Marine Policy 53 (2015) 188–197

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

# Vessel buybacks in fisheries: The role of auction and financing structures

Joshua Graff Zivin [a], Jamie Mullins [b,*]

[a] Department of Economics and IRPS, University of California, San Diego & NBER, 9500 Gilman Drive, MC 0519, La Jolla, CA 92014, USA
[b] Department of Economics, University of California, San Diego, 9500 Gilman Drive, MC 0508, La Jolla, CA 92014, USA

ARTICLE INFO

*Article history:*
Received 9 April 2014
Received in revised form
2 October 2014
Accepted 7 October 2014
Available online 6 January 2015

*JEL classifications:*
Q220
D240
Q280

*Keywords:*
Fisheries policy
Common pool
Buyback programs
Self-financing
Capacity reduction
Decommissioning schemes

ABSTRACT

Vessel buyback programs intended to address overcapacity and excess capitalization in fisheries can lead to dramatically different levels of decapitalization depending on program structure and availability of vessel-specific information. This paper develops a simple theoretical model of self-financing vessel buybacks to examine equilibrium outcomes using sequential versus take-it-or-leave-it auctions, and financing schemes which allocate costs either homogeneously or according to rents captured through the buyback. This model demonstrates that programs which spread costs evenly among remaining vessels limit the possible extent of buybacks, as do programs which buy vessels one at a time in sequence rather than all at once. In addition to the theoretical modeling, a stylized case study inspired by the Inter-American Tropical Tuna Fishery is also provided. This analysis suggests that a wide range of auction structures could roughly half the size of the existing fleet, and starkly demonstrates how information poor settings can entirely derail a buyback.



## 1. Introduction

For most of human history, fisheries, like most natural resources, have been treated as a common resource. Anyone with the means could extract fish from the common pool and since all participants are in competition for a (quasi-) finite resource, overexploitation arises. As new fishing technologies became available, this competition also led to overcapitalization as fleets raced to catch more of the resource. This tragedy of the commons arises because property rights over the fish are poorly defined, such that no individual has an incentive to conserve the resource, and all fear that others will consume it [8, 17]. As such, economists have advocated privatizing common pool resources as a means of avoiding overcapitalization and overexploitation [8, 17].

In the decades since the early writings on this subject, economists have generally coalesced around the use of individual transferable quota (ITQ) systems as the preferred structure for privatization. ITQs are essentially a form of cap-and-trade system, where the total harvest for a given year, known as the total allowable catch (TAC), is fixed and individuals are allocated a fixed share of that catch which they can freely trade with others. While the economic success of ITQ systems have been well documented in the locations in which they have been implemented (see, for example, [9]; Hannesson [11,16]), less than 2% of fisheries around the world use anything resembling an individual quota system, transferrable or otherwise [5].

Given the practical difficulties in the adoption of ITQ systems, which largely stem from the formal allocation of property rights and the resulting distributional shifts in rents associated with this transition (see Barrett [2] and Libecap [13] for a general discussion of this problem), many fisheries have employed an intermediate policy to protect fisheries from collapse—limited entry. In this system, individuals generally must have a permit to fish and a cap on the fishery-wide catch is established, either explicitly through a TAC or implicitly through restrictions on fishing seasons, gear types, and/or areas open to be fished. While this approach limits overexploitation of the resource by fixing the total catch (at least when the TAC is appropriately determined), it does little to limit capital stuffing by those vessels in the fishery, since the absence of individual quotas still leaves each fisherman

* Corresponding author. Tel.: +1 209 743 1454; fax: +1 858 534 7655.
*E-mail addresses:* jgraffzivin@ucsd.edu (J. Graff Zivin), jmullins@ucsd.edu (J. Mullins).

http://dx.doi.org/10.1016/j.marpol.2014.10.004
0308-597X/

with a strong incentive to outcompete others in order to capture the largest share of the TAC possible[1].

This paper explores the use of vessel buyback auctions to address issues of overcapacity and excess capitalization in this policy setting. Overcapacity of productive capital in a fishery is inefficient for all involved, and increases the likelihood of (by creating the capacity for) extraction beyond any TAC in place. A vessel buyback program is a decommissioning scheme in which a regulatory authority buys out existing vessels from a fishery and retires them in order to reduce the number of vessels vying for a particular fish stock. While such programs do not entirely eliminate incentives to overcapitalize for those boats that remain in the fishery, they can reduce industry-wide capacity for some time. Vessel buybacks can also play an important role in smoothing the transition to a rights-based management regime by rationalizing the market and easing enforcement by limiting the number of participants over which property rights must be allocated [18].

