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The tension between private benefits and degradation externalities from appropriation in the commons

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ABSTRACT

This experimental study examines behavior in a linear public goods game with an appropriation frame where we vary the value of individual benefits and the group losses from appropriation. Parallel to the literature on public goods provision, individual appropriation decreases with the marginal damage to the group that occurs through appropriation and increases in the private benefit from appropriation. In addition, we examine a novel set of decision situations where individual benefits and group damages change proportionately, as to hold the marginal per capita return constant. Individual responses to these proportionate changes are heterogeneous but on average, appropriation levels do not change significantly. These results are robust to two experimental designs, a one-shot menu-design where subjects make multiple choices and a complementary set of sessions where participants make a single decision in a one-shot game.

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1. Introduction

On a daily basis, individuals make decisions that affect ecosystem services. For example, the expansion of urban and agricultural land use reduces the size and characteristics of natural habitats. The importance of this issue is illustrated by the struggle of major carnivores to survive, and more generally by the need to develop programs to deal with the intrusion of wildlife on inhabited areas. Other less visible impacts from habitat destruction include jeopardizing the regulating services maintained by ecosystems (for example soil retention against desertification) and endangering provisioning services (such as plant-derived medicines). The implications of habitat destruction can be quite large and vary substantially across regions and ecosystems. Substantial research efforts are currently being undertaken to quantify the economic relevance of ecosystem

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services (see, for example, the Economics of Ecosystems and Biodiversity Global Initiative[2] or the Millennium Ecosystem Assessment[3]).

Previous literature addressing conservation of natural resources has provided extensive field and experimental evidence on management alternatives designed to avoid over-depletion of common pool resources (CPRs) and increasing the efficiency in use of those resources (Agrawal, 2001; Anderies et al., 2011; Baland and Platteau, 1996; Gordon, 1954; Ostrom, 1990; Wade, 1988). This literature focused primarily on *production externalities*, whereby appropriation by one user reduces the value of appropriation effort (rent dissipation) by other users. An implication is that this literature has largely neglected the implications of appropriation on the conservation of ecosystem services provided by the natural resources (for relevant exceptions, see Ostrom, 2007, 2009). To the extent that appropriation degrades the quality of such services to the group as a whole, it generates a negative externality referred to here as *degradation externalities*. In this sense, conservation, in the form of reduced appropriation, avoids such degradation externalities and constitutes the provision of a public good.[4]

The appropriation decision environment in this study is isomorphic to a linear public good VCM decision environment. Appropriation leads to private benefits, but at a cost of degradation in value of a shared group fund.[5] The central question addressed is to what extent appropriation levels respond to the tension between degradation externalities inflicted on the group and private benefits from appropriation. The consequences of appropriation are measured in terms of the efficiency in use of the resource as well as overall conservation of the group fund.

A first set of decision situations varies the magnitude of the degradation externalities, holding private benefits from appropriation constant. A second set of decision situations varies the magnitude of private benefits from appropriation, holding the magnitude of the degradation externalities constant. These two sets of parameter changes parallel the analysis of the relevance of variations in the marginal per capita return (*MPCR)* in VCM public goods games.[6] A third set of decision situations increases the degradation externalities and the private benefits from appropriation proportionately, as to hold the ratio of the two constant. Previous experimental research that addresses the influence of variations in the *MPCR* on the voluntary provision of public goods examines variations in *either* the private return from keeping units of the endowment or the marginal value of the public good.[7] To the best of our knowledge, however, this literature is silent on the impact of simultaneous variations of both components of the *MPCR* as to hold its value constant.

The investigation of simultaneous parameter changes in the context of the appropriation game is motivated by examples from the field where private benefits of appropriation are positively correlated with the value of ecosystem services, including for example, increased scarcity in water basins, reduced forest coverage, and hunting of endangered wildlife, among others. In these situations, increased scarcity induces a higher use value for remaining units of the resource (water for irrigation, wood for fuel, or animal parts for "traditional drugs"). At the same time, greater scarcity can lead to a higher marginal value of conservation (habitat maintenance in aquatic or forest ecosystems or biodiversity preservation). Analyzing situations where the *MPCR* remains constant is a special case that serves as a benchmark to investigate the tension between private benefits of appropriation and degradation externalities.

In addition, we include two decision situations where game parameters are asymmetric across subjects. These decision settings are motivated by field cases where the magnitude of degradation externalities vary across appropriators due, for example, to differences in technologies used for appropriation (see Ostrom et al., 1994).

The experimental decision setting includes sessions where participants make multiple decisions in a one-shot menu design and a complementary set of sessions where participants make a single decision in a one-shot game. By observing subjects' decisions in a number of parameter conditions in the menu design, without feedback information about other's decisions, we are able to investigate individual responses to parameter changes, as well as average responses pooling across subjects. The one-shot decisions in a single game serve as a robustness test of the results to potential framing or ordering effects in the menu design. Both sets of sessions address decision environments where there is no potential for signaling a

[2] http://www.teebweb.org/ (retrieved February 2, 2016).

[3] http://www.unep.org/maweb/en/Index.aspx (retrieved February 2, 2016).

[4] Production externalities occur as a "congestion" effect. As appropriation increases, the effect is to increase the marginal and average cost of appropriation for all units appropriated or reduce the marginal and average productivity of inputs used in appropriation. The magnitude of these externalities on individual appropriators depends on their individual levels of appropriation, increasing in the level of their appropriation. Degradation externalities explicitly focus on the impact of appropriation on the public good nature of the resource (ecosystem services). As modeled here, degradation externalities impact all users equally, independent of their individual appropriation levels.

[5] Unlike earlier experimental studies designed to address the behavioral effects of alternative frames for investigating provision versus appropriation games, the choice of examining the appropriation game presented here is based on its simplicity and relevance to investigating the research questions under consideration. Studies by Andreoni (1995) and Sonnemans et al. (1998) address decision environments in which subjects' decisions are framed in the context of negative externalities, or preventing a public bad. Travers et al. (2011) use a similar linear CPR appropriation game framed for fishing, focusing on the effect of alternative institutions. Also Dufwenberg et al. (2011) address the comparison between behavior in "GIVE frame" and "TAKE frame" games. Cox et al. (2013) includes a discussion of the isomorphism between the linear appropriation game studied in this paper and a provision game with the same marginal incentives. Two recent papers also consider comparisons between environments where only taking is possible, only giving is possible or both are part of the strategy set of subjects (Hoyer et al., 2014; Khadjavi and Lange, 2015).

[6] The *MPCR* is defined as the ratio of an individual's marginal return from the public good relative to the individual's marginal private cost of contribution to the provision of the public good (Isaac et al., 1994).

[7] For variation in the private return see Fisher et al. (1995), Falkiner et al. (2000), Palfrey and Prisbrey (1996), Brandts and Schram (2001), and Blanco et al. (2015). For variation in the marginal value of the public good, see Isaac and Walker (1988), Bagnoli and McKee (1991), Isaac et al. (1994), Offerman et al. (1996), Chan et al. (1999), Tan (2008), Reuben and Riedl (2009), Carpenter et al. (2009), and Fischbacher et al. (2015).

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