Directed Trust and Reciprocity in a Real-Life Social Network: An Experimental Investigation*

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Abstract

Trust is important in any social relationship. The level of trust (reciprocity) shown to others depends on the perceived likelihood of receiving reciprocation (trust) and the degree of social interconnectedness among individuals. We investigate the link between social ties in a real-life social network and trust and reciprocity by blending social network analysis and the experimental economics methodology. We show that trust and reciprocity is higher for closer connected individuals and the extent of directed trust and reciprocity tapers off beyond a second degree friendship. We also find that people tend to trust more central (popular) individuals. However, being a more central (popular) individual has little influence on one's degree of trust and reciprocity.

Keywords: Trust, Reciprocity, Real-life Social Network, Social Distance, Friendship Degree, Centrality

JEL Classification: C90, C92

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1 Introduction

Social capital, defined as informal cooperation-enhancing values or norms shared collectively by members of a group or a society (Fukuyama, 1997), plays a significant role in a wide array of social and economic outcomes. For instance, it has been shown in the literature that social capital promotes economic growth (Knack and Keefer, 1997), influences political participation (DiPasquale and Glaeser, 1999), enhances children's welfare (Putnam, 2000), improves judicial efficiency (LaPorta et al., 1997), reduces the crime rate (Akçomak and ter Weel, 2008), and is positively related to a nation's financial development (Guiso et al., 2004).

Two key sources of social capital are trust and reciprocity; in particular, they are important in reducing relationship friction in social and economic transactions by promoting social cohesiveness. Trust is often referred to as the willingness to believe that someone to whom one had earlier given favors is going to reciprocate the act. The decision to trust somebody is thus equivalent to putting oneself in the vulnerable state of not being reciprocated by the recipient. Reciprocity, on the other hand, points to one's willingness to return favors and can also be regarded as a measure of one's trustworthiness.

The measures of trust and reciprocity (trustworthiness) used in macroeconomic studies are typically obtained from surveys, such as the World Values Survey (WVS), which are commonly used to derive the cross-country trust index.[1] These elicited values can be considered as (self-declared) attitudinal measures of trust and/or trustworthiness in the economy. On the microeconomic side, behavioral measures of individual trust and trustworthiness are often measured through the exhibited behavior of subjects playing an experimental trust game.[2]

While trust is obviously important, it is often reciprocity (trustwothiness) that features prominently in social capital discourse. For example, Robert Putnam, who is regarded as one of the world leading authorities on social capital, defines social capital in his influential book (Putnam, 2000) as,

"*. . . connections among individuals – social networks and the norms of*

[1] See http://www.worlvaluessurvey.org.

[2] The trust, or investment, game was first established in Berg et al. (1995). It should be noted, however, that the "trust" measured here not only captures strategic trust but possibly also other-regarding preferences such as altruism (Cox, 2004). If one is interested in measuring strategic trust, altruism will have to be controlled for in the experiment: one possible way of doing so is to equalize subjects' initial endowments.

reciprocity and trustworthiness that arise from them . . .(Putnam (2000), p.19)"

It is interesting to note that Putnam highlights the significant role of social networks in determining reciprocity. Indeed, social networks are important in life. People are non-solitary beings. They are not arranged randomly without any relationship patterns; instead, they form connections with others through interpersonal links taking various shapes, structures, and lengths. People who are connected through these links vary with regard to their social distance from others and the centrality of their location within the network. These social network aspects could crucially determine the magnitude of trust and reciprocity displayed by network members. Trust and reciprocity might not depend solely on moral virtues and inherent personal traits but also on the social context behind people's interpersonal relationships. Despite the importance of these social network factors, economics experiments to date have not focused much on behavior exhibited within real-life social networks, focusing instead on random and anonymous interactions between selected participants. Although Glaeser et al. (2000) do attempt to examine possible social network effects on trust and trustworthiness, they do not elicit an actual network structure but instead measure social connectivity by simply counting the number of common friends and the duration of acquaintanceship subjects in a two-person trust game. They find that the level of social connectivity positively affects the levels of trust and trustworthiness.

Though informative, we believe that a clearer picture of the role played by network variables can be obtained by examining social behavior in real-life social networks. This can be done by blending the experimental economics methodology with social network analysis. To date, there are only few papers that offer such analysis, and surely more needs to be done. Examples of recent studies that have performed economic experiments in a real-life social network are Leider et al. (2009), Brañas-Garza et al. (2010), and Goeree et al. (2010). However, these studies focus on the altruistic behavior of individuals by conducting dictator games and their variants within real-life social networks. They find that altruism decreases with social distance as measured by the friendship degree, although they differ in the extent to which they account for social distance. In contrast, their findings on the effects of centrality are mixed. Brañas-Garza et al. (2010) find that centrality measures such as the between-centrality and reciprocal degree of the dictator

also affect altruistic behavior, while Goeree et al. (2010) find no significant effect of betweenness, closeness, or power centrality.

In contrast to the above papers, our paper delves further into trust and reciprocity: The former can be defined as the extent to which one believes in the reciprocal tendencies of others, while the latter is the willingness to return a kind act imparted by others. Specifically, we focus our analysis on how they are affected by specific social network characteristics. Cassar and Rigdon (2011) is, to the best of our knowledge, the closest paper to our paper. Their paper investigated the impact of network structure on trust and trustworthiness in a bilateral exchange setting. However, the network structure they considered in the experiment was generated artificially inside the lab. In particular, they focused on a three-node networked trust game where subjects are artificially linked. They considered two variations of this three-node network, namely a network with one sender and two receivers and a network with two senders and receivers. Thus, they introduced competition between either senders (receivers) and evaluate how this competition affects the level of trust and trustworthiness. Our paper focuses on an entirely different question. It investigates the link between social ties in a real-life social network and trust and reciprocity by blending social network analysis and the experimental economics methodology.

Specifically, we concentrate on (subsets of) three network characteristics: the social distance, the degree of centrality (popularity) of an individual within the social network, and the number of mutual friends. To the best of our knowledge, there has not yet been an experimental study analyzing the effects of such social network factors on trusting and reciprocal behavior via a trust game conducted within elicited real-life social networks. Understanding the micro-impact of networks on such pro-social behavior is important as it possibly allows one to evaluate the additional impacts of social policies which have effects on networks (e.g. community building). Furthermore, it also allows one to gain an insight into the possible heuristics determining individuals' trusting and reciprocal behavior.

In this paper, we use a laboratory controlled experimental approach, conducting two different sets of modified repeated trust games within real-life social networks, one for studying trusting behavior in a social network and the other focusing on reciprocity in a social network. We build upon the procedure introduced by Leider et al. (2009) in

their study on directed altruism, focusing here instead on directed trust and directed reciprocity.[3] Specifically, we analyze the trusting and reciprocal behavior of individuals in a social network controlling for social network factors and individual traits as well as expectations and deviations of actual behaviors from expected ones.

To elicit the real-life friendship network among student subjects, we incentivized subjects to collectively sign up for our experiment with their friends and also created a Facebook group for our experiment. As part of the registration process, we required subjects to join our Facebook group using their personal Facebook account. *NetVizz*, a Facebook application, was then used to extract social network information, which was processed by the network visualization software *Gephi* to construct a social graph representation of our subjects. Gephi in tandem with UCINET, a software package for performing social network analysis, allowed us to derive measures of network centrality and friendship degree. Subsequently, we conducted a modified multi-period trust game.

Our main results are that trust and reciprocity decrease with social distance as measured by friendship degree, controlling for other factors; in particular, any "directed effects" seem to taper off after the second degree. Furthermore, just as in the previous studies on altruism, we find that one's own centrality or popularity in the network has no significant influence on one's reciprocal or trusting tendencies. Nonetheless, we do find that even after controlling for trustors' expectations of trustworthiness, the centrality of one's partner positively affects one's trusting decisions; however, this effect is not present for reciprocity. Additionally, we find some evidence showing that less trusting individuals tend to be less reciprocal.

The rest of our paper is organized as follows. In Section 2, we describe our experimental design. In Section 3, we discuss several predictions of our experiment. We then present our findings in Section 4. Finally, Section 5 concludes the paper, providing a discussion on the implications of our results.

[3]Directed reciprocity (trust) refers to the tendency of receivers (senders) to treat closer connected senders (receivers) better than strangers by sending back more to the former than the latter. It should be noted that the main focus of our paper is not on the existence of directed trust and reciprocity per se but rather on the magnitude of the relative effects of friendship degree and other social network traits on trust and reciprocity and at which degree of friendship the effect on trust and reciprocity dies off.

