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In my thesis, I will assess to what extent network control affects trust in 2-person social dilemma using data from past experiments. The focus will predominantly, but not exclusively, be on experiments with Trust Games. Three research questions will be of interest, with the according hypotheses as bullet points:

1. To what extent does network control opportunities foster trust?

* Trustfulness and trustworthiness increase in the amount of network embeddedness (*ceteris paribus*, and thus after controlling for learning effects).

*Supplementary research questions that probably need to be assessed on a subset of the data.*

1. To what extent are network control effects different for trustors and trustees?

* Control effects are stronger for trustees than for trustors.

1. How do network control effects relate to dyadic control effects in terms of magnitude?

* Dyadic control effects are stronger than network control effects, for both trustors and for trustees.

**Datasets**

These research questions will be answered by reanalyzing the data of multiple experimental studies that assessed the effect of network embeddedness (see Table 1), and aggregating the evidence in favor of the hypotheses of interest using *Bayesian Evidence Synthesis*. Reanalyzing these data is required, because only a small subset of the data explicitly assessed network control effects. It must be noted in advance that not all data sets allow to assess the last two research questions, sometimes because not all studies distinguish between trustors and trustees (e.g., subjects play of Prisoner’s Dilemma or a Helping Game), and sometimes because the studies do not assess both dyadic and network embeddedness in a comparable way.

In all experiments considered, the participants were randomly allocated to one of multiple conditions. The conditions will be outlined below. Due to the fact that multiple data sets are used, I have provided a thorough description of two data sets that differ to quite some extent, while the other studies are fairly similar to one of these two, but might differ in some specifics. Hence, these two descriptions should give a general overview of what the data sets entail, and which analyses can be conducted.

Table 1 gives a broad overview of the studies that are considered to be included in the thesis. However, I actually have access to the data of only 7 of these studies. Whether it is possible to answer the third research question will be dependent on whether access to the currently not available data sets will be provided. The first two research questions can be answered already given the currently available data sets.

As is obvious from Table 1, the experiments conducted can be broadly classified into two groups. In the first group, network embeddedness is operationalized as a random matching procedure with information exchange through the network (Study 1-7). In the second group (Study 8-11), network embeddedness is implemented as a condition in which the interacting trustor and trustee are complemented by a second trustor that also interacts with the trustee. Both trustors obtain full information about the actions of the trustee against both trustors. Because of the similarity within the two groups, a single study of both of these groups will be discussed in more depth.

Table 1

Information on data sets that are considered to be included in the thesis.

|  |  |  |  |
| --- | --- | --- | --- |
| Authors | Game | Sample size | Experimental conditions |
| 1.Bolton, Katok & Ockenfels (2004) | Trust Game | *N =* 144; 48 per condition. | 1. No embeddedness – random matching without information exchange. 2. Network embeddedness – random matching, but the trustor is informed on how often the trustee honored trust against other trustors. 3. Dyadic embeddedness – the trustor and the trustee are partners throughout the repeated Trust Game. |
| 2.Bohnet & Huck (2004)\* | Trust Game | *N* = 156 | Similar to Bolton, Katok & Ockenfels (2004). |
| 3.Bohnet et al. (2005)\* | Trust Game | *N* = 96 | Similar to Bolton, Katok & Ockenfels, but without the dyadic embeddedness condition. |
| 4.Huck, Lünser & Tyran (2012)\* | Trust Game | *N =* 192 | Similar to Bolton, Katok & Ockenfels (2004), with the exception that dyadic embeddedness is operationalized as a condition with random matching in which trustors only receive information about their own past interactions. |
| 5.Corten, Rosenkranz, Buskens & Cook (2016) | Prisoner’s Dilemma | *N* = 156 (78 per condition). | Similar to Huck, Lünser & Tyran (2012), with the exception that a Prisoner’s Dilemma is played, and without no embeddedness and partial network embeddedness conditions (actors exclusively obtain information about their own past interactions or about all interactions in the network). |
| 6.Pfeiffer, Tran, Krumme & Rand (2012)\* | Prisoner’s Dilemma | *N* = 88 (40 and 48 per condition). | Similar to Corten et al. (2016), with the exception that actors in the no embeddedness condition do not know with whom they interacted in the past. |
| 7.Seinen & Schram (2006) | Helping Game | *N* = 112. | Similar to Bolton, Katok & Ockenfels, with the exception that a Helping Game is played, and that no condition with dyadic embeddedness is played. |
| 8.Frey, Corten & Buskens (2019) | Trust Game | *N* = 114 in both conditions. | 1. Dyadic embeddedness – trustors and trustees play a repeated Trust Game of six rounds. 2. Network embeddedness – two trustors and one trustee play a repeated Trust Game of six rounds, and all the actions by the trustee are common knowledge to both trustors.   Note that the study contains other conditions as well, these will not be considered. |
| 9.Buskens, Raub & Van der Veer (2010) | Trust Game | *N* = 72, 36 per condition. | Similar to Frey et al. (2019). |
| 10.Miltenburg, Buskens & Raub (2012) | Trust Game | *N* = 138. | Similar to Buskens, Raub & Van der Veer (2010). |
| 11.Barrera & Buskens (2009) | Investment Game | *N* = 138. | Similar to Frey et al. (2019), with the exception that an Investment Game is played, which can be considered a Trust Game with a continuous outcome. Note that this study contains some additional conditions as well; these will not be considered. |

