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## An Experiment on the Level of Trust in an Expanded Investment Game

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**Abstract:** The study presented an experimental study of an investment game modification. It introduced a variation based on expanding the traditional two-player structure of one sender and one receiver to a structure comprising of one receiver and multiple senders. Using experimental data, it has been shown that the number of senders in the given game structure has an effect on the level of trust and trustworthiness. The analysis also includes other personality traits that influence trust and trustworthiness.

**Key words:** Trust, trustworthiness, investment game, sender, receiver

### INTRODUCTION

The question of trust remains a widely discussed one in numerous fields of study, ranging from institutional and organization trust (Chirico and Presti, 2011; Rezaiean *et al.*, 2010; Safakli, 2007; Yilmaz, 2008; Tokuda and Inoguchi, 2008) to various studies and applications in information technology (Wang *et al.*, 2011; Teoh and Cyril, 2008; Jassim *et al.*, 2011; Rabah, 2004; Dingguo *et al.*, 2011). This study has presented a game theory approach to trust based on the widely used investment game.

The investment game (also called trust game) represents an experimental approach to the trust theory in economy as defined by Berg *et al.* (1995). In comparison with the ultimatum or the dictator games, it deals not only with the concepts of fairness or altruism but also with the concepts of trust and trustworthiness. The game involves two players, each of whom is assigned a role of either a sender or a receiver. The role of the sender is to send a portion of his initial budget to the receiver, simulating an investment process. This amount is then multiplied by an investment multiplier before being received by the receiver. The receiver, having received the multiplied amount as well as disposing with his initial budget, then returns some money (if any at all) back to the sender. Provided the existence of rational players, this situation can be modeled by the game theory. Here, the receiver would maximize his own utility by returning nothing and on the other hand, the sender, knowing he would not receive anything back for his investment, will not invest anything and all players finish the game with their resulting endowment equal to their initial budget.

According to Berg *et al.* (1995) the experimental results are not in concordance with the concept of rationality. They showed that only 6.25% of senders did not send anything and a total of 15% of senders sent their

whole initial budget. In a game with the initial budget of \$10 for each player, the average amount sent was \$5.36 and the average amount returned was \$6.46. Therefore, it can be stated that players in the role of sender do show a degree of trust (as the amount they sent is a strictly positive amount of monetary units) and the players in the role of receivers demonstrate a degree of trustworthiness (as the amount they return is not just strictly positive but often higher than the amount received). As the Berg *et al.* (1995) model of the investment game describes the nature of most economic interactions, its various modifications became the subject of a fruitful research.

Cassar and Rigdon (2008), besides other experimental results, compared the situation of the one sender-one receiver game structure with the situation of two senders and one receiver. Their experiment showed negligible differences in the demonstrated trust/trustworthiness. This fact is mention worthy, as one would expect trust and trustworthiness to change with the increasing number of senders. As most models of the managerial organization schemes as well as democratic decision-making structures are based on the presence of one central figure (receiver in our case) and a number of subordinates (senders), we aim to study these relations in extending the number of senders from one up to four. The question here is, if and how will the trust/trustworthiness change under these conditions. In the following part, we formulate the mathematical model of the experiment. The third part includes the experimental design, followed by the fourth part which presents the experimental data analysis.

### MODEL

- Players let  $I = \{1, 2, \dots, n\}$  be a set of senders
- Endowment let  $M \geq 0$  be an initial endowment of each player expressed in monetary units

- Payoff let  $\pi_i^S$  be a payoff of sender  $i$  and  $\pi^R$  be a payoff of a receiver
- Sender strategy let  $s_i$  (where  $0 \leq s_i \leq M$ ) be an amount sent by sender  $i$  to the receiver
- Receiver strategy let:

$$r_i \text{ (where } r_i \geq 0 \text{ and } \sum_{i \in I} r_i \leq M + \sum_{i \in I} 3s_i \text{)}$$

Be an amount returned by the receiver to the sender  $i$

- Trust and trustworthiness: The amount  $s_i$  represents the trust of the sender  $i$  and the ratio  $r_i/s_i$  represents the trustworthiness of the receiver
- Game stages all players start with their initial endowment  $M = 10$ . In the first stage, sender  $i$  sends the amount  $s_i$  to the receiver, with the receiver receiving this amount multiplied by 3. In the second stage, the receiver returns the amount  $r_i$  back to sender  $i$ . After the second stage, the payoff of sender  $i$  is equal to  $\pi_i^S = M - s_i + r_i$  and the payoff of the receiver is equal to:

