Another experimental look at reciprocal behavior: 
Indirect reciprocity*

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Abstract

We run a laboratory experiment which highlights a new social motivation we call “indirect reciprocity” through a three-player dictator-ultimatum game. Player 2 has the opportunity to reward or punish indirectly player 1 by inciting player 3 to accept or reject the division. Player 2’s offer is interpreted as a signal to player 3 about fairness or unfairness of player 1’s offer. To underline such motivation, we implement four treatments of information in which we make variable player 2’s available information, prior experience or player 3’s information. Results show that a large proportion of subjects - between 28% and 73.68% according to the treatment of information - behave as predicted by “indirect reciprocity”. Another reciprocal behavior, named “generalized reciprocity”, is investigated through a three-player dictator game. Our data show that 85% of players 2 act according to this reciprocal behavior. Such findings confirm that the more complex the strategic interaction becomes the more self-regarding behavior is likely and the less other-regarding behaviors, such as reciprocity, dominate.

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1. Introduction

As mentioned by Becker (1962), economic men cannot be considered only as selfish and rational. Their actions may be influenced by other motives and reciprocity is one of them. Importance of reciprocity in societies has been a long time considered by scholars as George Homans as well as by writers as Emile Durkheim. Reciprocity is considered as “one of the human rocks on which societies are built” (Mauss, 1954) and appears as one of the basic interactions forces that promotes and maintains harmony within societies. Nobody ventures nonetheless to give a straightforward definition of reciprocity until Gouldner (1960).

Reciprocity remains a very controversial issue. Some see reciprocity as an instance of enlightened self-interest favored by repeated encounters (reciprocal altruism) whereas for others - notably behavioral economists - reciprocity is a social norm that prescribes cooperation towards cooperators and punishment towards non-cooperators, even at personal cost (strong reciprocity). We positioned our article under the second point of view. Individuals are viewed as moral and emotional reciprocators.

In this paper, we focus on two of the various types of reciprocity that can be declined. The first one is the “generalized reciprocity” (Kolm, 2006): A’s kind act towards B implies that B acts similarly towards C without any consequences on A. The “generalized reciprocity” is based on the “helping behavior” analysed in social psychology and implies a "propagation effect". This type of reciprocity differs from the “indirect reciprocity” studied in this paper. The term “indirect reciprocity” is introduced by Alexander (1987) who argues that individuals’ behaviors towards others are not only influenced by their own experience but also by the observation of others’ behaviors too. “Indirect reciprocity” is based on the evolutionary biology (see the pioneering analyses of Nowack and Sigmund 1998a; Nowack and Sigmund 1998b) and works towards status and reputation. “Indirect reciprocity” implies that the "return is expected from someone others than the recipient of the beneficence” (Alexander, 1987, p. 85). This other individual could be involved in the original exchange or not. By contrast, economic studies deal with the “indirect reciprocity” where subjects reward or punish another person not involved in the original exchange, or it involves only two subjects.

In this paper we propose to study another kind of “indirect reciprocity”: return remains expected from someone others than the recipient of the initial beneficence but involved in the original exchange and without any repetitions. Let us consider a negotiation between three actors who act sequentially. “Indirect reciprocity” proceeds as follow: following A’s kind act towards B, B cannot directly reward A by acting kindly towards her. B can just act kindly towards a third actor C to incite her to be kind

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1 For an analysis of the impact of reciprocal behaviors in public policy, see Kahan (2005).
2 See also Takahashi and Mashima (2006) for an extended review of “indirect reciprocity”.
3 See for example the experiments of Dufwenberg et al. (2001), Seinen and Schram (2006), Masclet, Pénard (2007)
towards $A$. In consequence, this last actor has the possibility to “reward” $A$ by accepting the negotiation. Alternatively, if $B$ thinks $A$’s offer is unfair, she acts unkindly towards $C$ who has the opportunity to “punish” $A$ by rejecting the offer.

Let us emphasize that such reciprocal behavior may arise in labour relations. Suppose a competitive experimental market where three individuals intervene sequentially: boss’s boss, boss and worker. If the boss’s boss provides a high monetary offer to the boss, she could give a high wage to a worker in order to incite her to produce high effort which will reward the boss’s boss for her offer. High-wage worker could provide a higher effort than those she would provide if she has received a weaker wage. Then since high effort leads to higher productivity, it is beneficial for both. The boss acts according to positive “indirect reciprocity”\(^4\). An opposite argument holds if the boss’s boss supplies a small monetary offer.

Such a scenario may be analysed through a dictator-ultimatum game: a dictator game between player 1 and player 2 followed by an ultimatum game between player 2 and player 3. By the amount player 2 offers to player 3, she has the opportunity to incite her to accept (to reject) the offer - by sending a high (weak) share of player 1’s offer to player 3 - if player 1 makes a fair (unfair) offer. Player 2 has the opportunity to reward or to punish player 1, only in an indirect way, \(vía\) the incitation given to player 3. Our results confirm the existence of “indirect reciprocity”: between 28% and 73.68% of subjects - according to the treatment of information - follow this norm. “Generalized reciprocity” is more popular since 85% of subjects behave as predicted by this motivation. An explanation maybe could refer to the low-level of strategic interaction among players in the game implemented to study this last reciprocal behavior.

The remainder of this paper is organized as follow. In section 2 we display the framework implemented to study the “indirect reciprocity”. Section 3 provides the experimental design and section 4 the course of the experiment. We present our main results in section 5 and section 6 concludes.

2. Indirect reciprocity

The “indirect reciprocity” aims to establish a social norm of fairness, which is assumed to prevail on individuals’ behavior. It is noteworthy that subjects respond solely to kind or unkind actions without any expected material payoffs since the final decision is taken by another individual, i.e. outside their control.

\(^4\) Numerous studies, both theoretical and empirical, have shown that reciprocally motivated individuals respond to fair treatments such as higher wages with higher levels of motivation and work efforts (see Fehr et al. 1997, for example).
2.1. Framework

“Indirect reciprocity” is analysed through the combination of two well-known games: the dictator game and the ultimatum game. In this game, named "dictator-ultimatum" game (henceforth DUG), three players act sequentially. Player 1 has the opportunity to divide an amount of money among three people. She makes an offer to player 2 without determining the allocation of each opponent (player 2 and player 3). Player 2 has no veto power. She has to propose a division of player 1’s offer to player 3. Finally, player 3 decides whether to accept or to reject player 2’s offer and the game ends. If she rejects it, all players obtain zero, otherwise each player receives the payoff contracted. According to non-cooperative game theory, player 1 keeps for herself her entire endowment and gives nothing to player 2. Afterwards this last gives of course nothing to player 3, who accepts such division. The subgame perfect equilibrium is \((X - e, e_1, e_2)\), where \(X\) represents the initial endowment, and \(e, e_1, e_2\) are positive numbers, as small as possible, with \(e = e_1 + e_2\).

Nonetheless, player 1 cannot offer 0 to player 2 to allow player 2 to share player 1’s offer.

