

# 1 Trust as a Decision under Ambiguity

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9  
10 *January, 2018*

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12 Decisions to trust involve ambiguity in strategic situations. Despite many theoretical  
13 studies on the role of ambiguity in game theory, empirical studies have lagged behind  
14 due to a lack of measurement methods for ambiguities in games, where separating  
15 ambiguity attitudes from beliefs is crucial for proper measurements. Baillon et al.  
16 (2018) introduced a method that allows for such a separation for individual choice.  
17 We extend this method to strategic situations and apply it to the trust game, providing  
18 new insights. Both people's ambiguity attitudes and beliefs matter for their trust  
19 decisions. More ambiguity averse people decide to trust less, and people with more  
20 optimistic beliefs about others' trustworthiness decide to trust more. However, people  
21 who are more a-insensitive (insufficient discrimination between different likelihood  
22 levels) are less likely to act upon their beliefs. Our measure of belief, free from  
23 contamination by ambiguity attitudes, shows that traditional introspective trust survey  
24 measures capture trust in the commonly accepted sense of *belief* in trustworthiness of  
25 others. Further, trustworthy people also decide to trust more due to their *beliefs* that  
26 others are similar to themselves. This paper has shown that applications of ambiguity  
27 theories to game theory can bring useful new empirical insights.

28  
29 *Key words:* trust; ambiguity; belief measurement; strategic uncertainty; insensitivity

30 *JEL-codes:* C72, C91, D81

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# 1 INTRODUCTION

2 Keynes (1921) and Knight (1921) emphasized the importance of developing models  
 3 for ambiguity (unknown probabilities). Ambiguity is ubiquitous in economic  
 4 decisions and everyday life. Ellsberg (1961) showed that ambiguity models have to  
 5 be fundamentally different from traditional risk (known probabilities) models.  
 6 Despite the importance of ambiguity, it was not until the end of the 1980s that people  
 7 succeeded in developing the first decision models for ambiguity (Gilboa 1987; Gilboa  
 8 and Schmeidler 1989; Schmeidler 1989). Since then, many fields in economics  
 9 started catching up with ambiguity, including game theory, the field considered in this  
 10 paper.

11 In games, a major source of uncertainty concerns opponents' strategy choices.  
 12 Traditional game theory invariably assumed that all uncertainties can be expressed in  
 13 terms of Bayesian probabilities (e.g., Crawford, Costa-Gomes, and Iriberri 2013).  
 14 Yet, there is much evidence showing that the Bayesian principles are empirically  
 15 violated and people are usually ambiguity averse (Trautmann and van de Kuilen  
 16 2015). With the increased awareness in economics of the importance of ambiguity,  
 17 many theoretical studies have applied ambiguity models to the analysis of games,  
 18 producing more realistic predictions of people's choices.<sup>1</sup> However, experimental  
 19 exploration is lagging behind. For instance, many experimental studies measure  
 20 subjective beliefs of players about strategy choices of others but these studies  
 21 commonly take beliefs to be Bayesian (ambiguity neutral) additive probabilities  
 22 because no alternative tools were available yet.<sup>2</sup> Even if one assumes that using such  
 23 probabilities is rational<sup>3</sup>, then still this assumption does not hold empirically.

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<sup>1</sup> Such studies include Angelopoulos and Koutsougeras (2015), Battigalli et al. (2015), Chakravarty and Kelsey (2016), De Marcoa and Romaniello (2015), Grant, Meneghel, and Tourky (2016), Kellner (2015), Kelsey and le Roux (2017), Eichberger and Kelsey (2011), and Stauber (2011). In epistemic game theory (Perea 2012, 2014), beliefs themselves are Bayesian but unconventional updating methods are considered.

<sup>2</sup> See for instance Armantier and Treich (2009), Blanco et al. (2010), Costa-Gomes and Weizsäcker (2008), Heinemann, Nagel, and Ockenfels (2009), Huck and Weizsäcker (2002), Neri (2015), Nyarko and Schotter (2002), Palfrey and Wang (2009), Rutström and Wilcox (2009), Schlag, Tremewan, and van der Weele (2015), and Trautmann and van de Kuilen (2015 footnote 16).

<sup>3</sup> This assumption deviates from the rationality judgments by Ellsberg (1961), Gilboa et al. (2010), and others.

1        Some experimental studies have allowed for non-neutral ambiguity attitudes, and  
2 tested their effects on behavior in games.<sup>4</sup> However, in these studies the role of  
3 ambiguity is explored not by measuring ambiguity attitudes directly, but rather, by  
4 varying the level of ambiguity faced by players across treatments. Inferences that can  
5 be drawn from this approach are unfortunately limited if ambiguity attitudes of  
6 subjects are heterogeneous. Furthermore, treatment differences aimed at  
7 manipulating levels of ambiguity about the opponent (e.g., matching subjects with  
8 foreign vs. domestic opponents in a game or matching subjects with a game theorist  
9 vs. a grandmother) are likely to produce confounds with changing beliefs about  
10 opponents' strategy choices, necessitating a control for beliefs, which cannot be done  
11 properly without also accounting for ambiguity attitudes.

12        A difficulty that has hampered the application of ambiguity theories to natural  
13 events, including strategy choices of others, arises from the necessity to control for  
14 beliefs when measuring ambiguity. It had been unknown how to do this for natural  
15 events. This is why ambiguity measurements have so far focused on artificial  
16 ambiguity using Ellsberg urns or experimenter-specified probability intervals, where  
17 control of beliefs is possible using symmetries introduced by the experimental design.  
18 Such symmetries are virtually never available for natural events, including moves of  
19 others in strategic situations. Baillon et al. (2018) resolved the aforementioned  
20 difficulty for individual choice. They introduced an ambiguity measurement method  
21 that works for all events without the need of artificial symmetries in beliefs. We show  
22 how Baillon et al.'s (2018) method can be applied to games. By relating ambiguity  
23 attitudes to behavior in games, we thus show, with the specific example of the trust  
24 game, how accounting for ambiguity can enrich our understanding of decisions under  
25 strategic ambiguity.

26

27

## 2 TRUST AND AMBIGUITY

28        Trust received much interest in economics (Fehr 2009; Johnson and Mislin 2011;  
29 Li 2007; Smith and Wilson 2017). In the commonly accepted sense, trust represents

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<sup>4</sup> These include, besides some papers cited later, Di Mauro and Finocchiaro Castro (2011), Eichberger, Kelsey, and Schipper (2008), and Kelsey and le Roux (2017).

1 people's belief in trustworthiness of others (Gambetta 2000). In deciding to trust  
2 others, however, not only people's beliefs but also their attitudes towards uncertainty  
3 matter because usually it is not certain whether their trust will be reciprocated. Most  
4 previous studies focused on how people's risk attitude impacts their trust decisions,  
5 but found no clear relation (Eckel and Wilson 2004; Houser, Schunk, and Winter  
6 2010). However, we almost never know an objective probability of others being  
7 trustworthy, and the decision to trust usually is a decision under ambiguity. It has  
8 been well documented in the literature that people treat ambiguity differently than risk  
9 (Ellsberg 1961; Trautmann and van de Kuilen 2015). To properly understand  
10 people's trust decisions, it is desirable to reckon with their ambiguity attitudes. To  
11 illustrate, assume that we observe that person A decides not to trust whereas B does,  
12 where both are risk neutral. Then it is still possible that A is just more ambiguity  
13 averse and not less trusting (see Case 3 in the Appendix). Hence, a control for  
14 ambiguity attitude is needed. We provide this control. In particular, we are able to  
15 separate ambiguity attitudes from subjective beliefs and measure beliefs properly also  
16 if subjects are not ambiguity neutral.

17 We can now reveal how ambiguity affects trust decisions. Whereas risk attitudes  
18 may be unrelated to trust decisions, ambiguity attitudes play a significant role. They  
19 contaminate trusting decisions indeed as would be predicted by most current  
20 ambiguity theories: because the decision to trust involves making oneself vulnerable  
21 to the trustworthiness of another, which is ambiguous, the more a person dislikes  
22 ambiguity the less attractive she will find the trusting option. Thus, we empirically  
23 confirm that given same beliefs in trustworthiness of the other, the more ambiguity  
24 averse people decide to trust less, for the first time controlling all the aforementioned  
25 components.

26 Corcos, Pannequin, and Bourgeois-Gironde (2012) also argued that the trust  
27 game involves ambiguity, and found a positive relation between ambiguity aversion  
28 and trust decisions. They measured ambiguity aversion in the traditional way using

1 artificial Ellsberg urns.<sup>5</sup> However, ambiguity attitudes towards unknown urns can be  
2 different than towards the trustworthiness of others (Tversky and Fox 1995). We  
3 measure ambiguity attitudes for trust game events, increasing validity. In this respect,  
4 our contribution is the analog for ambiguity of what Bohnet and Zeckhauser (2004),  
5 Fairley et al. (2016), and Evans and Krueger (2017) did for risk: they measured risk  
6 attitudes both for artificial events and for trust game events, and showed that in the  
7 latter case risk attitudes provide better predictors.

8       Apart from aversion, which is a motivational component describing how much a  
9 person dislikes ambiguity, ambiguity attitude is characterized by a second, cognitive  
10 component called insensitivity, explained next. Insensitivity has been found to be an  
11 important predictor of behavior in experimental studies of individual choice  
12 (Trautmann and van de Kuilen 2015). It describes how much people perceive  
13 ambiguity in a given decision situation. The more they do, the more they treat all  
14 events alike, as one blur, resulting in lower discriminatory power towards different  
15 likelihood levels. As a result, insensitivity works to reduce a person's tendency to act  
16 in accordance with her beliefs. We show that insensitivity also plays a significant role  
17 in the trust decision. Although more optimistic beliefs about the other's  
18 trustworthiness lead to more trust decisions, we find that for people with equally  
19 optimistic beliefs the more insensitive people less often decide to trust. On the other  
20 hand, for people with equally pessimistic beliefs about the other's trustworthiness the  
21 more insensitive people more often decide to trust. Thus, we find that ambiguity  
22 about the opponent's choice in a strategic game has a two-fold effect on behavior:  
23 Ambiguity makes safe strategies more attractive to (averse) players, and it makes  
24 (insensitive) players less likely to act in accordance with their beliefs.

25       Because our techniques allow us to properly measure beliefs, we can further  
26 contribute new evidence to a number of open issues in the literature. In particular, we  
27 consider the relationship between survey and behavioral measures of trust. We can

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<sup>5</sup> Corcos, Pannequin, and Bourgeois-Gironde (2012) used Chakravarty and Roy's (2009) measure of ambiguity aversion. A difficulty is that this measure is contaminated by risk attitude, which does not cancel (Wakker 2017).

