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Trust, trustworthiness and social networks: Playing a trust game when networks are formed in the lab☆

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ABSTRACT

This paper investigates the impact of network formation on trust and trustworthiness. We run a laboratory experiment where, in sequence, networks are generated endogenously within an anonymous group and subjects play a trust game. The experimental design includes two main treatments and a baseline: in the baseline subjects play a trust game with no networks being formed, in treatment NT the network building phase precedes the trust game, and in treatment TN the network game is played at the end. This allows us to identify the two main factors through which networks impact on trust and trustworthiness: information accrued to subjects through social interaction (when this occurs first) and reputation (when it follows). We find that in NT, the overall level of trust is lower but offers are directed to more trustworthy recipients. A common past history matters in determining whom to trust (information value of networks). In TN, continuation play enforces higher levels of trust and trustworthiness (reputation and enforced reciprocity). Profits that subjects make in the trust game are higher in the presence of social interaction, and significantly so when network formation informs the decision of whom to trust.

1. Introduction

In the best-known version of the trust game (Berg et al., 1995) an agent is asked which portion of a given endowment he or she is willing to entrust to a complete stranger in expectation that the latter will in turn reciprocate by returning more money back than initially received as an offer. The accounting is made viable by the fact that any donation made by the sender is tripled before reaching the recipient. Pareto efficiency would require the sender to trust and the recipient to be trustworthy: if the sender makes a positive donation and the receiver returns an amount not lower than the offer received, both parties are better off (or at least not worse off). However, when this game is played only once game theoretic arguments struggle to reconcile trust with rational behaviour. Solving this simple game backwards, any rational recipient has no incentive to return anything, and as a consequence any rational sender (who is also aware of the rationality of his or her opponent) should not make any positive offer.

In the real world we rarely play trust games with complete strangers. More often we interact with those whom either we have already met and known in similar circumstances, or with those whom we are likely to meet again. In a repeated

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interaction setting trust can be fully reconciled with rationality: if we anticipate that we are going to have future occasions to interact, we may rationally choose to behave cooperatively in fear of future retaliation or in expectation of future rewards (enforced reciprocity); on the other hand, on the basis of the past behaviour of those whom we have already met, we are able to anticipate if they are trustworthy and likely to reciprocate in the future. Social interaction – in this paper mimicked by social network formation – fosters higher trustworthiness.

Leider et al. (2007) run a large scale field experiment where they map real friendship networks among university students and measure trust as a function of the social distance between them. They find that being friends increases the level of trust above what could be explained by altruistic preferences (*absolute trust*) and argue that *differential trust* is caused by repeated interaction. Brañas-Garza et al. (forthcoming) explore the role of social integration on altruism and find that social proximity (as measured by centrality) is an important determinant of giving: central players give more, while subjects with a low degree of integration rarely show altruistic behaviour.

We run a laboratory experiment where networks are generated endogenously within an anonymous group. While these networks do not replicate the complexity of real world friendship, they nevertheless possess the features of repeated interaction that have been claimed to explain differential trust (Leider et al., 2007). Compared to field experiments, the laboratory setting has the clear advantage that allows us to control the endogeneity of the network formation and therefore disentangle the differential trust that can be attributed to repeated interaction from any other possible explanation that may affect both trust and network formation.[1]

Our experiment builds on two phases in sequence: a network formation game, where experimental subjects make choices on potentially beneficial network connections, and a trust game. The trust game is played only once, while the network formation game is a repeated game with a random stopping rule. We run two treatments: one with the trust game followed by the network formation game (TN) and one with the sequence played the other way around (NT). As a control, experimental subjects play the trust game on its own (BSL).

The experimental design allows us to identify the two main factors through which networks impact trust and trustworthiness: information accrued to subjects through social interaction (when this occurs first) and reputation (when it follows).

We find that when there is social interaction before the trust game is played, the overall level of trust is lower compared to the baseline treatment. The economic interpretation of this finding is not obvious, mostly because there are several factors at play. In Section 3.3 we show that in NT the amount offered decreases when the sender was isolated in the network formation phase and when he or she did not manage to secure stable and recurrent connections. Hence a lower level of trust may be explained by the fact that subjects have been disappointed in the network formation phase (disappointment effect).

Also, while in the baseline senders take full responsibility for their recipients' final winnings, in NT senders are aware that their recipients will not leave the laboratory without money as they have already made some winnings in the network phase (reduced responsibility effect).

More interestingly, a common past history matters in determining whom to trust (information value of networks): response ratios and percentages of positive responses are significantly higher when offers are made to those with whom senders have previously interacted.

In the presence of social interaction after the trust game, continuation play enforces higher levels of trust and trustworthiness (reputation, and enforced reciprocity).

1.1. Literature review

Since a seminal article by Berg et al. (1995), extensive experimental literature has developed aiming to document and explain trust. Complementing experimental with survey data, a large literature starting from Glaeser et al. (2000) also attempts to measure trust and to identify its empirical correlates in variables such as gender (see also Bohnet and Zeckhauser, 2004; Eckel and Grossman, 2006; Alesina and La Ferrara, 2002; Eckel and Wilson, 2003), race (see also Fershtman and Gneezy, 2001), family status, social status and connections (the already cited Leider et al., 2007, but also Goeree et al., 2007). This literature is so vast that we do not attempt a review here and we focus instead on those contributions to which our paper and results can be more directly compared.

