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Weiwei Tasch, Daniel Houser

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Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
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Social Preferences and Social Curiosity

Abstract

Over the last two decades social preferences have been implicated in a wide variety of key economic behaviors. Here we investigate connections between social preferences and the demand for information about others' economic decisions and outcomes, which we denote "social curiosity." Our analysis is within the context of the inequality aversion model of Fehr and Schmidt (1999). Using data from laboratory experiments with sequential public goods games, we estimate social preferences at the individual level, and then correlate social preferences with one's willingness to pay to make visible others' contribution decisions. Our investigation enables us to shed light on how costs to knowing others' economic decisions and outcomes impact decisions among people with different social preferences, and in particular the extent to which such costs impact the willingness for groups to cooperate.

JEL-Codes: C910, H410.

Keywords: laboratory experiment, curiosity, inequality aversion, sequential public goods game.

Weiwei Tasch
Department of Economics and
Interdisciplinary Center for Economic
Science, George Mason University
Fairfax / VA / USA
wtasch@masonlive.gmu.edu

Daniel Houser
Department of Economics and
Interdisciplinary Center for Economic
Science, George Mason University
Fairfax / VA / USA
dhouser@gmu.edu

1. Introduction

Understanding connections between social preferences and the demand for information relevant for social comparisons is fundamental to design policies to promote pro-social behaviors. Substantial effort has been directed towards understanding other-regarding preferences for a number of decades (see Guth et al., 1982; Kahneman et al. 1986; Forsythe et al. 1994; Fehr et al. 1993; Berg et al. 1995), including the important model of inequity aversion by Fehr and Schmidt (1999). However, little discussion has surrounded the connection between social preferences and the desire to know others' economic decisions and outcomes. Here we investigate the connection between inequity aversion, within the context of Fehr and Schmidt (1999), and the demand to know others' economic decisions and outcomes. We refer to the latter as social curiosity.

Social curiosity may differ among individuals. As compared to those with purely selfish motivations, those sensitive to guilt or envy may benefit more from information about others' economic outcomes (Bolton 1991; Fehr & Schmidt 1999). The reason is that inequality averse individuals suffer more utility cost as their outcomes differ more from the outcomes of others. To avoid this, those sensitive to guilt and envy may be willing to pay for information about others' economic outcomes. Here, by "more sensitive," we refer to agents whose utility is more greatly impacted by departures from equal payoff outcomes.

We investigate the relationship between social preferences and social curiosity using laboratory experiments with a sequential public goods game, first developed by Kurzban and Houser (2005). We show that this game enables individual-level inference about Fehr-Schmidt inequity aversion. Further, by manipulating the pecuniary cost of knowing how others decide, we reveal the relationship between social preferences and social curiosity. In addition, our design allows us to discover the extent to which visibility of economic decisions promotes cooperative outcomes.

Specifically, players in our sequential public goods game (henceforth, SPG) make sequential contributions to an account that provides a return to all group members. In baseline treatments one can view all contributions from all group members prior to making one's own contribution. In another treatment players have the option to pay for this information. Importantly, in all treatments all players know the final outcomes of all participants. We show theoretically that this leaves inequity-averse players willing to pay for information about others' decisions and outcomes.

Consistent with previous literature, we find that people are conditionally cooperative: their contribution decisions are positively dependent on others' contributions. We further show that guilt and envy parameters are significant predictors of cooperative behavior. Moreover, consistent with our theoretical predictions, we find players more sensitive to guilt are willing to pay more for information about others' decisions and outcomes. Finally, we find that making information about others' decisions and outcomes free (i.e. without cost) promotes cooperation.

In sum, our paper makes both theoretical, methodological, and substantive contributions. We present a theoretical analysis that suggests a positive correlation between higher social preferences and higher willingness to pay for information. Methodologically, we introduce a new experiment design that enables joint inference regarding social preference parameters (envy and guilt) and willingness-to-pay for information about others' economic decisions and outcomes. Substantively, we rigorously demonstrate a positive association between these social preferences and social curiosity, and also show that more easily available information about others generates greater social cooperation. An implication is that pro-social people who are unable to satisfy their social curiosity cooperate less than when information about others' decisions and outcomes is readily available. This may help to explain why transparency is often thought necessary for cooperation among social groups (see for example Bicchieri, 2013).

The remainder of the paper is organized as follows: Section two reviews literature, and section three presents theoretical models. In section four we discuss the experimental design and procedures. Section five presents the results and our findings, and section six concludes.

2.Literature Review

2.1 Social Preference Models

Fehr and Schmidt (abbreviated as F&S) develop an outcome-based model of inequity-aversion modulated by envy and guilt (see Rabin 1993; Falk & Fischbacher 2006; Dufwenberg &

Kirchsteiger 2004; Falk & Fischbacher 2006; Xiao & Bichieri 2009; Falk et al. 2008; Bolton 1991; Bolton & Ockenfels 2000). Our SPG provides a novel alternative to studies that use within-subject designs that employ two different games, such as a binary ultimatum game and a binary dictator game, to elicit individual envy and guilt coefficients separately (e.g. Andreoni & Miller 2002; Blanco et al. 2011; Bellemare et al. 2017; Firman 2007). We simultaneously elicit and estimate envy and guilt at the individual level, and use this to draw inferences between social preferences and social curiosity.

2.2 Social Curiosity

Incentives to acquire or avoid information may include 1) whether the revealed information increases utility; 2) whether the information is instrumental to make consequent decisions; and 3) whether it simply reduces uncertainty (Golman et al. 2017; Golman & Loewenstein 2015; Elias & Schotter, 2010; Burger 1992 & Skinner 1995, in Prinder 2014, Grossman & Weele Forthcoming). Curiosity is a constituent of our cognition—a desire to learn what is unknown, which may arise from a gap between the information we know and what we want to know. However, while what one knows may be objective, what one wants to know is highly subjective (Loewenstein 1994; Kang et al. 2009; Maw & Maw 1970; Inan 2012; Phillips 2016; Kagan 1972). Upon acquiring information, social curiosity may be instrumental to cooperative behavior if used to enforce equality—we denote this type of social curiosity as instrumental curiosity. Information seeking behavior, however, can be incentivized by pure curiosity— a simple desire to avoid the perception that one is out of control with no intention to enforce equality. Our experiment enables us to distinguish these types of curiosity as well as their impact on group-level cooperative outcomes.

2.3 Social Comparison

People are sensitive to social comparisons. For example, it is well-established that relative earnings affect job satisfaction (see Fehr & Schmidt, 1999; Agell & Lundborg 1995; Bewley 1998; Clark & Oswald 1996). In recent years, field experimental studies have explored the impact of norm-based strategies on cooperation, coupling pro-social norm suggestions with social comparison information (see Allcott 2011; Ferraro & Price 2013; Ayres, Raseman, & Shih 2013). The importance of social comparison has also been studied in social psychology (see Festinger 1954; Stouffer 1949; Homans 1961; Adams 1963) and sociology (see Davis 1959; Pollis 1968; Runciman 1966) for more than half a century. Social comparison strategies have been used effectively to help reduce water and energy consumption (Allcott 2011; Ferraro & Price 2013). Our work extends this prior research by developing formal links between social preferences and the demand for information about others' economic decisions and outcomes.

3. Theory

In this section we discuss a theoretical model that allows us to simultaneously estimate individual inequality-aversion parameters in the context of F&S (1999). We then present a theoretical analysis that predicts a positive correlation between higher social preferences and higher willingness to pay for information, again based on F&S (1999). Last, we state and discuss four testable hypotheses of the theory.

