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Directed Trust and Trustworthiness in a Social Network: An Experimental Investigation^{*}

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Abstract

Trust and trustworthiness are important in social relationships. The levels of trust and trustworthiness are likely to depend on “social” utility; the magnitude of which is influenced by the social context governing individual relationships. An example of this social context is social network. This paper investigates how social networks influence trust and trustworthiness by blending social network analysis with experimental economics methodology in two separate experiments. We show that trust and trustworthiness are both higher for individuals who are more closely connected; in both cases, this relationship tapers off beyond second-degree friendships. We also find that people tend to trust more central (popular) individuals. However, being more central (popular) has little influence on one’s levels of trust and trustworthiness. We find these effects on trust to be only partially mediated by the expectation of trustworthiness. There exists bias toward closer connected and more popular individuals.

Keywords: Trust, Trustworthiness, Social Network, Friendship Network, Social Distance, Friendship Degree, Centrality

JEL Classification: C90, C92, H89

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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, 1995), plays a significant role in a wide array of social and economic outcomes. For instance, 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 (La Porta et al., 1997), reduces the crime rate (Akçomak and ter Weel, 2012), and is positively related to a nation's financial development (Guiso et al., 2004).

Two key sources of social capital are trust and reciprocity. These are particularly important in reducing the relationship friction in social and economic transactions by promoting social cohesiveness. Trust is often referred to as the willingness to believe that someone for whom one has already done a favor is going to reciprocate. The decision to trust somebody is thus equivalent to putting oneself in the vulnerable state of not receiving such reciprocation. 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. That is, higher willingness to return favors when there is no formal obligation, or contractual arrangement, to do so. The decision is thus motivated by the desire to live up to trustors' expectations.

Measures of trust and trustworthiness used in macroeconomic studies are typically obtained from surveys such as, for example, the World Values Survey (WVS), which is 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 derived from the behavior exhibited by individuals playing an experimental trust game.²

While trust is obviously important, it is often trustworthiness that features more prominently in the discourse of social capital. For example, Robert Putnam, who is regarded as one of the

¹ See <http://www.worldvaluessurvey.org>.

² The trust, or investment, game was first established by 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.

world's leading authorities on social capital, defines it in his influential book (Putnam, 2000) as “*connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them*” (p. 19).

It is interesting to note that Putnam highlights the significant role of social networks in determining trustworthiness. Indeed, social networks are an important part of life, and so social network traits like social distance and centrality may crucially determine the magnitude of trust and trustworthiness displayed by their members. Despite the importance of such social network factors, very few economics experiments have examined behavior exhibited within *real-life social networks*, most focusing instead on random and anonymous interactions between selected participants.³

Though this work is informative, we believe that a clearer picture of the role played by *network traits* can be obtained by examining social behavior in the context of real-life social networks. We attempt to do so by blending the methodology of experimental economics with measurements using social network analysis.

To the best of our knowledge, only a few papers to date offer such an integrated analysis, and it is apparent that more work of this type needs to be done. Examples of recent studies involving economic experiments in real-life social networks include Baldassarri and Grossman (2013), Brañas-Garza et al. (2010), D’Exelle and Riedl (2010), Goeree et al. (2010), Leider et al. (2009). However, these studies focus on *altruistic behavior* by conducting dictator games and their variants within real-life social networks.

In contrast to these papers, our work delves further into trust and trustworthiness⁴. The former can be defined as the extent to which one believes in other people’s reciprocal tendencies, while the latter is the willingness to return an act of trust displayed by others. Specifically, we focus our analysis on how these qualities are affected by specific network characteristics of pairwise relationships within a social network: geodesic distance and centrality (own and partners’), the latter of which we interpret as popularity.

³ Although Glaeser et al. (2000) attempt to examine possible social network effects on *trust and trustworthiness*, they do not elicit an actual network structure but instead measure social connectivity simply by counting the number of common friends and the duration of acquaintanceship of subjects in a two-person trust game. They find that the level of social connectivity positively affects levels of trust and trustworthiness.

⁴ We take the terms trustworthiness and reciprocity to be interchangeable in the sense that an individual who decides to reciprocate can also be considered to be deciding to be trustworthy.

While it should be expected that trust and trustworthiness falls with rising social distance, i.e. it is “directed”⁵, it is not clear the extent to which this is prevalent, or how indirect effects working through past experiences may play out⁶. Further, theoretically, either one’s own or other’s centrality within the network could influence pro-social behavior both in a negative and a positive manner⁷. Our paper seeks to elucidate the role such factors play in influencing the pro-social behavior of trust and trustworthiness.

This would allow us to gain insights into the possible heuristics determining individuals’ trusting and trustworthy behavior in response to others’ centrality or social distance and also examine how such behavior evolves with past experience. The extent of “directed” pro-social behavior is also analogous to the decay factor in network games and may be important in predicting equilibrium behavior in other exchange settings. It further enables a more holistic evaluation of the potential impact of social policies (e.g. community building) on individual and collective pro-social behavior within social networks in order to decide on the policy structure. The network distance to which such directed effects will propagate is significant. Finally, it allows us to elucidate any advantages/disadvantages that centrality/popularity may bring about, which would be relevant for further theoretical work in the area.

In this paper, we conduct two different experiments both using modified trust games which utilize elicited real-life social network data. The first was designed to examine trustworthiness while the second was designed to examine trust. In both experiments, we elicited the friendship network of the participants. We incentivized participants to collectively sign up for the experiment with others and were required to join a Facebook group specifically created for this study using their personal Facebook account. A Facebook application Netvizz was then used to extract the undirected network graph of the registrants. This data was subsequently used to calculate their network relationships and characteristics.

⁵We borrow this terminology from (Leider et al., 2009), using it to refer to decreasing geodesic distance within the network (degrees of separation) being associated with increasing levels of such (pro-social) behaviour.

⁶For example, does experiencing less pro-social behaviour have a stronger negative effect when concerning a close friend or a stranger; a desire to be more tolerant and forgiving of closer friends might make this answer uncertain.

⁷Higher centrality by increasing one’s “power” within the network could result in lower pro-social behaviour; alternatively, it could encourage it through stronger information effects or positive externalities. Higher partner centrality may encourage greater pro-social behaviour due to perceived stronger reciprocation via the reputation which it signals, it may also reduce it since the relative effects of pro-social behaviour may be lower given the partner’s central location.

Participants played a multi-period trust game in both roles: they were provided network information on randomly assigned partners⁸ but not their exact identity; this helped to control for reputation building. Further, there was an element of feedback between rounds in order to examine the effects of past experience in combination with network information.

With the role-reversal method, we need to be careful in controlling the information that participants should receive. For this reason, in the first experiment (the trustworthiness experiment), receivers were provided with information about the amount sent by their sender and their sender's network traits. Senders, in contrast, were not given information about the receiver's network traits nor the amount sent back by their receiver. In the second experiment (the trust experiment), it is senders who were provided with information about the amount sent back by their receiver and their receiver's network traits. Receivers were not given information about the sender's network traits nor the amount sent by their sender. This allowed us to restrict the feedback effects to only solely come from the experience as a receiver but not as a sender in the trustworthiness experiment; and from the experience as a sender but not as a receiver in the trust experiment.

The above design of the two separate experiments thus allowed us to examine how own and partners' network characteristics are related to decisions about whether to trust and be trustworthy, as well as how the latter may interact with feedback from past experience.

Controlling for other factors, our main findings are that trust and trustworthiness decrease with social distance as measured by the geodesic distance between the participant and his/her partner. In particular, these directed effects are more pronounced in trusting behavior but in both cases taper off after the second degree. Furthermore, akin to previous studies on altruism, we find that one's *own centrality or popularity* in the network does not have a robustly significant influence on one's trustworthy or trusting tendencies. In contrast, one's *partners centrality or popularity* does seem to have a significantly positive effect on trust; this effect, however, is not present in trustworthiness. With respect to trust, exploring the mechanism behind it, we find that even after controlling for trustors' expectations of their recipient's trustworthiness, geodesic distance and the centrality of one's partner still

⁸ Note that this can be considered to be pseudo within individual treatment.

positively affect one's trusting decisions. There thus seems to be some innate positive bias towards more closely linked and more central (popular) individuals. Finally, the experience of having a deviation from an expected level of trust/trustworthiness is also found to influence future levels of pro-social behavior.