The trust game that we consider here is different from the standard trust game in many respects. While the usual setting involves two subjects with distinct roles (sender and recipient), here we allow six subjects to choose simultaneously whom to trust with an offer. Hence in our setting: subjects choose whom to trust; they play both roles in the trust game; each subject may receive offers from more than one sender (and potentially reciprocate with each of them). Some of these features have already been considered in the literature, but not all of them within the same setting. Eckel and Wilson (2003) find that choosing the partner in a trust game increases both the level of trust and reciprocity. Burks et al. (2003) show that playing both roles in the trust game reduces the level of trust. They attribute this finding to a *reduced responsibility effect*: senders do not take full responsibility for their recipients' final winnings, being aware that they will in turn play as senders.

[1] Attractiveness, for example, affects the level of trust (Eckel and Wilson, 2006); cultural differences (Bornhorst et al., 2004a), gender (Bohnet and Zeckhauser, 2004; Eckel and Grossman, 2006; Alesina and La Ferrara, 2002; Eckel and Wilson, 2003) and race (Glaeser et al., 2000) have an impact on the level of cooperation among experimental subjects. Naturally friendship formation may also be influenced by the same variables.

The main innovation in our setup is in the fact that a one-shot trust game module is combined with a network formation phase. When network formation is played first, the trust game is no longer anonymous since participants know each other from the network formation game.[2] From this point of view our trust game shares common features with the experimental literature on 'partners versus strangers'; in a public good game, Andreoni and Croson (2001) test the behaviour of players in a repeated game (partners) and in a repeated single-shot game (strangers) and find that strangers cooperate significantly more than partners. If the network game follows the trust game, overall interaction is no longer one-shot as there is a continuation after the trust game. Bornhorst et al. (2004b) study a finitely repeated trust game and find that level of trust is higher than in one-shot games and declines over time. They attribute this finding to learning.

The experimental literature on endogenous network formation[3] has mostly focused on the issue of convergence of empirically observed networks to stable architectures.

Network effects on outcomes or individual behaviour have been studied in the context of exogenously given networks.[4] Cassar (2007) presents experimental evidence of network effects on cooperation and coordination. Cassar et al. (2007) run a field experiment on social network effects on trust. The papers by Leider et al. (2007), Brañas-Garza et al. (forthcoming) and Mobius and Szeidl (2007) focus on the role of social networks on trust and altruistic preferences: they elicit existing social networks and take them as given. Eckel et al. (forthcoming) test status in a star network. Burger and Buskens (2009) support the idea that social environment matters. Fatas et al. (2009) analyses different network structures in a linear public good game with and without punishment. Finally, Cassar and Rigdon (2008) focus on the interaction between network structure and bargaining behaviour in a laboratory experiment. In particular, their concepts of absolute and relativised trust in networks are very close to our results presented in Sections 3.2.1 and 3.2.2. The main difference between theirs and our approach is that in our paper networks are endogenously formed in the lab.

2. Experimental design

The experiment was run at the Center for Experimental Economics at Roma Est (CESARE, LUISS) with a sample of 108 undergraduates in Economics. Each subject participated in only one session and none had previously participated in a similar experiment. Subjects were randomly matched in groups of six and invited to reach the laboratory at different times. Upon arrival, each group was distributed detailed instructions[5] for the experiment and seating was assigned by the experimenters. The instructions were read aloud and time was allowed for questions. In a questionnaire run at the end of the session students confirmed that both the instructions and the experimental design were clear. The experiment was conducted by using a computerised setup[6] and communication among subjects in the room was prevented both by appropriately distanced seating and invigilation.

Each session lasted approximately 40 min and was composed of two phases in sequence: a trust game and a network formation game. At the beginning of each session subjects were informed that the experiment consisted of the two phases in sequence and they were told that the computer would inform them which of the two phases to play first. They were also informed that at the end of the session they had to complete a questionnaire.[7]

We run a total of 18 sessions in 3 treatments: 6 sessions with network formation first (treatment NT); 6 sessions with trust game first (treatment TN) and 6 control sessions with trust game only (BSL). Subjects total earnings were determined by the sum of the profits in each phase and were paid using a conversion rate of 100 points per euro.

2.1. The network formation game

The experimental implementation of the network formation game is as in Di Cagno and Sciubba (2008) and follows the theoretical framework in Goyal and Joshi (2003). The idea is that agents can propose links to one another. Proposals of links are unilateral, but links are established only if mutually agreed. The purpose of establishing links is that agents earn benefits for each other participant whom they are able to reach through their network: benefits are earned not only through those whom are reached directly, but also through those whom agents reach indirectly, through the connections made by others. While only direct links are costly, all connections, both direct and indirect, are beneficial in the same way. Hence the aim for a profit maximising agent is to reach as many nodes as possible with the minimum number of direct links (the equilibrium network is minimally connected: all agents are included and there are no redundant links). Players pay a cost for established links, but not for unmatched proposals.

[2] Real world identities are never revealed, but experimental subjects are identified by the same label across the two games.

