i = LOA^*GRT^*IHP/1{,}000{,}000.00 \quad (10)$$

Our study covers 614 purse seine vessels that were operative in 2007 or under construction and about to be launched. This provides a picture of the tuna fishing capacities that will be operative in the Mediterranean Sea in the near future. These vessels include multi-species purse seine vessels as we make the pessimistic assumption that the possibility to transfer catch capacities are limited, given that most other species are already overfished as well. Table 1 presents the distribution of the MBT purse seiners fleet between the main fishing nations, and the average efficiency per size of vessels.

Redistribution of Fishing Capacities in the Mediterranean Sea

Tables 2 and 3 present simulations of an international ITQ system equilibrium under the two scenarios. The first column lists the countries participating in the scheme: EU Mediterranean member states for Table 2 and Mediterranean countries for Table 3. The second and third columns present the estimated real catch potentials of each country, in tonnes and in number of vessels. The fourth column shows the initial allocation of quotas between countries which would result from the strict implementation of the 2007 ICCAT agreement.[24]

As we are considering an ITQ scheme organised for purse seiners only, we must account for the duality of MBT fishery. Since the mid-1990s, 85% of the MBT on average have been caught by purse seiners and the remainder by longliners. To account for this, we consider an adjusted TAC corresponding to 85% of the aforementioned 15,000 tonnes. Column 5 indicates the percentage variation of current real catch potentials (column 2) that would be necessary in order to comply strictly with TAC reduction objectives (column 4) and with no trade in quotas. The sixth column presents the RCP redistribution between countries that would result, in equilibrium, from the strict enforcement of the TAC, coupled with the implementation of an ITQ system. Column 7 gives the percentage variations between current RCP (column 2) and the ITQ equilibrium (column 6). The last column indicates the number of MBT purse seiners that would remain per country in the case of equilibrium.

Table 1
Size Distribution and Average Efficiency of MBT Purse Seiners Fleets

Country		Length: 20m ≤ LOA < 28.6m	28.6m ≤ LOA ≤ 38.5m	38.5m < LOA
Algeria	av. fec	68.50	38.72	15.78
	no. of vessels	6	6	2
Croatia	av. fec	65.43	19.02	1.75
	no. of vessels	65	13	6
France	av. fec	74.70	41.65	19.86
	no. of vessels	7	18	12
Italy	av. fec	33.17	23.56	13.65
	no. of vessels	56	21	25
Libya	av. fec	43.15	27.67	30.99
	no. of vessels	13	34	5
Spain	av. fec	-	70.01	30.03
	no. of vessels	0	4	2
Tunisia	av. fec	41.41	22.01	16.51
	no. of vessels	36	13	1
Turkey	av. fec	41.02	15.48	4.84
	no. of vessels	59	93	88

Note: av. fec = average fishing efficiency coefficient.

With the implementation of an ITQ scheme among Mediterranean EU member states only, Italy would lose 92% of its catch capacities (Table 2, column 7) instead of 72% without trade in quotas (column 5). In contrast, Croatia would benefit from this scheme because its catch capacities loss would be cut from 92% without trade to 54%. This is because the Italian MBT purse seine fleet is, on average, the least efficient in Europe, compared to the Croatian fleet, which is newer, and thus more efficient. In both cases, France would lose 73-75% of its capacities (23 of its 39 vessels). Spain would lose half its fleet instead of one-third. Greece and Malta would each keep their single operative purse seine vessels.

24 The proportion of the TAC that is given to a country corresponds to the one agreed in 2007 in the framework of the ICCAT.