1 confirm that introspective survey questions on trust, such as the ones included in the  
2 well-known and widely-used World Values Survey (WVS) and General Social Survey  
3 (GSS), do capture trust in the commonly accepted sense of *belief* in trustworthiness of  
4 others. Some authors have suggested that people use their own trustworthiness as a  
5 signal, and therefore are more likely to trust others. We show that this is indeed due  
6 to their *beliefs*: they believe others to be similar to themselves. This self-similar  
7 reasoning in belief formation may also explain why some previous studies found  
8 survey measures of trust (which, as argued before, capture people's beliefs about  
9 others) to be related to own trustworthiness (Glaeser et al. 2000). Trustworthiness, as  
10 we show, serves as a signal for forming beliefs about others.

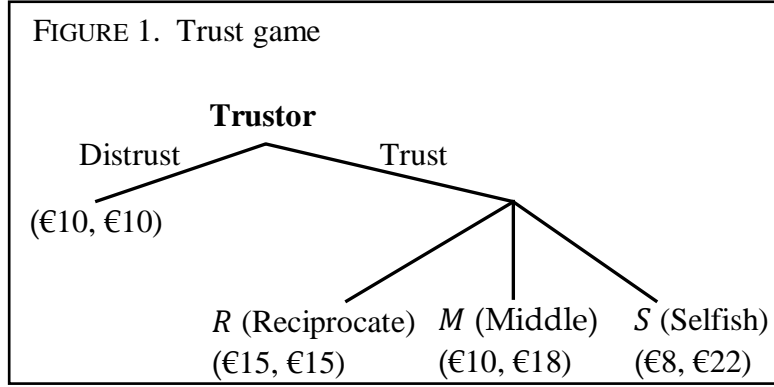
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### 12 3 METHOD

13 Figure 1 shows the trust game used in our study. A trustor faces a binary choice.  
14 If she chooses the option distrust, both she and her trustee receive €10 for sure and  
15 there is no uncertainty. Alternatively, she can also choose the trust option, whose  
16 outcome is uncertain. Then how much she receives is up to the trustee's choice from  
17 three allocation options,  $R$  (Reciprocate) = (€15, €15),  $M$  (Middle) = (€10, €18), and  
18  $S$  (selfish) = (€8, €10). Throughout, the first amount is the payment for the trustor  
19 and the second is for the trustee.

20 The game we used is a modification of the trust game of Bohnet and Zeckhauser  
21 (2004) and Bohnet et al. (2008). The only difference is that the trustee has one extra  
22 option ( $M$ ) to choose from. Option  $M$  gives the trustee the possibility to be selfish  
23 without hurting the trustor but at a slight efficiency cost—the total payment is then  
24 €28 instead of €30. We added this extra option so as to be able to observe ambiguity-  
25 generated insensitivity (defined later), for which at least three events are needed  
26 (Baillon et al. 2018).

27



Let  $E_i$  ( $i = r, m$ , or  $s$ ) denote the event that the trustee chooses option  $I$  ( $I = R, M$ , or  $S$ ). These events are exhaustive and mutually exclusive. We refer to them as *single events*. A *composite event*, denoted  $E_{ij}$  ( $j \neq i$ ), is the union  $E_i \cup E_j$  of two single events. For each event  $E$  ( $E_i$  or  $E_{ij}$ ) and a fixed outcome  $X > 0$  ( $X = €15$  in the experiment),  $X_E 0$  denotes a, possibly ambiguous, prospect that pays  $X$  if event  $E$  happens and 0 otherwise. Similarly,  $X_q 0$  denotes a risky prospect that pays  $X$  with probability  $q$  and 0 with probability  $1 - q$ .

DEFINITION 3.1. The *matching probability*  $m$  ( $m_i$  or  $m_{ij}$ ) of an event  $E$  ( $E_i$  or  $E_{ij}$ ) is the probability such that the decision maker is indifferent between prospects  $X_E 0$  and  $X_m 0$ .

The matching probability  $m$  of an event  $E$  depends on the decision maker's subjective belief in event  $E$ , but also on her ambiguity attitude. Dimmock, Kouwenberg, and Wakker (2016 Theorem 3.1) showed that, if we know beliefs, then matching probabilities capture people's ambiguity attitudes while controlling for their risk attitudes. Baillon et al. (2018) added the control for unknown beliefs. We next briefly introduce the two indexes of Baillon et al. (2018) that we use. Let  $\overline{m}_s = (m_r + m_m + m_s)/3$  denote the average single-event matching probability and let  $\overline{m}_c = (m_{rm} + m_{rs} + m_{ms})/3$  denote the average composite-event matching probability.

DEFINITION 3.2. The *ambiguity aversion index* is

$$b = 1 - \overline{m}_s - \overline{m}_c. \quad (3.1)$$

1

2 DEFINITION 3.3. The *a(ambiguity-generated)-insensitivity index* is

$$3 \quad a = 3 \times \left( \frac{1}{3} - (\overline{m}_c - \overline{m}_s) \right). \quad (3.2)$$

4

5 Under ambiguity neutrality,  $\overline{m}_s = \frac{1}{3}$  and  $\overline{m}_c = \frac{2}{3}$ , so that both indexes are 0. Note  
 6 how we could calibrate this without knowing beliefs. This is key to this method. For  
 7 an ambiguity averse person the matching probabilities are low and the aversion index  
 8 accordingly is high. She is willing to pay a premium (in winning probability) to avoid  
 9 ambiguity. A maximally ambiguity averse person has all matching probabilities 0 and  
 10 the aversion index is 1. For ambiguity seeking subjects, the aversion index is  
 11 negative.

12 The insensitivity index concerns the (lack of) discriminatory power of the  
 13 decision maker regarding different levels of likelihood. For a completely insensitive  
 14 person who does not distinguish between composite and single events ( $\overline{m}_c = \overline{m}_s$ ) the  
 15 insensitivity index takes its maximal value 1. This happens for people who take all  
 16 uncertainties as fifty-fifty. The better a person discriminates between composite and  
 17 single events, the larger  $\overline{m}_c - \overline{m}_s$  is and the smaller the insensitivity index is. The  
 18 index captures perception of ambiguity. The more ambiguity a person perceives, the  
 19 more the likelihoods of the events are perceived as one blur and the higher the index  
 20 is. The index also captures cognitive discriminatory power.

21 Several indexes of ambiguity attitude have been proposed in the literature under  
 22 particular theoretical assumptions. The beginning of §6 explains that our indexes  
 23 agree with most of those on their domain of definition. Further, they generalize those  
 24 domains. In this way, our indexes unify and extend many existing indexes.

25 Our elicitation method allows for extrapolating a-neutral probabilities  $p_i$ . These  
 26 can be interpreted as the beliefs of an ambiguity neutral twin of the decision maker,  
 27 who is exactly the same as the decision maker except that she is ambiguity neutral.  
 28 That is, a-neutral probabilities are additive subjective probabilities that result after  
 29 correcting for ambiguity attitudes. Baillon et al. (2018) showed that, under certain  
 30 assumptions:

$$31 \quad p_i = \frac{3(\overline{m}_c - \overline{m}_s) + 3m_i - 3m_{jk} + 2(1-a)}{6(1-a)}, \text{ where } \{i, j, k\} = \{r, m, s\}. \quad (3.3)$$



1 The appendix provides numerical examples to illustrate how ambiguity attitudes can  
 2 confound measurements of social preferences, and the desirability to correct for it.

3 We, finally, summarize our predictions:

- 4 (1) Matching probabilities are not Bayesian, and violate additivity; i.e., they are not  
 5 ambiguity neutral. Instead, subjects are (1a) ambiguity averse and (1b) a-  
 6 insensitive.
- 7 (2) Ambiguity attitudes confound effects of social preferences. (2a) more ambiguity  
 8 averse people less often decide to trust; (2b) a-insensitivity makes people less  
 9 likely to act upon their beliefs, dampening the effect of prediction 3 below.
- 10 (3) People with more optimistic beliefs in others' trustworthiness more often decide  
 11 to trust.

## 12 4 EXPERIMENTAL DESIGN

13 *Subjects.* In total, 182 subjects were recruited from the subject pool of the  
 14 experimental laboratory at Erasmus School of Economics. 56% were male.

15

16 *Incentives.* The experiment was computer-based<sup>6</sup> and consisted of seven sessions. It  
 17 was incentivized using a modification of the prior incentive system (Prince; Johnson  
 18 et al. 2015), avoiding income effects (Blanco et al. 2010). At the beginning of each  
 19 session (with  $n$  subjects), one volunteer was invited to randomly select  $n/2$  pairs of  
 20 sealed envelopes. Then the envelopes in the selected pile were un-paired by the  
 21 experimenter (by removing the clips holding each pair together). Each subject would  
 22 then draw one envelope from the pile.

23 It was explained to each subject that, throughout the experiment, she would be  
 24 paired with a partner whose subject ID was inside the envelope. During the  
 25 experiment, she would face different decision situations, where her payments  
 26 depended on both her own and her partner's decisions. One of these decision  
 27 situations was inside the envelope, and this was the only one that mattered for the real  
 28 payment at the end. Each subject earned €5 participation fee, plus the earnings from

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<sup>6</sup> The online appendix contains the structure and instructions of the experiment. The full experiment is available online at <http://www.peterwakker.com/trustnew/begin.php>. For testing, please use any 4-digit number starting with the digit 6 (e.g., 6067) as a subject ID.

1 the decision situation inside her envelope. Including the participation fee, an average  
2 subject earned €14.87 in our experiment.

3 FIGURE 2. Trust game: trustor decision situation

4

5 **The following may be inside your envelope.**

6 Recall that you are matched with one other participant. You can instruct the experimenters to  
7 give you one of the following two options:

8 **Option 1:** Follow your partner's instruction for payment

9 **Option 2:** Pay €10 to each of you

10

11 If you instruct the experimenters to give you Option 1,

12 your partner's instruction will determine the payments for the two of you. Your partner  
13 can instruct the experimenters to give you one of the following three options:

14 Option A: Pay €15 to each of you;  
15 Option B: Pay you €10, pay him/her €18;  
16 Option C: Pay you €8, pay him/her €22.

17 So if your partner has instructed to give Option A, you and your partner will get €15  
18 each. If your partner has instructed to give Option B, you will get €10 and your partner  
19 €18. Finally, if your partner has instructed to give Option C, you will get €8 and your  
20 partner €22.

21 If you instruct the experimenters to give you Option 2,  
you and your partner will get €10 each (and your partner's instruction will play no role).

