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«The role of players' identification in the population on the trusting and the trustworthy behaviour : an experimental investigation»

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The role of players' identification in the population on the trusting and the trustworthy behavior: an experimental investigation

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Abstract

We study to what extent identification does matter for trustfulness and trustworthiness to emerge in a population of players. Our experimental protocol is designed for isolating the effects of trustees' identification. Trustees' identification is a necessary condition for introducing a reputation mechanism. We run three treatments. In each treatment groups 6 players interact repeatedly and randomly and play a 30 periods investment game (Berg & al. 1995). In the first treatment players can't identify each other, in the second one players can identify each other as trustee and in the third one players identify each other both as trustee and trustor. We show that, according to the expectation, trustees' identification has a positive effect on reciprocity. However it doesn't affect the average trust in the population. Trust is significantly higher than in the complete anonymous treatment only when players identify each other in both roles. We show that this enhance of trust is the result of mutual trust-reciprocity relationships formation.

JEL Classification: C72; C91; D63
Keywords: Investment game, trust, reciprocity, population, experimental economics, repeated game, reputation

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1 Introduction

It has been claimed since Arrow (1974) that trust plays a key role in any economic transactions, because of asymmetric information, contract incompleteness, prohibitive monitoring costs, etc. Moreover, Fukuyama (1995) tried to argue that the level of trust at the society level determines its overall performance, a conjecture that is supported by several empirical studies (La Porta & al. 1997, Glaeser & al. 2000, Knack & Keefer 1997). At the society level, trust plays precisely the role of "lubricant of relations" suggested by Arrow, a role that is essential when individuals interact in large populations, where encounters are random and agents have the opportunity to accumulate experience both as trustor and as trustee. Features such as population size, repeatedness and randomness of interactions, and joint experience as trustor and trustee, are fundamental for studying the effects and evolution of trust in a society. To a large extend trust is endogenous, because people interact repeatedly and randomly in large populations, and their behavior becomes determined by the history of their past interactions. This important fact was already mentioned in the seminal experimental paper by Berg & al. (1995) who showed that informing subjects about the frequencies of trust and reciprocity levels in past experiments, increases the level of trust.

In such an environment a key determinant of trust is the identification of the people with whom agents interact. In most circumstances, interactions are not anonymous and agents can remember the outcome of past interactions. Even in the larger market place, Internet, on almost all commercial websites people must provide personal information for subscribing. For example a valid email address must be provided as personal identification, as for example on the eBay auction's website. Buyers are therefore able to identify each seller with whom they interact and remember past issues of their common interaction. Such identification systems of trustees' is likely to enhance reciprocity among agents involved in mutual exchange, and indirectly affects the level of trust in society. Reputation is the key variable in these systems. A trustee who knows that his decisions are individually observed is likely to be more reciprocal. The trustee's history of play towards a particular trustor is a central information for that trustor, who might rely on past records for his future decisions towards the same trustee. A trustee with a bad individual reputation with respect to a given trustor is likely to be not trusted. Therefore, in a population environment, trustees' identification creates individual incentives to be trustworthy for building up and keeping a "good" reputation and hence, expecting to be trusted in the future. Knowing trustees' individual interest trustors may become more trustful. We therefore conjecture that the level of trust within the population is enhanced by trustees' identification.

Most trust-based experiments have dealt with pair-wise fixed interactions. Starting with a one-shot interaction, Berg & al. (1995) showed that most experimental subjects do not play the subgame perfect equilibrium solution. Most trustors exhibit trusting behavior and most trustees tend to reciprocate. While these findings raise deep questions about game theoretic predictions, they also raise questions about the features of trust relations that can be captured in the lab. Several experiments also introduced explicitly repeated interactions in the investment game (see Cochard & al. 2004, Anderhub & al. 2002) to study the evolution of trust. Their main finding is that repeated interactions have a positive effect both on the level of trust and the level of reciprocity. These effects are predicted both by repeated game effects (reputation building) and by reciprocal behavior (trustees rewards higher trust with higher reciprocity). While these experiments take a step into the direction of letting trust relations emerge in a more realistic social interaction setting, most of them were based on repeated pair-wise interactions in a partner design. While they allow taking into account the effect of one's own past interactions, they neglect randomness of interactions within a large population of players. Furthermore, in real life situations; most people have experience both as trustor and as trustee, depending on the situation in which they are currently involved. Playing both roles has been investigated by Burks & al. (2002), who found that trust and reciprocity are lower when subjects play both roles in a one-shot investment game. To our knowledge the only experiment that combines repeated interactions in a large population with both roles was run by Murphy & al. (2006). Their experiment is based on a real-time centipede game with a random assignment of each subject to a new group after each round. Each subject could end the game at any time. Subjects were therefore both in a position to trust other subjects and to be trusted by others. While Murphy & al.'s experiment captures most of the central features of trust relations within a population, subjects do not have to take an explicit decision to trust other players. Furthermore there is no opportunity for reciprocating trusting decisions in this game.

Our aim in this paper is to try to capture the main features of trust relations within a population of players : repetition, random encounters and playing both roles with a "rich" strategy space. We do this by letting each subject play simultaneously both roles in the investment game over 30 periods. In each period, each subject is randomly paired with a trustor and with a trustee. We focus on the effects of identification, by letting subjects have permanent access to their history record of past interactions. In our experimental design history can matter only at the individual level. Depending on the treatment, subjects can accumulate knowledge about the level of trust and trustworthiness of subjects with whom they interacted with in past periods. The experiment is designed to investigate the effect of trustees' identification on trust and reciprocity. In a population environment trustees' identification is a necessary condition for a reputation mechanism to be implemented. Following Kreps & al.'s arguments, trustees' identification may be sufficient to enhance trust and reciprocity compared to an environment with anonymous players. When players interact repeatedly in fixed pairs, identification is exogenous, because players know that they will interact repeatedly with one another and that they can observe the history of past interactions. With random encounters in a large population, things are more complicated, because trustors can accumulate information about each trustee only if they are able to identify them, i.e. to recognize a trustee with whom he has already interacted. Hence, the key questions investigated in this paper are the following: (i) to what extend does trustees' identification in a population affect trust and reciprocity?, (ii) does trustors' identification has any impact on the levels of trust and reciprocity? Adding trustors' identification implies that individuals are also able to identify who trusts them. Both roles identification thus provides players with more information about each other and also with a stronger control on the others' decisions. Indeed, a player i that trusts a player j is likely to expect that player j trusts him too. If not, he may stop his trusting behavior. The same reasoning hold for reciprocity. Moreover in this environment individuals can form bilateral trust-reciprocity relationships. Our conjecture is that identification of player in both roles lead to higher levels of trust and reciprocity in the population than trustees' identification only.

In order to answer the two questions and to test our conjectures we run three treatments : complete anonymity, private identification of trustee's role and private identification of both roles. Our main findings can be summarized as follows : private identification of trustee's role increases reciprocity, adding private identification of trustor's role increases the average level of trust. However, trustees' role identification alone has no effect on trust and adding trustors' identification has no additional effect on reciprocity. Furthermore we find a strong correlation between own trust and own reciprocity independently of the treatment, between received amount and own reciprocity under trustee's role identification, and between received amount and own trust under identification of both roles. Finally we find that the higher trust levels observed under both roles identification can be attributed to the emergence of bilateral trust-reciprocity relationships within the population.

The remainder of the paper is organized as follows. Section 2 describes the experimental design, section 3 presents the results, at the group level and at the individual level, and section 4 concludes.

