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How do we choose whom to trust?
The effect of social networks on trust

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Abstract

Our social lives are governed by trust. But how do we choose whom to trust? In this work, based on a laboratory experiment, we explore whether building relationships in a social network increases individuals' level of trust. We find that social interactions direct trust, but their impulse is not sufficiently strong to result beneficial.

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JEL Classification: C72, C91, C92, D82, D85

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1 Introduction

In the real world, trust relationships often involve more than two counterparts. Think, for example, of the problem of an investor who can allocate a certain amount of money among different beneficiaries. Another example may be that of a local administrator who is asked to allocate funds, seeds or agricultural tools to some farmers (who are equally capable to exploit what received). Such farmers are expected (but not forced) to return something to the administration which may be part of the production or support in an election. The administrator might decide to invest in only one beneficiary or, alternatively, to invest in more than one beneficiary. Clearly, a rational investor will allocate resources to a party that is more likely to honour the trust by using the profits generated by the investment to repay the moral debt.[1]

But how do we choose whom to trust? Or, equivalently, what makes a potential beneficiary appear more trustworthy than others? In reality, economic actors are socially embedded and are likely to be influenced by social interactions.

Experimental studies of social capital effects on trust and trustworthiness commonly employ the two-player trust game (see Berg et al., 1995). In that game, a first-mover, the 'trustor', decides how much to send to a the second-mover, the 'trustee', who receives more than it has costed the trustor, and decides how much to return to the latter.

In this paper, we prime subjects in a social network in order to observe whether social relationships are able to build trust and convey trustworthiness. In our experiment, groups of six participants, identified by an icon, first play a trust-like game; then they interact in a network formation game for a number of rounds; finally, they play the trust-like game again.

We build on an earlier article, Di Cagno and Sciubba (2010), which finds that donors offer more to those with whom they have been linked more frequently in the network.

As in Di Cagno and Sciubba, we consider groups of six participants, who act as trustors and choose whom to trust. While in their experiment each trustor can choose only one trustee, we allow for the possibility that a trustor may allocate trust to every other player.

[1] Trust is at the heart of investment decisions. Even when a donor gets nothing in return, as in angel investments, higher levels of trust and trustworthiness have been associated with larger investments (Wong et al., 2009; Sudek, 2006; Kelly and Hay, 2003).

Each trustee then decides how much to return to the trustor (of an amount equal to three times the sum received, as in the original trust game).

Di Cagno and Sciubba (2010) use a between-subject design with three treatments: one in which participants play a trust game before some rounds of a network formation game; one in which participants play the trust game after the network formation game; one in which participants only face a trust game. Our experiment is based on a within-subject design, where each participant's trust-like choices are observed both before and after the network game is played.

Di Cagno and Sciubba (2010) focus mainly on the effect of social networks on trustworthiness, in that in their experiment trust is somewhat concealed. In fact, in the trust part of their experiment, donors are essentially faced with several decisions: whether they want to make an offer; in case, who is the recipient of the offer (only one of the other five group members); and finally the amount to offer. This way, only the group member whom the trustor deems the most trustworthy is identified. Therefore, not only changes in the level of trust with respect to the other participants (the ones not selected as trustee) are undetectable, but also it is impossible to trace the way in which the network formation changes the trustor's preferences (if not at a population level because of the between-subject design).

Instead, this work aims attention at trust. In order to identify the determinants of trust, we consider an involuntary trust game (McCabe et al., 2003), where the whole amount the trustor is endowed with must be allocated. This enables us to capture a situation where an individual (or an institution) is committed to invest a certain sum of money, and her/his problem is to identify one or more people who are trustworthy enough to return the funds. Preventing trustors from keeping the whole or part of the endowment for themselves ensures that rationality can only be exercised to recognise the allocation strategy which may earn the most, that is by allocating trust to those who are deemed more trustworthy.

Therefore, in our experiment, allocating money to someone is equivalent to trusting them: the more I trust someone, the more I give her/him with respect to others. For this reason, we refer to this game as the 'trust-allocation game'. By means of this game and our within-subject experimental design we want to observe whether, after the network formation game, a trustor changes her/his trust-allocation strategy based on the social relationships established in the network game.

We assess the effects of social network formation on trust by comparing allocation decisions made after the network formation game to allocations made before the network game. Our aim is to identify features of social interactions that contribute to increasing trust in one (or more) party.

Our results show that trustors choose their trust-allocation strategy depending on whether they are playing the trust game before or after the network formation phase. When the trust-allocation game is played after the network formation game, allocations to potential beneficiaries are less equally distributed compared to the baseline. Furthermore, an investor is more likely to allocate resources to someone s/he has been linked with and/or someone who has been directly linked with others more often. On the other hand, an investor is giving less to someone who has been isolated. Therefore, social interactions do direct trust. However, trustors rarely choose the allocation strategy that would earn them the most. In fact, the best strategy would be that of allocating the whole endowment to only one trustee, in that trustees' generosity increases with the level of trust they are given. Indeed, after the network formation game, trustors tend to favour some trustees with respect to others, and allocate more ECUs to them but not enough to make such a change beneficial. Basically, trustors seem to be reluctant to rely completely even on the trustee whom they deem more trustworthy.

The paper develops as follows. Section 2 discusses the related literature. Section 3 explains the experimental design, including the games, treatments and procedures. Section 4 gives the results. Section 5 concludes the paper.

2 Literature review

Trust games have been studied since the first appearance of Berg et al. (1995)'s contribution. The most common, two-player trust game has been used to address the link between trust, trustworthiness and socially relevant variables including gender (Eckel and Wilson, 2004; Bohnet and Frey, 1999; Hoffman et al., 1996; Buchan et al., 2008; Croson and Gneezy, 2009), race (Fershtman and Gneezy, 2001), and social connections (Leider et al., 2009).[2]

The game that we consider differs from standard, two-player trust games in two main respects: it has one trustor and five trustees, and the trustor has no choice but to give out the whole endowment.

McCabe et al. (2003) propose an 'involuntary trust game' where the trustor has no outside option (i.e. keeping everything by her/himself), as in our experiment, although s/he retains a positive amount. Cassar and Rigdon (2011) analyse a trust game where a trustor allocates an amount to each of two trustees, whom in turn decide how much to return to the trustor. In their game, how much a trustee receives relative to the other is a measure of trust by the trustor, in addition to the amount transferred to a trustee taken in isolation (which is also the only possible measure of trust in the standard trust game). Our game is a simplified version of theirs as it eliminates the latter source of trust by 'forcing' the trustor to give out everything. Furthemore, the game is played with the strategy method (Selten, 1965). More specifically, every subject in our experiment plays both roles of trustor and trustee. In the role of a trustor, a player decides how much to allocate to every other, five trustees; as a trustee, a player decides how much to return for every different level of investment, but irrespective of the identity of the trustee. Burks et al. (2003) show that trust decreases when subjects play both roles in a trust game because a trustor shifts responsibility of a trustee's payoff on random assignment of roles embedded in the strategy method.

Previous studies have considered the effects of social networks on coordination and cooperation (Cassar, 2007), trust (Cassar et al., 2007), altruism and trust (Brañas-Garza et al., 2010), contributions to public goods (Fatás et al., 2009). All these studies have considered exogenous social networks. In contrast, our work focuses on the behavioural consequences of social networks developed in the lab, as in Di Cagno and Sciubba (2010) and Di Cagno and Sciubba (2008).

Social network games similar to ours have been studied in the experimental literature on endogenous network formation. This literature has mainly focused on network convergence (Carrillo and Gaduh 2012) and strategies of link proposals (Callander and Plott 2005, Goeree

[2]See Camerer (2011) for a review of trust games studies.

et al. 2009, Conte et al. 2015).

3 Experimental design

3.1 Procedures

The experiment was run at the Experimental Economics Laboratory of the Max Planck Institute of Economics in Jena (Germany). Participants were mainly students from various backgrounds at the local, Friedrich Schiller University. Each participant was randomly assigned to a session and every subject played only one session.[3] Upon arrival, subjects were randomly allocated to cubicles, where they sat in front of the computer. Instructions were read aloud and time was given to answer questions. The experiment was computerised using z-Tree (Fischbacher, 2007).[4] Subjects were not allowed to communicate with each other during the experiment except for interacting via computers. Subjects were randomly divided into groups of six at the beginning of each session, and group composition was kept fixed until the end of the session.

Subjects in each group were randomly assigned an identifying icon (that is, @, #, ¶, ±, ˜ and ÷). Each subject retained the same icon throughout the session.

The experiment was divided in three parts: a trust-allocation game, followed by at least 30 rounds of the network formation game, followed by a trust-allocation game identical to the previous one. At the beginning of the experiment, participants were informed that the experiment was divided in three parts and that they would have received instructions for each part at the outset of the relevant part.[5]

Subjects were encouraged to ask for clarification after reading the instructions and at any time during the experiment.