\*I have contacted the authors, but do not have access to the data yet.

The study, and data, by Bolton, Katok & Ockenfels (2004) is exemplary for the studies in group 1. The authors compare three treatment conditions: (1) no embeddedness, (2) network embeddedness and (3) dyadic embeddedness. In condition 1, trustors are randomly matched with trustees without information about the trustee’s past information being provided. In condition 2, trustors are also randomly matched with trustees, but now obtain information about the number of times the trustee honored trust in past interactions. In condition 3, a trustor and a trustee are paired randomly in round 1, but repeat the Trust Game as a pair throughout. Each of the conditions was played in three sessions, with 16 participants per session, resulting in 48 participants in every treatment and a total sample size of . In all three conditions, subjects played the Trust Game 30 times.

Technically speaking, there were only six variables included in the data set. The ID of the trustor, the ID of the trustee, whether or not the trustor placed trust, whether or not the trustee honored trust, the round of the game and the treatment condition. The treatment condition was operationalized as a categorical variable (no embeddedness = 0; network embeddedness = 1; dyadic embeddedness = 2), similarly to the action of the trustor (not placing trust = 0, placing trust = 1) and the action of the trustee (abuse trust = -1, no choice because the trustor did not place trust = 0/NA, honoring trust = 1). Furthermore, the round variable ranges from 1 to 30.

Using these variables, control and learning (which will be treated as a *control* variable in the statistical sense) can be constructed. In general, there are three ways to operationalize the control effect. First, focus can be restricted to the first round of the game, which has several advantages. In the first round, no learning can have occurred, so differences between the treatment group in terms of trust in the first round of the game purely represent the anticipation of the actors regarding future sanction opportunities. In the network treatment, such control effects concern the sanction opportunities by other trustors that the trustee will meet in future rounds, while in the network treatment, control effects concern the sanction opportunities by the same trustor in future rounds. Second, focus can be restricted to the rounds in which the trustee has not (yet) abused trust. In this way, the amount of information a trustor has about a trustee is essentially kept constant, and thus excludes learning effects in the sense of Buskens & Raub (2002). However, it seems probable that trustors also condition their behavior on past actions against themselves, even by different trustees. Controlling for these experiences by focusing exclusively on the rounds in which a trustor has not observed any abuse of trust at all may be infeasible, because due to the random allocation, a trustor interacts with many trustees, and it is likely that the trustor will soon interact with at least one trustee who abused trust. Third, focus can be directed to controlling for learning in a statistical sense. After taking past actions by other trustees and the focal trustee into account, the effect of the number of rounds left can be estimated. When there are more rounds left to play, there are more control opportunities, while the amount of sanction opportunities decreases when there are fewer rounds to play. However, there should be controlled for learning, because as there are fewer rounds the play, the likelihood that a trustor has observed an abuse of trust and therefore withholds trust also increases. Although this would reflect an effect of embeddedness, it would not reflect an effect of control, which is what the focus is on. Similarly, when estimating the trustee’s behavior, it can be taken into account how often past trustors actually placed trust. If past trustors hardly placed trust, a trustee may expect that future trustors will also not place trust, reducing the relative severity of future sanctions. All these three measures make use of the *round* variable and the variables indicating the trustors’ and trustees’ past actions. Accordingly, these three measures can be compared over the treatment conditions.