In order to analyse the “generalized reciprocity” which implies no effect of player 3’s decision on player 1’s and player 2’s payoffs, we have to avoid player 3’s veto power. The situation is then represented by a three-player dictator game (henceforth three-player DG). Similarly to the previous game, player 1 cannot offer 0 to player 2.

2.2. Theoretical framework

Rabin (1993) argues that intentions play a crucial role when subjects are motivated by reciprocal considerations. Hence intentions depend on subjects’ beliefs and subjects’ kindness depends on their set of possibilities. As noted by Dufwenberg and Kirchsteiger (2004) when \(A\) wants to be kind to \(B\) who was kind to her (and unkind to \(B\) if \(B\) was unkind), she has to assess kindness (or unkindness) of her own action as well as of \(B\); i.e. \(A\) has to assess intentions behind \(B\)’s action. Perceiving intentions behind \(B\)’s action, \(A\) has to take an action which has the same intentions. Here, we analyse this kind of reciprocal behavior. In our context, where subjects have the opportunity to divide an amount of money without any property rights on it and where the choice is deliberate and purposeful, the determination of intentions may be assessed by the comparison with the equal split as social norm. The theoretical framework is formalized as follows.

Player 1 acts first. The division of the endowment, \(X\), proposed by player 1 displays her type. Let \(t\), player 1’s type, with \(t \in T = \{0;1\}\) and let \(\bar{x}\), the equal split, i.e. \(\bar{x} = \frac{X}{3}\). So,

- If player 1 makes an offer \(x < \bar{x}\), she has unkind intentions and \(t = 0\).
If player 1 makes an offer $x \geq \frac{x}{2}$, she has kind intentions and $t = 1$.

Thereafter, player 2 receives player 1’s offer. She has private information compared to player 3 since she knows player 1’s offer and the amount of the initial endowment whereas player 3 has incomplete information about player 1’s endowment. Through the observation of player 1’s choice, player 2 may assess player 1’s intentions and then she infers her type. As noted by Kahan (2005), the logic of reciprocity depends on individuals’ moral and emotional priors. Due to the absence of property rights on the initial endowment, we assume that for all individuals the fair split corresponds to the equal one.

With the knowledge of player 1’s type, player 2 has the opportunity to send a signal, $s$, to player 3 in order to inform her about player 1’s type. Player 3’s incomplete information appears as a key element.

Consequently, we face a traditional signalling game with two players: player 2 has the possibility to send a signal, $s$, to player 3 which reveals her private information. Her signal aims to influence the decision of player 3 in the sense (acceptance or rejection) wished. The strategy of behavior of player 2, $S$, is given by the following function:

$$\Sigma = \{ \sigma : T \times S \rightarrow [0,1] \ / \ \sum_s \sigma(t, s) = 1, \forall t \}$$

where $\sigma \in \Sigma$ represents the probability that player 2 sends a message $s$ when player 1 is of type $t$.

Player 2’s signal corresponds to the amount sent to player 3, this last being conditioned by player 1’s offer. It is a take-it-or-leave-it signal: player 3 can decide whether to accept or reject the offer through her action $a \in A = \{0,1\}$. This action is given by the following function:

$$\Delta = \{ \alpha : S \times A \rightarrow [0,1] \ / \ \sum_a \alpha(s, a) = 1, \forall s \}$$

Thus,

- If player 3 decides to accept the amount proposed by player 2, then $a = 0$
- If player 3 decides to reject the amount proposed by player 2, then $a = 1$

If the signal sent by player 2 reveals player 1’s type, then:

$$\begin{cases} s \in [0,1/2x] & \text{if } t = 0 \\ s \in [1/2x, x] & \text{if } t = 1 \end{cases}$$
Such a signal corresponds to the behavior we call “indirect reciprocity”: When player 1 is unfair \((t = 0)\), player 2 sends a bad signal \((s \in [0,1/2])\) to player 3 so as to incite her to reject the offer \((a = 1)\). On the contrary when player 1 is fair \((t = 1)\), player 2 sends a good signal \((s \in [1/2,1])\) to player 3 so as to incite her to accept the offer \((a = 0)\). Player 2 appears as an intermediary player whose only action consists in influencing player 3’s decision in the sense wished.

We assume that “indirect reciprocity” will be empirically confirmed if player 2’s relative offer is positively correlated to player 1’s (Figure 1). This positive correlation is represented by means of an attitude function (as Kirschteiger and Sebald 2006), to describe the signalling behavior of player 2. Her signal - her relative offer - is function of player 1’s relative offer:\[ s(x) \rightarrow [0,100] \]

We assume that \(s(x)\) is continuous and differentiable. If player 1 gives nothing to player 2 \((x = 0)\), player 2 has no choice and proposes nothing to player 3. Furthermore, the higher the offer made by player 1, the higher player 2’s relative offer. These considerations lead to:

\[ s(0) = 0 \quad \text{and} \quad s'(x) > 0 \]

There is no dominant strategy in indirect reciprocal behaviors. “Indirect reciprocity” implies multiple equilibria: player 2’s decision is related to player 1’s but decisions prescribe best responses in all stages of the game, as long as the concern for material payoff does not overcome the concern for reciprocity.

The simultaneous study of positive and negative reciprocity is not common. Some experimental games are implemented to test the positive reciprocity like trust game or gift-exchange game (Falk 2007; Falk and Zehnder 2006) whereas others like ultimatum game or public goods game with punishment are implemented to test the negative reciprocity (Fehr and Gachter 2000). Nonetheless, few of them seek to test at the same time the existence of both positive and negative reciprocity within individuals. Such studies report weak correlation between these two inclinations and the existence of potentially different determinants (see for example Dohmen et al. 2006). Our concept of “indirect reciprocity” – which requires having both negative and positive reciprocal inclinations – is consequently more restrictive but necessary in our study to characterize subjects as reciprocal ones. In fact, if subjects make a fair split when player 1 is fair, we could say that they adopt positive reciprocal behaviors. But if they make a fair split even if player 1 is unfair, then they always make a fair split of the amount received. In that case, they are never influenced by the fairness or unfairness of player 1.

\[ ^5 \text{i.e. in percentage of her endowment.} \]
when they take their decisions. They are only fair, whatever player 1’s intentions. An analogous argument holds if subjects make an unfair split whatever player 1’s intentions. In that case, they adopt an unfair behavior and not a reciprocal one.

3. Experimental design

3.1. Treatments of information

Our experiment consists of six treatments of information. The first four treatments of information are implemented to test the “indirect reciprocity” whereas the last two deal with the “generalized reciprocity”.

In the first two treatments of information, player 3 has a veto power and we vary player 2’s available information. Nature chooses X with probability 1/2 for X = F and 1/2 for X = f and the potential values of X and their probabilities are common knowledge. In all treatments $F = 2f$.

In treatment 1 (henceforth T1) only player 1 learns which value of X has been chosen; player 2 and player 3 face incomplete information.

In treatment 2 (henceforth T2) only player 3 has incomplete information.