We ran a total of 14 sessions in three treatments: 4 in 14, 6 in 15, and 4 in 16 endowment in the trust game. There were 30 participants in each session who were divided into 5 groups of 6 participants each, for a total of 420 participants and 70 groups.

[3]Participants were recruited via ORSEE (Greiner, 2015).
[4]We thank Albrecht Noll for expert computer programming and assistance during the experiment.
[5]Instructions are provided in the Appendix. The original instructions in German are available upon request.

For the trust-allocation game, the conversion rate was 1 ECU = €0.80. For the network formation game, the conversion rate was 1 ECU = €0.02.

Total earnings were defined by the earnings from part 1 or part 3 (the trust-allocation games), plus the earnings from part 2. The earnings from part 2 (network formation game) were determined by the earnings of one, randomly selected, round.

For parts 1 and 3, at the end of the experiment, one of the participants was randomly drawn and asked to draw a ball from an urn containing two balls, one labelled with the number 1 and another labelled with the number 3. The selected ball determined which part of the experiment (either part 1 or part 3) was relevant for determining participants' earnings. Finally, the computer randomly determined the role assigned to each player and the earnings were paid according to choices made in the selected role. The average earning was about €19. In addition to the monies earned in the experiment, all participants received a show-up fee of €2.50. Payments were made individually and anonymously at the end of each session.

3.2 The network formation game

We follow Di Cagno and Sciubba (2010) for the experimental implementation of the network formation game, based on the work of Goyal and Joshi (2003).[6] Players can propose links to one another. There are two types of links: direct and indirect. A direct link implies that two players are mutually proposing a link. An indirect link is a link to other players accessed via an existing link (either direct or indirect). A player can be isolated by having no links - either direct or indirect - with anyone. However, a player can earn only by linking her/himself to others. Direct and indirect links are equally beneficial. However, direct links are costly, unlike indirect links that are free to establish. Therefore, a profit-maximising player will seek to establish as many indirect links as possible.

The game consists of a minimum of 30 rounds of play with a random stopping rule after the thirtieth round.[7]

At the beginning of each round, the computer assigns to each players an initial endowment

[6] Conte et al. (2015) experimentally investigate how players establish connections using the data from the network formation game also analysed in Di Cagno and Sciubba (2010).

[7] More specifically, after the 30th round, the probability of entering a further round of play is 50%.

of 450 ECUs which is equal across participants. The network formation game develops as a series of repeated one-shot games. Therefore, at the beginning of each round, all players are isolated (i.e. there are no formed links among players within a group) and they are asked whether they want to propose any link to the other participants and, in case, to whom. Each player can propose up to 5 links. All players submit link proposals simultaneously. The computer collects the proposals from all participants, and displays the activated links on the screen by means of a line which connects the players who are linked. The symbol representing a player is inscribed in a blue circle.

Each link gives 100 ECUs, while the cost of a direct link is 90 ECUs. The profit rule is:

$$\begin{aligned}\text{Profit} = 450 \quad &+ \quad 100 \times \text{number of participants reached (directly and indirectly)} \\ &- \quad 90 \times \text{number of direct links}\end{aligned}$$

Other features of the experimental version of the game are:

- Profits are displayed on the computer screen;
- The screen provides further information:
  - whether the players have received link proposals (and by which players) that did not result in a direct link because a link to those players was not proposed; and
  - whether the players have made link proposals that have not been accepted.

3.3 The trust-allocation game

The trust-allocation game involved six players. These were the same players that were grouped together at the outset of the experiment, identified by the same icons used in the network formation game. Two identical trust-allocation games were played, i.e. one before (in part 1) and the other after the network formation game (in part 3) .

In each trust-allocation game, all subjects were endowed with 14, 15, or 16 ECUs, depending on the treatment. The game was played with the strategy-vector method. Each subject was asked to make two decisions: an allocation decision, in the role of a trustor, and a return decision, in the role of a trustee. For the allocation decision in the role of a trustor, each subject was asked to allocate the whole endowment among the five other players (each of which could be identified by an icon as described above). So, for each trustee in the second trust-allocation game, the trustor could recall play in the network formation game and condition his decision upon such information. In this respect, icons used in the first trust-allocation game were expected to carry no meaningful information. Any amount allocated to a trustee was multiplied by three, as in most common trust games (see Berg et al., 1995).

For the return decision in the role of a trustee, each subject was asked to specify how many ECUs s/he would return if the amount allocated would have been 1 (then of 3 ECUs), 2 (6 ECUs), 3 (9 ECUs), and so on. Note that a return decision could not be conditioned upon any information about a potential trustor, neither in part 1 nor in part 3, since players were not asked to state a return contingent upon the identity of a particular player, but only upon different levels of trust.[8] Given the presence of multiple trustees, a trustor earns the sum of points returned by the five (at most) trustees.

After the experiment was over, and the random draw meant to select whether it had to be the trust-allocation game in part 1 or the one in part 3 to be relevant for payment, the computer proceeded to assign at random the role of the trustor to one of the six players in the group. Her/his trust-allocation decisions were then applied to the other five players in the group, which had been consequently selected as trustees, and their return decisions retrieved and applied.

3.4 The game that subjects play

Although the network formation game and the trust-allocation game have been presented as two distinct games, the combination of the two in the experiment implies that subjects play a more complex game than just the sum of strategies of the two individual components. This is especially true for the trust-allocation game that follows the network formation game, where a subject playing the role of a trustor might condition her/his decisions upon observation of choices in the network formation game.

[8]It is as if for each trustee all the other group members were the trustor with 20% probability.

Given that the strategy space of the trust-allocation game following the network formation game is significantly larger, more equilibria exist in this game compared to the trust-allocation game that precedes the network formation. A full characterisation of the equilibria in this game is beyond the scope of this paper. In what follows, we only focus on the subjects' choices in the trust games before and after the network. Our aim is to identify the impact of the network formation on allocations and return decisions in the trust-allocation game. We can think of the first trust-allocation game as a game in isolation, given that feedback is withheld until the end of the experiment. In this game, a selfish trustee would return nothing to the trustor, irrespective of what the others have received. The same outcome would occur in the second trust-allocation game, given that is the last game in the sequence and no opportunity for punishing an unfair behaviour is provided thereafter.

The comparison of interest is between allocation decisions in the two trust-allocation games, given that, only when playing in the role of trustors, players in the trust-allocation game in part 3 can condition their choices upon information of the links established in the network formation game with respect to the identity of their co-players. More specifically, we are interested in whether social interaction as emerged in the network formation game can carry over to allocation decisions in the trust-allocation game, i.e. if a player in the role of a trustor can trust more or less a particular other(s), that would be captured by the decision to allocate more or less to a given other(s).

3.5 Treatments and trust-allocation strategies

The games played were the same across all sessions. However, for the trust-allocation games we used three sets of parameters as endowments: 14 ECUs, 15 ECUs, and 16 ECUs. In contrast, for the network formation game, we used the same parameters across the sessions. We refer to games with different values of endowments as treatments.

The optimal trust-allocation strategy depends on the trustor's preferences and on her/his expectations on how the trustees will respond. If the trustor is rational and expects trustees to be rational, any trust allocation would do. This is because rational trustees will return zero, no matter how trust is allocated.

If the trustor expects trustees to reciprocate and return positive amounts to positive offers, the optimal allocation of trust crucially depends on the trustees's response function. If the trustor expects trustees to return a given percentage of what they receive, a risk averse trustor will allocate trust by splitting his endowment equally across recipients.

If, on the other hand, the trustor expects trustees to return positive amounts only in response to very generous offers, it might be optimal to allocate trust unevenly when the trustor is risk averse.

For this reason, we take as an indicator of the trust-allocation strategy for the trustor, the Gini concentration index of her/his offers.

In the three treatments we consider, the trustor is able to implement an equal split of trust only when the endowment is 15 ECUs. In the 14 ECUs and 16 ECUs treatments, the amounts allocated cannot be the same across all players. More specifically, in the 14 ECUs treatment the most equal allocation will discriminate on trustee who will be assigned one point less than the other trustees; hence, it will assign three ECUs to four and two ECUs to one of the other trustees. Analogously, in the 16 ECUs treatment, the most equal allocation will favour one of the trustees by assigning her/him one ECU more than to the others; hence, 3 ECUs to all except one who will get 4 ECUs.

In the trust-allocation game in part 1, each player should have the same chance of being the one who receives less (in 14 ECUs) or more (in 16 ECUs) than the others; since a trustor knows nothing about the trustees (except their neutral identifying icons), s/he has no reasons to give one particular other less or more. This choice should then be made at random at this stage. However, after the network formation game, the icons can be used to identify who has behaved in a particular way in the network formation game, e.g. who has been linked (either directly or indirectly) more intensely to others, which might influence a trustor's choice of whom should get more or less.

4 The allocation of trust

In the trust-allocation games, subjects are demanded to allocate their endowment $m \in \{14, 15, 16\}$ to the other 5 members of her/his group, $j = 1, \ldots, 5$, in her/his most preferred way.