Table 2
European ITQ System (Mediterranean EU Member States)

	BYBFTCe[1] 2007		Adjusted ICCAT 2008		ITQ market equilibrium		
Country	tonnes	vessels	tonnes	change	tonnes	change	vessels
Greece	200	1	123	-0.39	200	0.00	1
Croatia	5157	85	407	-0.92	2366	-0.54	39
France	8715	39	2350	-0.73	2204	-0.75	16
Italy	6737	102	1855	-0.72	564	-0.92	16
Malta	276	1	168	-0.39	276	0.00	1
Spain	3498	6	2382	-0.32	1749	-0.50	3
Cyprus	0	0	73	-	0	-	0
Total	24583	234	7325	-0.70	7360	-0.70	76

[1] Best year bluefin tuna catches estimates.

Table 3
Mediterranean ITQ System

	BYBFTCe[1] 2007		Adjusted ICCAT 2008		ITQ market equilibrium		
Country	tonnes	vessels	tonnes	change	tonnes	change	vessels
Greece	200	1	117.00	-0.42	200	0.00	1
Croatia	5157	85	389.00	-0.92	2063	-0.60	34
France	8714.69	39	2242.00	-0.74	1393	-0.84	11
Italy	6737.05	102	1769.00	-0.74	366	-0.94	12
Malta	276	1	160.00	-0.42	276	0.00	1
Spain	3498	6	2272.00	-0.35	1749	-0.5	3
Cyprus	0	0	70.00	-	0	-	0
Algeria	1740	14	681	-0.61	160	-0.91	4
Tunisia	3499	50	1144.00	-0.67	1006	-0.71	21
Turkey	19198.52	240	414.00	-0.98	2304	-0.88	35
Morocco	500	1	1431.00	1.86	0	-1.00	0
Libya	5199.6	52	647.00	-0.88	1821	-0.65	15
Total	54719.86	591	11336.0	-0.79	11338	-0.79	62

[1] Best year bluefin tuna catches estimates.

Now consider a Mediterranean ITQ system involving Middle Eastern and North African (MENA) countries (Table 3). Compared to the situation without international trade in quotas, some MENA countries would lose additional capacities, such as Algeria (91% instead of 61%), Tunisia (71% instead of 67%) and Morocco, which would lose its single ship. In contrast, Turkey and Libya would benefit, with losses reduced from 98 to 88% and from 88 to 65% respectively.

Compared to the previous scenario with trade among European countries only, France, Croatia and Italy would lose additional capacities, whereas the situation would remain unchanged for Spain, Greece and Malta. This means that with a larger ITQ scheme involving southern and eastern Mediterranean countries, European member states would lose additional fishing capacities altogether to the benefit of MENA countries. This transfer would enable these latter countries to ease the adjustment of their purse seine fleets.

International Transfers of Quotas

Tables 4 and 5 present the international transfers of quotas for the two scenarios in equilibrium of the international ITQ system and the resulting international financial flows. A country's purchase or sale of permits depends on at least two main factors: first, the country's fishing effort in equilibrium, which is a function of its fleet's efficiency relative to foreign fleets, and secondly, the initial quotas allocation. If the country were producing the exact equilibrium distribution of catch efforts, there would be no trade. As already explained, we have arbitrarily chosen an allocation based on the 2007 ICCAT regime. It is a function of historical backgrounds, the result of political bargaining, and does not seem to weight current catch capacities significantly. This initial allocation scheme would lead to important international transfers of quotas as shown below. ITQs would be exchanged at the market equilibrium price, leading to international financial flows. In order to simulate the price of an MBT ITQ in a Mediterranean system, we transfer the price of SBT ITQ from the Australian system.[25] In September 2008, SBT ITQ was priced at AUS $175,000 for permanent transfer and AUS $9,000 for annual lease.[26]

We take these prices and convert them. We acknowledge that this simple and static procedure for estimating the price of ITQ is approximate. An alternative solution could be a dynamic simulation of the ITQ market, integrating a bioeconomic model of the fishery's biomass being rebuilt over time, and so simulating the appreciation of the value of ITQ over time. Such a sophisticated approach would nonetheless rest necessarily on numerous assumptions on parameters, and as a result, the ITQ price would still be approximate.

