Endogenous Reputation Formation: Cooperation and Identity under the Shadow of the Future

Kamei, Kenju

Durham University

27 January 2015

Endogenous Reputation Formation: Cooperation and Identity under the Shadow of the Future

Kenju Kamei

Department of Economics and Finance, Durham University
Email: kenju.kamei@durham.ac.uk, kenju.kamei@gmail.com

This version: January, 2015

Abstract:

People are interacting more with strangers thanks to recent technological advancement in online platforms. Online interactions can be characterized by infinitely-repeated games. Recent studies have shown that institutions that make people's decisions open to others may enhance cooperation in these situations. But it is still unknown whether people can successfully cooperate with each other by choosing to show their identities and building good reputation when there is an option to hide them. We deal with this question using an experimental laboratory. Our experiment shows that a non-negligible fraction of people conceal their identities and people fail to cooperate with each other if hiding identities is free. However, almost all show their identities and successfully achieve cooperation with their partners if a small explicit cost is charged for act of hiding.

JEL classification: C73, C92, D70, M21
Keywords: experiment, cooperation, reputation, prisoner dilemma game, internet, infinitely-repeated games

1. Introduction

How to sustain cooperation or trust among people is one of the most sought-after questions in our society. Reputation plays a key role in encouraging people to cooperate. While having a good reputation can benefit people significantly, having a bad reputation can be a disaster for a successful business or personal relationship. One needs to be identified to build reputation so that people can link his past behavior and his name (or his face or an identification number, if the name is unknown) in the future interactions. Therefore, identity is a crucial element in building reputation. With the increasing number of e-commerce transactions as well as the emerging businesses built on the idea of sharing economy such as Uber and Airbnb, however, we are interacting more with strangers – people whom we otherwise have no means to find, than we did a decade ago. While the technology has made our life more convenient (e.g., finding a birthday gift for a friend without leaving home or getting a cheaper car ride to an airport), it also means increased anonymity among buyers and sellers (e.g., buying a gift on an online store that doesn't have much information about it or taking a ride with a driver you found online whom you have never met before). Anonymous transactions, especially the ones conducted online, can lead to opportunistic behavior.

Some service providers have developed reputation building mechanisms as a solution to overcome the trust problem between users. For example, eBay and Uber have rating and feedback systems. While some users may still be motivated to engage in opportunistic behavior (e.g., a seller breaking her promise such as warranty or listing a better product that is different from her true product), it is more costly for them to do so with the rating or feedback systems present. For instance, if a seller wants to withhold information on her identity and a product she is selling, without good ratings or positive feedbacks from previous buyers, she may be less likely to find prospective buyers that are willing to deal with her. But in order to get good reputation, she must go through some due-paying periods to obtain others' trust, which may take some time. She may have to spend even a longer time in case she has committed misbehavior before, has less history information, and is therefore seen with suspicion by potential counterparts. In other words, building reputation can be considered as implicit cost to users.[1,2]

---

[1] eBay also has an additional incentive scheme in that they give privileges, such as higher selling limits, to well-established seller accounts (see http://pages.ebay.com/help/sell/sellinglimits.html). Uber has a policy that users can

As the online transactions are becoming a part of our everyday life, however, a large number of online frauds have been reported.[3] Frauds occur often due to the high degree of anonymity in transactions or features that allow users to have multiple accounts in a platform or creating them are easy (e.g., Pinker *et al.* 2003, Trevathan and Read 2006, Chua and Wareham 2002, Kwan *et al.* 2010). Online frauds can also be a consequence of low costs of entry and exit: users with opportunistic intentions can come back to marketplaces under different identities after cheating on their customers. There are several approaches taken by companies with regards to the usage of multiple accounts. Some companies such as eBay permit users to have multiple accounts and entrust users with their moral judgment about the use of the accounts.[4] Allowing multiple accounts can be convenient for users who wish to separate their accounts for some reasons (e.g., managing different product categories). But it also makes it possible for users to hide their identities and to engage in opportunistic behavior. Some online platforms such as Craigslist even allow users to trade each other without having a specific user ID.[5,6]

There are also other companies that attempt to prevent scams by imposing a strict ban on creating multiple accounts. This may help reassure users when using online transaction websites with respects to safety. This approach is chosen by Amazon.[7] The listings on the Amazon marketplace can be cancelled and suspended by Amazon if a seller does not follow the policy imposed by Amazon.

Other countermeasures that may effectively prevent users from misusing online services other than strict rules on multiple accounts are to impose an explicit cost on users by introducing an entrance fee or a time-consuming registration process for creating a new account (see Dellarocas (2003) for a survey). The presence of an upfront cost may give users a sufficient incentive not to deviate from honest and sincere behavior although this may prevent newcomers

---

be deactivated if they fail to maintain their ratings above the minimum required score (See http://blog.uber.com/feedback).

[2] Some providers have a system to ensure buyer confidence as well. For example, eBay provides a guarantee that buyers get money back if they don't receive what they ordered. See http://pages.ebay.com/help/policies/money-back-guarantee.html for the details.

[3] See 2013 Internet Crime Report published by Federal Bureau of Investigation.

[4] See http://pages.ebay.com/help/policies/multiple-accounts.html for the policy.

[5] Craigslist encourages its users to deal locally and meet in person for transactions. See http://www.craigslist.org/about/scams for the details.

[6] Regardless of policies on multiple accounts, many providers use some kinds of fraud detection/prevention technologies to protect their users. Research on early fraud detection methods has been actively conducted. The details are omitted to conserve space as they are beyond the scope of the paper.

[7] See http://www.amazon.com/gp/help/customer/display.html?nodeId=200414320 for the policy.

from joining the service which may hence reduce the efficiency (Friedman and Resnick, 2001). The employment of an explicit cost for creating a new account is simple.[8] Some forms of fixed payment in maintaining accounts are also often observed in real practices.[9] Thus, having multiple accounts is not free for a user. However, to our knowledge, the efficacy of having such an explicit cost in deterring opportunistic behavior remains as an empirical question due to the availability of data.

In economics, many transactions on internet can be explained by infinitely-repeated interactions as people's interactions continue without any definite end periods. However, neither theoretical nor experimental investigations of people's behavior in infinitely-repeated transactions are straightforward. This is because not only mutual defection but also mutual cooperation holds as an equilibrium under some conditions, regardless of which matching protocol, stranger or partner, is used, or whether individuals are informed of their partners' identities or their past decisions, as has been confirmed by many studies (e.g., Aoyagi and Fréchette 2009, Blonski *et al.* 2011, Camera and Casari 2009, Dal Bó 2005, Dal Bó and Fréchette 2011, Ellison 1994, Kandori 1992, Murnighan and Roth 1983, and Stahl 2013).[10] In the stranger matching protocol, individuals are randomly matched with each other from round to round. In the partner matching protocol, they are always matched with the same fixed partners.[11] Literature also suggests that institutions that make peoples' identities and behaviors observable to others may be effective in encouraging people to choose a mutual cooperation equilibrium (e.g., Camera and Casari 2009, Stahl 2013, Duffy *et al.* 2013, Takahashi 2010).[12] However, little is known about how people can endogenously form reputation by choosing to use their unique identities when there is an option to hide them (for example, by creating another account). In the

---

[8] Most online platforms such as Amazon ask potential users to go through a credit card authorization process for opening an account.

[9] For example, Amazon requires sellers to pay either (a) a fixed monthly fee or (b) a small fixed closing fee for each order instead of paying the monthly fee, in maintaining an account. See http://www.amazon.com/gp/help/customer/display.html/ref=hp_left_cn?ie=UTF8&nodeId=200306550 for the details. Other online marketplaces such as Sears and Rakuten also have similar policies on fixed fee payment.

[10] Mechanisms behind the evolution of cooperation have been also actively studied by biologists and political scientists (e.g., Axelrod 2006).

[11] Some studies show that mutual cooperation is more easily achieved under the partner matching protocol than under the stranger matching protocol (see Duffy and Ochs 2009).

[12] Similar effects of reputation mechanisms on raising cooperation or trust/trustworthiness have been widely found also in finitely-repeated setups (e.g., Bolton *et al.* 2004, Bolton *et al.* 2005, Gong and Yang 2010).

past infinitely-repeated experimental studies mentioned above, information on the identities and behaviors of other players are exogenously, not endogenously, given.[13]

This paper conducts an infinitely-repeated prisoner's dilemma game experiment, where the subjects themselves decide whether to use or hide their pre-assigned unique identification numbers (IDs) before each interaction. Hiding an ID corresponds to creating a new account unknown to others in real-life transactions. In order to simplify our design and also to reduce cognitive load required for subjects in the experiment, our design is set as (a) cooperation decisions of a subject are only recorded when the subject decides to use her pre-assigned ID and (b) when a subject does not use (i.e., hides) her pre-assigned ID, her decision does not get recorded and her partner is simply informed that he is interacting with an anonymous player unlike real-world transactions where her partner sees a different ID.[14] Following the convention of economic experiments, all terms are neutrally framed in the experiment.[15] In this paper, we address the following three questions. How often do people conceal their identities and attempt to trick their counterparts in their transactions? How are such use/hide decisions of their IDs affected by the presence of a reputation institution where people's decisions are open to others or by the presence of an explicit cost charged for hiding their IDs? Finally, if they use more than one platform (more than one infinitely-repeated game), what do they learn regarding the usage of IDs and their subsequent cooperation decisions? More specifically, do they learn to trick others by hiding their identities, or learn to behave pro-socially by showing their IDs?

Studying these questions is meaningful especially for two reasons, apart from the importance from empirical points of view mentioned above. First, our study has a valuable insight for theoretical research on the evolution of cooperation. Both theoretical and experimental researchers − including economists, political scientists and biologists, have actively

---

[13] Duffy *et al.* (2013) studied the effects of history information in sustaining cooperation. They let subjects play infinitely-repeated trust games. The subjects were provided their partners' past decisions for free or were given opportunities to purchase such information at a small cost. They find that regardless of whether the provision of reputation information was free or costly, trust and reciprocity were both enhanced, compared with a treatment with no history information available.

[14] This setup somewhat resembles the identifier commitment proposed by Friedman and Resnick (2001), in which each user chooses between a once-in-a-lifetime identifier (unique ID that can be obtained only once for each platform) and regular identifiers (which the users can obtain any time freely) in each period. They theoretically propose that no players use the regular identifiers in equilibrium as those who do not use once-in-a-lifetime identifiers are treated poorly by others. In our paper, as explained below, we further vary treatment by whether hiding IDs is cost-free or costly.