In order to evaluate and analyse the trust-allocation choices, for each subject i, we calculate the Gini's concentration index, varying from the value 0 for an equally split endowment to the value 2 for when the whole endowment is allocated to one single member of the group, in treatment 15. Instead, in treatments 14 and 16, being an equal split of the endowment unfeasible, the minima of this index take value 0.143 and 0.125, respectively. Therefore, for the sake of comparison, we normalise the index, so that in treatments 14 and 16 it takes values from 0 to 2 as in treatment 15.

Figure 1, top panels, displays the distributions of the Gini index in the three treatments before the network game is played. All the histograms are characterised by a large mass at 0, indicating a clear preference (roughly 80% of the observations) for an even allocation of trust. The remainder allocates the endowment in different, more unequal ways, but only very seldom to one player only. This might indicate that they want to signal to the trustee that they have preferred her/him to others and expect her/him to reciprocate by returning a fair amount.

According to t tests, there seems to be no difference in the distributions of the Gini index between treatments (between comparison: treatment 14 vs. 15, p-value = 0.4908; treatment 14 vs. 16, p-value = 0.2204; treatment 14 vs. 16, p-value = 0.4708).[9]

The distributions of the Gini index in the three treatments after the network formation game are displayed in Figure 1, bottom panels. These histograms show three more dispersed distributions, still with a large mass at the equal split, but reduced to roughly 45%, that is 35 percentage points less than when no social interaction had taken place among the members of the group. Again, t tests reveal that there is no difference between the three treatments (between comparison: treatment 14 vs. 15, p-value = 0.6668; treatment 14 vs. 16, p-value = 0.2629; treatment 14 vs. 16, p-value = 0.4294). In stark contrast, paired t tests

[9] All the tests in this and the following sessions are bootstrapped adjusting for clustering at group level.

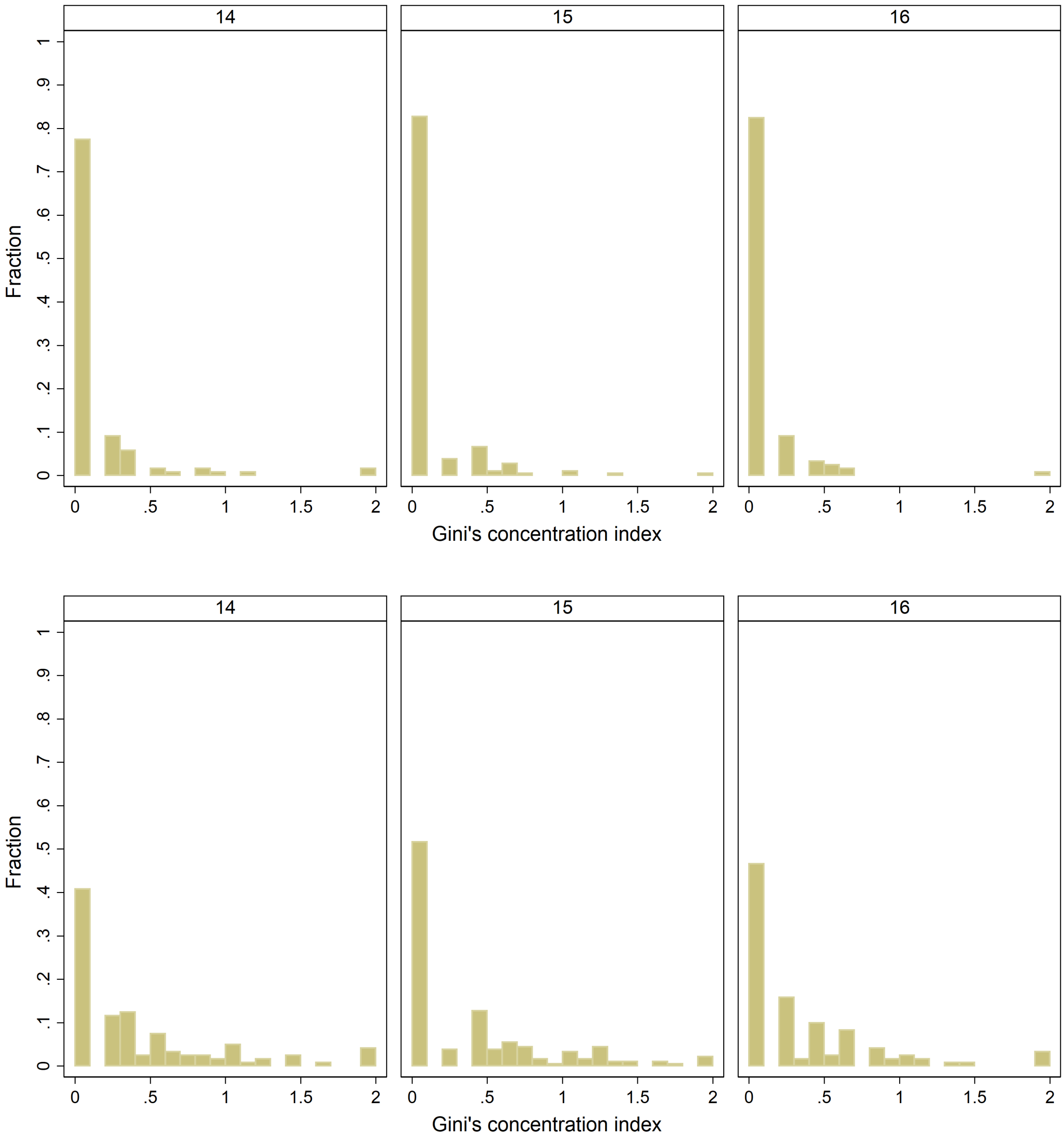


Figure 1
Histograms of Gini's concentration index from trust-allocation game data for part 1 (top panels) and part 3 (bottom panels) by treatment

expose that there is difference in the index distributions before and after the network game (within treatment comparison before vs. after: paired t test, p-value $= 0.0000$ for all the three treatments).

Table 1, left panel, reports the number of subjects who change their trust-allocation

Table 1
Changes in trust-allocation strategies
identical (left panel) and equal (right panel)

Change		14	15	16	*total*
		Treatment			
Change	No	15 12.50	91 50.56	11 9.17	117 27.86
	Yes	105 87.50	89 49.44	109 90.83	303 72.14
	total	120 100	180 100	120 100	420 100

Pearson χ^2 (2) = 81.0871 p-value = 0.000

Change		14	15	16	*total*
		Treatment			
Change	No	55 45.83	101 56.11	60 50.00	216 51.43
	Yes	65 54.17	79 43.89	60 50.00	204 48.57
	total	120 100	180 100	120 100	420 100

Pearson χ^2 (2) = 3.1820 p-value = 0.204

Note: Each cell displays the absolute frequency (top) and percentage per treatment (bottom). In each panel, the Pearson chi-squared test for the independence of rows and columns is reported.

strategy per treatment. There, 'No' indicates no change, 'Yes' that there has been a change in strategy. It would appear that, in treatment 15, 50% of the sample has changed strategy, while in the other two treatments almost 90%. This would account for as a striking difference, if we would not consider that, for example, the five ways in which the trustor can split the endowment to the others in the group but one ECU (which is subtracted from one member in treatment 14 and added to one member in treatment 16) amount to equivalent strategies (the Gini index is the same) even if not identical; as well as the ways in which everything can be given to only one member, whoever this is, correspond to equivalent strategies (also in this case the Gini index is the same), except for the beneficiary which may simply be chosen at random (at this stage, we cannot say anything about the way subjects choose to whom to allocate what). In the right panel of the table, we control for this and we see that the proportion of subjects who change the allocation strategy is close to 50% in all treatments.

Let us now investigate into the number of ECUs which have been allocated to trustees before and after the network. This is displayed in Figure 2. In line with what observed in Figure 1, we see that in part 1, trustors predominantly (77.2%) allocate 3 ECUs to the trustees. In part 3, instead, trustors redistribute the endowment so that the number of trustees who get a number of ECUs larger than 3 increases. Specularly, those who get less than 3 ECUs increases as well. We note that trustors, after the network formation game, tend to distribute the endowment less equally than before, but in a way to give 4 or 5 ECUs to some, rarely more. Only in a few cases (2.5%) they assign more than 6, and in 13 cases (0.4%) the whole sum.