2 Experimental Design and Procedures

Our experiment consisted of two stages, a network elicitation stage and a controlled laboratory experiment stage. In the network elicitation stage, we conducted a basic survey among the participants and elicited the structure of their friendship network. Subsequently, in the laboratory experiment stage, we conducted a modified multi-period trust game within various sub-networks of the derived friendship network where the participants played both roles. In particular, we had two treatments for the laboratory experiment stage: a directed reciprocity treatment (A) and a directed trust treatment (B). The two treatments differed in the manner in which we controlled for information and the influence of behavior so as to measure the effects of social network factors on reciprocal (A) and trusting (B) decisions. Treatments A and B together with their respective network elicitations were conducted at different times of the year: the former was conducted in March 2013, the latter in August 2013.

2.1 Stage 1: Network Elicitation Using Web Interface

From a pool of undergraduate students at Nanyang Technological University (NTU) majoring in various disciplines including engineering, science, humanities, and social sciences, we invited participants to take part in the study via email; 55 and 157 participants signed up for treatments A and B respectively. The participants were instructed to register in groups and were provided with a monetary incentive scheme, as illustrated in Table 1. This incentive scheme was designed to encourage them to bring their friends to register for the experiment as a group. The larger their group size, the bigger the monetary incentive received by each group member. Furthermore, a minimum group size of two was put in place so as to avoid singleton participation.

Number of members in group	Incentive per person in the group
2	\$0
3-4	\$2.5
5-6	\$3.5
7-8	\$4.5
9-10	\$5.0
>10	\$6.0

Table 1: The group incentive scheme for participants

When registering, participants were also required to complete a basic online survey to elicit their demographic variables and their risk and time preferences. After finishing the online registration, participants were then required to join a *Facebook* group which we specifically created for this experiment. Note that members of each registered group were not required to be all direct (first degree) friends with each other on Facebook: for example, a member of a registered group could invite a friend who was directly connected to him/her but not to others in the group. Once all of the participants had joined our Facebook group, their friendship-network data were extracted using the Facebook application NetVizz. The data were then used to generate their network graph using the social network visualization software Gephi (Bastian, Heymann and Jacomy, 2009).[4] The network graph for the two treatments are illustrated in Figures 1a and 1b. The nodes represent participants. The size of the nodes indicates the *eigenvector centrality*, a measure of individuals' popularity within the social network.[5] In both cases, there are several major friendship groups which are densely connected and several other smaller friendship groups in the periphery which are sparsely connected.[6] Some of these smaller friendship groups are isolated from other friendship groups.

Subsequently, the elicited social network information was used to extract data on the eigenvector centrality value of each participant within the network as well as the *social distance* of participants relative to one another (the *friendship degree*). To do so, we first exported the Gephi network file to a UCINET file format and then used UCINET/NETDRAW, a software package for the analysis of social network data (Borgatti, Everett and Freeman, 2002), to calculate the eigenvector centrality values of each individual. We opted for the eigenvector centrality measure as our popularity measure instead of *degree of centrality* or *betweenness centrality* because in our opinion, the former more accurately measures one's popularity in a network.[7] This measure assigns relative

[4]See http://pegasusdata.com/2013/01/10/facebook-friends-network-mapping-a-gephi-tutorial/ for further information on using Gephi to conduct a social network analysis.

[5]The node size representation was derived using the in-built eigenvector centrality function provided in Gephi; the values are slightly different from the ones derived from UCINET, which we use later on.

[6]Note that in some cases, individuals' data failed to be extracted (most likely due to Facebook privacy settings). These appear as individual nodes in the figure and were treated as controls in our experiment (i.e. should they turn up for the second stage experiment, their random partners were by default strangers). Six out of 114 who turned up for treatment B were in this situation.

[7]In the first treatment, we used the eigenvector centrality provided by NETDRAW, while in the second treatment, we used the 2-local eigenvector centrality, again calculated in NETDRAW, because it gave a better measure of overall centrality taking into account the greater number of cliques present. The simple eigenvector centrality c is calculated from the equation $\mathbf{A}c = \lambda c$, where A is the adjacency matrix of the network and λ is the eigenvalue associated with the eigenvector c. Bonacich (1987) introduced a

scores to all individuals, and those who are connected to others who have many connections receive larger scores. Essentially, individuals who are connected to larger numbers of popular people tend to be more popular too. A well-known variant of the eigenvector centrality measure is the Google page rank. In contrast, degree centrality, which is measured by the number of friends a person has, does not allow for comparisons between individuals with a similar number of first degree friends, while betweenness centrality, which is measured by counting the number of times a person assumes an important role connecting two other people through the shortest path, might produce a biased result when a person links two major social groups together.

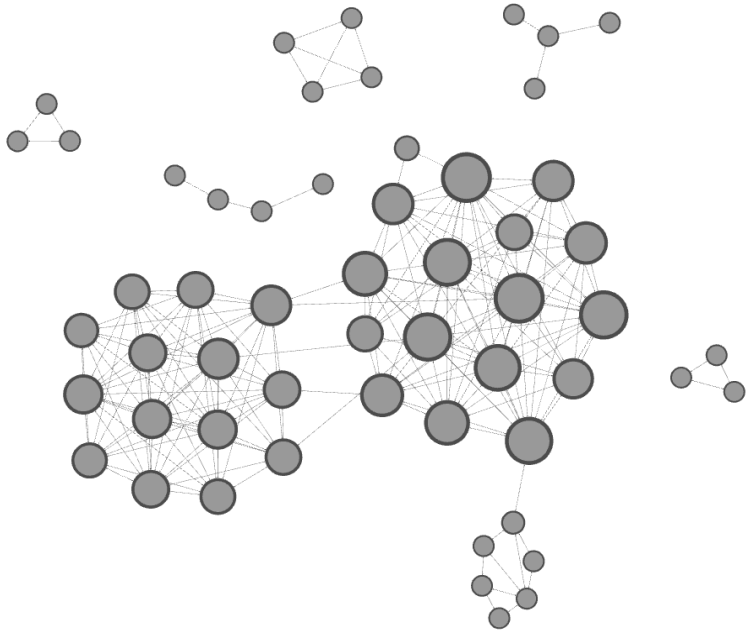

Figure 1a: Elicited friendship network for directed reciprocity treatment.

variation of this which included user-defined α and β such that $c(\alpha, \beta) = \alpha(\mathbf{I} - \beta\mathbf{A})\hat{}(-1)R * \mathbf{1}$, where $\mathbf{1}$ is a vector of ones.α scales is the node centrality, while β reflects how much a node's centrality is affected by those it is connected to: small values weight local structure while larger values weight global structure.

Figure 1b: Elicited friendship network for directed trust treatment.

The two concepts of friendship degree and eigenvector centrality are illustrated in Figure 2 below. In particular, eigenvector centrality takes into account the kind of partners one is connected to: In Figure 2 for example, H has a higher value than K despite both having only 1 link since he is directly connected to A, who is undoubtedly the most central person in this network. The degree of friendship is defined as the length of the shortest path which connects two individuals; if they are not connected, the friendship degree can be taken to be arbitrarily large. Hence, a direct friend has friendship of degree 1, while a friend of a friend who is not directly connected has a friendship of degree 2, and so on. To keep our analysis tractable, we considered individuals who are connected with a friendship degree higher than 3 to be strangers.

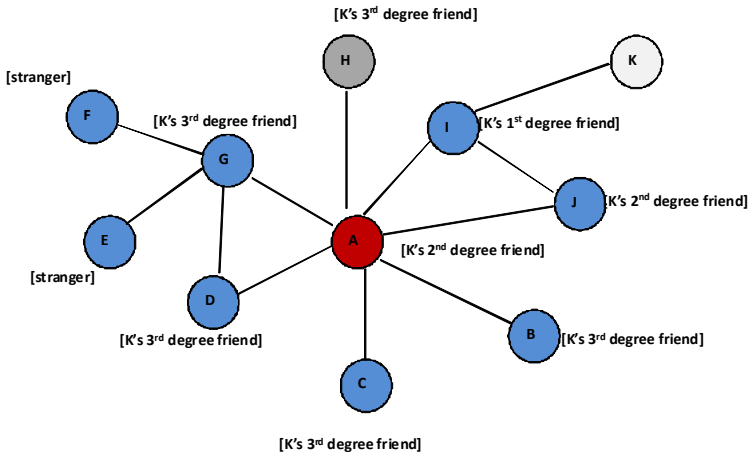

Figure 2: A hypothetical social network

2.2 Stage 2: Multi-Period Trust Game Within The Network

The second stage was conducted within one week after the end of the first stage; the directed reciprocity treatment lasted approximately two hours and the directed trust treatment one lasted for approximately hour. The repeated trust game, which was conducted in each treatment, was different as we had to control for different factors in order to better measure the effects of social network factors on either trust or reciprocity. Furthermore, using our experience from treatment A, which was conducted before treatment B, we enhanced the structure of the repeated trust game to allow for a smoother and more accurate elicitation of players' pro-social behavior.

