



Analysis

Negative externalities in cropping decisions: Private versus common land



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ABSTRACT

This paper analyzes to what extent the entitlement of property rights affects cropping decisions when these decisions generate negative externalities. To that end, we implement an experimental study where agents make cropping decisions in two different treatments: private and common land. The results show that there are no statistically significant differences between the two treatments in the contribution to the negative externality, thus revealing that the entitlement of property rights does not affect cropping decision in this context. Furthermore, our findings indicate that the implication of the agents in activities generating negative externalities tends to increase over time, thus amplifying its adverse consequences.

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1. Introduction

Two solutions have traditionally been proposed to address the appropriation externalities described in the tragedy of the commons (Hardin, 1968): the establishment of a coercive power and the imposition of private property rights. Although there are exceptions, privatization and government ownership have usually been considered panaceas for solving the problem of the commons. Nevertheless, some studies have remarked that in socio-ecological systems there are no one-size-fits-all solutions (Ostrom, 1990, 2007; Ostrom and Cox, 2010; Ostrom et al., 2007). The problems of overuse and destruction of natural resources are diverse and involve many different variables (biological, economic, and social) and it is therefore complicated to find a single solution. Each situation requires its own diagnosis and its own solution.

An extensive literature has examined the impact of different factors on the exploitation of common property resources, including monitoring and sanctioning (Casari and Plott, 2003; Ostrom et al., 1992), information and payoff structures (Apesteguía, 2006), and resource scarcity (Osés-Eraso and Viladrich-Grau, 2007; Osés-Eraso et al., 2008), among others. However, despite the fact that private property has been

proposed as a general solution to the problem of the commons, the testing of this hypothesis using experiments has received scarce attention in the literature. Some experimental studies have analyzed the effect that the entitlement of property rights may have on the behavior of the agents. Cox et al. (2009), for example, analyzed a trust game where initial endowment can be private or common property. They found that endowments which are induced as common property lead to marginally greater cooperation or trust, in contrast to what most scholars would expect. However, Cox and Hall (2010) showed that cooperation is lower in common property trust games when property right entitlements are strengthened. There are also cases of natural resources that have been privatized. For example, Grafton et al. (2000) examined the effects of privatization on the British Columbia halibut fishery, paying particular attention to the features of resources that are key to improving the degree of efficiency.

The entitlement of property rights is particularly relevant in land exploitation. When privatization is proposed as a general solution to the problem of the commons,¹ the basic idea is that the appropriation externality is internalized in such a context as one owner “plays a game against nature in a smaller terrain rather than a game against

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¹ As Ostrom (1990, p.13) says “it is difficult to know exactly what analysts mean when they refer to the necessity of developing private rights to some common-pool resources. It is clear that when they refer to land, they mean to divide the land into separate parcels and assign individual rights to hold, use, and transfer these parcels as individual owners desire”.

another player in a larger terrain” (Ostrom, 1990, p.12). However, there are situations in which it is difficult to internalize appropriation externalities. This is the case when externalities are related to the use of pesticides (Lankoski and Ollikainen, 2003; Wilson and Tisdell, 2001), or to the occurrence of diseases due to the specialization in certain crops (Lankoski and Ollikainen, 2003; Weitzman, 2000). In such cases, the externality does not know of property rights: farmers who adopt biological pest control strategies on their private land will be affected due to externalities of pesticides arising from neighboring holdings (Wilson and Tisdell, 2001), whereas farmers with relatively few high-yield crops encourage the development of more crop-specific parasites globally (Weitzman, 2000), regardless if the land is private or common. Despite these negative consequences, the use of pesticides and monoculture ecosystems is quite widespread in the real world. Farmers who do not use pesticides or do not plant a specific crop may be forced to do so to avoid economic losses, thus amplifying the negative effects of the externality.

Against this background, our paper aims to examine whether the entitlement of property rights affects cropping decisions when these decisions generate negative externalities. To that end, we develop an experimental study where agents face cropping decisions in two different settings. In the first setting, property rights are individually/privately defined (*private land treatment*), whereas in the second property rights fall on a well-defined community of users (*common land treatment*). This change in the entitlement of property rights does not modify the negative externality associated with cropping decisions, but simply modifies the context in which it develops. In the private land treatment, each player has her own plot of land, while in the common land treatment all players share a plot of land. In the two treatments agents face the same cropping decisions. In particular, they must choose between two alternative projects (i.e. crops) A and B. Project A represents externalities due to the use of pesticides or due to diseases related to crop specialization, whereas project B is free of externalities. Investment in project A is individually optimal but not socially optimal.

