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See no evil: Information chains and reciprocity

Eva-Maria Steiger [a], Ro'i Zultan [b,*]

[a] Department of Economics, Ludwig-Maximilians-University, Geschwister-Scholl-Platz 1, 80539 Munich, Germany
[b] Department of Economics, Ben-Gurion University, P.O.B. 653, Beer-Sheva 84105, Israel

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ABSTRACT

We study experimentally voluntary contributions to public goods when none, some, or all previous decisions are observable. When agents observe previous moves, they tend to condition their cooperation on observed cooperation. This leads to two effects of increased transparency: on the one hand, early movers are more likely to cooperate in order to encourage those who observe them to cooperate. On the other hand, as transparency increases, later movers are less likely to cooperate because they are more likely to observe defections and defect in response. With increasing returns to scale, where the effect of one agent's contribution is larger as more agents contribute, an information chain is as effective in inducing cooperation as full transparency. In a linear public good, where agents lose in monetary terms by contributing to the public good, information chains induce higher cooperation in early movers compared to a no-transparency treatment and in late movers compared to a full-transparency treatment. Thus, partial information can be used to balance the positive and negative effects of transparency.

1. Introduction

The nature of some public goods is such that agents decide on their (voluntary) contributions sequentially. This is the case in some common resource pool situations such as large-scale, centrally constructed irrigation systems, where those who are located closer to the source of the water have first opportunity to withdraw water from the system (Ostrom and Gardner, 1993) or inshore fisheries with seasonal migrations (Schlager et al., 1994). Moreover, some public goods, such as public infrastructure or scientific research, are typically produced by a sequential process involving several agents (e.g., architect, supplier, and constructor or theoretician, lab technician, and statistician). Fundraising activities as well are often performed sequentially, both in small groups such as churches (Soetevent, 2005) and in large groups such as in nationwide telethons.

In such cases, agents may have varying degrees of information about previous contributions. This information has the potential to influence contribution decisions in different ways.[1] On the one hand, early movers are more likely to cooperate in order to encourage those who observe them to cooperate. On the other hand, later movers are less likely to cooperate as transparency increases because they are more likely to observe defections and defect in response.[2] In many cases, a central designer can influence the flow of information between contributing agents. This may happen in interdisciplinary research, where collaborators often do not have the expertise or information needed to assess the quality of others' contributions. The head of a medical study, for example, can provide the clinician with information about the quality of the sample construction. Similarly, the head of a fundraising project can choose what information about previous donations to make public (List and Lucking-Reiley, 2002; Silverman et al., 1984; Soetevent,

* Corresponding author at: Ben-Gurion University of the Negev, Department of Economics, P.O.B. 653, Beer-Sheva 84105, Israel. Tel.: +972 86472306; fax: +972 86472941.
E-mail addresses: steiger@econ.lmu.de (E.-M. Steiger), zultan@bgu.ac.il (R. Zultan).

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[1] In some cases, agents do not observe previous moves, but can condition their contribution on the contribution of others as in, for example, committing to match funds the that will be provided by another agent see, e.g., Guttman (1978), for an analysis of matching mechanisms with simultaneous moves.

[2] The opposite may apply when contributions of different agents are substitutes, for example in sequential chicken games. This is not the case in the environments we study in this paper.

2005). The design of environments aimed at facilitating contributions should thus consider the optimal level of transparency while taking into account both its positive and negative effects on cooperation levels.

In this paper, we experimentally study these issues by comparing cooperation under different levels of transparency. Several experimental studies have explored situations in which some players have information about the contributions of other players at the time of making a contribution. However, in all the studies of which we are aware, informed players have perfect information about all previous moves.[3] In contrast, the aim of our experimental investigation is to test the efficacy of partial and imperfect transparency. The theoretical analyses we present in the paper suggest that the effects associated with full transparency are expected to occur as long as there is (direct or indirect) information flow between any two agents in the group. Accordingly, we focus on information chains, in which each agent only observes the decision of the preceding mover. Information chains present the minimal information structure that satisfies the theoretically-derived requirement. As such, they provide the best experimental tool allowing to capture general insights into the performance of partial transparency, as it naturally occurs, for example, in inshore fisheries with limited communication over large distances along the shore.

We study the effects of transparency under two different technologies. The first exhibits increasing returns to scale, i.e., the marginal effect of an agent's contribution is strictly increasing in the number of other agents who choose to contribute. The second technology defines a standard linear public good, in which the marginal amount of public good provided by each agent's contribution is fixed. We develop a theoretical model, following that of Winter (2010), to show that partial transparency is predicted to perform as well as full transparency in inducing cooperation under increasing returns to scale. We proceed to argue that if agents are intrinsically conditional cooperators due to reciprocal preferences, similar effects might be expected even in the linear public good. Furthermore, as early movers should be more likely to contribute because they are observed by more potential followers whereas late movers should be less likely to contribute because they observe more potential defectors, we predict that the positive effects of transparency decrease along the chain of agents.