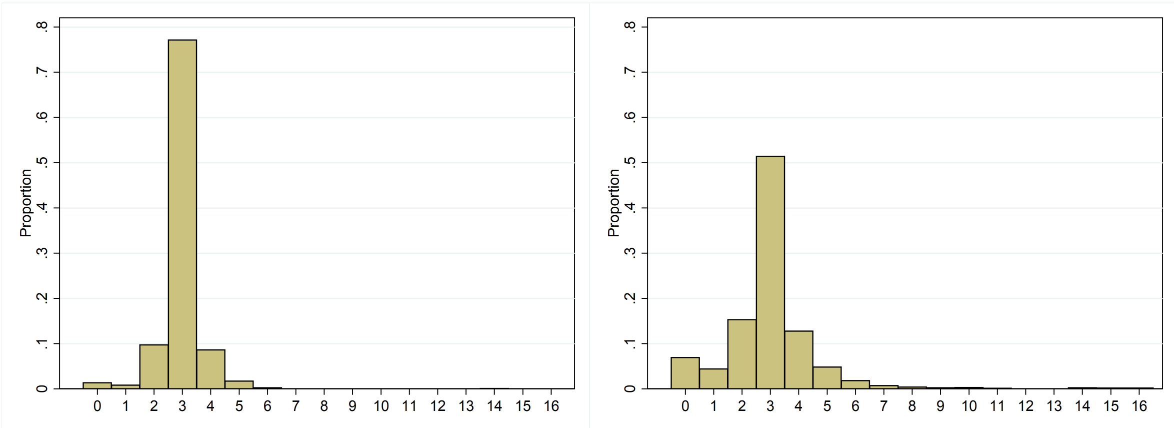


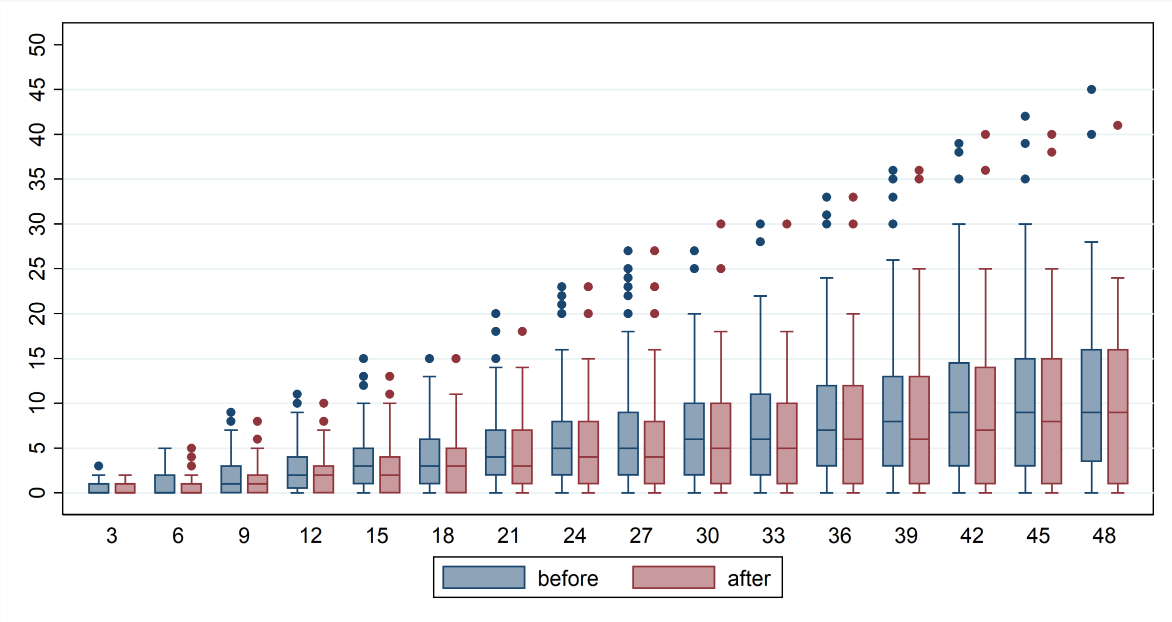
Figure 2
Histograms of the ECUs allocated to each trustee in part 1 (left panel) and in part 3 (right panel)

In summary, the results of this descriptive analysis of trust-allocation game data suggest that there seems to be no relevant difference among the three treatments either before or after the network formation game is played. However, differences emerge when we compare how donors allocate their trust before and after the network, in that at least 50% of them appear to change his/her own strategy, even if they rarely attach their trust to one single trustee. Whether such changes are induced by the relationships established in the course of the network formation game is what the econometric analysis in Section 5 is meant to shed light on.

4.1 Analysis of responses in the trust-allocation game

We also look at responses to trust by trustees in the trust-allocation game. Figure 3 displays box plots per received amount (already multiplied by three) before and after the network formation game (blue and red, respectively). On average, after the network, subjects tend to return less than before, except for when they receive only 3 ECUs (that is the proposer has allocated just 1 ECU to them). This also emerges from paired t tests per received amount.

All the tests have a p-value $= 0.000$, except for when the received ECUs are 3 and 48 with p-values equal to 0.1203 and 0.0251. In general, in part 1, trustees tend to return 20.25% (stand. err. 0.23) of the received amount and 17.09% (stand. err. 0.21) in part 3, on average, which are significantly different (paired t test: p-value $= 0.000$) but not enormously so. A possible explanation of this result may be an income effect induced by the network formation game, where all participants earn a positive amount of ECUs. Instead, when the trust-allocation game is played first, subjects do not know the characteristics of the games that they are going to face afterwards, and cannot anticipate such an effect.



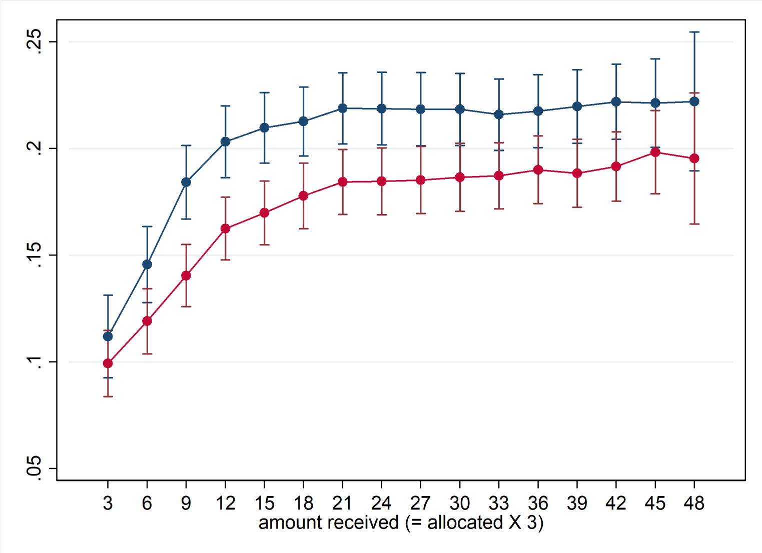
Note: The amount received, displayed on the horizontal axis, is already multiplied by 3.
Dots are outside values.

FIGURE 3

BOX PLOTS OF THE AMOUNT RETURNED IN THE TRUST-ALLOCATION GAME IN PART 1 (BLUE BOXES) AND PART 3 (RED BOXES) PER AMOUNT RECEIVED

The mean earnings from the trust-allocation game are 8.424 (stand. dev. 3.396) in part 1 and 6.419 (stand. dev. 3.309) in part 3. Their distributions are significantly different according to a paired t test (p-value $= 0.000$). In 310 cases (73.8%), trustors earn less after the network, and in only 56 cases (13.3%) they earn more.

Is the trustworthiness built in the network game well deserved? In other words, is it



Note: Capped spikes represent standard errors.

Figure 4

Average proportion of what returned with respect to allocations in part 1 (blue boxes) and in part 3 (red boxes)

convenient for the trust-allocator to change her/his strategy after the network? To answer this question, we have calculated the earnings for each player in the trust-allocation game in the role of trustor from the strategies submitted after the network, and the earnings s/he would have got after the network, had s/he adopted the same strategy used in the trust-allocation game before the network.

The mean earnings from the strategies adopted before the network formation game would have been 6.517 ECUs (stand. dev. 3.031), those adopted after were worth 6.419 ECUs (stand. dev. 3.309). The two distributions are not significantly different (paired t test, clustered at group level: $t = 0.163$, p-value $= 0.871$).[10]

Figure 4 shows the scatterplots of the proportions of the amount returned per received amount. Whenever the trust-allocation game is played, either before or after the network, the proportion of ECUs returned to the trustor is larger, on average, the larger the amount allocated. Had the trustors allocated the whole endowment to only one trustee or at most

[10]In 129 cases (30.71%), trustors earn less by changing strategy (the difference is -2.217 (stand. dev. 1.713)); in 106 cases (25.24%), instead, they earn more (the difference is 2.311 (stand. dev. 2.108)). For 185 trustors (44.05%), it does not make any difference either because they have not changed the strategy at all or because the strategy adopted after the network was worth exactly as much as that chosen before the network.

(but less efficiently) split it equally between only two trustees, they would have maximised their expected earnings, and certainly gained with respect to the equal split so popular in part 1.[11] Instead, trustors in part 3 mainly favour and discriminate one or two trustess by only 1 or 2 ECUs. By doing this, they seem to understand that by allocating more trust to a trustee they would earn her/his gratitude and, consequently, a larger amount of ECUs returned. However, they do not seem to be sufficiently committed to this idea or the trustees do not seem to have conveyed trustworthiness in the network so decisively to earn the trustor's complete trust.