The rest of our paper is organized as follows. In Section 2, we give a summary of the related literature. In section 3, we present the theoretical background and our experimental design. We then present our findings in Section 4, and Section 5 concludes the paper with a discussion of the implications of our results.

2. Related Literature

In this section, we briefly discuss the various literature related to our paper. Our paper connects to the larger body of literature on trust and reciprocity that study its determinants (e.g. Ben-ner and Halldorsson, 2010; Castelfranchi, 2008; Cox, 2004; Sapienza et al., 2013) as well as its impacts on economics outcomes (Bjørnskov, 2009; Breuer and McDermott, 2009; Horvath, 2013). Much of the experimental literature on these topics follows from the seminal paper on the investment/trust game (Berg et al., 1995), as does ours. Further, our incorporation of social network analysis in our experiment draws from the field of the economics of networks (Jackson, 2008).

Further, our incorporation of social network analysis in our experiment draws from the field of the economics of networks (Jackson, 2008). In particular, our focus on trust/reciprocity within networks is related to the theoretical literature on how cooperative behaviour is sustained/emerges in networks (For example, see Ali and Miller, 2009; Nowak, 2012; Wolitzky, 2006). In examining the impacts of geodesic distance on trust and reciprocity, our paper also relates to an existing empirical literature which examines the impact of low social distance (in a perceived closeness sense) on cooperative behaviour (Orbell et al., 1988). For example, increased perceived closeness to others resulting from, amongst others; double blind vs single blind protocols (Cox and Deck, 2005), Internet vs laboratory experiments (Charness et al., 2007), manipulations of perceived physical distance and the possibility of communication (Fiedler et al., 2011), past interaction (Frey and Bohnet, 1997), greater mutual friends and the duration of acquaintanceship (Glaeser et al., 2000), decreased anonymity when, for example, knowing the family name (Charness and Gneezy, 2008) are

found to positively affect other regarding and cooperative behaviour like trust, reciprocity and altruism. Common characteristics which lead to a perceived in-group identity of partners can also result in increased cooperation (Eckel and Wilson, 2002); in the social identity literature, the finding of in-group bias in various experimental games (Chen and Chen, 2011; Chen and Li, 2009; Goette et al., 2006; Smith, 2011) is also consistent with this idea of a positive impact of reduced social distance.

In our paper, we focus instead on social distance as measured by the actual *geodesic distance* between two individuals in their network, though admittedly the mechanism through which effects occur might be the same (i.e. via perceived closeness). Nevertheless, we are able to elucidate the extent (in terms of the degree of friendship) to which such effects arise. Furthermore, we also analyze the impact of own and others' centrality within the social networks. This can possibly help provide part of the story in network formation/stability where the centrality of others and self influences behavior and could influence such processes. Studies which involve economic experiments in real-life social networks are much more limited: examples of such research include Baldassarri and Grossman (2013), Brañas-Garza et al. (2010), D'Exelle and Riedl (2010), Goeree et al. (2010), Leider et al. (2009). However, these studies focus mainly on altruistic behavior in dictator games and their variants. They find that altruism decreases with social distance as measured by the degree of friendship, although they differ in the extent of geodesic distance that they account for. In contrast, their findings on the effects of own centrality on altruism are mixed. Baldassarri and Grossman (2013) and Goeree et al. (2010) find no significant effects for various centrality measures, while Brañas-Garza et al. (2010) find the contrary. D'Exelle and Riedl (2010) examine different social dimensions of networks in a rural village and find that own and partner's closeness and/or betweenness centrality in the network is significant in terms of generosity. More relatedly, Chandrasekhar et al. (2015) examine outcomes of cooperation in risk sharing games within a real-life network in the field and find that socially close and symmetrically important parties (as measured by eigenvector centrality) support higher levels of cooperation, especially when enforcement is lacking in the latter case.

Our paper seeks to extend the above papers' methodologies to the study of trust and trustworthiness (the former of which is more strategic) and their evolution with past experience. A main difference in our experiment protocol is that we provide information about social network information to participants, but not exact identities, which we believe

helps control for any confounders which may be present when providing identities (and thus approach a more causal understanding).

3.1 Theory and Hypotheses

Past research has incorporated factors like altruism, risk aversion, inequality aversion, guilt aversion, disappointment aversion, and reciprocal expectations, among others, into utility as an explanatory mechanism for trust and trustworthiness or pro-social behavior in general. However, many of these are embedded in a social context. If intensities of these factors in utility are moderated by network-related characteristics of oneself and others, then this would influence one's display of trust/trustworthiness. In this paper, we are interested in how social network characteristics like centrality (popularity) and geodesic (social) distance affect trust and trustworthy behavior as well as their evolution in the trust game.

In the case of social distance, the observation of directed altruism in past literature suggests that social utility (in one of its various forms) is indeed moderated by the network distance of one's partner to oneself. Trust and trustworthy behavior, being pro-social behaviors, are likely to be influenced by similar social utility factors; hence geodesic distance should exert similar impact. For example, in trustworthiness, the intensity with which one cares about others' utility (altruism, inequality aversion) or the expectations of others (guilt aversion) is likely to be stronger when the partner involved is socially close in the network, thus encouraging trustworthiness. In trust, lower network distance might raise altruistic concerns and reciprocal expectations, while lowering concerns for disappointment, thus encouraging greater trust. This leads to the following hypotheses:

Hypothesis 1: *Lower social distance as measured by network geodesic distance positively affects displayed trust and trustworthiness.*

In discussing the effects of centrality on trust and trustworthiness, there is no well-established theoretical literature that examines their role. We hence provide a more intuitive discussion.

With regards to partners' centrality (popularity), it can be seen that predictions are not *a priori* obvious in a general setting for trustworthiness. While a desire to build reputation with more central/popular senders (due to perceived external benefits) might lead to greater

reciprocity toward them, centrality or popularity may also result in a “public goods” kinds of problem in which receivers are less trustworthy towards them because they expect their actions to have less effects on the sender’s payoff given his/her popularity (he/she is likely to receive on average higher amounts from someone given his/her position.) The former explanation is ruled out by our maintained assumption.

Trust, however, involves a more strategic element than trustworthiness, thus expectations of trustworthiness are likely to play a larger role. High centrality/popularity of a partner might signal greater trustworthiness and this might encourage individuals to be more trusting toward them.

This leads to the following propositions:

Proposition 2: *Higher partner centrality has an ambiguous effect on trustworthiness (in the absence of reputation building).*

Further, for the case of trust, which is more strategic, we can also test the role of expectations of trustworthiness in mediating the above relationships (if found).

Proposition 3: *Higher trust with higher partner centrality and social distance is mediated by higher expectations of trustworthiness.*

Similarly, we also explore how own centrality or popularity is related to behavior in the trust game. Theoretical considerations do not seem to produce a clear prediction (this may also be the reason for mixed results in the dictator game). On one hand, higher centrality may be positively related to stronger trust and trustworthiness because such behavior is what led to their high centrality in the first place; alternatively, information or reputational concerns may be greater due to their central position (but the latter is ruled out by our design). On the other hand, more central individuals due to their greater “power” may systematically feel more justified in acting in a less trustworthy manner. Reverse causality might thus plague any causal estimation in this case: we thus omit its analysis in certain specifications.

Proposition 4: *The relation of own centrality to trust and trustworthiness is ambiguous.*

Lastly, we examine how past experience influences future trust and trustworthy behavior as mediated by expectations and explore how this may interact with social distance factors. In particular, treating expectations of others' behavior as a reference point (Kahneman and Tversky, 1979; Koszegi and Rabin, 2006), positive (or negative) deviations of other's behavior from it in past experiences can be expected to lead to higher (or lower) trust/trustworthy behavior in some kind of reinforcement learning. Social distance factors, however, may intensify or diminish such effects depending, for example, on whether one is more forgiving toward (or impressed by) strangers or close friends in negative (or positive) deviations. The literature does not seem to have a clear answer on this.

Proposition 5a: *Positive (or negative) deviations of partner's actions from past behavior leads to stronger (or weaker) trust/trustworthiness.*

Proposition 5b: *The interaction of the above with social distance factors is ambiguous.*

3.2. Experimental Design and Procedures

In this section we describe the experimental procedure, which we use to test the aforementioned hypotheses. Our experiment consisted of two stages; network elicitation and a controlled laboratory experiment. In the first of these, we conducted a basic survey of our registered 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 overall friendship network, which were split up by sessions. We used two separate and independent experimental designs, namely the trustworthiness experiment and the trust experiment. The two experimental designs were designed so as to allow for the examination of partners' social network characteristics on trust and trustworthiness decisions, as well as their possible interaction with feedback effects from past experience. The two experiments together with their respective network elicitations were conducted at different times of the year. The trustworthiness experiment was held in March 2013 and the Trust experiment in August 2013.