[15] For example, a stage game is not framed with terms in online transactions, but framed with neutral terms.

studied conditions under which cooperation evolves in infinitely-repeated situations. Exogenously given reputational information is one of the devices that have been shown to be helpful in encouraging cooperation in a community. However, as mentioned earlier, the possibility in which people conceal their identities and decisions (when given an option to do so) is, to our knowledge, understudied. If people cannot cooperate with each other in the environment where they can freely hide their IDs, our paper would stimulate theoretical research by providing a new important dimension in their work. Second, if people's motives to hide their identities and decisions are sufficiently strong and detrimental to the harmony in communities, then we may need some institutions that can effectively deter such opportunistic behavior. Our paper examines the efficacy of a costly-hiding institution (a scheme in which a subject incurs an explicit cost in case she attempts to hide her ID). This paper is aimed to contribute to the advancement of emerging research on institutions, including those that may encourage cooperation.

Our experiment consists of seven treatments, with three exogenous treatments and four endogenous treatments. Our design is a between-subjects design. The subjects in each treatment play five infinitely-repeated prisoner's dilemma games that have a random continuation rule in sequence. The design is based on the framework employed by Camera and Casari (2009). In each infinitely-repeated game, subjects are randomly assigned to groups of four and interact with a randomly selected member in their groups in every period. The matching protocol across the different infinitely-repeated games is a perfect stranger matching protocol. Each subject never interacts with a specific subject in more than one infinitely-repeated prisoner's dilemma game.

The three exogenous treatments serve as control treatments in this study. They differ by the quantity of information available to subjects. In one treatment, subjects are informed of neither their matched partners' IDs nor their past decisions. In the second treatment, subjects are informed of their matched partners' IDs in each interaction. Thus they can keep track of their partners' IDs and cooperation decisions. However, the subjects are not informed of the decisions made by the two unmatched others and their specific IDs in this treatment. In the third treatment, in addition to the information provided in the second treatment, subjects are also informed of the decisions made by the two unmatched group members along with their specific IDs.

In the four endogenous treatments, unlike the exogenous treatments, subjects themselves decide whether to show or hide their IDs for each interaction. When a subject decides to use (hide) her ID in a period, her matched partner is (is not) informed of her ID before making his cooperation decision in that period. In addition, the partner can refer to the subject's decision at any time after that period if she uses her ID. The four endogenous treatments differ by two dimensions. The first dimension is whether only a matched partner or all three group members learn the decisions of a group member who has revealed her ID. The second dimension is whether concealing an ID is free or costly. The cost charged for hiding is small enough that the stage game is still a prisoner's dilemma game. Thus, this part of our design is a 2×2 design.

Our data of the control treatments indicates that the subjects' average cooperation rates and the quantity of information are positively correlated. This result is consistent with the finding from previous studies in that reputation institutions making people's decisions open to others (e.g., rating systems) raise the cooperation rate or the degree of trust. However, our data of the endogenous treatments shows that having a free option to hide their IDs significantly undermines cooperation behavior. This negative effect is especially strong when the subjects' IDs and cooperation decisions can be observed only by their matched partners. A closer look at the data finds that substantial fractions of the subjects decide to conceal their IDs when given a choice to hide them. It also shows that those who hide their IDs are more likely to select defection in the stage games than those who show their IDs do so. An exploration of the trend of the subjects' decisions finds that the hiding rates (the fractions of cases where the subjects hide their IDs out of all decisions) decrease to some degree over the infinitely-repeated games. However, the overall hiding rates stay at a high level, even though their matched partners are more likely to choose defection when the subjects hide their IDs than when they show them.

By sharp contrast, when hiding IDs is *costly* with a small explicit fee automatically charged for hiding, almost all subjects decide to reveal their IDs. The average cooperation rates in the costly-hiding treatments are significantly higher than those in the free-hiding treatments. In addition, the former rates are statistically similar to the high cooperation rates of the corresponding exogenous treatments where their cooperation decisions are automatically open to the members.

Our study also shows that a subject's cooperation decisions with her IDs shown play a significant role when her future partners make their cooperation decisions as the partners' decisions are made based on the frequency of cooperation in her recorded history information. In addition, we find that a subject is less likely to choose to cooperate if she is faced with a subject whose ID she has never encountered before or if her partner has a history of frequent hiding. These suggest a possible mechanism where cooperation can be sustained by sufficient quantity of information as well as a potentially high efficacy of having a costly-hiding institution in online platforms.

The rest of the paper proceeds as follows: Section 2 describes our experimental design. Section 3 provides theoretical considerations and specific questions. Section 4 reports results, and Section 5 concludes.

2. Experimental Design

The design frame of our study is an infinitely-repeated prisoner's dilemma game. Our design consists of (a) three exogenous treatments and (b) four endogenous treatments (see Table 1). The former exogenous treatments serve as baseline treatments in this paper. These three treatments differ by quantity of information available to subjects when they make cooperation decisions. Two of the control treatments are from the treatments used in Camera and Casari (2009). We add one new treatment as the third baseline treatment. We then set up four new endogenous treatments.

Subjects play five infinitely-repeated prisoner's dilemma games in each treatment. We call an "infinitely-repeated prisoner's dilemma game" a super-game in this paper. Subjects are randomly assigned to a group of four at the beginning of each super-game. The list of four members' IDs is common knowledge in a group. Group assignment across the super-games follows the standard perfect stranger matching protocol. That is, once a super-game is over, subjects are randomly assigned to another group of four, and no one has the same subject as a group member in more than one super-game. Any information in a given super-game is not carried over to a future super-game. Within a super-game, each subject is randomly paired with another member in their group in every period. Since group size is four, the probability that a subject interacts with a specific group member in a period is 1/3. They do not interact with subjects outside their groups within a super-game. Neither their decisions nor their interaction outcomes in the past affect the matching process. The duration of each super-game is not pre-determined. Their interactions will be over with a probability 95%.[16] Thus, the expected length of each super-game is 20 (= 1/(1−.95)). The payoff matrix of the prisoner's dilemma game is shown in Figure 1. The seven treatments are varied by (a) whether or not disclosing assigned identification number involves subjects' decisions, (b) which member in a group learns the cooperation decisions of those who have decided to show their assigned IDs, and (c) whether a subject owes a fee if she hides her assigned ID. The fee in (c) corresponds to an upfront cost, such as an entrance fee or time required to be spent in order to create a new account, or an additional fee in maintaining another account (see footnote 9) in an online platform.

The "No Information" treatment, dubbed as the N treatment, is the "Private Information" treatment in Camera and Casari (2009). The identification numbers of subjects are not disclosed to their matched persons in groups in each period. Subjects just know that they are randomly matched with one of the three individuals in their groups when they make cooperation decisions. They learn their own pairs' interaction results (the cooperation decisions of their matched persons and their payoffs) at the end of each period without learning the partners' IDs. This corresponds to highly anonymous transactions between individuals in the real world (e.g., classified ads on newspapers or online).[17]

The "Reputation within Group" treatment, dubbed as the RG treatment, is the "Public Monitoring (non-anonymous)" treatment in Camera and Casari (2009). Each subject is informed of their matched counterpart's ID when making a cooperation decision in every period. At the same time, they are informed of all the past decisions made by each of the three other members in their group in a given super-game. At the end of each period, they learn the cooperation decisions of the other three members, including those who are not matched with them. Therefore, subjects in the RG treatment can build cooperative reputation within their groups. As Camera and Casari discussed in their paper, the mutual cooperation equilibrium is more easily achieved in the RG treatment than in the N treatment. This treatment corresponds to online platforms

[16] A integer between 1 and 100 is randomly drawn in each period. If it is less than 96 (greater than or equal to 96), subjects have (do not have) the next period. This setup can be interpreted that the discounting factor within a super-game is .95.
[17] Examples include Craigslist.

where users can use only one ID and there are post-transaction feedback mechanisms that allow users to see other users' decisions through ratings.

The last baseline treatment is called the "Reputation with Partner" treatment and dubbed as the RP treatment. In the RP treatment, as in the RG treatment, each subject is informed of their matched counterpart's ID in every period when making a cooperation decision. Subjects are also given the records of cooperation decisions by the past partners of theirs at the cooperation decision stage as in the RG treatment. However, subjects are not informed of any cooperation decisions by those who have not been matched with them, unlike the RG treatment. In other words, once a subject interacts with a member, the member's record will become available to the subject in the future periods. Therefore, each subject can build reputation with a specific member in their group only through her own decisions to that member. This treatment is set in order to examine how the use of single IDs (that are shown to their transaction partners) alone, without feedback systems, affects the evolution of cooperation norms in the market. In other words, the difference in the subjects' behavior between the RP and RG treatments can be attributed to the effects of feedback systems.

We design two sets of two endogenous treatments. In these four treatments, before engaging in a transaction, each subject can choose either to use her assigned ID, for example in order to build reputation, or to hide it so that her matched partner will not know whom he is interacting with. This endogenous aspect contrasts with the RP and RG treatments as the disclosure of the subjects' IDs and past decisions in the control treatments do not involve their decisions. The two sets of the main treatments are exactly the same except the presence of an explicit fee that a subject owes in a period if she decides to hide her assigned ID in the transaction.

In the "Reputation with Partner, Free Hiding" treatment, dubbed as the RP-F treatment, subjects decide whether to use their assigned IDs or to hide them without any costs in each period. If a subject *i* decides to use his assigned ID in a period, then his ID is informed to his matched person *j* before *j* makes her cooperation decision. In addition, the cooperation decision of subject *i* in that period will be shown on the computer screen of subject *j* in any future periods of the super-game as in the RP treatment. By contrast, if subject *i* decides not to use his assigned ID, his matched person *j* only knows that she will be playing with one of the three members in her group. Thus, the quantity of information that subject *j* has about the decisions of her matched person *i* in a given super-game is less than that in the RP treatment unless subject *i* always reveals his assigned ID when interacting with subject *j*. The "Reputation with Partner, Costly Hiding" treatment, dubbed as the RP-C treatment, is exactly the same as the RP-F treatment except that a subject has to pay a fee of two points when she decides to conceal her assigned identification number.

In the "Reputation within Group, Free Hiding" treatment (dubbed as the RG-F treatment) and the "Reputation within Group, Costly Hiding" treatment (dubbed as the RG-C treatment), subjects make decisions regarding the use of their assigned IDs at the onset of each period as in the RP-F and RP-C treatments. While a subject can disguise his ID without any fees in the RG-F treatment, a subject needs to pay a fee of two points each time she chooses not to use her assigned ID in the RG-C treatment. The consequence of a subject's using her assigned ID is the same as that in the RG treatment. Suppose that subject *i* decides to use her assigned ID in period *t* of a super-game. In this circumstance, the ID of subject *i* will be informed to her matched partner *j* in that period. In addition, after the interaction between subject *i* and partner *j* ends, all three members in her group will learn the cooperation decision of subject *i* in that period. Furthermore, her cooperation decision in period *t* will be always available to the three group members in any future rounds after period *t* in the super-game.