The result about trustees returning less to the trustor after the network formation game is in stark contrast with what Di Cagno and Sciubba find. They interpret the fact that trustworthiness is higher after social interaction as evidence of an 'information value' of network, whereby getting to know others provides information on their type and expected trustworthiness. In our setup, where trustees do not know the identity of the donor, the level of trustworthiness only depends on the received amount, suggesting that the higher level of trustworthiness in Di Cagno and Sciubba is due to subjects behaving as conditional cooperators rather than to the 'information value' of the network. However, we have to note that the two games (the standard trust game in one case and the trust-allocation game in the other) are different. In our game, after the network game, trustees, who now have collected information about the other group members (and may have formed beliefs about the other group members' trustworthiness), may free ride relying on the others' generosity. Such a behaviour cannot be observed in Di Cagno and Sciubba where only one trustee was the recipient of the donor's trust, and, therefore, may have felt compelled to remunerate a familiar and kind trustor.

5 The econometric model of trust allocation

Here, we describe the econometric model that we use to fit the data from choices on the allocation of trust.

[11] For example, in treatment 15, the equal split earns 8.2845 and 6.3225 ECUs, on average, in part 1 and 3, respectively. Instead, allocating all the sum to only one trustee would earn the trustor, on average, 9.96 and 8.92 ECUs, respectively.

For this purpose, let us try to figure out subject i (the trustor-allocator) faced with the other 5 group components, $j = 1, \ldots, 5$, to whom s/he is asked to allocate 1 ECU of trust.

The preferences in terms of trust of the trustor with respect to these co-players are evaluated as

$$v_{ij} = u_{ij} + \epsilon_{ij} = \beta' x_{ij} + \epsilon_{ij} \tag{1}$$

Here, u_{ij} is the deterministic component of the trust preference function, which is a linear combination of the characteristics of i and j and their relationship, x_{ij}, linked by the vector of coefficients β representing the effects of such characteristics on i's evaluation of j's trustworthiness; ϵ_{ij} is a random component, independent and identically distributed as a Gumbel distribution (see McFadden 1974).

Suppose that i is asked to choose to whom of the 5 co-players s/he wants to allocate 1 ECU of trust. Then, i assigns the 1 ECU to the j whose evaluation is highest. Finally, suppose that this operation is repeated m times. Then, the likelihood contribution of subject i is

$$L_i = \prod_{i=1}^{m} \prod_{j=1}^{5} p_{ij}^{m_{ij}} \tag{2}$$

Here, m_{ij}, with $\sum_{j=1}^{5} m_{ij} = m$, is the number of ECUs that i assigns to co-player j in m trials. This model is known as Grouped Conditional Logit.

The probability that subject i gives the 1 ECU worth of trust to subject j among his/her 5 co-players is

$$p_{ij} = \frac{\exp(u_{ij})}{\sum_{j=1}^{5} \exp(u_{ij})} \tag{3}$$

Guimarães et al. (2003) and Guimarães and Lindrooth (2007) show that, by interpreting the m_{ij}s as count variables following a Poisson distribution, this model can be estimated via a simple Poisson regression. However, all the variables which are constant within the set of alternatives, that means i's fixed effects and the fixed effects for the group to which i belongs cancel out, and cannot be evaluated.[12] We note that this does not mean that the model suffers from omitted variable bias for not being able to control for such fixed effects; on the contrary, it is as if i's and her/his group's fixed effects were all included in the regression, but their estimates remained concealed.

5.1 Estimation results

Table 2 reports the estimation results of the model described in Section 5 from data collected in the trust-allocation game played after the network formation game.[13] Results from the network formation game are used to control for the effects induced by the relationships established during the 30 or more rounds of play.

TABLE 2

ESTIMATION RESULTS OF NETWORK-INDUCED EFFECTS ON TRUST ALLOCATION

	Specification					
	(1)	(1-l5)	(2)	(2-l5)	(3)	(3-l5)
Proportion of times i and j have been directly linked	0.3154	0.3263	0.3537	0.3975	0.4593	0.5119
	(0.1536)**	(0.0943)***	(0.1333)***	(0.0848)***	(0.1381)***	(0.0896)***
Proportion of times i and j have been indirectly linked	-0.3313	-0.1567	-0.2912	-0.0910	-0.2614	-0.0363
	(0.1777)*	(0.1043)	(0.1589)*	(0.0971)	(0.1599)	(0.0982)
Proportion of times i's proposal was not reciprocated by j					0.2243	0.2114
					(0.0848)***	(0.0538)***
Proportion of times j's proposal was not reciprocated by i					0.2402	0.1324
					(0.0845)***	(0.0545)**
Proportion of times j has been isolated	-0.6842	-0.1734	-0.7663	-0.3485	-0.7858	-0.3199
	(0.2441)***	(0.1562)***	(0.1814)***	(0.1189)***	(0.1825)***	(0.1201)***
Average number of j's direct links	0.852	0.0615				
	(0.0319)***	(0.0232)***				
Average number of j's connections	-0.0670	-0.0071				
	(0.0524)	(0.0315)				
j's average profit			-0.0009	-0.0004	-0.0008	-0.0004
			(0.0003)***	(0.0002)**	(0.0003)**	(0.0002)**
j's performance in network better than i's (yes=1, no=0)	-0.2193	-0.0426	-0.2242	-0.0457	-0.2769	-0.0518
	(0.1350)	(0.0485)	(0.1346)*	(0.0485)	(0.1356)**	(0.0485)
j's performance in network better than i's (yes=1, no=0)	-0.1607	0.0129	-0.1626	0.0227	-0.2118	0.0186
	(0.1364)	(0.0512)	(0.1363)	(0.0509)	(0.1370)	(0.0509)
Constant	1.4845	0.9952	1.9488	1.3447	1.7947	1.2177
	(0.2319)***	(0.1246)***	(0.2584)***	(0.1548)***	(0.2625)***	(0.1585)***
# observations	2100	2100	2100	2100	2100	2100
# subjects	420	420	420	420	420	420
Log-likelihood	-3770.0223	-3779.0591	-3770.1486	-3780.5594	-3764.9057	-3772.3521

Note: The dependent variable is the number of ECUs assigned to other group members in the trust-allocation game played after the network game.
The performance in the network is measured by average profits.
* p-value < 0.10; ** p-value < 0.05; *** p-value < 0.01

The table presents three different specification of the model of trust allocation (labelled as 1, 2 and 3) in which all the explanatory network-related variables have been calculated over

[12]For example, i's fixed effects are those describing i's performance in the network game, his/her gender or instruction level; i's group fixed effects include measures that describe the performance of the group in the network game, as its connectivity, efficiency, and so on, its gender composition, etc.

[13]In the table, we report the specifications that, we believe, better resume the estimation results. Other specifications are available from the authors on request.

all the rounds of play, and other three (labelled as 1-l5, 2-l5, 3-l5) in which the same variables have been calculated over the last 5 rounds of play only.All the explanatory variables are described in Appendix B

In all the three specifications the 'proportion of times i and j have been directly linked' has a positive and statistically significant effect on the number of ECUs i assigns to j. Instead, the 'proportion of times i and j have been indirectly linked' has just a mild negative effect or no effect at all. In specification 3, the coefficients on the 'proportion of times i's proposal was not reciprocated by j' and the 'Proportion of times j's proposal was not reciprocated by i' are both positive and significant. These results suggest that what matters for the trust allocator is a direct, persistent relationship not one that evolves via mediators. What matter as well is not that link requests have been successful but the fact that both players have made attempts to be linked to each other.

As for the position of j in the network, the number of ECUs i is willing to assign to j is negatively influenced by the proportion of times j has been isolated (i.e. ended the round with no links) in the network game and positively by the average number of direct links established by j, while the number of j's connections (direct and indirect links) does not seem to matter. We deduce from these findings that those who tend to isolate themselves do not inspire much trust. In contrast, those who are happy to bear the costs of many direct links seem to be perceived as very trustworthy. It is not the same for those who have many connections: what matters are j's direct links not her/his connections. We note that one's profits are calculated as a linear combination of direct links and connections. Therefore, in Specification 3 we have included 'j's average profit' among the explanatory variables instead of j's direct links and connections. The estimated coefficient shows that the number of ECUs assigned to a co-player decreases with her/his average profit. It seems that being successful does not speak for one's trustworthiness, in that people may perceive successful individuals as selfish and greedy, and may not be willing to rely on their capacity to appreciate their trust. Alternatively, trust-allocators may be prone to give more to the "poor", that is to those who have collected less in the network formation game.

This last explanation may be in line with the results related to two dummy variables, one taking the value 1 if j's performance in the network game in terms of average profits was better than i's, the value 0 otherwise, and the other taking the value 1 if i's performed better than j's, the value 0 otherwise. The latter does not seem to matter, while the estimated coefficient on the first is negative and significant, indicating either a competitive behaviour of the trust allocator or a tendency to balance or redistribute earnings among the members of the group.