3.2.1. Stage 1: Network Elicitation Using Web Interface

We invited participants from a pool of undergraduate students at Nanyang Technological University (NTU) majoring in various disciplines including engineering, science, humanities, and social sciences to take part in our study, via email. A total of 55 and 157 participants signed up for the Trustworthiness and Trust experiments respectively. They were instructed to register in groups and were provided with a monetary incentive scheme as illustrated in Table 1. The larger their group, the bigger the amount each member received. Furthermore, a minimum group size of two was put in place so as to avoid singleton participation. It is worth mentioning that members of each registered group were not all required to be direct (first degree) friends with each other on Facebook. Thus, a member of a registered group could invite a friend who was directly connected to him/her but not to his/her other friends in the group. Given this incentive scheme, participants would typically invite their friends along to the experiment while also asking them to include their own friends. As in any experiment based on existing social networks, it is difficult, if not impossible, to elicit the entire friendship network since not all close friends were able to participate.

Number of members in group	Incentive per person in the group
2	S\$0
3-4	S\$2.50
5-6	S\$3.50
7-8	S\$4.50
9-10	S\$5.00
>10	S\$6.00

Table 1: Incentives for joining in larger groups

When registering, participants were required to complete a basic online survey to obtain demographic information. After finishing the survey and the registration process, participants were then required to join a Facebook group specifically created for this experiment. Once they had all done so, their friendship-network data was extracted using the Facebook

application *NetVizz*.⁹ The data was then used to generate the network graph and calculate several network related characteristics¹⁰. The network graphs for the two treatments are illustrated in Figures 1a and 1b. The nodes represent participants with their size scaled by their *eigenvector centrality*¹¹, which we interpret as a measure of individuals' popularity within the social network.¹² In both cases, there are several major friendship groups that are densely connected and smaller friendship groups on the periphery that are sparsely connected.¹³ Some of these smaller groups are isolated from the others.

We opted to use the (*non-normalized*) *eigenvector centrality* measure as our primary popularity measure instead of the *degree* or *betweenness centrality* because in our opinion, the former more accurately measures popularity in a network. This (recursive) measure assigns relative scores to all individuals, with those connected to higher scoring individuals receiving larger scores. Essentially, we are of the belief that individuals who are connected to larger numbers of popular people would tend to be more popular themselves.

⁹ See <https://apps.facebook.com/netvizz/>.

¹⁰ Graph visualization was carried out via the software *Gephi* (Bastian et al., 2009), while the calculation of eigenvector centrality and social distances were carried out using UCINET (Borgatti et al., 2002) and MATLAB.

¹¹ The node size representation was derived using the inbuilt eigenvector centrality function provided in *Gephi*; the values are slightly different from the ones derived from UCINET, which we used later.

¹² We had only a short time interval between registration and participation. When participants registered, they would be automatically connected to the Facebook group we created for this experiment. We verified that all participants have personal Facebook page prior to participating in our experiment. We then extracted the network data after they had registered but before they came to the lab to participate in the experiment. While it was possible that in this time interval some of them decided to connect with others unconnected to them previously, we believe that this was not the prevalent mode. Thus, the Facebook network data we have is a snapshot of friendship relationship on our Facebook group that was automatically captured when participants registered to our experiment. So the centrality measure in our data is unlikely be driven by the case of individuals who submitted many friend requests to others. Nevertheless, we agree that popularity is not the only possible meaning for centrality in our experiment, at least from the point of view of participants. For this reason, and to induce common interpretation (information), we told participants in the experimental instructions that centrality, which might be a too technical jargon for the general population, can be interpreted 'loosely' as popularity. We see this as helpful in mitigating polarized view among participations on the meaning of centrality.

¹³ In some cases, individuals' network data failed to be extracted due to individual Facebook privacy settings. They appear as individual nodes in the figure and were treated as controls in our experiment; if they participated in the second-stage experiment, they were randomly assigned partners who were strangers. Six of the 114 who attended Treatment B were in this situation. Excluding or including them does not affect our main results.

Figure 1: Networks in the Trustworthiness experiment (left), Trust experiment (right)

3.2.2. Stage 2: Multi-Period Trust Game within the Network

The second stage was conducted within a week of the end of the first stage. Subjects who had participated in the first stage were invited to join a modified trust game experiment.

We conducted two distinct experiments involving modified trust games to study trust and trustworthiness separately. This was done in order to focus on the direct impact of partners' network traits on individuals' trust (trustworthiness) decisions while at the same time to isolate the indirect feedback effect accrued from the experience of being reciprocated (trusted) by the receiver (sender) on their next round trust (trustworthiness) decisions.

The experiments were conducted in two experimental economics laboratories at Nanyang Technological University (NTU), each of which had 30 computer cubicles. Participants were randomly grouped (there are 5 groups for the trustworthiness experiment and 6 groups for the trust experiment), and randomly assigned into experimental sessions. We also ensure that randomization of pairing within each group would result in sufficient variation in terms of the degree of friendship and centrality across participants¹⁴. The way in which the networks in the 2 experiments were split is shown in Figures 2 and 3.

¹⁴ This was done in a pseudorandom manner through visual inspection of the networks.

It is important to note that in this paper, we do not delve into comparative analysis of trust (trustworthiness) decisions between the two experiments, because such comparative analysis will be meaningless given that their designs are different.¹⁵

Figure 2: Trustworthiness Experiment Network split into groups

¹⁵ For this reason, there are some small differences in the experimental procedures between the two treatments as we are able to improve on the second experiment (trust) using information from the first (trustworthiness).

Figure 3: Trust Experiment Network split into groups

The trustworthiness experiment lasted approximately two hours, while the trust experiment lasted around one-and-a-half hours. Detailed descriptions of both designs are presented below.

Trustworthiness Experiment

On the day of the experiment, we had some attrition. Of the 55 participants registered for the Trustworthiness experiment, only 46 took part¹⁶.

As mentioned above, a modified trust game experiment was played for 25 periods within the subnetwork groups illustrated in Figure 3¹⁷. Before the start of the experiment, the instructions were read aloud to participants, and a hard copy was also provided. The instructions included a diagrammatic description of the network variables labeled *friendship degree* and *centrality* (see supplementary materials); they were told that centrality could be to some extent interpreted as an individual's popularity. They were informed directly (but not in the written instructions) that the Facebook group which they joined was used to obtain this

¹⁶ Note that Figures 3 and 4 are based on the number of registered rather than actual participants in order to illustrate the full set of links involving all those who had signed up.

¹⁷ The experiment was programmed and conducted using the software z-Tree (Fischbacher, 2007).

information. 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 to ensure that they thoroughly understood the game. The first period of the main experiment was a trial, the outcomes of which were not considered in the calculation of the participants' final earnings.

In every period, participants began by playing as senders. They were asked to decide how many points out of their initial endowment they would like to send to an anonymous receiver who was also a member of their group. 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.

Following Brandts and Charness (2011), Charness and Rabin (2002), and Coffman (2011), we adopted the role reversal method¹⁸. Thus, once they had made their sending decisions, the participants then played as receivers. Each receiver randomly and anonymously received one of the sending decisions made earlier by a sender in their subgroup. We ensured that the receiver did not receive his/her own sending decision. Before notifying the receivers of their respective sender's decisions, we provided each receiver with information on the sender's social network traits (i.e. the *friendship distance* and the *centrality* in the network)¹⁹; they were not given a map of the entire friendship network or their position within it. Note that we opted to preserve the anonymity of the experiment by not revealing the exact identity of the sender. We also elicited each receiver's first-order belief (expectation) about the number of points a sender with those network traits would send to a stranger. 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

¹⁸ This partly helped ameliorate sample size issues, but was actually a key part of another plan to examine how experience in one role affected behaviour in the other (e.g. indirect reciprocity in the form of stronger trust in others as a result of stronger experienced trust). The paper is not in circulation, but is available on request from the author.