At the end of the fifth super-game, subjects are asked to answer open-ended questions regarding the reasoning of their cooperation decisions, along with questions on demographics such as gender.

3. Theoretical Considerations and Specific Questions

The standard economic theory does not provide a sharp prediction in our environment as we use an infinitely-repeated prisoner's dilemma game as a framework. Both mutual cooperation and mutual defection are equilibria even in the N treatment as demonstrated below:

Proposition (cited from page 986 in Camera and Casari 2009):

Let $\delta^* \in (0,1)$ *be the unique value of* δ *that satisfies*

$$\delta^2 \cdot (h - z) + \delta \cdot (2h - y - z) - 3(h - y) = 0.$$

If $\delta \geq \delta^*$*, then the efficient outcome can be sustained as a sequential equilibrium. In an economy with full cooperation, every player receives payoff* $y/(1-\delta)$.

Here, $h = 30$ (defection payoff when the counterpart is cooperating), $z = 10$ (mutual defection payoff), $y = 25$ (mutual cooperation payoff), $\delta = .95$ (continuation probability) and $\delta^* = .443$ in the N treatment. As discussed in Camera and Casari, mutual cooperation is more easily attained in the RG treatment than in the N treatment if the grim trigger strategy is used. The grim trigger strategy also predicts the threshold value of continuation probability δ^* in the RP treatment is the same as that in the N treatment. This is because each subject in the RP treatment learns only their matched partner's cooperation decisions.[18] Nevertheless, the availability of the information on partners' IDs may facilitate cooperation with specific players in the RP treatment, compared with the N treatment. In the RP treatment, each subject may attempt to build a cooperative partnership with specific partners as they are informed of the IDs of their randomly matched persons.[19] Therefore, we can expect positive correlation between the average cooperation rates and the amounts of information in our three exogenous treatments. These considerations lead to the first set of questions:

Question 1: Is the average cooperation rate higher in the RG treatment than in the RP treatment? Is the average cooperation rate higher in the RP treatment than in the N treatment?

In the endogenous treatments, the amounts of information available to subjects in a given period depend on the other subjects' decisions regarding whether or not to use their assigned IDs before that period. One potential reason that some subjects may not use their assigned IDs is to choose defection to their matched partners and at the same time attempt to avoid having records as defectors. Many past studies find that non-negligible fractions of subjects choose defection even if mutual cooperation can be sustained as an equilibrium in infinitely-repeated prisoner's dilemma games with stranger matching protocols (e.g., Dal Bó 2005, Camera and Casari 2009). In our context, some subjects may hide their identities and attempt to exploit their partners if

[18] With the grim trigger strategy, a subject chooses to defect from anyone as soon as one of the three members in her group chooses defection to the subject.

[19] For example, Kamei and Putterman (2014) find that some subjects seek to be matched with a specific person and build a trustful relationship with her in a finitely-repeated regrouping treatment although the only available information is subjects' IDs and their own interaction outcomes in their paper (see the LR-LG treatment and the LR-HG treatment in Kamei and Putterman).

they can do so for free. If this is the case, cooperation norms may not evolve in the RP-F and RG-F treatments.[20] On the other hand, subjects may not hide their identities even if it is cost-free if they consider building reputation to be worthwhile. Going through the "due-paying" periods to build trustful relationships with their partners while letting partners see their IDs results in a higher payoff (which can be sustained as an equilibrium), compared with obtaining a one-time increased payoff from defection (after which they may be trapped in a mutual defection equilibrium). Concealing an ID also implies that it takes more periods for a subject to build cooperative reputation. It might be more costly for a subject as having less history information may be seen suspicious by others and thus it may take time to repair the negative image. The presence of this extra implicit cost could motivate subjects to show their IDs. Given these considerations, we ask the following questions in our paper:

Question 2: (a) Is there a non-negligible fraction of subjects in the RP-F and RG-F treatments who hide their IDs in their interactions? (b) If the answer to question (a) is (is not) affirmative, is the cooperation rate in the RP-F treatment lower than (similar to) that in the RP treatment? (c) Is the cooperation rate in the RG-F treatment lower than (similar to) that in the RG treatment?

An explicit cost for disguising IDs is present in the RP-C and RG-C treatments. The small fee for hiding their true IDs may substantially prevent subjects from engaging in opportunistic behavior at least for two reasons. First, it may reduce the temptation to defect to some degree. A subject obtains 28 points instead of 30 points if (a) she chooses to pay a fee of 2 points, (b) she chooses defection and (c) her counterpart chooses to cooperate with her. Second, not building cooperative record using her assigned ID may serve as a strong signal that she may behave opportunistically in her future interactions in a given super-game. This signaling aspect could be stronger when hiding identities is costly, compared with when it is cost-free. If a subject decides to conceal her ID even though she has to pay to do it, her matched counterpart may contemplate her intention to hide her ID more deeply and may be more likely to choose defection than the subjects in the RP-F and RG-F treatments. Subjects in the RP-C and RG-C treatments may therefore show their IDs more frequently than those in the RP-F and RG-F treatments. If the small fee constrains act of concealing IDs and thus increases the quantity of records available to

[20] Although the structure of experiments are different, in finitely-repeated (as opposed to infinitely-repeated) trust games where the trust-trustworthy relationship is not an equilibrium, Wibral (forthcoming) recently finds that with an option of identity changes both the degree of trust and that of trustworthiness decrease significantly.

others due to these two reasons, subjects' cooperation rates may rise. Combined with the consequence on cooperation decisions, we ask the following third questions in our experiment:

Question 3: (a) Are subjects in the RP-C and RG-C treatments more likely to use their IDs than those in the RP-F and RG-F treatments? (b) As a result, is the average cooperation rate higher in the RP-C treatment than in the RP-F treatment? (c) Likewise, is the average cooperation rate higher in the RG-C treatment than in the RG-F treatment?

Lastly, we note that the subjects may learn to build good reputation by showing their IDs over the super-games. If this is the case, the extra implicit cost a subject owes in case of hiding IDs mentioned along with Question 2 alone may be sufficient enough to make the subjects select Y (cooperation). As a result, even if the answers to questions 2(a) and 3(a) are affirmative, the effects of the explicit fee (two points) on stopping some subjects from choosing defection may become less and less over the super-games. Having said that, there is also a chance that a non-negligible fraction of subjects keep hiding their assigned IDs if it is cost-free, similar to the experimental evidence that the average cooperation rate usually does not reach 100% when subjects play more than one infinitely-repeated prisoner's dilemma game with stranger matching protocols. In that case, cooperation norms in the RP-F and RG-F treatments may continue to be weaker than in the RP-C and RG-C treatments, respectively.

4. Results

14 sessions, with two sessions per treatment, were conducted at the University of Michigan in Ann Arbor from July to October, 2014.[21] No subjects participated in more than one session in the experiment. Subjects were asked to answer a couple of control questions to check their understanding of the experiment at the start of each session. No communication among the subjects was allowed after entering the laboratory and before the experiment ended. All instructions were neutrally framed. The average duration of the experiment (including the payment to subjects) was around two hours.

[21] All subjects were recruited using solicitation emails on the University of Michigan online recruiting system based on the Online Recruitment System for Economic Experiments (ORSEE). The number of female subjects was 134 (56.8% of the subjects). The average earnings (excluding the participation fee) were $21.80.

We will first compare the average cooperation rates across the treatments (Figure 2 and Table 2). First, the data of the three exogenous treatments reveals a significantly positive correlation between the quantity of information and average cooperation rates. The average cooperation rate is substantially higher when each subject's assigned IDs can be seen by their matched partner (the RP treatment), compared with when they are not (the N treatment). It is a big increase of 29.2 percentage points. This suggests that simply making people's IDs available to their matched interaction persons can be very effective in encouraging them to achieve mutual cooperation with specific partners. The average cooperation rate is even higher when the subjects' IDs and decisions are shown to all group members. This suggests reputation mechanisms (e.g., ratings) that make people's decisions open to the public are furthermore helpful in deterring their opportunistic behavior.

Result 1: Average Cooperation Rates in the Exogenous Treatments

The average cooperation rate is the highest in the RG treatment, followed by the RP treatment and the N treatment in this order.

Second, the presence of the ID-hiding option significantly alters the subjects' subsequent cooperation behavior if hiding IDs is not associated with explicit costs. The average cooperation rates are 31.9 percentage points and 18.6 percentage points lower in the RP-F and RG-F treatments than in the RP and RG treatments, respectively (Figure 2). These decreases are statistically significant (see coefficient estimates of variables (iii) and (v) of Table 2).[22] Consequently, the average cooperation rate in the RP-F treatment is statistically similar to that in the N treatment while the RG-F treatment still has significantly higher average cooperation rate than in the N treatment. However, the average cooperation rates jump with the scheme in which subjects have to pay two points each time they hide their IDs. The average cooperation rates in the RP-C and RG-C treatments record statistically similar levels to those in the RP and RG treatments, respectively (see Table 2 and Appendix Table A.1).

Result 2: Average Cooperation Rates in the Endogenous Treatments

[22] Standard errors are clustered by session number in the analysis as the subjects' decisions could be correlated within the sessions.

The average cooperation rates in the endogenous treatments are significantly lower than the corresponding exogenous treatments in which subjects' ID are open to others, if hiding IDs is cost-free. However, they are statistically similar if hiding IDs is associated with payment of fees.

An analysis of the trend of the average cooperation rates by treatment shows that the subjects learn to cooperate over the phases when history information is available (Appendix Figure A.1). The average cooperation rate in the N treatment begins at around 45% and gradually declines over the five phases. By sharp contrast, in the RG treatment, it is much higher from the very fast phase, around 65%, and reaches above 80% in the last three phases. When cooperation decisions are open only to matched partners (the RP treatment), the average cooperation rate is at the similar level to that in the N treatment in Phase 1, but it steadily increases over the phases. A regression analysis finds that the increase rates of average cooperation rates are statistically significant in the RP and RG treatments (Table 2 and Appendix Table A.1).

Letting subjects decide whether to show or hide IDs to their matched persons, we find that they learn to cooperate over the phases even if their cooperation decisions are revealed only to their matched partners (Appendix Figure A.1(b)). However, the level of average cooperation rates substantially differs by whether or not hiding is free. The average cooperation rate is much higher in any given phase when hiding is costly (the RP-C treatment) than when hiding is cost-free (the RP-F treatment). The very low level of cooperation in the RP-F treatment, around 40% even in the last phase, is somewhat surprising. By contrast, with cooperation decisions revealed also to two unmatched group members, the subjects cooperate highly from the onset and learn to cooperate over the phases even if hiding is cost-free (Appendix Figure A.1(c)). This shows some success of the reputation system in enhancing cooperation. But when hiding is costly, the subjects learn to cooperation more quickly. We see that the average cooperation rate in the RG-C treatment exceeds that in the RG-F treatment in each of the last three phases.