Treatment 3 (henceforth T3) is similar to T2 except player 3’s available information. Here, player 3 doesn’t know the exact value of X to enable player 2’s signal – as in T2 – but player 3 knows the player 1’s offer to player 2 when she takes her decision. This informational situation increases the ability of player 3 to understand player 2’s signal. The study of relative offer proposed in this treatment allows us to know if the understandings of player 2's signal favour the behavior of “indirect reciprocity”, compared to T2.

Treatment 4 (henceforth T4) consists of two different games. The first one represents a usual dictator game (henceforth DG): the proposer has the opportunity to offer an amount of money, between 0 and her endowment X, to a receiver. The receiver has no choice but to accept the amount given by the proposer and the game ends. The initial endowment is the same for all proposers and receivers have incomplete information about it. Once this game ends, all proposers take part to the DUG - as player 2s - with new subjects who have never participated to an experiment. The informational situation is the same than that of T2. In these two games, we vary the origin of the amount to divide. This treatment allows us to see - by means of a within-subjects design - if subjects adopt the same behavior when they share an amount given by the experimenter and when the amount provides to a fair or unfair player. To attenuate the influence of player 3’s veto power in the DUG, player 3 knows only a distribution of probability for X and she has no information about player 1’s offer to player 2.

6 See Blount (1995) for an earlier study on the influence of the origin of the offer.
In the last two treatments, player 3 has no veto power. The DUG becomes a three-player DG. Consequently player 3 does not take any decisions and the payoffs of all players depend on the decisions of player 1 and player 2. Here player 2 cannot fear of player 3’s rejection and her behavior highlights her true reaction to player 1’s offer. Nonetheless, player 2 cannot punish or reward player 1, not even indirectly. Player 2 may react to player 1’s intentions but her signal has hence no impact. In that case, player 2 may adopt a behavior of “generalized reciprocity”: The higher player 1’s offer, the higher player 2’s relative offer, without any possible consequences on player 1’s payoff.

In treatment 5 (henceforth T5), only player 1 knows the true amount of the initial endowment. Player 2 and player 3 face incomplete information (as in T1).

Finally in treatment 6 (henceforth T6), only player 3 faces incomplete information (as in T2).

To summarize, the six treatments of information are presented in Table 1.

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3.2. Behavioral hypotheses

In addition to indirect and generalized reciprocal behaviors, other behavioral hypotheses are likely to occur due to the experimental design implemented. In this section, we expose these behavioral hypotheses.

**Hypothesis 1. True motivations: Selfishness or social motivations?**

T5 allows highlighting player 2’s true motivations since they cannot be influenced by player 1’s offer due to their incomplete information; neither by the fear of rejection since player 3 has no veto power. Player 2 can have two types of motivations. Note $y$ the player 2’s offer and $\bar{y}$ the equal split.

Player 2 has either selfish motivations: $y = 0$ (Hypothesis H1A). Or she has altruistic motivations: $y > 0$ (Hypothesis H1B). In this last case, two types of relative offers can be made. If $0 < y < \bar{y}$, then player 2 makes an unfair offer (Hypothesis H1B-1). Conversely, if $y \geq \bar{y}$ then player 2 makes a fair offer (Hypothesis H1B-2).

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According to the experimental literature, without property rights, we consider that the threshold departs from which a person is fair is such that she sends 40% of player 1’s offer (the strict equal split would be equal to 50%).
Hypothesis 2. Fear of rejection

If player 2s in the three-player DG makes, on average, smaller offers than those in DUG - for a given informational situation - then offers in DUG have to be justified by the fear of rejection rather than by a sense of fairness\(^8\) (i.e. mean offer (T1) > mean offer (T5); mean offer (T2) > mean offer (T6)).

Hypothesis 3. Influence of player 1s’ intentions

To test whether subjects are influenced by player 1’s intentions when they take their decisions, we proceed on two steps. Firstly, we compare behaviors adopted by subjects who face complete information and those who face incomplete information. These last subjects cannot be influenced by player 1’s intentions. In consequence, such comparisons allow us to test an “income effect” according to which subjects give a higher relative offer to player 3 due to the higher amount to divide at their disposal and not due to player 1’s fairness. The assumption of “income effect” has to be rejected to confirm the influence of player 1’s intentions on player 2’s decisions. For T4, we proceed in a different way. We compare player’s share when she is the proposal in the DG and her share when she is player 2 in the DUG. In this last game, she has to divide an amount that comes from a fair or unfair split whereas in the first game, the endowment is given by the experimenter.

Secondly, we rely on intra individual comparison of player 2’s relative offers undertaken in complete information. Two situations are conceivable.

- Player 2 is influenced by player 1’s intentions (Hypothesis A). In that case, either she acts as predicted by “indirect reciprocity” or “generalized reciprocity” according to the treatment of information (Hypothesis A-1). Or she adopts a strategic behavior to maximize her expected payoff (Hypothesis A-2). Player 2 is then influenced by player 1’s offer, not to signal player 1’s intentions but to maximize her expected payoff. Thus, the higher player 1’s offer, the fewer player 2’s relative offer, but enough high to incite player 3 to accept it. Data observed in T2 will be confronted to those obtained in T3 so as to study the impact of player 3’s available information on player 2s’ behaviors. It will be noteworthy to examine whether player 3’s understanding of player 2’s signal favors the behavior of “indirect reciprocity”. In another way nonetheless the fear of player 3’s judgement could force player 2 to make a fair split of the amount received, whatever player 1’s intentions - in order to appear fair with regard to player 3.

- Player 2 is not influenced by player 1’s intentions (Hypothesis B). In that case, no difference in player 2’s offers according to each player 1’s possible offer is observed. Yet, player 2 could have two types of motivations. Either she has selfish motivations: she tries to maximize her

\(^8\) We cannot compare offers in T3 (or T4) with T6 since more than one element varies between these treatments.
own payoff by making a null offer (Hypothesis B-1). Or she has altruistic motivations and proposes a positive offer without any correlation with player 1’s (Hypothesis B-2).

4. Participants and procedures

All experiments were run by hand. To insure that no one knew the role to each others, subjects had drawn personal code from a box to determine who will be player 1, 2 or 3 (anonymity). In this way, the role of subjects was randomly allocated and they were never informed about the identity of their partners. Each subject answered the questionnaire corresponding to her role. We implemented a one-shot game to insure that no subject could ever gain a reputation for being, for example fair. This experimental procedure allows avoiding the fear of further retaliations or conversely the hope of further rewards.

We used the Strategy Method, proposed by Selten (1967) to elicit subjects' strategy. This allows measuring how much subjects would propose for every possible amount received (Figure 2).

The Strategy Method lets us observe if the relative amount player 2's propose depends on player 1’s intentions. To determine final results of the game, we had selected answers from all members of a group. For player 1’s offer, we had associated player 2’s share, and once this division selected, we had noted if player 3 - who has to establish minimal acceptable offers - accepted or rejected player 2’s offer; this last step concerned only the DUG since in the three-player DG player 3 has no veto power.

363 undergraduates' students were recruited from the University of Montpellier. The experimental subjects were volunteers from undergraduate courses of economics. Prior the beginning of the experiment, subjects were told that the money they earned would depend upon their decisions and the decisions of others in their experimental group.