Treatment A: Directed Reciprocity

Two experimental laboratories, each with 30 computer cubicles and each connected to different z-Tree servers, were used for treatment A. As the participants indicated different preferences with regard to the time slots they were available for, it was not possible to place all participants in the same session for each of these treatments. Instead, we allocated them to several sessions, ensuring that within a session there was sufficient variation in terms of the degree of friendship and centrality across participants. Specifically, prior to the commencement of the experiment, we divided the 55 registered participants in treatment A into 5 subnetwork groups (11 members in each) and allocated them into 3 experimental sessions. The first and second sessions had 2 groups each, and the third

session had 1 group. Figure 3 illustrates the groupings and the sessions. Nodes with the same color denote participants from the same group. Participants were not informed of the sub-network groups they belonged to. On the day of the experiment, 46 of the 55 participants registered for treatment A eventually turned up.

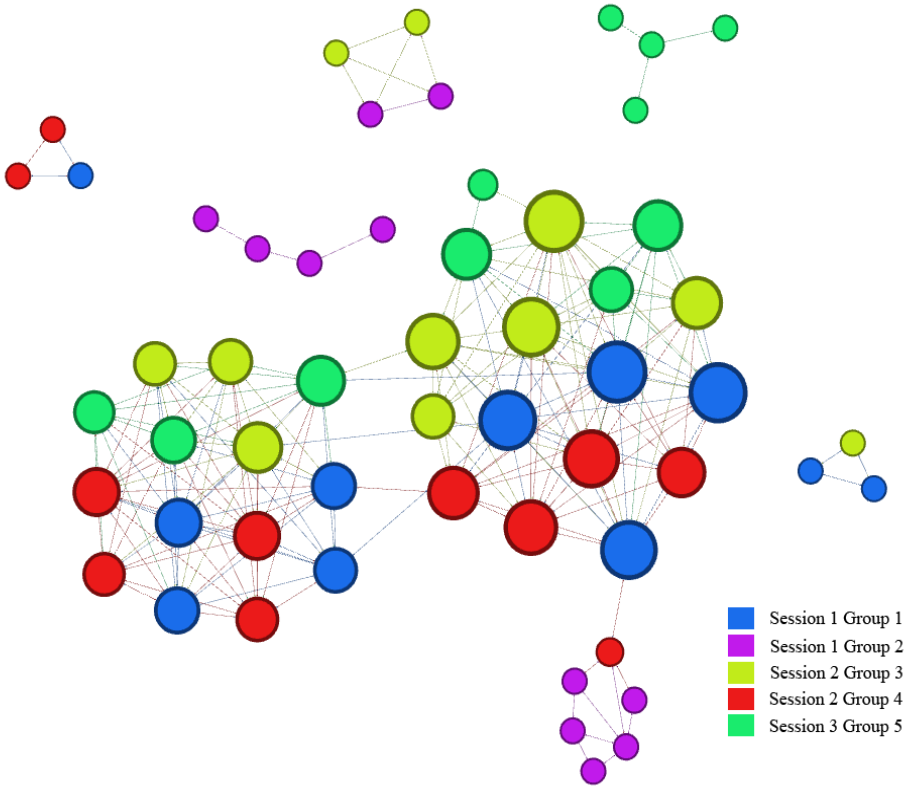

Figure 3: Network split into sessions and groups

A modified trust game experiment was then played for 25 periods in the subgroups shown in Figure 3. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007). Before the start of the experiment, instructions were read aloud to the participants; a hard copy of these instructions was also given to them. The participants were also given a set of control questions about the details of the game to be played. They had to answer all of these questions correctly before proceeding to the main experiment; this was to ensure that the participants thoroughly understood the game to be played. The first period of the main experiment was a trial period, the outcomes of which were not considered in the calculation of the participants' final earnings.

In every period, the participants began by playing as senders. They were asked to decide how many points out of their initial endowment points they would like to send

to a receiver. The senders' endowment was set at 100 ECU, and every ECU sent to the receiver was tripled. The exchange rate used was 1 SGD: 100 ECU.

After they had made their sending decisions, the participants then played as receivers. As receivers, they randomly and anonymously received one of the sending decisions made earlier by a sender, other than themselves, in their subgroup. Prior to notifying receivers of their partnered senders' decisions, we provided each of them with information on the social network traits of their partner (i.e. the degree of friendship and the degree of centrality in the social network of their respective sender). To give participants a frame of reference for centrality values, we also provided the minimum, maximum, and average centrality value in the entire network. We then elicited receivers' first-order beliefs (expectations) about the number of points such a sender would send to a stranger. More specifically, we asked them the following question:

> "*How many points on average (on a scale from* 0 *to* 100*) would you expect a sender with the above traits to send to a stranger in this game?*"

This belief elicitation was incentivized. If the prediction was within 5 ECU of the actual amount sent, they would receive a reward of 20 ECU. This amount was set (in real money terms) such that it was not too large to cause disappointment in the event of a wrong prediction but was large enough to provide an incentive for participants to come up with accurate predictions.

Following the belief elicitation, receivers were informed of their respective partner's actual sending decision and asked to decide how many of the tripled points received they would like to return to their original sender. The amount of money (points) sent back by a receiver to a sender was then taken to be a measure of reciprocity (trustworthiness). We repeated this process for 25 periods and employed a random re-matching protocol to vary partners across periods.

Thus, each period consisted of a sending, an expectation, and a receiving decision for each participant. Thus, in total, each participant had to make 75 (25×3) decisions. At the end of the experiment, 5 of these 25 periods were randomly selected to determine the final payoff of each participant. A show-up fee of 3 SGD was also given to all participants. Participants earned 13.7 SGD on average from playing the trust game. The lowest earnings were 6 SGD and the highest earnings were 24 SGD. On top of this sum,

each participant also received their group incentive bonus, which varied depending on the size of the group they registered with.

Notice that an asymmetric information framework was adopted in our design; that is to say, we only provided information on senders' social network traits to receivers and did not provide any information on receivers' social network traits to senders. Furthermore, senders were only informed of the amounts returned by their partner receivers in each period at the very end of the experiment. This was done to prevent information on the amounts returned affecting individuals' future sending and reciprocal behavior. Hence, this design allowed us to isolate the impact of social network factors on receivers' reciprocal/trustworthy behavior without worrying about any feedback loop effects arising due to senders' actions or their experiences as a sender in the stage prior to the receiving stage. From a sender's viewpoint, he/she faced a standard anonymous trust game and we treated the amount they sent as a measure of their *baseline trust*.[8] But from a receiver's viewpoint, he/she had to make a sending back decision knowing the social network traits of his/her partner sender. Note also that this experimental design implicitly prevents any reputation building as senders do not know receivers' identities or the amounts returned.[9]

Treatment B: Directed Trust

In treatment B, we had a friendship network consisting of 157 registered participants. Due to the laboratory space constraint and the time slot preferences of the participants, we followed the same experimental procedures we had adopted in treatment A; that is, we divided these 157 subjects into 6 subnetwork groups. The number of participants in each group ranged from 21 to 29. We conducted 6 experimental sessions with one group in each session. Figure 4 illustrates the groupings and the sessions. Nodes with the same color denote participants in the same sub-network group and session. Of the

[8] By baseline trust, we refer to trust when interacting with strangers. Note also that since endowments of the sender and receiver are not equal in this treatment, trust here to some extent also includes altruistic motives.

[9] Since randomization was done among subgroups with a size of around 11 for 25 periods, in actual fact, participants did in fact meet some partners more than once, though this information was not provided explicitly. To minimise participants taking chances by reciprocating on the basis of the number of friends in their lab, we ensured that each lab did not contain too many of a participant's friends: the proportion of first degree friends in the lab for participants has a mean of 0.163, with a maximum of 0.381. Further, we also used this as a control variable in our regression analysis. Another issue is that participants, when playing as receivers, may notice similar social network information being displayed in different periods and somehow this may influence their reciprocal decisions. We controlled for this using a variable indicating the number of times a participant had played before with a specific partner in the subgroup.