25 The exchange rate is €0.57 for AUS $1, which was the average exchange rate in September 2008.
26 Clean Seas Tuna Limited, op. cit. In mid-2008, the price for permanent transfer was almost 20 times higher than the leasing price. The theory predicts a relation between these two prices that is based on the discounting value of a perpetuity. This is what R. Newell, K. Papps and J. Sanchirico, op. cit. observe in the case of New Zealand fisheries. On average, the ITQ price, based on permanent transfer, is approximately equal to 10 times the price of an annual lease over the sample period, and roughly equal to the present value of a perpetuity discounted at 10%. This is also what was observed on average on the Australian market for Southern bluefin tuna (SBT) fishing quotas until 2004, as shown in Figure 1.

Table 4
International Trade in Quotas, European Market

Country	Number of quotas sold (+) or bought (-)	Revenue (€ million) Lease	Permanent transfer
Italy	1290.0	6.6	128.7
Spain	633.0	3.2	63.1
France	146.0	0.7	14.6
Cyprus	73.0	0.4	7.3
Greece	-76.6	-0.4	-7.6
Malta	-108.0	-0.6	-10.8
Croatia	-1960.0	-10.1	-195.5

Table 5
International Trade in Quotas, Mediterranean Market

Country	Number of quotas sold (+) or bought (-)	Revenue (€ million) Lease	Permanent transfer
Morocco	1431.0	7.3	142.7
Italy	1403.2	7.2	140.0
France	848.7	4.4	84.7
Spain	523.0	2.7	52.2
Algeria	521.0	2.7	52.0
Tunisia	138.0	0.7	13.8
Cyprus	70.0	0.4	7.0
Greece	-83.0	-0.4	-8.3
Malta	-116.0	-0.6	-11.6
Libya	-1174.2	-6.0	-117.1
Croatia	-1673.8	-8.6	-167.0
Turkey	-1889.6	-9.7	-188.5

The simple procedure we use in this study produces figures that should be taken cautiously, but we consider that they are a good illustration for the purpose of this political economy analysis.

SBT and MBT are good substitutes on the Japanese tuna market. For example, in 2003-2004, the price of SBT dropped in Japan (and consequently, the price of SBT ITQ as shown in Figure 1) due to a significant rise in the supply of bluefin tuna from the Mediterranean Sea.[27]

With 7,326 tonnes of quotas (adjusted TAC) allocated to the purse seiners of Italy, Spain, Cyprus, Malta, France and Croatia, 2,142 quotas, or 29% of the total issued, would be transferred internationally. The main sellers would be Italy, due to the major adjustment of its fleet, followed by Spain and France. The main buyer would be Croatia due to the fact that the ICCAT-based donation of quotas, well below its real catch capacities, has grown quickly since the mid-1990s. In the case of a seasonal lease of the quotas, and given our estimates of ITQ prices, Italy would receive €6.6m annually (Table 4, column 2). With a permanent transfer of the quotas, the initial revenue would be €128.7m. In Spain, these figures would be €3.2m and €63.1m respectively, and for France, €0.7m and €14.6m. The sale of ITQs would thus offer significant compensation to fishermen or vessel owners leaving the fisheries. As a counterpart, Croatia would pay €10.1m for annual leasing or €195.5m for permanent transfers. As explained below, this cost would be passed on to customers, and therefore not supported by the fishing industry.

In a Mediterranean system, with a total of 11,338 tonnes of ITQs granted to the purse seiners of these countries, 4,938 quotas would be transferred. This is the equivalent of 43.5% of the total quantity issued, which is a higher proportion than in the previous scenario. Indeed, enlarging the system to MENA countries would enhance diversity among national purse seiner vessel fleets, both in terms of size (real catch capacities) and in terms of efficiency. Therefore, this would raise the gains from trading quotas.

