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# Trust and Trustworthiness under Information Asymmetry and Ambiguity

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Abstract:

We introduce uncertainty and ambiguity in the standard investment game. In the uncertainty treatment, investors are informed that the return of the investment is drawn from a publicly known distribution function. In the ambiguity treatment, investors are not informed about the distribution function. We find that both trust and trustworthiness are robust to the introduction of these changes.

[1] The authors would like to thank Valerio Capraro for comments. * Corresponding author.

## I. Introduction

Most daily interactions involve elements of uncertainty or ambiguity. For example, a visit to the doctor, the quality of education, or the outcome of a business venture, are situations all characterized by ambiguity.[2] Ambiguity arises when the distribution of returns is not known. Under uncertainty, however, this distribution is precisely known.

In this paper we study how uncertainty and ambiguity impact trust and trustworthiness in the investment game (Berg, Dickhaut and McCabe, 1995). The general result from these games (see the meta survey by Mislin and Johnson, 2011) is that on average trust towards strangers is observed and receivers return the amount sent, although the results may depend upon features such as the size of the multiplier, culture, the development of institutions, etc. However, little is known about the robustness of trust in situations with information asymmetry.

Our experimental design modifies the standard trust game to allow for two types of information asymmetry. In the first variation, the uncertainty treatment, the return of the investment is an equally likely draw from the distribution {2, 3, 4}. In the second variation, i.e. the ambiguity treatment, the investor only knows that the return of the investment is greater than one, and has no other knowledge of the underlying distribution. The information regarding the value of the multiplier in this case is thus ambiguous.[3]

The introduction of information asymmetry does not change the theoretical prediction based on rational and selfish subjects. Even with information asymmetry, investees would return zero and investors would anticipate this and send the same. This may, however, not be the case if behavior is driven by a combination of conditional (reciprocity) and unconditional other-regarding preferences (such as unconditional altruism or inequality aversion; see Cox 2004). For the same level of investment, investees may perceive a greater level of trust under information asymmetry than under certainty and return a higher amount to investors. Similarly, investors' decisions could be affected by their belief about the actual return of the investment (unknown under

[2] The distinction between risky and ambiguous outcomes (Keynes (1921) and Knight (1921)) was shown to be relevant by Ellsberg (1961). He found that, in violation of expected utility theory (von Neumann and Morgenstern (1944), Savage (1954)), individuals, in general, preferred lotteries associated with known rather than unknown probabilities.

[3] Note that we are not comparing uncertainty vs ambiguity in the Ellsberg (1961) framework.

information asymmetry, even if they know the distribution of returns). For example, an altruistic investor may send a higher amount if the personal cost is lower (i.e. higher return of investment). Given this, we do not make explicit a priori conjectures about the effect of information asymmetry on trust and trustworthiness.

We find that trust and trustworthiness are mostly robust to the variations introduced to the standard investment game. The number of individuals sending zero is larger under ambiguity, but they are a very small number. However, the overall effect on trust is not significant as the behavior of the majority of the subjects who send a positive amount is not affected by the introduction of information asymmetry.

The paper is structured as follows. Section II describes the experimental design. In Section III we present the results, and Section IV concludes.

## II. Experimental design

A total of 346 undergraduate students from Universidad Carlos III were recruited for an hour. The average payoff was approximately €12.34. Including the instructions, the experiment lasted 45 minutes. All subjects were given a questionnaire prior to their recruitment. Responding to the questionnaire was a pre-requisite to participating in the experiments. The questionnaire contained personal information about age, studies, grades, family origin etc.

Individuals were randomly selected into sessions and roles were randomly assigned. Senders (investors) and receivers (investees) of the investment game were assigned to separate rooms in the same building before they arrived for the experiment. Senders and receivers were referred to as player A and player B, respectively, and were told that they would be paired with another person (A/B) in a different room.

The following details were common to all treatments. All instructions[4] were computer based. Participants were paid their earnings privately. Both senders and receivers got a 100 dex[5] endowment. The sender could send any amount (M) between 0 and 100 dex to the receiver. The amount received by the receiver was multiplied by *k*. Upon receipt the

[4] Appendix B.
[5] Experimental money.

receiver decided how much to send back to the sender. Below we outline the specific characteristics of each treatment.

**Baseline**: Both senders and receivers were told that $k$ took a value of 3. All information was known by all players.

**Uncertainty**: The sender was told that $k$ could take any value between {2, 3, 4} with equal probability. The receiver knew the actual value of $k$ and was aware that the sender did not know its true value. All this was common information.