Our hypothesis is that property rights can influence appropriation decisions in this context. One reason for this may be framing. Numerous studies have analyzed equivalent games in positive and negative frameworks and shown how the agents' behavior varies despite the equivalence of the games (e.g. Andreoni, 1995; Cox and Hall, 2010; Cox et al., 2009; Tversky and Kahneman, 1981). Both of our equivalent games are described in a context of negative externalities, with the only difference between them being land entitlement. However, we expect that the behavior of the players may be different in this situation as they are faced with the same conditions in different property regimes. A possible explanation for this has to do with the effect of group identity on agents' behavior when the land is common property (Bulte and Horan, 2010). As pointed out by Chen and Li (2009), the extent to which group identity affects behavior depends ultimately on the strength of the social identity. These authors report that a greater likelihood of social-welfare maximizing actions and reciprocity actions is a prominent effect of group identity.

The experimental design is based on Andreoni (1995) and on Osés-Eraso and Viladrich-Grau (2007). The first study analyzed cooperation in a framework of negative externalities against a framework of positive externalities, while the second modified Andreoni's design to study the appropriation of common resources. We slightly modify Andreoni's negative framework for our private land treatment and take the equivalent design of Osés-Eraso and Viladrich-Grau for our common land treatment.

In our analysis, we pay particular attention to the potential impact on the results of the existence of differences in the subjects' preferences. For this reason, in both treatments cropping decisions are taken in two different contexts: a conditional context and a simultaneous context. In the first context, each agent knows the cropping decision of others before making her own decision. In the second context, all agents

make cropping decisions simultaneously and repeatedly, using only the information provided by past cropping decisions. The conditional context is based on Fischbacher et al. (2001), who applied a variant of the so-called “strategy method” (Selten, 1967) to draw out agents' preferences.

The experimental results show that the contribution to these types of negative externalities is quite extended, thus confirming the behavior that we encounter in the real world (Lankoski and Ollikainen, 2003; Weitzman, 2000; Wilson and Tisdell, 2001). Furthermore, our findings show that this contribution is independent of land entitlement. This suggests that private land entitlement has no effect on appropriation decisions when it does not lead to the internalization of the externality. Therefore, the results of the paper reveal that privatization does not increase efficiency in this type of negative appropriation externalities, which confirms that each socio-ecological system requires its own diagnosis and its own solution (Ostrom et al., 2007). In addition, the implication of agents in crops that generate negative externalities tends to increase over time. The results also indicate that the preferences shown in the conditional context are one of the determinants of the agents' behavior in the simultaneous context.

The paper is organized as follows. Section 2 introduces the theoretical settings of the private land game and the common land game, while Section 3 describes the experimental design and procedure. Section 4 shows the experimental results. Finally, conclusions and future research are presented in Section 5.

2. The Games

2.1. Private Land Treatment

Assume n landowners each of whom has a plot of potential value P . The final value of the plot depends on cropping decisions. Each landowner has an endowment e to make cropping decisions. Two different crops are available: crop A and crop B. Each endowment point invested in crop A returns m points to the landowner but reduces the landowner's plot value and the other landowners' plot value by α points. In turn, each endowment point invested in crop B returns w points to the landowner and has no additional impact on individual plots. In the rest of the paper, we refer to investment in crop A as *contribution* to the negative externality.

Each landowner invests her entire endowment between the two types of crops. Let x_i be the part of the endowment invested in crop A by landowner i , that is, contribution to the negative externality. In turn, $(e - x_i)$ is agent i 's investment in crop B. The individual plot value after the cropping decisions of all landowners is $P_F = P - \alpha \sum_{i=1}^n x_i$. The game payoff for landowner i after the cropping decisions, π_i , is the sum of the return from her investment in crop A, the return from her investment in crop B and the plot value.

$$\pi_i = mx_i + w(e - x_i) + P - \alpha \sum_{i=1}^n x_i$$

where $m - n\alpha < w < m - \alpha$. That is, for each landowner the marginal net return from crop A is greater than the marginal net return from crop B, $m - \alpha > w$. Likewise, the marginal net return for all landowners from crop A is smaller than the marginal net return for all landowners from crop B, $m - n\alpha < w$. Therefore, the game represents a social dilemma where individually optimal decisions are not socially optimal. As can be checked, the Nash solution is the full contribution to the negative externality, $x_i = e$, while the efficient solution is $x_i = 0$.

2.2. Common Land Treatment

Assume that n landowners share a plot of potential value C . The final value of the plot depends on cropping decisions. Each landowner has an endowment e to make cropping decisions. Two different crops are

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