Vessel buyback programs, along with other decommissioning schemes focused on the acquisition of fishing licenses or gear, have been deployed in a handful of fisheries with mixed success (see Curtis and Squires [6] for a review). While the ultimate impacts of these programs has been idiosyncratic to the fishery and policy specifics, there is a general consensus that all such programs have been rather inefficient—with budgeted funds garnering lower levels of capacity reduction than should have been possible. One of the particularly thorny issues in program implementation is that vessels within a fishery generally differ in both the profitability and sizes of their operations. Thus, the most ineffective vessels may not be the vessels with the lowest buyout reservation prices, and it might be that highly profitable, but small, boats are bought out (since they had low total reserve prices) while large, but inefficient vessels remain[2]. Such outcomes overpay per ton of catch-capacity removed and forfeit rents available from the transfer of catch from less efficient vessels to vessels with higher profits per unit of catch. While a few studies have explored some general theoretical properties of buyback auctions (Campbell [3]; [19]; and Clark et al., [4]), the realistic case of a buyback program in a fishery with a heterogeneous fleet remains entirely unexamined.

As such, this paper develops a simple model of a buyback program implemented in a fishery comprised of vessels that differ in their skill and/or cost structures, such that the profitability of any given catch level varies across boats. It is assumed that the fishery is subject to a TAC, closed to entry, and that the buyback program is self-financing so that the vessels that remain in the fishery must fully cover the costs of the buyout. Equilibrium industry size under several financing and auction structures is then derived. The model is made concrete through an application based on data from the Inter-American Tropical Tuna Fishery.

The remainder of the paper is organized as follows. The next section provides a basic economic model of vessel buybacks under homogenous and heterogeneous financing systems. Section 3 briefly discusses the implications of the model for auction design. Section 4 presents the tuna case study. Section 5 offers some concluding remarks.

## 2. The model

In this section, a simple model is developed of a vessel buyback program in a fishery that does not have an existing rights based management system, transferrable or otherwise[3]. The fishery operates under a cap on TAC and entry into the fishery is assumed to be restricted by those managing the fishery. The goal of the buyback program is to reduce the total number of vessels competing for a fixed total annual harvest[4]. Vessels are assumed to be heterogeneous in their productivity such that some are more profitable than others, i.e. vessels differ in their revenue net of operating and capital costs for any given level of catch. To avoid confusion with colloquial usage of the word productivity to refer to yields rather than efficiency, this paper will refer to the productivity of vessel $k$ will be referred to as its skill denoted by $\gamma_k$. Without loss of generality vessel skill is assumed to take on values between 0 and 1, with 0 representing the least skilled vessel in the fishery and 1 the most skilled. There are $N$ boats in the fishery before the buyback program is initiated, each vessel has a unique skill level, and the distribution of skills within the fishery is known to all members. For simplicity, the technological stock of the fishery is assumed fixed, such that vessels do not alter their investments in anticipation of (or in response to) the buyback program[5]. The profits earned by any boat $k$ can be expressed as follows:

$$\pi_k\left(h_k, \gamma_k, \sum_{i=0}^{N} \gamma_i\right) \tag{1}$$

Profits for boat $k$ will depend on its harvest, its skill, and the skill-weighted number of boats participating in the fishery, with each term appearing in parenthesis in that order. The last term is especially important when considering the buyback program, since all boats are vying for a share of the TAC and the skill and size of the boats removed will influence the magnitude of the change in profits for those that remain. If for example, the least skilled boats caught comparatively little fish, then removing that boat will have a relatively small impact on the profits of the boats that remain since each of them can, at most, see only a small change in yield. Thus, the assumption is that vessel profits are increasing in own yield and skill and decreasing in competition for the resources, as measured by a skill-weighted fleet-size term. For simplicity, it is assumed that all vessel owners have the same time

[1] TAC limits may in fact exacerbate overcapitalization concerns, as such limits increase the potential value of additional productive capital. In addition to forcing players to compete for a smaller pie, the restriction of total supply may lead to price increases for the goods produced, increasing the marginal revenues of production, and thereby incentives to invest in productive capital.

[2] It is also a concern that license holders that do not actively participate in the fishery might be bought out, and that such purchases of 'latent effort' do little to impact the number of vessels that remain active in the fishery. However, the costs of buying out such licenses should be relatively low and may still facilitate fishery consolidation and the transition to a rights-based system.

[3] The analyses throughout this paper presume that licenses are tied to vessels and that all vessels eligible to participate in the auction are licensed to participate within the fishery. In this sense, a buyback auction over vessels is identical to one over licenses. Such an auction would be more complicated in the realistic case where licenses are not necessarily tied to vessels. In this case, auctions should be structured over licenses with buyers and sellers determined by the profitability of licensing arrangements. Additional arrangements may be needed to compensate vessel owners who are effectively renting licenses.

[4] Clearly, a buyback program would be of little value in an open fishery, as the rents created by reducing the fleet would encourage new entrants who would then rapidly dissipate those rents. The entry constraint can be relaxed in a self-financing buyback program as long as all new entrants will be required to contribute to the financing of the buyback. As will become obvious from the models that developed later in this section, new vessels will only enter if they are sufficiently high-skilled to justify buying out a lower-skilled boat in the fishery. In this case, the derived results are a lower-bound on equilibrium fleet size.

[5] In practice, there is a legitimate concern that bought out vessels could use their proceeds to reinvest in the fishery, further highlighting the importance of closing the fishery before conducting the auction. Even with such precautions, bought out vessel owners may well make capital investments in other fisheries. Such externalities are beyond the scope of this paper, but represent an important area for future research.