$$\pi^R = M + \sum_{i \in I} 3s_i - \sum_{i \in I} r_i$$

## EXPERIMENTAL DESIGN

The experiment had a form of a typical classroom experiment. It involved 62 participants, divided into 5 groups with  $n = 1$ , 4 groups with  $n = 2$ , 5 groups with  $n = 3$  and 4 groups with  $n = 4$  senders. Each group featured one receiver. All participants were university students of economics and finance in their 4 or 5th year of the study. Before starting the experiment, the participants had been asked to draw a random sealed envelope. This envelope contained the instructions of the experiment, the questionnaire and the playing card marked with the group the participant would be in and the role he would play within the group. This process ensured random matching of the players. The instructions for each sender included the information about the total number of senders in his group, as well as the information that the receiver would respond to each of the senders individually. Since, the participants were instructed to open the envelopes after they had been seated and were not allowed to communicate after this point, the matching was also anonymous. Once all participants were ready, the organizers of the experiment explained the rules of the experiment, the way the experiment would be operated and also the reward the participants would be paid after the experiment. Then, the experiment commenced.

The experiment represented a one shot game. Each participant started the game with the initial endowment of  $M = 10$ . The experiment itself consisted of 3 stages. In the first stage, the participant that had been assigned the role of sender  $i$  had to write down into the playing card the amount  $s_i$  he wanted to send to the receiver in his group. At the same time, the receiver was asked to write down into the playing card his expected amount  $s_i^*$  (the amount he expects to receive) for each sender  $i$  within his group. The first stage ended after the organisers had collected the playing cards of all participants. Before stage 2 commenced, the organisers had marked the amounts  $s_i$  sent by every sender  $i$  within a group into the playing card of the receiver of that group, as well as the total amount the receiver had available at this point to avoid mathematical errors of the participants. During this time, the participants were asked to fill out the provided questionnaires. Once this was done, all participants were returned their playing cards and stage 2 commenced. During this stage, each participant in the role of sender  $i$  was asked to write down in to the playing card the expected amount  $r_i^*$ . Each receiver was asked to write down into the playing card the amount returned  $r_i$  for every sender  $i$  within his group. The second stage ended with the organisers collecting the playing cards of all the participants. Before stage 3 commenced, the organisers had marked the amounts  $r_i$  received by every sender  $i$ . Again, during this time the participants were asked to fill in the provided questionnaires. Once all the participants were returned their playing cards, the final stage commenced. During this stage, the participants reviewed their playing cards containing the final outcome of the game and were paid their adjusted total amount achieved during the experiment in real money.

## ANALYSIS

Analyzing the experimental data we first look at the average amount of money sent  $s_i$ , money returned  $r_i$  and the level of trustworthiness  $r_i/s_i$  recorded. The results are given in Table 1.

As seen in Table 1, with the rising number of senders  $n$  in a group, the average amount sent  $s_i$  is getting lower. In case of the average amount returned  $r_i$ , this trend is not so clear and is disrupted by  $n = 3$ . The average level of trustworthiness  $r_i/s_i$  demonstrates no trend with the increasing number of senders. However, we have to also take into account the personal characteristics of individual players which require a more complex analysis, regarding data from the personal questionnaire. The questionnaire was anonymous and contained various

Table 1: Average amounts sent and returned, the average level of trustworthiness

|                   | No. senders |       |       |       |
|-------------------|-------------|-------|-------|-------|
|                   | n = 1       | n = 2 | n = 3 | n = 4 |
| $s_i$             | 5.40        | 4.38  | 4.27  | 3.63  |
| $r_i$             | 9.40        | 7.00  | 8.73  | 5.09  |
| $\frac{r_i}{s_i}$ | 1.71        | 1.37  | 2.16  | 1.43  |

Table 2: Statistically significant factors influencing sender trust

| Variable                            | Estimate | SD                              | t-statistic | Pr ( $> t $ ) |
|-------------------------------------|----------|---------------------------------|-------------|---------------|
| Constant                            | 2.784    | 1.036                           | 2.687       | 0.011**       |
| $s_i^{**}$                          | 0.419    | 0.087                           | 4.828       | 2.54e-05***   |
| Gender                              | -1.443   | 0.395                           | -3.653      | 0.001***      |
| Altruism                            | 0.656    | 0.300                           | 2.187       | 0.035**       |
| No. senders                         | -0.330   | 0.173                           | -1.906      | 0.065*        |
| Coefficient of determination: 0.650 |          | JB test: 3.136, p-value = 0.209 |             |               |
| F-statistic: 16.68                  |          | BP test: 3.616, p-value = 0.460 |             |               |
| p-value = 8.053e-08***              |          | RESET: 0.223, p-value = 0.801   |             |               |

Dependent variable  $s_i$ . Level of significance: \*\*\*p>0.01; \*\*p>0.05; \*p>0.1, JB: Jarque-Bera, BP: Breusch-Pagan, RESET: Ramsey specification error test

questions concerning the altruism, income, expenditures, risk attitude, gender and family background of the participants. A copy of the questionnaire is available on demand.