¹⁹ To give participants a frame of reference for centrality values, we also provided the minimum, maximum, and average centrality values for the entire network.

amount sent, they would receive a reward of 20 ECU. This amount was set (in real money terms) to be small enough not to cause disappointment in the event of getting it wrong but large enough to provide an incentive for participants to make accurate predictions.

Following the belief elicitation, each receiver was informed of his/her partner's actual sending decision and asked to decide how many of the tripled points received he/she would like to return to the original sender. The amount of money (points) sent back by a receiver to a sender was taken to be our measure of trustworthiness. We repeated this process across 25 periods and employed a random rematching protocol²⁰ to vary partners across periods.

Accordingly, each period consisted of a *sending*, an *expectation*, and a *receiving* decision for each participant. 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. An attendance fee of 3 SGD was also given to all participants. Participants earned 13.7 SGD on average from this experiment. The lowest earnings were 6 SGD and the highest 24 SGD. In addition to this sum, each participant also received their group incentive bonus, which varied depending on the size of the group with which they had registered.

It should be highlighted that we only provided information on the sender's social network traits to the receiver while senders were not informed of the receiver's traits. This was to prevent social network factors from playing a role in how feedback about senders' actions affected subsequent behavior as a receiver. Also, note that while receivers were aware of how much they had obtained from senders, in contrast, senders received no interim feedback on amounts returned by their partners; this was only provided to them at the very end of the experiment.

The above asymmetry in information provided to senders and receivers thus helps ensure that the effects of feedback in the experiment were isolated to one's experience as a receiver. Thus, from a sender's viewpoint, he/she faced a standard anonymous trust game and we

²⁰ Since the sample size was smaller in this experiment, we opted for more periods in order to increase statistical power. This meant that it was not a pure stranger matching protocol in that they might actually be paired up with the same partner more than once and notice the same information being displayed when playing as a receiver. To control for this, we have calculated the number of times they met a particular partner and used it as a control in our analyses.

treated the amount sent as a measure of baseline trust.²¹ But from a receiver's viewpoint, he/she had to make a sending-back decision with knowledge of the social network traits of his/her partner sender.²² Note also that this experimental design implicitly prevents reputation-building, as the senders do not know the receivers' identities or the amounts returned prior to the end of the experiment.²³

Trust Experiment

In the Trust Experiment, of the 157 registered participants, 114 took part in the second stage.

From experience in the Trustworthiness Experiment, we decided to limit the number of periods to 15 so as to reduce the time taken to conduct the experiment as well as the possible fatigue from lengthy participation. We eliminated the possibility of players encountering the same partner more than once by setting the number of periods to 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 three times as many as in the directed reciprocity treatment).

As in the Trustworthiness Experiment, instructions were read aloud to the participants before the start of the experiment and they were also given a hard copy. This included a diagrammatic description of the network variables labeled *friendship degree* and *centrality*. They were also given a set of control questions about the details of the game to be played, which had to be answered correctly before proceeding to the main experiment. The first

²¹ By baseline trust, we refer to trust when interacting with strangers. Note also that since the endowments of the sender and receiver are not equal in this treatment, trust here to some extent also captures altruistic motives.

²² One might argue that there is an experimenter demand effect here due to the provision of information about social network traits, which induces participants to respond more favorably when their partner's traits (e.g. the degree of friendship) indicate that the partner is a first degree friend. Consequently, providing actual identities in the experiment would be better than providing information on social network traits. However, one can also argue that providing actual identities could itself give rise to the same effect. That is, a participant may be subtly primed to give more to somebody he/she knows better than somebody who is not well known. We decided to adopt the current approach in order to preserve the anonymity of our experiment. However, we believe each approach has its own merits.

²³ To minimize participants taking chances by reciprocating on the basis of the number of friends in their group, we ensured that each experimental cohort did not contain too many of a given participant's friends: the proportion of first-degree friends had a mean of 0.163 and a maximum of 0.381. We used this as a control variable in our regression analysis.

period of the main experiment was a trial period, the outcomes of which were not considered in the calculation of participants' final earnings.

Here, we equalized the endowments of senders and receivers to 100 ECU so as to minimize any altruistic motive behind the senders' sending decisions and to make the influence of social networks more apparent.

As a receiver, participants made the sending-back decision only once before period 1 commenced using the strategy method. In particular, participants had to choose, at intervals of 10, how much of the tripled amount they wished to return to their respective sender. If the sender sent an amount between the interval, the amount returned would be linearly interpolated from their strategy method table.²⁴ Since this sending-back decision was made only once using the strategy method, reciprocal decisions would thus remain constant across periods. Participants were not informed of the actual amount they received as a receiver in each period until the end of the experiment, this controlled for experience as a receiver endogenously affecting their subsequent decisions as a sender.

Similar to our directed trustworthiness design, we also adopted the role reversal method. Subsequently, participants played as senders, where they were paired randomly and anonymously with a receiver whose strategy method decisions were used to determine the amounts returned. Before notifying senders of their partnered receiver's decision, we provided them with information on the latter's social network traits. In addition to the *friendship distance* and *centrality*²⁵ in the social network of the receiver, we also provided the *number of mutual friends* and the *partner's gender*. Similarly, they were not given a map of the entire friendship network or their position within it. Senders were then asked to decide how much to pass to their partner receiver.

We then elicited senders' first-order belief (expectation) about the amount a receiver with those social network traits would return to a stranger by asking the following question.²⁶

²⁴ For example, if the receiver indicated that he/she wanted to send back 20 when receiving 10, the tripled amount was 30; if returning 30 when receiving 20, the tripled amount was 60. Accordingly, if the actual amount received was 15, 25 would be sent back.

²⁵ Similarly, to give participants a frame of reference for centrality values, we also provided the minimum, maximum, and average centrality values for the entire network.

²⁶ In contrast to Treatment A, we opted not to incentivize the elicitation of expectations here so as to remove

“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?”

Since all the participants knew that receivers would only make send-back decisions at the beginning of the experiment, their expectations should also have taken into account the fact that any reciprocal decisions of receivers at each stage were static and hence should not have responded to previous play. After the belief elicitation and before the beginning of the next period, they were then provided feedback on how much their partner had returned to them. The above-described sending and expectation stages were repeated across multiple periods, with the full history of all periods’ transfers by senders provided at the end.

We randomly chose a single period for the calculation of payoffs. The conversion rate was $30 \text{ ECU} = 1 \text{ SGD}$, with an attendance fee of 3 SGD. The mean payoff was 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 as above.

Notice that in contrast to the Trustworthiness experiment, we only provided information on receivers’ social network traits to senders. This was to prevent social network factors from playing a role in how feedback about receivers’ actions affected subsequent behavior as a receiver. Further, note that only when playing as a sender did participants receive feedback about their partners’ actions.

The above asymmetry in information provided to senders and receivers (which is directly opposite to that in the Trustworthiness experiment) thus helps ensure that the effects of feedback in the experiment were isolated to one’s experience as a sender. Anonymity on both sides as well as the use of randomized matching (such that no one played with each other twice or more) allowed us to control for reputation building.

some of the incentive effects on trust we had found in Treatment A and to allow us to focus only on the influence of expectations on trust. An argument against the no-incentive procedure is that participants may become lazy in inputting their expectations without it. However, we verified that this did not appear to present a problem: they did not systematically input some easy to type number.

4. Results

Table 2 presents some descriptive statistics. In Treatment A, 46 out of 55 registered participants actually took part over 25 periods, giving a total of 3450 observations consisting of an equal number (1150) of sending, receiving, and expectation decisions. In Treatment B, 114 out of 157 registered participants attended with an average of 14.66 decision periods. This gave a total of 3342 observations consisting of an equal number (1671) of sending and expectation decisions. From the strategy method elicitation stage, we obtained 114 sets of trustworthiness (sending-back) decisions. Gender composition was roughly balanced across both treatments. We observed a wide variation of eigenvector centrality in both.

The majority of plays were between strangers, and the rest were approximately even between first-, second-, and third-degree friends.