**Ambiguity**: The sender was told that $k$ could take any value greater than one, and that the receiver knew the actual value of $k$. The receiver knew the value $k$ took and was told about the information the sender had. All this was common information for both players.[6]

## III. Results

### III.i. Trust

The standard measure of trust is the proportion of the endowment that the investor (sender) sends to the trustee (receiver). In Table 1 we report the descriptive statistics of the measure of trust for our treatments. We find that trust is not significantly affected by the introduction of information asymmetry (Kruskal-Wallis, *KW*, *p=0.3238*). Compared to the baseline, average trust does not change significantly under uncertainty (Mann-Whitney-Wilcoxon, *MWW*, *p=0.5166*) or ambiguity (*MWW*, *p=0.1091*). Also, we do not find significant differences between uncertainty and ambiguity treatments (*MWW*, *p=0.5440*).

**Table 1:** Descriptive statistics. Trust.

| Average<br>(median)<br>[standard deviation] | Baseline | Uncertainty treatment | Ambiguity treatment |
|---|---|---|---|
| **Trust** | 0.462<br>(0.500)<br>[0.295] | 0.438<br>(0.300)<br>[0.344] | 0.375<br>(0.350)<br>[0.283] |
| **N** | 61 | 55 | 57 |

[6] In this treatment the value of $k$ was always equal to 3.

We further confirm our results by running OLS regressions in which we regress *trust* on the treatment dummy and several controls, such as year of birth, gender, and dummies reflecting whether the subjects are foreigners and first year students (*freshman*). We also control for session dummies. Our results (Table A1 in Appendix A) confirm that our measure of trust is not significantly affected by the introduction of information asymmetry. We also analyze the behavior of those who send zero and, those who send a positive amount. Interestingly, we observe that the proportion of individuals who send zero (Appendix A, Table A1- column two) is marginally higher (10% significance level) under ambiguity compared to the baseline. However, restricting to those subjects who sent a positive amount we find no treatment differences (Appendix A, Table A1- column three). Given that the proportion of subjects sending zero is relatively small (Baseline: 2 out of 61, 3.3%; Uncertainty: 5 out of 55, 9.1%; Ambiguity: 8 out of 57, 14.0%), we don't find an overall effect on trust as a majority of the subjects (who send a positive amount) do not change their behavior significantly.

***Result 1:*** *Trust is unaffected by the introduction of uncertainty and ambiguity. However, the introduction of ambiguity marginally increases the probability that subjects send zero.*

III.ii. Trustworthiness

In Table 2 we report the descriptive statistics for trustworthiness. Trustworthiness is defined as the percentage returned by the receiver (out of the amount received) to the sender. We find that the average level of trustworthiness is not different across treatments (Kruskal-Wallis, *KW*, $p=0.7681$). Compared to the baseline, average trustworthiness does not change significantly under uncertainty (*MWW*, $p=0.7976$) or ambiguity (MWW, $p=0.5597$). Also, we do not find significant differences between uncertainty and ambiguity treatments (MWW, $p=0.\ 5153$). A more detailed regression analysis (Table A2 in Appendix A)[7] also reveals no significant effect of uncertainty or ambiguity on trustworthiness. Below we state result 2.

***Result 2:*** *Trustworthiness is unaffected by the introduction of uncertainty and ambiguity.*

[7] As before, we run OLS regressions.

**Table 3:** Descriptive statistics. Trustworthiness

| Average (median) [standard deviation] | Baseline | Uncertainty treatment | Ambiguity treatment |
|---|---|---|---|
| **Trustworthiness** | 0.190 (0.166) [0.212] | 0.185 (0.073) [0.225] | 0.199 (0.160) [0.195] |
| **N** | 59 | 50 | 49 |

## IV. Conclusion

We find that both trust and trustworthiness are robust to the introduction of uncertainty and ambiguity in the standard investment game. The probability of sending zero marginally increases under ambiguity but the majority of subjects, who send a positive amount, do not change their behavior significantly. The fact that trustworthiness is unaffected suggests that receivers are not sensitive to or do not pay attention to the amount of information given to senders.