**Sender analysis:** Since, the individual senders had no way of communicating with each other and had no information about each other, we can use individual senders as the unit of the analysis. Due to incompletely filled questionnaires we excluded 3 senders from the analysis. Aiming to perform a linear regression we firstly excluded multicollinear variables based on the variance inflation factor ( $VIF > 5$ ). Then, proceeding from general to specific, we started with the overparametrized model including all the remaining variables. The statistically insignificant regressors were then excluded taking into account the Akaike information criterion and other standard linear regression tests. The results are given in Table 2.

Here, out of all considered variables and questionnaire answers, the ones having statistically significant impact on the amounts sent ( $s_i$ ) are the following:

- $s_i^{**}$  (second order expectation) is the amount of monetary units the sender expects he is expected by the receiver to send. The higher the expectation of the sender, the higher the amount the sender sends. We can interpret this as a form of social responsibility
- Gender (0-male, 1-female). Female senders sent on average 1,44 less than male senders. This can be

Table 3: Significant factors influencing receiver trustworthiness-ordinary least squares model

| Variable                        | Estimate | SD                              | t-statistic | Pr ( $> t $ ) |
|---------------------------------|----------|---------------------------------|-------------|---------------|
| $r_i^{**}$                      | 0.084    | 0.012                           | 6.845       | 1.35e-07***   |
| Gender                          | 0.691    | 0.152                           | 4.550       | 8.27e-05***   |
| No. senders                     | 0.515    | 0.059                           | 8.798       | 8.27e-10***   |
| Relation                        | -0.262   | 0.081                           | -3.213      | 0.003***      |
| Profit                          | -0.061   | 0.006                           | -9.372      | 2.03e-10***   |
| Adjusted R <sup>2</sup> : 0.949 |          | JB test: 0.298, p-value = 0.862 |             |               |
| F-statistic: 131.1              |          | BP test: 5.378, p-value = 0.251 |             |               |
| p-value = 2.2e-16***            |          | RESET: 2.494, p-value = 0.101   |             |               |

Dependent variable  $r_i/s_i$ , \*\*\*p>0.01; \*\*p>0.05; \*p>0.1, JB: Jarque-Bera, BP: Breusch-Pagan, RESET: Ramsey specification error test

accounted for by the higher risk aversion of female players and the fact that females seem to trust less than males in general as shown by Chaudhuri and Gangadharan (2003)

- Altruism is a five-degree scale variable factor identified in the questionnaire. This question asked the participants, if they would engage in voluntary activities. As shown, the higher the level of altruism of a given sender, the more he is willing to send. Here, altruism represents a form of unconditional kindness as showed by Fehr and Gächter (2000)
- No. senders (n) is the number of senders in the group. Although, the statistical significance of this factor is quite disputable, removing it from the model causes an increase of the Akaike information criterion. That is why we decided not to exclude this variable. The result supports our observation that the higher the number of competing senders in a group, the lower the average amount they send. This could be attributed to the fact that if a sender playing with three other senders in the same group sent the same amount as a single sender playing in a pair, the resulting profit of the receiver would be much higher. Therefore, it is reasonable to assume this motivates senders to send lower amounts in bigger groups as a result of inequity aversion (Rabin, 1993)

**Receiver analysis:** For the purpose of analyzing the effect of the number of senders on the receiver's trustworthiness  $r_i/s_i$  we use sender-receiver pair as the unit of the analysis. Here, receivers who returned more than they had received were excluded (7 pairs in total). Sender-receiver pairs with both amount sent and amount returned equal to 0 were also excluded (2 pairs). To avoid multicollinearity, we excluded variables according to their variance inflation factor ( $VIF > 5$ ). Then, using the ordinary least squares regression, we proceeded from general to specific by eliminating variables based on their statistical significance and Akaike Information Criterion (AIC). The results are given in Table 3.