22 *Stimuli.* During the experiment, subjects encountered three types of decision  
23 situations. Subjects, further, answered some demographic and introspective survey  
24 questions, which were not incentivized. Each subject first faced the trustor decision  
25 of the trust game (Figure 2). It was explained to her that her own and her partner's  
26 choice as a trustee would be used to determine their final payment if this decision  
27 situation came out of her envelope.

28 After making their choices as the trustor, subjects proceeded to the second part of  
29 the experiment, where they faced 24 decision situations designed to elicit their  
30 matching probabilities. Figure 3 depicts a typical decision situation of this type. A  
31 subject chose between two options, both of which might pay her €15 but under  
32 different conditions. Option 1 was an ambiguous prospect paying €15 if her partner  
33 (as the trustee) chose option *R* in the trust game. Option 2 was a risky prospect  
34 paying €15 with a 50% chance.

35 An example with an explanation of the typical decision situation was presented to  
36 the subjects before they made their decisions. Subjects had to answer four questions

1 checking their understanding correctly before they could proceed.<sup>7</sup> Subjects could  
2 also click on a reminder button to view the description of the trust game again.

3 Matching probabilities were elicited for all single events  $\{E_r, E_m, E_s\}$  and  
4 composite events  $\{E_{rm}, E_{ms}, E_{rs}\}$ . For each single or composite event, bisection was  
5 used to elicit its matching probability. For instance, for event  $E_r$  the subject first  
6 faced the decision situation in Figure 3. If she chose option 1, in the next decision  
7 situation the winning probability in option 2 increased; otherwise, it decreased. For  
8 each event, subjects faced four decision situations, where option 1 stayed fixed and  
9 the winning probability in option 2 varied depending on the choices in the previous  
10 situation.<sup>8</sup> Figure 4 shows how the probabilities for later decision situations and  
11 ultimately the event's matching probability were determined given subjects' choices.  
12 We will refer to the four decision situations for each event as a block. The 24  
13 decision situations for eliciting matching probabilities thus constituted 6 blocks. The  
14 blocks appeared in a random order, and between two consecutive blocks, a  
15 demographic question<sup>9</sup> was asked to refresh subjects' thinking mode. The  
16 demographic questions also appeared in a random order.

17  
18 FIGURE 3. A typical ambiguity decision situation

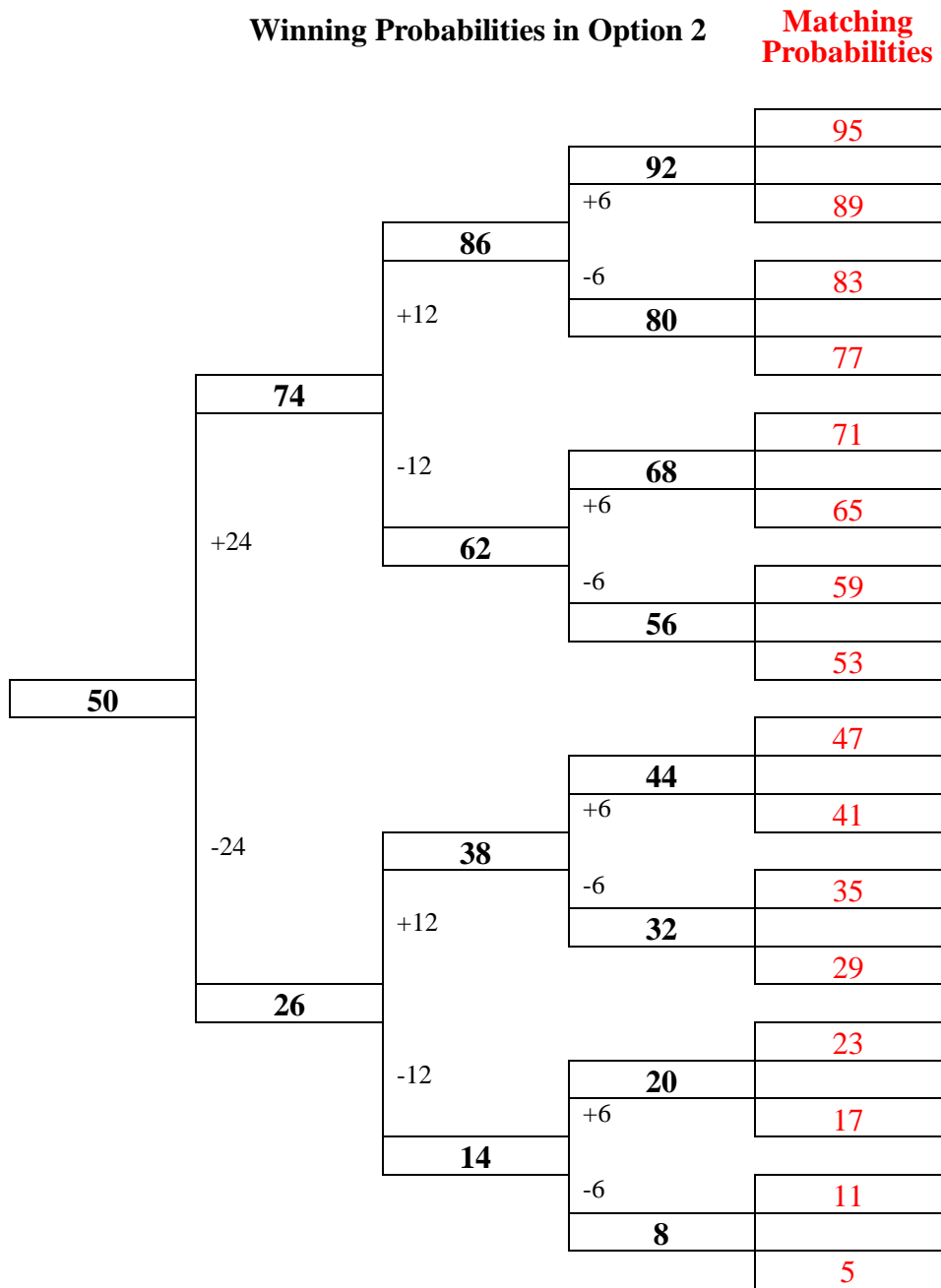


<sup>7</sup> Online appendix OB provides information on the frequency of subjects failing these comprehension questions. Robustness tests in the appendix show that removing subjects who failed the test more than 3 times do not affect the findings in this paper.

<sup>8</sup> The advantage of using Prince (Johnson et al. 2015) to implement the bisection procedure is that it enhances incentive compatibility. Under Prince, the decision situation that eventually mattered is pre-determined and does not depend on subjects' choices during the experiment, excluding the possibility to answer strategically so as to manipulate later stimuli. It is, therefore, always in the best interest of subjects to reveal their true preferences, and this is simple and transparent to subjects.

<sup>9</sup> We asked five demographic questions: gender, drinking habits (weekly average number of alcoholic drinks consumed), subjective well-being, nationality (Dutch or non-Dutch), and number of siblings.

FIGURE 4. Determination of probabilities in the bisection method



NOTES: For each event, the winning probability of the first decision situation is always 50%. At each node, if the subject chooses option 1 (2), the probability on the upper (lower) branch is used as the winning probability in option 2 in the next decision situation, while option 1 remains the same. The last column is the matching probability recorded depending on subjects' choices in the previous four decision situations.

1 Following the matching probability decision situations, in the third part of the  
 2 experiment subjects made a decision as the trustee in the same trust game as before.  
 3 Figure 5 shows the trustee decision situation.

4  
 5 **FIGURE 5. Trust game: trustee decision situation**

6  
 7 **The following may be inside your envelope.**  
 8  
 9 Recall that you are matched with one other participant. You can instruct the experimenters to  
 10 give one of the following three options:  
 11  
 12 **Option A:** Pay **€15** to each of you  
 13 **Option B:** Pay you **€18**, pay your partner **€10**  
 14 **Option C:** Pay you **€22**, pay your partner **€8**  
 15  
 16 Your partner can instruct the experimenters to give you one of the following two numbered (1  
 17 and 2) options:  
 18  
 19 Option 1: Follow your instruction for payment  
 20 Option 2: Pay **€10** to each of you  
 21  
 22 The experimenters will follow your instruction only if your partner instructed to give you Option  
 23 1. If your partner instructed Option 2, then you and your partner will get €10 each, and your  
 24 instruction will play no role.

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Subjects also answered non-incentivized introspective questions about their general trust attitudes. The three questions, which are identical to the general trust questions used in the VWS and the GSS, were: “Generally speaking, would you say that most people can be trusted or that you can’t be too careful in dealing with people?”; “Would you say that most of the time, people try to be helpful, or that they are mostly just looking out for themselves?”; and “Do you think that most people would try to take advantage of you if they got the chance or would they try to be fair?”. In each question, subjects could choose to agree or disagree with the statement. The answer indicating the trust decision was coded as 1 for each question, and the other answer as 0. The general trust measure was then taken as the average of the three responses.

*Payment.* After all subjects finished the experiment, they were called to the payment desk one by one. Each subject opened her envelope. If it was the trust game decision situation (either as the trustor or the trustee), her decision and her partner’s choice would be used to determine her final payment. If the envelope contained a matching

1 probability decision situation that she had encountered during the experiment, her  
 2 partner's trustee decision determined her final payment had she chosen the ambiguous  
 3 option 1. Otherwise, the winning probability of option 2 decided her payment.<sup>10</sup> The  
 4 same matching probability decision situation was in her partner's envelope, so that  
 5 her trustee decision determined her partner's final payment in case the partner had  
 6 chosen the ambiguous option 1. It could also happen that the subject had not  
 7 encountered the matching probability decision situation that came out of her envelope.  
 8 In case this happened, we inferred the subject's choice in the new situation from her  
 9 choice in a similar situation by dominance. For instance, suppose the subject had  
 10 chosen option 1 in the decision situation in Figure 3, but a decision situation with a  
 11 winning probability of 26% came out of her envelope. Because of the bisection  
 12 procedure, she could not have encountered this situation during the experiment. We  
 13 would then explain to the subject that, since she preferred the ambiguous option 1 to  
 14 an even better option 2 (with 50% winning chance), we inferred that in the decision  
 15 situation where option 2 gives 26% winning chance, she would also prefer option 1.  
 16 We would then implement option 1.

17

18

## 5 RESULTS

### 19 5.1 Description of data

20 Of the 182 participants, we removed 20 (11.0%) who failed monotonicity  
 21 checks<sup>11</sup> at least twice. Table 1 shows summary statistics. 54% of trustors chose to  
 22 trust their trustees. Of the trustees, 22% reciprocated the trust by choosing option *R*,  
 23 25% chose the middle option *M*, and 53% chose the selfish option *S*. There was  
 24 substantial heterogeneity in trustors' ambiguity attitudes and beliefs. The median  
 25 trustor was ambiguity indifferent (contrary to Prediction 1a), a-insensitive (Prediction

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<sup>10</sup> If, for instance, the winning probability of option 2 was 50%, then the subject threw two 10-sided dice, and any number below 50 (which had 50% chance of occurring) meant that the subject would be paid the prize.

