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Analysis

Evaluating the role of co-management in improving governance of marine protected areas: An experimental approach in the Colombian Caribbean

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ABSTRACT

Complexities associated with the management of common pool resources (CPRs) threaten governance at some marine protected areas (MPAs). In this paper, using economic experimental games (EEGs), we investigate the effects of internal communication, external regulation, and the interaction between internal regulation and non-coercive authority intervention—what we call co-management—on fishermen's extraction decisions. We perform EEG with fishermen inhabiting the influence zone of an MPA in the Colombian Caribbean. The results show that co-management exhibits the best results, in terms of both reduction in extraction and resource sustainability, highlighting the importance of strategies that recognize communities as key actors in the decision-making process for the sustainable use and conservation of CPR in protected areas.

1. Introduction

Worldwide, marine protected areas (MPAs) are intended to conserve—and in some cases provide for sustainable use of—the resources and biodiversity they host. In developing countries, however, MPA are exposed to pressures generated by human activities, fishing being one of the most relevant. The conflict between conservation goals in MPAs and fishermen's private interests is typically centered around common pool resources, characterized by both non-excludability and rivalry (Feeny et al., 1990; Ostrom, 1990). These two characteristics often induce individual fishermen to ignore the social costs of their actions, and to collectively engage in the over-exploitation of the resource (Hardin, 1968). Hardin (1968) suggested that under such conditions this self-centered and shortsighted behavior would lead to the overuse and rapid depletion of resources, in what he calls "the tragedy of the commons."

To avoid this "tragedy," Hardin (1968) proposed two solutions: (i) establishing private property rights; or (ii) establishing state property rights, whereby access and use are clearly instituted and regulated. The establishment of a MPA is a classic example of the second case, in which the state regulates and controls the use of and access to the resources in an attempt to conserve strategic ecosystems. In Colombia, currently there are 55 protected areas, 14 of them marine. Among these, there is a MPA, the *Parque Nacional Natural Corales del Rosario y San Bernardo* (PNN-CRSB), that is located in the Colombian Caribbean Sea; it is considered of great strategic importance, as it conserves the most developed fringe of the coral reef at the Continental Colombian marine platform (UAESPNN, 2006). Similar to other marine protected areas in developing countries, the creation of a national park with laws and regulations controlling access and use has not sufficed to protect it from exploitation. In addition of being the most visited national park in the country, the extraction of its marine resources by native communities, which are located either inside the limits of the park or just outside it, constitutes a great source of pressure. Due to factors such as the size of this MPA (1200 km^2), the nature of the resource, and budget constraints for environmental authorities, achieving the conservation goals is a difficult task, making *de jure* state property seem more a *de facto* open access (Camargo et al., 2009). In addition, local communities have as the main, and sometimes only, source of income the extraction of resources from the MPA, making compliance a complex issue. Under such conditions, a conflict between local communities and park authorities emerges, undermining MPA governance.

Given the problems of assigning property rights and the often-weak enforcement of fishery regulations worldwide, there has been a shift in fisheries-management alternatives towards devolution, especially in developing countries. In the ideal case of devolution, the communities themselves are responsible for defining the regulatory framework, both with respect to what is and is not

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allowed, and in determining the appropriate measures if the regulations are not followed (Ostrom, 1990). This suggests that, to some extent, fishermen might cooperate in reaching agreements for managing fisheries in a more sustainable way, which implies some collective behavior or others-regarding preferences (e.g., Bolton and Ockenfels, 2000; Dufwenberg and Kirchsteiger, 2004; Fehr and Schmidt, 1999).

Experimental evidence has shown that individuals do not always behave based only on self-interest (Fehr and Fischbacher, 2003; Fehr and Leibbrandt, 2008; Vélez et al., 2009), and that they often make decisions that balance their own and collective interests (Davis and Holt, 1993; Kagel and Roth, 1995). Many field and lab experiments support the argument that the behavior of individuals might be determined by, along with the possibility of pure material gain, additional motivations such as others-regarding preferences or collective action (Cárdenas, 2004). Experimental economic literature shows that elements such as altruism, reciprocity, inequity aversion, reputation and conformity could play a relevant role (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Fehr and Gachter, 2000; Bardsley and Sausgruber, 2005; Vélez et al., 2009).

The success and sustainability of internal norms depends greatly on many factors, among them the institutional environment, the social cohesion of the relevant communities, the size of the groups involved, and the degree of interaction these communities have with the market. Some authors argue that it is doubtful that a pure self-governing institution could be a realistic option for a case as complex and diverse as fisheries in a modern industrial society, inasmuch as market pressures and the reality of integration with surrounding societies may effectively undermine collective management (Rova, 2004). An intermediate solution would be to combine state regulation and user self-management—what is known as co-management—as suggested by Feeny et al. (1990). Co-management has been seen as an alternative that would improve both the effectiveness and equitability of fishery management as well as compliance with agreed-upon rules (Jentoft, 1989; McCay, 1996).