[3] See: Deck and Johnson (2004); Callander and Plott (2005); Falk and Kosfeld (2003); Vanin (2002); Galizzi and Bernasconi (2005); Berninghaus et al. (2007); Corbae and Duffy (2008); Celen and Hyndman (2007); Choi et al. (2005) and Choi et al. (2004).

[4] For a thorough review, see Kosfeld (2004).

[5] See Appendix A.

[6] We thank Andrea Lombardo (InformaRoma) for developing very nice software.

[7] See Appendix A.

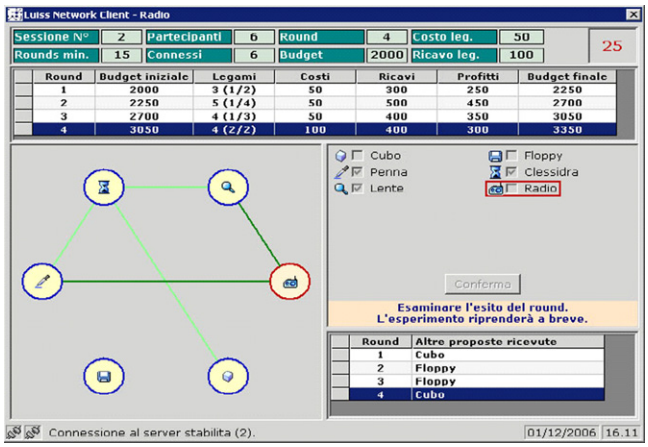

Fig. 1. The participants' screen at the end of round 4.

Sessions consisted of a minimum of 15 rounds, with a random stopping rule determining the end of the experiment.[8]

Participants are represented on the screen by different symbols which we considered neutral in that they do not provide subjects any particular clue when deciding to establish a link with another player in the group.[9] Subjects do not know their symbol (or the other participants' symbols) in advance and can identify themselves on the screen because their symbol is circled in red. The screen also displays the relevant parameters for the session at play. In particular the initial endowment which participants have at their disposal, the unitary cost for established links and the unitary benefit for reached nodes.

In each round subjects are asked to submit (anonymously and independently) their choice of intended links: they can do so by ticking the relevant boxes on the right-hand side of the screen. After all subjects have confirmed their choices, the computer checks which links are mutually desired and activates them. At the end of each round payoffs are computed and displayed on the screen. Great care was put in making sure that all information available to experimental subjects was provided in a user-friendly way. For this reason the graphical interface was designed so that actual links were visualised on the screen as a graph, rather than as a list of activated ties, or as a matrix of 0/1 connections.

As an example, Fig. 1 shows the participants' screen[10] at the end of round number 4. It displays the graph of all active links, total revenues, costs and profits in the round. It also provides information on unmatched proposals: each subject is informed of those players who have proposed a link to them but whom they have not reciprocated. At any time during the experiment participants have access to a great deal of information on past history: by clicking on the bar corresponding to each round they are able to visualise the graph of active links, profits obtained, and all other information relevant to that round.

2.2. The trust game

The trust game is played by a group of six subjects. This is the same group which plays the network formation game and each participant in the group is identified by the same icon which also identifies him/her in the network formation game (which may precede or follow).

All subjects are freshly endowed with 1000 experimental units and have the possibility to choose to donate any integer amount between 0 and 1000 to one and only one subject of their choice within the same group. When the trust game is played before the network formation game, the trust game is completely anonymous. When the trust game is played after the network formation game, participants have observed others' past behaviour in the network formation phase.

Offers are collected by the computer, multiplied by 3 and shown on the screen of the receivers.

Receivers observe the icon corresponding to the donors and have the possibility to reciprocate by sending back a sum between 0 and the amount received (in turn, equal to three times the offer made by the donor). When more than one offer is

[8] At the end of round 15 (and of each additional round after that), a lottery administered by the computer decided if an additional round had to be played. The probability of new rounds was fixed at 50 percent. The lottery was visualised on participants' screens as two flashing buttons, one red (with a NO sign) and one green (with a YES sign).

[9] In this setting we want to avoid any salient coordination device that induces coordination on a particular network. In the pilot for a network formation experiment (see Di Cagno and Sciubba, 2005) we labeled participants with A–F and we found that the alphabetical ordering was explaining most of the networking decisions. See also Galizzi and Bernasconi (2005) and Falk and Kosfeld (2003).

[10] Experimental sessions were run in Italy and all information available on the screen was in Italian. We report below the English translation. *Sessione N* = Session number; *Partecipanti* = Participants; *Round* = Round; *Costo leg* = Unitary link cost; *Rounds min* = Minimum number of rounds; *Connessi* = Number of connected nodes; *Budget* = Endowment; *Ricavo leg* = Unitary revenue from connection; *Budget iniziale* = Initial endowment, *Budget finale* = Final endowment; *Legami* = Links; *Costi* = Costs; *Ricavi* = Revenues; *Profitti* = Profits; *Cubo* = Cube; *Penna* = Pen; *Lente* = Lens; *Floppy* = Floppy disk; *Clessidra* = Hourglass; *Radio* = Radio; *Esaminare l'esito del round. L'esperimento riprendera' a breve* = Please notice the outcome from this round. The experimental session will resume shortly; *Altre proposte ricevute* = Other received proposals; *Connessione al server stabilita* = Successfully connected to the server.

received, beneficiaries have the opportunity to reciprocate with each individual donor according to the same rules. Subjects are aware that the trust game is played only once. In those sessions where the trust game is played first, subjects are also aware that a network formation game will follow and that the same identities will be carried over.