2 Experimental design

Experimental sessions were organized at LEEM, the experimental lab of Montpellier. 108 student subjects, from various faculties, participated in the experiment. Subjects were randomly selected from a pool of volunteers. None of the recruited subjects had ever participated in an experiment on social dilemma. Each subject was randomly assigned to a group of 6 participants. We run three different treatments, with 6 independent groups per treatment. Upon arriving at the experimental lab subjects received written instructions[1]. After reading the instructions subjects answered a short questionnaire (on the computer screen) to check their understanding.
Subjects participated in a repeated investment game (Berg & al. 1995), played for 30 periods, in which they simultaneously played both roles (trustor and trustee). In each period each subject had to take a decision as trustor and a decision as trustee. In each period, each subject in a group was randomly paired with a trustor selected among the five other group members, and with a trustee selected in the same way. Treatments differ with respect to the identification of players in the population.
In the NI treatment (No Identification) identification of players is not possible. Subjects who take a trusting decision only know that an anonymous player X will receive three times the amount sent. Conversely, subjects acting as trustees

[1] Instructions are available on the website `http://www.duboishome.info/dimitri/index.php?page=publications&lang=eng`

	NI	TI	TTI
Investment	3.76	4.14	4.98
Reciprocity[a] (%)	19.78	25.41	24.87
Average net payoff as trustor[b]	-1.45	-0.54	-0.49
Average net payoff as trustee[b]	8.97	8.81	10.45
Average final payment[c]	15.77	16.45	17.96

[a] Calculated only for positive sendings, [b] in ecus, [c] in euros.

Table 1: Averages for each treatment

only know that the received amount comes from an anonymous player Y. Subjects know that X and Y are members of their group but are unable to identify them. In the TI treatment (Trustees' Identification) subjects acting as trustee are identified by a letter. Before taking their decision, subjects acting as trustor are informed with which subject (B, C, D, E or F) they will be interacting with. Each letter identifies only one subject in the group and each subject keeps the same letter for the whole session. Notice that the identity of the trustee remains private information, and that all subjects had exactly the same instructions. Finally, in the TTI treatment (Trustors' and Trustees' Identification) each subject is identified by a unique letter, B, C, D, E or F. Before taking his trusting decision each trustor knows with which trustee he is paired with, and also knows from which of the trustees he will eventually receive some currency.
Endowments and gains are measured in ECUs (Experimental Currency Unit) with the conversion rate, 1 ECU = 0.03 euros, stated in the instructions. In each treatment subjects have access to a history screen providing information about past period decisions : the amount sent and returned in their trustor role, the amount received and returned in their trustee role, the gain of the period and the cumulative gain since the beginning of the experiment. In the TI treatment an additional column displays the letter of the trustee with whom a subject is interacting. In the TTI treatment there are two additional columns, one identifying the trustor and another one identifying the trustee.

3 Results

3.1 General results

Table 1 reports average data for the three treatments: the average investment level, average reciprocity (in percentage of the (positive) received amount), the average net profit as trustor (calculated as the average of the difference between the amount sent and the amount returned by the trustee) and the average net profit as trustee (calculated as the average of the difference between the amount received and the amount returned).

Result 1:
(i) Trustees' identification significantly increases the average level of reciprocity but not the average level of trust compared to the benchmark.
(ii) Both roles identification significantly increases both the average

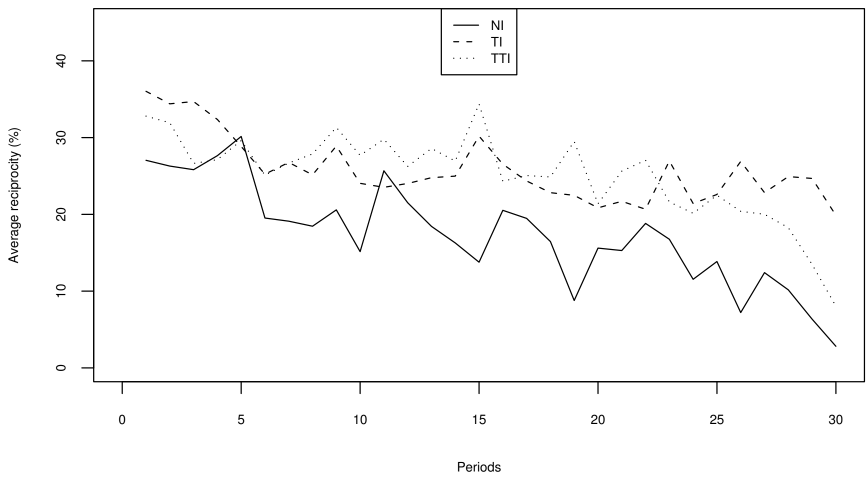

Figure 1: Evolution of reciprocity for each treatment

levels of reciprocity and trust compared to the benchmark. Compared to trustees' identification only (TI), the average level of trust is significantly larger.

The average trust in the NI treatment (3.76) is lower than in the TI treatment (4.14), which is also lower than in the TTI treatment (4.98). The comparison between the NI and the TI treatment does not reveal any significant difference in the average level of trust (Mann Whitney Unilateral U-test (thereafter MW) p-value=0.409) while the average trust in the TTI treatment is significantly higher than in the two other treatments (MW, TTI vs. NI p-value=0.047, TTI vs. TI p-value=0.047). With identification (TI and TTI) the average reciprocity is significantly higher than without (MW, TI vs. NI p-value=0.066, TTI vs. NI p-value=0.066). However the difference between treatments TI and TTI is not significant (MWU p-value=0.469).

Figure 1 shows the evolution of the average level of reciprocity for each treatment. Identification has a positive effect on the reciprocity level at the beginning of the game. In the first period the average reciprocity is equal to 27.04% in treatment NI, 36.03% in treatment TI and 32.80% in treatment TTI, respectively. In treatments with identification the average reciprocity in period 1 is close to one third and is significantly higher than in the NI treatment (MW NI vs TI p-value=0.021, NI vs TTI p-value=0.032). There is no significant difference between the TI and the TTI treatments however (p-value=0.120). The TI and TTI curves follow closely the same path, while the NI curve lies clearly below the former ones. For purpose of comparison we divide the 30 periods into three sequences of 10 periods each : an initial (or first) sequence (periods

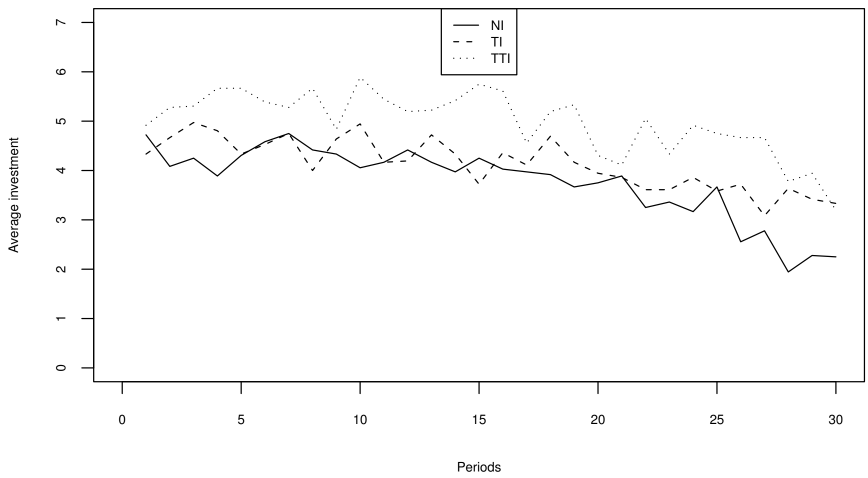

Figure 2: Evolution of trust for each treatment

1-10), an intermediary (or second) sequence (periods 11-20) and a final sequence (periods 21-30). In both treatments with identification (TI and TTI) there are two consecutive sequences in which the average reciprocity is not significantly different. This is not the case in the treatment NI. More precisely the averages in the three sequences of treatment NI are respectively equal to 22.98%, 17.65% and 11.52%. A Wilcoxon one-sided test shows that the average in sequence 1 is greater than in sequence 2 (p-value=0.031), the latter being greater than in sequence 3 (p-value=0.016). In treatment TI the corresponding averages are respectively equal to 29.64%, 24.45% and 23.25%. Averages in sequences 2 and 3 are not significantly different (p-value=0.281), while the average in sequence 1 is significantly higher than in sequence 2 (p-value=0.016). Finally in treatment TTI the average reciprocity in sequences 1 and 2 are not significantly different (p-value=0.219) while the average in sequence 3 is significantly lower than in sequence 2 (p-value=0.016). The average reciprocity thus evolves differently in the three treatments : we observe a persistent decline in the NI treatment; a decline between sequence 1 and 2 but not between 2 and 3, under trustees' identification, and a decline only in the final sequence when both the trustor and the trustee are identified. The average reciprocity in the NI treatment is moreover always lower than in the other treatments (MW, initial sequence: NI vs. TI p-value=0.032, NI vs. TTI p-value=0.032; intermediary sequence: NI vs. TI p-value=0.090, NI vs. TTI p-value=0.013; and final sequence: NI vs. TI p-value=0.031, NI vs. TTI p-value=0.031). Between treatments TI and TTI the three sequences do not exhibit a significant difference (MW, p-value=0.409, p-value=0.350, p-value=0.294 for each sequence respectively).