Table 4: Significant factors influencing receiver trustworthiness-linear mixed model

| Random effects: +1   receiver_ID                          |          |           |             |           |
|-----------------------------------------------------------|----------|-----------|-------------|-----------|
|                                                           |          | Intercept | Residual    |           |
| SD                                                        |          | 0.300     | 0.356       |           |
| Fixed effects: -1+r*_i+Gender+No. senders+Relation+Profit |          |           |             |           |
| Variable                                                  | Estimate | SD        | t-statistic | Pr (> t ) |
| r*_i                                                      | 0.081    | 0.015     | 5.503       | 0.000***  |
| Gender                                                    | 0.695    | 0.205     | 3.395       | 0.005**   |
| No. senders                                               | 0.524    | 0.083     | 6.321       | 0.000***  |
| Relation                                                  | -0.326   | 0.082     | -3.910      | 0.001***  |
| Profit                                                    | -0.061   | 0.009     | -6.609      | 0.000***  |

Dependent variable  $r_i/s_i$ , \*\*\*p>0.01; \*\*p>0.05; \*p>0.1

In the ordinary least squares regression given in Table 2 we neglect to take into consideration the fact that the sender-receiver pairs belonging to a single receiver are influenced by his individual characteristics. To account for this fact, a linear mixed model is used with each receiver representing a group with a specific intercept (random effect in the model). Using the linear mixed model we increase the effectiveness of the estimation of parameters but on the other hand, we have to deal with the small sample bias which pertains in the model. Surprisingly, after using the general to specific methodology, we arrive at the same conclusions regarding the statistically significant factors influencing the receiver's trustworthiness  $r_i/s_i$ . The results are presented in Table 4.

The estimated regression coefficients of the two presented models display only negligible differences. Out of all considered variables and questionnaire answers, the ones with statistically significant impact on the amount ( $r_i/s_i$ ) are the following:

- $r^*_i$ (second order expectation) is the amount the receiver expects he is expected to return back to the sender. According to the sign of the estimated regression coefficient, the higher the receiver second order expectation, the higher his trustworthiness. This can be interpreted as a form of social responsibility
- Gender (0-male, 1-female). Female receivers presented a higher level of trustworthiness than male receivers which can be explained by females being more generous and demonstrating a higher level of reciprocity than males in general (Chaudhuri and Gangadharan, 2003)
- No. senders (n) is the number of senders in the group. The higher the number of senders in the group, the higher the trustworthiness. This can be interpreted by the fact that in larger groups with more senders, the receiver is accumulating a higher total amount he will receive at the end of the game and

thus he will return more as a result of his inequity aversion like in the study of Rabin (1993). On the other hand, Holm and Danielson (2005) and other studies showed that trustworthiness is constant with the amount sent in the case of citizens of developing countries (balanced norm of reciprocity) and is increasing in case of developed countries (conditional norm of reciprocity). Then, our results could be the evidence of the conditional norm of reciprocity. Interpreting this fact we must take into account that the total amount receiver by the receiver increases with the number of senders in the group, even though the amounts received from individual senders are decreasing (as showed by the sender analysis in Table 2)

- Relation represents -1; 0; 1 values based on the sign of the difference between the amount really received and the amount the receiver expected to receive from the sender ( $s_i-s^*_i$ ). The expected positive sign of the estimated regression coefficient could model the punishing/rewarding effect appropriately (Dufwenberg and Kirchsteiger, 2004, Falk and Fischbacher, 2006). Surprisingly, the negative sign expresses the situation where the receiver that received the amount higher than he had expected has shown a lower level of trustworthiness than the receiver that has received the amount lower than he had expected to receive. This fact could be caused by the receivers making their decisions about the amount they will return back to the senders based partly on the amount they expected to be sent and not only on the amount they were really sent
- Profit represents the amount the receiver keeps for himself from the total amount received from all the senders in his group. The negative sign of the estimated coefficient represents the material preferences of the receiver

## DISCUSSION

The article introduced an experiment based on a modification of the investment game. We used a modified structure with a single receiver and a varying number of senders (1-4). In the provided analysis we showed that the game structure does have an effect on the level of trust of senders in a group, with the rising number of senders lowering the level of trust. The analysis also showed that the trust is affected by the gender of the senders, with female senders exhibiting a lower level of trust than male senders. The other statistically significant factor proved to be the sender altruism. Using a concept

of the second order expectations, the influence of the social responsibility also seems to be statistically significant.

A similar analysis on the part of receivers proved that the number of senders, the receiver faces in the group, positively affects the receiver trustworthiness. We interpret this as a manifestation of the inequity aversion extensively discussed in literature. Other factors that proved to influence the trustworthiness of receivers include gender, social responsibility and material preferences. The difference between the amount the receiver really received and he had expected to receive proved to be statistically significant, as the receivers also base the amount they return to the senders on the amount they expected to receive and not only on the amount they really received.

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