<sup>11</sup> For each subject, we performed six monotonicity tests. By monotonicity, subjects' matching probabilities for a composite event should not be lower than those of the single events included in the composition. Therefore, two tests were performed for each composite event, resulting in six tests in total per subject. On average, the fail rate of these monotonicity checks was 7.5%.

1 1b), and believed that the trustee was equally likely to choose any of the three options.  
 2 In addition to these variables elicited from subjects' choices, Table 1 also describes  
 3 subjects' responses to the introspective survey questions about general trust, gender,  
 4 number of siblings, nationality, subjective well-being, and drinking habits.

5

TABLE 1. Summary statistics

	mean	median	st.dev	min	max	interquartile range
trusted	0.54	1	0.5	0	1	[0, 1]
trustee	2.31	3	0.8	1	3	[2, 3]
ambiguity aversion	-0.01	0	0.17	-0.78	0.58	[-0.08, 0.06]
a-insensitivity	0.23	0.16	0.25	-0.32	1	[0.1, 0.34]
$p_r$	0.31	0.32	0.21	0	1	[0.17, 0.38]
$p_m$	0.30	0.33	0.16	0	0.96	[0.21, 0.37]
$p_s$	0.41	0.33	0.24	0	1	[0.27, 0.56]
general trust	0.47	0.33	0.35	0	1	[0.33, 0.67]
gender (male = 1)	0.56	1	0.5	0	1	[0, 1]
weekly drinks	4.18	2	5.15	0	30	[1, 5]
nationality (Dutch = 1)	0.56	1	0.5	0	1	[0, 1]
happiness	7.01	7	1.67	0	10	[6, 8]
siblings	1.48	1	1.18	0	8	[1, 2]

6 NOTES: trusted = 1 if the trustor chooses the trusting option 1 and 0 otherwise;  
 7 trustee = 1, 2, and 3 if trustee chooses option R, M, and S respectively;  
 8 ambiguity aversion and a-insensitivity are the index values of ambiguity  
 9 attitudes;  $p_r$ ,  $p_m$ , and  $p_s$  are the a-neutral probabilities for the three events;  
 10 general trust is the mean score in the WVS/GSS questions; gender = 1 if the  
 11 subject is male; weekly drinks is the weekly number of alcoholic beverages  
 12 consumed; nationality = 1 if the subject is Dutch and 0 if not; happiness is the  
 13 subjective answer to the question "Do you feel happy in general?", which can  
 14 take values from 0 to 10; siblings is the number of siblings.

15

16 We did not find any gender effects and will not report statistics on them.

17 Unsurprisingly, trustee decisions were not related to their ambiguity aversion

18 ( $\rho = .03, p = 0.75$ ) nor to their a-insensitivity ( $\rho = 0.08, p = 0.40$ ). We now turn  
 19 to trustors.

## 20 5.2 Ambiguity attitudes and beliefs as determinants of trust decisions

21 Table 2 presents binary logistic regressions of our subjects' decisions to trust on  
 22 their ambiguity attitudes and beliefs. Model 1 includes as explanatory variables the  
 23 two indexes (aversion and insensitivity) describing subjects' ambiguity attitudes.

24 Model 2 includes a variable that measures subjects' beliefs about their trustees'

1 trustworthiness,  $(p_r - p_s)$ , with higher values corresponding to more optimistic  
2 beliefs. Model 3 combines Models 1 and 2. Model 4 adds an interaction between  
3 beliefs and a-insensitivity, and Model 5 adds demographic controls.

4       Because the decision to trust involves choosing an ambiguous prospect over a  
5 certain prospect, the more ambiguity averse a trustor the less attractive she is expected  
6 to find the trusting option. More ambiguity averse subjects indeed less often decided  
7 to trust (Prediction 2a). Subjects' beliefs also mattered for their decisions to trust.  
8 Subjects who were more optimistic about their trustees' trustworthiness were more  
9 likely to decide to trust (Prediction 3). However, this positive effect of optimistic  
10 beliefs on trusting behavior was dampened by subjects' a-insensitivity – the second  
11 component of ambiguity attitude (Prediction 2b). The more insensitive a decision  
12 maker, the less she distinguishes between different levels of likelihoods, the less her  
13 decisions are impacted by those differences, and the less she acts in accordance with  
14 her beliefs. The negative interaction effect between insensitivity and beliefs (in  
15 Models 4 and 5) confirms this prediction.

16       Average marginal effects computed from the regression results in Table 2  
17 indicate that the aforementioned effects were also behaviorally significant. For  
18 instance, estimates of Model 5 show that one standard deviation increase in ambiguity  
19 aversion was associated with 8 percentage points decrease in the subject's predicted  
20 probability of deciding to trust. As beliefs became more optimistic (one standard  
21 deviation increase in  $p_r - p_s$ ), the probability of deciding to trust for a subject with a-  
22 insensitivity index value 0 increased by 26 percentage points. But for subjects with a-  
23 insensitivity index values of, say, 0.16 and 0.34, corresponding to the 0.5 and 0.75  
24 quantiles, respectively, the same improvement in beliefs led to lower increases in the  
25 probability of deciding to trust—22 and 15 percentage point increases, respectively.  
26



1

TABLE 2. Regression: What contributes to the decision to trust?

	<i>Dependent variable:</i>				
	trusted				
	(1)	(2)	(3)	(4)	(5)
ambiguity aversion	-2.09** (1.04)		-2.39** (1.18)	-2.56** (1.17)	-2.56** (1.27)
a-insensitivity	0.51 (0.68)		0.72 (0.74)	-0.07 (0.79)	-0.34 (0.86)
$p_r - p_s$		1.96*** (0.46)	2.10*** (0.49)	3.81*** (0.92)	3.90*** (0.95)
a-insensitivity * ( $p_r - p_s$ )				-5.96*** (2.25)	-6.34*** (2.40)
Demographic Controls	No	No	No	No	Yes
Observations	162	161	161	161	161
Log Likelihood	-109.19	-100.21	-97.60	-93.79	-90.40
Akaike Inf. Crit.	224.38	204.42	203.19	197.57	200.80

\* p&lt;0.1; \*\* p&lt;0.05; \*\*\* p&lt;0.01

2 NOTES: 162 subjects remained after removal of those who failed  
3 monotonicity checks at least twice. Model 1 has 161 observations  
4 because for one subject, her a-neutral probabilities were not  
5 identifiable since her matching probabilities for all events were the  
6 same.

7

### 8 5.3 What do introspective survey questions measure?

9 In the literature on trust, an oft addressed and still unresolved issue concerns the  
10 validity of attitudinal survey questions on trust. For instance, experiments by Glaeser  
11 et al. (2000), Lazzarini et al. (2005), and Ashraf, Bohnet and Piankov (2006) found  
12 that, instead of measuring people's trust in others, attitudinal survey questions  
13 captured people's own trustworthiness. Fehr et al. (2003), however, found  
14 trustworthiness to be unrelated to attitudinal trust and that trusting behavior did in fact  
15 correlate with some of the survey questions on trust. In Sapienza, Toldra-Simats, and  
16 Zingales (2013), attitudinal trust was related to both trust and trustworthiness  
17 behaviors. These authors argued that trust decisions are affected by other-regarding  
18 preferences and risk aversion—preference components other than people's belief in  
19 the trustworthiness of others—whereas survey questions may capture mainly the

1 belief component. (Fehr et al. 2003 also suggested that attitudinal trust may relate to  
2 trust behavior through the belief component.)

3 Our main findings have shown that ambiguity present in the trust game also  
4 affects trusting behavior through the trustor's motivational (aversion) and cognitive  
5 (perception) attitudes toward ambiguity. We have thus shown an additional  
6 preference-based component affecting trusting behavior. Below, we show that  
7 people's trust survey responses are positively correlated with their beliefs. Thus, we  
8 provide evidence confirming that survey questions on trust are measuring trust in the  
9 commonly accepted sense of belief in others' trustworthiness, expressed for instance  
10 by Gambetta (2000): "When we say we trust someone or that someone is trustworthy,  
11 we implicitly mean that the probability that he will perform an action that is beneficial  
12 or at least not detrimental to us is high enough for us to consider engaging in some  
13 form of cooperation with him."

14 In Table 3 we examine the relationship between our subjects' responses to the  
15 introspective survey questions about general trust and their trusting and  
16 trustworthiness behaviors. For all models we use linear regressions with the  
17 dependent variable being the mean score of subjects' responses to the three WVS and  
18 GSS questions about general trust. Model 1 examines the extent to which trusting  
19 behavior in the two-person game is related to the survey measure of trust. Model 2  
20 looks at subjects' trustworthiness behavior rather than their trusting behavior. In  
21 Model 3 we include as explanatory variables subjects' ambiguity attitudes and beliefs,  
22 which were found to determine trusting behavior. Model 4 adds our demographic  
23 controls to Model 3.

24

1

TABLE 3. Regression: What is the general trust survey measuring?