The difference in the cooperation rate by the presence of the explicit cost can be partly explained by the subjects' frequencies of using their assigned IDs. As shown in Figure 3, the subjects in the RP-F treatment hide their assigned IDs around 39.5% of the entire experiment. When cooperation choices along with their IDs are also shown to their two unmatched others, the subjects on average disguise their IDs at a slightly lower rate, around 30.0% of the entire periods. However, the decrease in the frequency of concealing IDs in the RG-F treatment is not statistically significant (Appendix Table A.2). By sharp contrast, in the treatments with the explicit-fee scheme, the average fractions of cases in which the subjects hide their IDs are only 3.3% and 2.9% in the RP-C and RG-C treatments, respectively. These two fractions (3.3% and 2.9%) are not significantly different.

A phase-by-phase examination of their ID disclosure decisions finds that the subjects in the RP-F treatment do learn to reveal their assigned IDs to some degree over the phases.[23] However, the average ID-hiding rate stays higher than 30% across the five phases in that treatment (Appendix Figure A.2). With cooperation choices along with their IDs revealed also to the two unpaired members, the subjects appear to learn to use their IDs to a large degree. But the ID-hiding rates in the RG-F treatment are still above 10% even in the last two phases. By contrast, with the presence of the fee payment for hiding, the subjects convey their assigned IDs to others from the very first phase, and the ID-hiding rates decrease further over the phases. The fractions of cases where the subjects hide their IDs in the last three phases are far below 5% in both the RP-C and RG-C treatments. The difference in the hiding rate is significant in each of the five phases between the RP-F (RG-F) treatment and the RP-C (RG-C) treatment (see Panel (1) of Appendix Table A.2).

Result 3: Frequencies of Showing IDs in the Endogenous Treatments

The subjects in the RP-C and RG-C treatments show their assigned IDs in their interactions significantly more often than those in the RP-F and RG-F treatments, respectively. The differences in the ID-hiding rate are significant in each phase.

A closer look at the subjects' cooperation choices by use of IDs shows that not using her assigned ID is a clear sign for a subject to defect in the on-going interaction (see Appendix Figure A.3). The average cooperation rate when the subjects hide their IDs ranges from 4.9% in the RP-F treatment to 12.5% in the RP-C and RG-C treatments. The opportunistic behavior of those who hide IDs stays at a similar level over the phases in each treatment. By contrast, the average cooperation rate when the subjects convey their assigned IDs in transactions is

[23] The average ID-hiding rate significantly decreases over the phases in each treatment. However, the level of the ID-hiding rate and the speed to learn to show IDs differ by treatment. See Panel (2) of Appendix Table A.2 for the details.

substantially higher in each treatment.[24] The average cooperation rate is the highest in the RG-F treatment (76.84%), followed by the RG-C treatment (76.76%), the RP-C treatment (63.9%) and the RP-F treatment (44.2%) in this order.

In order to examine the determinants of the subjects' cooperation decisions, we conduct a regression analysis separately for (a) the RP-F and RP-C treatments and (b) the RG-F and RG-C treatments. The dependent variable is a dummy variable that equals 1 if a subject *i* chooses Y (cooperate) in period *t*; 0 otherwise, for each dataset. As for independent variables, first, we include the "Use-ID dummy" variable (which equals 1 if subject *i* reveals her ID in period *t*; 0 if she hides it) as use/hide decisions are closely related to the subjects' subsequent cooperation choices as mentioned above. Second, we add the "Observe-ID dummy" variable (which equals 1 if the matched person of subject *i* reveals his ID in period *t*; 0 if he hides it) in order to examine the response of subject *i* to her period *t* partner's disclosure decision. Third, we further include an interaction term between the Observe-ID dummy and the "Observe-No-History dummy" variable (which equals 1 if the matched person has no recorded history available to subject *i* in period *t*; 0 otherwise) in order to see the response of subject *i* to her period *t* partner's past ID revelation decisions (variable (iii) in Table 3). Moreover, we include a variable summarizing the level of reputational information of subject *i*'s partner to supplement the third variable. This variable is added as subject *i* could condition her decision on the previous cooperation decisions that her current partner made with his ID shown. For dataset (a), we add the fraction of cases in which subject *i*'s unmasked interaction partner in period *t* has chosen Z (defection) *to subject i* using his assigned ID before period *t* (variable (iv) in Table 3).[25] For dataset (b), we add the fraction of cases in which subject *i*'s unmasked partner in period *t* has chosen Z *in their group* using his assigned ID before period *t* (variable (v) in Table 3).[26] Finally, in columns (4) and (6), we include the interaction terms between all variables and the Costly hiding dummy (which equals 1 for the RP-C and RG-C treatments; 0 otherwise), as the impact of each variable may differ by the

[24] See also Appendix Table A.3. This is also confirmed by a regression analysis as discussed with Table 3.
[25] Suppose that it is in period 12 and subject *i*'s current-period partner revealed his ID to subject *i* twice out of their three past encounters in this super-game. Also suppose that the partner chose Y once out of these two interactions where he showed his ID. In this circumstance, variable (iv) is calculated as .50 (= 1/2).
[26] Suppose that it is in period 12 and subject *i*'s current-period partner revealed his ID eight times out of the past 11 periods in this super-game. Also suppose that the partner chose Y five times out of these eight periods in which he showed his ID. In this circumstance, variable (v) is calculated as .625 (= 5/8).

presence of the explicit-cost scheme. In each specification, standard errors are clustered by session level as the subjects' behavior could be correlated with each other within the sessions.

As shown in Table 3, we confirm our earlier observation as to the subjects' intention to conceal their IDs. That is, those who convey their IDs decide to choose Y (cooperate) significantly more often than those who hide their IDs do in each endogenous treatment (see variable (i) of Table 3). This result is not much affected by the presence of the costly hiding institution (see variable (vii) of Table 3). In addition, the subjects respond differently to their current-period partners depending on the partners' decisions to use or hide IDs. The subjects are more likely to choose Y when they interact with those who have revealed their IDs. This result is not much affected by the experimental factor of the RP or the RG (see variable (ii) of Table 3).

Result 4: Effects of Using IDs on the Interaction Outcomes in a given Period

The subjects who show their IDs in period t are more likely to choose Y (cooperation) in that period than those who conceal their IDs do. The subjects are more likely to choose Y in period t if their current-period partners show their IDs in that period.

The regression analysis also finds that the cooperation decisions of the subjects in period *t* depend on their matched persons' reputational information accumulated before period *t* in a given super-game. First, subject *i* is reluctant to select cooperation when her current-period matched partner has no history information available for subject *i* even if he shows his ID to subject *i*. This effect is often significant (see variables (iii) and (ix) of Table 3). Second, the cooperation decisions of the subjects and their partners' frequencies of choosing Y with IDs shown in the past are positively correlated. Specifically, the higher variable (iv) in period *t*, the less likely subject *i* is to choose cooperation in that period in the RP-F and RP-C treatments. Likewise, the higher variable (v) (also variable (xi)) in period *t*, the less likely subject *i* is to choose cooperation in that period in the RG-F and RG-C treatments. These results, combined with Results 3 and 4, suggest that by having good recorded history information available to a matched partner, subject *i* is significantly more likely to have her matched partner select Y. Our findings also suggest that the low average cooperation rate when hiding is cost-free is not only due to the opportunistic behavior of masked subjects, but also due to the significantly smaller quantity of recorded history information, which causes the subjects to choose defection more.

Result 5: The Value of Reputation Accumulated before the Current Period

A subject is less likely to choose Y (cooperation) if her matched partner has no history information available to her. The higher the fraction of Y her matched partner has in his recorded history information, the more likely a subject is to choose Y to the partner.

In the RG-F and RG-C treatments, all subjects are informed of each of their group members' ID disclosure decisions in each period. We can therefore measure the quantity of a subject's history information in period *t* by using the hiding rate (the fraction of cases in which the subject did not use her assigned ID before period *t*). To supplement the analyses of the RG-F and RG-C treatments in Table 3, we perform a regression by using (a) the interaction term between the Observe-ID dummy and the hiding rate variable, instead of variable (iii) in Table 3, and (b) the same variables in Table 3 except the change as described in (a). As shown in Appendix Table A.4, we find that the new interaction term obtains a significantly negative coefficient. This result also supports Result 5 in that a smaller amount of recorded history information in a community leads to less cooperation in that community.[27]

5. Conclusions

This paper experimentally studies how people form reputation when they have an option to hide their IDs that is either for free or costly in an infinitely-repeated setting. First, our control treatments without such a hiding option confirm a positive correlation between the quantity of information and the average cooperation rates. The average cooperation rate is significantly higher when the subjects' decisions are revealed to their matched persons. In addition, the average cooperation rate is even higher when the subjects' decisions are revealed also to two unmatched others in their groups. Second, we find that having a free option to hide their IDs substantially undermines their cooperation behavior. Our subjects choose to hide their IDs around 30% to 40% of the time, and those who hide their IDs are more likely to choose defection than those who show their IDs. In addition, faced with a partner that hides her ID, a subject is reluctant to choose cooperation to him. This is in a sharp contrast with the subjects' decisions where hiding is costly. When subjects are charged a small fee for hiding, almost all subjects decide to use their assigned IDs. In addition, their average cooperation rates are statistically

[27] Results on the coefficient estimates on the Use-ID dummy, the Observe-ID dummy and the fraction of Z in his recorded history information are similar to those in Table 3, which suggests Results 3 and 4 are robust.

similar to those in the corresponding control treatments where their decisions are automatically conveyed to others. Third, our study suggests the importance of having a good reputation record if a subject wants her partner to cooperate with her. The larger amount of records a subject has without much hiding history and the higher cooperation rate her partner sees in her recorded history information, the more likely her partner is to decide to cooperate with her.

Opportunistic behavior is observed more frequently when hiding is cost-free. This is in line with what we see in our society in that some online service providers make users pay some kind of cost for entering their services (see Section 1). Many providers also impose some additional explicit cost, such as a time-consuming registration process with credit card authorization, to potential users for opening their accounts (e.g., the Amazon marketplace). Our results suggest that having such an explicit cost may be highly effective in encouraging users to behave in an honest and sincere manner.