Figure 2 reports the evolution of average trust in the three treatments. In the first period of play average trust is equal to 4.72 for the NI treatment, 4.33 for the TI treatment and 4.92 for the TTI treatment. These averages are not significantly different even if it apparently larger in the TTI treatment (MW, NI vs. TI p-value=0.211, NI vs. TTI p-value=0.531, TI vs. TTI p-value=0.167). However, average trust in the TTI treatment becomes larger very quickly with respect to the two other treatments. Indeed, from period 2 average trust in treatment TTI is slightly more than 50% of the endowment. The average investment stays at this level until period 20 of the game. Such a high level of average trust is never reached in the other treatments. In the first sequence of the NI treatment average trust is 4.34, which is significantly larger than in the second sequence (4.03, Wilcoxon one-sided test p-value=0.047). There is also a significant decrease between the intermediary and the final sequence (p-value=0.078). In treatments TI and TTI we observe average trust in the first and second sequences is not significantly different (Wilcoxon one-sided test, sequence 1 vs. sequence 2, TI p-value=0.156, TTI p-value=0.281) but falls in the third sequence with respect to the second one (TI p-value=0.031, TTI p-value=0.078). In treatment TTI the average trust in sequences 1 and 3 are also not significantly different from each other (p-value=0.109). Providing subjects with the ability to identify who trusts them in the group has thus not only an effect on the average but also on the evolution over time. Both roles identification leads subjects to trust the others at a higher level and over a longer period of time.

Even in a complete anonymous environment subjects exhibit trust and reciprocity, as shown by many experimental papers. We found that this result also holds in a population environment where subjects play simultaneously both roles in the game. Following Kreps & al.'s arguments adding trustees' identification in the population introduces a reputation mechanism that creates incentives for trustees to be trustworthy. Knowing trustees' incentive to reciprocate trustors's decisions, may increase the level of trust. We therefore conjectured that trustees' identification leads to higher levels of trust and reciprocity in the population. As stated in result 1 trustees' identification has a significantly positive effect on reciprocity but no effect on trust. This positive effect on reciprocity is present in the very first period of the repeated game, meaning that subjects take into account the individual incentive to be trustworthy. The evolution of reciprocity in the population is also affected: without identification reciprocity decreases continuously over time, but remains at a high level when identification is available. However the increase in average reciprocity is not sufficient for subjects acting as trustor to become more trustful. We therefore conclude that the introduction of incentives for trustworthiness is not enough for enhancing trust in a population environment. Our results contrast with other findings in a fixed-pairs environment (Anderhub & al. 2002, Cochard & al. 2004). Two reasons might explain the difference. First, trusting decisions in a population environment where only trustees are identified remain partially anonymous. In a fixed pairs, since the trustor interacts repeatedly with the same trustee, the trustor is aware that his trustee observes his decisions. Therefore the pair is able to build up a trust-reciprocity relationship. In a population environment with random matching and anonymous trustors the trustee reacts mechanically according to his incentives but is unable to observe the evolution of the trusting decisions of his counterparts. Second, the trustor has only a weak control on the trustee's

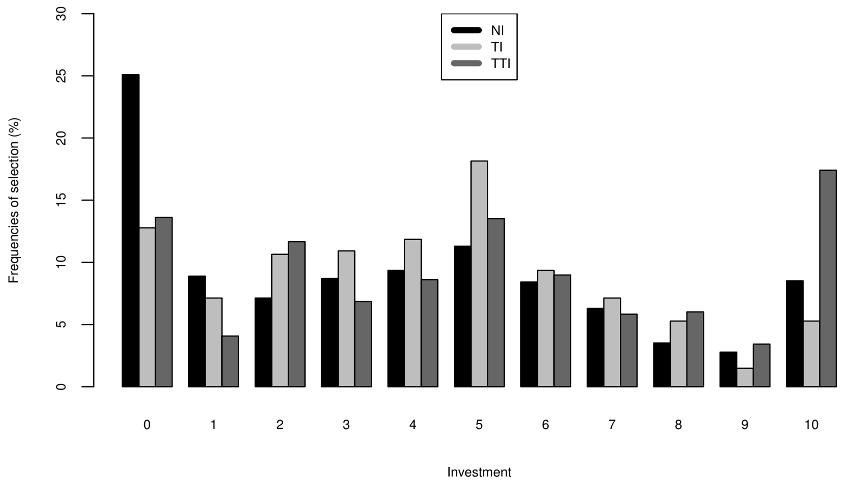

Figure 3: Frequencies of each investment level, in the three treatments

decisions. Since subjects play both roles, under trustees' identification, trustors have only a control on other members' reciprocity decisions but not on their trust decisions. A subject may therefore trust a counterpart who does not trust him (or less), i.e. who does not contribute to the achievement of an efficient outcome for the pair. The second part of result 1 supports this interpretation: adding trustors' identification leads to higher average trust in the population. This positive effect is present in the very first period of play. Moreover average trust stays at a high level for most periods in contrast to treatments where trustors' identification is not feasible.

3.2 Trust and reciprocity choices

Result 2:
(i) Equilibrium strategies are significantly more frequently chosen under complete anonymity,
(ii) "Full trust" is significantly more frequent when both roles are identified,
(iii) Average reciprocity is positively correlated to the investment level in all treatments.

Figure 3 reports the choice frequencies of each level of trust for the three treatments. A one-sided Kolmogorov-Smirnov test performed on each pair of treatments reveals that distributions do not differ significantly (NI vs. TI p-value=0.441, NI vs. TTI p-value=0.441 and TI vs. TTI p-value=0.695). Nevertheless one can obviously observe that in each treatment one strategy is more frequently chosen than the others. In the NI treatment "no trust" (amount sent equal to zero) is the most frequently chosen strategy (25.09%), this is higher

