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Analysis

Insiders, outsiders, and the adaptability of informal rules to ecological shocks☆

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ABSTRACT

The history of the world is strewn with the remains of societies whose institutions failed to adapt to ecological change, but the determinants of institutional fragility are difficult to identify in the historical record. We report a laboratory experiment exploring the impact of an exogenous ecological shock on the informal rules of property and exchange. We find that geographically-induced tribal sentiments, which are unobservable in the historical record, impede adaptation post shock and that inequality declines as wealth and sociableness increase. Quantitative measures of individual and group sociality account for some of the differences in successful or failed adaptation.

1. Introduction

Rules, institutions, conventions — the formal and informal practices that define the bounds on human behavior and facilitate mutualistic gains from exchange — form the bedrock on which societies develop. From ancient rituals to modern property rights regimes, persistent institutions are often uniquely adapted to social and ecological circumstances (Baker, 2003; Clay and Wright, 2005; Ellickson, 1989; Frazer, 1909; Janssen et al., 2010; Ostrom, 1990; Ostrom et al., 1994; Pufendorf, 1762; Skarbek, 2011).[1] But what happens to extant institutions when their practitioners experience unforeseeable ecological changes? In the face of precipitous ecological change, old orders may be easily overturned. Ecological shocks may be a spur to collective action and the creation of centralized administration or new forms of governance (Carneiro, 1970; Folke et al., 2005), but historical evidence suggests that in some circumstances, whole cultures have seen their footprints sharply reduced or have even vanished with hardly a trace (Diamond, 2005; Medina-Elizalde and Rohling, 2012; Tainter, 2004; Weiss and Bradley, 2001). The rise and fall of both small bands/tribes and large scale societies depends on how well groups maintain order, manage resources, and engage in trade in the face of an evolving environment, but from historical data alone it is often difficult to understand why some groups in the past were successful and why others failed.

In this paper, we design a laboratory experiment to observe the process of institutional adaptation in response to unforeseeable ecological change. We explore the fragility of ownership and governance of resources in the face of a sudden and sharp decline in resource productivity affecting one subset of a broader population. Specifically, we compare the impact of an ecological shock in two treatment conditions that differ only in the initial *geographical* distribution of resources and individuals across our virtual world. The change in virtual geography changes the social history among individuals because it determines whether they organize into either one or two distinct communities. We find that the degree to which our virtual tribes collapse depends upon whether the society is initially fractured prior to the unanticipated ecological shock.

2. The Experimental World

We construct a virtual world, modeled on early human agricultural settlements, in which subjects harvest and consume two renewable resources to maintain their "health", the integral over time of which is converted to cash and paid to them at the conclusion of the session. Subjects have a "metabolism" such that their health diminishes over time and must be replenished by consuming resources. Sessions last 41 experimental periods and are divided into "weeks" by a fallow period every 7th period in which no harvesting or consumption may take place and subjects

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[1] This notion is echoed in the literature on animal territoriality, in which it is well-known that the extent of a species' territoriality depends on, among other characteristics, the density, predictability, and scarcity of resources (Maher and Lott, 2000), and experimental evidence with human subjects confirms similar territorial tendencies characterize human behavior under similar circumstances (DeScioli and Wilson, 2011).

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do not lose health due to metabolism.[2] Each subject can harvest from one resource patch per period, and after a patch has been harvested, its productive capacity is reduced by 1/2. At the beginning of each non-fallow period, each patch renews so that capacity doubles relative to the final capacity at the end of the previous period, up to an exogenous limit: high-yield patches are capped at producing 16 units, and lower-yield patches may be capped at 8, 4 or 2 units. Hence, if the same resource is harvested by more than one person in a period, it will not fully renew unless it is left untouched for one or more periods.

Prior to the shock, sufficient resource capacity exists for all subjects to harvest from a privately-accessed, high-yield resource patch, and through single pairwise exchanges they are able to consume resources at a rate far above what is necessary to replace the losses due to metabolism. However, partway through each session, in period 17, *half* of the resource base is struck by an unanticipatable exogenous shock (a "drought") that reduces resource capacity in that area. After the shock, the environment is still capable of producing sufficient resources to support all of the individuals at levels of consumption just above metabolic replacement, but achieving this outcome requires multilateral exchanges and coordinated restraint in resource extraction — in short, the informal rules of property and exchange must adapt.

In the absence of external enforcement and punishment mechanisms, these patterns of behavior can only emerge if subjects adapt their conventions of harvesting and exchange to fit the new ecological reality. Theoretical models of conventions require agents to share knowledge and beliefs about the strategies of others, though how agents acquire the relevant information is usually outside of the model (Lewis, 2002; Skyrms, 2004), and we will see that this depends crucially on social history. Such models also require that conventional strategies be Nash equilibria, but here, due to the multiplicity of candidate equilibria and the complexity of explicitly modeling any but the most trivial, we will be concerned only with conventions as they are reflected in measured differences in harvest and trade practices across groups, without regard to whether such behaviors constitute equilibria. In practice, experimental evidence suggests that the creation of property conventions depends crucially on the history and group orientation of the individuals involved (Janssen, 2010; Jaworski and Wilson, 2013; Kimbrough et al., 2010; Wilson et al., 2012). To develop conventions, participants must discuss strategies, incentives, and common objectives with one another and form endogenous consensus on the appropriate actions. However, for proposed conventions to stick, the participants must develop a community (or in-group) within which they can freely discuss how changes in behavior will benefit all members of the group.