Our results have a significant implication for recent studies on infinitely-repeated prisoner's dilemma games and on reputation mechanisms. While recent experiments have shown that reputation institutions can encourage people to choose a mutual cooperation equilibrium, the question of whether they can achieve mutual cooperation by their own by choosing to show their IDs remains, to our knowledge, as an open question. Our results in the RP-F and RG-F treatments appear to suggest a negative answer to the above question. Even though mutual cooperation was an equilibrium, a substantial fraction of subjects did not use their IDs in their interactions and selected defection. The subjects in the RG-F treatment, however, gradually learned to show their assigned IDs and to cooperate over the phases, but the average cooperation rate was still lower than the corresponding exogenous treatment. Nevertheless, our data does not completely reject the possibility of people's endogenous formation of cooperative norms. We find that almost all subjects decided to reveal their IDs to their partners when only a small cost was imposed for act of hiding, and a substantially high percentage of the subjects selected cooperation afterwards. Further investigation to check the robustness of our findings could be useful as recent studies show that subjects' behavior and strategy choices might be sensitive to payoff matrices and continuation probabilities in infinitely-repeated settings (e.g., Dal Bó and Fréchette, 2011, Dal Bó and Fréchette, 2014).[28]

Lastly, we note that one possible side effect of having an explicit cost is that it may discourage some potential users from joining the service as mentioned in Section 1. This side effect might be large enough to cancel out its positive effect of preventing opportunistic behavior by those who are already in the market. But, the presence of an explicit cost may discipline new entrants as well. Our study is definitely the initial step in regards to people's endogenous formation of reputation. Experimental investigation of the same question with opt-in or opt-out options or with alternative institutions could be useful and remain for future research.

Acknowledgement: I thank Yan Chen for her hospitality in letting me conduct the experiment at the University of Michigan. This project was supported by a grant-in-aid from the Telecommunications Advancement Foundation.

[28] Also see Duffy *et al.* (2009). In their paper, unlike other papers, mutual cooperation did not evolve in an infinitely-repeated prisoner's dilemma experiment with a random matching protocol even when history information was exogenously provided.

References

Aoyagi, Masaki and Guillaume Fréchette, 2009. "Collusion as Public Monitoring Becomes Noisy: Experimental Evidence." *Journal of Economic Theory* 144(3): 1135-1165.

Axelrod, Robert, 2006. "The Evolution of Cooperation: Revised Edition," *Basic Books*.

Blonski, Matthias, Peter Ockenfels and Giancarlo Spagnolo, 2011. "Equilibrium Selection in the Repeated Prisoner's Dilemma: Axiomatic Approach and Experimental Evidence." *American Economic Journal: Microeconomics* 3(3): 164-192.

Bolton, Gary and Katok, Elena and Axel Ockenfels, 2004. "How Effective are Online Reputation Mechanisms? An Experimental Investigation." *Management Science* 50(11). 1587-1602.

Bolton, Gary and Katok, Elena and Axel Ockenfels, 2005. "Cooperation among strangers with limited information about reputation." *Journal of Public Economics* 89: 1457–1468.

Camera, Gabriele and Marco Casari, 2009. "Cooperation among Strangers under the Shadow of the Future." *American Economic Review* 99(3): 979-1005.

Chua, Cecil Huang and Jonathan Wareham, 2002. "Self-Regulation for Online Auctions: An Analysis," *International Conference on Information Systems Proceedings*, paper 11.

Dal Bó, Pedro, 2005. "Cooperation under the Shadow of the Future: experimental evidence from infinitely repeated games." *American Economic Review* 95(5): 1591-1604.

Dal Bó, Pedro and Guillaume Frechette, 2011. "The Evolution of Cooperation in Infinitely Repeated Games: Experimental Evidence." *American Economic Review* 101(1): 411-429.

Dal Bó, Pedro and Guillaume Frechette, 2013. "Strategy Choice In the Infinitely Repeated Prisoners' Dilemma." working paper.

Dellarocas, Chrysanthos, 2003. "The Digitization of Word of Mouth: Promise and Challenges of Online Feedback Mechanisms." *Management Science* 49(10): 1407-1424.

Duffy, John, Hunan Xie and Yong-Ju Lee, 2013. "Social norms, information, trust among strangers: theory and evidence." *Economic Theory* 52: 669-708.

Duffy, John and Jack Ochs, 2009. "Cooperative behavior and the frequency of social interaction." *Games and Economic Behavior* 66(2): 785-812.

Ellison, Glenn, 1994. "Cooperation in the Prisoner's Dilemma with Anonymous Random Matching." *Review of Economic Studies* 61: 567–588.

Fischbacher, Urs, 2007. "z-Tree: Zurich Toolbox for Ready-made Economic Experiments." *Experimental Economics* 10(2): 171-178.

Friedman, Eric and Paul Resnick, 2001. "The Social Cost of Cheap Pseudonyms." *Journal of Economics & Management Strategy* 10(2): 173-199.

Gong, Binglin and Chun-Lei Yang, 2010, "Reputation and Cooperation: an Experiment on Prisoner's Dilemma with Second-order Information, unpublished manuscript.

Greiner, Ben, 2003. "An Online Recruitment System for Economic Experiments." In: Kurt Kremer, Volker Macho (Eds.): Forschung und wissenschaftliches Rechnen. GWDG Bericht 63, Goettingen : Ges. fuer Wiss. Datenverarbeitung, 79-93.

Internet Crime Compliant Center, 2013. "Internet Crime Report," United States Federal Bureau of Investigation.

Kamei, Kenju and Louis Putterman, 2014. "Play it Again: Partner Choice, Reputation Building and Learning in Restarting, Finitely-Repeated Dilemma Games." Department of Economics Working Paper 2013-8, Brown University.

Kandori, Michihiro, 1992. "Social Norms and Community Enforcement." *Review of Economic Studies* 59(1): 63-80.

Kwan, Michael, Richard Overill, Kam-Pui Chow, Jantje Silomon, Hayson Tse, Frank Law, Pierre Lai, 2010. "Evaluation of Evidence in Internet Auction Fraud Investigations." *Advances in Digital Forensics VI: IFIP Advances in Information and Communication Technology* 337: 121-132.

Murnighan, Keith and Alvin Roth, 1983. "Expecting Continued Play in Prisoner's Dilemma Games." *Journal of Conflict Resolution* 27(2): 279-300.

Pinker, Edieal, Abraham Seidmann and Yaniv Vakrat, 2003. "Managing Online Auctions: Current Business and Research Issues." *Management Science* 49(11): 1457-1484.

Stahl, Dale, 2013. "An Experimental Test of the Efficacy of a Simple Reputation Mechanism to Solve Social Dilemmas." *Journal of Economic Behavior & Organization* 94: 116-124.

Takahashi, Satoru, 2010. "Community Enforcement when Players Observe Partners' Past Play." *Journal of Economic Theory* 145: 42-62.

Trevathan, Jarrod and Wayne Read, 2006. "Undesirable and Fraudulent Behaviour in Online Auctions." 2006 *SECRYPT* 450-458.

Wibral, Matthias, forthcoming, "Identity Changes and the Efficiency of Reputation Systems." *Experimental Economics*.

Figure 1: Payoff Matrix of the Stage Game

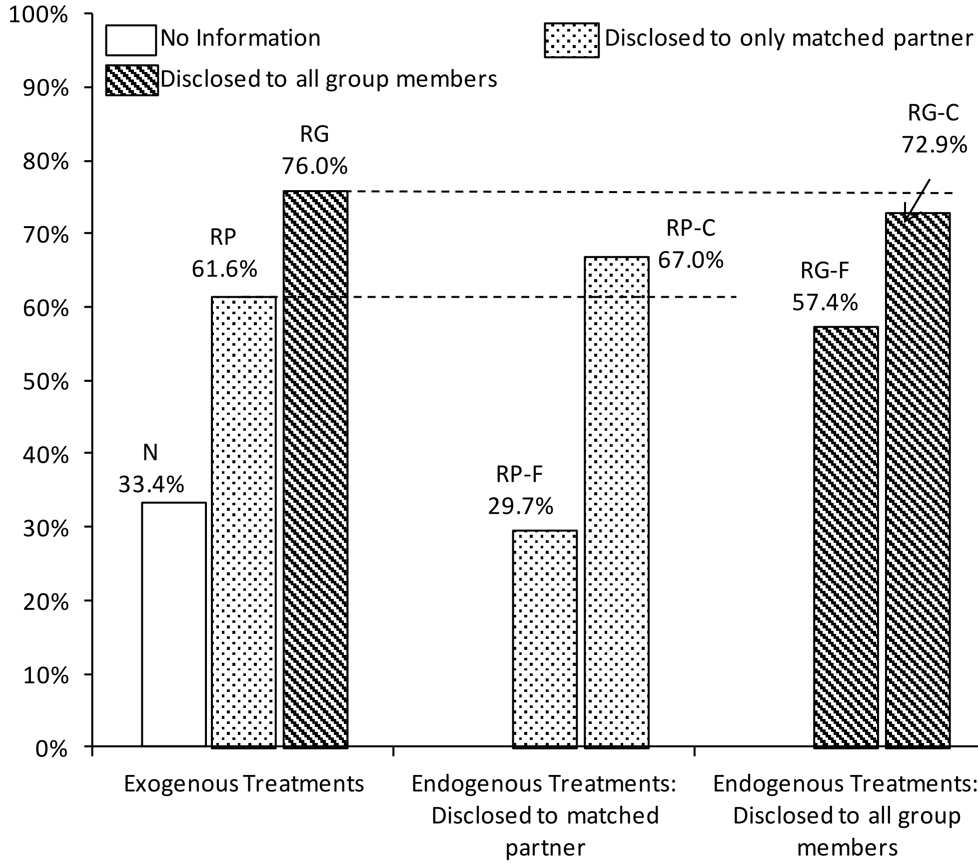
subject 1 \ subject 2	Y (cooperate)	Z (defect)
Y (cooperate)	25, 25	5, 30
Z (defect)	30, 5	10, 10

Note: This payoff matrix is from Camera and Casari (2009).

Table 1: Summary of Treatments

Treatment Name	Subject Identification Numbers	Explicit Cost of Hiding ID	Transaction Results in Period *t*
I. Exogenous Treatments:			
N (No Information)	Not Available	n.a.	Not Available
RP (Reputation with Partner)	Disclosed to matched partner	n.a.	Disclosed to period *t* matched partner
RG (Reputation within Group)	Disclosed to all group members	n.a.	Disclosed to all group members
II. Endogenous Treatments:			
RP-F (Reputation with Partner, Free Hiding)	Disclosed to matched partner if a subject chooses to use her ID	0 points	Disclosed to period *t* matched partner if she uses her assigned ID in period *t*
RG-F (Reputation within Group, Free Hiding)	Disclosed to all group members if a subject chooses to use her ID	0 points	Disclosed to all group members if she uses her assigned ID in period *t*
RP-C (Reputation with Partner, Costly Hiding)	Disclosed to matched partner if a subject chooses to use her ID	2 points	Disclosed to period *t* matched partner if she uses her assigned ID in period *t*
RG-C (Reputation within Group, Costly Hiding)	Disclosed to all group members if a subject chooses to use her ID	2 points	Disclosed to all group members if she uses her assigned ID in period *t*

Figure 2: Average Cooperation Rate by Treatment



Notes: In order to calculate each bar, we first calculated average cooperation rates by subject. We then averaged the average cooperation rates by treatment.