Learning can be defined in terms of past actions by trustors and trustees. Learning for the trustor concerns how often the trustee abused the trust of other trustors, and possibly also how often an abuse of trust by other trustees was directed towards the trustor involved. Accordingly, the frequencies of these actions can be summed over all past rounds (and eventually be weighted). Additionally, as past actions are likely to be considered more important than actions from a longer time ago, a dummy can be created to represent whether the trustee abused trust in the last round. A similar measure can be created for the trustee, but defined in terms of past actions by trustors, although the trustee only observed past actions directed against this trustee, and not the past actions of the trustor involved (unless embeddedness is dyadic).

Subsequently, the control effects can be estimated separately for trustor and trustee, and a hypothesis test on the difference can be formalized as , which implies that a single model is used to estimate trust for both trustors and trustees. Accordingly, the measures for control can be estimated as interaction terms, interacting the measure with the actor involved, to estimate different regression slopes for both actors. Estimating the same effects for the treatment with dyadic embeddedness directly implies a comparison between the two conditions. This can be formalized as , where each addresses one of the three operationalizations of network control effects.

*Table 2*

Overview of the concepts of interest included in the study by Bolton, Katok and Ockenfels (2004), and how these concepts can be translated into actual operationalizations.

|  |  |  |
| --- | --- | --- |
| Construct | Variable | Operationalization |
| Role | Role | Trustor = 0; trustee = 1 (to estimate interaction terms). |
| Embeddedness | Treatment | Network = 1 if treatment = network  Dyadic = 1 if treatment = dyadic |
| Trust | Trust | Placed trust (trustor) or honored trust (trustee) |
| Control | Round | Interaction with role, to estimate separately for trustor and trustee.  Interaction with treatment, to estimate separately over the conditions.  1.Focus on first round behavior (no learning yet).  2. Focus on first round in which trust is not placed/first abused (all actors have exactly the same amount of learning until that moment (i.e., they know nothing that is unique to their interactions).  3.Statistically control for learning (see next row). |
| Learning | Past trust | Interaction with role, to estimate separately for trustor and trustee  Sum past times trustor’s trust was abused (all zero for trustee)  Sum past times trustee abused other trustors’ trust (all zero for trustee)  Sum past times trustors placed trust against trustee (all zero for trustor) |

Table 2 displays the operationalizations of the key variables schematically, while a more in-depth discussion of these measures can be found in the paragraph above. Similar measures can be constructed for the other studies in the first group of studies (Study 1-7). It must be noted that these studies differ in terms of sample size, the number of rounds that will be played, and possibly in terms of how the information is transmitted. Yet, these differences are too small to discuss extensively here. Also note that Studies 5-7 do not distinguish between trustors and trustees, because they play different games. Hence, in these studies, the distinction between trustors and trustees disappears, because all actors have the same role. These actors can decide to cooperate or to defect, but whether one cooperates or defects to protect against opportunistic behavior by one’s partner, or to try to exploit one’s partner, cannot be distinguished.

The second group of studies uses a different operationalization of network embeddedness, as shown in Table 1. The study by Frey, Corten & Buskens (2019) is exemplary for this group of studies, and hence will be discussed in more depth. In the study by Frey et al. (2019) network embeddedness is characterized as a small network, in which two trustors interact 6 times with a single trustee, while both trustors receive information on the behavior of the trustee against both trustors. Hence, this network represents a small network with full information exchange between all actors. The baseline condition is a condition without a network, that is, a trustor and a trustee are involved in a repeated interaction of 6 rounds, while no information is exchanged between actors that are not involved in the focal transaction. In the experiment, 114 people participated in both conditions, and all played 12 repeated games of six rounds each, and played all roles (Trustor 1, Trustor 2, Trustee) in every condition (Dyadic Embeddedness, Network Embeddedness) twice.