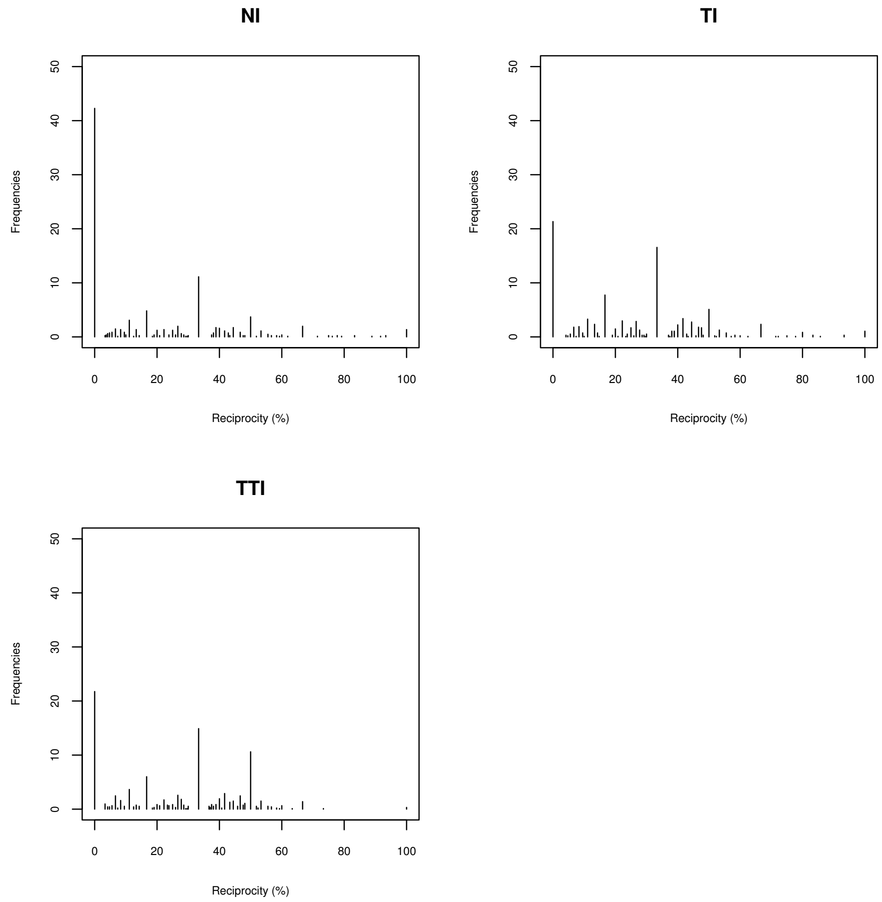

Figure 4: Frequencies of each reciprocity level, in the three treatments

than in the TI treatment (12.78%, MW p-value=0.064) and than in the TTI treatment (13.61%, MW p-value=0.074). The most frequently chosen strategy in the TI treatment corresponds to sending half of the endowment, which represents 18.15% of the choices. The corresponding frequency in the NI treatment is 11.30% which is significantly less (MW p-value=0.067), and 13.52% in the TTI treatment which is not significantly different from TI's (MW p-value=0.131). Finally, full trust (sending of the whole endowment) is the most frequently chosen strategy in the TTI treatment and differences with the two other treatments are significant (MW, TTI vs NI p-value=0.010 and TTI vs TI p-value=0.071).

Figure 4 shows the frequencies of reciprocity decisions. In the NI treatment the zero return strategy represents slightly more than 40% of the trustees' decisions, which is significantly more than in the two treatments with identification (TI: 21.34%, MW p-value=0.013 and TTI: 21.76%, MW p-value=0.013). Between treatments TI and TTI the difference is not significant (MW p-value=0.591). If

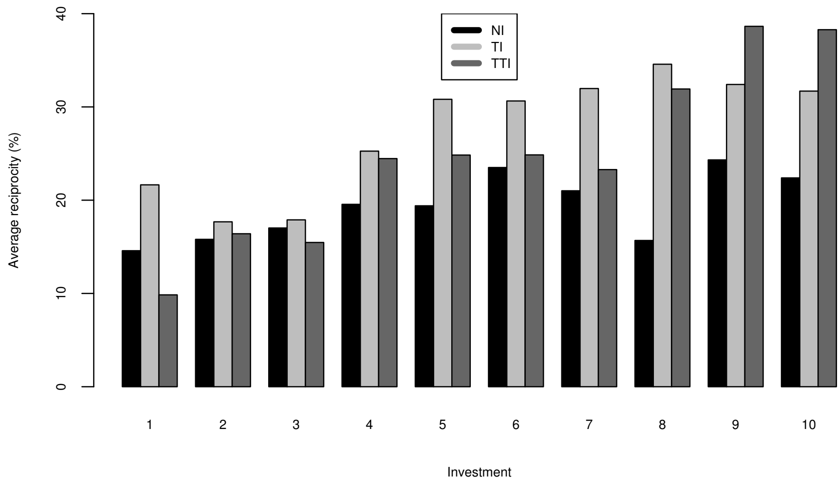

Figure 5: Average reciprocity for each investment level, in the three treatments

the trustee returns at least one third of the amount received the trustor receives a positive share of the surplus created by his investment decision. In the NI treatment only 32.26% of the amounts returned by the trustees are equal or larger than 1/3, which is significantly less than in the treatments with identification: 45.86% in the TI treatment (MW p-value=0.090) and 47.37 in the TTI treatment (MW p-value=0.066). Identification of one role is sufficient for sharing the surplus since again the difference between the treatments with identification is not significant (MW p-value=0.469).

Figure 5 reports the average reciprocity for each trust level. In the three treatments the Spearman correlation coefficient between the investment levels and the average reciprocity is significantly positive (NI: 0.661 p-value=0.042, TI: 0.867 p-value=0.002 and TTI: 0.903 p-value=0.001). A Mann Whitney one-sided test based on correlation coefficients by groups reveals also that in the TTI treatment the correlation is significantly stronger than in the two other treatments (TTI vs. NI p-value=0.013 and TTI vs. TI p-value=0.039), while no such difference appears in the comparison between treatments NI and TI (p-value=0.242). In the NI treatment none of the trust levels generates an average reciprocity at least equal to one third. In the TI treatment the average reciprocity is close to one third for all levels of investment equal or larger than half of the endowment. In the TTI treatment this is can be observed only for very high investment levels (8 to 10).

The investment game has a unique subgame-perfect equilibrium: the trustor keeps his entire endowment and the trustee never returns a positive amount if he receives a positive amount. The equilibrium is inefficient since it leads to a joint payoff of 20 instead of 40 if the trustor sends his whole endowment. If players interact randomly in both roles with each other there is no individual incentive to be trustworthy and consequently trustors have no reason to send positive amounts. As a consequence equilibrium strategies are significantly more frequently chosen by subjects leading more frequently to the most inefficient outcome. On the other hand, with trustees' identification, players acting as trustee have an incentive to build up a trustworthy reputation since it may influence the trustor's future attitude towards them. As expected trustees' identification not only leads to higher average reciprocity as stated by result 1, but also to fewer choices of equilibrium strategies and more surplus-sharing. Our interpretation is that trustees understand the incentive to behave in a trustworthy way when their decisions are privately observed by counterparts with whom they are likely to interact in future periods. However, it is only when they are identified as well that trustors act in a more efficient way, in particular "full trust" (sending the whole endowment). Once again two interpretations are possible : (i) trustors believe that trust is less risky since they have a greater control on their counterpart's decisions, and (ii) trustors signal their cooperative intentions in order to achieve the social optimum in the pair.

3.3 Individual decisions

Kovacs (2006) shows that reciprocity decisions of a subject is positively correlated to the trust he exhibits. In their experimental protocol subjects participates to a one-shot investment game. Before role assignment in the game (trustor or trustee), subjects have to answer a questionnaire in which they must state how much they would send if they would play the role of trustor in the game and for each amount received (0, 3, 6, . . . , 27, 30) how much they would return if they would play the role of trustee. Based on this strategy method the author shows that more trustful subjects are also more trustworthy. Since our subjects play both roles in the game, we can also test if their trust decisions are related to their reciprocity decisions.
A central hypothesis about trustees' identification is that trustors can condition the amount sent on the trustee's type. Is it the case that more trustworthy subjects are more trusted than untrustworthy ones? When both roles are identified, subjects can condition the amount sent on the trustors' type : are trustful subjects more trusted than untrustful ones?

<u>Result 3:</u> There is a strong correlation between :
(i) own average trust and own average reciprocity in all treatments,
(ii) the received amount and average reciprocity under trustees' identification,
(iii) the received amount and average trust under trustors' and trustees' identification.

Figure 6 illustrates the relation between own average trust and own reciprocity. More precisely, for the 36 subjects in each treatment we report subjects' own average trust and own average reciprocity (in percentage of the amount received). In the three treatments there is a significantly positive correlation between subjects' own average trust and average reciprocity. The Spearman correlation coefficients are respectively equal to 0.386 (p-value=0.020) in the NI treatment,