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## Appendix A

TABLE A1. Regressions of trust

| PANEL A | Amount sent | Proportion of subjects sending zero | Amount sent, if positive |
|---|---|---|---|
| Uncertainty treatment | -0.0746 | 0.245 | 0.00902 |
| | (0.145) | (0.156) | (0.154) |
| Ambiguity treatment | -0.0513 | 0.276* | 0.0716 |
| | (0.142) | (0.163) | (0.138) |
| Woman sender | -0.0139 | -0.0392 | -0.0383 |
| | (0.0510) | (0.0449) | (0.0523) |
| Foreign sender | 0.00856 | -0.00708 | 0.0128 |
| | (0.0738) | (0.0676) | (0.0772) |
| Freshman sender | -0.0396 | -0.0322 | -0.0578 |
| | (0.0715) | (0.0515) | (0.0723) |
| Year of birth | yes | yes | yes |
| Session dummies | yes | yes | yes |
| N | 172 | 172 | 157 |
| $R^2$ | 0.113 | 0.125 | 0.092 |

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE A2. Regressions of trustworthiness

| PANEL A | Amount returned | Proportion of subjects returning zero | Amount returned, if positive |
|---|---|---|---|
| Uncertainty treatment | -0.0653 | 0.156 | -0.0658 |
| | (0.0609) | (0.246) | (0.0968) |
| Ambiguity treatment | 0.0508 | -0.0190 | 0.0224 |
| | (0.0845) | (0.267) | (0.120) |
| Woman receiver | -0.0130 | -0.0945 | -0.0264 |
| | (0.0372) | (0.0730) | (0.0405) |
| Foreign receiver | 0.0171 | -0.122 | -0.00287 |
| | (0.0576) | (0.102) | (0.0517) |
| Freshman receiver | 0.0529 | -0.104 | 0.0345 |
| | (0.0406) | (0.101) | (0.0475) |
| Year of birth | yes | yes | yes |
| Session dummies | yes | yes | yes |
| N | 156 | 156 | 111 |
| $R^2$ | 0.171 | 0.138 | 0.284 |

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

## Appendix B

Sender instructions-Translated from Spanish:(*Part in italics vary according to treatments*)

**Baseline:**

Thanks for coming. These instructions explain how the experiment works.

You have been selected at random as individual A. Another participant, in another place (outside of this room), has been selected at random to play with you. This person will be individual B. You and your partner will each receive 100 dex (experimental money).

After the experiment you will be able to convert the experimental money into real money that will be paid in cash at the end of the experiment. The exchange rate is 1 € = 12.5 dex.

This is how the experiment works:

*First, you will have the opportunity to transfer all, none, or part of the 100 dex to individual B. The amount sent to individual B will be multiplied by 3. Individual B also knows that each unit that you send will be multiplied by 3. Thus, if you send 50 dex, individual B will receive 3 x 50 = 150 dex.*

*The amount you send will appear on the display of individual B. Individual B will then have the possibility to send you back some of the amount received. Individual B may send any amount between zero and the amount you sent multiplied by 3.*

*For example, if you send 50 dex to individual B, then individual B receives 3x50 = 150 dex. Given this, individual B can send you any number between 0 and 150 dex. The amount individual B will send back will not be further multiplied.*

The experiment ends after the decision of individual B. Your earnings will be calculated on the following basis. You will be earning the initial 100 dex, minus the amount transferred to individual B, plus the amount individual B sends back to you.

Thus, if you send 50 dex to individual B and individual B sends back 70 dex, then your earnings will be 100 dex- 50 dex + 70dex = 120 dex. Applying the exchange rate this will be 9.60€. This will be your profit in this example.

The game will be played only once. Once the game ends, we will ask you to answer a few questions. Your answers will not have any influence on your earnings and will be treated as strictly confidential. The results of the experiment and the questionnaire will be used only in our research.

In the experiment today you will not interact with your partner again. You will not be able to know the identity of your partner. Similarly, your partner, nor any other participant, will know any details about you. Please do not talk to anyone during the experiment and raise your hand if you have any questions.

You are participating in a science experiment funded by the Ministry of Science and Technology. The information you give will not be associated with you and will be treated as confidential.