The results just discussed for the specifications which rely on variables calculated over the entire network formation game are confirmed and, sometimes, made even starker when the variables only refer to the last 5 rounds of the game.

6 Final remarks

Trust is at the centre of our lives which are regulated by social relationships. We do not keep money in our homes. Instead, we may decide to entrust it to one or more financial promoters whom we may personally know, expecting that they will not betray us. Parents may need to decide to whom of their (equally skilled) children they want to allocate their limited budget, hoping to earn their help when they get old. Landowners may need to rely on some farmers to cultivate their land counting on a return from the harvest.

Can trust be built and trustworthiness be conveyed in a social environment? If so, how? These are the questions we have tried to answer via a laboratory experiment.

In our experiment, we have used a modified version of the involuntary trust game, which we have named the 'trust-allocation game', in which we have not allowed trustors to allocate anything to themselves. Instead, we have imposed on them to allocate the endowment to different people, to whom they may or may not be socially connected. Basically, we have created a framework in which being rational simply means allocating trust to those who we deem more trustworthy.

Participants have been organised in groups of six. The number of ECUs allocated to a group member by the trustor has been considered a measure of her/his level of trust towards that individual. We have observed that at least 50% of trustors change their initial, rather uniform distribution of trust in favour of allocations less equally distributed, after a number of rounds of a network formation game, in which group members get to know each other via direct and indirect links and network architectures.

Given the choices of the trustees on the amount of ECUs to return to the trustor for each possible amount received, it appears that it would have been convenient for the trustor to concentrate the amount donated in the hands of one or (at most) a couple of trustees both in the trust-allocation game played before and that played after the network formation game. It is likely that a trustee who has been assigned more ECUs than others may feel gratified and reciprocate by rewarding the trustor.

After the network formation game, trustors seem to do so by redistributing their trust in favour of those with some characteristics emerged throughout the network formation game. However, trustors do not seem to be sufficiently willing to confide in a single trustee, who may have not have inspired sufficient trustworthiness to deserve the level of trust necessary to make the post-network redistribution beneficial to the trustor.

In conclusion, getting to know each other in a social environment has proven profitable to the trustees who have been able to convey more trustworthiness in the network formation game, but disadvantageous (or unprofitable) to the trustors who have not been willing to rely on them completely.

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Appendices

[These appendices are part of the supplemental material accompanying this paper]

A Experimental Instructions in their English translation

General instructions

Welcome to this experiment. The results of the experiment will be used for the purpose of academic research and will be published in a way that preserves your anonymity.

The funds for this research have been provided by the Max Planck Institute of Economics. The experiment is straightforward. There is a participation fee of €2.5. In addition, you may earn a considerable amount of money, depending partly on the decisions that you make during the experiment and partly on the decisions of your partners. The participation fee and any amount that you may earn in the experiment will be paid to you in cash immediately at the end.

The experiment is composed of three parts, labelled as 'part 1', 'part 2' and 'part 3'. The instructions for each part will be distributed at the beginning of each part. Please read these instructions carefully before you turn to the computer. The instructions for each part will continue to be available to you for reference throughout the experiment.

The payment rule is the following. At the end of the experiment, we will ask one of the participants to draw a ball from an urn containing two balls, one labelled with the number 1 and another labelled with the number 3. The selected ball determines which part of the experiment (either part 1 or part 3) is relevant for determining your earnings. In other words, only the payoffs obtained in one of the two mentioned parts of the experiment will be paid. Instead, the payoff you obtain in Part 2 is paid to you and all the other participants with certainty.

In each part, earnings are expressed in ECUs (Experimental Currency Units). The conversion rate for the ECUs you get from **part 1** of the experiment is **1 ECU = €0.80**. For the tokens you get from **part 2**, the conversion rate is **1 ECU = €0.02**. For the tokens you get from **part 3**, the conversion rate is **1 ECU = €0.80**.

At the beginning of the experiment, you are placed in a group of 6 participants. The 6 participants in each group will play together in all the three parts of the experiment. Each of the 6 participants is randomly assigned an icon (@, #, ¶, ±, ˜, ÷) by the computer. This will identify you and your partners throughout the experiment.

The icons representing you and your co-participants are displayed on the screen in a circle. Please, notice that such a representation is only meant to ease the graphical representation of the results of your decisions, and it is not meant to suggest or imply anything concerning your decisions.

Note that there are neither right nor wrong ways to complete the experiment. You may take as much time as you need to complete the experiment.

As already said, the experiment is divided in three parts. We are now giving you instructions for part 1.

If you have any questions, please raise your hand. An experimenter will come to help you.

Instructions for part 1

In this part of the experiment, in your group there are two roles: one donor and five beneficiaries. The role you take on will be revealed to you only at the end of the experiment, when it will be determined by a random draw. Therefore, now you are asked to play both roles: firstly the role of the donor; secondly the role of the beneficiary.

As a donor, at the beginning of this part, you are assigned an endowment of 15 (14 or 16) ECUs (equal across participants). You are asked to allocate all the 15 (14 or 16) ECUs of your endowment among the other 5 participants (referred to as beneficiaries) in your group in the way you prefer. You cannot keep any token for yourself.

Each beneficiary receives the offered amount multiplied by **three**. For example, if participant @ decides to allocate:

- 3 ECUs to participant #, # receives 9 ECUs;
- 5 ECUs to participant ±, ± receives 15 ECUs;
- 2 ECUs to participant ˜, ˜ receives 6 ECUs;
- and so on.

As a beneficiary, you do not receive any endowment. After the distribution phase, you and all the other participants in your group are given the chance to give back to the donor part of the tokens received. Any number of ECUs can be given back, even 0 ECUs or the whole amount but not more than what you have received.

The computer will ask you to specify the number of ECUs you are willing to give back if you are chosen as a beneficiary of different hypothetical amounts. In the specific, you will be asked how many ECUs you want to give back to the donor, if you receive 6 ECUs, 9 ECUs, 12 ECUs and so on. Please, note that the screen displays the hypothetical amounts received already multiplied by 3.

Your payment in this part

At end of the experiment, only one of the 6 participants in your group is selected as the donor and his/her allocations are implemented for real. Consequently, the other 5 participants are the beneficiaries of the donor's allocations. The beneficiaries' decisions concerning the amounts to give back to the donor in the hypothetical scenarios are then matched with the donor's allocations and the final payoffs are determined.

For example, suppose that @ is selected as the donor and that s/he has allocated 4 ECUs to ÷, and that ÷ has stated that s/he would have given 5 ECUs back, had he received 12 ECUs (4 ECUs multiplied by 3) from the donor. In this case, for this particular pair of participants, @ (the donor) obtains 5 ECUs and ÷ 7 ECUs (12 ECUs - 5 ECUs).

Be careful: beneficiaries are asked to state the amount of ECUs they want to give back to the donor without knowing the identity of the donor (the donor can be any of the other 5 participants in the group). In fact, the participant whose allocations are implemented (who actually plays the role of the donor) is only revealed at the end of the game via a random selection (operated by the computer) of one of the 6 participants in your group.

In summary, your earnings in this part of the experiment are determined as follows:

a) if you are the selected donor, then you earn the sum of the amounts which are returned to you by all your beneficiaries (this amount can be 0 if none of the beneficiaries has returned any ECUs to you);

b) if you are a beneficiary (that is you are not selected as the donor), you earn 3 times the amount received by the selected donor minus what you stated you are willing to send back to the donor. Please, note that, if the selected donor has not assigned any ECUs to you, your earnings in this part of the experiment is zero.

Instructions for part 2

This part of the experiment lasts a random number of rounds: there are at least 30 rounds to be played, after which, and for every further round, a lottery administered by the computer determines whether there is going to be an additional round in this part or whether this part of the experiment is over. The lottery is represented by red and green lights flashing on the screen. If the lights stop on green, your group will play another round; it they stop on red, this part of the experiment is over. The lights will stop either on green or on red with equal probability.

At the beginning of each round, the computer assigns to you an initial endowment of 450 tokens which is equal across participants.

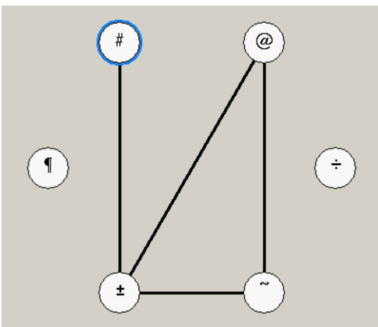
As already explained, every participant in your group is represented by the same icon as in the previous part.

At the beginning of every round all participants are isolated, i.e. there are no formed links among participants within a group. In each round, the computer asks you whether you want to propose any link to the other participants and, in that case, to whom. You may propose 0, 1 or more links (up to 5). All participants submit link proposals simultaneously (that is, without observing the other participants' link proposals). You can choose to whom to propose a link by clicking on the relevant boxes corresponding to each of the other participants in the window on the right-hand side of your screen.

When all participants in your group have submitted their link requests, the computer collects the proposals from all participants, and displays the activated links on the screen by means of a line which connects the participants who are linked.