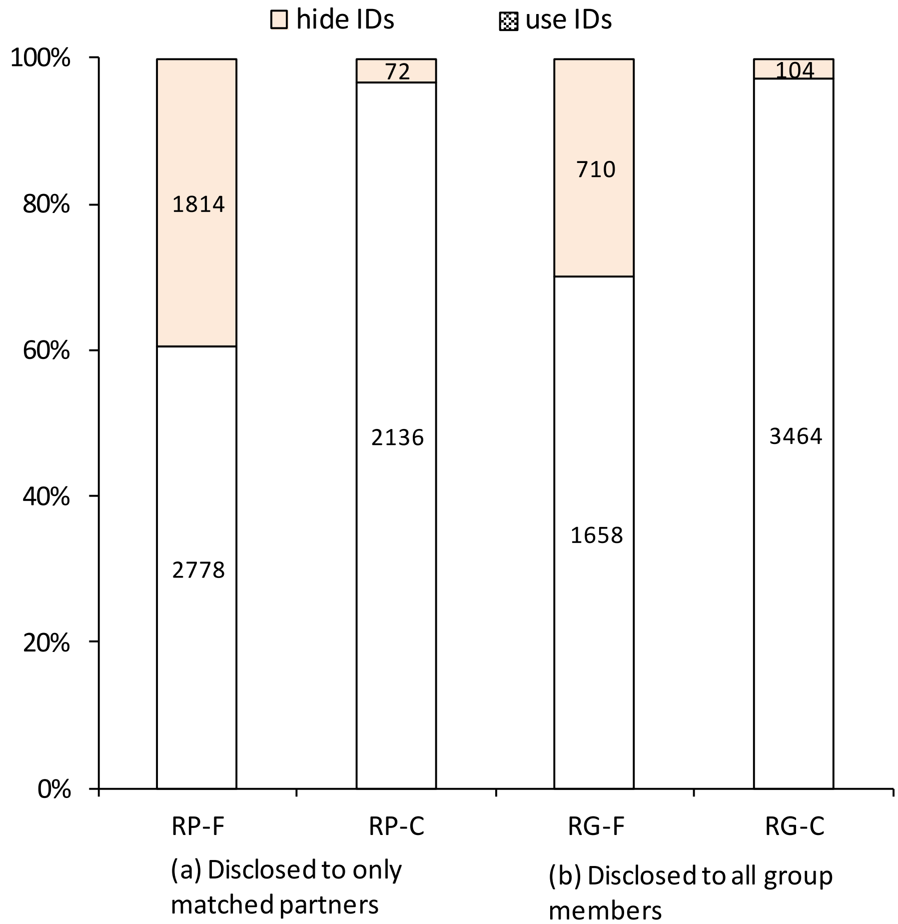
Table 2: The Effects of Each Treatment Factor on the Average Cooperation Rate

Dependent Variable: A dummy variable that equals 1 (0) if a subject chooses to cooperate (defect) with her matched partner

Independent Variable	(1)	(2)
(i) Disclosed-to-matched-partner dummy {= 1 for the RP, RP-F and RP-C treatments; 0 otherwise}	.28** (.12)	-.11 (.14)
(ii) Disclosed-to-all-group-members dummy {= 1 for the RG, RG-F and RG-C treatments; 0 otherwise}	.43*** (.12)	.14 (.11)
(iii) Variable (i) × Endo. dummy {= 1 for the RP-F and RP-C treatments; 0 otherwise}	-.32*** (.056)	-.22** (.11)
(iv) Variable (i) × Endo. dummy × Costly hiding dummy {= 1 for the RP-C treatments; 0 otherwise}	.37*** (.070)	.26** (.10)
(v) Variable (ii) × Endo. dummy {= 1 for the RG-F and RG-C treatments; 0 otherwise}	-.19*** (.16)	-.30*** (.11)
(vi) Variable (ii) × Endo. dummy × Costly hiding dummy {= 1 for the RG-C treatments; 0 otherwise}	.16** (.076)	-.096 (.12)
Phase Number {= 1, 2, 3, 4, 5}	----	-.034*** (.0033)
Variable (i) × Phase Number	----	.12*** (.018)
Variable (ii) × Phase Number	----	.11*** (.021)
Variable (iii) × Phase Number	----	-.035* (.018)
Variable (iv) × Phase Number	----	.032* (.020)
Variable (v) × Phase Number	----	.016 (.026)
Variable (vi) × Phase Number	----	.065*** (.017)
Constant	.34*** (.12)	.46*** (.11)
# of Observations	21756	21756
R-Squared	.1296	.1640

Notes: Random effects linear regressions with robust standard errors clustered by session id. The reference group is cooperation decisions in the N treatment. The Endo. dummy equals 1 for the RP-F, RP-C, RG-F and RG-C treatments; 0 otherwise. The Costly hiding dummy equals 1 for the RP-C and RG-C treatments; 0 otherwise. See Appendix Table A.1 for tests comparing the coefficient estimates across independent variables. *, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Figure 3: Percentages of ID Usages in the Endogenous Treatments



Notes: The numbers in each bar indicate the number of use/hide decisions of their IDs in each treatment. See Appendix Table A.2 for test results comparing the average fractions of the cases where the subjects use their assigned IDs between the RP-F and RP-C treatments, and between the RG-F and RG-C treatments. See Appendix Table A.2 also for the fractions of using their assigned IDs by phase.

Table 3: The Determinants of Cooperation Decisions in the Endogenous Treatments

Dependent Variable: A dummy variable that equals 1 (0) if subject *i* chooses Y (Z) to her matched partner in period *t*

Independent Variable	Exogenous treatments RP (1)	RG (2)	The RP-F and RP-C treatments (3)	(4)	The RG-F and RG-C treatments (5)	(6)
(i) Use-ID dummy {= 1 if subject *i* used her assigned ID; 0 otherwise}	----	----	.12** (.024)	.12** (.031)	.36*** (.047)	.44*** (.018)
(ii) Observe-ID dummy {= 1 if the matched partner of subject *i* revealed his assigned ID in period *t*; 0 otherwise}	----	----	.58*** (.013)	.59*** (.016)	.53*** (.012)	.47*** (.019)
(iii) Variable (ii) × Observe-No-History dummy {= 1 if subject *i* has no history information of her matched partner in period *t*; 0 otherwise}[#1]	-.17 (.091)	-.13**	-.23** (.066)	-.31* (.11)	-.13** (.033)	-.074 (.067)
(iv) Variable (ii) × (1 − Observe-No-History dummy) × The fraction of cases in which the matched partner of subject *i* has chosen Z (defection) to subject *i* using his ID before period *t*	-.67* (.065)	----	-.62*** (.029)	-.62*** (.030)	----	----
(v) Variable (ii) × (1 − Observe-No-History dummy) × The fraction of cases in which the matched partner of subject *i* has chosen Z (defection) using his ID before period *t*	----	-.65* (.086)	----	----	-.59*** (.076)	-.35*** (.059)
(vi) Phase variable {= 1, 2, 3, 4, 5}	.041* (.0054)	.019 (.0042)	.020 (.0091)	.013** (.0026)	.027 (.012)	-.00042 (.0017)
(vii) Variable (i) × Costly hiding dummy[#2]	----	----	----	.057 (.031)	----	-.19 (.087)
(viii) Variable (ii) × Costly hiding dummy	----	----	----	-.040 (.047)	----	.014 (.028)
(ix) Variable (iii) × Costly hiding dummy	----	----	----	.17 (.11)	----	-.065 (.068)
(x) Variable (iv) × Costly hiding dummy	----	----	----	-.029 (.050)	----	----
(xi) Variable (v) × Costly hiding dummy	----	----	----	----	----	-.30** (.070)
(xii) Variable (vi) × Costly hiding dummy	----	----	----	.021* (.0071)	----	.048** (.013)
Constant	.72** (.018)	.88*** (.0078)	.021 (.030)	.012 (.019)	-.066** (.017)	.0017 (.030)
# of Observations	3264	2656	6800	6800	5936	5936
R-Squared	.4551	.2957	.4814	.4905	.4724	.4878

Notes: Fixed effects linear regressions with robust standard errors clustered by session id. [#1] The Observe-No-History dummy variable equals 0 in period *t* if the partner at least once revealed his ID to subject *i* before period *t* in the RP-F and RP-C treatments; and if the partner at least once revealed his ID to some member before period *t* in the RG-F and RG-C treatments; 1 otherwise. This variable equals 1 for any periods greater than 1 within phases in the RG treatment. [#2] The Costly hiding dummy equals 1 for the RP-C and RG-C treatments; 0 otherwise. *, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Not for Publication

Supplementary Online Appendix for Kamei, 2015,

"Endogenous Reputation Formation: Cooperation and Identity

under the Shadow of the Future"

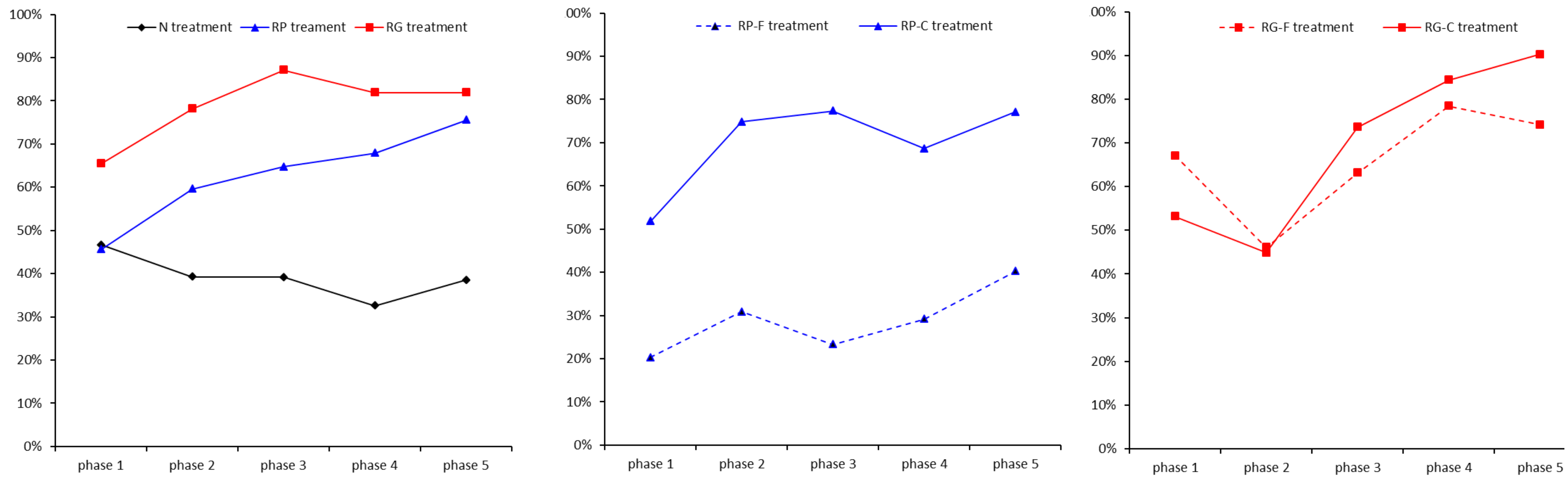
Kenju Kamei

Department of Economics and Finance, Durham University, Durham, UK.