We organized three sessions for T1, three sessions for T2 with 18 subjects per session; three sessions for T3 with 21 subjects per session; and four sessions for T5, four sessions for T6 with 15 subjects per session. We adopted a between-subjects design in these five treatments to provide inter individual comparisons.

The procedure implemented in T4 was different. We used a within-subjects design to compare behaviors adopted in the DG and thereafter in the DUG. Such comparisons could reveal a correlation

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9 Altogether we recruited 363 participants which include the ones who are player 1, player 2 and player 3. This paper focuses on player 2's behaviors where we have: 18 “player 2” in T1, 18 in T2, 19 in T3, 18 in T4; 20 in T5 and 20 in T6. Unfortunately, due to the elimination of subjects who failed to understand the instruction, we did not manage to have the same amount of data in each treatment.
between the type of players in the two games. We organized three sessions with 24 subjects per session (12 subjects for the DG and 18 subjects for the DUG including 6 subjects who have taken part in the DG). More precisely, each session comprised two steps. First of all, 12 subjects took part in the DG (6 players P and 6 players R). The role of subjects was randomly allocated. According to their role, subjects went in one of the two experimental rooms, player Ps and player Rs being in two separate rooms. Player Ps were provided with sealed envelopes to make their choice. At the beginning, 10 “fictitious Tickets of 100 experimental points” were deposited in their envelope and they may propose any, all or none of their experimental points to player R. They deposited the sum corresponding to their offer to player R in the envelope for player R then they gave the envelope to the experimenter. The experimenter transmitted the envelopes to the experimenter who was with player Rs. Each player R then chose randomly one envelope and received the corresponding sum before leaving. Player Ps gave next their envelopes to the experimenter. The personal code of each player was noted on their envelope to pay them at the end of the experiment. Once the first game finished, the second step of this treatment began. Player Ps selected randomly a new personal code - corresponding to the role of player 2 - for the second game. In this manner, all player Ps became player 2s. To compare behaviors adopted in these two games, we asked them to register their personal code corresponding to the two games on the forms of the DUG. Once the new codes allocated to player 2s, 12 new subjects arrived. They had the role of player 1 or player 3 and they did not know that subjects already sat in this room had taken part in an experiment before. The second step of the experiment could start with 18 subjects by session. The course of this game was similar to those of other treatments. Moreover, player 2s knew at the beginning of the experiment that they took part in two scenarios with different subjects.

In all treatments, the remuneration of subjects included a show up (3€) and the amount corresponding to their performance in the experiment. Subjects were handed out detailed instructions distributed at the beginning of the experiment. After all subjects had read instructions, an oral version was given. Then we ask them to fill out a pre-experimental questionnaire to assess the subjects’ understanding of instructions. In particular, they have to indicate the payoff of each player in different possible alternatives of the game used. Once this questionnaire corrected, the experiment began. For each treatment, one session lasted one hour.

5. Results

In this section, we present the true motivations of player 2s, then we examine the influence of player 3’s veto power before analysing the influence of payer 1’s intentions on player 2’s relative offers.

10 Instructions are available upon request to authors.
11 We focus on results obtained for player 2s where their offers are expressed in percentage of player 1’s offer. A discussion of player 1s’ and player 3s’ behaviors in this experiment is provided in Bonein, Serra (2004).
5.1 True motivations

In T5, player 2s face incomplete information about player 1’s endowment and player 3 has no veto power. In that case, player 2s cannot be influenced by other players when they take their decisions. This treatment allows us to know their true motivations. The average division corresponds to an unfair division (28.32%) that results from heterogeneity of behaviors at the individual level (Table 2 and Figure 3). 15% of subjects have selfish motivations: they give nothing to player 3. Among 85% of altruistic subjects, only 35.30% of them act in a fair way by offering 43.79% but none of them offers on average more than half of player 1’s offer. The major part of subjects (64.70%) makes a positive but unfair offer (27.60% on average).

Result 1: Heterogeneity of player 2s’ motivations
The average division corresponds to an unfair one even if a diversity of individuals’ behaviors from purely selfish behaviors (Hypothesis H1A) to fair behaviors (Hypothesis H1B-2) exists.

5.2. Impact of player 3’s veto power on player 2’s decision

Comparison of behaviors observed in the DUG and in the three-player DG points out the impact of player 3’s veto power on decisions undertaken (see Figures 4 & 5).

When player 2s face incomplete information about player 1s’ endowment, offers are significantly different in the two games. On average player 2s offer 45.16% in T1 and only 28.32% in T5 (Mann-Whitney U test, p< 0.001). This difference is also significant when we compare the type of player 2’s relative offers. Firstly no selfish behavior is observed when player 3 has a veto power (T1), contrarily to T5. Secondly, unfair player 2s are less frequent (from 64.70% in T5 to 22.23% in T1; Chi-square test, p<0.001) and a little less pronounced when player 3 has a veto power (they offer on average 36.29% in T1 and 27.60% in T5; Mann-Whitney U test, p = 0.151). In the same manner, fair behavior are more frequent (from 30% in T5 to 77.77% in T1; Chi-square test, p<0.001) and more pronounced (player 2s offer 47.70% in T1 and 43.79% in T5; Mann-Whitney U test, p = 0.039).

Our data point the same mainstream, even if changes dues to player 3's veto power are less marked, when player 2s have complete information about player 1s’ endowment. On average, player 2s offer 40.11% in T2 and only 30.21% in T6 (Mann-Whitney U test, p = 0.178). As previously noted, no selfish behavior is observed in the DUG compared to the three-player DG (5%). The difference in
relative offers is here only significant for the unfair ones: Player 2s offer 31.18% in T2 and 16.50% in T6 (Mann-Whitney U test, p = 0.021). Nonetheless, the frequency of unfair behavior is not significantly different in the two treatments of information (44.45% in T2 and 47.37% in T6; Chi-square test, p=0.753). If we turn to fair behaviors, no significant differences appear. On average, subjects make same offers in the two treatments (47.26% in T2 and 45.57% in T6; Mann-Whitney U test, p = 0.544). And the frequency of fair behavior is the same one in the two treatments of information too (55.55% in T2 and 52.63% in T6; Chi-square test, p=0.774). Now if we differentiate a fair from an unfair player 1’s offer\textsuperscript{12}, differences in behaviors adopted in T2 and T6 are solely significant when player 1 makes an unfair split. When player 1’s offer is unfair player 2s offer, on average 41.22% in T2 and 28.04% in T6 (Mann-Whitney U test, p = 0.053). Whereas, when player 1’s offer is fair, player 2s offer on average 38.44% in T2 and 33.57% in T6 (Mann-Whitney U test, p = 0.519). The difference of trend in T2 and T6 (from 41.22% to 38.44% in T2 and from 28.04% to 33.57% in T6) suggests different strategies within individuals in these two treatments. This will be tested in the next analysis.

-------------------------------------------------[Insert Figure 5]-------------------------------------------------------

**Result 2: Impact of player 3’s veto power**

The introduction of player 3’s veto power leads to higher average offer, the disappearance of selfish behaviors, less pronounced unfair offers and more pronounced and more frequent fair offers, when player 2s have incomplete information. The tendency is less clear in case of complete information.

