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Analysis

The Endogenous Evolution of Common Property Management Systems

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ABSTRACT

Traditional co-management of common property resources involves stakeholders contributing knowledge and ideas about rules for access and extraction, which are analyzed and implemented by the regulator. We examine an emerging alternative system, in which self-identifying clubs of users are allocated a share of a total allowable extraction, that they manage with considerable autonomy. When multiple clubs concurrently extract under different self-selected rules, users gravitate toward more profitable regulations in subsequent seasons, putting evolutionary pressure on less profitable systems. We show experimentally that strong individual property rights, and the efficiencies associated with them, emerge endogenously from this process. A taste for competition among some individuals limits realized efficiency, but not extensive adoption of individual rights. Thus, regulators need not directly implement strong individual rights to achieve their benefits; regulators may instead assign a collective property right and provide a self-governance pathway toward management that supports better outcomes.

1. Introduction

In order to leverage the local knowledge and legitimacy benefits of involving resource users in the governance process (McCay and Acheson, 1987; Ostrom, 1990; Ostrom et al., 1999), managers have worked to formally engage users in co-management processes that identify regulations that govern access to and exploitation of water, forests and fisheries. These processes allow regulations to incorporate the needs and preferences that dominate within user communities (Agrawal, 1994; Blomquist, 1994; Blomquist, 1992; Trawick, 2001). However, uniform regulations, by their nature, do not reflect heterogeneity in user preferences over management methods, which may impede implementation of effective community management.

An emerging approach to co-management seeks to reflect differences among users by allowing sub-groups to claim collective resource use allocations, which they can manage with considerable flexibility. For example, outcomes improved among Mexican forest *ejidos* when individual communities were allowed to self-determine configurations of private and collective rights systems (Barnes, 2009; Barsimantov et al., 2010). Fisheries that allocate target or non-target harvest quota to cooperatives experienced better bycatch management (e.g., Abbott et al., 2015; Stram and Ianelli, 2015) or improved safety (North Pacific Fishery Management Council, 2016; Pfeiffer and Gratz, 2016). Increased profitability was observed among subsets of users who manage a collective allocation, while others participate in a common pool (e.g., Georges Bank Cod Fixed Gear Sector, 2010; Knapp, 2008; Pinto Da Silva and Kitts, 2006; Scheld et al., 2012; Verani, 2006).

The Northeast (US) Multispecies Groundfish Fishery is extending this approach by encouraging the formation of multiple "sectors", or new self-identifying clubs of users. Importantly, cooperative self-governance has not emerged in this fishery, and harvesters preferring a competitive fishery have politically blocked efforts by other harvesters to establish fishery-wide individual quota allocations (Scheld and Anderson, 2014; Scheld et al., 2012). Sectors, however, can manage their allocated shares—proportional to their joining members' historical share of catch—in different ways while pursuing the same resource. Thus, harvesters pursuing individual allocations can form a sector and subdivide their collective allocation, while those preferring competitive pursuit can do so with their allocation, allowing innovation without establishing a political consensus for any particular change (Jenkins et al., 2017). The Multispecies fishery has seen improvements in economic outcomes (Scheld and Anderson, 2014) and social capital (Holland et al., 2015), raising the general question of whether and how innovations can effectively diffuse among sectors exercising autonomy beyond the specific control of regulators. This diffusion does not require coordination within or among sectors; users can simply switch to a sector that uses a different system, taking their associated allocation with them. Effective management strategies can expand in two ways:

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when additional sectors adopt them, or when users switch into sectors using them.

This policy experiment is unfolding in the absence of a framework for predicting the properties of the management that will emerge. There is no general theory of institutional selection, and previous experimental work has focused on the emergence of market institutions (Crockett et al., 2009; Jaworski and Wilson, 2013; Kimbrough et al., 2008). As such collective catch share programs expand, it is necessary to predict the evolution of self-management, to support biological and social evaluation mandated through the Regulatory Impact Review process. Given the range of alternative institutions, and potential mechanisms through which they might emerge and transform, addressing this need comprehensively requires a broad research program.

As a first step, we investigate individual resource users' choice of a management system under a certain circumstance, which mirrors a number of recent catch share programs in US (Scheld and Anderson, 2014; cf., Georges Bank Cod Fixed Gear Sector, 2010; Pinto Da Silva and Kitts, 2006; Scheld et al., 2012; Verani, 2006). Specifically, the role of expected profitability is highlighted, when resource users are presented with a choice between an institution that provides a secure individual extraction right, and an institution with competitive extraction. The Rhode Island Fluke Sector Pilot Program is a representative example (Scheld and Anderson, 2014), featuring a club managed by individual quota, and a limited entry derby for other harvesters. We design a controlled economic experiment in which harvesters are allowed to choose whether to join the individual quota club before each season, drawing on their experiences from previous seasons. Communication within and between clubs is not allowed, reflecting the historic failure of New England fishermen—and stakeholders in many other fisheries—to coordinate collective action around improved management. We test the hypothesis that the individual quota system, which supports the efficient harvesting strategy as a Nash equilibrium (cf., Gürerk et al., 2006), yields higher profits and attracts more participants than the less restrictive common pool institution (e.g., Agrawal, 2002). If true, this would imply the eventual efficiency and distributional outcomes of decentralized, club-based management will be well predicted by models of an individual quota system. We then associate individual variation in the rate of moving to the individual quota system with individual social preferences, risk preferences, and a taste for competition.