Morocco, Italy, France, Spain and Algeria would sell significant shares of their donated quotas (Table 5). They would earn revenues ranging from €2.7m to €7.3m in the case of leasing and from €52m to €142m in the case of permanent transfers. The main buyers would be Turkey, Croatia and Libya. These three countries share common characteristics: their fleets expanded quickly during the 1990s, and they are given quotas within the framework of ICCAT in quantities well below their RCP.

Altogether, European countries would be net sellers of ITQs, whereas MENA countries would be buyers. This means that considering solely the criterion of fishing efficiency compared to the ICCAT regime, MENA countries should be allocated more quotas.

Political Acceptability of an MBT TAC Reduction

The MBT Resource Rent

Based on our estimates of ITQ prices, and assuming a TAC set to 15,000 tonnes in 2009, the MBT fisheries would be worth €4.6bn, the total value of quotas in the case of permanent transfer. This would generate an annual rent of €77m, which is the total annual leasing value of the quotas. These figures are certainly underestimated, because our rough estimates of ITQ prices cannot account for the potential price

27 P. Newton et al., op. cit.

effect induced by a significant TAC reduction. Table 6 presents the distribution of this rent among purse seine fleets by country and according to a 2007 ICCAT-based allocation of the adjusted TAC. The annual rent will be passed on to consumers through a rise in the producer price and should accrue to the owners of the resource. This happens with ITQs as they set property rights on the resource. They must be considered as an input to the fishing activity, with the opportunity cost of their use (their market value) to be passed on through the producer price.

If an ITQ system had been implemented for MBT and the fishing quotas allocated to countries according to the 2007 ICCAT regime, the Italian tuna purse seine sector would have received additional annual revenue of €9m in 2009. The French sector would have received €11.4m, Spanish €11.5m, Moroccan €7.3m and Tunisian €5.8m. With permanent transfers of the quotas, these revenues would be €174.4m, €221m, €224m, €141.1m and €112.7m, respectively (Table 6, last column).

The annual rent already exists in the bluefin tuna market. It is passed on to final consumers but does not end up in the Mediterranean fishing sectors due to the property rights regime on the resource and to the tuna sector's industrial structure.

Raising the Political Acceptability of a TAC Abatement

This situation offers additional arguments supporting the organisation of a Mediterranean ITQ system. First, it would frame and facilitate the cooperation between Mediterranean fisheries. Second, the market mechanisms would induce the spontaneous internalisation of the MBT resource rent in producer prices. This would raise Mediterranean fisheries' revenue, eventually compensating them for the costs of cutting the MBT TAC, depending on the quotas' initial allocation.

Table 7 indicates the value of capital investment amortisation of the main Mediterranean fleets for 2009 and for the last year of amortisation. This may be considered to be one of the main components of the cost of decommissioning vessels.[28] Columns 5 and 6 show that, except for Turkey, the share of the annual rent received by countries according to the 2007 ICCAT agreement would more than compensate for the cost of decommissioning their entire purse fleets. For example, France would need 8.66% of the rent to cover this opportunity cost whereas it receives 17.38%. Spain would need 2.10% but receives 17.61%. Morocco would need

28 This is from the micro-perspective of vessel owners. From the more macro-perspective of regions, one could consider the additional economic and social consequences of a reduction in activity and a rise in unemployment.