3.1 Inequality Aversion

In a two-stage SPG, following Kurzban & Houser (2005), n players indexed by $i \in \{1, \ldots, n\}$ decide simultaneously on their contribution levels $g_i \in [0, e]$ to public goods in stage 1. Stage 2 has multiple rounds—in a round t, a player i, is informed about the contribution vector (g_1^{t-1}, ... g_n^{t-1}), and is able to update her initial/previous contribution decision. Each player has an endowment e. Let $x = x_1, \ldots, x_n$ denote the vector of monetary payoffs, then the monetary payoff for player i at period t is given by $x_i^t = e - g_i^t + a \left(\sum_j g_j^t \right)$, where $1/n < a < 1$. Following F&S (1999), we assume that in addition to individuals who care only about their monetary payoffs, there are people who dislike inequalities in payoffs. Based on the F&S (1999) model, we suggest that a pro-social player i increases her contribution when she updates her contribution decision to reduce advantageous inequality, and decreases her contribution to reduce disadvantage inequality. Assuming that before the information is revealed, a pro-social player i realizes zero disutility caused by inequality in contributions. When information about others' contributions is available, the difference between player *i*'s monetary payoff and player *j*'s monetary payoff at round *t*, $x_i^t - x_j^t$, is equal to the negative difference between their contributions, $g_i^t - g_j^t$. For player *i*, a change in monetary payoff, $-(1-a)(g_i^t - g_i^{t-1})$, is equal to the achieved sum of normalized disutility, $-\alpha_i * (1/n\text{-}1) \sum_{j\neq i} \max\{g_i^t - g_j^t, 0\} + \beta_i * (1/n\text{-}1) \sum_{j\neq i} \max\{g_j^t - g_i^t, 0\}$, after updating a contribution, where α_i and β_i are the disadvantageous and advantageous inequality aversion (envy and guilt parameters), respectively. Thus,

(1) *Change in Monetary Payoff* = (- *Envy Parameter* ∗ *Disadvantageous Inequality* + *Guilt Parameter* ∗ *Advantageous Inequality*) / *n*-1

Equation (1) presents the theoretical model that allows us to estimate envy and guilt parameters simultaneously, formal derivations of the equation are presented in Appendix A. A crucial assumption underlying our theory is that each contribution decision (other than the first) is made as though it is the final contribution decision. This is reasonable in view of our design—people know that the game can stop at any time after each player is given a chance to update their initial contribution. This allows us to avoid "strategic" reasons for contributions as in Kurzban & Houser (2005), where they found that the "types" uncovered as a result of an analysis based on this assumption predicted well the way players subsequently behaved.

3.2 Social Curiosity and Inequality Aversion

In the context of social dilemmas, we suggest that one may choose strategic ignorance; upon acquiring information, instrumental curiosity motivates information acquiring behavior and it is crucial to cooperative behavior. When information seeking behavior is incentivized by pure curiosity, the instrumental role to cooperate vanishes.

Furthermore, our theoretical analysis based on the F&S (1999) model suggests that higher sensitivity to guilt and envy, are correlated with higher willingness to pay for information when information is costly to access. Let $F(e, g_i^t, G_{b,-i}^t, c_i, \alpha_i, \beta_i) = Eu_c - Eu_n$ denotes the difference between expected utilities when player *i* pays for information and when she/he does not pay for information, where $G_{b,j}^t$ denotes player *i*'s belief about the total contribution made by other players. When information about others' economic outcomes can be acquired only by paying a positive amount of cost players receive a separate account with a balance equal to the cost for information, c, from which they can pay the cost for information. For player i with $0 < \beta_i < 1$

$$(2)\qquad dc_i / d\beta_i = (\sum_{l=0}^{n-1} \Pr(k = l)^* (1/n\text{-}1) \sum_{j \neq i} \max\{(g_{b,j}{}^{t} + c_{b,j}) - g_i{}^{t}, 0\} - \sum_{j \neq i} \max\{(g_j{}^{t} + c_{b,j}) - g_i{}^{t}, 0\}) / (1/n\text{-}1) > 0$$

if $\sum \max\{g_{b,j}{}^{t} + c_{b,j} - g_i{}^{t}, 0\} > 0$ in (2). Furthermore, for player i with $1\text{-}a < \beta_i < 1$,

$$(3)\qquad dc_i / d\alpha_i = (\sum_{l=0}^{n-1} \Pr(k = l)^* (1/n\text{-}1) \sum_{j \neq i} \max\{g_i{}^{t} - (g_{b,j}{}^{t} + c_{b,j}), 0\} - \sum_{j \neq i} \max\{g_i{}^{t} - (g_j{}^{t} + c_{b,j}), 0\}) /(1/n\text{-}1) > 0,$$

if $\sum \max\{g_i{}^{t} - (g_{b,j}{}^{t} + c_{b,j}) > 0$ in (3). $\Pr(k = l)$ is the probability that there are l players with $\beta < 1\text{-}a$ in the group, and $g_{b,j}{}^{t}$, $c_{b,j}$ denote player i' s belief about the contribution and cost paying decision made by another player j in the group. A player with $0 < \beta_i < 1$ makes her/his decision about whether to pay for information based on her/his belief about the advantageous inequality in economic outcomes under uncertainty, and the higher the guilt parameter the higher is this player's willingness to pay the cost of information. Furthermore, a player with $1\text{-}a < \beta_i < 1$ makes her/his decision about whether to pay for information based on her/his belief about the disadvantageous inequality in economic outcomes under uncertainty, and the higher the envy parameter the higher is this player's willingness to pay for the cost for information. Detailed analysis is presented in Appendix B.

3.3 Hypotheses

We state four primary hypotheses. Hypothesis 1 is that a low guilt player contributes less than a player with a high guilt parameter. Formal analysis is shown in Appendix C. Based on Equation (1), Hypothesis 2 is that a purely selfish player i with $\beta_i = 0$ makes no changes when facing an updating contribution opportunity; it further implies that a player i with $\beta_i > 0$ makes changes when facing updating contribution decision opportunities based on her social preferences and beliefs about others' economic behavior and outcomes. Based on equations (2) and (3), Hypothesis 3 states a positive relation between inequality aversion and individual cost accepting behavior. Hypothesis 4 is that groups cooperate more when information is freely available than when it is not. Detailed analysis for Hypothesis 4 is shown in Appendix D.

Hypothesis 1:

With information about others decisions and outcomes is costless,

(i) for players with β_i < 1- a, a dominant strategy is to contribute zero to the public good, if α_i > (n-k-1) (n-1) a/k; and a low positive amount to the public good, if α_i < (n-k-1) (n-1) a / k, where k denotes the number of players among other n -1 players with β_i < 1- a, $0 \leq k \leq n-1$;

(ii) Players with β_i > 1- a contribute a positive amount from their endowment to the public goods depending on their beliefs about others' economic outcomes.

Hypothesis 2:

(i) Players with $\beta_i = 0$ make no changes when updating their contribution;

(ii) Players who are sensitive to guilt make changes when updating contributions, depending on their social preferences and beliefs about others' economic outcomes. A higher sensitivity to guilt (envy), correlates with a higher positive (negative) change in the updated contribution.

Hypothesis 3:

(i) Cost accepting behavior is positively correlated with the guilt parameter for all players;

(ii) Cost accepting behavior is positively correlated with the envy parameter for players with $1- a < \beta_i < 1$.

Hypothesis 4:

(i) When information is costless, a player i with β_i < 1- a contributes positive amounts to the public good, if α_i < (n-k-1) (n-1) a / k, k denotes the number of players among other n -1 players with β_i < 1- a, $0 \leq k \leq n-1$;

(ii) When information is costly, a player i with $\beta_i < 1 - a$ has an optimal strategy that $g_i = 0$, if player i expects that all other players choose not to pay for the information. If $\beta_i \leq [\alpha_i k + (n-1)(1-a-ma)] / (n-k-m-1)$ for player i, $0 \leq m \leq n-1-k$, player i has no incentive to contribute any positive amount to the public project if m of player j with $\beta_j > 1 - a$ pay the cost, and contribute $g_j = g_i$, but $n-1-k-m$ of player j with $\beta_j > 1 - a$ do not pay the cost and contribute $g_i = g$, $g \in (0, e]$.

Hypothesis 4 (i) is that when information is costless there are many equilibria with positive total contributions, including a social optimum equilibrium where every group member contributes their entire endowment. Due to the reciprocal behavior of pro-social players, when information is costless in all rounds, a selfish player has an incentive to contribute if she/he expects to confront a pro-social player with $\beta_i > 1 - a$, since a pro-social player will contribute zero when observing zero other contribution(s). Hypothesis 4 (ii) is that costs discourage pro-social players from acquiring information, meaning selfish players have no incentive to contribute any positive amount.

4.Experiment Design

4.1 Treatments

Our experiment consists of three treatments in two different environments. The two environments are *Info-free* environment, which has two treatments: *All-info* and *Show-info,* and *Info-cost* environment, which has one treatment: *Info-cost.*

In *info-free* environment, information about others' economic decisions and outcomes is freely available; in the *info-cost* environment this information must be purchased at a known cost. Under *all-info*, information about others' contributions are shown to all; under *show-info* information is free but to view the information requires clicking the "ShowInfo" buttons. The treatment *show-info* tests whether individuals are indeed using information about others' contributions to make their own decision.

4.2 Design Overview

An SPG experiment includes multiple games; the number of games is predetermined while the number of rounds in each game is randomly predetermined with a four percent probability that a game will end after any round. The number of games and number of rounds in a game is unknown to the subjects. Participants are informed, however, by the instructions that there will be a 4 percent chance that the game will end after any person's contribution; although each participant will have at least one chance to update their contribution in any given game. As predetermined, each experiment has ten games, which have 16, 7, 23, 32, 32, 34, 4, 17, 31, and 8 rounds from game 1 to 10, respectively.

