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ITQ markets with administrative costs: An application to the industrial common sardine and anchovy fishery in Chile

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ABSTRACT

Using numerical simulations of the mixed common sardine and anchovy fishery of central-southern Chile, this article studies the effects of the distribution of administrative costs between the government and the fishing industry in an individual transferable quota system. Consistent with recent theoretical results, the analysis indicates that the presence and distribution of the administrative costs can have important impacts on the performance of an individual transferable quota system. The numerical simulations reveal significant and non-monotonic effects on the optimal paths of transferable quotas, biomass, quota price, size of the active fishing fleet, and the value of the fishery. While the effects of the distribution of administrative costs are complicated in the case study under analysis, the results suggest that it is likely optimal for the industry and government to share the administrative costs in this fishery.

1. Introduction

Markets for individual transferable fishing quotas (ITQs) allow the achievement of a total allowable catch (TAC) with the maximum social benefit. ITQs involve setting a maximum cap on catches to comply with a biological target, and the creation of individual transferable rights consistent with the cap. Conceptually, ITQ systems can prevent over-exploitation of a fishery and create incentives for fishermen to manage their fleets and related fishing effort efficiently.[1]

The operation of an ITQ system involves several administrative costs associated with implementing and managing the regulation, including the formulation of regulatory requirements, monitoring and sanctions to deter illegal fishing, and research to support management efforts. These activities can generate significant costs [1,14]. Despite the potential relevance of the administrative costs of an ITQ system, there has been very little research on the welfare effects of these costs, how they affect the design of an ITQ system, and the optimal distribution of these costs between the government and the fishing industry.

In fact, Chávez and Stranlund [3] appear to be the first to provide a rigorous economic model of an ITQ fishery to address these issues. They model four influences on administrative costs that ultimately determine the optimal distribution of these costs. The quota price may have a direct positive influence on administrative costs because fishers have a greater incentive to violate their quota with a higher price, requiring greater enforcement effort to maintain compliance. There may also be a direct positive effect of individual harvests if landings require costly certification. There could be a fleet size effect as well if more vessels require greater enforcement or other administrative effort. Finally, the level of administrative costs may depend on the distribution of these costs because of the deadweight cost of raising public revenue.

In the absence of all of these effects the quota market equilibrium, aggregate administrative costs, and the value of the fishery is unaffected by the distribution of administrative costs. However, the deadweight costs of public funds, the fleet size effect, and the quota price effect all suggest shifting the burden of administrative costs to the industry. It is only the harvest effect that can lead to

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[1] There are currently hundreds of fishery regulations that use some system based in the use of individual catch quotas [2]. In Latin America, ITQs are being used in Chile and Peru. These systems are also being used in some African countries, including South Africa, Morocco, and Namibia (see, for example, [4,7,9,13]).

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having the public bear a portion of administrative costs. Chávez and Stranlund conclude that, except in special cases, an efficient design of an ITQ system should make the regulated fishing industry pay the administrative costs.[2] In this paper this analysis is extended to consider a fishery's transition to the steady state and the results suggest that these transitional net benefits might change this conclusion.

Chávez and Stranlund [3] also show that the presence and distribution of administrative costs affects the steady-state allowable catch, biomass, and quota market equilibrium, but that these effects are indeterminate because the presence and distribution of administrative costs generate ambiguous stock effects on the total costs of fishing (the total costs of administrative and fishing effort) and on the shadow price of the resource stock. These ambiguities suggest that the market effects of the distribution of administrative costs and their optimal distribution are empirical matters that must be settled on a case-by-case basis.

In this paper such an empirical analysis is conducted. Specifically, data from the mixed common sardine and anchovy fishery of central-southern Chile is used to calibrate a dynamic ITQ model with administrative costs. The article evaluates how the optimal total allowable catch and equilibrium in the quota market for a period change with changes in the distribution of administrative costs and the current biomass. The work also estimates the optimal steady state biomass, total allowable catch, number of vessels, and the quota price, as well as the paths of these variables to the steady state. Finally, the value of the fishery as a function of the initial biomass and the distribution of administrative costs is also calculated. The results suggest that the distribution of administrative costs can have non-monotonic effects on the paths of the optimal quota and market equilibria, much of which show up in differences in the transitions to the steady state. Ultimately, there are important non-monotonic effects of the distribution of administrative costs on the value of the fishery.