157 registered participants, there were only 114 of them turned up for the second stage. As a result, in some sub-network groups, not all participants were present during the experiment. To reduce the time taken to conduct the experiment as well as the possible fatigue from long participation which was observed in treatment A, we decided to limit the number of periods to 15 in treatment B. We eliminated the possibility of players encountering the same partner more than once by letting the number of periods be less than the number of participants in the laboratory. This method of randomization was possible for this treatment due to the larger number of registered participants (almost 3 times as many as that in the directed reciprocity treatment).

As in treatment A, instructions were read aloud to the participants before the start of the experiment and a hard copy of these instructions was also provided to them. A set of questions about the details of the game to be played was also given to participants; these had to be answered correctly before proceeding to the main experiment. The first period of the main experiment was a trial period, the outcomes of which were not considered in the calculation of participants' final earnings.

However, contrary to the procedure in treatment A, we equalized the endowments of senders and receivers to 100 ECU so as to control for possible altruistic motives behind the senders' sending decisions in the experiment and to allow us to focus on the *strategic trust* motive. Furthermore, since we were interested in the effects of social network factors on strategic trust, we opted to put in place experimental procedures in treatment B which allowed us to control for the effects of *reputation*, *experienced reciprocity*, and *influence from playing as a receiver*.[10] These experimental procedures are described below.

[10]This is analogous to the part in treatment A where we controlled for experience from playing as a sender.

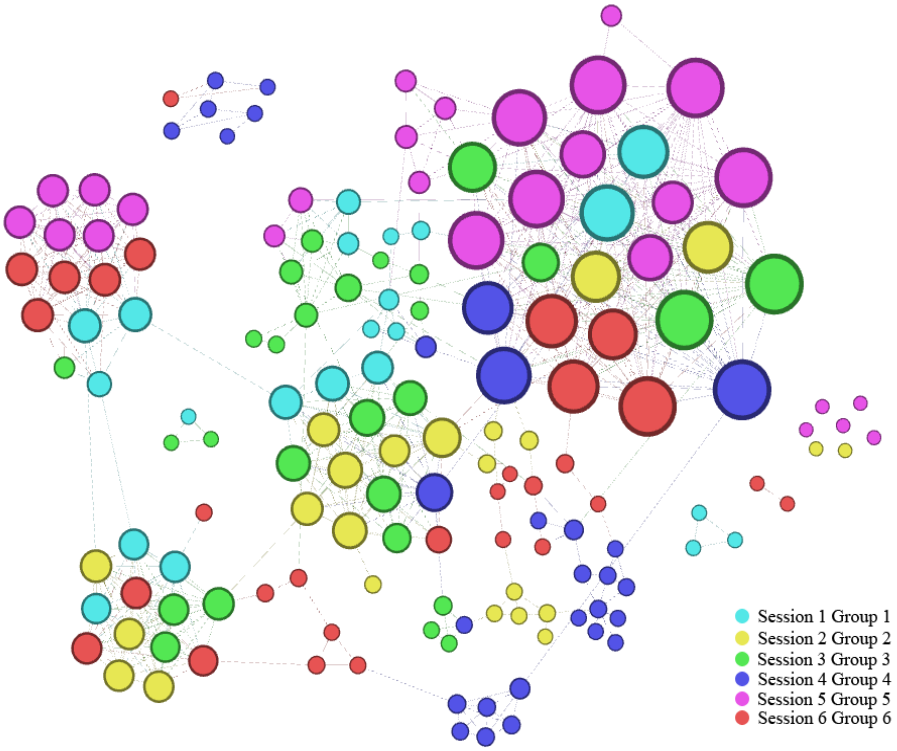

Figure 4: Network split into sessions and groups

First, there was only 1 receiving stage, where a receiver made the sending back decision, throughout the entire game, and this stage was conducted using the strategy method before period 1 commenced. Participants had to choose, at intervals of 10, how much of the tripled amount they wished to return. Note that receivers were only allowed to return out of the triple amount received and not out of additional amounts from their initial endowment. If the sender sent an amount in between the interval, the amount returned would be linearly interpolated from their strategy method table. For example, if the receiver indicated that he/she wanted to send back 20 when receiving 10 (tripled amount is 30) and 30 when receiving 20 (tripled amount is 60), then if the actual amount received is 15, 25 would be sent back. Since this sending back decision was elicited only once using the strategy method, reciprocal decisions would thus remain constant across periods, avoiding the need to control for how experience as a receiver may have affected reciprocity endogenously. Similar to treatment A, we also had an asymmetric information structure whereby this time, only senders were provided with partial information about the receiver when making their decisions. This allowed the provided social network factors to influence their sending decisions without affecting their reciprocal behavior. Anonymity on

both sides as well as randomized play such that no one played with each other twice also meant that reputation building was not possible. We randomly chose 1 period for the calculation of payoffs. The conversion rate here was 30 ECU: 1 SGD, with a show-up fee of 3 SGD. The mean payoffs were 12.8 SGD, while the lowest and highest payoffs were 8 SGD and 21 SGD respectively. On top of this, the participants also received the group incentive bonus mentioned earlier.

Subsequently, participants played as senders, where they would randomly and anonymously be paired with another member whose strategy method decisions were used to determine the amounts returned. Prior to notifying senders of their partnered receivers' decisions, we provided them with information on the social network traits of their respective partners. In addition to the friendship degree, and the degree of centrality in the social network of their respective partners (which was provided in treatment A), we also provided the *number of mutual friends* they had as well their respective *partner's gender*. Similarly, to give participants a frame of reference for centrality values, we also provided the minimum, maximum, and average centrality value in the entire network. Senders then had to decide how much to pass to the receiver, given this information. After this stage, we elicited senders' first-order beliefs (expectations) about the number of points a receiver with those social network traits would return (out of the tripled points they passed) to a stranger.[11] More specifically, we asked them the following question:

> "*How many points on average out of the amount available would you expect a receiver with the above traits to send back to a stranger in this game?*"

Note also that since all participants knew that receivers would only make send-back decisions at the beginning of the experiment, the elicited expectations should also have taken into account that any reciprocal decisions of receivers at each stage were static and hence should not have respondedto past play. Finally, the sending and expectation stages were repeated for the rest of the experiment, with the full history of all periods' transfers by senders provided only at the end.

[11] In contrast to treatment A, we opted not to incentivize the elicitation of expectations here so as to remove the incentive effects on trust we found in treatment A and to allow us to focus only on the influence of expectation on trust. An argument against the no-incentive procedure is that participants may become lazy in inputting their expectations without such an incentive. However, we verified this and did not seem to find such a problem.

3 Experimental Predictions

If social network factors have any effect on trust and reciprocity, the provision of network information in both treatments should influence participants' sending and sending-back decisions. In this section, we list a set of predictions on the impacts of social network traits on reciprocity and trust. The first prediction concerns the relationship between either reciprocity or trust and the social distance as measured by the degree of friendship between senders and receivers.

Prediction 1 *Reciprocity and trust decreases with the social distance (i.e. the friendship degree between receivers and senders).*

Following Brañas-Garza et al. (2010), Goeree et al. (2010), and Leider et al. (2009), all of whom examined the effects of social distance on altruistic tendencies in a dictator game setting, we conjectured that similar to the concept of directed altruism found in their papers, directed reciprocity and directed trust also exist: that is, individuals tend to trust and be more reciprocal to closer connected people.

Second, with regards to the relationship between the centrality of either receivers or senders and reciprocity, we have the following two predictions:

Prediction 2 *In the directed reciprocity (trust) treatments, reciprocity (trust) increases with receivers' (senders') centrality in the social network.*

In Brañas-Garza et al. (2010), a significant positive correlation was found between the displayed altruism in individuals and their betweenness centrality, but not their eigenvector centrality. With regards to reciprocity, which is analyzed in treatment A, the direction of causality between reciprocity and one's own (eigenvector) centrality in the social network is not a priori obvious. One may argue that a more central or popular receiver would be more inclined to reciprocate senders than a less central receiver because failure to do so might undermine his/her 'reputation' within the network. However, it is also plausible to argue that a receiver obtains his/her central position in the network because he/she has a strong reciprocal tendency in the first place, which would encourage senders to link up with him/her. Either way, a positive relationship between receivers' degree of reciprocity and their centrality in the social network is expected. Likewise,

with regards to the trusting behavior studied in treatment B, we should expect a positive relationship between senders' degree of trust and their centrality in the social network.