**Uncertainty:**

*First, you will have the opportunity to transfer all, none, or part of the 100 dex to individual B. The amount sent to individual B will be multiplied by X, where X can take the values 2, 3 or 4 with equal probability, and is determined at random. The different values that X can take are also known for the individual B. Thus, if you send 50 dex and, for example, X = 3, individual B will receive 3x50 = 150 dex.*

*The amount you send will appear on the display of individual B, with the value that X has finally taken. Individual B will then have the possibility to send you back some of the amount received. Individual B may send any amount between zero and the amount you sent multiplied by X.*

*For example, if you send 50 dex to individual B and X = 3, then individual B receives 3x50 = 150 dex. Given this, individual B can send you any number between 0 and 150 dex. The amount individual B will send back will not be further multiplied.*

**Ambiguity:**

*First, you will have the opportunity to transfer all, none or part of the 100 dex to individual B. The amount sent to individual B will be multiplied by X (X>1). Individual B knows that X>1. Thus, if you send 50 dex and, for example, X = 3, individual B will receive 3x50 = 150 dex.*

*The amount you send will appear on the display of individual B, with the value that X has finally taken. Individual B will then have the possibility to send you back some of the amount received. Individual B may send any amount between zero and the amount you sent multiplied by X.*

*For example, if you send 50 dex to individual B and X = 3, then individual B receives 3x50 = 150 dex. Given this, individual B can send you any number between 0 and 150 dex. The amount individual B will send back will not be further multiplied.*

Receiver instructions-Translated from Spanish: (*Part in italics vary according to treatments*)

**Baseline:**

Thanks for coming. These instructions explain how the experiment works.

You have been selected at random as individual B. Another participant, in another place (outside of this room), has been selected at random to play with you. This person will be individual A. You and your partner will each receive 100 dex (experimental money).

After the experiment you will be able to convert the experimental money into real money that will be paid in cash at the end of the experiment. The exchange rate is 1 € = 12.5 dex.

The experiment works like this:

*First, individual A will have the opportunity to transfer, all, none, or part of their 100 dex to you. The amount sent by individual A will be multiplied by 3. Thus, if individual A sends 50 dex, you will receive 3 x 50 = 150 dex.*

*The amount sent by individual A will appear on your screen. You will then have the possibility to send back some of the amount received. You may send any amount between zero, and the amount sent by individual A to you multiplied by 3.*

*For example, if individual A sends 50 dex to you, then you will receive 3x50 = 150 dex. Given this, you can send to individual A any number between 0 and 150 dex. The amount you send back will not be further multiplied.*

The experiment ends after your decision. Your earnings will be calculated on the following basis. You will be earning the intitial 100 dex plus the difference between the amount received from individual A and the amount you send back (to individual A).

Thus, if individual A sends 50 dex to you and you send back 70 dex, then your earnings will be 100 dex + 150 dex – 70 dex = 180 dex. Applying the exchange rate this will be 14.40€. This will be your earnings in this example.

The game will be played only once. Once the game ends, we will ask you to answer a few questions. Your answers will not have any influence on your earnings and will be treated as strictly confidential. The results of the experiment and the questionnaire will be used only in our research.

In the experiment today you will not interact with your partner again. You will not be able to know the identity of your partner. Similarly, your partner, nor any other participant, will know any details about you. Please do not talk to anyone during the experiment and raise your hand if you have any questions.

You are participating in a science experiment funded by the Ministry of Science and Technology. The information you give will not be associated with you and will be treated as confidential.

**Uncertainty:**

*First, individual A will have the opportunity to transfer, all, none, or part of their 100 dex to you. The amount sent by individual A will be multiplied by X, where X can take the values 2, 3, or 4 with equal probability, and it is determined at random. Thus, if individual A sends 50 dex and, for example, X=3, you will receive 3 x 50 = 150 dex.*

*The amount sent by individual A will appear on your screen. You will also get to know the value taken by X. This value is not known to individual A, but he or she knows that X can take the values 2, 3, or 4 with equal probability and is determined at random.*

*You will then have the possibility to send back some of the amount received. You may send any amount between zero, and the amount sent by individual A to you multiplied by X.*

*For example, if individual A sends 50 dex to you and X=3, then you will receive 3x50 = 150 dex. Given this, you can send to individual A any number between 0 and 150 dex. The amount you send back will not be further multiplied.*

**Ambiguity:**

*First, individual A will have the opportunity to transfer, all, none, or part of their 100 dex to you. The amount sent by individual A will be multiplied by X (X>1). Thus, if individual A sends 50 dex and, for example, X=3, you will receive 3 x 50 = 150 dex.*

*The amount sent by individual A will appear on your screen. You will also get to know the value taken by X. This value is not known to individual A, but he or she knows that X>1.*

*You will then have the possibility to send back some of the amount received. You may send any amount between zero, and the amount sent by individual A to you multiplied by X.*

*For example, if individual A sends 50 dex to you and X=3, then you will receive 3x50 = 150 dex. Given this, you can send to individual A any number between 0 and 150 dex. The amount you send back will not be further multiplied.*