5.3. Influence of player 1’s intentions on player 2’s decisions

5.3.1. Do intentions matter?

A first look at mean relative offers made by player 2 in case of incomplete information and complete information, under the same condition of veto power, does not highlight strong significant differences. This observation is confirmed by both Mann-Whitney test (p = 0.093 for T1/T2 and p= 0.364 for T5/T6) and one-way Anova test (p = 0.092 for T1/T2 and p = 0.728 for T5/T6) and for the within-subjects design (T4) by paired-samples T test (p = 0.606) and Wilcoxon sign rank test (Z = -0.936, p = 0.349). Nonetheless slight differences may be noted (see Figure 6) about the variance of the relative offers in each treatment. The Levene statistic reveals that the hypothesis of homogeneity of variance is rejected\textsuperscript{13} for T1/T2 (p = 0.094) and T4 (p < 0.001) but not for T5/T6 (p = 0.193).

\textsuperscript{12} Such comparisons can be carried out only in case of player 2’s complete information, i.e. T2 and T6.

\textsuperscript{13} Even though the hypothesis of homogeneity of variance is rejected, the one-way Anova test works since the size of the sample for compared treatments is the same.
To reject the hypothesis of “income effect”, we have to proceed on a second type of comparison. It is noteworthy that even if, on average (i.e. for all possible player 1’s offers), similar relative offers are observed - under the same player 3’s veto power condition - some differences appear within individuals. No strong differences appear in T2 since the mean offer is equal to 41.22% when player 1 is unfair and 38.44% otherwise (Wilcoxon sign rank test, Z = -0.980, p = 0.270). Nonetheless, this non significance could hide a compensation effect between reciprocal and strategic subjects. We will test further this potential explanation. The same tendency is observed in T4 where subjects proposes 31.29% of player 1’s offer when this last is unfair and 28.88% when player 1 is fair (Wilcoxon sign rank test, Z = -1.894, p < 0.001).

The opposite and significant tendency is observed in T3 and T6. In T3, player 2s propose 38.61% when player 1 is unfair and 42.56% otherwise (Wilcoxon sign rank test, Z = -2.135, p = 0.033); similarly in T6 player 2s offer on average 28.04% when player 1 is unfair and 33.57% otherwise (Wilcoxon sign rank test, Z = -3.428, p < 0.001). These last two results suggest the prevalence of reciprocal behaviors at the individual level and more generally the influence of player 1’s intentions.

To confirm this intuition we rely on the comparison of the distributions of player 2’s relative offers in each treatment. The Kruskal Wallis test confirms the influence of player 1’s intentions on player 2’s relative offers ($\chi^2(5) = 185.199, p < 0.001$). More precisely, the distributions of player 2’s relative offers between T1 and T2 and then between T5 and T6 are significantly different at 1% level. Such results mean to suggest that player 2s are influenced by player 1’s intentions and the hypothesis of “income effect” does not constitute an explanation of behaviors observed.

The influence of player 1’s intentions established, we proceed now on two steps. In a first step ,we study results obtained in the DUG - when player 2s have complete information – to test the “indirect reciprocity”, then we study the “generalized reciprocity” through results obtained in the three-player DG.

5.3.2 Indirect reciprocal behaviors Vs strategic behaviors

A first analysis of individual correlations between player 1’s offers and player 2’s relative offers is required to identify players’ motivations. Heterogeneity of individual behaviors may be underlined since 44.45% of subjects propose a decreasing relative offer with the rise of player 1’s whereas 55.55% offer an increasing relative offer. These findings indicate that, 44.45% of player 2s adopt a strategic behavior (Hypothesis A-2) which is confirmed by the Spearman rank correlation
coefficient\(^{14}\) (\(r = -0.705, \ p < 0.001\) when \(X = F\) and \(r = -0.929, \ p < 0.001\) when \(X = f\)). On the other side, 55.55\% of player 2s act according to the “indirect reciprocity” (Hypothesis A1): the higher player 1’s offer, the higher player 2’s relative offer so as to reward player 1’s fairness (\(r = 0.561, \ p < 0.001\) when \(X = F\) and \(r = 0.669, \ p < 0.001\) when \(X = f\)).

Furthermore, we observe substantial heterogeneity across individuals, for both strategic and reciprocal behaviors. Indeed if we study player 2’s relative offers when player 1 makes an unfair offer and thereafter a fair one, we note few changes in player 2s’ behaviors\(^{15}\) (See Figures 1 and 2; Wilcoxon sign rank test , \(Z = -2.805, \ p = 0.005\) for reciprocal subjects and \(Z = -2.521, \ p = 0.012\) for strategic ones). In case of strategic behaviors, for instance, subjects do not make a null offer to player 3 when player 1 is fair and an equal split otherwise. We note a low-level of variations in behaviors. When subjects act strategically, 50\% of them make a fair relative offer when player 1 makes an unfair split; otherwise, they make an unfair relative offer. For the others, the higher player 1’s offer, the lower player 2’s relative offer, without changing the type (fair or unfair) of the offer. This change is less pronounced in case on “indirect reciprocity”. Only 20\% of subjects make an unfair relative offer if player 1 makes an unfair split and a fair relative offer otherwise. For the others, we note an increasing trend between player 1’s offer and player 2’s relative offer.

As expected in T3, player 3’s available information favours indirect reciprocal behaviors since 73.68\% of player 2s act according to the “indirect reciprocity” (and only 55.55\% in T2). In other words, a positive and significant correlation exists between player 1’s offer and player 2’s (\(r = 0.945, \ p < 0.001\) when \(X = F\) and \(r = 0.719, \ p = 0.001\) when \(X = f\)). Yet, we note substantial heterogeneity in the degree of reciprocity across individuals. Among reciprocal subjects, only 35.71\% change the nature of their offers according to player 1’s intentions. For the others, we note only an increasing trend between player 1’s offer and player 2’s relative offer. The remainder of subjects, 26.32\%, acts strategically by proposing a decreasing relative offer (\(r = -0.213, \ p= 0.188\) when \(X = F\) and \(r= -0.649, \ p= 0.002\) when \(X = f\)). The decrease of strategic behaviors is relevant both by the frequency of subjects who adopt such behaviors (44.45\% in T2 and 26.32\% in T3; Chi-square test, \(p=0.031\)) and by the weaker negative correlation noted in T3 than in T2. Player 3’s available information, i.e. her ability to judge player 2’s share, deters player 2’s from acting strategically. In consequence player 2 seems to be influenced by player 3’s judgment when she takes her decision.

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\(^{14}\) All coefficients of correlation in this paper are computed by means of this method. The coefficient of correlation is computed on the average of player 2s’ relative offers, for each player 1’s offer. Nonetheless, the distinction between subjects paired with player 1s who have f and those who have F is required since the threshold for fair offers differs according to the amount of the initial endowment.