2.3. The game that subjects play

Although for expositional convenience we separate the two phases of the game that subjects play in a "network formation game" and a "trust game", experimental subjects play a single game which is composed by two phases in sequence. Game TN is composed by a trust game in the first phase, followed by network formation. Game NT is composed by a network formation phase, followed by a trust game.

The important implication of considering the two phases as part of the same game is that the set of strategies which each individual has at his/her disposal is larger because subjects'choices in the second phase can be made dependent on the observed outcome of the previous phase. As a result, in TN, subjects' choices for network formation may depend on the observed outcome of the trust game. Similarly, in NT, subjects' choices in the trust game can be made conditional on the observed outcome in the network formation game.

Given that subjects may now choose among a larger strategy space, more equilibria are possible compared to the two games played in isolation. A full characterisation of such equilibria (which would also describe equilibrium behaviour in the network formation phase) is beyond the scope of our analysis. Given our focus on the impact of network formation on trust, we limit ourselves to a partial characterisation of the set of equilibria, where we only predict subjects' behaviour in the trust phase in each of the two treatments.

The trust game played on its own (our baseline treatment, BSL) has a unique and well-known subgame perfect equilibrium: backward induction implies that recipients will not respond positively, hence it is never optimal for the sender to make a positive offer.

Both TN and NT are games with random stopping time and hence can be modelled as infinitely repeated games. As such both games will account for multiple equilibria. The comparison of interest is with the baseline case, in order to establish whether positive levels of trust and trustworthiness can occur in equilibrium in each of the two cum-network treatments.

Let us consider treatment NT first. Here the trust game is played as a final subgame, after the network formation phase has already come to an end. Simple backward induction implies that there is no equilibrium for this game which involves positive levels of trust or trustworthiness. Although subjects may make their choices dependent on the past history of the game, for example by making their offers dependent on the behaviour of the recipient in the network formation phase, it will always be optimal for a recipient not to send any money back in the very last period and as a result, no donor should make any positive offer, irrespective of everyone's behaviour in network formation.

Let us now consider treatment TN. Here a infinitely repeated network formation phase follows the trust game which is played only once at the beginning. We argue that in this case positive levels of trust and trustworthiness may be enforced by appropriate punishments in the network formation phase. Short-term gains for any recipient who does not reciprocate can be offset by the long term gains of belonging to a network. Hence if subjects care for future payoffs and if network gains are sufficiently high, a positive level of trust and trustworthiness can be enforced through the punishment of being forever isolated in the network in case of deviation. Such punishment is credible because mutual isolation (i.e. players who do not propose each other) constitutes a Nash Equilibrium for the network formation game.

2.4. Treatments

We run a total of 18 sessions: 6 sessions with network formation first (treatment NT); 6 sessions with trust game first (treatment TN); and 6 control sessions with trust game only (BSL).

For the network formation phase we used two sets of parameters: in particular 6 sessions (3 from treatment NT and 3 from treatment TN) involved a lower cost of link formation; 6 sessions (3 from treatment NT and 3 from treatment TN) involved a higher cost of link formation. Initial endowment and unitary benefit were kept constant across sessions. In the trust game phase the initial endowment was kept equal to 1000 throughout. In more detail, parameters for all sessions are presented in the table below:

	Subjects	Phase played first	Network phase			Trust phase
			Initial endowment	Unitary cost	Unitary benefit	Initial endowment
Treatment NT						
Sessions 1–3	6	Network	500	90	100	1000
Sessions 4–6	6	Network	500	120	100	1000
Treatment TN						
Sessions 7–9	6	Trust	500	90	100	1000
Sessions 10–12	6	Trust	500	120	100	1000
Baseline treatment						
Sessions 13–18	6	–	–	–	–	1000

All relevant parameters were equal across participants and displayed on the screen at any time throughout the experiment.

2.5. Questionnaire

At the end of all sessions the computer administered a simple multiple-choice questionnaire to gather basic demographic information and trust indicators for the experimental subjects. The complete questionnaire is in Appendix A. Summary statistics for the answers obtained are reported below:

Treatment	NT	TN
What is your sex? (% female)	36.11	13.89
Have you a brother or a sister? (% yes)	63.89	66.67
Where are you from? (% north, % center, % south)	2.78	5.55
	54.89	52.78
	33.33	41.67
Are you satisfied with the amount you earned during the experiment? (% no)	52.78	44.44
Were the instructions and the experiment clear? (% yes)	36.11	27.78
Do you think that you would have earned more if you had more experience with this game? (% yes)	19.44	13.89
Do you like to share things with your friends? (% no)	25	19.44
You have forgotten your watch in the university lavatories. Do you expect that you will find it there when you go back? (% no)	50	83.33
You have lost your wallet on a bus. Do you expect that it will be given back to you? (% no)	58.33	69.44
You are sharing a lottery ticket with some friends, but the ticket is with them. In the case you win, do you expect that your friends will share the price? (% no)	16.67	8.33

We tested whether demographics and reported trust indicators matter in explaining observed differences across the two treatments, however we could not detect any significant role of these variables (see tables in Appendix A).