Our experimental results validate the theoretical predictions under increasing returns to scale, with partial transparency resulting in high cooperation similar to that observed with full transparency. The effects of transparency are not evident in early periods, but become apparent over time as group members who play according to the equilibrium prediction prompt their partners to follow suit.

Significant conditional cooperation is also observed in the linear public good, where cooperation is not consistent with an equilibrium based on monetary payoffs alone. Participants are consistently and significantly more likely to contribute if every other participant they observe has contributed. However, the magnitude of conditional cooperation is considerably lower than with increasing returns to scale, so that overall contribution levels do not differ significantly depending on the transparency level. Nonetheless, we find that both full and partial transparency have a significantly positive effect on early movers, whereas full transparency has a significantly negative effect on late movers. As a result, highest contribution levels are observed in the information chain, since it benefits from the positive effect of reciprocity on early movers, while avoiding the detrimental effect on late movers.

The rest of the paper is organized as follows. We present the theoretical arguments and the resulting hypotheses for technologies with increasing returns to scale and linearity in Sections 2 and 3, respectively. In Section 4 we develop a formal model underpinning the hypotheses drawn in the preceding sections. Sections 5 and 6 describe the experimental design and results and Section 7 concludes.

2. Transparency with increasing returns to scale

The interaction between transparency and technology was theoretically studied in a principal–agent model by Winter (2006, 2010), who characterized the optimal reward mechanisms that can induce effort in teams under different information structures and different production technologies. An optimal mechanism determines the reward that each agent receives contingent on the team outcome such that all agents exert effort in equilibrium. Winter (2006) showed that when the production function has increasing returns to scale, transparency increases efficiency in equilibrium. Due to the complementarities in the technology, an observed contribution by one agent can incentivize the observing agents to contribute as well, thereby increasing the incentives of the observed agent.[4]

However, this clear intuition is not enough to determine the efficacy of different partial-transparency environments. Winter (2010) addressed this issue by extending the framework to compare different information structures. Winter (2010) proved that one information structure is more transparent (and therefore efficient) than another if the *closure* of the directed graph representing the latter is included in the closure of the directed graph representing the former, i.e., if every arc that exists in one also exists in the other (Winter, 2010, Proposition 4, p. 13). In other words, if agent i observes agent j, and agent j observes agent k, whether i observes k directly or not does not affect the optimal mechanism required to extract full contributions from the agents. This result is driven by the fact that the effect of the transparency is maximized when each agent benefits from contributing if and only if she does not observe any defections. In this case, when i observes j contributing, she infers that k has also contributed, otherwise contribution would have been dominated for j.

It follows that the minimal information structure required to maximize the incentivizing effect of transparency is an *information chain*, such that the agents decide sequentially and each agent observes only the action of her immediate predecessor. That is, *indirect* transparency can be as efficient as *direct* transparency in facilitating cooperation in teams. This premise is the starting point of our experimental investigation into sequential contributions to public goods. We compare contribution decisions in three different information treatments:

No information (NI): Agents do not observe the contribution decisions of other agents.
Chain information (CI): Each agent observes only the contribution decision of her immediate predecessor.
Full information (FI): Each agent observes the contribution decisions of all previous movers.

Treatments NI and FI are equivalent to the simultaneous and sequential protocols previously studied in the literature, respectively. We construct the environment such that, with increasing returns to scale, all agents contribute in the unique subgame-prefect equilibrium outcome of FI, whereas zero contributions consist a Nash equilibrium in NI. This environment provides the backdrop against which we study indirect transparency, as manifested in our CI treatment. Our first hypothesis addresses the basic effect of transparency while the second reflects the prediction with regard to partial transparency:

Hypothesis 1. Contribution levels in FI are higher than those in NI.

Hypothesis 2. Contribution levels in CI are as high as those in FI.

[3] Theoretical studies include Varian (1994), Hermalin (1998), Romano and Yildirim (2001), Vesterlund (2003). Experimental studies include Andreoni et al. (2002), Chen and Komorita (1996), Coats and Neilson (2005), Dorsey (1992), Figueres et al. (2012), Gächter et al. (2010), Kurzban et al. (2001), Kurzban et al. (2005), Levati et al. (2007), Levati and Zultan (2011).

[4] This may lead to paradoxical incentive reversals, as increasing the incentives of the observing agent may remove the incentives of the observed agent. See Winter, 2009; Klor et al., in press)