There are 12 subjects in an SPG experiment, organized into three groups of four players, but who are rearranged in each game. Each of the ten games has two stages. As the first stage starts, each player simultaneously decides how much to contribute to a public project from their endowment of 50E$. The second stage begins immediately after the first stage, in the *info-free* environment. When the information has a positive cost in the *info-cost* experiment, however, the players decide whether to accept the cost or not before entering the second stage. In the second stage, with a randomly rotating order among the four players, one player sees the information about the others' contributions and chooses whether, or/and by how much to update, either by increasing or decreasing the initial contribution decision. Specifically, when information is available one (and only one) player can see her/his own contribution to the group project as well as the contributions from the other three group members in a given round. The contributions of the others are shown to this single player in a random order so that each player's contribution in each round remains anonymous.

4.3 Features of Design

In an *info-free* environment, we draw connection between estimated individual guilt and envy parameters and cooperation decisions. In an *info-cost* environment, we draw inference about the relationship between estimated individual guilt and envy parameters and social curiosity, measured by the highest willingness to pay for information.

Information about others' contributions is free in the first six games of the experiment under both the *info-free* and the *info-cost* environments. In games 3 to 6, updated contribution decisions are used to estimate individual guilt and envy parameters. The estimations are made from more than 30 updated decisions that a subject made in games 3 to 6. Due to the random order of the display of other group members' contributions, a player will not know who makes what contribution, but they will see the inequality between his/her contribution and others'—thus this allows us to estimate the aversion coefficients. This is summarized by Figure 1, "Experimental Design." Table E.1 in Appendix E summarizes the stages of each game in each treatment.

4.4 Cost Parameters

We set endowment, *e*, equal to 50 experiment dollars (50E$), with the exchange rate of 50E$ = 1 USD. We set the marginal return to investment in a public project, *a,* equal to 0.5, in a four person public goods game. Our theoretical analysis (see Appendix F) suggests that players with $\beta_i < 1 - a$ will accept the cost for information up to 5E$. We set cost for information, *c*, to be 0, 1, 5, and 10E$, which are 0, 2%, 10%, and 20% of a player's endowment in a particular game, converted to 1 cent, 2 cents, 10 cents and 20 cents USD.[3]

[3] All participants were provided full information about the features of their treatments. Players in *info-cost* were informed there would be positive costs of information during rounds 7-10, while players in *info-free* were aware information would always be free. An alternative of providing vague or incomplete information about costs could create experimenter demand effects when costs are ultimately revealed, and could also perhaps be viewed as deceptive. Regardless, we find no evidence that this difference influenced the distribution of α and β between *info-cost* and *info-free* treatments ($p > 0.6$ in both comparisons; see fn. 6).

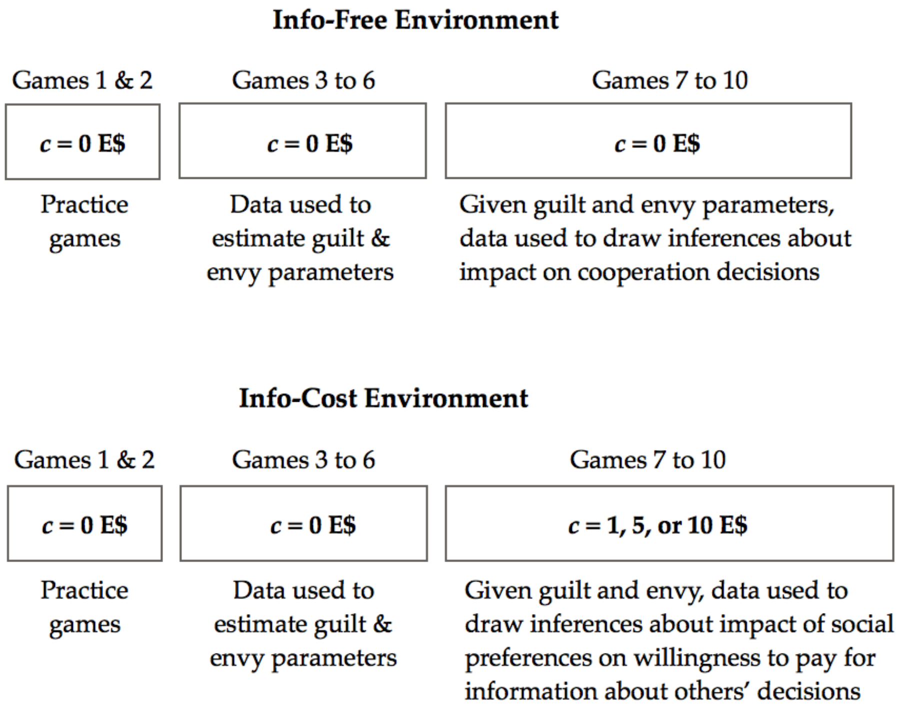

Figure 1. Experimental Design. *C* denotes cost for information about others' economic decisions and outcomes. In i*nfo-free* environment, this information is freely available in games 1 to 10. In *info-cost* environment, this information is freely available in games 1 to 6; however, it must be purchased at a known positive cost in games 7 to 10. Cost for information is randomly determined, and set to be 5, 10, 1 and 10E$ in games 7, 8, 9, and 10, respectively.

4.5 Experiment Procedures

The experiments are programmed in z-Tree (Fischbacher, 2007). Our preliminary experiment included 272 participants in 23 sessions. In the *info-free* environment, eight sessions were completed in *all-info*, and eight sessions took place in *show-info*, and the remaining seven sessions were completed in treatment *info-cost*. Experiments were completed during the Fall, 2016 and Spring and Fall 2017 semesters with participants recruited from George Mason University's student population, using the recruitment system established for Mason's Interdisciplinary Center for Economic Science (ICES). The experiments were held at ICES' Fairfax, VA campus laboratory. In the experiment, participants were seated at computer terminals that were divided by partitions. In each session, participants were first given a hard copy of the experiment's instructions to read, after which they were given a quiz to check their understanding of the rules stated in the instructions. After the experiment was completed, participants filled out a hard-copy questionnaire, and received their payment in private. Subjects' average earning is about 20$ for about 2 hours of participation. Table E.1 in Appendix E summarizes the numbers of sessions and participants in each treatment.

5.Results

5.1 Envy & Guilt Parameters

We estimate envy and guilt parameters, using data generated in games 3 to 6, for the 260 subjects who made their updated contributions using information about others' economic outcomes.[4] We use an econometric model drawn from equation (1) to estimate envy and guilt parameters, α_i and β_i respectively for a player *i*. Recall that for player *i,* a change in monetary payoff, is equal to the achieved sum of normalized disutility, after updating a contribution, thus

$$(4) \qquad -(1-a)(g_i^t - g_i^{t-1}) = -\alpha_i * (1/n\text{-}1) \sum_{j \neq i} \max\{g_i^t - g_j^t, 0\} + \beta_i * (1/n\text{-}1) \sum_{j \neq i} \max\{g_j^t - g_i^t, 0\} + \varepsilon_i^t,$$

where ε_i is independent and identically distributed across individuals and periods. Further, consistent with the Fehr-Schmidt theory, we implement the following parameter restrictions: $\alpha_i \geq 0$ and $0 \leq \beta_i < 1$.[5] The constraint $\beta_i \leq \alpha_i$ also appears in Fehr-Schmidt, but is relaxed since previous studies found this assumption to be regularly empirically violated (see Bellemare et al. 2008; Blanco et al. 2011). Figure 2 shows the joint α_i and β_i distribution, with 260 observations; each hollow dot represents an individual's envy and guilt, α and β, respectively. The line represents $\alpha = \beta$, and observations to the left of the line have $\alpha_i < \beta_i$. We found both α and β

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4 In total, 272 subjects participated in the experiments, among which, 12 subjects did not look at information in games 3 to 6, and hence do not have estimated envy and guilt parameters.

5 We conducted the estimation using a non-linear regression implemented with the Stata command "nl".

widely distributed in the population, and there is a strong violation of the F&S assumption that individual envy is greater than or equal to guilt. Many subjects are found to the left of the envy and guilt equal line, similar to the findings in Bellemare et al. (2008) and Blanco et al. (2011). Table 1 presents summary statistics.