The variables that were measured in this experiment were relatively similar to the variables explained in the section on the study by Bolton, Katok & Ockenfels (2004). Yet, because some differences remain, I will explain the key variables in the study by Frey et al. (2019) here. As said, there is the treatment variable, indicating whether embeddedness is implemented dyadically, or as a small network consisting of two trustors and one trustee with complete information exchange. Subsequently, the data contains the *role* of the actor, that is, whether the actor was a trustor or a trustee. Additionally, the data contains the ID of the actors, and an indicator of the supergame (indicating which of the twelve games an action occurred in). Similarly, trustfulness and trustworthiness was measured with an indicator, reflecting whether a trustor placed or withheld trust, and whether a trustee honored trust, abused trust, or was not in the position to do so, because the trustor did not place trust. Lastly, the variable *round* indicates in which of the rounds (1-6) the decisions were made.

Control effects can be tested similarly to the descriptions given in the section on Bolton, Katok and Ockenfels (2004). First, analysis can be tailored towards the first round of the repeated games, in which no learning can have occurred with regard to the trustee. While trustors and trustees can have gained experience from earlier games, this will not be controlled for in a statistical sense, but the fact that the same trustors and trustees make decisions multiple times will be accounted for by incorporating the multilevel structure. Second, focus can be directed towards the game in which no trust has been abused. In contrast to the study by Bolton, Katok and Ockenfels (2004), this should be easier here, because the trustors and trustees are not randomly matched. Since the same two trustors interact with the same trustee for multiple periods, the focus can easily be on the rounds in which the trustee has not abused trust. Third, the control effect can be assessed by focusing on the number of rounds left to play, while controlling for learning in a statistical sense. When there are more rounds left to play, there are more control opportunities, while the amount of sanction opportunities decreases when there are fewer rounds to play. However, there should be controlled for learning, because as there are fewer rounds the play, the likelihood that a trustor has observed an abuse of trust and therefore withholds trust also increases. Although this would reflect an effect of embeddedness, it would not reflect an effect of control, which is what the focus is on. Similarly, when estimating the trustee’s behavior, it can be considered how often past trustors actually placed trust. If past trustors hardly placed trust, a trustee may expect that future trustors will also not place trust, reducing the relative severity of future sanctions. All these three measures make use of the *round* variable and the variables indicating the trustors’ and trustees’ past actions. Accordingly, these three measures can be compared over the treatment conditions.

Learning can be defined in terms of past actions by trustors and trustees. Learning for the trustor concerns how often the trustee abused the trust of other trustors, and possibly also how often an abuse of trust by other trustees was directed towards the trustor involved. Accordingly, the frequencies of these actions can be summed over all past rounds (and eventually be weighted). Additionally, as past actions are likely to be considered more important than actions from a longer time ago, a dummy can be created to represent whether the trustee abused trust in the last round. A similar measure can be created for the trustee, but defined in terms of past actions by trustors, although the trustee only observed past actions directed against this trustee, and not the past actions of the trustor involved (unless embeddedness is dyadic).

Subsequently, the control effects can be estimated separately for trustor and trustee, and a hypothesis test on the difference can be formalized as , which implies that a single model is used to estimate trust for both trustors and trustees. Accordingly, the measures for control can be estimated as interaction terms, interacting the measure with the actor involved, to estimate different regression slopes for both actors. However, in contrast to the previous data set, comparing the effects of dyadic and network control on trust is more problematic, because network embeddedness is always implemented alongside dyadic embeddedness. I am unsure whether this allows for a honest comparison between the conditions. Namely, if the dyadic control effect is already very large, the margin of improvement for network embeddedness is very small. Accordingly, it may be that only the studies that do not implement network embeddedness alongside dyadic embeddedness can be used to test this hypothesis. There might be other data sets that allow to test this hypothesis (e.g., Bolton, Katok and Ockenfels, 2004; Bohnet & Huck, 2004). Eventually, the hypothesis can be dropped entirely, as it is optional anyway.

Similar measures can be constructed for other studies in the second group (Study 8-11). Although these studies differ with regard to some aspects, these differences can be regarded as minor. Yet, note that the subjects in the studies considered by Buskens et al. (2010), Van Miltenburg et al. (2012) and Barrera and Buskens (2009) played 15 rounds in a supergame, and that the sample sizes differed. Additionally, the study by Barrera and Buskens (2009) concerned an Investment Game, rather than a Trust Game, in which people had to decide how much to invest (which is a continuous, rather than a dichotomous measure of trustfulness) and how much to return (a continuous measure of trustworthiness).

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