Table 6

Annual and Permanent Values of the MBT Fisheries

Country	Area	Quotas granted by country, ICCAT 2007 agreement	Annual value of quotas, 2009 (€m)	Permanent value of quotas, 2009 (€m)
Croatia	EU Med	384.1	2.0	38.3
Cyprus	EU Med	68.9	0.4	6.9
France	EU Med	2215.6	11.4	221.0
Greece	EU Med	115.8	0.6	11.6
Italy	EU Med	1748.8	9.0	174.4
Malta	EU Med	158.4	0.8	15.8
Spain	EU Med	2245.6	11.5	224.0
Algeria	MENA	673.2	3.5	67.2
Libya	MENA	639.7	3.3	63.8
Morocco	MENA	1414.3	7.3	141.1
Syria	MENA	23.7	0.1	2.4
Tunisia	MENA	1130.3	5.8	112.7
Turkey	MENA	409.1	2.1	40.8
China	others	29.3	0.2	2.9
Japan	others	1120.7	5.7	111.8
Korea	others	79.2	0.4	7.9
Taiwan	others	31.7	0.2	3.2
Portugal	EU	211.3	1.1	21.1
Other EU	EU	2.7	0.0	0.3
Iceland	others	23.7	0.1	2.4
Norway	others	23.7	0.1	2.4
Adjusted TAC[1]		12750.0	65.4	1271.8
TAC		15000.0	77.0	1496.3

[1] The adjusted TAC allocated to purse seiners is 85% of the TAC.

0.54% but receives 11.09%. In contrast, Turkey would need 30.58% whereas it only receives 3.21% of the adjusted TAC under the 2007 ICCAT regime. Libya would need 14.39% but receives only 5.02%, and Croatia would need 6.53% whereas it only receives 3.01%.

Actually, the leasing value of all ITQs (adjusted TAC) for 2009 is €65.3m, which exceeds the amortisation cost of the whole Mediterranean purse seiners fleet of €52.5m. There are two remarks at this level. First, even with a TAC set to 15,000 tonnes, not all Mediterranean tuna purse seiners would be decommissioned. Second, the decommissioned vessels would have a residual value, even if transfers across fisheries are limited. Therefore, there exists an initial allocation of the annual resource rent such that each Mediterranean fishing nation could be at least compensated for the opportunity cost of decommissioning some of its purse seiners. This distribution rule must satisfy, as a minimum condition, the donation of resource rent proposed in column 5 of Table 7.

Table 7

Amortisation Costs of Mediterranean Purse Seiners Fleets[1]

Country	Last year of amortisation: Year	Last year of amortisation: Cost, €m	Amortisation cost for 2009, €m	% of annual 2009 resource rent sufficient to cover amortisation cost	% of resource rent received by countries for 2009, based on ICCAT 2007 agreement
Greece	-	-	-	0.00	0.90
Croatia	2017	1.097	4.262	6.53	3.01
France	2015	1.131	5.654	8.66	17.38
Italy	2014	0.704	7.248	11.10	13.72
Malta	2014	0.243	0.243	0.37	1.24
Spain	2011	0.732	1.374	2.10	17.61
Cyprus	-	-	-	-	0.54
Algeria	2016	1.017	2.452	3.75	5.28
Tunisia	2016	0.333	1.529	2.34	8.86
Turkey	2016	1.515	19.967	30.58	3.21
Morocco	2015	0.353	0.353	0.54	11.09
Libya	2016	2.139	9.399	14.39	5.02
Total		9.264	52.481		

[1] Amortisation flow of gross fleet capital investment, by country, as of 2007, on a 10-year amortisation period basis.

Given our simulations, and compared to a distribution scheme based on the 2007 ICCAT agreement, only Turkey, Libya and Croatia would need to be given higher quotas.

Conclusion

This paper showed that implementing ITQ systems for the conservation of marine resources can increase the political acceptability of reducing the TAC. Indeed, it enables a regulator to get control over the resource rent and to redistribute it to fisheries through the initial quota allocation, so as to compensate them for the short-run costs induced by the ecological constraint.

We have applied our analysis to the case of the Mediterranean bluefin tuna, simulating the equilibrium of an international ITQ system organised for Mediterranean BT purse seiners, or for European ones only, with a TAC set to 15,000 tonnes per year.

We find that the leasing value of all ITQs in 2009, i.e. the annual resource rent, would far exceed the cost of decommissioning all Mediterranean purse seine fleets. In addition, and in order to have each Mediterranean fishery at least better off following the international ecological constraint, it would be necessary to slightly modify the initial distribution of the fishing rights, compared to the one agreed in 2007 in the ICCAT.