	<i>Dependent variable:</i>			
	general trust			
	(1)	(2)	(3)	(4)
trusted	0.11** (0.06)			
trustee		-0.05 (0.04)		
ambiguity aversion			-0.27 (0.17)	-0.20 (0.17)
a-insensitivity			0.05 (0.12)	0.09 (0.12)
$p_r - p_s$			0.15** (0.07)	0.13** (0.06)
Demographic Controls	No	No	No	Yes
Observations	161	125	160	160
R <sup>2</sup>	0.02	0.01	0.05	0.10

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

2 NOTES: In Table 3, the number of observations in all models is 1 less than  
3 models in Table 2, because for 1 subject, the survey responses were missing.  
4 The number of observations for Model 2 is lower because 36 subjects in the  
5 first two sessions of the experiment did not make the trustee decision.  
6  
7

8 Subjects' responses to the survey questions were positively correlated with their  
9 decisions to trust, but had no relation with their decisions as the trustee  
10 (trustworthiness behavior).<sup>12</sup> These findings are reflective of the mixed results  
11 obtained in previous studies. Models 3 and 4 offer an insight. In our sample, subjects  
12 with more optimistic beliefs about their trustees' trustworthiness scored higher in the  
13 survey measure of trust, whereas their ambiguity attitudes were unrelated to the scores  
14 in the survey measure. These results show that the survey questions about general  
15 trust do capture people's beliefs. They also suggest an added reason for why the  
16 survey measure of trust may not robustly relate to trusting behavior in the trust game:  
17 trusting behavior is affected by people's ambiguity attitudes in addition to their

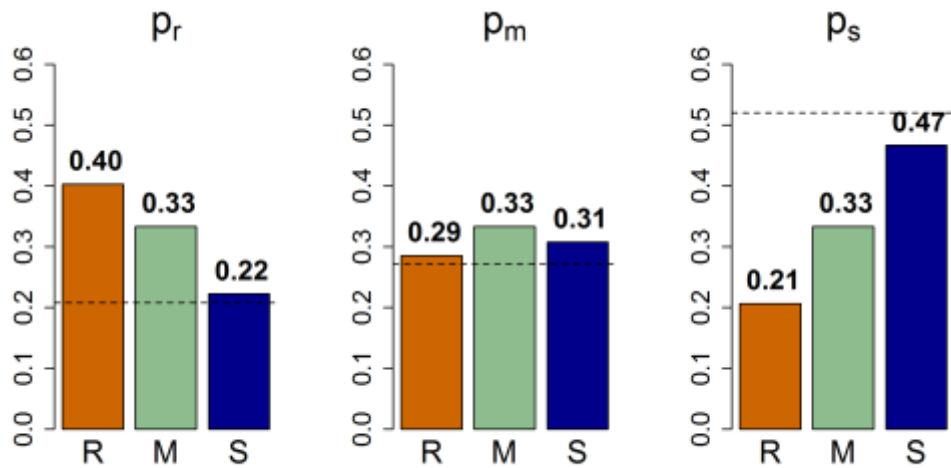
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<sup>12</sup> The same holds if we include the trustee decisions as separate dummy variables in the regression.

1 beliefs, whereas the survey measure captures beliefs alone and is not distorted by  
2 ambiguity attitudes.

3 The finding that survey questions on trust can capture people's beliefs in the  
4 trustworthiness of others also offers an explanation for why some studies (e.g. Glaeser  
5 et al. 2000) found a correlation between people's answers to survey questions on trust  
6 in others and their own trustworthiness behavior. People often form their beliefs  
7 about others based on their own types (Ross, Greene, and House 1977; Rubinstein and  
8 Salant 2016). They expect others to be similar to themselves. Consistent with this  
9 self-similar reasoning in belief formation, Figure 6 shows that subjects' beliefs in the  
10 trustworthiness of others is strongly correlated with their own trustworthiness.  
11 Subjects who in the role of a trustee chose the reciprocating option  $R$  also believed  
12 their trustees to be most likely to choose option  $R$  ( $p$ -value  $< 0.01$ ; Jonckheere test).  
13 Those who chose the selfish option  $S$  similarly believed their trustees to be most  
14 likely to do the same ( $p$ -value  $< 0.01$ ; Jonckheere test), but not for option  $M$ .

15  
16  
17  
FIGURE 6. Belief about partner by own trustworthiness



18 NOTES: Each panel in Figure 6 presents the median a-neutral probabilities of  
19 an event ( $R$ ,  $M$ , or  $S$ ) split by subjects' own trustee decisions. The dashed  
20 horizontal line indicates the actual frequency.

21  
22 If survey questions capture beliefs about others' trustworthiness and if beliefs  
23 about others are based on own trustworthiness, then it is plausible to expect a  
24 correlation between the survey measure and people's own trustworthiness. However,

1 as shown in Table 4 (Model 2), in our sample there was no significant relationship  
2 between trustworthiness and the survey measure of trust.

3 Finally, we note that the self-similar reasoning in belief formation provides  
4 insight into previous findings on earnings in trust games, namely, that trusting people  
5 lost money on average (Berg, Dickhaut, and McCabe 1995; Ashraf, Bohnet and  
6 Piankov 2006). In our sample, the actual frequencies of trustee decisions (21%, 27%,  
7 and 52% choosing option *R*, *M*, and *S*, respectively) were closest to the median beliefs  
8 of the most prevalent type: the selfish trustees who chose option *S*. The self-similar  
9 reasoning in belief formation would predict this. The other two types, by applying the  
10 same reasoning, ended up being overly optimistic about others' trustworthiness.  
11 Because trusting behavior is driven by (overly) optimistic beliefs, trusting subjects  
12 lost money on average.

13  
14

## 15 6 DISCUSSION AND RELATED LITERATURE

16 For ambiguity attitude measurements, we used the ambiguity indexes of Baillon  
17 et al. (2018). We briefly discuss features and validity of these indexes here. See  
18 Baillon et al. (2018) for more details. Indexes can never completely capture complex  
19 phenomena, and cannot be valid for all theories. For instance, the popular relative  
20 risk aversion index  $-\alpha U''(\alpha)/U'(\alpha)$  varies with wealth under constant absolute risk  
21 aversion, and with probability under prospect theory (Wakker 2008). Baillon et al.  
22 (2018) explain that their ambiguity indexes are valid under all “uni-separable”  
23 ambiguity theories. This includes Ghirardato and Marinacci’s (2001) biseparable  
24 utility and, thus, Gilboa and Schmeidler’s (1989) maxmin expected utility, Gilboa’s  
25 (1987) and Schmeidler’s (1989) Choquet expected utility, Tversky and Kahneman’s  
26 (1992) prospect theory for gains (as in our case), and  $\alpha$ -maxmin utility (Ghirardato,  
27 Maccheroni, and Marinacci 2004; Luce and Raiffa 1957, §13.5). Non-biseparable  
28 theories include Einhorn and Hogarth (1985) and some others. Baillon et al.’s  
29 indexes agree with, and thus unify and generalize (e.g., by not assuming expected  
30 utility for risk) many indexes proposed in papers before, including those of Dow and  
31 Werlang (1992) and Schmeidler (1989) for Choquet expected utility, Abdellaoui et al.

1 (2011) and Dimmock, Kouwenberg, and Wakker (2016) for prospect theory,  
2 Ghirardato, Maccheroni, and Marinacci (2004) and Luce and Raiffa (1957, §13.5) for  
3  $\alpha$ -maxmin expected utility, and Dimmock et al. (2015) and Epstein and Schneider  
4 (2010) for  $\varepsilon$ -contamination multiple priors. Baillon et al. (2018) also showed that,  
5 whereas the aversion index could be estimated from two matching probabilities, for  
6 the insensitivity index we need six.

7 The aforementioned theories have in common that ambiguity attitudes are  
8 modeled through event dependence; i.e., functions operating on events. The utility  
9 function of outcomes is assumed invariant across different contexts. This assumption  
10 underlies the use of matching probabilities.<sup>13</sup> Another kind of ambiguity models  
11 captures ambiguity attitudes through functions on outcomes, Klibanoff, Marinacci,  
12 and Mukerji's (2005) smooth model being the most popular one. Under these models,  
13 our indexes can become outcome dependent, in the same way as the relative index of  
14 risk aversion can be wealth or probability dependent. This also holds for more  
15 general theories including Gul and Pesendorfer (2015) and Maccheroni, Marinacci,  
16 and Rustichini (2006).

17 A convenient feature of matching probabilities, and the indexes derived from  
18 them, is that they capture ambiguity attitudes irrespective of what risk attitudes are  
19 (Dimmock, Kouwenberg, and Wakker 2016, Theorem 3.1). The intuitive explanation  
20 is that risk attitude plays the same role for the two prospects in Definition 3.1 and,  
21 hence, drops from the equations. The remarkable implication is that measuring  
22 ambiguity attitudes is easier than measuring risk attitudes.

23 Many theoretical studies recently incorporated ambiguity into game theory, and  
24 some empirical studies did (see introduction). We are aware of two studies that  
25 measured aversion towards strategic ambiguity (Camerer and Karjalainen 1994;  
26 Ivanov 2011). However, these studies did not use ambiguity attitudes to predict  
27 strategic behavior, but, conversely, devised special games with the purpose of  
28 deriving ambiguity attitudes from strategic behavior. They did not derive beliefs from  
29 revealed preferences, but Ivanov (2011) controlled for beliefs by deriving them from  
30 introspection. Both studies only considered ambiguity aversion, and not insensitivity.  
31 Our measurements of ambiguity attitudes, carried out in trust games, can be used in

---

<sup>13</sup> For specialists: this is captured by Savage's (1954) P4 axiom.

1 all game situations, are independent from the actual behavior in the games so that they  
2 can be used to predict game behavior, are entirely revealed preference based, and also  
3 consider insensitivity. That Prediction 1a (ambiguity aversion) was not confirmed is  
4 not surprising in view of many recent findings that ambiguity aversion is less  
5 prevalent than thought a decade ago (see Kocher, Lahn, and Trautmann, 2018, and  
6 their references).

7 Reversing the direction of the preceding paragraph, game theoretic considerations  
8 played a role in early studies of ambiguity. As pointed out by Brewer (1963), subjects  
9 could be averse to gambles on drawing from urns with unknown composition because  
10 they could suspect that the experimenters might have deliberately made such  
11 compositions unfavorable. Schneeweiss (1973) provided a game-theoretic analysis.  
12 Nowadays, papers measuring ambiguity attitudes usually add controls for such  
13 suspicion, e.g. by letting subjects choose winning colors of balls only after the  
14 experimenter's composition of the urns.

15 Most studies on decisions to trust have so far focused on relations with risk  
16 attitudes. Fehr (2009) reviewed the existing literature and argued that trust decisions  
17 are not just a special case of decision under risk. In decisions under social uncertainty  
18 like the betrayal uncertainty faced in the trust decision, other components of  
19 preferences play important roles. Our study supports this claim. Even if risk attitudes  
20 of trustors play no role in their decisions to trust (Eckel and Wilson 2004; Ashraf,  
21 Bohnet, and Plankov 2006; Houser, Schunk, and Winter 2010), ambiguity attitudes  
22 matter. Our measures of ambiguity attitude describe attitudes of our subjects  
23 specifically toward the betrayal ambiguity that they face in the trust game. We have  
24 shown that aversion to this ambiguity reduces people's tendency to trust others. In  
25 addition, the ambiguity-generated likelihood insensitivity dampens the tendency of  
26 people to act on their beliefs about the trustworthiness of others. Clots-Figueras,  
27 González, and Kujal (2016) and Evans and Krueger (2017) considered effects of  
28 information provision on trust games, in the form of objective risks and in the form of  
29 ambiguous risks. The former study found no significant differences, but the latter  
30 study found more effect from objective than from ambiguous information, suggesting  
31 that the latter information is less valuable and changes less relative to the real  
32 situation.

33 The ambiguity attitudes measured in this paper reflect differences between  
34 unknown probabilities and known probabilities and, thus, reflect a component

1 conceptually distinct from risk attitude. Yet these two components may be related  
2 empirically and interact in their impact on trust decisions. Measuring both subjects'  
3 risk attitudes and their ambiguity attitudes and then studying such interactions is a  
4 topic for future research.

