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# The coevolution of economic institutions and sustainable consumption via cultural group selection

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ABSTRACT

Empirical research has identified various institutions that improve resource longevity by supporting individual resource conservation. However, the mechanisms by which these institutions emerge have not been established. We speculate that economic institutions which support resource conservation, such as property regimes and systems of production, may emerge via a process of cultural group selection amongst social-ecological systems. To explore this proposition, we develop a multilevel selection model of resource management institutions with endogenous group dynamics. The endogenous design permits us to determine whether a given social adaptation is due to individual or group-level evolution. We demonstrate how resource conservation and supporting economic institutions coevolve, and reveal when cultural group selection is involved. In the model, sustainable societies emerge in only a minority of cases. Simulations reveal that property norms facilitate sustainable outcomes most, followed by social group marking, and production norms. We describe the institutional transitions which occur along the evolutionary trajectory most likely to achieve sustainability. Analysis of the model reveals that when groups compete indirectly for survival in a harsh environment cultural group selection favors institutions that support resource conservation. However, when groups compete for abundant resources institutions emerge to support overconsumption.



## 1. Introduction

Sustainability entails both the preservation of natural resources and the provision of human wellbeing (Clark and Dickson, 2003). But because humans often benefit from overexploitation of resources, these goals are frequently in conflict. Institutions may solve this conflict by balancing individual and collective interests. Thus, achieving both sustainability goals requires establishing sustainable behaviors (e.g. resource conservation), and maintaining those behaviors through durable supporting institutions (e.g. property regimes).

The largest and most challenging sustainability problems such as anthropogenic climate change, regional water depletion, biodiversity loss, pollution and overfishing share a number of common features. They involve entire populations, consume renewable resources, occur over large territories and play out over periods much longer than a human lifespan. These conditions create social-environmental dilemmas in which the short-term interests of the individual require resource consumption and conflict with the long-term survival and wellbeing of the population, which requires resource conservation. Environmental conservation is therefore often hard to maintain because it requires the cooperation of individuals at the cost of their short-term utility. In other words, achieving cooperation is a fundamental problem in many of our major sustainability challenges.

Human cooperation dynamics are well studied in game theory, economics, evolutionary biology, and psychology. This research shows that cooperative behavior can be augmented or stabilized by factors that enhance group structure or create more effective groups. For instance, reciprocity, punishment, conformity, and ethnic marking can encourage cooperation within human groups, particularly when clearly defined groups compete for resources (Boyd and Richerson, 2002, 2009; Buchan et al., 2011; Chudek and Henrich, 2011; Wilson et al., 2014). One major implication for sustainability efforts is that mechanisms that maintain group structure also tend to promote the adoption of cooperative and individually costly behaviors, such as voluntary resource conservation, and may therefore provide a promising applied tool. However, the role of group structured cultural evolution, or *cultural group selection* (Henrich, 2004; Richerson et al., 2016), in achieving and maintaining cooperative behaviors such as conservation has been largely overlooked in ecological economics and the sustainability literature. A second implication for sustainability is that human cooperation is typically directed toward group goals rather than beneficial outcomes for humanity or the environment. So, to leverage group structure and cooperative dynamics toward sustainable outcomes one must attend

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to the differences between goals and objectives at the individual, group, and population scales.

A separate strain of research details how institutions, as the formal and informal rules that govern social behavior (North, 1990), can bolster cooperation, conservation and effective resource management (Ostrom, 1990), thereby boosting chances for resource sustainability. Rustagi et al. (2010) present evidence from the management of forest commons that both cooperative conservation and the supporting institution of monitoring are key factors in sustaining the resource. However, it remains unclear how these supporting institutions could come to be well fit to their environment (Folke et al., 2007) in the first place. This leads to a conundrum. If sustainable behaviors require supporting institutions, where do supporting institutions come from? To better understand this problem, we turn to the special role of group structure in the co-evolutionary dynamics of institutions and cooperative behaviors.

We conduct a test of Waring et al.'s (2015) hypothesis that cooperative conservation practices and supporting institutions may both emerge *de novo* via cultural group selection. Our theoretical model demonstrates that supporting institutions *can* emerge via cultural group selection, but that cultural group selection may also favor exploitative institutions and overconsumption in certain circumstances. In this paper, we present agent-based computer simulations elaborating this hypothesis, determine how prevailing conditions determine institutional evolution and suggest avenues for further refinement.

## 2. Groups, culture, and evolution

Evolutionary theory has value for ecological economics and sustainability research (Beddoe et al., 2009; Rammel et al., 2007; Waring et al., 2015). If properly employed, evolutionary models can help specify the conditions required for desirable social equilibria, such as resource conservation. With an eye to this possibility, we briefly review theory concerning the evolution of cooperation in group-structured cultural populations. For a review of the empirical evidence for cultural group selection, see Richerson et al. (2016).