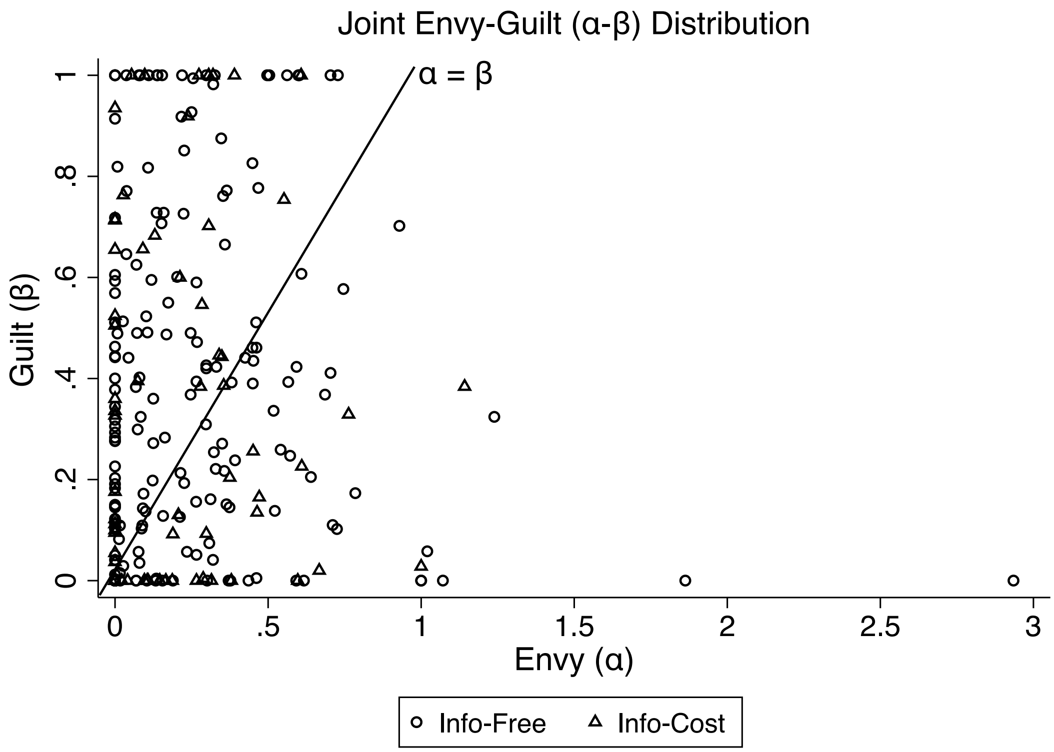

Figure 2. The joint envy - guilt (α - β) distribution. Each hollow circle represents an individual's envy and guilt, α and β, respectively, parameters in *info-free*, and each hollow triangle represents an individual's envy and guilt, α and β, respectively, parameters in *info-cost.* The envy and guilt parameters are estimated from games 3 to 6. The line represents $\alpha = \beta$, observations to the left of the line have have $\alpha_i < \beta_i$. Total observations: 260 (191 in *info-free* and 69 in *info-cost*).

Table 1. Summary Statistics

	Number of Obs.	Mean	Std. Dev.	Min	Max
Total Participants	272				
Estimated Envy Parameters	260	0.239	0.321	0	2.935
Estimated Guilt Parameters	260	0.354	0.339	0	1
Gender (Female=1, Male=0)	272	0.489	0.500	0	1

Field of Studies (Econ&Finance=1, Others=0)	272	0.080	0.273	0	1
Had Economics Courses previous-ly (Yes=1, No=0)	272	0.492	0.500	0	1
Had public goods game before (Yes=1, No=0)	272	0.198	0.399	0	1

5.2 Predictive Power of Estimated Envy & Guilt Parameters

The individuals with estimated α_i and β_i coefficients are considered to be valid in the SPG, if the cooperative behavior is statistically higher for high-guilt type players (with $\beta_i > 0.5$) than for low-guilt type players (with $\beta_i < 0.5$).[6] In *info-free* environment, the mean of high-guilt type players' contributions at the end of games 7-10, namely 32.4 E$, is higher than the mean of low-guilt type players' contribution, 24.0 E$. The difference in contribution behavior between low-guilt and hight-guilt players is statistically significant ($p < 0.001$).[7] This result confirms Hypothesis 1. We then test Hypothesis 2 by testing the following model:

$$\textit{Updated Contribution} = b_0 + b_1 * \textit{Others' Mean Contribution} - b_2 * \textit{Estimated Envy Parameter} + b_3 * \textit{Estimated Guilt Parameter} + u$$

Hypothesis 2 predicts that a pure selfish player makes no changes when facing an updating contribution opportunity; it further implies that a player with $\beta_i > 0.5$, makes changes when facing updating contribution decision opportunities based on their social preferences and beliefs about others' economic behavior and outcomes. As reported in regression (3) in Table 2, with

[6] Consistent with the Fehr-Schmidt theory, we group players with $\beta_i < 1\text{-}a$ into low-guilt type and players with $\beta_i > 1\text{-} a$ into high- guilt type, where $a = 0.5$ in our experiment.

[7] An OLS regression, where mean of contribution in games 7 to 10 is the dependent variable, and "Type" (defined by guilt estimates, where a low- and high -guilt type player has $\beta_i < 0.5$ and $\beta_i > 0.5$, respectively), as a dummy independent variable, and other independent variables, including gender, ethnicity, and etc, shows that the high-guilt types contribute 8.4E$ higher than the low-guilt types ($p < 0.001$). Robust standard errors adjusted for clusters by "session."

Table 2. OLS Regression Analysis Result

Dependent Variable: Mean Update Contribution in Games 7 to 10			
	(1)	(2)	(3)
Mean of others' contributions ((b_1)	0.84*** (0.054)	0.83*** (0.062)	0.815*** (0.060)
Estimated envy coefficient from games 3 to 6 (b_2)	-5.81*** (1.95)	-6.08*** (1.90)	-5.97*** (1.85)
Estimated guilt coefficient from games 3 to 6 (b_3)	11.52*** (1.80)	11.08*** (2.07)	11.80*** (1.83)
Gender (Female=1, Male=0)		-0.66 (1.57)	
Field of Studies (Econ &Finance=1, Others=0)		-1.46 (3.43)	
Had Economics Courses previously (Yes=1, No=0)		0.11 (1.52)	
Had public good game (Yes=1, No=0)		3.57* (1.74)	3.29* (1.83)
Academic Status (Undergrad = 0, Grad=1)		-2.77 (2.20)	
Ethnicity (Asian=1, Hispanic=2, Caucasian=3, African American =4, Others=5)		0.63* (0.32)	
Constant	0.39 (1.92)	-0.66 (2.95)	0.20 (1.66)
Number of Obs.	191	191	191
R^2	0.524	0.524	0.533

*** Significant at 1% level. ** Significant at 5% level.* Significant at 10% level. Robust standard errors adjusted for clusters by "session" are shown in parentheses.
Note: The analysis uses observations from Treatment 1 and 2. There are 192 subjects, among which one subject did not review information in games 3-6.

clustering by session, mean updated contribution in games 7 to 10 is significantly positively correlated with the observed mean contributions from the reference group ($p < 0.001$), and with the estimated guilt coefficients ($p < 0.001$), but is, however, significantly negatively correlated with the estimated envy coefficient ($p < 0.01$).[8] We conclude that the results support Hypothesis 2, which is also in line with Dannenberg et al. (2010) and Kuzban et al.(2001). Thus, the

[8] In a regression (2), we found that gender, academic level, and previous economic study do not play significant roles in predicting individual cooperative behavior.

estimated guilt and guilt coefficients predict individuals' cooperative behavior in the context of Fehr-Schmidt.

5.3 Social curiosity

In the *info-free* environment, all participants display social curiosity. Among 80 subjects in *info-cost*, 11 players did not acquire the information about others' economic outcomes at any cost, including zero; 20 players acquired the information when it was free; 20 players acquired the information when it costs 0 and 1E$; 15 players accept any cost that is equal to 5E$ or less (0, 1, and 5E$); and 14 players accept all the costs (including 0, 1, 5 and 10E$).

5.4 Cost Accepting Behavior vs. Guilt Parameter

We group 69 players who had information access in games 3-6 into two types according to their cost accepting actions, by the following criteria: High cost accepting players are willing to pay costs up to 5 and even 10E$; low cost accepting players are willing to pay only 0 or 0 and 1E$. The group of high cost accepting players has a mean of guilt estimated at 0.42; the group of low cost accepting players has a mean of guilt estimated at 0.25; the difference in guilt estimates is 0.17 between the two groups, and statistically significant ($p < 0.05$, two-tailed t-test). This result confirms Hypothesis 3 (i), that cost accepting behavior is positively correlated with the guilt parameter. We do not, however, observe a statistically significant correlation between cost accepting behavior and envy.[9]

5.5 Social Curiosity is Instrumental for Conditional Cooperators

Further data analyses suggest that barriers to information may impede players' willingness to cooperate through the following channels: When social curiosity is a crucial intermediate step for

[9] We group 69 players into two types according to their cost accepting actions, as in the part for hypotheses 3 testing, the group of high costs accepting players has a mean of envy estimated at 0.24; the group of low costs accepting players has a mean of envy estimated at less than 0.07; the difference in envy estimates between the two groups is not statistically significant(p = 0.279, t-test). Furthermore, there is no statistically significant predicting power on cost paying behavior from the estimated envy parameters for players with $1- a < \beta_i < 1$.

prosocial players to enforce equality, barriers to information raise strategic information ignorance and hinder individuals' willingness to meet their own social curiosity.