Links can be direct and indirect. A direct link between two participants is established **if and only if** both participants propose a link to each other. An indirect link between two participants is established when the two participants are not directly linked but they are both directly linked to either another participant or a chain of participants.

Given the link proposals submitted by all participants in a round, suppose that the following links are activated.



- # is directly linked to ± and indirectly to @ and ˜
- @ is directly linked to ± and ˜ and indirectly to #
- ÷ has no direct or indirect links
- ˜ is directly linked to ± and @ and indirectly to #
- ± is directly linked to #, @ and ˜
- ¶ has no direct or indirect links

Activating a direct link has both costs and revenues, which are equal across participants.

Each direct link that you manage to activate costs 90 ECUs. Please, notice that links proposed but not activated (because not proposed back by the participants to whom they have been proposed) bear no cost. Please, note that indirect links have no cost.

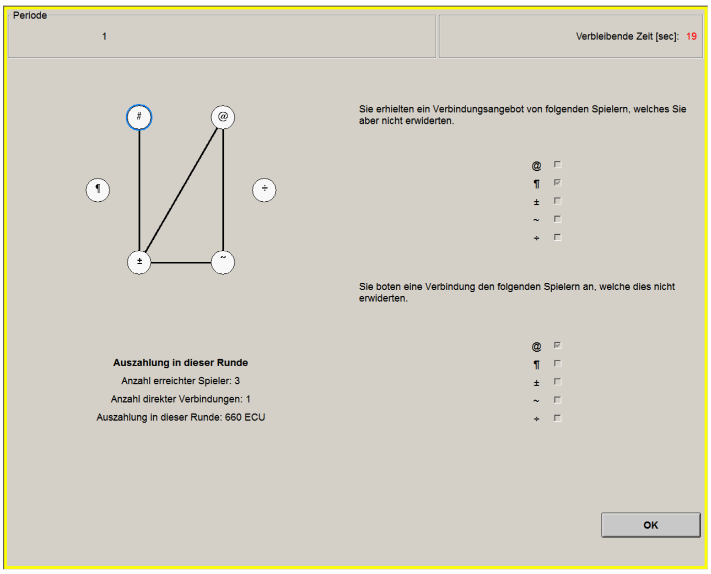
For each link that you manage to activate, both direct and indirect, you earn 100 ECUs. You also earn 100 ECUs for each participant to whom you are indirectly linked with. It may happen that you are linked to some participants both directly and indirectly, and you may also be able to reach a participant indirectly through different chains of participants. In such a case, you only earn the 100 ECUs for having reached that participant once. In other words, you earn 100 ECUs for each participant that you manage to be linked with through both your direct links and the links activated by other participants.

In summary, in each round, your profit is computed as follows:

$$\begin{aligned} \text{Profit} = 450 \quad & + \quad 100 \times \text{number of participants reached (directly and indirectly)} \\ & - \quad 90 \times \text{number of direct links} \end{aligned}$$

In the example portrayed in the previous figure, participants' profits are:

- # $\quad 450 + 100 * 3 - 90 * 1 = 660$
- @ and ˜ $\quad 450 + 100 * 3 - 90 * 2 = 570$
- ÷ and ¶ $\quad 450 + 100 * 0 - 90 * 0 = 450$
- ± $\quad 450 + 100 * 3 - 90 * 3 = 480$



At the end of each round, you will see an overview of whom you are directly and / or indirectly connected to on the screen in front of you. The computer will also calculate your earnings for this round and display them on the left side of the screen. The information on the right side of your screen indicates whether and from which player you have received connection suggestions (please note the gray checkmarks), but there was no direct connection between them because you did not suggest a connection. Below you can see your own connection suggestions, which were not replied by the respective player.

At the end of each round, the computer will initiate a new round and you will be able to choose again to whom to link.

Your payment in this part

At the end of the experiment, one round of the several (30 or more) played in this part of the experiment will be randomly selected by the computer for payment. You will be paid according to the profit obtained in that round computed in the way explained above in agreement with your and your partners' link proposals.

Remember that the earnings obtained in this part of the experiment are always paid.

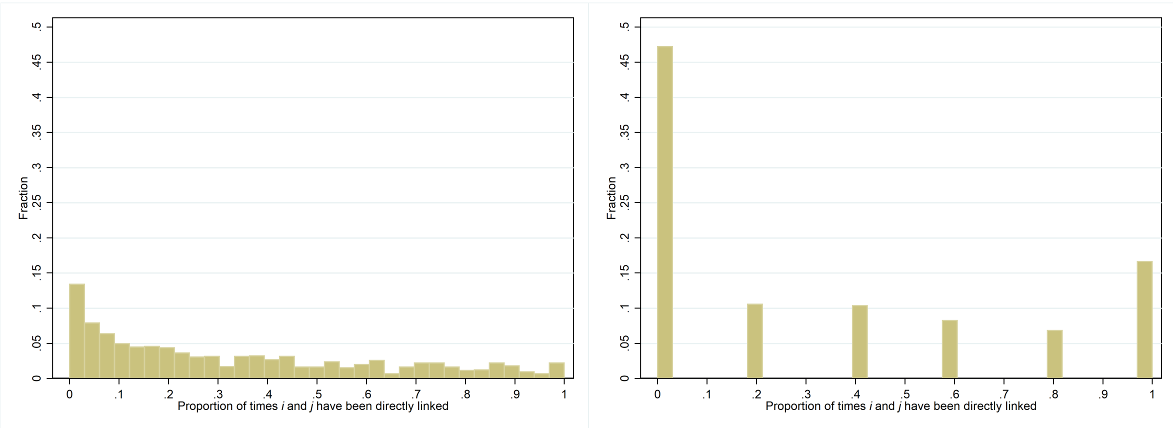
Instructions for part 3

This part of the experiment is identical to part 1. For details on this part, its rules and the way payments are determined, you are referred to the instructions for part 1. Obviously, you are free to make choices different from those submitted in Part 1.

Please, remember that at the end of the experiment, we will randomly select (by drawing a ball from an urn) only one of the two parts (Part 1 and Part 3) for payment. Part 2 is paid with certainty.

B Description of the explanatory variables used in the fitting of the econometric model on trust-allocation data described in Section 5

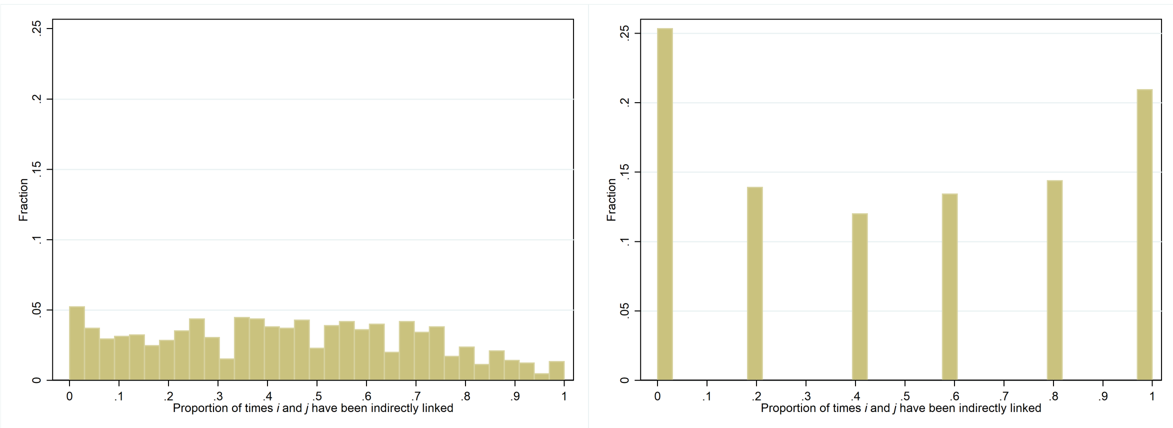
All the variables described here are calculated from the data collected from the network formation game, either from all the rounds of play or only the last five. We also report the correlation between the two distributions.