\(^{15}\) This observation explains that the introduction of a dummy variable representing the intentions of player 1 (this variable being equal to 1 if player 1 has fair intentions and 0 otherwise) is rarely significant in further random-effects Ordered Probit regressions. That’s why regressions are implemented without it.
In T4, even if mean offers in the DG and the DUG are close, we note that player 2’s relative offers vary according to player 1’s intentions. This observation leads us to reject the hypothesis of the “income effect” even if, on average and only on average, no strong difference appears between the two games. Contrary to other treatments, we note the prevalence of strategic behavior. 72.23% of subjects adopt strategic behaviors ($r = -0.752, p < 0.001$ when $X = F$ and $r = -0.280, p = 0.134$ when $X = f$) whereas only 27.77% of subjects act as predicted by “indirect reciprocity” ($r = 0.293, p = 0.050$ when $X = F$ and $r = 0.787, p < 0.001$ when $X = f$). As in T2, only few subjects change radically their strategies according to player 1’s intentions (Wilcoxon sign rank test, $Z = -1.214, p = 0.225$ for reciprocal subjects and $Z = -2.970, p = 0.003$ for strategic subjects). Firstly, when subjects adopt strategic behaviors, only 11.11% of them make a fair division when player 1 is unfair and an unfair division otherwise. Such variations are staggeringly more pronounced in case on “indirect reciprocity”: 20% of them adopt an unfair behavior if player 1 is unfair too; otherwise they make a fair division.

Lastly, 50% of player 2s make a null offer to player 3 when player 1 gives an amount lower than 10% of her endowment. This behavior highlights a straightforward signal of the rejection of player 1s’ unfairness. With an offer to player 3 equal to 0, player 2 maximizes the probability of rejection. A finer analysis of relative offers within individuals points out interesting and somewhat surprising results. 66.66% of player 2s make a higher mean relative offer in the DUG than in the DG (Figure 9). This result means to suggest that even if player 3 has incomplete information, the veto power influences player 2s’ decisions. A surprising result appears in the study of a possible correlation between actions undertaken in the two games. Despite the prominence of unfair relative offers in the DG and strategic behaviors in DUG, data do not show a clear correlation between them. More precisely, whatever the offer in the DG, i.e. fair or unfair, in the two cases strategic behaviors dominate in the DUG: Among unfair players in the DG, 75% act strategically in the second game and among fair players 66.66% act strategically in the second game. Nevertheless, it is noteworthy that reciprocal behaviors are more frequent when subjects act fairly in the DG, even if strategic behavior dominates. From another point of view, we note that among reciprocal subjects, 40% make a fair offer in the DG whereas among strategic subjects, only 30.77% act in this way. Such analysis highlights a slight inclination for fair subjects to adopt reciprocal behaviors even if strategic behaviors dominate.

As noted by Fehr and Gachter (2000) there is a substantial proportion of subjects who behave reciprocally but there is also a non-trivial fraction of subjects who behave completely selfishly or strategically. The proportion of indirect reciprocal subjects in our data is quite similar to those of Fehr et al. (1997) who find that between 40% and 60% of subjects have inclinations for strong reciprocity.
5.3 Generalized reciprocal behaviors Vs strategic behaviors

The three-player DG allows testing “generalized reciprocity”. We have shown that player 2’s relative offers, on average, differ according to player 1’s intentions. The study of player 2’s relative offers in T6 highlights that 85% of player 2s give an increasing relative offer (r = 0.744, p < 0.001 when X = F and r = 0.972, p < 0.001 when X = f). This result implies that in the DG, although player 2s could take advantage of the absence of veto power to adopt strategic behaviors so as to maximize their payoffs, without any risk, 85% of them act as predicted by the “generalized reciprocity”. In Table 2, we have noted that 5% of subjects act according to game theory. For the other subject, they act strategically since they give a decreasing share of player 1's offer to player 3 (r=-0.681, p<0.001). These behaviors might appear strange: since player 3 has no veto power, player 2 doesn't have to make a high offer to player 3 in order to incite her to accept.

Finally, in T6, variations in behaviors adopted according to player 1’s intentions are more pronounced but only for reciprocal\(^{16}\) subjects (Wilcoxon sign rank test, Z= -3.362, p < 0.001). It turns out that the large majority of player 2s agrees with the above mentioned statements, implying that generalized reciprocal inclinations are the rule rather than the exception. A closer inspection reveals however that there is substantial individual heterogeneity in the strength of reciprocal inclinations.

Finally, our data underline a higher proportion of generalized reciprocal inclinations than the indirect reciprocal ones: 55.55% or 27.77% of subjects according to the experimental design act according to the “indirect reciprocity” whereas 85% of subjects act as “generalized reciprocity” predicts. Solely when player 3 has the capacity to understand player 2’s signal without any ambiguities (T3), the frequency of indirect reciprocal subjects is close to that of generalized reciprocal ones. Fehr and Schmidt (2006) highlight in their survey that the more complex the strategic interaction becomes, the more self-regarding the behavior is likely. Our observation tends to confirm their findings. The complex strategic setting implemented in the DUG tends to reduce other-regarding behavior, especially the reciprocal one.

5.4. Econometric analysis

In this section we rely on econometric analysis to examine statistical significance of both strategic and reciprocal behaviors. The data set is extended to all player 1’s possible offers and the effects of these last on player 2’s types of relative offers are estimated. In consequence, we estimate panel models since there are several observations per subject (one for each player 1’s possible decision). Rather than player 2's relative offer to player 3, we focus on the type of player 2's relative

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\(^{16}\) We haven’t got enough data for strategic subjects to perform the Wilcoxon sign rank test.
offers. For that, we implement Ordered Probit regressions. The dependent variable is the type of player 2's relative offers defined in the following way \(^{17}\):

\[
y_i = \begin{cases} 
0 & \text{if player 2 offers less than 20\% of the } i^{\text{th}} \text{ player 1’s offer} \\
1 & \text{if player 2 offers between 20\% and 40\% of the } i^{\text{th}} \text{ player 1’s offer} \\
2 & \text{if player 2 offers at least 40\% of the } i^{\text{th}} \text{ player 1’s offer} 
\end{cases}
\]

The observed level of relative offers is assumed to be related to the continuous latent kindness variable \(y_i^*\) according to three distinct classes:

\[
y_i = \begin{cases} 
0 & \text{if } y_i^* \leq c_1 \\
1 & \text{if } c_1 < y_i^* \leq c_2 \\
2 & \text{if } y_i^* > c_2 
\end{cases} \forall i = 1, ..., N
\]

With \(c_2 > c_1\) and the latent kindness variable \(y_i^*\) is defined in the following way:

\[
y_i^* = Z_i \beta + \epsilon_i
\]

With \(Z_i = (Z_i^1, ..., Z_i^K), \forall i = 1, ..., N\), \(\beta = (\beta_1, ..., \beta_K) \in \mathbb{R}^K\), \(K\) being the number of explanatory variables, \(\epsilon_i\) the error term iid and normally distributed \((0, \sigma^2)\).