3. Results

3.1. Network formation

Table 1 provides some descriptive statistics for the network formation phase. While the study of how behaviour in the trust game may affect subjects' choices in the network formation stage is outside the scope of the present paper, it is nevertheless interesting to notice that there do not seem to be obvious ways in which the network formation phase differs across the two treatments. The average number of proposals and links established by each subject does not seem to differ across treatments (t-tests, not reported here, confirm that averages are not significantly different). The number of connections which are secured through a single direct link appears higher when the network game follows the trust game (2.03 in treatment TN versus 1.75 in treatment NT), but a t-test fails to detect any significant difference between the two (t = 1.2168, p-value = 0.2516). Also, average profits earned by subjects in the network formation phase in the two treatments are 2382 (with standard deviation of 1725.18) and 1956 (with standard deviation of 1279.19) in treatments NT and TN, respectively, and they are not significantly different (t = 1.1904, p-value = 0.2379).

More in general we do not detect any significant differences in the way in which networks are formed across treatments and in both cases the results conform to the ones obtained in Di Cagno and Sciubba (2008) where no trust game was played.

Table 1
Descriptive statistics on network formation, by treatment and cost parameter.

Session	Treat	Cost	Rounds	Links	Connections	Conn/links	Proposals	Prop/links
1	NT	Low	15	2.13	4.00	1.88	3.12	1.46
2	NT	Low	20	1.80	4.15	2.31	2.72	1.51
3	NT	Low	20	1.23	2.43	1.98	2.23	1.81
4	NT	High	18	1.24	1.30	1.05	2.32	1.87
5	NT	High	18	0.57	0.68	1.19	0.60	1.05
6	NT	High	18	1.26	2.67	2.12	2.34	1.86
7	TN	Low	15	1.29	2.69	2.09	2.59	2.01
8	TN	Low	17	1.73	3.61	2.09	2.87	1.66
9	TN	Low	16	1.54	3.17	2.06	2.79	1.81
10	TM	High	19	1.46	3.51	2.40	2.30	1.58
11	TN	High	15	1.02	1.80	1.76	1.78	1.75
12	TN	High	20	0.98	1.78	1.79	1.94	1.98
Avg.	NT			1.37	2.54	1.75	2.22	1.59
Avg.	TN			1.34	2.76	2.03	2.38	1.80
Avg.		Low		1.62	3.34	2.06	2.72	1.71
Avg.		High		1.09	1.94	1.72	1.88	1.68

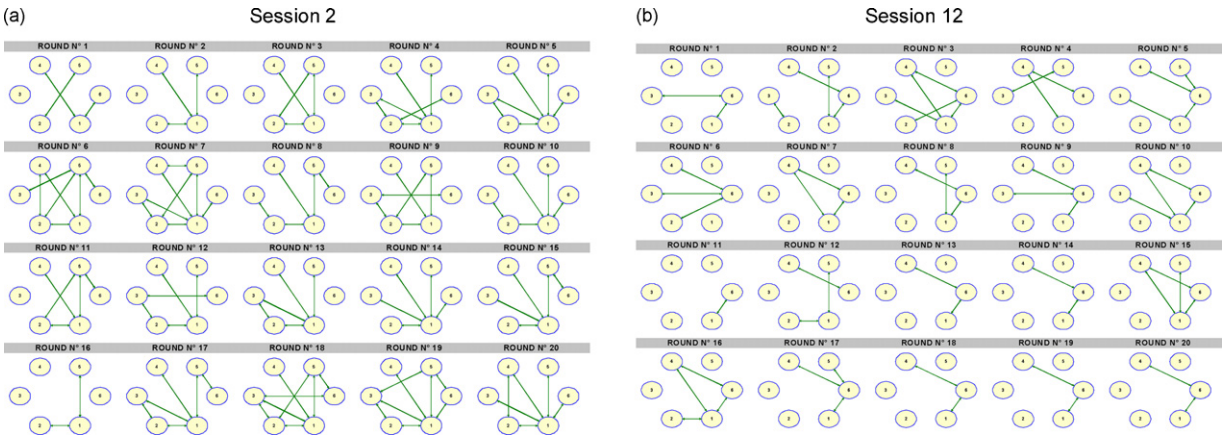

Fig. 2. Network formation in session 2 (treatment NT and low cost). Network formation in session 12 (treatment TN and high cost).

As far as network formation is concerned most of the action lies in cost differences: in low cost sessions (1–3 and 7–9) the number of proposals, connections and links are significantly[11] higher than in high cost sessions (4–6 and 10–12).

Fig. 2a and b provide typical examples of network formation for low cost (session 2 displayed here) and high cost (session 12 displayed here) sessions. There are a few features which are common across low cost sessions and worth noticing: the number of links which subjects succeed in establishing increases after the first few rounds; although there is a tendency to include more and more subjects in the network, some remain isolated at times; some links are recurrent over time (see, for example, the link between subjects 1 and 4, and 1 and 5); some subjects emerge as 'hubs' for a star network across agents (in session 2 subject 1 takes this role). Session 12 is quite typical of high cost sessions, with a much lower number of links established: as for low cost sessions, we notice here that the few persistent links are across the same subjects (link between 4 and 6; and between 1 and 6).