	Trustworthiness Experiment		Trust	Experiment
	Observations	Percentage	Observations	Percentage
Friendship Distance of partner receiver				
Stranger	560	48.7	1035	61.94
1 st Degree Friend	268	23.3	221	13.23
2 nd Degree Friend	169	14.7	197	11.79
3 rd Degree Friend	153	13.3	218	13.05
Total	1150	100	1671	100
Gender	Frequency	Percentage	Frequency	Percentage
Female	22	47.83	51	44.74
Male	24	52.17	63	55.26
Total	46	100	114	100
Time-Invariant Variables	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)
Eigenvector Centrality	90.52 (93.33)	0 (278)	117.9 (128.4)	0 (451)
Proportion of 1 st Degree in the Lab	.1630 (0.1165)	0 (0.381)	.1227 (.0956)	0 (0.381)

Table 2: Summary Statistics

Figures 4 and 5 show the line plots (in black) of the average baseline trust, expressed as the proportion of the amount sent to the initial endowment, and the magnitude of trustworthiness,

expressed as the proportion of the amount sent back to the tripled amount in the Trustworthiness experiment. They also show the bubble plots (the size of the green circles corresponds to the frequencies in each bin) of the average baseline trust and average trustworthiness for each period in bins of 0.2 (20%). The negative bin in Figure 5 corresponds to cases where receivers did not receive anything and thus trustworthiness is not defined.

Figure 4: Bubble and Line plots of Baseline Trust (Trustworthiness Experiment)

**Figure 5: Bubble and Line plots of Trustworthiness (Trustworthiness Experiment);
Negative values indicate no ECU received.**

The average baseline trust over all periods was about 49.3%. The initial trust level started slightly higher than the average typically found in trust game experiments, but ended slightly lower, at around 41.3% (Johnson and Mislin, 2011). Nevertheless, in general, the results do not seem to deviate greatly from those found in previous 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 increased as the period progressed, indicating that more senders decided to give lower amounts later in the experiment.

The average level of trustworthiness shown in Figure 5 was around 16.2%, which is considerably lower than the average found in previous experiments of about 37% (Johnson and Mislin, 2011). The lowest average trustworthiness we recorded was around 11%. It should be noted that for this value of trustworthiness, senders earned an average negative return on investment. All in all, these figures suggest that on aggregate, without controlling for the degree of friendship between receivers and senders and the centrality of the latter, the level of trustworthiness tended to decrease over time.

Next, we take a preliminary look at how the level of receivers' trustworthiness was affected by senders' friendship degree.

Figure 6 presents a bar and CDF plot illustrating how the level of trustworthiness varied with the degree of friendship between receivers and senders in the Trustworthiness Experiment. This offers an aggregate examination of the level of receivers' trustworthiness, which includes the influence of other experimental variables. It can be seen that there is a somewhat negative relationship between these two variables although the difference between first- and second-degree friends is not significant and the proportion returned is lower when the sender is a third-degree friend rather than a stranger. This is likely due to observed and unobserved time-invariant heterogeneity which influences one's network position and thus the range of types with which one can be randomly matched in the network. In the subsequent regression analysis, the decreasing relationship can be observed more clearly.

Figure 6: Bar plots and CDF of Trustworthiness by Friendship Distance

Figure 7 illustrates the line plot of the average level of trust (the amount sent by senders) expressed as a proportion of the initial endowment across periods, and the bubble plots, the size of which denotes the frequencies of the average level of trust expressed in bins of 0.2 (20%) in the Trust Experiment. In contrast to the Trustworthiness Experiment, the average level of trust in Treatment B was not polarized into low and high groups. Furthermore, a substantial build-up of trust level can be seen as the experiment progressed, something that is rarely observed in this type of experiment. On average, the trust level increased from around 36.6% in period 1 to around 53.4% in period 15, which is an almost 50% increase overall. One possible reason for this difference in trust between the two experiments could be due to initial over-pessimism of receivers in the Trust experiment in contrast to over-optimism in the Trustworthiness experiment²⁷.

²⁷This could be because receivers had partial information on senders in the trustworthiness treatment, from which senders surmised that they would be better treated. Over-pessimism could however be corrected from feedback in the trust experiment; this might have helped to combat the natural decay of trust over time.

Figure 7: Bubble and Line Plots of Trust in the Trust Experiment

Figure 8 shows that the trust level generally decreased as friendship distance increased, though a similar reversal (albeit smaller) is present for third-degree friends and strangers. Recall that in Treatment B, the level of trustworthiness was elicited once before period 1 commenced, using the strategy method. Consequently, we do not have an across-period plot of trustworthiness.

Figure 8: Barplots and CDF of Trust by Friendship Distance

We now present a more in-depth regression analysis of the two treatments, beginning with the Trustworthiness Experiment.

We consider the effects of social network traits and the most immediate past experience²⁸ with a sender as a receiver on their trustworthiness behavior in the following panel-data set-up:

$$TW_{it} = \alpha + FD'_{it} \lambda + \delta_1 Cent_i + \delta_2 PCent_{it} + \beta_1 D_{it} + \beta_2 D_{it} \times FD'_{it} + X'_{it} \theta + (u_i + \varepsilon_{it}) \quad (1)$$

TW_{it} is our measure of trustworthiness, which is the amount sent back by receiver i in period t as a proportion of the tripled amount received, α is the intercept, and D_{it} is the deviation of the actual amount received by receiver i from his/her sender from the amount that receiver i expected to receive from them. $Cent_i$ is the time-invariant receiver i 's centrality, $PCent_{it}$ is the centrality of the sender with whom receiver i is partnered, and $FD'_{it} = [1stDegree, 2ndDegree, 3rdDegree, Stranger]$ is a vector of the dummy variables for the degree of friendship between receiver i and his/her sender. Note that the baseline case for the regression is *Stranger*. X'_{it} is a vector of time variant and time-invariant control variables that include gender, session-specific fixed effects, period, the number of times a participant had played before with his/her partner, the proportion of the first-degree friends of receiver i who shared the same experimental session, and session-specific fixed effects. Finally, $(u_i + \varepsilon_{it})$ is the composite error term, and u_i the individual effects.

Given the presence of censored observations of trustworthiness, we present the results for our preferred specification, the random effects Tobit model, relegating the discussion of robustness to other methodologies in the next section. Table 3 presents the regression results. Here, the centrality measures are all eigenvector centrality, which are scaled by $1/(\text{maximum value})$ in order for easier interpretation of the coefficients. Model A is the baseline model with no control variables. Model B adds the control variables, while Models C and D add D_{it} and its interactions with Friendship distance respectively.

²⁸ Here, this would be the interaction with the current partner sender where the receiver obtains the tripled amount.

	Model A	Model B	Model C	Model D
1 st degree Friend	11.823*** (3.427)	11.663*** (3.762)	13.508*** (3.006)	13.872*** (3.025)
2 nd degree Friend	11.256*** (3.939)	9.739** (4.261)	8.181** (3.878)	6.465* (3.480)
3 rd degree Friend	2.550 (5.161)	1.953 (4.802)	3.883 (4.527)	1.465 (5.366)
Partner's centrality	-8.351 (5.905)	-9.490* (5.582)	-5.216 (5.141)	-4.965 (4.515)
Own centrality	-3.116 (14.857)	-2.478 (34.406)	-3.621 (21.929)	-4.331 (24.412)
Deviation from Expected Trust:			0.189*** (0.034)	0.171*** (0.057)
× 1 st degree Friend				-0.079 (0.065)
× 2 nd degree Friend				0.101 (0.085)
× 3 rd degree Friend				0.174 (0.114)
Male	-19.622* (11.476)	-16.582 (11.901)	-16.647 (13.061)	-15.976 (9.912)
Period		-1.075*** (0.255)	-1.187*** (0.290)	-1.200*** (0.250)
No. of Times Played Previously		-0.688 (1.025)	-0.226 (1.177)	-0.106 (0.805)
Proportion 1 st Degree Friends		45.887 (111.622)	50.420 (79.542)	49.681 (91.038)
Session Fixed Effects	NO	YES	YES	YES
Constant	12.293 (8.476)	8.038 (18.062)	2.227 (14.655)	2.269 (15.877)
Observations	915	915	915	915
Log likelihood	-2423.0	-2377.2	-2335.8	-2328.9

***, **, and * denote significance at 1%, 5%, and 10% levels. Bootstrap standard errors used. Trustworthiness multiplied by 100, Centralities scaled such that maximum has value of 1.