The use of panel data method would allow controlling individual effects. The substantial heterogeneity observed in our data leads us to reject models with fixed individual effects \(^{18}\). Consequently, the statistical framework adopted is the random-effects Ordered Probit model to allow for unobserved heterogeneity. The \(j^{\text{th}}\) player 2's types of relative offers \((j= 1, ..., J)\), with respect to the \(i^{\text{th}}\)

\(^{17}\) Thresholds have been established according to explanations provided by the experimental literature. If subjects propose less than 20\% of the amount received, they are qualified as selfish (a selfish man would be the one who proposes 0 but we haven’t got enough observations to create such classe); if they offer between 20\% and 40\% of the amount received, they act in a kind manner without making an equal split; lastly, if they propose at least 40\% of the amount received they are seen as fair even if the strict equal split would be equal to 50\% of the amount received.

\(^{18}\) As Vieira (2005), in the absence of a satisfactory fixed effects estimator for the Ordered Probit model we rely on the random-effects Ordered Probit specification. In order to have an indication as to whether this assumption is reasonable for the case under analysis, we have run OLS equations for player 2's relative offers and perform a Hausman (1978) test. The obtained statistics \((H = 1.59, p=0.451\) for reciprocal subjects and \(H = 0.80, p=0.671\) for reciprocal subjects) favor the random-effects model.
player 1’s offer (i=1…N) is assumed to be determined by player 1’s relative offer - the percentage offered - \( x_{ji} \), a dummy variable corresponding to the initial endowment \( X_{ji} \) and an individual specific term \( \mu_j \). The corresponding specification is:

\[
y_{ji}^* = Z_{ji} \beta + \mu_j + \epsilon_{ji}
\]

Where \( \beta \) are coefficients that measure the impact of explanatory variables \( (Z_{ji}) \) on the \( j \)th player 2’s types of relative offers \( (y_{ji}^*) \), and \( \epsilon_{ji} \) is a multivariate normally distributed random error \((0, \sigma^2_\epsilon)\). The random components \( \mu_j \) are distributed normally \((0, \sigma^2_\mu)\) and \( \mu_j \) are independent of \( \epsilon_{ji} \). In addition, \( Z_{ji} \) are independent of \( \mu_j \) and \( \epsilon_{ji} \) \( \forall\{i,j\} \). However, we do not observe \( y_{ji}^* \), but rather an indicator variable of the type:

\[
y_{ji} = \begin{cases} 
0 & \text{if } Z_{ji} \beta + \mu_j + \epsilon_{ji} \leq c_1 \\
1 & \text{if } c_1 < Z_{ji} \beta + \mu_j + \epsilon_{ji} \leq c_2 \\
2 & \text{if } Z_{ji} \beta + \mu_j + \epsilon_{ji} > c_2 
\end{cases}
\]

As usual in random effects Ordered Probit model, we assume that \( c_1 = 0 \) and \( \sigma^2_\epsilon=1 \). Moreover we rely on two specific regressions.\(^{19}\) The first one concerns subjects who have been classified as reciprocal and the second for subjects classified as strategic. Due to the few amount of data for strategic or reciprocal subjects in some treatments, we estimate random-effects Ordered Probit regressions with observations obtained in all treatments.\(^{20}\) We include as explanatory variables the logarithmic player 1’s relative offer \((\ln(x_{ji}))\), to avoid a problem of "size effect" in the iteration process, and a dummy variable for the initial endowment \((X_{ji} = 1 \text{ if player 1 has a large endowment})\).\(^{21}\)

\(^{19}\) By proceeding on separate regressions for reciprocal and strategic subjects, there is the same relation between player 2’s types of relative offers and player 1’s offer. Panel data used is justified and the sole source of heterogeneity could come from \( \mu_j \).

\(^{20}\) Results obtained on random-effects Ordered Probit regressions per treatment and type of subjects are available upon request to authors. Only regression implemented in treatment 6 for strategic subjects leads to a problem of non convergence, since we have only 10% of subjects who act strategically.

\(^{21}\) Unfortunately, we have no information about socio-demographic characteristics of subjects to improve our regressions and to provide finer explanations. A larger model including the squared of the logarithmic player 1’s relative offer was also run but this variable has been rarely significant in random-effects Ordered Probit regressions per treatment and per type of subjects and hence it was drop from the analysis.
and 0 otherwise). The model is estimated by Maximum likelihood methods using the random effects Ordered Probit routine of the statistical package Limdep 7.0.\textsuperscript{22}

If we compare the results (Table 3) of the standard Ordered Probit equations with the random-effects estimates, we find that the likelihood decreases dramatically when we introduce random-effects, and especially for reciprocal subjects. Furthermore the Pseudo R\textsuperscript{2} rises between the usual Ordered Probit (columns 1 and 3) and the random-effects Ordered Probit (columns 2 and 4) for both strategic and reciprocal subjects. Estimation results indicate the importance of heterogeneity (the significance of sigma). As expected, player 1's offer has a strong positive impact on player 2's types of relative offers in case of reciprocal behavior. In order to have a better understanding of this process, we calculate the marginal effects of the logarithmic player 1's relative offer and the initial endowment on the probability that player 2 makes a specific types of offers (Table 4). Marginal effects underline that an increase in the logarithmic player 1's relative offer implies a decrease in the probabilities Y = 0 and Y = 1 (i.e. player 2 makes an unfair relative offer). On the contrary, marginal effects point out that an increase in the logarithmic player 1's relative offer leads to a rise of the probability that player 2 undertakes a fair relative offer. If we turn to the initial endowment, it seems that being paired with a player 1 who has the large endowment increases the probability to propose a high share of the amount received. This observation is confirmed both by the sign and significance of the initial endowment, and the marginal effects. Conversely in case of strategic behavior, being paired with a player 1 who has the large endowment or the small one seems having no significant impact. As expected, player 2's types of relative offers are negatively related to player 1's offer. Yet, marginal effects highlight that an increase in the logarithmic player 1's relative offer disfavours player 2's fair relative offer (Y = 2), with respect to offers less than 40% of the amount received, especially Y = 0.

6. Conclusion

In this paper, we have shown that a sophisticated behavior of reciprocity could exist. We find that between 27.77% and 73.68% of subjects – according to the treatment of information – have such inclinations: Player 2 seeks to punish or reward player 1 by means of her offer to player 3. Our data

\textsuperscript{22}Convergence was reached with the default convergence criterion and initial parameters, so that no further modifications were needed (Greene, 1998). As routine in Ordered Probit, the variance of the error term is standardized so that $\sigma_{\varepsilon} = 1$. Thus, the total error variance is equal to $1 + \sigma_{\mu}^2$. 

underline a substantial heterogeneity in the degree of reciprocity across individuals: Some make an unfair split when player 1 is unfair; otherwise they make a fair split. But a large fraction of subjects do not change radically their relative offers according to player 1’s intentions; they solely propose an increasing relative offer to player 3, when player 1 becomes fair.

Nonetheless, there is a non-trivial fraction of subjects who behave completely selfishly. They adapt their offer with respect to the player 1’s one so as to maximize the probability of acceptance. Like Fehr and Schmidt (2006), we believe that the most important heterogeneity in strategic games is the one between purely selfish subjects – who seek to maximize their expected payoffs – and subjects with a preference for reciprocity.