3.2. *Trust game*

We run six control sessions where subjects played our version of the trust game only. Interestingly the results obtained here show that the modified framework does not change the main qualitative results which have been long established by the experimental literature. All subjects made a positive offer, ranging from a minimum of 100 to a maximum of 1000. On average subjects donated slightly more than half of their endowment (average offer of 578); 20 over the 36 recipients reciprocated the offer, with a ratio between average amount sent back and average offer equal to 32 percent.

In sessions 1–6, where the network formation game is played before the trust game (treatment NT), 29 subjects out of 36 made a positive offer; the average amount offered was lower here with respect to the baseline, and equal to 231.94; 21 over the 29 recipients returned strictly positive amounts. Although as a level the average amount sent back was lower in NT than in the baseline treatment, the ratio between the average amount returned and the average offer received was higher and equal to 59 percent.

In sessions 7–12, where the trust game is played before the network formation game (treatment TN), all subjects except one made a positive offer; the average offer was higher than in NT and equal to 551.86; 25 out of the 35 recipients reciprocated by sending back a positive amount. The ratio between average amount sent back and average offer received was 66 percent.

The full set of experimental results obtained for the trust game is presented in tables A2, A3 and A4 in Appendix A.

3.2.1. *Offer*

We can use a box plot to represent graphically the distributions of offers for each of the three treatments (Fig. 3).

It is clear that the distribution of offers in treatment NT has a lower mean and is more concentrated than the distribution of offers in both the baseline and TN treatments. *T*-tests confirm that the average offer in NT is significantly lower than the average offer in both the baseline ($t = 5.3172$, p-value = 0.0000) and TN ($t = 4.2822$, p-value = 0.0001). There is no significant difference between the average offer in BSL and TN ($t = 0.3188$, p-value = 0.7509).

The fact that subjects make lower offers when they play the trust game at the end (NT) rather than at the beginning (TN) is not surprising. When the trust game is followed by the network formation phase, more generous offers in the trust game can be enforced by either fear of retaliation or expectation of reward in the continuation play. A generous offer in the first stage is used as a signal for willingness to cooperate for the remainder of the game.

[11] *T*-tests, not reported here, confirm that these differences are significant.

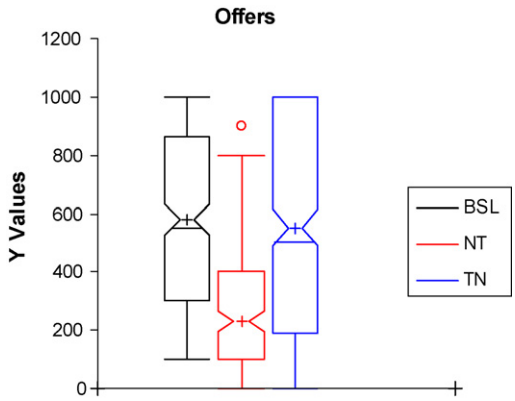

Fig. 3. Trust game, box plot for Offers.

The comparison between BSL and NT is more intriguing. Both when the trust game is played in absence of network formation (BSL) and when it is played after the network formation phase is terminated (NT), there is no continuation play. Hence any significant difference in behaviour between the two frameworks cannot be attributed to expectations which subjects may have about their future interaction within the same group, but has to be put in relation with their common past history.

Our results are unambiguous in showing that a common past history reduces the level of trust: when subjects play the trust game after the network formation game, they make fewer and lower offers.

The economic interpretation of this finding is not obvious, mostly because there are several factors at play. In Section 3.3 we show that in NT the amount offered decreases when the sender was isolated in the network formation phase and when he or she did not manage to secure stable and recurrent connections. Hence a lower level of trust may be explained by the fact that subjects have been disappointed in the network formation phase (disappointment effect).

Also, while in the baseline senders take full responsibility for their recipients' final winnings, in NT senders are aware that their recipients will not leave the laboratory without money as they have already made some winnings in the network phase (reduced responsibility effect). The correlation between offers made in the trust game and recipients' profits in the network formation phase is negative and equal to −0.18: those who made more money in the network formation phase received fewer and/or lower offers in the trust game which followed.

3.2.2. Responses

Summary statistics for the amount sent back for each of the three treatments are reported in Table 2.

The average amount sent back is greater in TN than in the other two treatments. However, while the difference between TN and NT is statistically significant ($t = 2.0221$, p-value = 0.0470), the difference between the average amount sent back in TN is not significantly different from the baseline ($t = 1.5725$, p-value = 0.1203). Similarly, the amount sent back in NT is not significantly different from the baseline ($t = 1.0334$, p-value = 0.3050).

The level of the amount sent back does not *per se* capture trustworthiness, unless we put it in relation with the average offer received. If we look at response ratios, i.e. the ratios between average amount sent back (over all recipients) and average amount offered (over all senders) in each treatment, we obtain a more interesting picture.

In the baseline treatment, the response ratio is equal to 0.32, while in NT and TN it is much larger, respectively, equal to 0.59 and 0.66. Hence even when the average absolute offer is lower in NT than in BSL and TN, there is more reciprocity (responders give back a higher proportion of the offer) when a common past history is available.

The existence of a common past history generates lower offers but at the same time triggers a better response: the existence of a common past lets subjects choose whom to trust. They trust less but they know whom to trust and they manage to get a better response ratio.

Table 2
Trust game, summary statistics for responses.