Table 3: Random Effects Tobit Regressions of Trustworthiness

As can be seen from Table 3, the coefficients of the dummy variables for first- and second-degree friendship in all models are all roughly similar and were both positive and significant. Furthermore, the magnitude of the coefficients decreased with the degree of friendship. That is, on average, receivers returned a higher proportion of money to first- and second-degree friends (12 – 14% and 6 – 11% of the tripled amount, respectively) than strangers. In the full specifications (Models C and D), the effect of a first-degree friend is 1.5 to 2 times the size that of a second-degree friend. This confirms the existence of *directed trustworthiness* and is consistent with the discussion presented earlier in this paper. People tend to treat closer friends better than more distant ones. The coefficient of the dummy variable for third-degree friendship is not significant, implying that there is no difference in

trustworthy behavior between third-degree friends and strangers. Directed trustworthiness effects hence tend to taper off after the second degree.

However, the regression coefficients for both the participant and his/her partner's eigenvector centrality were mostly insignificant. This implies that neither the social network popularity of oneself or others affected receivers' decisions to be trustworthy. It is interesting to note that the estimated direction of own and partner's centrality is always negative. In the former case, 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 to the sender. In the latter case, (controlling for reputation building) this would be consistent with our earlier discussion that receivers might feel that popular senders have less need for reciprocity since others would help take the slack given the sender's popularity.

From Model C, it can be observed that positive deviations from expectation in terms of the actual amount received were also associated with a higher degree of trustworthiness. That is, when the actual level of trust exceeded expectations by 10 points, receivers correspondingly returned 1.89% more of their tripled received amount and vice versa. This is on the same order of magnitude as the effects of social network traits. This illustrates that past experience, mediated by expectations as a reference point, can have an important role in influencing trustworthiness. In Model D, we examine whether past experience has varying effects depending on the friendship distance of the involved partner; however, we do not find evidence of this.

We now move on to the regression analysis of the Trust Experiment. Similarly, we consider the effects of social network traits and the most immediate past experience²⁹ with a receiver as a sender on their trustworthiness behavior in the following panel-data set-up:

$$T_{it} = \alpha + FD_i' \lambda + \delta_1 Cent_i + \delta_2 PCent_{it} + \delta_3 M_{it} + \beta_1 L.D_{it} + \beta_2 L.D_{it} \times FD_{it}' + X_{it}' \theta + (u_i + \varepsilon_{it}), \quad (2)$$

T_{it} is the sending decision of sender i in period t , α is the intercept, $L.D_{it}$ is the

²⁹ Here, this would be the interaction with the receiver in the previous period where the sender received information about how much he/she got back. Unlike in the Trustworthiness Experiment, this would instead be indirect and may thus exhibit smaller effects.

deviation of the actual trustworthiness of sender i 's receiver from the expected trustworthiness of sender i 's receiver in the previous period. $Cent$ is the time-invariant sender i 's centrality, $PCent_{it}$ the centrality of a receiver with whom sender i plays the trust game, and 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 for the degree of friendship between sender i and his/her receiver. $\mathbf{X}'_{it}$ is a vector of time variant and time-invariant control variables that includes gender, partner's gender, period, the proportion of first-degree friends with whom sender i shared the same experimental session, and session fixed effects. Finally, $(u_i + \varepsilon_{it})$ is the composite error term and u_i the individual effects. We used the stranger relationship between sender i and his/her receiver as the baseline for comparison.

Given the presence of censored observations of trust and to keep our methodology consistent, we present the results for a random effects Tobit model, again relegating the discussion of robustness to other methodologies in the next section. Table 4 presents the results of this regression. The specification of Models A to D is the same as presented above.

It can firstly be seen that a significant predictor of trust is expected trustworthiness: a 1% increase in expected trustworthiness led to an increase of approximately 0.4% in the level of trust. This shows that a significant proportion of trust is strategic, in that it aims to induce the receiver to send back more money and increase the sender's payoff.

Similar to the Trustworthiness Experiment, we also note the presence of *directed trust*; that is, individuals tend to show more trust to friends who are more closely connected. On average, participants sent a higher proportion of their endowment to first- and second-degree friends (14 – 15% and 24 – 28%, respectively) than to strangers. In the fully specified models C and D, the effects of a first-degree friendship on trust is approximately 1.9 times that of a second-degree friendship. In contrast, on average, senders do not treat strangers and third-degree friends significantly differently. As before, we find that directed trust also tapers off after the third degree.

	Model A	Model B	Model C	Model D
1 st degree Friend	23.831*** (4.068)	24.085*** (5.492)	28.034*** (5.252)	28.140*** (4.975)
2 nd degree Friend	13.768*** (3.184)	14.031*** (2.923)	15.255*** (3.898)	15.356*** (3.739)
3 rd degree Friend	3.069 (1.979)	3.442 (2.782)	3.578 (2.205)	3.680 (2.875)
Mutual friends	-0.226 (0.401)	-0.245 (0.434)	-0.478 (0.552)	-0.477 (0.503)
Partner's centrality	12.536*** (3.121)	12.687*** (2.508)	11.597*** (3.379)	11.433*** (2.719)
Own centrality	12.173 (13.641)	13.149 (15.358)	12.756 (17.826)	12.522 (12.484)
Lagged Deviation from Expected Trustworthiness:			0.044* (0.025)	0.058*** (0.021)
× 1 st degree Friend				-0.091 (0.067)
× 2 nd degree Friend				-0.048 (0.064)
× 3 rd degree Friend				0.029 (0.065)
Male	12.931* (6.836)	5.513 (6.243)	8.837 (7.254)	8.780 (7.537)
Male Partner	-3.273** (1.622)	-3.506** (1.504)	-3.384** (1.681)	-3.287* (1.742)
Male × Male Partner	1.599 (2.284)	1.622 (2.710)	1.517 (2.714)	1.528 (3.219)
Period	0.858*** (0.232)	0.846*** (0.232)	0.640*** (0.215)	0.650*** (0.242)
Proportion 1 st Degree Friends		53.321 (37.722)	42.148 (39.907)	42.249 (35.145)
Session Fixed Effects	NO	YES	YES	YES
Constant	21.609*** (6.332)	-26.558** (11.756)	2.891 (8.925)	3.455 (7.042)
Observations	1671	1671	1431	1431
Log likelihood	-6354.4	-6334.5	-5600.1	-5598.6

***, **, and * denote significance at 1%, 5%, and 10% levels. Bootstrap standard errors used. Trustworthiness multiplied by 100, Centralities normalized to 1 for the maximum.

Table 4: Random Effect Tobit Regressions of Trust

In contrast to the Trustworthiness Experiment, the partner's centrality was highly statistically significant. In particular, *ceteris paribus*, playing with the most popular individual (scaled centrality = 1) was associated with an increase of $\approx 11.5\%$ of one's endowment sent. However, the sender's centrality again had no statistically significant impact on his/her trusting decisions. It is interesting to note that unlike in the Trustworthiness Experiment, the signs of own centrality are now positive. This may suggest that more popular individuals tended to show a higher level of trust towards receivers which would be consistent with the earlier finding that popular individuals (senders here) feel more justified in their actions and

thus expect to get back more from others.

The number of mutual friends was also not statistically significant. This could be because of the low variation in this variable due to the majority of plays taking place between pairs of strangers or third-degree friends who, by definition, had hardly any friends in common. Finally, we observe from Model C and D that the past period deviation of actual from expected trustworthiness had an effect on current period trust but was not differential according to the friendship distance of the partner involved. Specifically, if actual trustworthiness (proportion of tripled amount returned) in the past period exceeded expected trustworthiness by 10%, the current level of trust increased with one sending an additional $\approx 0.5\%$ of one's endowment. Thus, the impact during any individual period was relatively small. As a side note, we also find that male partners tend to be less trusted than females in general.

One reason for the observations of higher trust towards more closely connected and popular individuals could be because individuals systematically expect them to be more trustworthy, as mentioned in the theory section³⁰. We explore this in the regressions in Table 5 by including the expectations of trustworthiness as a mediating variable. If there were no direct effects of social connectedness or partner popularity, the effects and significance of these variables should disappear while the expectations variable should become significant. Further, expectations of trustworthiness should be positively related to both of these social network factors. In Model C, we find that these positive relations do indeed hold, though less so for partner centrality. In Model B, we find that expectations of trustworthiness are indeed positively related to higher trust. However, even after controlling for expected trustworthiness, while the magnitude of the network variables' coefficients does indeed decrease as compared to Model A, they still remain strongly significant. There is thus evidence of only partial mediation and there is some strong direct bias beyond that of expecting reciprocity, which leads to trusting closer and popular individuals more. One reason may be that, similar to past dictator game experiments in the literature, individuals are more generous and forgiving towards such individuals in the sense that they expect and are willing to accept less reciprocity from them.