Next, regarding the effect of partners' degree of centrality on directed trust and reciprocity, we have the following predictions:

Prediction 3A *In the directed reciprocity treatment, the effect of the partners' (sender) degree of centrality on reciprocity is ambiguous.*

Prediction 3B *In the directed trust treatments, higher partner (receiver) centrality is positively correlated with trust.*

With regards to prediction $3A$, since our experimental procedure implicitly controls for reputation building, partners' centrality should not play a role in receivers' reciprocal decisions through any reputation mechanism.[12] Alternatively, individuals may just systematically treat more central individuals differently. The effect here is, however, ambiguous. Reciprocity may be positively affected if individuals inherently favor central individuals. In contrast, a more popular partner might justify lower reciprocity if one conceives that others will tend to reciprocate more to him/her.

In contrast, prediction $3B$ states that senders should be expected to trust more central/popular receivers. Unlike in the directed reciprocity treatment, the network information about receivers is now useful to senders: that is, senders might interpret the centrality or popularity of receivers in the network as an indicator of the trustworthiness of receivers. Being trustworthy may be a virtue that makes receivers popular in the network.

Lastly, with regard to the number of mutual friends which we included as a control variable in the directed trust treatment, we have the following prediction:

Prediction 4 *The strength of friendship bonds as proxied by the number of mutual friends is positively correlated with trust.*

[12] Because senders made anonymous decisions to receivers, there was no logical reason for receivers to send back a larger amount to a more central sender, for example to curry favour in order to strategically influence senders to send a higher amount to receivers in the next round. Furthermore, senders and receivers were randomly re-matched in every period, which made reputation building impossible. Lastly, since we also did not reveal the amount sent back by receivers until the end of experiment, any attempt to build reputation was again not viable.

As in Glaeser et al. (2000), we control for the strength of friendship ties by using the number of friends in common in the directed trust treatment. In particular, one might expect a stronger perceived bond between individuals to systematically positively influence trust outside of what expectations an individual may have. This may occur as a further extension of directed trust: among friends of similar degree, one trusts those with stronger bonds more.

4 Results

Treatment A: Directed Reciprocity

Table 2 gives the main summary statistics of our experiment's participants. In terms of gender composition, the sample was roughly balanced. With 44 participants and 25 periods, we had a total of 3450 observations consisting of an equal number (1150) of sending decisions, receiving decisions, and expectation decisions. Of these 1150 interactions between receivers and senders, around 33.3% were between first degree friends, 14.7% were between second degree friends, 13.3% were between third degree friends, and 48.7% were between strangers.

Friendship degree of partner receiver				Frequency	Percentage
Stranger				560	48.7
1st Degree Friend				268	23.3
2nd Degree Friend				169	14.7
3rd Degree Friend				153	13.3
Gender				**Frequency**	**Percentage**
Female				22	47.83
Male				24	52.17
Time-Invariant Variables	**Count**	**Mean**	**SD**	**Min**	**Max**
Centrality	46	90.52	93.33	0	278
Proportion of 1st degree friends in lab	46	.1630	.1165	0	.3810

Table 2: Summary statistics (Treatment A)

Figure 5 below depicts the line plot of the average baseline trust as a proportion of the initial endowment across periods and the bubble plots of its frequencies in bins of 0.2 (20%) for each period. A bigger size of the bubble plot in a particular bin for a particular period implies a higher baseline trust frequency. For example, in period 20, the average

baseline trust was around 46% of the endowment and the highest frequency occurred at bin 0.1 (10%), while the second highest frequency occurred at bin 0.9 (90%).

The average baseline trust over all periods was around 49.3%. The initial trust level in our study started slightly higher than the average initial trust level typically found in trust game experiments, but it ended slightly below at around 41.3%. This figure is not far from the one obtained by Johnson and Mislin (2011) who showed that the average amount sent as a percentage of the initial endowment in 161 trust game experiments was around 50%. Nevertheless, in general, the results do not seem to deviate too much from the existing trust game experiments. It can also be seen from the bubble plots that there was a reasonably high degree of baseline trust polarization: that is, the amounts sent were typically clustered around the highest (90%) and lowest (10%) bins. The size of the bubble plots at the lowest bin grew bigger as the period progressed, indicating that more senders decided to give a lower amount at later periods.

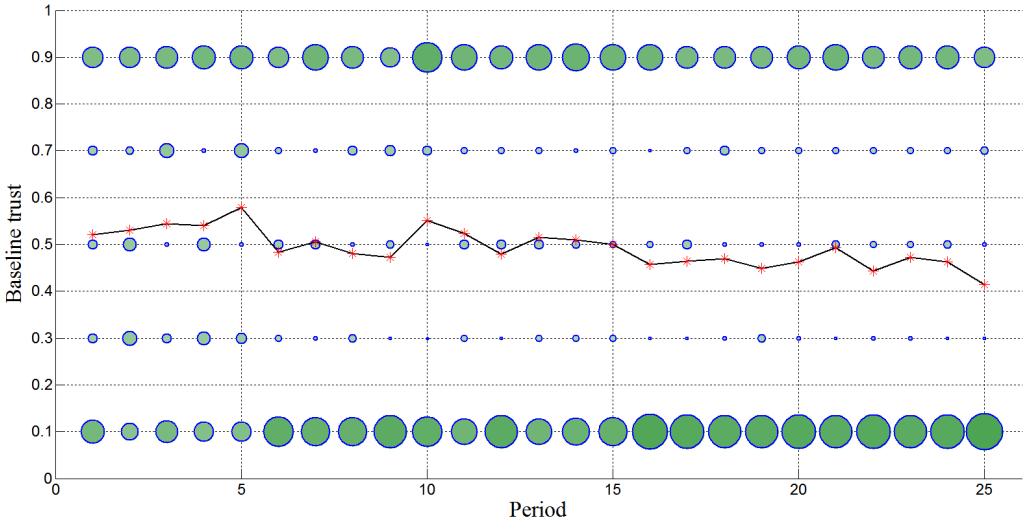

Figure 5: The proportion of baseline trust to the initial endowment

Figure 6 shows the line plot of the average amount sent back by receivers as a proportion of the maximum possible send-back value, which was equal to the tripled amount received. The amount sent back measures the degree of trustworthiness (reciprocal behavior) of receivers. Figure 7 also depicts the bubble plots of the frequencies of the trustworthiness plotted in bins of 0.2 (20%). The negative bin was used to denote that zero amount was received from senders; this is because for such a case, the trustworthiness

measure is undefined. Note that the trustworthiness behavior of a receiver can only be measured when a positive amount is received from a sender in the first place; otherwise, there is nothing for the receiver to send back to the sender. Compared with the baseline trust shown in Figure 6, reciprocity was on the low side (around 16.2%) compared with the average trustworthiness of receivers found in the existing trust game experiments, which is around 37% (Johnson and Mislin, 2011). The number obtained in our experiment was considerably lower. In particular, the lowest average trustworthiness recorded in our experiment was around 11%. Notice that for this value of trustworthiness, senders earned on average negative returns on their investment. At an aggregate level, without controlling for the degree of friendship between receivers and senders and the degree of centrality of senders, trustworthiness also tended to decrease somewhat over time. Next, we evaluate how the exhibited receivers' trustworthiness is affected by senders' social network traits.

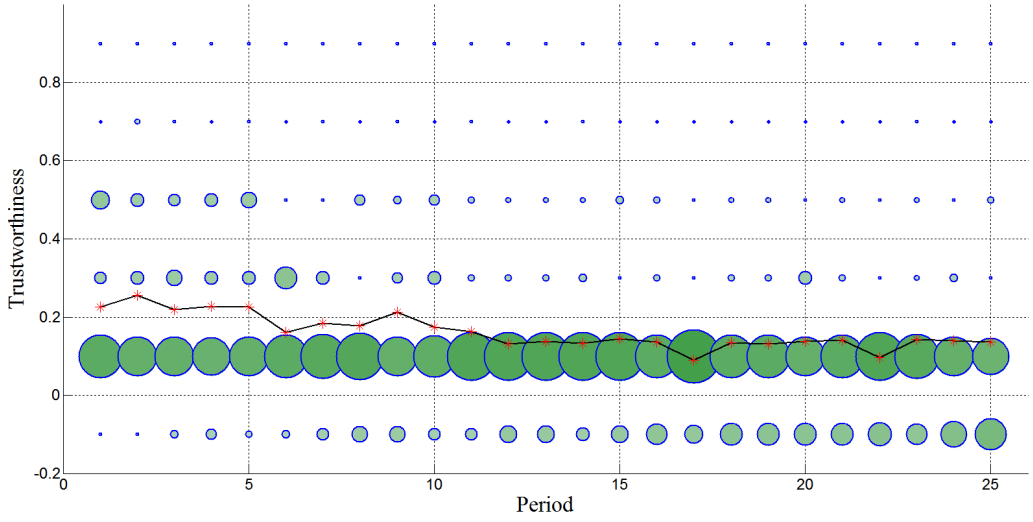

Figure 6: The trustworthiness measure: the proportion of the amount sent back to the tripled endowment.