Note: Correlation 0.8453

Figure B.1

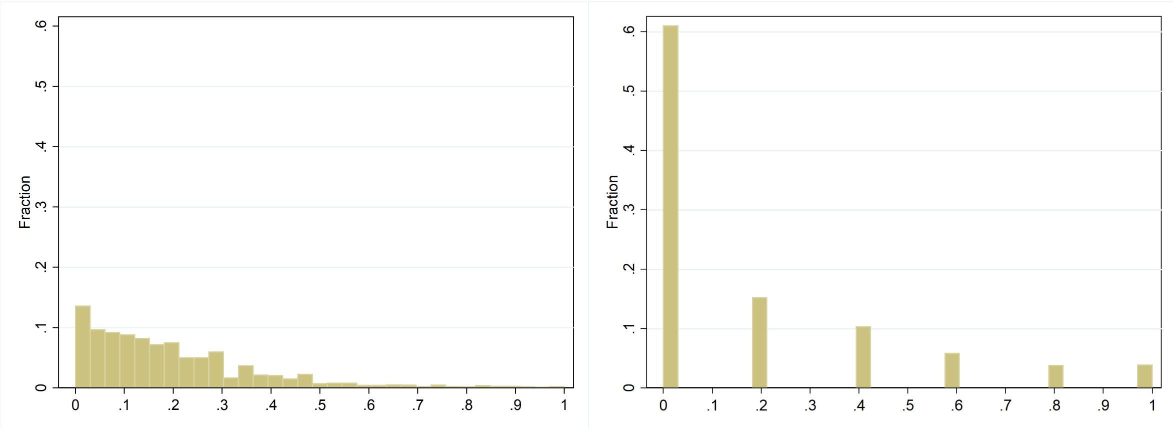
Proportion of times i and j have been directly linked in all rounds of play (left panel) and in the last 5 rounds (right panel)



Note: Correlation 0.8129

Figure B.2

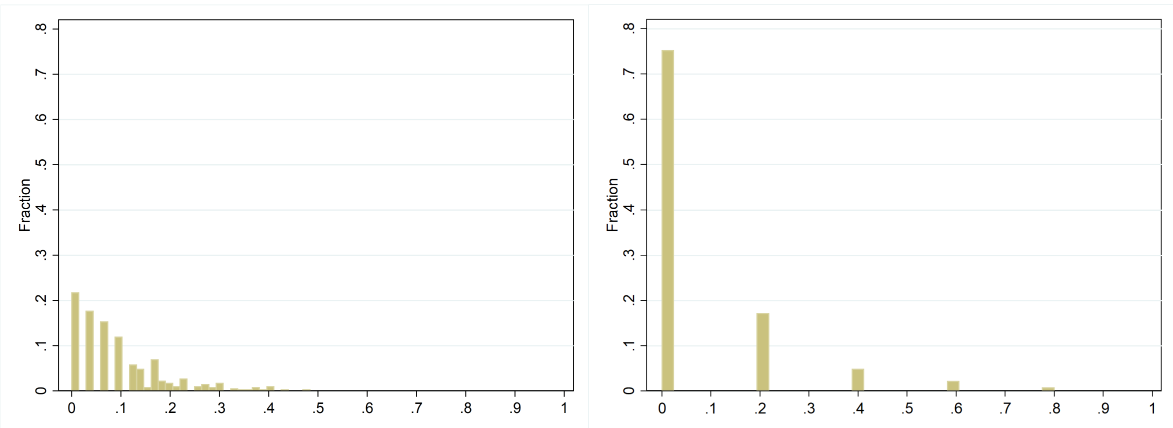
Proportion of times i and j have been indirectly linked in all rounds of play (left panel) and in the last 5 rounds (right panel)



Note: Correlation 0.7308

FIGURE B.3

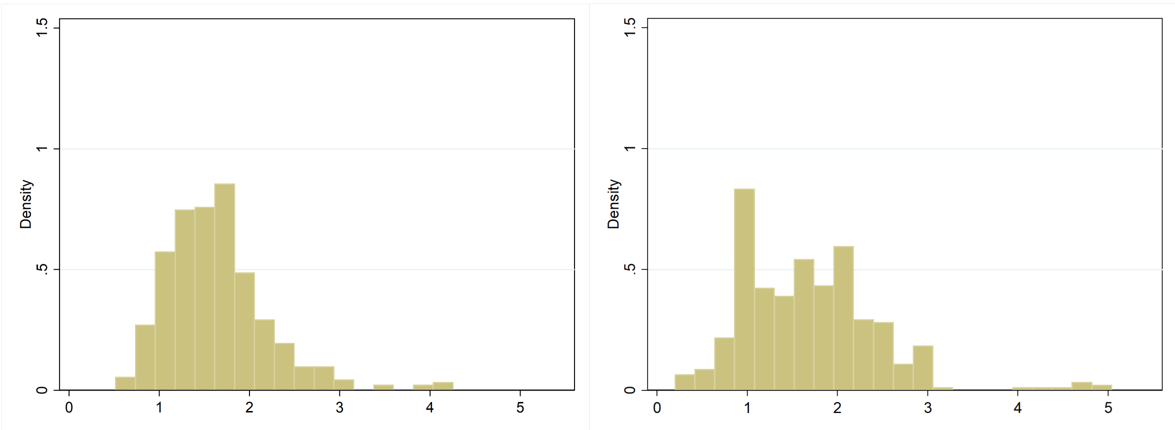
PROPORTION OF TIMES i'S (j'S) PROPOSAL WAS NOT RECIPROCATED BY j (i) ACROSS ALL ROUNDS OF PLAY (LEFT PANEL) AND IN THE LAST 5 ROUNDS (RIGHT PANEL)



Note: Correlation 0.5932

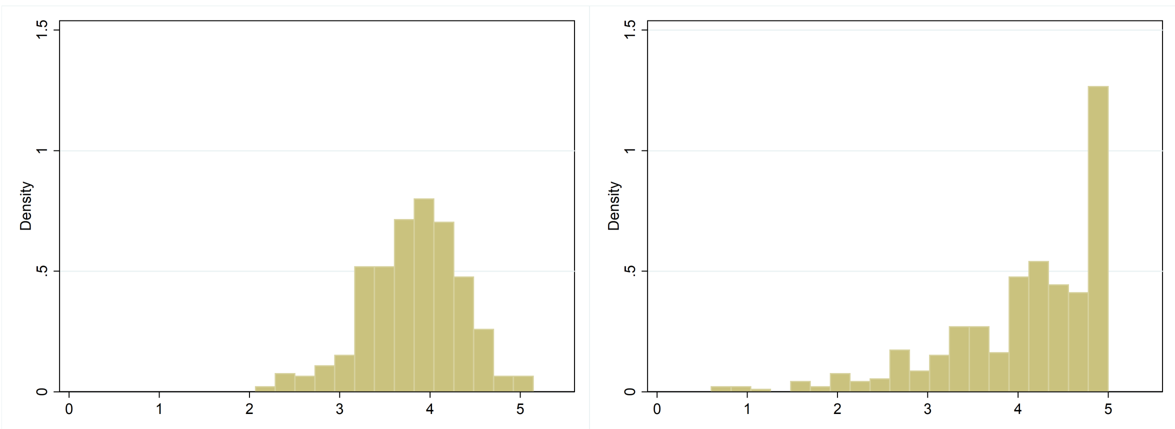
FIGURE B.4

PROPORTION OF TIMES j HAS BEEN ISOLATED ACROSS ALL ROUNDS OF PLAY (LEFT PANEL) AND IN THE LAST 5 ROUNDS (RIGHT PANEL)



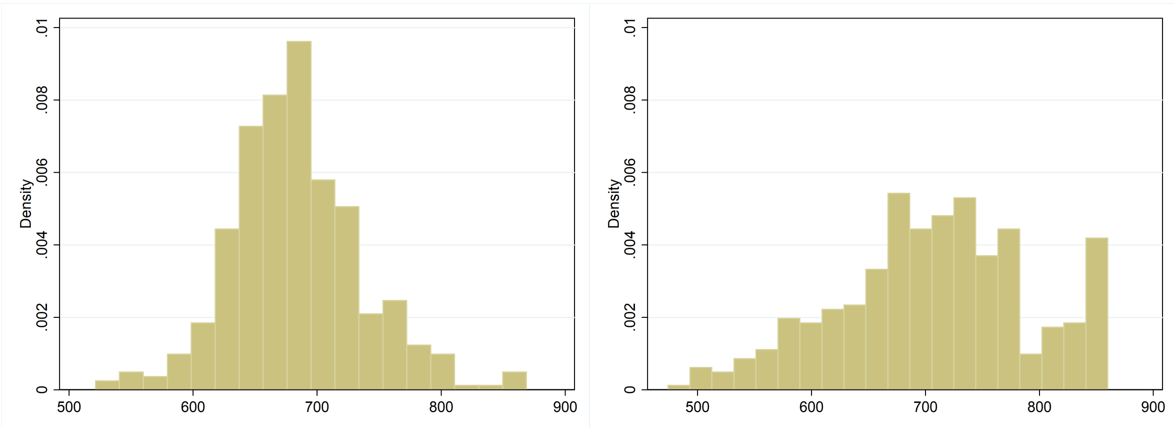
Note: Correlation 0.8346

FIGURE B.5
AVERAGE NUMBER OF j'S DIRECT LINKS
ACROSS ALL ROUNDS OF PLAY (LEFT PANEL) AND IN THE LAST 5 ROUNDS (RIGHT PANEL)



Note: Correlation 0.6157

FIGURE B.6
AVERAGE NUMBER OF j'S CONNECTIONS
ACROSS ALL ROUNDS OF PLAY (LEFT PANEL) AND IN THE LAST 5 ROUNDS (RIGHT PANEL)



Note: Correlation 0.7150

Figure B.7
Histogram of j's average profit
across all rounds of play (left panel) and in the last 5 rounds (right panel)