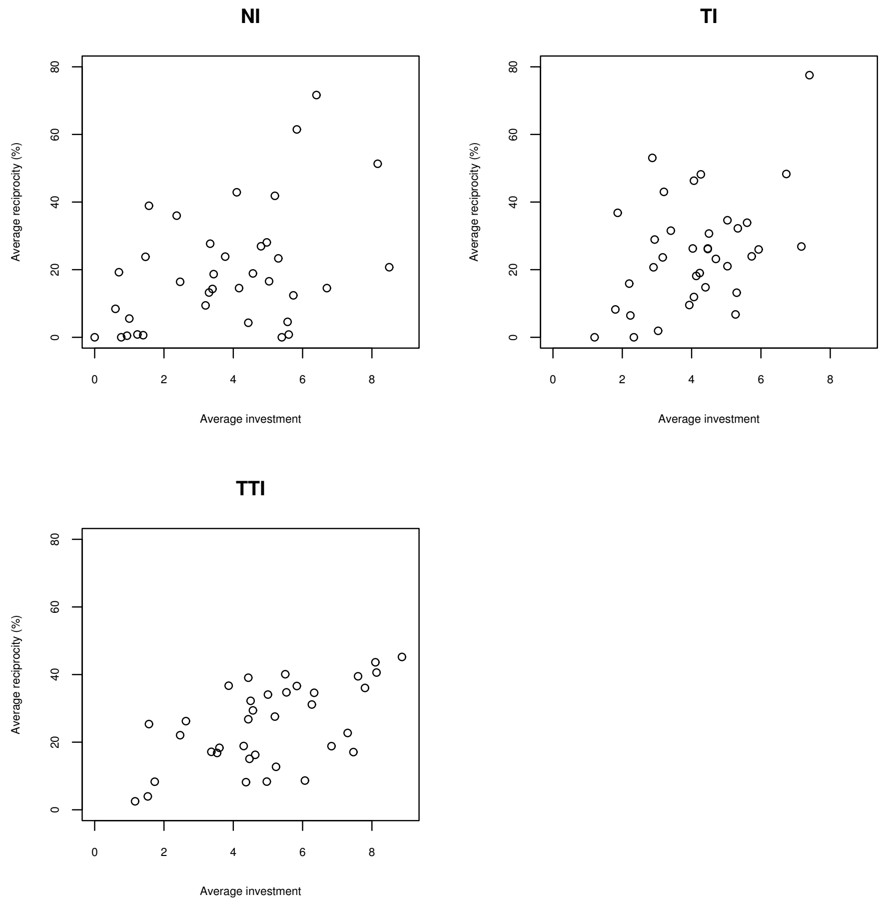

Figure 6: Average reciprocity and average investment of the 36 subjects, in the three treatments

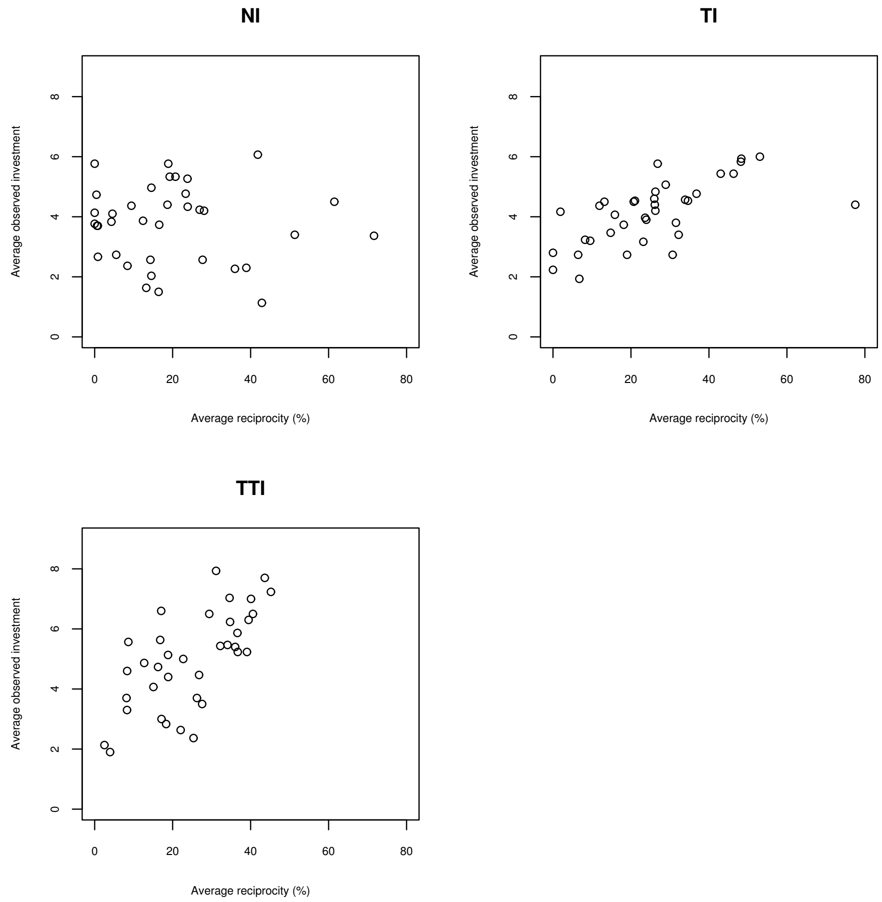

Figure 7: Average reciprocity and average observed investment of the 36 subjects, in the three treatments

0.363 (p-value=0.029) in the TI treatment and 0.558 (p-value<0.001) in the TTI treatment. A Mann Whitney test performed on the average correlation coefficients per groups reveals that the intensity of the correlation is not significantly different between treatments (NI vs. TI p-value=0.235, NI vs. TTI p-value=0.315 and TI vs. TTI p-value=0.131). This result is in line with Kovacs' (2006).

Figure 7 reports, for each treatment, each subject's average reciprocity and average trust placed in them. In the NI treatment subjects cannot condition their trusting decision on the trustee's reciprocity in past periods. In contrast, in the TI and TTI treatments, trustors have at their disposal private records of their past interactions with each trustee. In the NI treatment the Spearman correlation coefficient between subjects' average level they have been trusted and average reciprocity is equal to -0.014, which is not significantly different from

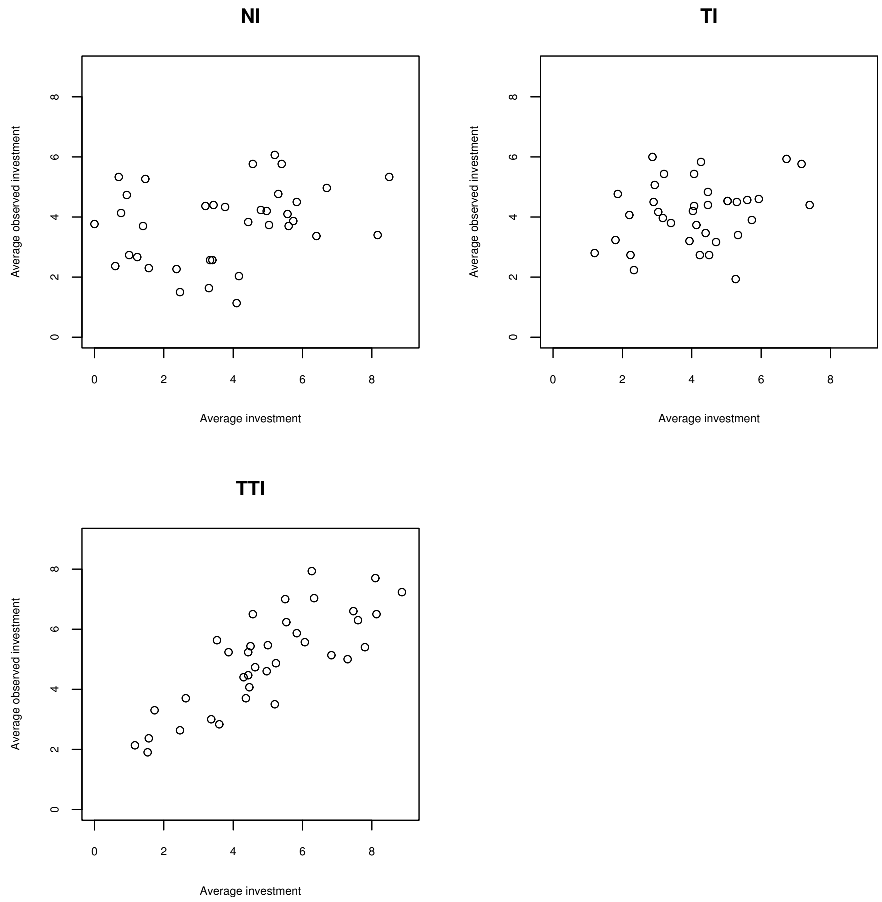

Figure 8: Average observed investment and average investment of the 36 subjects, in the three treatments

zero (p-value=0.936). In the TI and TTI treatments the Spearman correlation coefficients are respectively equal to 0.698 and 0.661, both are significantly different from zero (p-value<0.001 in both cases). These two coefficients are not significantly different from each other (MW p-value=0.5). Hence, as expected, reciprocal subjects are more trusted when trustees' identification is feasible, meaning that trustors effectively condition their trusting decision on trustees' observed behavior.