Social curiosity seems to be instrumental for players with pro-social preferences ($\beta_i > 0.5$), and causes no effect on contribution behavior for players with pure curiosity and low social preferences ($\beta_i < 0.5$). We denote an absolute change in updated contribution as "Changes in updated contributions." Specifically,

Changes in updated contribution = Abs (*Mean updated contribution in games 7 to 10* - *Mean updated contribution in games 3 to 6*)

We divide 49 players who are willing to pay at least 1E$ for the information in info-cost into two groups according to their social preferences (players who refuse to pay the minimum positive cost for information are considered showing no social curiosity), see Table 3. Changes in updated contribution made by players with instrumental curiosity are significantly greater than changes made by other players with pure curiosity (p <0.05, Welch's t-test). Instrumental social curiosity seems to be crucial and instrumental for pro-social players in their cooperative action; but pure curiosity of players with low social preferences has no instrumental effect on their decision to choose cooperative actions.

Table 3. Changes in Updated Contribution

Group	Estimated Guilt Coefficient	Highest Cost for Accepted (E$)	Number of Obs.	Changes in Updated Contribution (E$)
Instrumental Curiosity	≥ 0.5	1, 5, or 10	18	14.30
Pure Curiosity	< 0.5	1, 5, or 10	31	6.48

Note: Estimated guilt coefficient are generated using the updated decisions in games 3 to 6.

5.6 Barriers to Information Impede Willingness to Cooperate

We found that while individuals display the same distribution with regard to social preferences, individuals' cooperative behavior in the *info-free* environment is significantly higher than in the *info-cost* environment.[10] And that the mean of game-end contribution in games 7 to 10 in the *info-free* environment is significantly higher than in *info-cost*. This finding is represented in Figure 3. This result confirms Hypothesis 4.

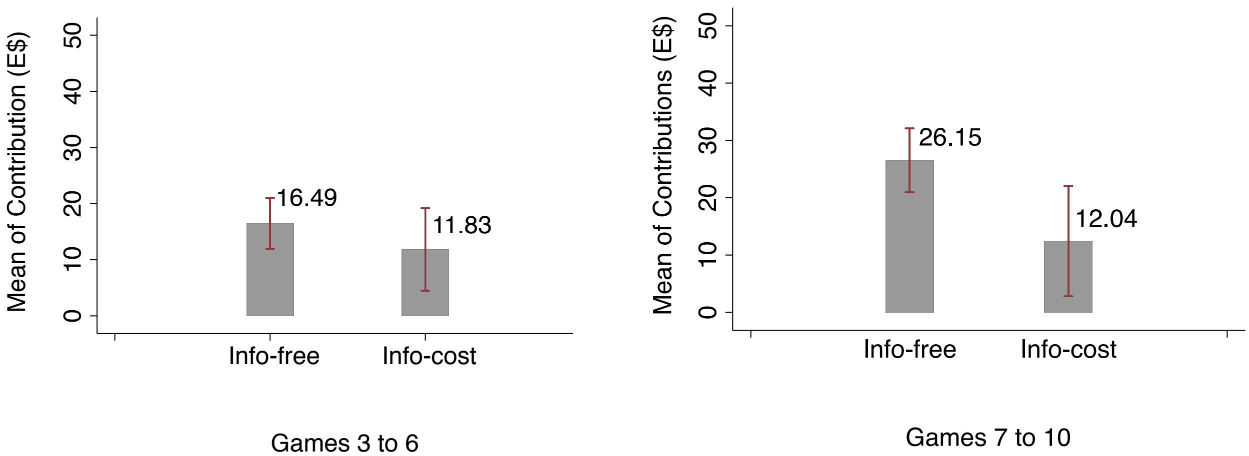

Figure 3. Mean Comparisons of *Info-free* and *Info-cost* Environments. The left graph shows the means of the game-end contributions in games 3 to 6 in *info-free* and *info-cost* respectively; the right graph shows the means of the game-end contributions in games 7 to 10 in *info-free* and *info-cost* respectively. In the *info-free* environment and *info-cost* environment there are 16 and 7 observations, respectively. Y-axis is the mean of the end contribution from the total endowment of 50E$.

5.7 Players' Earnings in Info-Cost Environment

We found a statistically significant difference in earnings between subjects who pay and who do not pay for the information ($p < 0.001$, two-tailed t-test).[11] In games 7 to 10 in *info-cost* environment, the earnings by players in games where they do not pay for the information is 71.4E$; and mean earnings among players who pay is 62.8E$. The lower earnings among people who pay is consistent with the view that those more sensitive to guilt and envy are willing to pay to avoid incurring those utility costs.

[10] The estimated envy and guilt in *info-free* and *info-cost* are the same ($p = 0.8955$, $p = 0.617$, WMW test, respectively), cooperative behavior is different in the two environments, as predicted by Hypothesis 4. The mean of individual contributions at the end of the games 7 to10 is statistically different in info-fee in the info-cost environment with observations 16 and 7 respectively respectively—26.15 E$ in *info-free,* 12.04 E$ in *info-cost* ($p < 0.01$, WMW test).

[11] The t-test includes all 80 subjects in the info-cost environment.

6. Conclusion

In this study we investigated how barriers to information about others' economic decisions and outcomes affects cooperation among people with different social preferences. We provided a theoretical analysis based on Fehr and Schmidt (1999) showing that greater sensitivity to guilt or envy can be associated with greater willingness to pay for information about others' economic outcomes. Our laboratory experiments allow us to investigate this relationship empirically, while also informing how departures from complete information impacts cooperation.

In line with the literature, our participants are conditionally cooperative: Their contribution decisions are positively dependent on others' contributions. Our results go further in demonstrating that one's inequality aversion is a statistically significant predictor of cooperation, and in the direction that the theory predicts. Specifically, those with greater sensitivity to guilt demonstrate a higher willingness-to-pay for information about others' economic decisions and outcomes.

We find overall greater cooperation when information about others' decisions is more readily available. This finding is anticipated by Bicchieri (2010; 2013), who suggests the creation of positive social norms in social-dilemmas can include transparent information sharing. Our results are consistent with this, in that conditions with open and visible information about others' behavior were associated with greater pro-social decisions.

In view of this, one might consider visibility of information about individuals' or groups' economic decisions and outcomes a public good. Further studies are needed to investigate the production or obstruction of such information, and how this might be determined by contexts including the social preferences of a group's members.

Our study thus suggests a new direction for promoting cooperation within and across societies. In addition to direct incentives based on punishment or reward, we suggest focusing on sharing information about others' economic decisions and outcomes. While incentive-based mechanisms can require costly monitoring, technological advances may enable information sharing at vastly lower costs, and thus may be an efficient approach for promoting and maintaining large-scale cooperation.

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Appendix A

Consider a set of n players indexed by $i \in \{1, \ldots, n\}$. In a public goods game, there are $n \geq 2$ players who decide simultaneously on their contribution levels $g_i \in [0, e]$, $i \in \{1, \ldots, n\}$ to a public good. Each player has an endowment e. Let $x = x_1, \ldots, x_n$ denote the vector of monetary payoffs, then the monetary payoff for player i at period t is given by $x_i^{\,t} = e - g_i^{\,t} + a\,(\sum_j g_j^{\,t})$. In a two-stage SPG, following Kurzban & Houser (2005), n players indexed by $i \in \{1, \ldots, n\}$ decide simultaneously on their contribution levels $g_i^0 \in [0, e]$ to public goods in stage 1. Stage 2 has multiple rounds. In the first round of stage 2, a player i, is informed about the contribution vector (g_1^0, ... g_n^0), and is able to update her initial contribution decision g_i^0 to g_i^1, which is her first updated contribution. The contribution vector after the first round becomes (g_1^1, ..., g_n^1), where $g_i^1 = g_i^1$ and $g_{-i}^1 = g_{-i}^0$. In the second round of stage 2, another player j, is informed about the contribution vector (g_1^1, ..., g_n^1), and can update her initial contribution decision, g_j^1 to g_j^2, her first updated contribution. The contribution vector after the second round becomes (g_1^2, ..., g_n^2), where $g_j^2 = g_j^2$ and $g_{-j}^1 = g_{-j}^2$. Each round follows another, as one player from the group, in random order, receives information and updates her/his previous contribution decision from $g^{\,t-1}$ to $g^{\,t}$, and the contribution vector after the round t becomes (g_1^t, ... g_n^t), where $g_i^t = g_i^t$ and $g_{-i}^{\,t-1} = g_{-i}^{\,t}$, $i \in \{1, \ldots, n\}$.