Table of Contents

Appendix A: Additional Tables and Figures

Figure A.1: Phase-by-Phase Average Cooperation Rates by Treatment



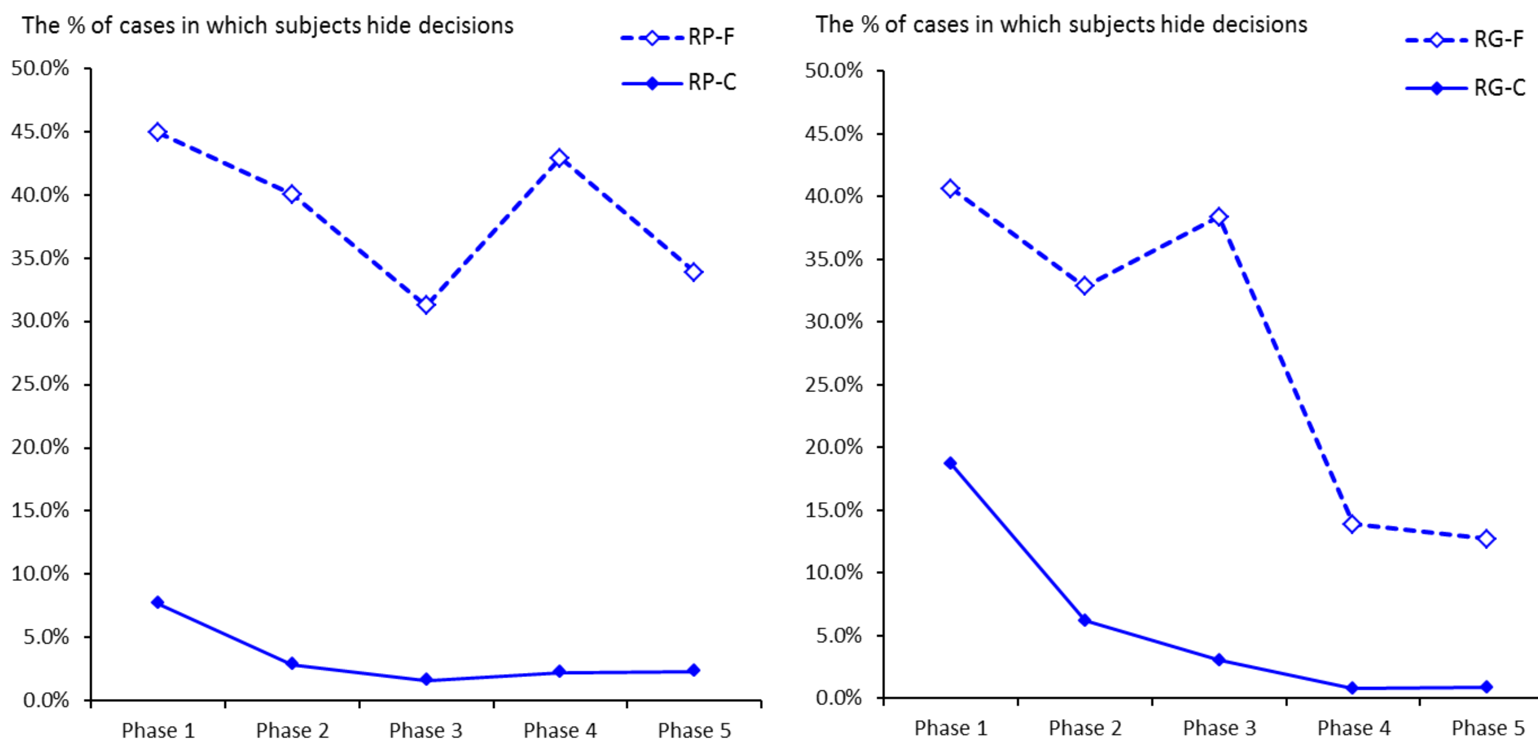
(a) Exogenous Treatments

(b) RP-F treatment versus RP-C treatment

(c) RG-F treatment versus RG-C treatment

Notes: In order to calculate the average cooperation rate (each point in the figures) in a given phase, we first calculated each subject's average cooperation rate across all periods in that phase. We then averaged them across all subjects in that treatment. In other words, it is, $\frac{1}{N}\sum_i\left[\frac{1}{T_P}\sum_t c_{ti}^p\right]$, where $c_{ti}^p = 1$ (0) if subject *i* selected Y (Z) in period *t* of phase *p*, *N* is the number of subjects in a given treatment, *p* is the phase number, T_P is the number of realized periods in phase *p*, $t \in \{1, 2, \dots, T_P\}$. As for the statistical tests of the dynamics of the average cooperation rates, see Table 2 in the manuscript.

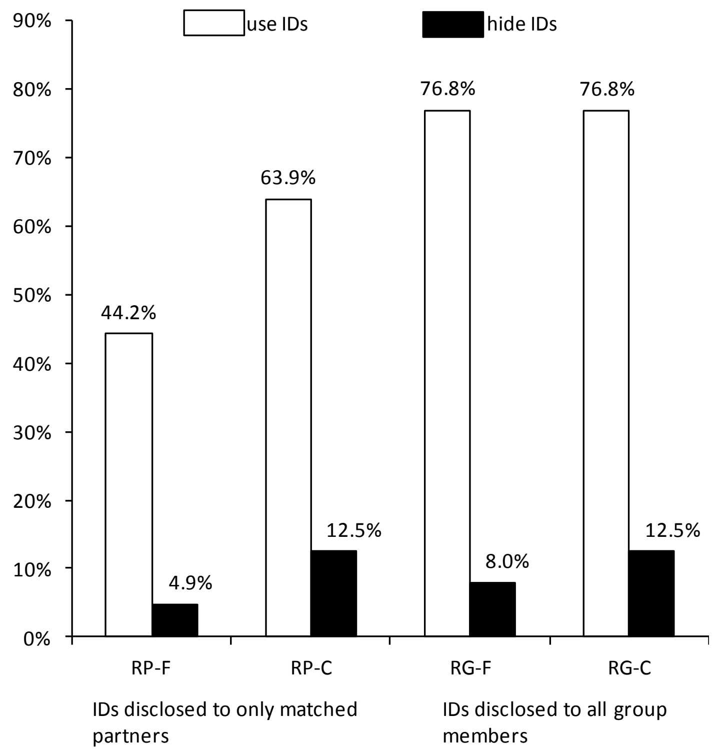
Figure A.2: The Phase-by-Phase Percentages of Cases in which Subjects Hide their IDs by Treatment (supplementing Figure 3 of the manuscript)



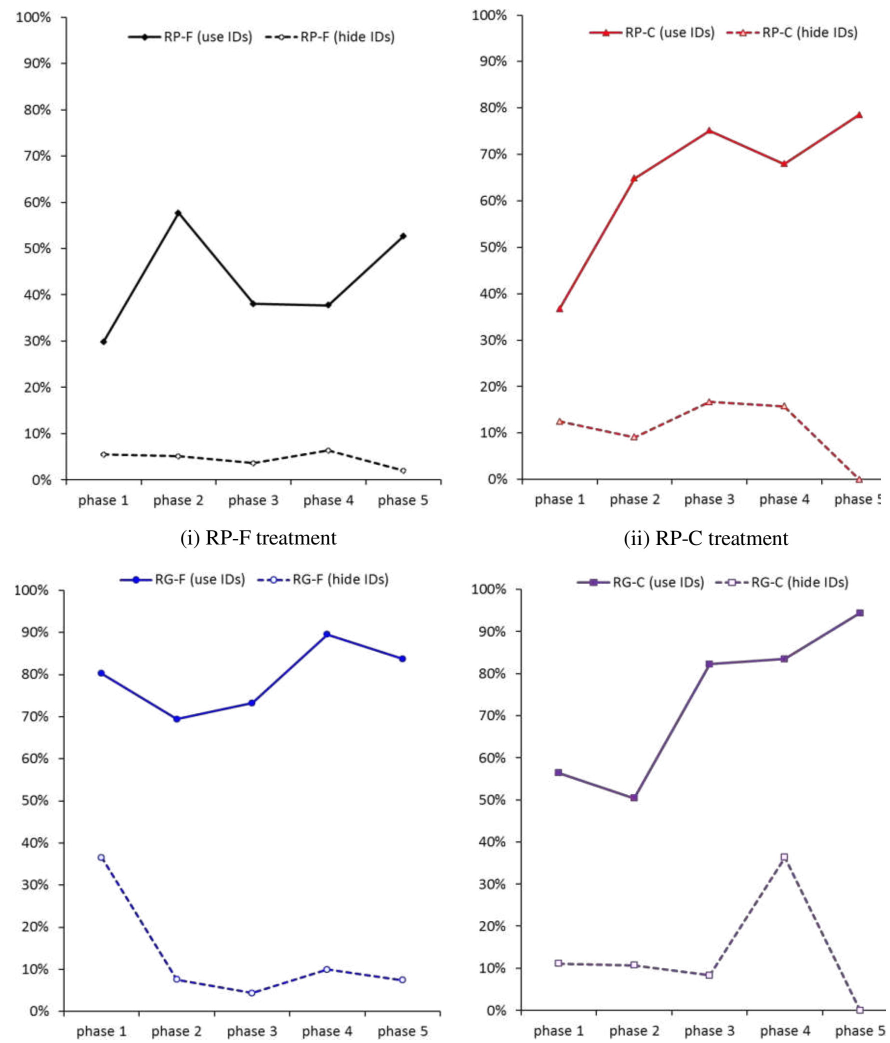
(a) IDs disclosed to only marched persons (b) IDs disclosed to all group members

Notes: The percentages of subjects' hiding decisions are calculated by: (the total number of subjects' hiding decisions in a given phase)/(the total number of decisions in a given phase)·100. A phase-by-phase comparison of the percentages between the endogenous treatments can be found in Appendix Table A.2.