5 Our methodology allows for separating preference-based ambiguity attitudes  
6 from the belief component. This opens up the possibility in future research for  
7 understanding whether differences in attitudes or beliefs drive observed trust  
8 differences, e.g., concerning culture, social groups. Social groups (Etang, Fielding,  
9 and Knowles 2011; Ferschtman and Gneezy 2001) and culture (Doney, Cannon, and  
10 Mullen 1998; Bornhorst et al. 2010) have been argued to drive a wedge in trust.  
11 Another question concerns whether such differences are driven primarily by  
12 differences in preferences or beliefs.

13 Belief measurements have been widely used in experimental economics, but  
14 invariably under the empirically invalid assumption of ambiguity neutrality.  
15 Ambiguity attitudes have therefore confounded such belief measurements so far.  
16 Using our techniques, we could substantiate a number of hypotheses on trust and  
17 trustworthiness with evidence from revealed preference data and proper  
18 measurements of beliefs.

19 Our finding that optimistic beliefs about others' trustworthiness (after correcting  
20 for ambiguity attitudes) increase trust decisions is similar to the findings of Ashraf,  
21 Bohnet and Piankov (2006) and Sapienza, Toldra-Simats, and Zingales (2013). They  
22 used a variation of Berg, Dickhaut, and McCabe's (1995) investment game, in which  
23 trustors could choose the part of their endowment to send to their trustee. The amount  
24 sent to the trustee would then be tripled, and the trustee decided how much of the total  
25 amount received to send back to the trustor. To elicit subjects' beliefs about their  
26 trustees' trustworthiness, they asked subjects to estimate the amount their trustee  
27 would return. They found a positive correlation between subjects' estimations of the  
28 amount returned and the amount that subjects sent.

29 Our measure of belief is directly expressed in terms of probabilities rather than  
30 indirectly through a point estimate of a money amount, and is directly derived from  
31 revealed preferences with incentivization. Sapienza, Toldra-Simats, and Zingales  
32 (2013) rewarded accurate estimates of average amounts that would be sent back by  
33 trustees, but their implementation was not fully incentive compatible. First, because  
34 minimal distances between the estimates and the actual amounts sent were rewarded,



1 subjects did not have the incentive to truthfully reveal extreme expectations. Second,  
2 because subjects were rewarded for accurate estimates for each possible amount sent  
3 and sent back, hedging through strategic (and not truthful) guesses was possible.

4 Using our belief measurements, we could also provide evidence confirming that  
5 introspective survey questions on trust are good measures of trust in the sense of  
6 belief in others' trustworthiness. Whereas decisions in the trust game are affected by  
7 both beliefs and ambiguity attitudes, trust survey responses are only positively  
8 correlated with beliefs, and not with ambiguity attitudes. This provides an additional  
9 explanation for why survey and behavioral measures of trust may not be robustly  
10 related to each other. Moreover, we could confirm that people's beliefs about others  
11 are positively correlated with their own trustworthiness.

12 In the psychology literature, false consensus has been found, which describes  
13 people's tendency to expect others to be close to themselves in characteristics,  
14 preferences, and so on (Ross, Greene, and House 1977). For instance, people who are  
15 happy themselves expect a larger proportion of the population to be happy than  
16 unhappy people do. Although the name of this phenomenon suggests that it is a bias,  
17 later studies showed that it could be the result of rational Bayesian updating using  
18 one's own type as a signal (Dawes 1990; Prelec 2004). Similar to Rubinstein and  
19 Salant (2016), we find support for the self-similar reasoning in our game theoretical  
20 setting: people's belief about others' trustworthiness is correlated with own  
21 trustworthiness. This result may explain why several studies found that survey  
22 measures of trust were correlated with people's own trustworthiness. Combined with  
23 our finding that survey measures do capture beliefs in others' trustworthiness, the  
24 self-similar reasoning in belief formation predicts that people's own trustworthiness  
25 would be correlated with their beliefs about others.

26 Interestingly, the aforementioned result indicates that prevalence of own type  
27 may determine accuracy of beliefs about others in strategic interactions and, hence,  
28 also the earning of players acting on those beliefs. In our sample, the beliefs of the  
29 most prevalent type—the non-trustworthy one—are indeed closest to the actual  
30 distribution of trustworthiness. Previous findings that trusting people lost money on  
31 average (Berg, Dickhaut, and McCabe 1995; Ashraf, Bohnet and Piankov 2006) may  
32 be explained by the trustworthy types not being the prevalent type in the particular  
33 experimental samples.

34

## 7 CONCLUSION

1

2 Most studies on decisions to trust have so far focused on relations with risk  
3 attitudes (usually finding none) because ambiguity attitudes, while relevant, could not  
4 be measured there. We could measure them, by applying Baillon et al.'s (2018) new  
5 method to games. Thus, we could analyze—and correct for—ambiguity attitudes. In  
6 particular, we could correct belief measurements (e.g. of another person being  
7 trustworthy) this way. Belief measurements have been widely used in experimental  
8 economics, but invariably under the empirically invalid assumption of ambiguity  
9 neutrality. These belief measurements have so far been confounded by ambiguity  
10 attitudes.

11 We used our method to investigate the role of ambiguity in trust games. We  
12 found that the motivational ambiguity aversion reduces people's trusting behavior.  
13 The cognitive likelihood insensitivity, not studied before in game theory, dampens the  
14 effect of people's beliefs about others' trustworthiness on their trust decisions. By  
15 analyzing and correcting belief measurements for ambiguity attitudes, we could shed  
16 new light on some unsettled issues in the literature. Thus, based on revealed  
17 preference data we showed that survey trust questions do capture people's beliefs  
18 about others' trustworthiness. Moreover, people's beliefs about others are positively  
19 correlated with their own trustworthiness. Hence, own type serves as a signal about  
20 others, explaining why trustworthy people lose excessively if most others are  
21 untrustworthy. This paper has shown the way to reckon with ambiguity attitudes  
22 when studying human behavior in strategic situations, and the desirability to do so.

23

## 1 APPENDIX: NUMERICAL ILLUSTRATION

2 This appendix illustrates numerically how ignoring ambiguity attitudes can lead  
 3 to wrong conclusions about social preferences in the trust game. To focus on  
 4 ambiguity and simplify the analysis, we assume that both players maximize expected  
 5 utility for risk. Many social preference models have been used to analyze the trust  
 6 game, and to justify non-selfish choices by the trustee (Cox, Friedman, and Gjerstad  
 7 2007; Galizzi and Navarro-Martínez 2017; Smith and Wilson 2017). Because of its  
 8 simplicity, we use Fehr and Schmidt’s (1999) inequity aversion model. The trustee is  
 9 affected by inequality aversion, so that she may for instance prefer (15,15) to (10,18).  
 10 She is also affected by guilt, inducing an extra dislike of outcomes for the trustor  
 11 below 10 that make the trustor suffer from having trusted. Depending on the strength  
 12 of these effects, she may prefer either of  $R$ ,  $M$ , or  $S$ , and the trustor is uncertain about  
 13 this.<sup>14</sup> We focus on the trustor's decision in what follows.

14 The trustor likes to gamble as much on  $R$ ,  $M$ , and  $S$ , so that these events have the  
 15 same matching probability. If the trustor is ambiguity neutral, maximizing expected  
 16 utility, then the subjective probabilities of these events are  $1/3$ , and so are their  
 17 matching probabilities and decision weights. Her utility function is

$$U(x, y) = x - a \times \max\{x - y, 0\} - b \times \max\{y - x, 0\}$$

18 with  $a$  her aversion to being richer (“ahead”) and  $b$  her aversion to being poorer  
 19 (“behind”).<sup>15</sup> In this game,  $a$  is irrelevant because the trustor is always poorer. We  
 20 assume  $a = 0$ . We first present four cases and then discuss them.

21

---

<sup>14</sup> Fehr-Schmidt utility functions characterizing the trustee's type can be as follows. The trustee's individual utility  $u$  is defined by  $u(x) = x$  for all  $x \geq 10$  and  $u(8) = 2$ , four times overweighting the loss 2 from 10 (guilt). The overall utility function  $U$  of the trustee, incorporating inequality aversion, is

$$U(x, y) = u(y) - a \times \max\{u(y) - u(x), 0\} - b \times \max\{u(x) - u(y), 0\}.$$

Here  $b$  reflects the inequality aversion resulting from being poorer (“behind”), playing no role in our analysis, and  $a$  reflects the inequality aversion resulting from being richer (“ahead”). For  $a > 3/8$  the trustee chooses  $R = (15,15)$ , for  $3/8 > a > 1/3$  the trustee chooses  $M = (10,18)$ , and for  $1/3 > a$  the trustee chooses  $S = (8,22)$ . Between indifferent options, random choice is assumed. The trustor is uncertain about the type ( $a$ ) of the trustee and, hence, about the trustee's choice.

<sup>15</sup> We assume that the trustor, unlike the trustee, does not perceive guilt in outcome 8.

1 CASE 1 [no aversion to inequality and ambiguity neutrality]. The trustor is ambiguity  
 2 neutral and  $b = 0$ . Trust has utility  $\frac{1}{3} \times 15 + \frac{1}{3} \times 10 + \frac{1}{3} \times 8 = 11 > 10$ . Trust is  
 3 chosen.

4  
 5 CASE 2 [aversion to inequality and ambiguity neutrality]. The trustor is ambiguity  
 6 neutral and  $b = 0.15$ . Trust has utility  $\frac{1}{3} \times 15 + \frac{1}{3} \times 8.8 + \frac{1}{3} \times 5.9 = 9.9 < 10$ .  
 7 Distrust is chosen.

8  
 9 CASE 3 [no aversion to inequality and ambiguity aversion]. Here  $b = 0$ . But, because  
 10 no known objective probabilities have been provided, the trustor perceives ambiguity.  
 11 She is averse to ambiguity, and, relative to Case 1, pays extra attention to deviations  
 12 in unfavorable directions. She therefore assigns extra weight 0.50 to the unfavorable  
 13 S, and only weight 0.50 to the expected utility of Case 1.<sup>16</sup> The utility of the trust  
 14 decision is  $0.50 \times 8 + 0.50 \times 11 = 9.50 < 10$ . Distrust is chosen.