³⁰ Technically, such beliefs involving social distance here would involve a bias since in our experiment, receivers do not know about partner's characteristics. It is thus impossible for them to condition trustworthy behaviour on social network characteristics like social distance and rationally, senders should thus not believe so.

	Model A Trust	Model B Trust	Model C TW Exp
1 st degree Friend	23.898*** (4.724)	20.893*** (4.340)	8.091*** (2.396)
2 nd degree Friend	10.936*** (3.857)	9.484*** (2.950)	4.460*** (1.666)
3 rd degree Friend	1.576 (2.733)	2.025 (2.590)	-0.741 (1.303)
Mutual friends	-0.362 (0.429)	-0.256 (0.416)	-0.288 (0.254)
Partner's centrality	9.916*** (2.656)	8.731*** (2.535)	2.611* (1.468)
Own centrality	9.502 (14.653)	8.756 (11.480)	1.324 (5.390)
Expectations of trustworthiness		0.393*** (0.059)	
Lagged Deviation from Expected Trustworthiness	0.025 (0.018)	0.034* (0.018)	-0.036* (0.019)
Male	11.528** (4.815)	10.384* (6.136)	2.702 (3.468)
Male Partner	-3.516** (1.669)	-3.451** (1.681)	-0.016 (1.521)
Male × Male Partner	2.282 (2.557)	2.624 (2.363)	-0.825 (1.927)
Period	0.696*** (0.219)	0.730*** (0.196)	-0.120 (0.146)
Proportion 1 st Degree Friends	41.335 (38.069)	29.802 (35.101)	26.413 (20.627)
Session Fixed Effects	YES	YES	YES
Constant	10.907 (7.976)	-2.155 (6.795)	33.070*** (9.257)
Observations	1373	1373	1373
Log likelihood	-5421.1	-5379.5	-5379.4

***, **, and * denote significance at 1%, 5%, and 10% levels. Bootstrap standard errors used. Trustworthiness multiplied by 100, Centralities scaled such that maximum has value of 1. In Model A, observations where no trust is shown are excluded (i.e., sent 0); this is to allow comparability with Model B which excludes these cases automatically since trustworthiness is only defined when a non-zero amount is sent.

Table 5: Random Effects Tobit Regressions of Trust/Expectations

4.1. Robustness

In this section, we discuss certain issues with the analysis and the robustness of our results. First, as mentioned before, the allocation of partners (and thus the network characteristics of partners one faces) is likely only to be conditionally random since they were allocated at random out of the elicited network structure. Second, own centrality might be endogenous since there may be some simultaneity bias/ reverse causality issue: higher trust/trustworthiness leads to a more central position and vice versa. Finally, given we are only looking at a subnetwork of participants' full networks, the network characteristics may

be incorrectly measured and thus cause an issue with our analysis. However, there are reasons to believe that these problems will not affect our results significantly.

4.1.1. Issue 1: Unobserved time-invariant heterogeneity

Since the random partner allocation is dependent on the elicited network structure, which depends on pre-existing covariates, there may be a problem of omitted variable bias in interpreting causality of the partner-related network variables. In particular, the main issue would be unobserved time-invariant variables which influence their initial network position and hence types of possible partners to be randomly allocated. In our main regressions, we use a random effects Tobit model to deal with censoring issues. The ideal way to deal with this would be to have a fixed effects Tobit model, however there is no easy solution due to the lack of a parametric conditional fixed effect Tobit model (a sufficient statistic allowing the fixed effects to be conditioned out does not exist); other more complex methods that might be applicable include the correlated random effects model which assumes a specific distribution conditional distribution of the unobserved heterogeneity given the regressors.

Here, we utilize a standard (non-censored) panel data framework and show that the results do not change much even when using different methods of dealing with unobserved heterogeneity. In particular, looking at Tables 6 and 7, compared to the random effects specification (Model B), the coefficients of the variables concerning our main results in a fixed effect specification and a Hausman Taylor specification (internal instruments for endogenous network variables) remain mostly unchanged. There is, however, a drop in effect sizes from shifting to a non-censored panel framework; it thus seems plausible to treat the Fixed Effects results as a conservative estimate of the actual effects for which there is no qualitative difference from our earlier exposition.

4.1.2. Issue 2: Endogenous own centrality

This is likely to be a smaller issue since we do not find significance of own centrality in our results and are thus less dependent on it, even though it may result in some contamination of other estimates. However, as mentioned earlier in Issue 1, the fixed effects model, which removes all time-invariant influence (including that of own centrality, which is fixed) has similar qualitative results to those described earlier.

	Model A RE Tobit	Model B RE	Model C FE	Model D Haus Taylor
1 st degree Friend	13.508*** (3.143)	7.125*** (2.113)	7.240*** (2.067)	7.228*** (2.073)
2 nd degree Friend	8.181** (3.483)	5.066** (2.177)	5.070** (2.131)	5.153** (2.127)
3 rd degree Friend	3.883 (4.199)	2.233 (2.677)	2.560 (2.659)	2.476 (2.671)
Partner's centrality	-5.216 (4.783)	-2.586 (2.596)	-2.882 (2.537)	-2.890 (2.541)
Own centrality	-3.621 (29.046)	-11.553 (13.026)	-	-8.862 (51.165)
Deviation from Expected Trust	0.189*** (0.043)	0.086*** (0.019)	0.088*** (0.019)	0.086*** (0.019)
Male	-16.647 (11.210)	0.015 (4.300)	-	-0.775 (10.882)
Period	-1.187*** (0.333)	-0.581*** (0.143)	-0.582*** (0.143)	-0.580*** (0.144)
No. of Times Played Previously	-0.226 (1.107)	-0.046 (0.581)	-0.054 (0.587)	-0.062 (0.588)
Proportion 1 st Degree Friends	50.420 (105.167)	50.634 (46.053)	-	49.098 (99.835)
Session Fixed Effects	YES	YES	YES	YES
Constant	2.227 (16.969)	7.601 (6.886)	20.999*** (1.801)	7.107 (6.910)
Observations	915	915	915	915

***, **, and * denote significance at 1%, 5%, and 10% levels. Clustered/Bootstrap standard errors used. Trustworthiness multiplied by 100, Centralities scaled such that maximum has value of 1.

Table 6: Robustness Regressions for Trustworthiness

4.1.3. Issue 3: Measurement error

As in any network related experiment, ours faces the problem of difficulty in eliciting a complete network since this would involve non-participating individuals as well (participation is voluntary). In our experiment design, we provided network characteristics extracted from the social network data directly to participants when they had to make their choices. This was done in conjunction with an explanation of what these variables meant (see Instructions in appendix). This means that, while there may be measurement error in these network characteristics, participants were making their choices conditional on this given information.

	Model A RE Tobit	Model B RE	Model C FE	Model D Haus Taylor
1 st degree Friend	28.034*** (5.378)	24.722*** (4.109)	25.020*** (4.125)	25.049*** (4.137)
2 nd degree Friend	15.255*** (3.803)	12.311*** (2.980)	12.359*** (2.987)	12.282*** (2.997)
3 rd degree Friend	3.578 (2.882)	2.048 (2.122)	2.207 (2.104)	2.209 (2.114)
Mutual friends	-0.478 (0.449)	-0.590* (0.358)	-0.622* (0.361)	-0.625* (0.362)
Partner's centrality	11.597*** (3.202)	9.709*** (2.557)	9.832*** (2.550)	9.778*** (2.554)
Own centrality	12.756 (12.865)	6.123 (8.947)	0.000 (.)	23.748 (14.653)
Lagged Deviation from Expected Trustworthiness	0.044* (0.024)	0.028 (0.020)	0.035* (0.020)	0.028 (0.020)
Male	8.837 (6.856)	7.884 (5.221)	0.000 (.)	7.228 (5.476)
Male Partner	-3.384** (1.493)	-2.642* (1.487)	-2.715* (1.494)	-2.600* (1.485)
Male × Male Partner	1.517 (2.492)	0.799 (2.325)	0.847 (2.341)	0.755 (2.324)
Period	0.640*** (0.228)	0.518*** (0.199)	0.522*** (0.198)	0.524*** (0.198)
Proportion 1 st Degree Friends	42.148 (32.994)	34.417 (25.886)	0.000 (.)	16.660 (28.262)
Session Fixed Effects	YES	YES	YES	YES
Constant	2.891 (7.670)	10.933* (5.902)	39.090*** (2.029)	6.335 (6.335)
Observations	1431	1431	1431	1431

***, **, and * denote significance at 1%, 5%, and 10% levels. Clustered/Bootstrap standard errors used. Trustworthiness multiplied by 100, Centralities scaled such that maximum has value of 1.