The paper is organized as follows. In Section 2, the conceptual framework of Chávez and Stranlund [3], which forms the basis of the simulation exercise, is presented. In Section 3 the common sardine and anchovy fishery in central-southern Chile is described and details of the model calibration are presented. Section 4 contains the simulation results. Conclusions from this work are presented in Section 5.

2. Conceptual model of individual transferable quotas with administrative costs

In this section the structure of the conceptual model of Chávez and Stranlund [3] is briefly presented, and some of its main implications are reviewed.

2.1. Model elements

Consider an ITQ fishery with n endogenous fishers. An individual fisher's harvest in a period is q, which sells at a competitive price p. The current biomass of the fishery is B. A fisher's harvest cost function is $c(q, B) + \lambda$, which is increasing and convex in harvest, decreasing in the stock of the resource, and the marginal cost of harvest decreases with the biomass so that $c_{qB} < 0$. λ denotes a fixed cost. To simplify their model Chávez and Stranlund assume that the variable part of the cost function is the same for all fishers, but costs vary according to fixed costs. In the numerical simulation the assumption of identical variable cost functions is relaxed.

Fishers operate under a competitive ITQ program. The total allowable catch in a period (TAC) is achieved with Q quota, which trade at price w. Ownership of a quota confers the legal right to harvest a unit of the resource in a single period, and it is assumed that fishers do not violate their quota. A fisher receives an initial allocation of quota q^0; it holds q quota and harvests that amount after trading is completed.

Administrative costs associated with each active fisher is the function $m(w, q)$.[3] This function is non-decreasing in the quota price, reflecting the possibility that a higher price can lead to a greater incentive to violate and, consequently, a greater need to allocate resources to deter illegal fishing. The administrative cost function may also be increasing with greater harvests, because greater harvests may be associated with higher costs of certifying their legality. Administrative costs are strictly positive for all active fishers even if they are independent of quota price and individual level of harvest because there are likely to be costs that vary with the number of fishers. The model does not include administrative costs that are independent of the number of fishers. This is a simplifying assumption that does not affect the results as long as these costs are not so high that any ITQ program is inefficient. Since the government and fishers may share administrative costs (or administrative services which can be modeled as cost sharing), let α be the fraction of administrative costs borne by the government: $1 - \alpha$ is the portion borne by fishers. This cost-sharing arrangement is the same for all fishers. Finally, since public financing requires revenue raised with distortionary taxes, let the marginal cost of public funds devoted to fishery administration be $\mu \geq 1$.[4] Combining all the components of administrative costs to specify an aggregate administrative cost function produces

$$M = (1 - \alpha + \alpha\mu)nm(w, q) \tag{1}$$

Of aggregate administrative costs, $(1 - \alpha)nm(w, q)$ is borne by the fishing industry, while $\alpha\mu nm(w, q)$ is borne by the government. Note that there are potentially four direct effects that impact aggregate administrative costs; a quota price effect, an individual harvest effect, the effect of the deadweight cost of public funds, and a fleet size effect. Be aware that these are only direct effects, as each parameter can also have indirect effects that work through the quota market. For example, the distribution parameter α can have indirect effects on equilibrium individual harvests, the quota price, and the active fleet size. These equilibrium interactions are now specified.

[2] Other work on fisheries management suggests that there is an equity reason for distributing administrative costs to fishers. This is that administration of an ITQ system mainly benefits fishers, and it might be unfair to require the public to pay for what is largely a private benefit [11,12]. Arnason et al. [1] suggest another reason why shifting the burden of administrative costs to fishers can promote efficiency. They argue that doing so will give fishers a powerful incentive to make sure the administrative services are provided efficiently. These additional possibilities are not considered in this paper.

[3] The theoretical model assumes that all administrative costs are associated with individual fishers that operate under the ITQ program. However, this does not mean that individual fishers will actually bear the costs associated with them or that all management costs are attributable to individual fishers. The assumption does allow, for modeling purposes, to describe total administrative costs as an aggregation of these costs over fishers. Moreover, the implementation of any distribution of administrative costs can be accomplished by distributing responsibilities for the necessary services between the fishers and regulators, and possibly with auxiliary fees and subsidies.

[4] This does not mean that the government is less efficient in providing management services than the fishing industry, but that to fund administrative activities the government must raise funds using distortionary taxes, consequently one dollar of government expenditure costs more than one dollar. The marginal cost of public funds is equal to one plus the marginal excess burden of taxation, where the latter is the efficiency loss of a higher tax per dollar of increased revenue.