We conjectured that under double identification a positive relation exists between subject own trust and trust placed in him by the others. Because subjects can identify each other in both roles, a given subject may be more trustful with respect to a member of his group who was trustful to him. Reciprocating trust by trust for a given pair of subjects increases the long term efficiency of their relationship. Figure 8 reports, for each treatment, each subject's average trust level and average trust placed in him. In the NI and TI treatments subjects are trusted anonymously, therefore there is no reason for more trustful players to be more trusted. The Spearman correlation coefficients are respectively equal to 0.281 (p-value=0.096) in the NI treatment[2], 0.200 (p-value=0.242) in the TI treatment and 0.793 (p-value<0.001) in the TTI treatment supporting the conjecture.

As claimed in the introduction of this subsection an important question when subjects play both roles in the investment game is whether subjects' decisions are correlated, that is whether a trustworthy subject is also a trustful subject and conversely. Our data provides positive support for this intra-personal relationship for all treatments. Another important question is related to the effects of identification on individual decisions. Trustees' identification in the population introduces a reputation mechanism in the repeated game. Since trustees are observed in their reciprocity decision they have an incentive to be reciprocal for matched group members to keep on placing trust in them. But this supposes that trustors effectively condition the trust they place in a trustee to the latter's history of play. For measuring this conditional behavior we have analyzed the correlation between the average reciprocity of a subject and the average level he has been trusted. Both correlation coefficients in treatments TI and TTI are in line with the hypothesis. Hence it is in the interest of trustees to be reciprocal when they are individually identified in the population because subjects condition their trust decision on the observed trustworthy behavior in previous interactions. When players are identified in the population both as trustee and as trustor, conditional behavior based on trustworthy past behavior but also on past trustfulness behavior is possible. Do subjects condition also the trust they place in a group member in the latter's trust decision in previous interactions? Once again the answer is positive so that we can conclude that in a repeated trust situation where individual decisions are privately observed by matched players, "cooperative" behavior lead to be more trusted.

3.4 Trust-reciprocity relationships

According to our results identification plays an important role in the emergence of trust relationships. In particular it allows trustors to condition the current amount sent on their counterpart's history of play and expected behavior in future interactions. This possibility to condition one's trust according to the person with whom one is matched means that in the population trust-reciprocity relationships emerged for some pairs of subjects while such relations failed to built up for other pairs. We identify such trust-reciprocity relationships between subjects based on the following definition: a trust-reciprocity relationship between trustor i and trustee j is formed if and only if both players obtain on average a positive (net) profit from their interaction. The (net) profit for a trustor in period t is the amount he gets back less the amount he has initially sent to the trustee, and the (net) profit for a trustee in period t is the amount received from i less the amount returned to i. Taking the average profit implies that the relation between players may have evolved over time. It does not

[2]The correlation coefficient is based on individual averages. If we agregate the correlation coefficients at the group level, the average correlation in the NI treatment is equal to -0.631.

	Treatment	$\overline{s}_{i,ij}$	$\overline{r}_{j,ij}$	$\overline{\pi}_{i,ij}$	$\overline{\pi}_{j,ij}$	Frequency (%)
	NI	3.81	10.53	-2.43	10.05	76.54
Failure	TI	3.76	15.76	-1.75	9.26	68.33
	TTI	3.95	15.12	-1.92	9.83	66.48
	NI	3.59	45.85	1.43	5.75	23.46
Success	TI	4.78	44.07	1.61	7.95	31.67
	TTI	6.70	40.70	2.00	11.40	33.52

Table 2: Trust-reciprocity relationships that failed and those that succeeded, for each treatment

impose a positive profit each period players have interacted together (with i as trustor and j as trustee). Notice that the relation is "trust-oriented". Since players have both roles in the game, a given pair of players may form zero, one or two trust-reciprocity relations. Formally, we consider (ex-post) that a trust-reciprocity relation has been formed between trustor i and trustee j if and only if:

$$\begin{aligned} \overline{\pi}_{i,ij} =& \frac{1}{n} \times \sum_{\tau=1}^{n} (-s_{ij,\tau} + r_{ji,\tau} \times 3s_{ij,\tau}) \geq 0 \\ &\text{and} \\ \overline{\pi}_{j,ij} =& \frac{1}{n} \times \sum_{\tau=1}^{n} (3s_{ij,\tau} \times (1 - r_{ji,\tau})) \geq 0 \\ \text{subject to } &\overline{s}_{ij} > 0 \end{aligned} \tag{1}$$

where n is the number of periods players i and j have interacted together, with i as trustor and j as trustee, $s_{ij,\tau}$ is the amount sent by i to j in period τ and $r_{ji,\tau}$ is the reciprocity (in percentage of the (positive) received amount) return by j to i in period τ.

Result 4:
(i) Trustees' identification increases the frequency of trust-reciprocity relationships in the population,
(ii) Trustors' and trustees' identification lead to higher trust level in the trust-reciprocity relationships between population members

Table 2 reports, for relations that have failed and those that have succeeded according to our definition, the frequency of occurrences, average trust, average reciprocity and the average (net) profit for each treatment (see table 6 in the appendix for the detailed statistical tests inter-treatments and intra-treatment). In each treatment 180 relations (36 players that can form 5 relations each) can potentially be formed if every subject in a group interacts with each other subject in both roles. In the NI and TTI treatments one subject who acted as trustor never met one of the members of his group. Therefore for these treatments the total number of possible links is only 179 instead of 180. In the NI treatment since subjects cannot form links voluntarily the observed links are "chance

	Treatment	$\overline{s}_{i,ij}$	$\overline{r}_{j,ij}$	$\overline{\pi}_{i,ij}$	$\overline{\pi}_{j,ij}$	Frequency (%)
Unilateral	NI	3.42	45.90	1.42	5.42	85.71
	TI	4.53	45.39	1.79	7.28	68.42
	TTI	5.13	38.30	1.18	9.08	40.00
Bilateral	NI	6.09	47.33	1.87	10.30	14.29
	TI	5.92	42.52	1.62	10.23	31.58
	TTI	7.52	44.91	2.71	12.32	60.00

Table 3: Trust-reciprocity unilateral and bilateral relationships, for each treatment

links". 23.46% of the links that could potentially be formed have been effectively formed in the NI treatment, it is less than in the TI treatment (31.67%, χ^2=3.024 p-value=0.082) and less than in the TTI treatment (33.52%, χ^2=4.442 p-value=0.035). In the relations that failed to form the average trust in the three treatments is quite similar (MW, p-value=0.409 in the three comparisons). In the NI treatment the average trust is not higher in formed links compared to unformed one (Wilcoxon one-sided test p-value=0.281), supporting the hypothesis that links are randomly formed. In both environments with identification trustors can voluntarily establish a trust relationship. In these treatments the average trust when link formation succeeded is significantly higher compared to the average trust when it failed (Wilcoxon one-sided test TI p-value=0.031, TTI p-value=0.016). With both roles identification the average trust in the formed links is even higher than with trustee's role identification only (MW p-value=0.013). Trustor's role identification has thus a positive impact on trust between players. However, as previously shown, this positive effect only concerns trust, not reciprocity. The latter is not significantly different in treatment TI compared to treatment TTI (p-value=0.350). Finally, in treatments NI and TI the average net profit of the trustees is significantly higher in unformed-links (Wilcoxon one-sided test, NI p-value=0.016 and TI p-value=0.016) while in treatment TTI this profit is higher in formed-links, even if the difference is not significant (Wilcoxon p-value=0.109).

Among the formed links we distinguish unilateral and bilateral ones. A bilateral relation in the pair corresponds to the existence of two unilateral links. Table 3 reports, for unilateral and bilateral relations, the frequency of occurrences, the average trust, the average reciprocity and the average (net) profit for each treatment (see table 7 for the detailed statistical tests inter-treatments and intra-treatment).

<u>Result 5:</u>
(i) Both roles identification lead to a higher frequency of bilateral relations formation
(ii) In bilateral relations formed voluntarily (TTI treatment), average trust, average reciprocity, average net profit of trustors and average net profit of trustees are higher than in unilateral relations.