Figure 7 illustrates how the level of trustworthiness varied with the degree of social distance between receivers and their senders. In this aggregate examination of receivers' trustworthiness, which omits the influence of other control variables, it can be seen that there is a negative relationship between trustworthiness and the degree of social distance between receivers and senders. Interestingly, it also shows that the receivers consistently sent back a lower amount when partner senders were their third degree friends than when

they were strangers. However, it can also be seen that the difference between the two disappeared when other control variables were included in the regression analysis below.

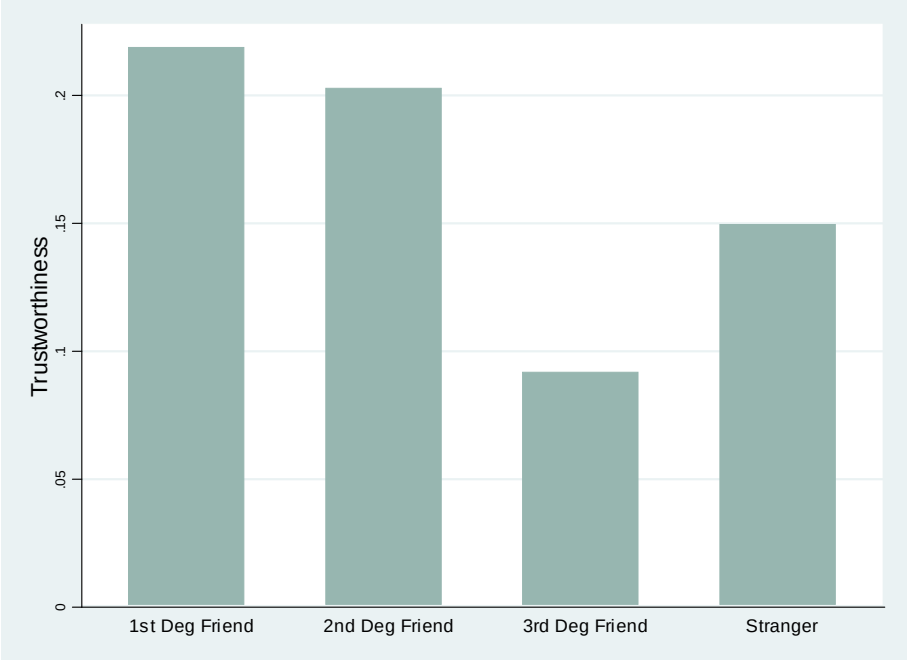

Figure 7: Barplots of trustworthiness over social distance

To examine the effect of social network traits on trustees' trustworthy behavior, we estimated the following panel-data random-effects regression of the receivers' behavior.[13]

$$\begin{aligned} TW_{it} &= \alpha + \beta_0 T_{it} + \beta_1 E_{it} + \beta_2 D_{it} + \delta_1 Cent_i + \delta_2 PCent_{it} + \mathbf{FD}'_{it}\boldsymbol{\lambda} + \eta_1 \left(Cent_i \times PCent_{it}\right) \\ &\quad \mathbf{X}'_{it}\boldsymbol{\theta} + (u_i + \varepsilon_{it}) \end{aligned} \tag{1}$$

where TW_{it} is the amount sent back by receiver i in period t as a proportion of the amount received, α is the intercept, T_{it} is receiver i's baseline trust (i.e. the amount sent by receiver i in period t when he/she plays as a sender), E_{it} is the amount sent by receiver $i's$ partner sender in period t, and D_{it} is the deviation of the actual amount received by receiver i from his/her partner sender from the amount that receiver i expected to receive from his/her partner sender.

Next, $Cent_{it}$ is the time-invariant receiver $i's$ degree of centrality measured by his/her eigenvector centrality, $PCent_{it}$ is the degree of centrality of the sender with whom receiver i is partnered, and $\mathbf{FD}'_{it} = [1stDeg, 2ndDeg, 3rdDeg, Stranger]$ is a vector of dummy

[13] We used a random effects specification with session fixed effects based on the results of the Hausman test of fixed vs. random effects as well as the Breusch-Pagan test for random effects vs. pooled OLS.

variables for the degree of friendship between receiver i and his/her partner sender. Note that the baseline case for the regression is $Stranger$. Lastly, $\mathbf{X}'_{it}$ is a vector of control variables that include gender, year of study, risk preferences elicited using Holt and Laury's procedure (Holt and Laury, 2002), session-specific fixed effects, the period, the number of times a participant had played before with a partner (not explicitly known to the receiver), and the proportion of the first degree friends of receiver i who share the same experimental session; $(u_i + \varepsilon_{it})$ is the composite error term, and u_i are the individual effects. We used TW_{it} as our measure of the degree of reciprocity.

On the basis of the predictions derived earlier, we should expect to find that (1) reciprocity decreases with the degree of friendship (**FD**) (i.e. the further away the sender is from the receiver, the lower the degree of reciprocity will be); (2) reciprocity increases with the receiver's degree of centrality in the social network (i.e. $\delta_1 > 0$); (3) the impact of the sender's degree of centrality on the receiver's degree of reciprocity is ambiguous (i.e. either $\delta_2 > 0$ or $\delta_2 < 0$); and (4) a higher than expected sender's trusting behaviour would lead to higher reciprocity.

Table 3 below presents the regression results. Model A is the baseline model. Models B and C include, respectively, an additional control for time specific variables and for the proportion of first degree friends. For the purpose of interpreting the results, we focus mainly on the regression results obtained from Model C, which includes all the control variables.

	Model A	Model B	Model C
Cent	-0.008	-0.010	-0.043
	(0.025)	(0.024)	(0.046)
PCent	0.004	0.001	0.002
	(0.012)	(0.012)	(0.012)
Cent × PCent	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
1st Degree Friend	7.070***	6.951***	6.864***
	(2.200)	(2.091)	(2.108)
2nd Degree Friend	4.684*	3.805*	3.785*
	(2.427)	(2.224)	(2.226)
3rd Degree Friend	3.127	3.103	3.000
	(2.631)	(2.451)	(2.468)
Baseline Trust	0.080*	0.057	0.057
	(0.048)	(0.043)	(0.043)
Expectation	0.142***	0.149***	0.150***
	(0.025)	(0.025)	(0.025)
D	0.122***	0.129***	0.130***
	(0.027)	(0.026)	(0.026)
Male	-2.377	-2.202	0.236
	(3.870)	(3.899)	(4.138)
Year of Study	-2.137	-2.646	-0.961
	(2.868)	(2.800)	(2.008)
Risk	-0.733	-0.815	-0.792
	(1.491)	(1.497)	(1.384)
2.session	3.486	3.292	7.488
	(3.813)	(3.818)	(4.759)
3.session	15.482*	16.361*	18.191**
	(8.312)	(8.380)	(8.703)
Period		-0.562***	-0.562***
		(0.131)	(0.131)
Times played before		-0.112	-0.106
		(0.525)	(0.524)
Proportion of 1st degree friends in lab			53.140
			(41.967)
Constant	5.907	15.127	3.786
	(12.712)	(12.293)	(7.059)
Observations	915	915	915
Overall R-squared	0.247	0.275	0.323
Chi2	84.48	137.3	148.9
Model df	14	16	17

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, Standard errors are in parentheses, Heteroskedasticity-robust standard errors used. D = (Amount received - Expectation), Trustworthiness is multiplied by 100.

Table 3: Random effects regressions of trustworthiness

The coefficients of the dummy variables for first degree and second degree friendship were both positive and significant (p-values were respectively 0.001 and 0.089). The baseline comparison was the stranger relationship between receivers and senders. Furthermore, the magnitude of the coefficients decreased with the degree of friendship. There was a significant difference between the first and second degree (p-value: 0.0985), while the difference between second and third degree was insignificant (p-value: 0.7225); that is, on average, receivers returned a higher proportion of money for first and second degree

friends, 6.864% and 3.785% respectively, relative to strangers. This shows the existence of directed reciprocity and is consistent with our prediction: people tend to treat closer friends better than more distant ones. The coefficient of the dummy variable for third degree friendship was not significant, implying that there is no difference in reciprocal behavior between third degree friends and strangers. Directed reciprocal effects hence tend to taper off after the second degree.