Table 7: Robustness Regressions for Trust

As long as there is no systematic bias in the way that participants interpret the information provided and they interpret them as explained in the instructions³¹, we believe there should not be significant qualitative change in our main results: namely with regard to social distance in both experiments and partner centrality in the Trust experiment³².

The problem does remain, however, for interpretation of effects of own centrality and we agree that this might be a contributing factor to the non-significant effects here. Since own centrality is a variable that is not provided to players, we can in fact explore for the impact of

³¹ Participants were explicitly told that the network statistics were obtained from the Facebook group they joined during registration. Further, in the post-experiment questionnaire, the majority of participants reported understanding these instructions.

³² One can treat it as being analogous to a deception method of providing a randomly generated set of network statistics, but with participants believing that these are indeed true since there was a procedure to elicit the network. Of course, ours has no such deception and this is partly what contributes to issue 1.

other kinds of own centrality variables, such as in the aforementioned papers on altruism. We do so in Tables 8 and 9 for degree, betweenness, and harmonic-closeness centrality³³, but they are mostly insignificant³⁴ although the signs of their effects are mostly consistent.

	Model A Eigenvector	Model B Degree	Model C Betweenness	Model D Harmonic closeness
1 st degree Friend	13.508*** (3.440)	13.533*** (3.581)	13.455*** (3.020)	13.564*** (2.982)
2 nd degree Friend	8.181* (4.249)	8.202** (3.479)	8.008** (3.611)	8.261** (3.683)
3 rd degree Friend	3.883 (4.629)	3.910 (3.678)	3.805 (3.121)	3.967 (4.290)
Partner's centrality	-5.216 (5.977)	-5.147 (3.598)	-5.263 (4.534)	-5.167 (5.214)
Own centrality	-3.621 (33.751)	-11.267 (27.791)	34.297 (23.345)	-15.350 (32.300)
Deviation from Expected Trust	0.189*** (0.039)	0.189*** (0.037)	0.190*** (0.037)	0.189*** (0.039)
Male	-16.647 (11.766)	-16.100* (9.344)	-22.044** (10.558)	-14.608 (10.845)
Period	-1.187*** (0.286)	-1.187*** (0.324)	-1.189*** (0.301)	-1.186*** (0.331)
No. of Times Played Previously	-0.226 (1.119)	-0.225 (0.906)	-0.227 (1.024)	-0.226 (1.136)
Proportion 1 st Degree Friends	50.420 (104.090)	63.536 (93.360)	45.320 (74.260)	71.726 (111.538)
Session Fixed Effects	YES	YES	YES	YES
Constant	2.227 (14.939)	4.001 (14.113)	1.373 (18.557)	5.451 (15.740)
Observations	915	915	915	915
Log likelihood	-2335.8	-2335.7	-2334.5	-2335.4

***, **, and * denote significance at 1%, 5%, and 10% levels. Bootstrap standard errors used. Trustworthiness multiplied by 100, Centralities scaled such that maximum has value of 1.

Table 8: Random Effects Tobit Regressions of Trustworthiness (Various ‘Own Centrality’ Measures)

5. Concluding Remarks

This study has investigated the link between social ties in a real-life social network and trusting and trustworthy behavior. It has done so by combining social network analysis and the methodology of experimental economics. Specifically, we elicited the friendship networks of experiment participants through a novel design utilizing Facebook. Firstly, we

³³ Harmonic closeness centrality uses the sum of reciprocal of distances instead of the reciprocal of the sum of distances as in closeness centrality and thus “behaves better” in graphs with infinite distances: i.e. not strongly connected

³⁴ Note also that coefficients of social distance variables and partner’s centrality are not affected.

	Model A Eigenvector	Model B Degree	Model C Betweenness	Model D Harmonic closeness
1 st degree Friend	28.034*** (5.556)	28.057*** (5.696)	27.894*** (4.749)	27.971*** (5.173)
2 nd degree Friend	15.255*** (4.000)	15.268*** (3.095)	15.217*** (3.266)	15.150*** (3.056)
3 rd degree Friend	3.578 (2.636)	3.566 (2.518)	3.630 (2.574)	3.505 (2.157)
Mutual friends	-0.478 (0.449)	-0.481 (0.503)	-0.458 (0.385)	-0.474 (0.445)
Partner's centrality	11.597*** (2.637)	11.608*** (3.317)	11.541*** (3.168)	11.608*** (3.291)
Own centrality	12.756 (14.646)	16.537 (14.890)	14.308 (10.945)	21.201* (12.791)
Lagged Deviation from Expected Trustworthiness	0.044** (0.020)	0.044* (0.026)	0.044** (0.021)	0.044** (0.021)
Male	8.837 (8.093)	8.565 (5.996)	8.978 (6.605)	9.865 (7.032)
Male Partner	-3.384** (1.674)	-3.390** (1.621)	-3.386** (1.654)	-3.404** (1.726)
Male × Male Partner	1.517 (2.548)	1.527 (2.921)	1.518 (2.953)	1.553 (2.628)
Period	0.640*** (0.248)	0.640*** (0.229)	0.640** (0.285)	0.640** (0.249)
Proportion 1 st Degree Friends	42.148 (36.246)	29.374 (35.191)	51.625 (33.844)	23.369 (36.889)
Session Fixed Effects	YES	YES	YES	YES
Constant	2.891 (7.853)	1.220 (7.300)	0.520 (6.112)	-6.447 (9.630)
Observations	1431	1431	1431	1431
Log likelihood	-5600.1	-5599.9	-5600.1	-5599.3

***, **, and * denote significance at 1%, 5%, and 10% levels. Bootstrap standard errors used. Trustworthiness multiplied by 100, Centralities scaled such that maximum has value of 1.

Table 9: Random Effects Tobit Regressions of Trust (Various Own Centrality Measures)

encouraged participants to register for our experiments along with their friends. As part of the registration process, they were asked to link their Facebook profile with a Facebook group we had created specifically for our experiments. From this, we were able to observe the patterns of interconnection among the participants and generate their social network data. We then used the data to perform a social network analysis and derive social network measures including the degree of friendship, 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 to play the roles of receiver and sender respectively. In this manner, the network traits of their partners could be varied. Our modified trust game experiments were designed to investigate whether each of directed trust and directed reciprocity existed in the 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 have shown that both directed trust and trustworthiness were present. Individuals tended to show more trust and trustworthiness toward closer friends than strangers. In addition, both effects tapered off beyond the second degree of friendship. This suggests that trust and reciprocity, two important elements of social capital may become much stronger as the density of social networks increases and network members exhibit stronger dyadic connections. Further, we find that partner's centrality significantly influences trusting behavior, but not trustworthy behavior. Investigating expectations of reciprocity as a potential mediator for the higher trust, we find that the above social distance and partner centrality factors still play a role even after controlling for expected trustworthiness; this seems to indicate that individuals have a bias toward more popular and closer individuals. In contrast, we do not obtain robust results on the impacts of own centrality on either trust or trustworthiness, which mirrors previous findings in the literature. Further, deviations from one's expectations in past experience are found to influence one's future trust and trustworthy behavior, though we cannot find evidence that social distance affects this evolution.

In a more general context, the evidence of directed trust and trustworthiness presented here suggests that a public policy that is intended to enhance social capital in a pluralistic society cannot focus solely on mixing individuals from different social groups, but should also be complemented by an effort to enhance the degree of interconnection by significantly reducing the average path length between two members of the society.

Indeed, based on our results, a complete network where everyone is directly connected to everyone else, such that the average path length is short, would exhibit higher level of trust and trustworthiness. Such a society would enjoy larger social capital and have a better chance of survival and making steady economic and social progress. Unfortunately, in the real world, it is not easy to have a complete network. This is simply because relationships that are based on pure trust and trustworthiness are often prone to defection and require strong commitment from all parties. When defection occurs, relationships are often broken up. Only when individuals are sufficiently care about others and willing to sustain a long-term relationship that we will have a relatively dense social network. Ultimately, public policies aimed at increasing social cohesion among people are crucially needed.

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