Since in the NI and TI treatments bilateral links cannot be voluntarily established there is no reason for average trust to be higher in bilateral relations than in unilateral relations. In both treatments the average trust in bilateral relations is not significantly different from the average in unilateral ones (Wilcoxon one-sided test, NI: p-value=0.500 and TI p-value=0.125). In the TTI treatment bilateral relationships can be deliberately created between population's members. 60% of the observed links are bilateral which is significantly more than in the NI and in the TI treatment (NI: 14.29% χ^2=21.32 p-value<0.001 and TI: 31.58%, χ^2=9.5 p-value=0.002). Average trust in bilateral relationships is higher than in unilateral ones (7.52 against 5.13), a significant difference (p-value=0.063). Average reciprocity is significantly higher in bilateral than in unilateral relations only in the TTI treatment (Wilcoxon one-sided test p-value=0.063). Although trustors' identification does not affect average reciprocity at the population level (result 1) it does so in bilateral relationships. Therefore, the average net profit of subjects acting as trustor in the TTI treatment is significantly higher in bilateral relations than in unilateral relations (Wilcoxon one-sided test p-value=0.031), which is not the case in the other treatments (p-value=0.250 and 0.313 respectively in treatment NI and TI). The average net profit of subjects acting as trustee is also higher in bilateral relations in the TTI treatment (Wilcoxon one-sided test p-value=0.061).

The understanding of endogenous formation of linked-by-trust relationships between agents is a challenge for future research. Our experimental design provides some insights about such relationships. The criterion we have adopted for identifying trust-reciprocity relationships between individuals is close to the one used in the literature related to endogenous network formation (see Jackson & Wolinsky 1996). Based on this criterion our experimental data show that identification is a key feature for trust-reciprocity relationships to emerge. As expected trustees' identification leads subjects to form unilateral links. In these links the average trust is higher than in relations that have failed to form. But more interestingly we observe the formation of mutual trust-reciprocity relationships. In treatment TTI where players identify each other in both roles, mutual link formation is possible. The analyzes show that in these bilateral links average trust and average reciprocity are both significantly higher than in unilateral links and of course higher than in relations that have failed to form.

3.5 Dynamic of individual decisions

Trustees' identification in a population of player involved in a repeated social dilemma generates a reputation mechanism. Such a mechanism provides incentives to be reciprocal and produces information to players about decisions taken in previous interactions. In this section we rely on a panel data analysis to capture the dynamics of subjects' decisions and to identify variables that affect trust and reciprocity. Without identification (treatment NI) subjects have no private information about past decisions taken by the group member they interact with in the current period. Subjects only know a "global" history of play: the average observed trust and the average observed reciprocity in the population. Of course they also know how much they sent, received and returned since the beginning of the game. A subject's current decision can therefore only be influenced by his own past decisions and by global decisions observed in the population. In the TI treatment where only trustees are identified, reciprocity

decisions are influenced by the same variables than in the NI treatment. However, subjects know that they are individually observed. In contrast the current trust decision can be conditioned on past interactions with the current opponent. Finally in the TTI treatment subjects know the past trusting decisions and reciprocity decisions of their current opponent as well as their own past decisions with him. To what extent, does this additional available information condition their trust decision and/or their reciprocity decision?
We estimate a separate model for trust decisions and for reciprocity decisions, independently for each treatment. Equation (2) corresponds to the estimated model for trust decisions in the NI treatment.

$$s_{it} = \alpha + \beta_1 \overline{s}_i + \beta_2 \overline{3s}_j + \beta_3 \overline{r}_i + \beta_4 \overline{r}_j + \beta_5 \overline{\pi}_i + u_{it} \tag{2}$$

where $\overline{s}_i = \frac{1}{t-1} \times \sum_{l=1}^{t-1} s_{il}$ is the average amount sent by i since the beginning of the game, $\overline{3s}_j = \frac{1}{t-1} \times \sum_{l=1}^{t-1} 3s_{jl}$ is the average amount received by i in previous periods, $\overline{r}_i = \frac{1}{t-1} \times \sum_{l=1}^{t-1} r_{il}$ is i's average reciprocity from the first period to period $t-1$, $\overline{r}_j = \frac{1}{t-1} \times \sum_{l=1}^{t-1} r_{jl}$ is the average reciprocity observed by i i.e. the average reciprocity of players j player i has trusted since the first period, $\overline{\pi} = \frac{1}{t-1} \times \sum_{l=1}^{t-1} \pi_{il}$ is the average gain per period of player i, with $\pi_{it} = 10 - s_{it} + r_{jt} \times 3s_{it} + 3s_{jt}(1 - r_{it})$, and $u_{it} = \mu_i + \varepsilon_{it}$ with μ_i an effect specific to i and ε_{it} an idiosyncratic error term ($\varepsilon_{it} \sim N(0, \sigma_i^2)$).

For the TI treatment we introduce two additional independent variables: the average amount sent to the current opponent in previous interactions ($\overline{s}_{ij}$) and the latter's average reciprocity ($\overline{r}_{ji}$). The model is given in (3).

$$s_{it} = \alpha + \beta_1 \overline{s}_i + \beta_2 \overline{3s}_j + \beta_3 \overline{r}_i + \beta_4 \overline{r}_j + \beta_5 \overline{\pi}_i + \beta_6 \overline{s}_{ij} + \beta_7 \overline{r}_{ji} + u_{it} \tag{3}$$

For the TTI treatment we introduce two more independent variables which refer to the behavior of the current opponent acting as trustor in previous interactions: the average received amount from him ($\overline{3s}_{ji}$) and the average reciprocity toward him ($\overline{r}_{ij}$). The model is given in (4).

$$\begin{aligned} s_{it} = & \alpha + \beta_1 \overline{s}_i + \beta_2 \overline{3s}_j + \beta_3 \overline{r}_i + \beta_4 \overline{r}_j + \beta_5 \overline{\pi}_i + \beta_6 \overline{s}_{ij} + \beta_7 \overline{r}_{ji} + \beta_8 \overline{3s}_{ji} + \beta_9 \overline{r}_{ij} \\ & + u_{it} \end{aligned} \tag{4}$$

Table 4 reports the estimates for each treatment[3]. For the NI treatment subjects' trust choices are positively affected by their own average past trust ($\overline{s}_i$), their own average past reciprocity ($\overline{r}_i$) and the average reciprocity observed in the population ($\overline{r}_j$). However the average amount received ($\overline{3s}_j$) has no impact on their trusting decision, meaning that own trust is independent from other subjects' trusting decisions. The constant is significant and negative, corresponding to the strong decrease over time. Several differences appear in the

[3]Estimations have been performed with the *xtreg* Stata's command. In all the models estimations revealed some heteroscedasticity and first order auto-correlation we have corrected. Estimations for (2) revealed the existence of random individual effects (pooled versus individual effects test and Hausman test). The other estimations ((3), (4), (5) and (6)) revealed individual fixed effects.

	NI	TI	TTI
$\overline{s}_i$	0.773***	-0.256*	-0.481*
	(0.063)	*(0.152)*	*(0.269)*
$\overline{3s}_i$	0.027	0.222	0.031
	(0.055)	*(0.135)*	*(0.215)*
$\overline{r}_i$	0.023**	0.038	0.084
	(0.012)	*(0.032)*	*(0.063)*
$\overline{r}_j$	0.044***	0.018	0.077
	(0.011)	*(0.030)*	*(0.050)*
$\overline{\pi}_i$	0.061	-0.070	-0.042
	(0.071)	*(0.173)*	*(0.272)*
$\overline{s}_{ij}$		0.482***	0.360***
		(0.063)	*(0.085)*
$\overline{r}_{ji}$		0.041***	0.045***
		(0.005)	*(0.008)*
$\overline{3s}_{ji}$			0.097***
			(0.017)
$\overline{r}_{ij}$			0.023**
			(0.011)
const.	-2.535***	-1.409	-1.914
	(0.813)	*(1.786)*	*(3.261)*
Wald	$\chi^2(5)$=401.74	F(7,852)=321.61	F(9,730)=42.64
	prob> χ^2=0.000	prob>F=0.000	prob>F=0.000

*** significant at the 1% level, ** at the 5% level and * at the 10% level

Table 4: Trust decision's dynamic for each treatment

regressions for the TI and TTI treatments. Two variables are no longer significant: subjects' own past average reciprocity and past average reciprocity observed in the population. The reason is that subjects rely on their available private information about past decisions of their current trustee : the average amount they sent to him ($\overline{s}_{ij}$) and the latter's average reciprocity ($\overline{r}_{ji}$). Both variables have a positive impact on their current level of trust. This confirms result 3 which stated that if identification is feasible subjects condition their trust decision on the trustee's reciprocity decisions. As for the NI treatment, others' trusting decisions do not affect the subject's own trust. Under both roles identification, subjects also condition their trust in a group member on the latter's trust toward themselves. This favors the formation of bilateral links between some subjects in the population and explains the positive impact of these variables on efficiency in mutual trust relationships.