However, the regression coefficients of both the participant's and the participant's partner's eigenvector centrality ($Cent$ and $PCent$) and their interaction are not significant. This implies that neither a particular participant's popularity nor the sender's popularity in the social network affected the receivers' decisions to reciprocate. In particular, partner sender's centrality remained highly insignificant throughout all models (p-value > 0.8); this is most likely due to reputation building being controlled for. Interestingly, the sign of one's own centrality (which is closest to being significant) was negative, suggesting a negative relationship between one's own centrality and reciprocity. This could be because a popular receiver might think that it is justifiable for him/her to receive a favor (privilege) given his/her position and therefore might feel less inclined to reciprocate back to the sender. Nonetheless, the finding that one's own centrality is insignificant to some extent resembles Brañas-Garza et al.'s (2010) finding that an individual's eigenvector centrality is not correlated with altruistic behavior. Another possible explanation for the insignificant effects of centrality is that the social network in our experiment elicited through Facebook emphasizes a particular dimension of friendship which may not be directly related to reciprocal behavior in particular.[14] Thus, the derived popularity measures may not bear any direct relationship with reciprocal behavior.

Interestingly, the regression results show to some extent that the baseline trust in each period, which is the amount participants send to receivers when playing as senders, is positively correlated with their reciprocal behavior in the same period; its significance however drops when additional control variables are included. Baseline trust essentially captures the innate trusting behavior of participants when playing as senders under the stranger condition and receiving no information on the social network traits of their receivers or on the amount sent back by their previous period receivers. This indicates

[14]For example, Facebook networks could be said to reflect acquaintance with others, while reciprocity might be affected instead by a stronger network dimension like social friendship (i.e. with more frequent interactions).

some tendency for participants who possess a higher propensity to trust strangers to also have a higher propensity to reciprocate, although the impact is smaller economically. On average, an individual with full baseline trust is associated with a 5.7% increase in trustworthiness. Also, higher expectations of trust as well as positive deviations of the actual amount received from one's expectations are also associated with a higher degree of reciprocity.

Treatment B: Directed Trust

In this subsection, we discuss the results from the directed trust treatment. Table 4 gives the summary statistics for the important variables in this treatment. The gender composition of the sample was again roughly balanced. In this part of the study, we had 114 participants and an average of 14.66 decision periods.[15]. This gave us a total of 3342 observations consisting of an equal number (1671) of sending and expectation decisions. From the strategy method elicitation, we also had 114 observations of reciprocal (sending back) decisions. Of these 1671 interactions between receivers and senders, around 13.23% were between first degree friends, 11.79% were between second degree friends, 13.05% were between third degree friends, and 61.94% were between strangers.

Friendship degree of partner receiver				Frequency	Percentage
Stranger				1035	61.94
1st Degree Friend				221	13.23
2nd Degree Friend				197	11.79
3rd Degree Friend				218	13.05
Gender				**Frequency**	**Percentage**
Female				51	44.74
Male				63	55.26
Time-Invariant Variables	**Count**	**Mean**	**SD**	**Min**	**Max**
Centrality	114	117.9	128.4	0	451
Proportion of 1st degree friends in lab	114	.1227	.0956	0	.3810

Table 4: Summary statistics (Treatment B)

Figure 8 illustrates the line plot of the average trust level (the amount sent) expressed as a proportion of the initial endowment across periods and the bubble plots of the

[15] One of the sessions had 13 participants and hence by the randomization procedure, 12 periods were conducted with them.

frequencies expressed in bins of 0.2 (20%).[16] In contrast to treatment A, the trust level here was not polarized into low and high groups. Further, it can be seen that there was quite a substantial buildup of trust level as the experiment progressed, something which is rarely observed in experiments. On average, the trust level increased from around 36.6% in period 1 to around 53.4% in period 15, which is almost a 50% increase in the overall trust level.[17]. Figure 9 gives the aggregate view of the possible effects of social network traits without controlling for other variables. As can be seen, the trust level in general fell with the friendship degree.

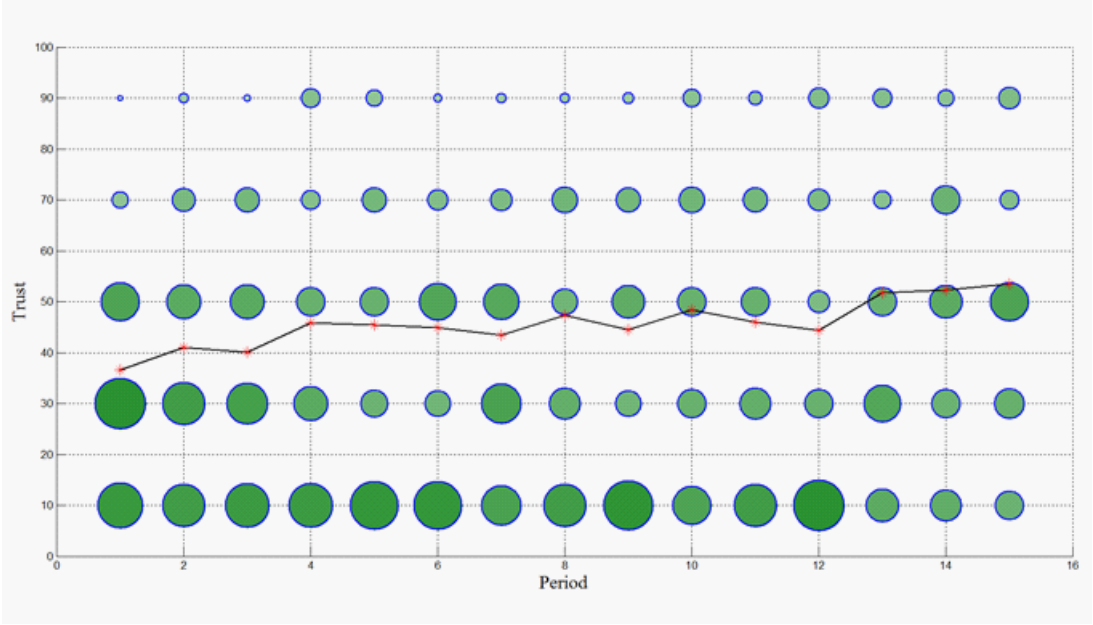

Figure 8: Binned Plot of Trust over time

[16]It should be noted that in treatment B, when senders made their sending decision, the information on the social network traits of their receivers were provided to them. In contrast, in treatment A, as the focus of our analysis was on the directed reciprocity, when the senders made their sending decisions, we did not provide any information on the social network traits of their receivers so as to rule out the impact of the feedback reputation effect on receivers' reciprocity. This allowed us to focus on receivers' directed reciprocity.

[17]A face level comparison to treatment A suggests that this lower initial average level of trust is consistent with the experimental procedure of equalizing endowments, controlling to some extent for altruism and hence lowering trust. Interestingly, possible higher trustworthiness due to inequity aversion on the part of the receiver with the higher endowment does not seem to outweigh the former effect, at least initially. For more details on the effects of endowments/inequality in the trust game, see Cox (2004) and Smith (2011).

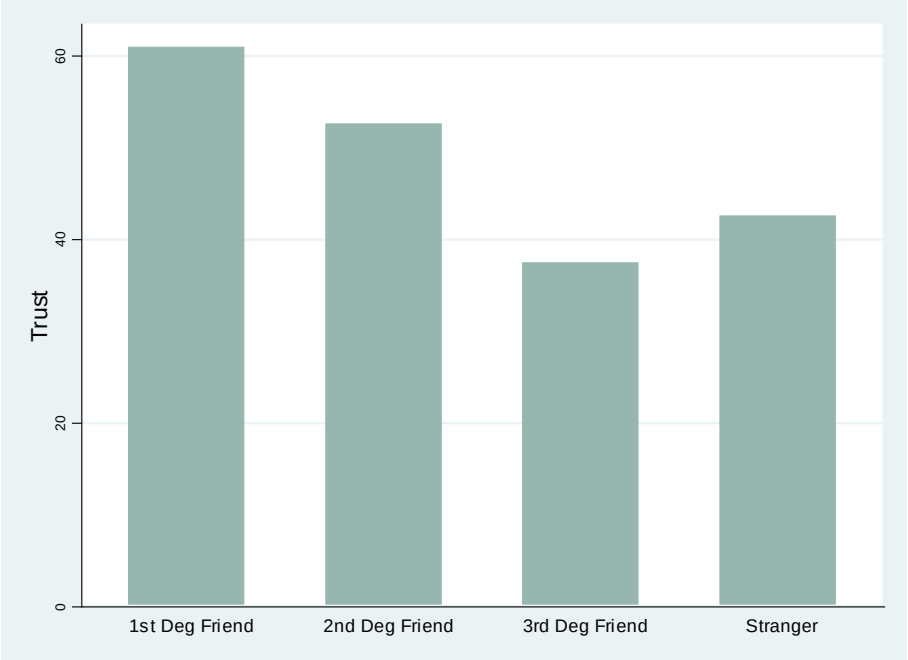

Figure 9: Barplots of trust over social distance

To examine the effect of social network traits on senders' trusting behavior, we estimated the following panel data random-effects regression of the senders' sending decisions.[18]