We vary the geographical distribution of individuals and resources in our environment in order to vary the means by which potentially xenophobic in-groups are formed. Thus, we can observe how the structure of our world impacts the evolution of harvesting and exchange conventions after the drought. In one treatment all subjects begin the session in one part of our virtual world so that they are effectively placed into a single group in which they can observe and socially engage one another, via computerized chat, from the outset of the session. When the drought occurs, it impacts one-half of the members of an already-existing *group*. In our other treatment, half of the subjects each begin the session in two geographically-isolated areas and are initially restricted to observe and interact only with others nearby. Then, when the drought strikes it directly affects only one of the two distinct groups, and at the same time a barrier disappears (a body of water recedes) connecting the two groups so that migration is possible. Subjects in the drought-stricken area will have to migrate to the other territory (at no explicit cost) in order to acquire sufficient resources to maintain their health and earn their cash rewards. This ensures that, when migration occurs,[3] the two groups approach one another as complete strangers, having already had the opportunity to develop fellow-feeling with the members of their separate groups.

We refer to our sessions with a single large group as the *Us* treatment, and the sessions with two geographically separated groups as the *Them* treatment. We also add a visual cue to emphasize the different social histories and make the between-group distinction more salient (Frank and Gilovich, 1988). Specifically, each subject's avatar is displayed in a different color, and their names reflect the shade. In particular, four avatars are named for shades of blue (Cornflower, Dodger, Steel, and Turquoise) and four avatars are named for shades of red (Tomato, Crimson, Coral and Brown). In the *Them* treatment, all four red shaded avatars are on the side of the barrier that is eventually stricken by the drought.

In many simple experimental games, it is well-known that other-regarding behavior is inversely related to the social distance between the subjects and experimenters (Camerer, 2003; Cherry et al., 2002; Hoffman et al., 1994, 1996) and that individuals treat members of in- and out-groups differently (Chen and Li, 2009; Tajfel, 1970). Moreover, recent experimental evidence suggests that induced differences in individuals' social identification with a group can impact the extent to which people discover and exploit gains from exchange (Kimbrough and Wilson, 2011) and contribute to group welfare in a minimum effort game (Chen and Chen, 2011). Thus, we hypothesize that our treatment difference in group composition created by the geography and coupled with the visual cue will hamper, if not thwart, the participants in the *Them* treatment from adapting their conventions after the drought to support profitable resource governance.[4] Since the performance of each economy depends on the evolution of its harvest and trade practices, we hypothesize that this geographical distinction will lower both the amount harvested and consumed after the drought. Furthermore, we expect this difference in the fruits of cooperation to be reflected in the density of trading networks.

Recall that multilateral sharing is required to achieve a welfare maximizing allocation after the drought. Our design allows us to measure the extent of multilaterality, and we hypothesize that trade will be more multilateral in *Us* than in *Them*. At the individual level, subjects have two available means to extend the boundaries of community membership to the strangers and coordinate harvesting and consumption: 1) freeform text-based conversation and 2) planting a color-coded 'sign' on which an individual can display a one-line message to other subjects. We included the sign feature to facilitate staking claims to property,[5] and although both methods of communication are "cheap talk" with respect to the formal rules of the virtual world, the decision to engage in either indicates an active desire to modify the informal rules of behavior. Moreover, experimental evidence from a variety of games suggests that communication improves prospects for cooperation (e.g. Bochet et al., 2006; Crawford, 1998; Ostrom et al., 1992). Thus, if interpersonal engagement contributes to individual success, then both chatting and the use of signs will be correlated with harvesting and health.

3. Experimental Design, Procedures, and Hypotheses

3.1. Design

Eight subjects each control an avatar that can move around a 5040×2100 pixel grid that constitutes our experimental landscape to harvest, exchange, and consume resources and to chat with other

[2] Thus, there are 6 weeks with 5 total fallow periods occurring on the 7th, 14th, 21st, 28th and 35th periods.

[3] And it always does: no subject from the drought-stricken group ever refuses to migrate to the other area, though when resource conflict becomes pervasive some subjects eventually return to their homeland.

[4] Here our design anticipates an interaction effect between geographical separation and visible differences between the agents in the two groups. While it may be interesting to observe the effect of geographical separation in isolation, the visual cue makes it easier for any homegrown xenophobia to be expressed in behavior.

[5] Since the sign can be placed at any location on the screen, one potential use is to indicate one's claim to a particular patch, by e.g. planting the sign directly next to the patch with the message "property of [color]". We anticipated that this would be a valuable signifier of property claims that could maintain stable rules of possession even when the "owner" was not in the immediate vicinity of his/her claim.