15  
 16 CASE 4 [aversion to inequality and a-insensitivity]. Here  $b = 0.15$ . The trustor  
 17 perceives ambiguity. Relative to the analysis in Case 2, because of ambiguity, she

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<sup>16</sup> We will not take the space to define several ambiguity theories, but briefly indicate how the weights can result from theories defined in the papers cited. The weights result from Gilboa and Schmeidler's (1989) maxmin expected utility for instance if the set of priors is the set of probability vectors:

$$\{\lambda_1(1,0,0) + \lambda_2(0,1,0) + \lambda_3(0,0,1) + \lambda_4\left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right) : \lambda_j \geq 0 \forall j; \lambda_4 \geq \frac{1}{2}\},$$

where the maxmin expected utility results from  $\lambda_3 = \frac{1}{2} = \lambda_4$ . This is the special case of  $\alpha$ -maxmin expected utility (Luce and Raiffa 1957, §13.5) with  $\alpha = 0$ . The weights result from Abdellaoui et al.'s (2011) source method—which is a special case of Gilboa's (1987) and Schmeidler's (1989) Choquet expected utility and of Tversky and Kahneman's (1992) prospect theory—if, for instance, the a-neutral probability vector is  $\left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right)$  and  $w_T(p) = p/2$  for all  $p < 1$ ,  $w_T(1) = 1$ , with  $w_T$  the source function capturing the ambiguity attitude for the trust game. In all aforementioned models, the trustor is indifferent between gambling on either event  $R, M$ , or  $S$ , and they all have matching probability  $\frac{1}{6}$ . The ambiguity aversion

index is  $\frac{1}{2}$ . Sensitivity has also been reduced, and the a-insensitivity index is also  $\frac{1}{2}$ .

1 extra reckons with deviations in both directions (favorable and unfavorable). She  
 2 assigns extra weight 0.25 to the favorable  $R$ , extra weight 0.25 to the unfavorable  $S$ ,  
 3 and only weight 0.50 to the expected utility of Case 2.<sup>17</sup> The utility of trust is  
 4  $0.25 \times 5.9 + 0.25 \times 15 + 0.50 \times 9.9 = 10.18 > 10$ . Trust is chosen.

5

6 The four cases show how ambiguity attitudes can confound the analyses of social  
 7 preferences. A researcher who does not reckon with ambiguity aversion in Case 3  
 8 may confuse it with Case 2 and erroneously conclude that there is inequality aversion.  
 9 Similarly, Case 4 may be confused with Case 1 with the erroneous conclusion that  
 10 there is no inequality aversion. Galizzi and Navarro-Martínez (2017) reported  
 11 negative findings on the external validity of social preference models in game theory.  
 12 Correcting for ambiguity attitudes may help to improve the case.

13

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<sup>17</sup> These weights cannot result from Gilboa and Schmeidler's (1989) maxmin expected utility because this model only allows for aversion and not for insensitivity. They can result from  $\alpha$ -maxmin expected utility if, for instance, the set of priors is the set of all possible probability distributions  $0.5 \left( \frac{1}{3}, \frac{1}{3}, \frac{1}{3} \right) + 0.5Q$  for any probability distribution  $Q$ , and  $\alpha = 0.5$ . They can result from Abdellaoui et al.'s (2011) source method if, for instance, the a-neutral probability vector is  $\left( \frac{1}{3}, \frac{1}{3}, \frac{1}{3} \right)$  and  $w_T(p) = 0.25 + 0.50 \times p$  for all  $0 < p < 1$ ,  $w_T(0) = 0, w_T(1) = 1$ . In all aforementioned models, the trustor is indifferent between gambling on either event  $R, M$ , or  $S$ , and they all have matching probability  $\frac{5}{12}$ . The ambiguity aversion index is 0, and the a-insensitivity index is 0.50.

## REFERENCES

- 1
- 2 Abdellaoui, Mohammed, Aurélien Baillon, Laetitia Placido, and Peter P. Wakker  
3 (2011) “The Rich Domain of Uncertainty: Source Functions and Their  
4 Experimental Implementation,” *American Economic Review* 101, 695–723.
- 5 Angelopoulos, Angelos and Leonidas C. Koutsougeras (2015) “Value Allocation  
6 under Ambiguity,” *Economic Theory* 59, 147–167.
- 7 Armantier, Olivier and Nicolas Treich (2009) “Subjective Probabilities in Games: An  
8 Application to the Overbidding Puzzle,” *International Economic Review* 50,  
9 1013–1041.
- 10 Ashraf, Nava, Iris Bohnet, and Nikita Piankov (2006). “Decomposing Trust and  
11 Trustworthiness,” *Experimental Economics* 9, no. 3: 193-208.
- 12 Baillon, Aurélien, Zhenxing Huang, Asli Selim, and Peter P. Wakker (2018)  
13 “Measuring Ambiguity Attitudes for All (Natural) Events,” working paper.
- 14 Battigalli, Pierpaolo, Simone Cerreia-Vioglio, Fabio Maccheroni, and Massimo  
15 Marinacci (2015) “Self-Confirming Equilibrium and Model Uncertainty,”  
16 *American Economic Review* 105, 646–677.
- 17 Berg, Joyce, John Dickhaut, and Kevin McCabe (1995) “Trust, Reciprocity, and  
18 Social History,” *Games and Economic Behavior* 10, 122–142.
- 19 Blanco, Mariana, Dirk Engelmann, Alexander K. Koch, and Hans-Theo Normann  
20 (2010) “Belief Elicitation in Experiments: Is there a Hedging Problem?,”  
21 *Experimental Economics* 13, 412–438.
- 22 Bohnet, Iris and Richard Zeckhauser (2004) “Trust, Risk and Betrayal,” *Journal of*  
23 *Economic Behavior and Organization* 55, 467–484.
- 24 Bohnet, Iris, Fiona Greig, Benedikt Herrmann, and Richard Zeckhauser (2008)  
25 “Betrayal Aversion: Evidence from Brazil, China, Oman, Switzerland, Turkey,  
26 and the United States,” *American Economic Review* 98, 294–310.
- 27 Bornhorst, Fabian, Andrea Ichino, Oliver Kirchkamp, Karl H. Schlag, and Eyal  
28 Winter (2010) “Similarities and Differences when Building Trust: The Role of  
29 Cultures,” *Experimental Economics* 13, 260–283.
- 30 Brewer, K.R.W. (1963) “Decisions under Uncertainty: Comment,” *Quarterly Journal*  
31 *of Economics* 77, 159–161.

- 1 Camerer, Colin F. and Risto Karjalainen (1994) “Ambiguity-Aversion and Non-  
2 Additive Beliefs in Non-Cooperative Games: Experimental Evidence,” *Models  
3 and Experiments in Risk and Rationality*, Springer, Netherlands, 325–358.
- 4 Chakravarty, Surajeet and David Kelsey (2016) “Ambiguity and Accident Law,”  
5 *Journal of Public Economic Theory* 18 doi:10.1111/jpet.12160.
- 6 Chakravarty, Sujoy and Jaideep Roy (2009) “Recursive Expected Utility and the  
7 Separation of Attitudes towards Risk and Ambiguity: An Experimental Study,”  
8 *Theory and Decision* 66, 199–228.
- 9 Clots-Figueras, Irma, Roberto Hernán González, and Praveen Kujal (2016) “Trust and  
10 Trustworthiness under Information Asymmetry and Ambiguity,” *Economics  
11 Letters* 147 (2016) 168–170.
- 12 Corcos, Anne, François Pannequin, and Sacha Bourgeois-Gironde (2012) “Is Trust an  
13 Ambiguous rather than a Risky Decision,” *Economics Bulletin* 32, 2255–2266.
- 14 Costa-Gomes, Miguel and Georg Weizsäcker (2008) “Stated Beliefs and Play in  
15 Normal-Form Games,” *Review of Economic Studies* 75, 729–762.
- 16 Cox, James C., Daniel Friedman, & Steven Gjerstad (2007) “A Tractable Model of  
17 Reciprocity and Fairness,” *Games and Economic Behavior* 59, 17–45.
- 18 Crawford, Vincent P., Miguel Costa-Gomes, and Nagore Iriberri (2013) “Structural  
19 Models of Nonequilibrium Strategic Thinking: Theory, Evidence, and  
20 Applications,” *Journal of Economic Literature* 51, 5–62.
- 21 Dawes, Robyn M. (1990) “False Consensus Effect,” *Insights in Decision Making: A  
22 Tribute to Hillel J. Einhorn*, University of Chicago Press, Illinois, 179–199.
- 23 De Marcoa, Giuseppe and Maria Romaniello (2015) “Variational Preferences and  
24 Equilibria in Games under Ambiguous Belief Correspondences,” *International  
25 Journal of Approximate Reasoning* 60, 8–22.
- 26 Di Mauro, Carmela and Massimo Finocchiaro Castro (2011) “Kindness, Confusion,  
27 or ... Ambiguity?,” *Experimental Economics* 14, 611–633.
- 28 Dimmock, Stephen G., Roy Kouwenberg, Olivia S. Mitchell, and Kim Peijnenburg  
29 (2015) “Estimating Ambiguity Preferences and Perceptions in Multiple Prior  
30 Models: Evidence from the Field,” *Journal of Risk and Uncertainty* 51, 219–244.
- 31 Dimmock, Stephen G., Roy Kouwenberg, and Peter P. Wakker (2016) “Ambiguity  
32 Attitudes in a Large Representative Sample,” *Management Science* 62, 1363–  
33 1380.

- 1 Doney, Patricia M., Joseph P. Cannon, and Michael R. Mullen (1998) “Understanding  
2 the Influence of National Culture on the Development of Trust,” *Academy of*  
3 *Management Review* 23, 601–620.
- 4 Dow, James and Sérgio R.C. Werlang (1992) “Uncertainty Aversion, Risk Aversion  
5 and the Optimal Choice of Portfolio,” *Econometrica* 60, 197–204.
- 6 Eckel, Catherine C. and Rick K. Wilson (2004) “Is Trust a Risky Decision?,” *Journal*  
7 *of Economic Behavior and Organization* 55, 447–465.
- 8 Eichberger, Jürgen and David Kelsey (2011) “Are the Treasures of Game Theory  
9 Ambiguous?,” *Economic Theory* 48, 313–393.
- 10 Eichberger, Jürgen, David Kelsey, and Burkhard C. Schipper (2008) “Granny versus  
11 Game Theorist: Ambiguity in Experimental Games,” *Theory and Decision* 64,  
12 333–362.
- 13 Einhorn, Hillel J. & Robin M. Hogarth (1985) “Ambiguity and Uncertainty in  
14 Probabilistic Inference,” *Psychological Review* 92, 433–461.
- 15 Ellsberg, Daniel (1961) “Risk, Ambiguity and the Savage Axioms,” *Quarterly*  
16 *Journal of Economics* 75, 643–669.
- 17 Epstein, Larry G. and Martin Schneider (2010) “Ambiguity and Asset Markets,”  
18 *Annual Review of Financial Economics* 2, 315–346.
- 19 Etang, Alvin, David Fielding, and Stephen Knowles (2011) “Does Trust Extend  
20 beyond the Village? Experimental Trust and Social Distance in Cameroon,”  
21 *Experimental Economics* 14, 15–35.
- 22 Evans, Anthony M. and Joachim I. Krueger (2017) “Ambiguity and Expectation-  
23 Neglect in Dilemmas of Interpersonal Trust,” *Judgment and Decision Making* 12,  
24 584–595.
- 25 Fairley, Kim, Alan Sanfey, Jana Vyrastekova, and Utz Weitzel (2016) “Trust and  
26 Risk Revisited,” *Journal of Economic Psychology* 57, 74–85.
- 27 Fehr, Ernst (2009) “On the Economics and Biology of Trust,” *Journal of the*  
28 *European Economic Association* 7, 235–266.
- 29 Fehr, Ernst, Urs Fischbacher, Bernhard von Rosenblatt, Jürgen Schupp, and Gert G.  
30 Wagner (2003) “A Nation-Wide Laboratory: Examining Trust and  
31 Trustworthiness by Integrating Behavioral Experiments into Representative  
32 Survey,” working paper.
- 33 Fehr, Ernst & Klaus Schmidt (1999) “A Theory of Fairness, Competition and  
34 Cooperation,” *Quarterly Journal of Economics* 114, 817–868.