2. Methods and Materials

2.1. Continuous Fishing Game

A two-stage sequential game is repeated for 20 "seasons." In the first stage, all players simultaneously choose to join one of two clubs: an individual quota (IQ) club—where each player receives their quota share as individual allocation—or a common pool (CP) club—where the quota associated with each player is placed in a pool to be competitively harvested by all players choosing CP. Players then learn how many others are in each club, and in the second stage, earn money fishing under the rules of their chosen institution. Both club membership and fishing decisions take place independently and without communication: our hypothesis is not about conditions under which users can communicate to improve outcomes. Rather, we are mirroring a field situation in which common pool users have not successfully communicated, and testing the potential for introducing a group that has coalesced around a management strategy—in our field example, they communicated to develop contracts for individual quota—to provide a pathway to improved outcomes for members of the larger group, whose self-governance attempts were non-existent, or failed.

We use a quasi-continuous common-pool resource game developed by Anderson and Uchida (2014) for the fishing subgame in the second stage. Standard common-pool resource experiments are done as one-shot, static games in which players choose a level of extraction (e.g. Walker et al., 1990). Although it has been modified to capture variously structured congestion externalities, dynamic populations, and other features (Gardner et al., 1997; Gardner and Walker, 1992), our environment demonstrates the within-season temporal distribution of effort incentives that distinguish the race-to-fish that arises under Total Allowable Catch (TAC) from the lack of resource competition observed under individual allocation. This quasi-continuous game allows us to examine agents' choice of their level of fishing effort over a number of "weeks" during a fishing season, subject to a seasonal TAC. While Fell (2009) modeled intraseasonal fishing under a TAC with and without IQ similarly, Anderson and Uchida (2014) provides a simplified version tailored to our motivating policy, which highlights the market externality and facilitates a closed form solution.

In our game, one season consists of a sequence of 52 weeks, in which harvesters decide how many days to go fishing every week. Their choice may range from not fishing at all (0 days) to fishing every day (7 days), subject to the constraint that they cannot fish after the individual or collective quota that applies to them is exhausted for the season. The stock is assumed to be held in steady state by the overall quota, and the common pool externality is experienced through the market. The price received for fish changes each week, decreasing in the total weekly landings from both IQ and CP clubs; harvesters can earn more profits at the same cost of fishing by catching in weeks when the total landings are lower. In each week, players are provided the previous week's harvest by each club and the resulting price, their individual harvest and profit, as well as the remaining quota within each club, and their remaining individual quota if they are in the IQ club.

The second-stage subgame is a common-pool resource appropriated by $i = 1, \cdots, N$ players. Each player i chooses effort level $e_i \in [0, e_{max}]$ to maximize the following payoff function regardless of the choice of management systems in the first stage:

$$\pi_i = \frac{e_i}{E} h(E)[\alpha - \beta h(E)] - c(e_i),$$

where $h(\cdot)$ is a concave production function, $c(\cdot)$ is a linear cost function, $E = \sum_{i=1}^{N} e_i$, and α and β are parameters. The unit price is determined by the weekly inverse demand curve, $[\alpha - \beta h(E)]$, which decreases as the total landings from all players in both clubs increases. Thus, players can increase their profits by fishing in the weeks when the total landings are lower. A symmetric Nash equilibrium with each player exerting $\bar{e}$ satisfies the first-order condition

$$\frac{1}{N}\left[\frac{dh(\bullet)}{de} P(N\bar{e}) + h(N\bar{e})\frac{dP(\bullet)}{de}\right] + \frac{N-1}{N^2\bar{e}} h(N\bar{e})P(N\bar{e}) - \frac{dc(\bullet)}{de} = 0,$$

where $P(N\bar{e}) = \alpha - \beta h(N\bar{e})$. When $N = 1$, the Nash equilibrium coincides with the sole owner solution. When $N > 1$, the equilibrium is no longer optimal and the equilibrium effort increases up to the level where average revenue equals marginal cost.

We apply this model to a fishery within a season of $t = 1, \cdots, T_{max}$ weeks, similar to Gardner et al. (1997). We specify zero discount rate and no stock effect on the harvest function (Anderson and Uchida, 2014). The maximization problem becomes:

$$\max_{e_{it},\, T} \pi_{it} = \sum_{t=1}^{T} \left\{\frac{e_{it}}{E_t} h(E_t)[\alpha - \beta h(E_t)] - c(e_{it})\right\},$$

subject to $0 \le e_{it} \le e_{max}$,

$T \le T_{max}$,

$\sum_{t=1}^{T} h(\sum_{i=1}^{m} e_{it}) \le m\bar{q}$ for CP club,

$\sum_{t=1}^{T} h(e_{it}) \le \bar{q}$ for IQ players,

where m is the number of CP players and $0 \le m \le N$.

CP and IQ players face the same maximization problem except that their total harvest for a season is constrained to collective quota for players under CP management and individual quota for IQ management.