When information about others' contributions is available and free, the difference between player i's monetary payoff and player j's monetary payoff at round t, $x_i^{\,t} - x_j^{\,t}$, is equal to the negative difference between their contributions, $g_i^{\,t} - g_j^{\,t}$, given by $x_i^{\,t} - x_j^{\,t} = g_j^{\,t} - g_i^{\,t}$, and player i's utility function

$$\text{(A1)} \qquad u_i(x_i^{\,t}, \{x_j^{\,t}\}_{j \neq i}) = e - g_i^{\,t} + a\,(g_i^{\,t} + \textstyle\sum_{j \neq i} g_j^{\,t}) - \alpha_i * (1 / n\text{-}1) \textstyle\sum_{j \neq i} \max\{ g_i^{\,t} - g_j^{\,t}, 0\}$$
$$- \beta_i * (1 / n\text{-}1) \textstyle\sum_{j \neq i} \max\{ g_j^{\,t} - g_i^{\,t}, 0\}$$

where $\sum_{j \neq i} g_j^{\,t} = \sum_{j \neq i} g_j^{\,t-1}$, and $g_j^{\,t-1}$ becomes available information and known by player i only in round t. A change in contribution from $g_i^{\,t-1}$ to $g_i^{\,t}$ causes a change in player i' s monetary payoffs by

(A2) $\{e - g_i^{\,t} + a\,(g_i^{\,t} + \sum_{j\neq i} g_j^t)\} - \{e - g_i^{\,t-1} + a\,(g_i^{\,t-1} + \sum_{j\neq i} g_j^{\,t-1})\} = (1 - a)\,(g_i^{\,t-1} - g_i^{\,t})$

Equation (A2) states that one more unit in contribution to the public good occurred when player i updates her decision, creates a marginal monetary payoff loss of 1- a for player i. Conversely, by decreasing one unit contribution to the public good, player i gains 1- a in her monetary payoff.

The F&S (1999) model suggests that for pro-social player i with $\beta_{\mathrm{i}} > 1- a,$ the contribution to the public good should be positively correlated with guilt parameter β_{i}, and negatively correlated with envy parameter α_i, We further suggest that pro-social player i increases her contribution when she updates her contribution decision to reduce advantageous inequality, and decreases her contribution to reduce disadvantage inequality. Assuming that before the information is revealed, a pro-social player i realizes zero disutility cased by inequality in contribution. After learning the inequality in contribution, for player i, a change in monetary payoff, $-(1- a)\,(g_i^{\,t} - g_i^{\,t-1})$, is equal to the achieved sum of normalized disutility, $-\alpha_i * (1/n\text{-}1) \sum_{j\neq i} \max\{g_i^{\,t} - g_j^t, 0\} + \beta_{\mathrm{i}} * (1/n\text{-}1) \sum_{j\neq i} \max\{g_j^t - g_i^t, 0\}$, after updating a contribution, where we assume α_i and β_i are the disadvantageous and advantageous inequality aversion (envy and guilt parameters). An increase (decrease) in contribution after updating, is negatively (positively) correlated with the term, $\beta_i * (1/n\text{-}1) \sum_{j\neq i} \max\{g_j^t - g_i^t, 0\}$, the disutility from advantageous inequality, which is the product of guilt parameter and normalized advantageous inequality. An increase (decrease) in contribution after updating, is positively (negatively) correlated with the term, $\alpha_i * (1/n\text{-}1) \sum_{j\neq i} \max\{g_i^{\,t} - g_j^t, 0\}$, disutility from disadvantageous inequality, which is the product of envy parameter and normalized disadvantageous inequality.

(A3) $-(1\text{-}a)\,(g_i^{\,t} - g_i^{\,t-1}) = -\alpha_i * (1/n\text{-}1) \sum_{j\neq i} \max\{g_i^{\,t} - g_j^t, 0\} + \beta_{\mathrm{i}} * (1/n\text{-}1) \sum_{j\neq i} \max\{g_j^t - g_i^t, 0\}$

Equation (A3) estimates envy and guilt parameters when information about others' economic outcome is freely available for the players.

QED

Appendix B

We first consider the case where player i has $\beta_{\text{i}} > 1$- a. Assume the k of other n -1 players have β_l < 1- a , and n - 1 - k players are with $\beta_h >$ 1- a. Denote c_i and c_j as the cost for information accepted by players i and j, respectively; c is the available balance/fund in an information cost account for every player, and it is equivalent to the cost for acquiring information. Following F&S (1999),

$$x_i^{\,t} = e - g_i^{\,t} + a\,(g_i^{\,t} + G_{-i}^{\,t}) + (c - c_i)$$
$$x_j^{\,t} = e - g_j^{\,t} + a\,(g_j^{t} + G_{-j}^{\,t}) + (c - c_j)$$

and

(B1) $$u_i(x_i, \{x_j\}_{j \neq i}) = e - g_i + a\,(g_i^{\,t} + G_{-i}^{\,t}) - \alpha_i * (1/n\text{-}1) \sum_{j \neq i} \max\{x_j^{\,t} - x_i^{\,t}, 0\} - \beta_{\text{i}} * (1/n\text{-}1) \sum_{j \neq i} \max\{x_i^{\,t} - x_j^{\,t}, 0\}$$

Let F $(e,\ g_i^{\,t}, G_{b,-i}^{\,t}, c_i, \alpha_i, \beta_{\text{i}})$ = E u_c - E u_n , where E u_c is the expected utility with certainty when player i pays the cost for information about others' contributions and hence economic outcomes, and E u_n is the expected utility with uncertainty if player i does not pay the cost for information. F represents the difference in player i' s expected utility under certainty and uncertainty, given

(B2) $$\text{E}\,u_c = \text{E}\,[e - g_i^{\,t} + a\,(g_i^{\,t} + G_{-i}^{\,t}) + (c - c_i) - \alpha_i * (1/n\text{-}1) \sum_{j \neq i} \max\{g_i^{\,t} - (g_j^{\,t} + c_j), 0\} - \beta_{\text{i}} * (1/n\text{-}1) \sum_{j \neq i} \max\{(g_j^{\,t} + c_j) - g_i^{\,t}, 0\}]$$
$$= e - g_i^{\,t} + a\,(g_i^{\,t} + G_j^{\,t}) + (c - c_i) - \alpha_i * (1/n\text{-}1) \sum_{j \neq i} \max\{g_i^{\,t} - (g_j^{\,t} + c_{b,j}), 0\} - \beta_{\text{i}} * (1/n\text{-}1) \sum_{j \neq i} \max\{(g_j^{\,t} + c_{b,j}) - g_i^{\,t}, 0\}\,],$$

where $c_{b,j}$ denotes player i' s belief whether player j pays for the cost of information, and $c_{b,j}$ = E[c_j]. Since player j pays for the cost of information, we have $c_i = c$.

(B3) $$\text{E}\,u_n = \text{E}\,[e - g_i^{\,t} + a\,(g_i^{\,t} + G_{-i}^{\,t}) + (c - c_i) - \alpha_i * (1/n\text{-}1) \sum \max\{g_i^{\,t} - (g_j^{\,t} + c_j), 0\} - \beta_i * (1/n\text{-}1) \sum \max\{(g_j^{\,t} + c_j) - g_i^{\,t}, 0\})]$$

$= e - g_i^t + a (g_i^t + G_{b,j}^t) + (c - 0) - \sum_{l=0}^{n-1} \Pr (k = l) * [\alpha_i * (1 / n\text{-}1) \sum \max\{g_i^t - (g_{b,j}^t + c_{b,j}),$

$0\} + \beta_i * (1 / n\text{-}1) \sum \max\{ (g_{b,j}^t + c_{b,j}) - g_i^t, 0\}]$

where $\Pr (k = l)$ is the probability that there are l players with $\beta < 1 - a$ in the group. Suppose that it is common knowledge that there are p percentage of population with $\beta > 1- a$, and $1\text{-}p$ percentage of population with $\beta < 1- a$. $G_{b,j}^t$ denotes player i' s belief about the total contribution made by other players, and $G_{b,j}^t = \mathrm{E}[G_j^t]$, and $c_{b,j} = \mathrm{E}[c_j]$. Player i does not pay the cost for information, so that $c_i = 0$.