- 1 Ferschtman, Chaim and Uri Gneezy (2001) “Discrimination in a Segmented Society:  
2 An Experimental Approach,” *Quarterly Journal of Economics* 116, 351–377.
- 3 Galizzi, Matteo M. & Daniel Navarro-Martínez (2017) “On the External Validity of  
4 Social Preference Games: A Systematic Lab-Field Study,” *Management Science*,  
5 forthcoming.
- 6 Gambetta, Diego (2000) “Can We Trust Trust,” *Trust: Making and Breaking*  
7 *Cooperative Relations*, electronic edition, University of Oxford, 213–237.
- 8 Ghirardato, Paolo & Massimo Marinacci (2001) “Risk, Ambiguity, and the Separation  
9 of Utility and Beliefs,” *Mathematics of Operations Research* 26, 864–890.
- 10 Ghirardato, Paolo, Fabio Maccheroni, & Massimo Marinacci (2004) “Differentiating  
11 Ambiguity and Ambiguity Attitude,” *Journal of Economic Theory* 118, 133–173.
- 12 Gilboa, Itzhak (1987) “Expected Utility with Purely Subjective Non-Additive  
13 Probabilities,” *Journal of Mathematical Economics* 16, 65–88.
- 14 Gilboa, Itzhak, Fabio Maccheroni, Massimo Marinacci, and David Schmeidler (2010)  
15 “Objective and Subjective Rationality in a Multiple Prior Model,” *Econometrica*  
16 78, 755–770.
- 17 Gilboa, Itzhak and David Schmeidler (1989) “Maxmin Expected Utility with a Non-  
18 Unique Prior,” *Journal of Mathematical Economics* 18, 141–153.
- 19 Glaeser, Edward L., David I. Laibson, Jose A. Scheinkman, and Christine L. Soutter  
20 (2000) “Measuring Trust,” *Quarterly Journal of Economics* 115, 811–846.
- 21 Grant, Simon, Idione Meneghel, and Rabee Tourky (2016) “Savage Games,”  
22 *Theoretical Economics* 11, 641–682.
- 23 Gul, Faruk & Wolfgang Pesendorfer (2015) “Hurwicz Expected Utility and  
24 Subjective Sources,” *Journal of Economic Theory* 159, 465–488.
- 25 Heinemann, Frank, Rosemarie Nagel, and Peter Ockenfels (2009) “Measuring  
26 Strategic Uncertainty in Coordination Games,” *Review of Economic Studies* 76,  
27 181–221.
- 28 Houser, Daniel, Daniel Schunk, and Joachim Winter (2010) “Distinguishing Trust  
29 from Risk: An Anatomy of the Investment Game,” *Journal of Economic*  
30 *Behavior and Organization* 74, 72–81.
- 31 Huck, Steffen and Georg Weizsäcker (2002) “Do Players Correctly Estimate What  
32 Others Do? Evidence of Conservatism in Beliefs,” *Journal of Economic Behavior*  
33 *and Organization* 47, 71–85.

- 1 Ivanov, Asen (2011) “Attitudes to Ambiguity in One-Shot Normal-Form Games: An  
2 Experimental Study,” *Games and Economic Behavior* 71, 366–394.
- 3 Johnson, Cathleen, Aurélien Baillon, Han Bleichrodt, Zihua Li, Dennie van Dolder,  
4 and Peter P. Wakker (2015) “Prince: An Improved Method for Measuring  
5 Incentivized Preferences,” working paper.
- 6 Johnson, N. D., and Mislin, A.A. (2011). Trust games: A meta-analysis. *Journal of*  
7 *Economic Psychology*, 32(5), 865-889.
- 8 Kellner, Christian (2015) “Tournaments as a Response to Ambiguity Aversion in  
9 Incentive Contracts,” *Journal of Economic Theory* 159, 627–655.
- 10 Kelsey, David and Sara le Roux (2017) “Dragon Slaying with Ambiguity: Theory and  
11 Experiments,” *Journal of Public Economic Theory* 19, 178–197.
- 12 Keynes, John Maynard (1921) “*A Treatise on Probability.*” McMillan, London. 2nd  
13 edn. 1948.
- 14 Klibanoff, Peter, Massimo Marinacci, & Sujoy Mukerji (2005) “A Smooth Model of  
15 Decision Making under Ambiguity,” *Econometrica* 73, 1849–1892.
- 16 Knight, Frank H. (1921) “*Risk, Uncertainty, and Profit.*” Houghton Mifflin, New  
17 York.
- 18 Kocher, Martin G., Amrei Marie Lahno, and Stefan T. Trautmann (2018) “Ambiguity  
19 Aversion is not Universal,” *European Economic Review* 101, 268–283.
- 20 Lazzarini, Sergio G., Regina Madalozzo, Rinaldo Artes, and José de Oliveira Siqueira  
21 (2005) “Measuring Trust: An Experiment in Brazil,” *Brazilian Journal of Applied*  
22 *Economics* 9, 153–169.
- 23 Li, Wei (2007) “Changing One’s Mind when the Facts Change: Incentives of Experts  
24 and the Design of Reporting Protocols,” *Review of Economic Studies* 74, 1175–  
25 1194.
- 26 Luce, R. Duncan & Howard Raiffa (1957) “*Games and Decisions.*” Wiley, New  
27 York.
- 28 Maccheroni, Fabio, Massimo Marinacci, & Aldo Rustichini (2006) “Ambiguity  
29 Aversion, Robustness, and the Variational Representation of Preferences,”  
30 *Econometrica* 74, 1447–1498.
- 31 Neri, Claudia (2015) “Eliciting Beliefs in Continuous-Choice Games: A Double  
32 Auction Experiment,” *Experimental Economics* 18, 569–608.

- 1 Nyarko, Yaw and Andrew Schotter (2002) “An Experimental Study of Belief  
2 Learning Using Elicited Beliefs,” *Econometrica* 70, 971–1005.
- 3 Palfrey, Thomas R. and Stephanie W. Wang (2009) “On Eliciting Beliefs in Strategic  
4 Games,” *Journal of Economic Behavior and Organization* 71, 98–109.
- 5 Perea, Andrés (2012) “*Epistemic Game Theory: Reasoning and Choice*.” Cambridge  
6 University Press, New York.
- 7 Perea, Andrés (2014) “Belief in the Opponents’ Future Rationality,” *Games and  
8 Economic Behavior* 83, 231–254.
- 9 Prelec, Drazen (2004) “A Bayesian Truth Serum for Subjective Data,” *Science* 306,  
10 October 2004, 462–466.
- 11 Ross, Lee, David Greene, and Pamela House (1977) “The ‘False Consensus Effect:’  
12 An Egocentric Bias in Social Perception and Attribution Processes,” *Journal of  
13 Experimental Social Psychology* 13, 279–301.
- 14 Rubinstein, Ariel and Yuval Salant (2016) “‘Isn’t Everyone Like Me?’: On the  
15 Presence of Self-Similarity in Strategic Interactions,” *Judgment and Decision  
16 Making* 11, 168–173.
- 17 Rutström, Elisabet E. and Nathaniel T. Wilcox (2009) “Stated Beliefs versus Inferred  
18 Beliefs: A Methodological Inquiry and Experimental Test,” *Games and  
19 Economic Behavior* 67, 616–632.
- 20 Sapienza, Paola, Anna Toldra-Simats, and Luigi Zingales (2013) “Understanding  
21 Trust,” *The Economic Journal* 123, 1313–1332.
- 22 Savage, Leonard J. (1954) “*The Foundations of Statistics*.” Wiley, New York. (2nd  
23 edn. 1972, Dover Publications, New York.)
- 24 Schlag, Karl H., James Tremewan, and Joël J. van der Weele (2015) “A Penny for  
25 Your Thoughts: A Survey of Methods for Eliciting Beliefs,” *Experimental  
26 Economics* 18, 457–490.
- 27 Schmeidler, David (1989) “Subjective Probability and Expected Utility without  
28 Additivity,” *Econometrica* 57, 571–587.
- 29 Schneeweiss, Hans (1973) “The Ellsberg Paradox from the Point of View of Game  
30 Theory,” *Inference and Decision* 1, 65–78.
- 31 Smith, Vernon L. & Bart J. Wilson (2017) “Sentiments, Conduct, and Trust in the  
32 Laboratory,” *Social Philosophy & Policy* 34, 25–55.
- 33 Stauber, Ronald (2011) “Knightian Games and Robustness to Ambiguity,” *Journal of  
34 Economic Theory* 146, 248–274.

- 1 Trautmann, Stefan T. and Gijs van de Kuilen (2015) “Belief Elicitation: A Horse  
2 Race among Truth Serums,” *Economic Journal* 125, 2116–2135.
- 3 Tversky, Amos & Daniel Kahneman (1992) “Advances in Prospect Theory:  
4 Cumulative Representation of Uncertainty,” *Journal of Risk and Uncertainty* 5,  
5 297–323.
- 6 Tversky, Amos & Craig R. Fox (1995) “Weighing Risk and Uncertainty,”  
7 *Psychological Review* 102, 269–283.
- 8 Wakker, Peter P. (2008) “Explaining the Characteristics of the Power (CRRA) Utility  
9 Family,” *Health Economics* 17, 1329–1344.
- 10 Wakker, Peter P. (2017) “Annotated Bibliography.”  
11 <http://personal.eur.nl/wakker/refs/webrfrncs.pdf>  
12