Figure A.3: Average Cooperation Rates by the Use of IDs



(a) Average cooperation rates across all phases[1]



(i) RP-F treatment

(ii) RP-C treatment

(i) RG-F treatment

(ii) RG-C treatment

(b) Phase-by-phase average cooperation rates[1]

Note: [1] Each number in a given category was calculated as: the number of the subjects' choices of Y (cooperation) divided by the total number of decisions.

Table A.1: Test Results concerning Table 2 in the Manuscript

(A) Chi-Squared Tests for the coefficient estimates in column (1)

- H_0: Variable (i) = Variable (ii)
  Chi-squared = 11.01
  p-value (two-sided) = .0009***

  Result: The average cooperation rate in the RG treatment is significantly higher than that in the RP treatment.

- H_0: Variable (i) + Variable (iii) = 0
  Chi-squared = .09
  p-value (two-sided) = .7615

  Result: The average cooperation rate in the RP-F treatment is statistically similar to that in the N treatment.

- H_0: Variable (ii) + Variable (v) = 0
  Chi-squared = 3.85
  p-value (two-sided) = .0496**

  Result: The average cooperation rate in the RG-F treatment is significantly higher than that in the N treatment.

- H_0: Variable (iii) + Variable (iv) = 0
  Chi-squared = .85
  p-value (two-sided) = .3574

  Result: The average cooperation rate in the RP-C treatment is statistically similar to that in the RP treatment.

- H_0: Variable (v) + Variable (vi) = 0
  Chi-squared = .17
  p-value (two-sided) = .6820

  Result: The average cooperation rate in the RG-C treatment is statistically similar to that in the RG treatment.

(B) Chi-Squared Tests for the coefficient estimates in column (2)

- H_0: Variable (i) = Variable (ii)
  Chi-squared = 7.15
  p-value (two-sided) = .0075***

- H_0: Variable (i) + Variable (iii) = 0
  Chi-squared = 6.89
  p-value (two-sided) = .0087***

- H_0: Variable (ii) + Variable (v) = 0
  Chi-squared = 1.15
  p-value (two-sided) = .2839

- H_0: Variable (iii) + Variable (iv) = 0
  Chi-squared = .13
  p-value (two-sided) = .7164

- H_0: Variable (v) + Variable (vi) = 0
  Chi-squared = 30.39
  p-value (two-sided) = .0000***

- H_0: The Phase Number variable + the Variable (i) × Phase Number variable = 0
  Chi-squared = 23.10
  p-value (two-sided) = .0000***

Result: The average cooperation rate significantly increases over the phases in the RP treatment.

- H_0: The Phase Number variable + the Variable (ii) × Phase Number variable = 0
  Chi-squared = 12.99
  p-value (two-sided) = .0003***

Result: The average cooperation rate significantly increases over the phases in the RG treatment.

Table A.2: Additional Analyses on the Subjects' Decisions about Whether to Use or Hide Their IDs (supplementing Figure 3 of the manuscript and Figure A.2 of the online Appendix)

(1) Testing the Differences in the Subjects' Use/Hide Decisions of their Assigned IDs without versus with the Explicit Cost

Dependent Variable: A dummy variable that equals 1 (0) if a subject chooses to (not to) use her ID

Independent Variable	All phases (1)	Phase 1 (2)	Phase 2 (3)	Phase 3 (4)	Phase 4 (5)	Phase 5 (5)
(i) The RG-F dummy {= 1 for the RG-F treatment; 0 otherwise}	.092 (.087)	.13 (.11)	.057 (.12)	.10 (.16)	.20 (.12)	.13 (.11)
(ii) The RP-C dummy {= 1 for the RP-C treatment; 0 otherwise}	.35*** (.081)	.47*** (.097)	.40*** (.11)	.35*** (.10)	.32*** (.12)	.24** (.12)
(iii) The RG-C dummy {= 1 for the RG-C treatment; 0 otherwise}	.35*** (.081)	.35*** (.10)	.36*** (.11)	.32*** (.11)	.33*** (.12)	.25** (.12)
Constant	.62*** (.080)	.47*** (.095)	.56*** (.10)	.64*** (.10)	.66*** (.12)	.74*** (.12)
# of Observations	12736	1280	2576	2512	4016	2352
Wald Chi-squared	75.88	54.74	45.91	16.55	195.62	119.63
Prob > Wald Chi-squared	.0000	.0000	.0000	.0009	.0000	.0000
R-Squared	.1703	.1352	.1500	.1506	.2717	.1255
Chi-squared test results						
H_0: (i) = (iii)						
Chi-squared	51.85	10.24	19.31	3.04	187.21	58.44
Prob > Chi-squared	.0000***	.0014***	.0000***	.0813*	.0000***	.0000***
H_0: (ii) = (iii)						
Chi-squared	.29	8.91	1.68	1.37	1.55	.14
Prob > Chi-squared	.5931	.0028***	.1950	.2410	.2132	.7105

Notes: Random effects linear regressions with robust standard errors clustered by session id. *, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

(2) The Trends of the Subjects' Decisions to Use their Assigned IDs over the Phases

Dependent Variable: A dummy that equals 1 (0) if a subject chooses to (not to) use her ID

Independent Variable	(1)	(2)
(i) The RG-F dummy {= 1 for the RG-F treatment; 0 otherwise}	.10 (.11)	.027 (.15)
(ii) The RP-C dummy {= 1 for the RP-C treatment; 0 otherwise}	.35*** (.11)	.53*** (.090)
(iii) The RG-C dummy {= 1 for the RG-C treatment; 0 otherwise}	.34*** (.11)	.47*** (.10)
(iv) Phase Number {= 1, 2, 3, 4, 5}	.052*** (.013)	.066*** (.0073)
(v) Variable (i) × Phase Number	-----	.026 (.022)
(vi) Variable (ii) × Phase Number	-----	-.053*** (.0074)
(vii) Variable (iii) × Phase Number	-----	-.039*** (.014)
Constant	.45*** (.10)	.40*** (.090)
# of Observations	12736	12736
R-Squared	.1713	.1708
Chi-squared test results		
H_0: (i) = (iii)		
Chi-squared	24.90	11.53***
Prob > Chi-squared	.0000***	.0007
H_0: (ii) = (iii)		
Chi-squared	.49	1.15
Prob > Chi-squared	.4850	.2826
H_0: (iv) + (v) = 0		
Chi-squared	-----	19.58
Prob > Chi-squared	-----	.0000***
H_0: (iv) + (vi) = 0		
Chi-squared	-----	117.75
Prob > Chi-squared	-----	.0000***
H_0: (iv) + (vii) = 0		
Chi-squared	-----	5.18
Prob > Chi-squared	-----	.0228***

Notes: Random effects linear regressions with robust standard errors clustered by session id. *, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Table A.3: Non-parametric Tests for Equality of the Average Cooperation Rates between Those Who Use their Assigned IDs versus Those Who Hide their Assigned IDs (supplementing Appendix Figure A.3 Panel (a))

Procedure to compare average cooperation rates between (a) the cases in which subjects use their assigned IDs and (b) the cases in which subjects hide them:

Step 1: For each subject, compute (i) the average cooperation rate when she uses her assigned ID and (ii) the average cooperation rate when she hides her assigned ID.

Step 2: Perform individual-level Wilcoxon Signed Ranks tests.

Results are summarized as below:

	The RP-F treatment	The RP-C treatment	The RG-F treatment	The RG-C treatment
p-value (two-sided)	.0010*** (25)	.0186** (14)	.0000*** (24)	.0064*** (13)

Notes: The observations of subjects who hid their IDs in all periods and of those who showed their IDs in all periods are excluded in the analyses. The numbers in parenthesis are the numbers of subjects used for the tests. *, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

In the manuscript, we also performed a regression analysis by (1) including the Use-ID dummy variable and (2) using the data of all subjects. The results are similar to the non-parametric test results reported here. See Table 3 of the manuscript for the details.

Table A.4: The Determinants of Cooperation Decisions in the RG-F and RG-C Treatments (supplementing Table 3 of the manuscript)

Dependent Variable: A dummy variable that equals 1 (0) if subject i chooses Y (Z) to her matched partner in period t

Independent Variable	Period within phase = 1 (1)	Period within phase > 1 (2)	(3)
(i) Use-ID dummy {= 1 if subject *i* used her assigned ID in period *t*; 0 otherwise}	.47** (.15)	.34*** (.042)	.41*** (.023)
(ii) Observe-ID dummy {= 1 if the matched partner of subject *i* revealed his assigned ID in period *t*; 0 otherwise}	.14** (.042)	.58*** (.016)	.53*** (.030)
(iii) Variable (ii) × The hiding rate of the matched partner of subject *i* (fraction of cases in which the partner did not use his assigned ID before period *t*)	----	-.20** (.041)	-.27*** (.015)
(iv) Variable (ii) × (1 − Observe-No-History dummy) × The fraction of cases in which the matched partner of subject *i* has chosen Z (defection) using his ID before period *t* [#1]	----	-.57*** (.089)	-.28** (.073)
(v) Phase variable {= 1, 2, 3, 4, 5}	.032 (.035)	.023 (.012)	-.0076* (.0032)
(vi) Variable (i) × Costly hiding dummy[#2]	----	----	-.17 (.086)
(vii) Variable (ii) × Costly hiding dummy	----	----	.0034 (.035)
(viii) Variable (iii) × Costly hiding dummy	----	----	.019 (.045)
(ix) Variable (iv) × Costly hiding dummy	----	----	-.36** (.083)
(x) Variable (v) × Costly hiding dummy	----	----	.049** (.013)
Constant	.12 (.077)	-.078** (.020)	-.0043 (.030)
# of Observations	320	5616	5616
R-Squared	.2410	.4869	.5073

Notes: Fixed effects linear regressions with robust standard errors clustered by session id. [#1] The Observe-No-History dummy variable equals 0 in period t if the partner of subject i revealed his ID to subject i at least once before period t in the RP-F and RP-C treatments; and if the partner revealed his ID to some member at least once before period t in the RG-F and RG-C treatments; 1 otherwise. This variable equals 1 for any periods greater than 1 within phases in the RG treatment. [#2] The Costly hiding dummy equals 1 for the RP-C and RG-C treatments; 0 otherwise. *, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.