	BSL	NT	TN
Mean	187.5	136.21	366.89
Std. dev.	251.389	159.65171	636.642
Median	75	100	100
Min	0	0	0
q1	0	0	0
q3	300	200	400
Max	1000	500	3000

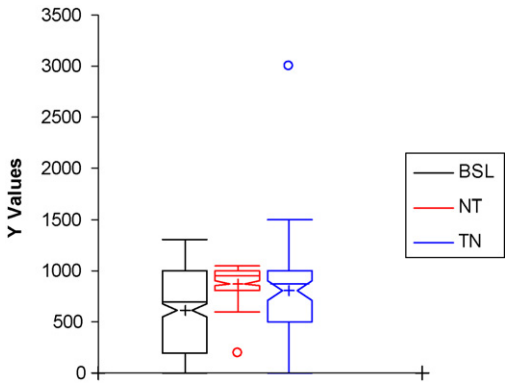

Fig. 4. Senders' profits, box plot.

This finding is confirmed when one looks at the percentages of positive responses in the trust game, i.e. the percentages of recipients who send back a strictly positive amount. In the BSL 56 percent of recipients (20 over 36) respond positively, in NT and TN these percentages are higher and equal, respectively, to 72 percent (21 over 29) and 71 percent (25 over 35).

The existence of a common history seems to play a significant role. When subjects had the chance to interact first, they make lower offers, but the proportion of positive responses increases relative to the baseline.

The network formation phase has an important effect on trustworthiness, both for those sessions where the network formation phase is played before the trust game (treatment NT) and for those sessions where the network formation phase is played after the trust game (treatment TN). The economic interpretation which we provide of this finding is as follows: when the network formation phase is played before the trust game, the offer in the trust game is endogenously directed towards those subjects who signalled themselves as trustworthy in the network formation phase. When the network formation phase is played after the trust game, response ratios are higher because they serve as signals for future cooperation.

Hence social interaction – in this experiment mimicked by the network building phase – fosters higher trustworthiness. This occurs for two separate reasons: information and reputation. Looking at the past (treatment NT), subjects know whom to trust: they spot those who behaved as trustworthy and, by choosing their recipients endogenously, direct their trust to them. Looking at the future (treatment TN), recipients behave in a trustworthy manner, both in fear of retaliation in the future and in expectation of reward for generous behaviour.

While both information (in NT) and reputation (in TN) influence trustworthiness by increasing by a similar extent response ratios and the percentage of positive responses, the impact of these two separate factors can be more clearly distinguished when one looks at the proportion of "generous responses". Generous responses are those such that the amount sent back is higher than the amount offered. In the baseline treatment 16.67 percent (6 over 36) of responses are generous. In NT we have a much smaller proportion of generous responses (3.45 percent, 1 over 29), while in TN the same proportion is higher (28.57 percent, 10 over 35).

While there are almost no generous responses in NT, generous behaviour is rather important in TN. This occurs because such generous behaviour in TN is enforced by the continuation play. In TN subjects may have an incentive to signal that they are willing to cooperate in the next stage. Relative to NT, in TN there are potential gains to exploit. Hence for both sender and recipient it is rational to be "generous".

3.2.3. *Profits*

In this section we focus on the analysis of the profits made by senders in the trust game. Given that all subjects in our version of the game play both the sender and the recipient roles, we isolate the profits made when in a sender role by computing them as follows:

$$\text{initial endowment} - \text{offer made} + \text{amount received back}$$

We find that while average profits in TN are not significantly different from either the baseline (t = 1.6790, p-value = 0.0976), or NT (t = 0.7404, p-value = 0.4616), average profits in NT are significantly different from the baseline (t = 3.58, p-value = 0.0006). Our interpretation of this finding is that the information generated in the network formation phase, when this precedes the trust game, allows senders to choose whom to trust and secures them higher profits both with respect to the baseline and with respect to treatment TN.

The distribution of senders' profits can be represented graphically by a box plot (see Fig. 4).

Senders' profits in NT are more concentrated around the mean: the information obtained through the network formation phase allows senders to direct their offers so as to achieve higher and less volatile profits: informed offers prove less risky for the senders.

We can analyse this further by examining the rate of return on offers made in the three treatments. In the baseline treatment, for each experimental unit offered, senders make 2.52 units (with standard deviation of 3.27), in NT the return

Table 3
Offers, OLS regression, treatments NT and TN.

	Treatment NT			Treatment TN		
	Coefficient	Std. error	*p*-Value	Coefficient	Std. error	*p*-Value
Dependent variable: amount that *i* sends to *j*						
Links of *i* in session (cum)	−5.51	6.55	0.405	13.39	8.06	0.108
Links of *j* in session (cum)	−9.44	3.66	9.017	3.22	8.01	0.691
i Proposed to *j* in session (cum)	37.86	17.75	0.044	1.93	20.35	0.925
j Failed with *j* in session (cum)	−31.58	16.60	0.043	5.72	30.08	0.850
j s Profit in network game	−0.01	0.03	0.771	0.11	0.09	0.229
High cost session	56.31	113.30	0.620	120.89	267.04	0.654
Constant	354.73	163.98	0.042	−113.90	400.91	0.778
Number of observations	29			35		
R^2	0.4331			0.1842	Robust std. errors	

for each unit offered is equal to 5.25 (standard deviation of 3.76), finally in TN the rate of return on offers is 19.15 (but with very high standard deviation of 84.55).