Within the context of the conflict between environmental authorities and local communities at the PNN-CRSB, the objective of this paper is to investigate the effect of introducing a co-management strategy on fishing decisions as an alternative to other strategies to manage marine resources at the MPA.

To do that, we apply a framed field economic experiment, i.e., a laboratory experiment using real framing (fishing decisions) and real decision-makers (fishermen) (Harrison and List, 2004). Using a common pool resource model, we compare four different fishery management approaches: (i) open access; (ii) external regulation with random monitoring and monetary punishment; (iii) internal communication; and (iv) co-management. To investigate whether behavior differs depending on actual place of residency—that is, whether communities located within the park behave differently than those located outside of it—tested management strategies are compared using a between-subject design, involving real fishermen inhabiting the MPA influence zone.

Although many economic experimental games aimed at analyzing the behavior of individuals in response to daily-life problems have been carried out in the field (Cárdenas et al., 2000, 2002; Cárdenas, 2003, 2004)—including some that use dynamic frameworks and voting (Cárdenas et al., 2008)—few have tested combinations of institutions in which cooperation and external intervention play simultaneous roles (Bischoff, 2007; Vélez et al., 2010).

In this study we want to test, in a dynamic context, two hypotheses:

1. The co-management treatment in a CPR game reduces the extraction more than any other tested treatment (e.g. external regulation or internal communication).
2. The responses to the treatments vary depending on whether participants are located inside or outside the marine protected area in the zone. This hypothesis is supported by the observation that, given budget constraints and the scope of environmental authorities, communities located outside the MPA are less exposed to control, surveillance and environmental-education programs than are communities located inside of it.

Based on the motivations discussed above, the contribution of this paper is to analyze the reinforcement effect between repeated communication and non-coercive government intervention—co-management—in reducing extraction, in the context of a dynamic framework in which stock level may vary. The non-coercive government strategy we test here requires the participation of park rangers, specifically, those who work directly with local communities on environmental-education issues. This involvement of a real ranger from the PNN-CRSB as an additional participant in the experimental game constitutes an innovative approach for field experimental games analyzing CPR dilemmas.

The findings show that the co-management rule is the best strategy in terms of both reducing extraction and in sustaining the resource. The parametric analysis shows that extraction decisions depend on socioeconomic characteristics such as per capita income, on perceptions about participation in solving natural resource-related problems, and on endogenous characteristics of the game, such as the condition of the stock (at present and previous periods), among others. Complementing these findings, this study shows that co-management rule might be the most effective strategy not only for individuals located inside national parks but also for those located outside of them.

The paper is organized as follows: after providing the context for the discussion in Section 1, we present our theoretical model in Section 2. In Section 3 we discuss the experiment design and game procedures. In Section 4, we present our main findings. We present our conclusions in Section 5.

2. The Common Pool Resource Experiment

2.1. A Dynamic Common Pool Resource Game

The experiment is a framed field experiment; this means that we simulate an actual fishing problem with real resource users. A common pool resource dilemma for a fishery is defined by the difficulties that arise in excluding people from fishing in open-access areas, but in which, at the same time, only one individual can consume a specific unit of the given resource. Thus, there are two potentially opposing characteristics inherent in CPRs: non-exclusion and rivalry. Essentially, the key characteristic of the common resource problem is that, if acting alone, an individual has an incentive to appropriate more of the resource than if cooperating with others about how much of the resource should be appropriated; i.e., the private solution (Nash equilibrium) and the social optimal solution differ. The model presented below is based on the one proposed by Cárdenas (2004). We extend this model by introducing a dynamic renewable-resource structure, by letting the catch rate for fish in one period determine the stock of fish with a logistic recruitment term in the following period. The benefits (and costs) that a fisherman receives from catching fish will depend on his own extraction ($x_{i,t}$) and on the available stock of the resource (S_t). In order to capture the features of non-exclusion and rivalry, these benefits are defined with the following pay-off function:

$$\pi_{i,t}\left(x_{i,t},S_t\right)=f\left(x_{i,t},S_t\right)+g\left(\sum_i x_{i,t}\right)=\alpha x_{i,t}-\frac{\beta x_{i,t}^2}{2S_t}+\gamma\sum_{i=1}^{n}\left(e-x_{i,t}\right). \quad (1)$$

The benefit function can be divided into two parts: (i) a private benefit, function $f(x_i, S)$; and (ii) the impact of aggregated extraction on individual benefits, function $g(.)$.[2]

[2] It is assumed that $f_x \geq 0, f_{xx} \leq 0, f_S \geq 0, f_{SS} \leq 0, g_x \leq 0, g_{xx} \geq 0$.