$$\begin{aligned} T_{it} &= \alpha + \beta_1 E_{it} + \beta_2 L.D_{it} + \delta_1 Cent_i + \delta_2 PCent_{it} + +\delta_3 M_{it} + \mathbf{FD}_i'\boldsymbol{\lambda} + \eta_1 \left(Cent_i \times PCent_{it}\right) \\ &\quad + \mathbf{X}_{it}'\boldsymbol{\theta} + (u_i + \varepsilon_{it}) \end{aligned} \tag{2}$$

where T_{it} is the sending decision of sender i in period t, α is the intercept, E_{it} is sender i's expectation about the trustworthiness (the amount sent back) of his/her partner receiver in period t, and $L.D_{it}$ is the deviation of the actual trustworthiness of sender i's partner receiver from the expected trustworthiness of sender i's partner receiver in the previous period. We used this lagged variable as we expected that the amount sent to a receiver by sender i may also depend on his/her met or unmet expectation about the trustworthiness shown by a previous receiver. $Cent_i$ is the time-invariant sender i' s degree of centrality as measured by his/her eigenvector centrality value; $PCent_{it}$ is the degree of centrality of a receiver with whom sender i plays the trust game; M_{it} is the number of friends that both sender i and his/her receiver have in common; $\mathbf{FD}_{it}'$ is a vector of dummy variables

[18] We used a random effects specification with session fixed effects. This was supported by a Hausman test of fixed vs. random effects as well as a Breusch Pagan test for random effects vs. pooled OLS.

for the degree of friendship between sender i and his/her partner receiver; $\mathbf{X}'_{it}$ is a vector of control variables that include gender, partner's gender, the year of study, the risk preferences, the period, and the proportion of the first degree friends with whom sender i shared the same experimental session; $(u_i + \varepsilon_{it})$ is the composite error term; and u_i are the individual effects. For $\mathbf{FD}'_{it}$, we again used the stranger relationship between sender i and his/her receiver as our baseline for comparison. Table 5 below presents the regression results where we again focus on Model C which includes all of the control variables for inference.

The results on social network traits are in agreement with some of our main predictions. We see that directed trust also exists: that is, individuals tend to show more trust to closer connected friends. In particular, its significance again seems to die off beyond the second degree friendship, which is in line with our previous results from treatment A on directed reciprocity. Individuals seem to regard third degree friends as being not significantly different from strangers. Additionally, playing with a first degree friend has more than twice the impact of playing with a second degree friend; this difference is statistically significant (p-value: 0.002).

Further, in contrast to our results from Treatment A, the degree of centrality of one's partner is highly statistically significant. Every unit increment in the degree of centrality of one's partner was associated with an increase in the amount sent by sender i of 0.020 ECU. While the magnitude may not be economically significant, it nevertheless seems to suggest that senders do take into account the centrality (popularity) of their receiver partner when making their trusting decisions. This is in contrast to the insignificant impact of the partner's centrality (popularity) on the reciprocity decisions we found in treatment A. However, we find that the sender's centrality does not seem to have any significant impact on the sender's trusting decision, even though the direction of the impact is as expected. The number of mutual friends is also not significant. This could be because of the low variation in this variable due to majority of plays being between pairs of strangers or third degree friends who by definition have no friends in common.

	Model A	Model B	Model C
1st Degree Friend	19.674***	19.622***	19.534***
	(3.981)	(3.904)	(3.919)
2nd Degree Friend	7.997***	8.129***	8.117***
	(2.815)	(2.835)	(2.836)
3rd Degree Friend	0.660	0.827	0.796
	(2.306)	(2.245)	(2.248)
PCent	0.020***	0.019***	0.020***
	(0.007)	(0.007)	(0.007)
Cent	0.021	0.020	0.015
	(0.020)	(0.020)	(0.021)
Cent × PCent	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Mutual friends	-0.281	-0.309	-0.308
	(0.406)	(0.403)	(0.403)
L.D	3.401*	3.206*	3.234*
	(1.872)	(1.838)	(1.838)
Expected Trustworthiness	34.967***	35.539***	35.432***
	(6.156)	(5.923)	(5.942)
Male Sender	8.895*	8.836*	8.805*
	(4.663)	(4.669)	(4.691)
Male Partner	-2.129*	-1.995*	-1.999*
	(1.187)	(1.173)	(1.174)
Year of Study	2.715	2.783	3.465
	(3.218)	(3.225)	(3.330)
Risk	0.055	0.097	0.167
	(0.856)	(0.861)	(0.870)
2.session	12.840	11.552	10.793
	(8.676)	(8.746)	(8.508)
3.session	8.740	7.626	8.591
	(7.747)	(7.765)	(7.499)
4.session	12.920	11.701	11.765
	(9.121)	(9.130)	(9.005)
5.session	8.058	6.834	6.213
	(8.275)	(8.328)	(8.104)
6.session	26.087***	24.929***	25.634***
	(7.745)	(7.769)	(7.523)
Period		0.627***	0.627***
		(0.197)	(0.197)
Proportion of 1st degree friends in lab			23.649
			(25.558)
Constant	4.038	-0.765	-4.952
	(9.704)	(9.604)	(10.708)
Observations	1331	1331	1331
Overall R-squared	0.241	0.246	0.248
Chi2	203.5	264.8	272.9
Model df	18	19	20

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, Standard errors are in parentheses, Heteroskedasticity-robust standard errors used. L.D = (Experienced trustworthiness – Expected trustworthiness)

Table 5: Random effects regressions of trust

In addition, we see that the past period deviation of the actual trustworthiness from the expected trustworthiness has a marginally statistically significant effect on the current period trust. However, the effect is relatively small: that is, if one's expectation is exceeded by the maximum amount of 1, which occurs when the expected trustworthiness

was 0 but the partner receiver ends up returning everything, the trust amount increases by around 3 units on average, controlling for other factors. Note however that this effect is cumulative; thus, even if the impact in an individual period is small, the accumulated impact over time might become economically significant. This shows the importance of past experience in influencing the trust level and could explain why we found an increasing trust level over time in this treatment. Further, the expected trustworthiness, somewhat unsurprisingly, has a much larger and more statistically significant impact on a sender's decision to trust the receiver.

5 Conclusion

This paper investigates the link between social ties in a real-life social network and trusting and reciprocal behavior. It does so by combining social network analysis and the experimental economics methodology. Specifically, we elicited the friendship networks of our experiment participants through a novel design utilizing Facebook. First, we encouraged participants to register together with their friends for our experiments. As part of the registration process, they were asked to link their Facebook profile with the Facebook profile we specifically created for our experiments. From this, we were able to observe the patterns of interconnection among our participants and generate their social network data. We then used the data to perform a social network analysis and derived some social network measures, which include the degree of friendship, the degree of centrality (popularity), and the number of mutual friends. Participants then played a modified repeated game where they were paired with a random sender and receiver in each period for their receiver and sender roles respectively. In this manner, the network traits of their partners were varied. Our modified trust game experiments were respectively designed to investigate whether directed trust and directed reciprocity exist in a social network. Directed trust (reciprocity) refers to the tendency of senders (receivers) to treat closer connected receivers (senders) better than strangers by sending back more to the former than to the latter.

We find that directed trust and reciprocity indeed exist; that is, individuals tend to show more trust and reciprocal attitude towards closer friends than strangers. In addition, directed trust and reciprocity tapers off beyond the second degree of friendship. This result suggests that trust and reciprocity, two important fabrics of social capital,

tend to become stronger when the density of social networks is higher and their network members exhibit stronger dyadic connections. Further, we find that people tend to trust more central and popular individuals. In contrast, being a more central and popular individual does not seem to influence one's degree of trust and reciprocity.

In a more general context, the evidence of directed trust and reciprocity found in our paper suggests that a public policy that is intended to enhance social capital in a pluralistic society cannot be focused only on mixing individuals from different social groups but should also be complemented with an effort to enhance the degree of interconnection among society members by significantly reducing the average path length between two society members.

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