Explanatory variables of individual reciprocity decisions are captured by the model in expression (5) for the NI and the TI treatments, since subjects observe the same variables in these two treatments. The treatments differ however because in TI subjects acting as trustee know that they are observed by the trustor. Since the reciprocity decision is taken after the trust decision within a period, we introduce as independent variables the amount sent at the begin-

	NI	TI	TTI
s_i	1.346***	0.315	0.856***
	(0.269)	*(0.223)*	*(0.222)*
$3s_j$	0.294***	0.273***	0.406***
	(0.069)	*(0.074)*	*(0.111)*
$\overline{s}_i$	0.695	0.429	0.830
	(1.010)	*(0.684)*	*(1.327)*
$\overline{3s}_i$	-0.642	-0.832	-1.456
	(0.734)	*(0.738)*	*(1.674)*
$\overline{r}_i$	0.395**	0.464**	0.314
	(0.200)	*(0.207)*	*(0.460)*
$\overline{r}_j$	0.007	0.203	0.409
	(0.113)	*(0.182)*	*(0.401)*
$\overline{\pi}_i$	0.927	0.994	0.447
	(0.964)	*(0.974)*	*(2.200)*
$\overline{3s}_{ji}$			0.422***
			(0.125)
$\overline{r}_{ij}$			0.074
			(0.074)
$\overline{s}_{ij}$			0.713
			(0.470)
$\overline{r}_{ji}$			0.116**
			(0.049)
const.	-12.212	-8.76	-14.510
	(13.242)	*(10.992)*	*(22.141)*
Wald	F(7,703)=9.52	F(7,859)=8.00	F(11,605)=28.02
	prob>F=0.000	prob>F=0.000	prob>F=0.000

*** significant at the 1% level, ** at the 5% level and * at the 10% level

Table 5: Reciprocity decision's dynamic for each treatment

ning of the current period (s_{it}) and of course the amount received ($3s_{jt}$). In the TTI treatment, subjects know the average trust of their opponent in past interactions and their own average reciprocity towards him. They also know the average level they trusted him in the past and the latter's average reciprocity towards themselves. The model for the TTI treatment is given in (6).

$$r_{it} = \alpha + \beta_1 s_{it} + \beta_2 3s_{jt} + \beta_3 \overline{s}_i + \beta_4 \overline{3s}_j + \beta_5 \overline{r}_i + \beta_6 \overline{r}_j + \beta_7 \overline{\pi}_i + u_{it} \tag{5}$$

$$\begin{aligned} r_{it} =& \alpha + \beta_1 s_{it} + \beta_2 3s_{jt} + \beta_3 \overline{s}_i + \beta_4 \overline{3s}_j + \beta_5 \overline{r}_i + \beta_6 \overline{r}_j + \beta_7 \overline{\pi}_i \\ &+ \beta_8 \overline{3s}_{ji} + \beta_9 \overline{r}_{ij} + \beta_{10} \overline{s}_{ij} + \beta_{11} \overline{r}_{ji} + u_{it} \end{aligned} \tag{6}$$

Table 5 reports the estimates for models (5) and (6). In all treatments subjects' reciprocity is without surprise positively affected by the amount received. In the NI and TI treatments the reciprocity decision is positively affected by the subject's past average reciprocity but not in the TTI treatment. In the NI treatment the decision is also positively affected by the level of trust chosen in the current period, but not in the TI treatment. In the TTI treatment two variables have a positive effect on the current reciprocity choice: $\overline{3s_{ji}}$, average trust in past interactions of the current opponent, and $\overline{r}_{ji}$, his average past reciprocity. The subject's own average past reciprocity towards his opponent ($\overline{r}_{ij}$), and the subject's own average trust towards him ($\overline{s}_{ij}$) are not significant. Hence, under both roles identification subjects refer more to the paired player's past decisions than to their own behavior in previous periods. Once again this confirms result 3 about conditional behavior as well as results 4 and 5 about the formation of mutual trust-reciprocity relationships. While these models shed some light about the dynamics of decisions in the population, future research should focus on the learning process inside pairs, by allowing subjects to interact more frequently together and over a longer period of time.

4 Conclusion

The aim of our paper was to investigate trusting and trustworthy behavior in a setting close to many real life situations. We implemented therefore several key features of trust relationships that characterize trust in a population : repetition, randomness and experience in both roles (trustee and trustor). Our main interest is in the effects of role identification. Indeed, trustees' role identification is a necessary condition for a reputation mechanism to be introduced in the repeated game. Cochard & al. (2004) and Anderhub & al. (2002) showed that repetition favors both trust and reciprocity in fixed pair of players. In these papers players' identification is exogenous, since at the beginning of the repeated game, players know that they will always interact with the same partner and observe the decisions of the matched player.
Our aim was to isolate trustees' identification in a population where players encounters are random. We found that trustees' identification as such, positively affects average reciprocity but has no impact on trust itself. Even if identified trustees have a stronger incentive to be reciprocal, it is not sufficient for trustors to become more trustworthy. However, with both roles identification trust and reciprocity in the population increase compared to complete anonymity. Furthermore, playing both roles and being identified in each role allows players to built up self-enforcing bilateral trust-reciprocity relationships. We showed that such relations lead to higher trustfulness and higher trustworthiness for linked players and, as a consequence, to more efficient outcomes.

Simultaneity of both roles might have affected our results. Therefore, we intend in future research to investigate the effects of alternating roles. Another interesting extension is to make past trust and/or reciprocity decisions public information. Finally, the population size and the number of periods might have affected our results. It would be therefore of interest to check the robustness of our findings with respect to these dimensions.

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Test		$\overline{s}_{i,ij}$ (p-value)	$\overline{r}_{j,ij}$ (p-value)	$\overline{\pi}_{i,ij}$ (p-value)	$\overline{\pi}_{j,ij}$ (p-value)
Wilcoxon one-sided	NI fail. vs. NI suc.	0.281	0.016	0.016	0.016
	TI fail. vs. TI suc.	0.031	0.016	0.016	0.016
	TTI fail. vs. TTI suc.	0.016	0.016	0.016	0.109
MW, relations that failed	NI vs. TI	0.409	0.013	0.066	0.294
	NI vs. TTI	0.409	0.013	0.155	0.531
	TI vs. TTI	0.409	0.531	0.350	0.409
MW, relations that succeeded	NI vs. TI	0.047	0.409	0.350	0.032
	NI vs. TTI	0.002	0.242	0.242	0.001
	TI vs. TTI	0.013	0.350	0.197	0.004

Table 6: Statistical tests on trust-reciprocity relationships

Test		$\overline{s}_{i,ij}$ (p-value)	$\overline{r}_{j,ij}$ (p-value)	$\overline{\pi}_{i,ij}$ (p-value)	$\overline{\pi}_{j,ij}$ (p-value)
Wilcoxon one-sided	NI uni. vs. NI bi.	0.500	0.750	0.250	0.500
	TI uni. vs. TI bi.	0.125	0.063	0.313	0.063
	TTI uni. vs. TTI bi.	0.063	0.063	0.031	0.063
MW, unilateral relationships	NI vs. TI	0.047	0.469	0.242	0.047
	NI vs. TTI	0.021	0.090	0.531	0.004
	TI vs. TTI	0.242	0.047	0.155	0.047
MW, bilateral relationships	NI vs. TI	0.733	0.267	0.400	0.600
	NI vs. TTI	0.286	0.429	0.286	0.286
	TI vs. TTI	0.206	0.365	0.143	0.143

Table 7: Statistical tests on unilateral and bilateral trust-reciprocity relationships

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