Our findings add to the understanding of behaviors adopted in labour relations with several hierarchical levels. If we go back to our initial example - under “indirect reciprocity” - when the boss's boss gives only weak monetary offer to the boss, the latter, due to her dissatisfaction, will propose a small wage to the worker who won’t be incited to produce a high effort. The small level of effort won’t satisfy the boss's boss. Conversely, if the boss's boss provides a high monetary offer to the boss, the boss will give a high wage to the worker to incite her to produce a high effort and to reward the boss's boss. But selfish motivations may appear, as noted in our experiment in such labour context too. If we associate the desire to punish or reward the boss's boss to the desire to perpetuate the labour relations, strategic behaviors observed in our experiment could be an explanation of existing labour behaviors: if the boss's boss gives a small monetary incentive to the boss, the latter, in the hope to satisfy her boss and to carry on their relations, could give a high share of the boss's boss's offer. But if the boss's boss provides a high offer, the boss could give a part high enough to incite the worker to produce a high effort, but smaller than that if the boss's boss gave a small monetary incentive, to maximize her payoff, without compromising the satisfaction of the boss's boss.

References


Masclet D, Pénard T (2007) Is the eBay feedback mechanism truly efficient? An experimental study, mimeo, CREM Université Rennes I

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Figure 1: Theoretical and empirical indirect reciprocity Vs. Equal split
Table 1: Treatments of information

<table>
<thead>
<tr>
<th></th>
<th>Player 2’s available information about player 1’s endowment</th>
<th>Player 3’s available information about player 1’s offer</th>
<th>Player 3’s veto power</th>
<th>Prior experiment for player 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>incomplete</td>
<td>incomplete</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>T2</td>
<td>complete</td>
<td>incomplete</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>T3</td>
<td>complete</td>
<td>complete</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>T4</td>
<td>complete</td>
<td>incomplete</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>T5</td>
<td>incomplete</td>
<td>incomplete</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>T6</td>
<td>complete</td>
<td>incomplete</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>
Figure 2: Player 2's decision task

Please make a mark with "X" to the amount you will give to player 3, for each player 1's offer to you in the following table:

<table>
<thead>
<tr>
<th>Player 1's offer</th>
<th>0</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
<th>600</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>To you</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Player 2’s offers according to their motivations

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Selfish behaviors</strong></td>
<td>Frequency</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td><strong>Frequency</strong></td>
<td><strong>22.23%</strong></td>
<td><strong>44.45%</strong></td>
<td><strong>31.57%</strong></td>
<td><strong>94.45%</strong></td>
<td><strong>64.70%</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Unfair split</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Mean offer</strong></td>
<td><strong>36.28%</strong></td>
<td><strong>31.17%</strong></td>
<td><strong>28.41%</strong></td>
<td><strong>29.01%</strong></td>
<td><strong>27.60%</strong></td>
</tr>
<tr>
<td><strong>Altruist behaviors</strong></td>
<td><strong>Frequency</strong></td>
<td><strong>77.77%</strong></td>
<td><strong>55.55%</strong></td>
<td><strong>68.43%</strong></td>
<td><strong>5.55%</strong></td>
<td><strong>35.30%</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fair split</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Mean offer</strong></td>
<td><strong>47.70%</strong></td>
<td><strong>47.26%</strong></td>
<td><strong>45.50%</strong></td>
<td><strong>53.47%</strong></td>
<td><strong>43.79%</strong></td>
</tr>
<tr>
<td><strong>All subjects</strong></td>
<td><strong>Mean offer</strong></td>
<td><strong>45.16%</strong></td>
<td><strong>40.11%</strong></td>
<td><strong>40.10%</strong></td>
<td><strong>30.37%</strong></td>
<td><strong>28.32%</strong></td>
</tr>
</tbody>
</table>

*In percentage of altruistic subjects; b in percentage of player 1’s offer.*
Figure 3: Heterogeneity of player 2s' behaviors in treatment 5
Figure 4: Impact of player 3's veto power on player 2's repartition

In case of incomplete information
Figure 5: Impact of player 3's veto power on player 2's repartition

In case of complete information
Figure 6: Mean and variance of player 2's relative offers in each treatment of information
Figure 7: Trend of player 2's relative offers in case of reciprocal behaviors
Figure 8: Trend of player 2’s relative offers in case of strategic behaviors
Figure 9: Offers made by proposers in usual DG and thereafter player 2s in DUG
Table 3: Ordered Probit regressions and random-effects Ordered Probit regressions models for
player 2s’ types of relative offers according to the type of behaviors

<table>
<thead>
<tr>
<th></th>
<th>Reciprocal subjects</th>
<th>Strategic subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ordered Probit model</td>
<td>Random-effects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ordered Probit model</td>
</tr>
<tr>
<td>Player 1’s relative offer (in Ln)</td>
<td>0.4931***</td>
<td>1.0357***</td>
</tr>
<tr>
<td></td>
<td>(0.0385)</td>
<td>(0.0314)</td>
</tr>
<tr>
<td>Initial endowment ( =1 if ( X = F ))</td>
<td>0.6973***</td>
<td>1.0244***</td>
</tr>
<tr>
<td></td>
<td>(0.0673)</td>
<td>(0.1366)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.9860***</td>
<td>-1.2431***</td>
</tr>
<tr>
<td></td>
<td>(0.1505)</td>
<td>(0.1671)</td>
</tr>
<tr>
<td>Nb observations</td>
<td>1470</td>
<td>1470</td>
</tr>
<tr>
<td>Nb individuals</td>
<td>-</td>
<td>47</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-1199.4440</td>
<td>-688.9621</td>
</tr>
<tr>
<td>Wald ( \chi^2 )</td>
<td>260.0354</td>
<td>1020.9640</td>
</tr>
<tr>
<td>Prob &gt; ( \chi^2 )</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Pseudo R^2</td>
<td>0.0978</td>
<td>0.4256</td>
</tr>
<tr>
<td>Mu^a</td>
<td>0.9821***</td>
<td>2.0102***</td>
</tr>
<tr>
<td></td>
<td>(0.0469)</td>
<td>(0.0517)</td>
</tr>
<tr>
<td>Sigma^b</td>
<td>-</td>
<td>1.6280***</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(0.0809)</td>
</tr>
</tbody>
</table>

*** indicates significance at 1% level. Standard errors in parentheses. \(^a\) Threshold parameters for index; \(^b\) Standard deviation of random effect.
Table 4: Marginal effects

<table>
<thead>
<tr>
<th></th>
<th>Reciprocal subjects</th>
<th>Strategic subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y = 0</td>
<td>Y = 1</td>
</tr>
<tr>
<td>Player 1’s relative offer (in Ln)</td>
<td>-0.0507</td>
<td>-0.1243</td>
</tr>
<tr>
<td>Initial endowment ( =1 if ( X = F ))</td>
<td>-0.5900</td>
<td>-0.1219</td>
</tr>
</tbody>
</table>