We are interested in the effect on cost accepting decision from an increase in the individual's guilt parameter, β_i. We specify the function $\mathrm{F} (e, g_i^t, G_{b,-i}^t, c_i, \alpha_i, \beta_i)$, and

(B4) $dc_i / d\beta_i = - (\partial \mathrm{F}/\partial \beta_i) / (\partial \mathrm{F}/\partial c_i) = - (1/ n\text{-}1) \sum \max\{ (g_j^t + c_{b,j}) - g_i^t, 0\}$

$+ \sum_{l=0}^{n-1} \Pr (k = l)* (1/ n\text{-}1) \sum \max\{(g_{b,j}^t + c_{b,j}) - g_i^t, 0\} > 0,$

if $\sum \max\{ g_{b,j}^t + c_{b,j} - g_i^t, 0\} > 0$. The analysis above suggests that the willingness to pay for the cost for information is an increasing function in the guilt parameters for players with $\beta_i > 1- a$ who believe that there is at least one contribution made by others that is bigger than her/his updated contribution in t. By the same procedure, we obtain

(B5) $dc_i / d \alpha_i = - (\partial \mathrm{F}/\partial \alpha_i) /(\partial \mathrm{F}/\partial c_i) = - (1/ n\text{-}1) \sum \max\{g_i^t - (g_j^t + c_{b,j}), 0\}$

$+ \sum_{l=0}^{n-1} \Pr (k = l)* (1/ n\text{-}1) \sum \max\{g_i^t - (g_{b,j}^t + c_{b,j}), 0\} > 0$

$dc_i / d \alpha_i > 0$, if $\sum \max\{g_i^t - (g_{b,j}^t + c_{b,j}) > 0$. The willingness to pay for the cost for information is an increasing function in the envy parameters for players with $\beta_i > 1- a$, who believe that there is at least one contribution made by another that is smaller than her/his updated contribution in t. We suggest that $\sum_{l=0}^{n-1} \Pr (k = l)* (1/ n\text{-}1) \sum \max\{ (g_{b,j}^t + c_{b,j}) - g_i^t, 0\}]$ is greater than $(1/ n\text{-}1) \sum \max\{(g_{b,j}^t + c_{b,j}) - g_i^t, 0\}$, and that player i experiences less disutility under certainty than under uncertainty about how to reduce inequality.

We now consider players with β_i < 1- a . A pure selfish player has $\alpha_i = \beta_i = 0$, and makes zero contributions both in the initial contribution and in the updated contribution decisions. A pure selfish player will not pay for any costs for information but pocket the available balance to the account payable for the cost for information. But a player with $0 < \beta_i < 1- a$ may pay the cost for information depending on the magnitude of the cost and her/his belief in others' economic outcomes.

Assuming k of $n-1$ players with $\beta_i < 1- a$ contribute $g_1 = g_2 = \ldots = g_k = 0$ at t-1, and $n-1-k$ players with $\beta_i > 1- a$ contribute $0 = g_k \leq g_{k+1} \leq \ldots \leq g_n \leq e$. For player i with $\beta_i < 1- a$,

$$\text{(B6)} \quad dc_i / d\beta_i = - (\partial F/\partial \beta_i) / (\partial F/\partial c_i) = - (1/ n\text{-}1) \sum \max\{ (g_j^{\,t} + c_{b,j}) - g_i^{\,t}, 0\} + \sum_{l=0}^{n-1} \Pr(k = l)^* (1/ n\text{-}1) \sum \max\{(g_{b,j}^{\,t} + c_{b,j}) - g_i^{\,t}, 0\} > 0$$

A player with $0 < \beta_i < 1- a$ makes her/his decision about whether to pay for information based on her/his belief about the advantageous inequality in economic outcome under uncertainty, and the higher the guilt parameter the higher is this player' s willingness to pay for the cost for information.

QED

Appendix C

Suppose that we are in the info-free environment, and that $\beta_i < 1- a$ for player i. Consider an arbitrary contribution vector $(g_1, \ldots g_{i-1}, g_{i+1}, \ldots, g_n)$ of other players after initial contributions are made by all players. Suppose $0 = g_{i-1} \leq g_i \leq g_{i+1} \ldots \leq g_n$. Assume that other players' with $\beta_j > 1- a$ contribute g_j is a function of g_i, and $g_j = f(g_i)$ and further assume that $\partial g_j / \partial g_i = m$, and $m > 0$.

If player i chooses $g_i = 0$ in a sequential public goods game where $a = 0.5$ and $n = 4$, according to Proposition 4 in F&S (1999), all players j contribute $g_j = 0$ after observing $g_i = 0$, and thus

$$u_i(g_i = 0) = e - g_i + a \sum_{j \neq i} g_j - \beta_i * (1 / n\text{-}1) \sum_{j \neq i} \max\{g_j - g_i, 0\} = e$$

If player i chooses a positive contribution level, $g_i = \varepsilon + 0$, where $\varepsilon > 0$, assume k players with $\beta_i < 1- a$ contribute nothing, while $n\text{-}k$ players with $\beta_i > 1- a$ contribute $g = g_i$, then

$$u_i(g_i > 0) = e - g_i + (n\text{-}k)\, a g_i - \alpha_i\, (1/n\text{-}1)\, k\, g_i = e + [(n\text{-}k)\, a\text{-}1] g_i - \alpha_i (k / n\text{-}1)\, g_i$$

$u_i(g_i > 0) > u_i(g_i = 0)$ if and only if $[(n\text{-}k)\, a\text{-}1]g - \alpha_i (k / n\text{-}1)\, g > 0$ or

$$\alpha_i < [(n\text{-}k)\, a\text{-}1]\, (n\text{-}1) / k$$

This implies that when $k = 0$, player i has $u_i(g_i > 0) > u_i(g_i = 0)$, and chooses $g_i > 0$. When $k = 1$, player i with $\alpha_i < 1.5$ has $u_i(g_i > 0) > u_i(g_i = 0)$, and chooses $g_i > 0$. When $k = 2$, player i with $\alpha_i = 0$ has $u_i(g_i > 0) = u_i(g_i = 0)$, and may chooses $g_i = 0$. ε is a small positive amount of contribution: but enough to convince the pro-social players that player i is not a purely selfish player.

QED

Appendix D

Now suppose that we are in the info-cost environment, and

1) if all players j with $\beta_j > 1- a$ do not pay the cost, they can not observe g_i , and $g_j = g$, where $g \in [0, e]$. For player i with $\beta_i < 1- a$

$$u_i (g_i = 0) = e + (n\text{-}k\text{-}1)\, ag - \beta_i \,(1/n\text{-}1)\,(n\text{-}k\text{-}1)\, \mathrm{g}$$

and

$$u_i (g_i > 0) = e - g_i + ag_i + (n\text{-}k\text{-}1)\, ag - \alpha_i \,(1/n\text{-}1)\, k\, g_i - \beta_i\, (1/n\text{-}1)\,(n\text{-}k\text{-}1)(\mathrm{g}\text{-}g_i)$$

$u_i (g_i > 0) \leq u_i (g_i = 0)$ iff

$$\beta_i \leq [\alpha_i k + (n\text{-}1)(1\text{-}a)\,] \,/\, (n\text{-}k\text{-}1)$$

Since $\beta_i < 1- a$, $u_i (g_i > 0) \leq u_i (g_i = 0)$. Player i has no incentive to contribute any positive amount to the public project in info-cost environment when no-one pays the cost for information.

2) if all players j with $\beta_j > 1- a$ pay the cost, they observe g_i , and for player i with $\beta_i < 1- a$,

$$u_i (g_i = 0) = e$$

and

$$u_i (g_i > 0) = e - g_i + (n\text{-}k)\, ag_i - \alpha_i \,(1/n\text{-}1)\, k\, g_i = e + (n\text{-}k\text{-}1)\, ag_i - \alpha_i (k\,/n\text{-}1)\, g_i$$

$u_i (g_i > 0) > u_i (g_i = 0)$ if and only $[(n\text{-}k)\, a\text{-}1]g - \alpha_i (k\,/n\text{-}1)\, g > 0$ or $\alpha_i < [(n\text{-}k)\, a\text{-}1]\,(n\text{-}1) / k.$

3) if m of player j with $\beta_j > 1- a$ pay the cost, and contribute $g_i = g_i$, and $n\text{-}1\text{-}k\text{-}m$ of player j with $\beta_j > 1- a$ do not pay the cost, and contribute $g_i = g,$ then For player i with $\beta_i < 1- a$

$$u_i (g_i = 0) = e + (n\text{-}k\text{-}m\text{-}1)\, ag - \beta_i \,(1/n\text{-}1)\,(n\text{-}k\text{-}m\text{-}1)\, \mathrm{g}$$

and

$$u_i(g_i > 0) = e - g_i + ag_i + mag_i + (n\text{-}k\text{-}m\text{-}1)\, ag - \alpha_i\, (1/n\text{-}1)\, k\, g_i - \beta_i\, (1/n\text{-}1)\, (n\text{-}k\text{-}m\text{-}1)(g\text{-}g_i)$$

$u_i(g_i > 0) \leq u_i(g_i = 0)$ iff

$$\beta_i \leq [\alpha_i k + (n\text{-}1)(1\text{-}a\text{-}ma)\,] \,/\, (n\text{-}k\text{-}m\text{-}1)$$

Player *i* has no incentive to contribute any positive amount to the public project in info-cost environment when not all other players pays the cost for information, if $\beta_i \leq [\alpha_i k + (n\text{-}1)(1\text{-}a\text{-}ma)\,] \,/\, (n\text{-}k\text{-}m\text{-}1)$. Table D.1 represents player *i*'s optimal strategy.