Comparing the average rates of return across treatments we notice that while the high standard deviation of profits in TN does not allow us to state that the average return on offers is any higher in TN than it is in either the baseline treatment (t = 1.1792, p-value = 0.2423), or in NT (t = 0.9857, p-value = 0.3277), we can nevertheless confirm that the average return on offers in NT is significantly different from the baseline (t = 0.329, p-value = 0.0016).

The (statistically significant) difference between the return on offers in NT and the return on offers in the baseline can be interpreted as the value of the information which is released to senders in the network formation phase.

3.3. Networks and trust

We run several OLS regressions to explain the amount offered and the amount sent back as a function of subjects' behaviour in the network formation game. We also add demographic data and trust indicators made available through a questionnaire run at the end of each session.

For the amount offered we propose that it is a function of: total number of direct links of the sender in the network formation phase; total number of direct links of the receiver; number of times which the sender proposed to the receiver; number of times which the sender failed to have his/her proposal to the receiver matched; profit of the sender in the network game; whether the session was a high or low cost one for link formation. Results for treatments NT and TN are in Table 3.

As expected, the results are very different across treatments. In treatment TN, where the network formation game only occurs after the trust game has already been played, none of the network variables are significant in explaining the amount offered. We take this to confirm that any significance detected in treatment NT depends exclusively on the sequentiality between the two phases and it is not to be attributed to other variables which jointly determine both the level of trust and subjects' behaviour in the network game.

In treatment NT we find that donors make larger offers to those with whom they have succeeded in establishing frequent relationships: the amount offered is increasing in the number of times which the donor has proposed to the recipient, but decreasing in the number of times which the recipient has failed to reciprocate such proposals. Moreover offers tend to be larger when recipients do not have many links in place. It would seem that trust is established through frequent but exclusive relationships: subjects donate to those whom they have been linked to and who have been linked with not too many others.

We test for significance of demographic factors and trust indicators. We do this in a OLS regression over both treatments, to find that none matters.[12]

As for the amount sent back, we find that in both treatments it mostly depends on the amount received, with a coefficient of 0.51 in treatment NT and 0.43 in treatment TN, to confirm that response ratios are higher when there is a common past history. Profits made in the network formation phase also have an impact: in NT the recipient sends back a smaller amount when his/her profit in the network formation game is lower and in those sessions where the network formation involved higher costs, which again will have impacted negatively on recipients' profits.

Interestingly we find that having established reliable links in the network formation phase has no significance in explaining reciprocity and trustworthiness. One may be tempted to conclude from this that recipients do not respond more generously to those with whom they have been linked more often. However, recipients have been selected because they are more trustworthy by those senders who (profitably) interact with them. This is a basic endogeneity issue which the OLS estimation does not capture.

[12] See table in Appendix A.

Table 4
Responses, OLS regression, treatments NT and TN.

	Treatment NT			Treatment TN		
	Coefficient	Std. error	*p*-Value	Coefficient	Std. error	*p*-Value
Dependent variable: amount that *j* returns to *i*						
Amount offered by *i*	0.51	0.13	0.0011	0.43	0.16	0.012
Links of *i* in session (cum)	0.73	6.94	0.917	−4.20	2.56	0.131
Links of *j* in session (cum)	1.93	2.01	0.346	0.94	2.83	0.741
j Proposed to *i* in session (cum)	−12.02	12.87	0.361	−8.58	10.99	0.442
j Failed with *i* in session (cum)	5.03	14.35	0.729	−1.04	13.88	0.941
j's Profits in network game	−0.06	0.03	0.065	−0.003	0.05	0.944
High cost session	−223.90	63.06	0.002	−141.70	158.94	0.381
Constant	285.87	136.23	0.048	248.62	180.12	0.179
Number of observations	29			35		
R^2	0.5284			0.5027	Robust std. errors	

Results for treatments NT and TN are shown in Table 4.

Again, in our regressions for reciprocity demographics and trust indicators do not matter.[13]

4. Concluding remarks

History of play in the network formation game matters in determining both the level and the direction of trust. The overall level of trust is lower when participants have known each other through the network formation phase than in the baseline treatment, where they play the trust game in isolation and with complete strangers.

In choosing whom to trust, subjects select those with whom they have established stable links over time, by offering them relatively more than they do to the others. Such trust is well directed in that senders manage to choose more trustworthy recipients. Response ratios are significantly higher among subjects who have previously interacted in the network formation phase than in the baseline.

When the network formation phase follows the trust game, we observe both a higher level of trust and a higher level of trustworthiness than in the baseline treatment. In this framework trust and trustworthiness are enforced by the continuation play.

We believe that the results which we obtain in the lab are a useful complement to what has been observed in field experiments. It has been documented that higher levels of trust and trustworthiness are observed among friends (Leider et al., 2007) and among those who are socially more integrated (Brañas-Garza et al., forthcoming). Our analysis suggests that this is due both to the fact that we choose our friends (or whom to trust) as more trustworthy, and to the fact that social interaction enforces higher levels of cooperation among those who interact repeatedly over time.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jebo.2010.04.003.

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[13] See table in Appendix A.

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