Culture can be described as information which can be passed between individuals, such as behaviors, beliefs, norms, technology (Richerson and Boyd, 2005), as well as organizing information such as institutional roles and rules (Smaldino, 2014). Theory on the evolution of culture utilizes dynamic models to consider the various factors that determine how behaviors or cultural traits compete and spread in a population. These models consider factors such as costs and benefits, cultural transmission, institutions, and population structure. Cooperative behavior has garnered extra attention in this tradition. One common factor in the emergence of cooperation is group structure: all known mechanisms for the evolution of cooperation foster interactions between cooperative individuals (Fletcher and Doebeli, 2009; Nowak, 2006). The essence of this insight is that when cooperators can interact preferentially with other cooperators by any means, the benefits of cooperation are concentrated within groups, and cooperative behavior can propagate. Therefore, group structure is a fundamental factor in the evolution cooperation in any context.

Group selection is simply the process of natural selection across groups (Okasha, 2004), as often occurs through direct or indirect group competition. Just as natural selection on individuals favors individual adaptations, group selection facilitates the accumulation of group-level adaptations (Wilson and Wilson, 2007). For group selection to be a prevailing evolutionary process, three elements are required: group structure, trait variation between groups, and trait-driven differences in group fate. Group selection is rare in natural genetic systems (but see Pruitt and Goodnight, 2014 for an example), but animal breeders, who can tightly control social groupings, regularly employ group selection to breed cooperative, docile and productive animal strains (Wade et al., 2010). In real-world systems, group selection is difficult to detect because behavioral selection can occur on many levels simultaneously, and in conflicting directions. *Multilevel selection* provides a framework to account for these countervailing pressures statistically (Okasha, 2004).

Human groups are a special case. Unlike most animals, human group membership can be signaled with culturally transmitted symbols, or social markers. Human group boundaries are therefore free to evolve along with the rest of culture (Boyd and Richerson, 1987; McElreath et al., 2003). Also unlike other animals, human social groupings are often strong enough to determine individual survival yet transcend biological relatedness (Nowak and Highfield, 2011). Well-marked social groups facilitate cooperation and solving collective action problems such as resource procurement and inter-group conflict (Boyd and Richerson, 2009). Empirical demonstrations have also shown that when initially meaningless social markers are culturally inherited, they rapidly evolve to demarcate groups, assisting the emergence of cooperation (Efferson et al., 2008). Moffett (2013) even argues that societies cannot persist without stable cultural group markers.

The fact that social marking facilitates the development of cooperative groups is one reason that group selection is stronger in human culture than other systems (Bell et al., 2009; Durham, 1992; Richerson et al., 2016). Moreover, differential learning and imitation between groups can facilitate the spread of group-level adaptations. Differential between-group imitation, or *imitative group selection*, is one of three mechanisms of cultural group selection, along with differential between-group proliferation and migration (Henrich, 2004). For example, some villages (groups) might store seasonal rainfall in a reservoir while others do not (group-level trait variation). If villages that store their water have better health outcomes (differential fate), or are imitated more frequently (differential imitation), then cultural group selection can occur on village water management behaviors, and the frequency of reservoirs should increase across the population of villages. And, as long as water storage is imitated enough between villages, the group-level adaptation could spread even if it came at a net cost to individuals.

We surmise that both cooperation and supporting institutions are necessary to achieve long-term sustainable environmental resource use, and that social groupings are fundamentally related to both factors. Cultural group selection has been mostly employed to explain the rise and spread of cooperative behaviors (Richerson and Boyd, 2005). But some have argued that group-structured cultural evolution can also explain the evolution of complex institutions (Bowles et al., 2003; Richerson and Henrich, 2012; van den Bergh and Gowdy, 2009).

## 3. Institutional evolution

Institutions can be considered as a kind of group-level cultural trait, composed of the coordinated actions of individuals in specialized roles, producing outcomes that cannot be replicated by any individual (Smaldino, 2014). Institutional scholars often describe institutional change as a process of social evolution. For instance, Ostrom's (1990) institutional design principles are among the clearest examples of group-level adaptations in human cultures because they appear to be generally advantageous to common pool resource management groups (Ostrom, 1990), social-ecological governance groups (Anderies et al., 2004), and perhaps any human group (Wilson et al., 2013, 2014). Although Ostrom argued that institutions for collective action, such as her design principles, emerge through a process of cultural evolution (Ostrom, 2008), she did not specify *which* evolutionary mechanisms might be involved. This leaves an important explanatory gap: how do institutions that foster collective action emerge and spread?

Ecological economists have proposed that various economic institutions might evolve by cultural group selection (Safarzynska and van den Bergh, 2010; van den Bergh and Gowdy, 2009). Wilson et al. (2013) have suggested that Ostrom's design principles, in particular, evolved via cultural group selection. To give flesh to these hypotheses, consider the impact of Ostrom's institutional principles on group success in evolutionary terms: if the principles sustain resources, they may also