Table D.1 Predicted Optimal Strategy

	$u_i(g_i > 0) \leq u_i(g_i = 0)$ iff	Predicted Dominant Strategy			
		$k = 0$	$k = 1$	$k = 2$	$k = 3$
$m = 0$	$\beta_i \leq (\alpha_i k + 1.5) /(3\text{-}k)$	$\beta_i \leq 0.5$, $g_i^*=0$; $\beta_i > 0.5$, $g_i^* > 0$	$\beta_i \leq 0.5\alpha_i+0.75$, $g_i^*=0$; $\beta_i > 0.5\alpha_i+0.75$, $g_i^* > 0$	for any *i* with $\beta_i \leq 2\alpha_i+1.5$, $g_i^*=0$	for all *i*, $g_i^* = 0$
$m = 1$	$\beta_i \leq \alpha_i k /(2\text{-}k)$	for any *i* with $\beta_i > 0$, $g_i^* > 0$	$\beta_i \leq \alpha_i$, $g_i^*=0$; $\beta_i > \alpha_i$, $g_i^* > 0$	for all *i*, $g_i^* = 0$	
$m = 2$	$\beta_i \leq (\alpha_i k - 1.5)/(1\text{-}k)$	for all *i*, $g_i^* > 0$	$\alpha_i > 1.5$ $g_i^* = 0$; $\alpha_i \leq 1.5$ $g_i^* > 0$		
$m = 3$	$\beta_i \leq (\alpha_i k - 3)\,(-k)$	for all *i*, $g_i^* > 0$			

QED

Appendix E

Table E. 1 Summary of One Game in Each of the Treatments

<table>
<tr><td></td><td></td><td colspan="2">Info-free Environment</td><td>Info-cost Environment</td></tr>
<tr><td></td><td></td><td>All Info</td><td>Show-info</td><td>Info-cost</td></tr>
<tr><td>Information</td><td></td><td colspan="2">Freely Available</td><td>Must be Purchased at a Known Cost</td></tr>
<tr><td rowspan="3">Players' Actions & Decisions</td><td>Stage One*</td><td colspan="3">Each player simultaneously decides how much to contribute to a public project from an endowment of 50 E$</td></tr>
<tr><td>Before Entering 2nd Stage</td><td colspan="2">No actions or decisions are needed</td><td>Each player decides whether to accept the cost or not</td></tr>
<tr><td>Stage Two</td><td>• Review information about others' contributions
• Update contribution</td><td>• Click the "ShowInfo" buttons to review information about others' contributions
• Update contribution</td><td>If a player pays for information:
• Click the "ShowInfo" buttons to review information about others' contributions, and
• Update contribution
If a player does not pay for information:
• Update contribution without seeing any information about others' contributions</td></tr>
<tr><td># of Players in a Group</td><td></td><td>4</td><td>4</td><td>4</td></tr>
<tr><td># of Sessions</td><td></td><td>8</td><td>8</td><td>7</td></tr>
<tr><td># of Subjects</td><td></td><td>96</td><td>96</td><td>80**</td></tr>
</table>

*Numbers of Rounds in Stage One: One. Numbers of Rounds in Stage Two: Multiple, predetermined but unspecified to the players

**Six sessions have 12 participants in each, and one session has 8 participants.

Appendix F

Let c_i denotes the cost paid by player i, $c_i = c$ or $c_i = 0$, where c is the cost for information in a particular game. Let c_j denotes the cost paid by other player(s), $c_j = c$ or $c_j = 0$. According to Appendix A, for all n players,

$$- (1\text{-}a)\,(g_i^{\,t} - g_i^{\,t\text{-}1}) + c_i = \mathrm{E}\,[\, - \alpha_i * (\,1/n\text{-}1) \sum_{j \neq i} \max\{\, (g_i^{\,t} + c_i) - (g_j^{\,t} + c_j^{\,b}),\, 0\} + \beta_{\mathrm{i}} * (\,1/n\text{-}1)\, \sum_{j \neq i} \max\{(g_j^{\,t} + c_j^{\,b}) - (g_i^{\,t} + c_i)\,,\, 0\},$$

where $c_j^{\,b}$ is player i's belief whether player (s) j pay(s) the cost for information. Assume that k of n-1 players with $\beta_{\mathrm{i}} < 1\text{-}\ a$ contribute $g_1 = g_2 = \ldots = g_k = 0$ at t, and n-1-k players with $\beta_{\mathrm{i}} > 1\text{-}\ a$ contribute $0 = g_k \leq g_{k+1} \leq \ldots \leq g_n$.

According to Proposition in F&S (1999), player i with $\beta_{\mathrm{i}} < 1\text{-}\ a$ contributes 0 at t, or $g_i^{\,t\text{-}1} = 0$, and make no changes in t+1, therefore $g_i^{\,t} = 0$. Let $g_j^{\,t}{}_{\_bar}$ be the average of the contributions that is higher than player i's contribution. For player i,

$$- (1\text{-}a)\,(g_i^{\,t} - g_i^{\,t\text{-}1}) + c_i = \mathrm{E}\,[\, \beta_{\mathrm{i}} * (\, n\text{-}1\text{-}k\, /n\text{-}1)\, [g_j^{\,t}{}_{\_bar} + c_{\text{-}i}^{\,b}) - \, (g_i^{\,t} + c_i\,)]]$$

since $g_i^{\,t\text{-}1} = g_i^{\,t} = 0$,

$$c_i = \mathrm{E}\,[\, \beta_{\mathrm{i}} * (\, n\text{-}1\text{-}k\, /n\text{-}1)\, \sum_{j \neq i} \max\{(g_j^{\,t} + c_{\text{-}i}^{\,b}) - \, c_i\,,\, 0\}$$

Denote $A = (\, n\text{-}1\text{-}k\, /n\text{-}1)$

$$c_i = \mathrm{E}\,[\, \beta_{\mathrm{i}} * A * \, \sum_{j \neq i} \max\{(g_j^{\,t}{}_{\_bar} + c_{\text{-}i}^{\,b}) \,/\, (1 + \beta_{\mathrm{i}} * A)]$$

Following F&S(1999), let A= 0.4, and $\mathrm{E}[g_j^{\,t}{}_{\_bar}\,] \in (0, 50]$, where 50 is the endowment in our SPG. Table E.1 shows the equilibrium cost for information that player i with $\beta_{\mathrm{i}} < 1\text{-}\ a$ accepts in a game. According to the table, player i with low social preferences will not accept the cost of information that is as high as E$10 in order to complete social comparison.

Table F.1 Equilibrium Cost for Information for Player *i* with β_i < 1- *a*

	$c_j^{\,b} = c$	$c_j^{\,b} = 0$
$\beta_i = 0$	0	0
$\beta_i = 0.1$	[0, 2]	[0, 1.92]
$\beta_i = 0.2$	[0, 4]	[0,3.70]
$\beta_i = 0.3$	[0, 6]	[0,5.36]
$\beta_i = 0.4$	[0, 8]	[0, 6.89]
$\beta_i = 0.49$	[0, 9.8]	[0, 8.19]

Further, for player *i* with $\beta_i > 1- a$,

$$- (1\text{-}a)\,(g_i^{\,t} - g_i^{\,t\text{-}1}) + c_i = \mathrm{E}\,[\, - \alpha_i * (k\,/n\text{-}1) * (g_i^{\,t} + c_i - c_{\text{-}i}^{\,b}\,) + \beta_i * (\,n\text{-}1\text{-}k\,/n\text{-}1)\,[g_j^{\,t}{}_{\_bar} + c_{\text{-}i}^{\,b}) - (g_i^{\,t} + c_i\,)]]$$

Let E [n-1-k /n-1] = A and E [k /n-1] = 1-A, denote $c_{\text{-}i}^{\,bh}$ and $c_{\text{-}i}^{\,bl}$ as player *i*'s belief about the cost accepting behavior from players who contribute higher and lower than herself, respectively.

$$c_i = \{A\, \beta_i\, g_j^{\,t}{}_{\_bar} + [(1\text{-}A)\, \alpha_i - A\beta_i\,]\, g_i^{\,t} + (1\text{-}a)\,(g_i^{\,t} - g_i^{\,t\text{-}1}) + A\, \beta_i\, c_{\text{-}i}^{\,bh} - (1\text{-}A)\, \alpha_i\; c_{\text{-}i}^{\,bl}\} / \{1 + A\beta_i - (1\text{-}A)\, \alpha_i\}$$

From above analysis, cost accepting decision made by player *i* with $\beta_i > 1- a$ is a function of a few variables, including both of the advantageous and disadvantageous inequality aversion, her own previous contribution, and expectation about others' contribution decision. Table F.1 shows the cost for information that player *i* with $\beta_i < 1\text{-}a$ accepts.

QED