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ORIGINAL PAPER

Trust as a decision under ambiguity

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Abstract

Decisions to trust in strategic situations involve ambiguity (unknown probabilities). Despite many theoretical studies on ambiguity in game theory, empirical studies have lagged behind due to a lack of measurement methods, where separating ambiguity attitudes from beliefs is crucial. Baillon et al. (Econometrica, 2018b) introduced a method that allows for such a separation for individual choice. We extend this method to strategic situations and apply it to the trust game, providing new insights. People's ambiguity attitudes and beliefs both matter for their trust decisions. People who are more ambiguity averse decide to trust less, and people with more optimistic beliefs about others' trustworthiness decide to trust more. However, people who are more a-insensitive (insufficient discrimination between different likelihood levels) are less likely to act upon their beliefs. Our measurement of beliefs, free from contamination by ambiguity attitudes, shows that traditional introspective trust survey measures capture trust in the commonly accepted sense of *belief* in trustworthiness of others. Further, trustworthy people also decide to trust more due to their *beliefs* that others are similar to themselves. This paper shows that applications of ambiguity theories to game theory can bring useful new empirical insights.

Keywords Trust · Ambiguity · Belief measurement · Strategic uncertainty · Insensitivity

JEL Classification C72 · C91 · D81

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1 Introduction

Keynes (1921) and Knight (1921) emphasized the importance of developing models for ambiguity (unknown probabilities). Ambiguity is ubiquitous in economic decisions and in everyday life. Ellsberg (1961) showed that ambiguity models have to be fundamentally different from traditional risk (known probabilities) models. Despite the importance of ambiguity, only at the end of the 1980s people succeeded in developing the first decision models for ambiguity (Gilboa 1987; Gilboa and Schmeidler 1989; Schmeidler 1989). Since then, many fields in economics started catching up with ambiguity, including game theory, the field considered in this paper.

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

Some experimental studies did allow for non-neutral ambiguity attitudes and tested their effects on behavior in games.[4] However, they did not measure ambiguity attitudes directly but rather varied the level of ambiguous information. Inferences from this approach are limited because ambiguity attitudes of subjects are heterogeneous. Furthermore, manipulating levels of ambiguity (e.g., by matching subjects with foreign vs. domestic opponents) produces confounds due to changes in beliefs about opponents' strategy choices. Controlling for beliefs would have been required, but this could not be done properly without also accounting for ambiguity *attitudes*.

A difficulty that has hampered the application of ambiguity theories to natural events, including strategy choices of others, arises from the necessity to control for beliefs when measuring ambiguity. Until recently, it was not known how to do this

[1] Such studies include Angelopoulos and Koutsougeras (2015), Battigalli et al. (2015), Chakravarty and Kelsey (2016), De Marcoa and Romaniello (2015), Grant et al. (2016), Kellner (2015), Kelsey and le Roux (2017), Eichberger and Kelsey (2011) and Stauber (2011), and, for updating, Perea (2014).

[2] See, for instance, Armantier and Treich (2009), Blanco et al. (2010), Costa-Gomes and Weizsäcker (2008), Heinemann et al. (2009), Huck and Weizsäcker (2002), Nagel et al. (2018), Neri (2015), Nyarko and Schotter (2002), Palfrey and Wang (2009), Rutström and Wilcox (2009), Schlag et al. (2015) and Trautmann and van de Kuilen (2015, footnote 16).

[3] This assumption deviates from the rationality judgments by Ellsberg (1961), Gilboa et al. (2010), and others.

[4] Such studies include, besides some papers cited later, Di Mauro and Castro (2011), Eichberger et al. (2008) and Kelsey and le Roux (2017).

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for natural events. This is why ambiguity measurements have so far focused on artificial ambiguity through Ellsberg urns or experimenter-specified probability intervals, where controlling for beliefs is possible using symmetries introduced by the experimental design. Such symmetries are rarely available for natural events, such as those about moves by others in strategic situations. Baillon et al. (2018b) resolved the aforementioned difficulty for individual choice. They introduced an ambiguity measurement method that works for all events without the need for artificial symmetries in beliefs. We show how Baillon et al.'s method can be applied to games. By relating ambiguity attitudes to behavior in games, we thus show, with the specific example of the trust game, how accounting for ambiguity can enrich our understanding of decisions under strategic ambiguity.

2 Trust and ambiguity

Trust has received much interest in economics (Fehr 2009; Johnson and Mislin 2011; Li 2007; Smith and Wilson 2017). In the commonly accepted sense, trust represents people's belief in the trustworthiness of others (Gambetta 2000). In deciding to trust others, however, not only people's beliefs but also their attitudes towards uncertainty matter because usually it is uncertain whether their trust will be reciprocated. Most previous studies focused on how people's risk attitude impacts their trust decisions. No clear relation was found (Eckel and Wilson 2004; Houser et al. 2010). However, we almost never know an objective probability of others being trustworthy, and the decision to trust is usually a decision under ambiguity. It has been well documented in the literature that people treat ambiguity differently than risk (Ellsberg 1961; Trautmann and van de Kuilen 2015). To properly understand people's trust decisions, it is desirable to take their ambiguity attitudes into account. To illustrate, assume we observe two risk neutral persons. Person A decides not to trust whereas person B does. Then it is still possible that A is not less trusting than B, but only more ambiguity averse (see Case 3 in the Appendix). Hence, a control for ambiguity attitude is needed. This paper provides this control. We separate ambiguity attitudes from subjective beliefs and measure beliefs[5] properly also if subjects are not ambiguity neutral.

We can now reveal how ambiguity affects trust decisions. Whereas risk attitudes may be unrelated to trust decisions, ambiguity attitudes play a significant role. They contaminate trusting decisions as predicted by most current ambiguity theories: the decision to trust involves making oneself vulnerable to the trustworthiness of another, which is ambiguous. Hence, the more a person dislikes ambiguity, the less attractive she will find the trusting option. We thus empirically confirm, for the first time controlling all the aforementioned components, that, given same beliefs in trustworthiness of the other, people who are more ambiguity averse decide to trust less.

[5] In this paper, beliefs refer to additive subjective probabilities as under ambiguity neutrality. All deviations from ambiguity neutrality, also if cognitive, are referred to as ambiguity attitude here.

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Corcos et al. (2012) also argued that the trust game involves ambiguity, and found a positive relation between ambiguity aversion and trust decisions. They measured ambiguity aversion in the traditional way using artificial Ellsberg urns.[6] However, ambiguity attitudes towards unknown urns can be different than towards the trustworthiness of others (Tversky and Fox 1995). We will measure ambiguity attitudes directly for trust game events, thus increasing validity. In this respect, our contribution is the analog for ambiguity of what Bohnet and Zeckhauser (2004), Evans and Krueger (2017) and Fairley et al. (2016) did for risk: they measured risk attitudes both for artificial events and for trust game events, and showed that risk attitudes provide better predictors in the latter case.

Apart from aversion, which is a motivational component describing how much a person dislikes ambiguity, ambiguity attitude is characterized by a second, cognitive component called insensitivity. Insensitivity has been found to be an important predictor of behavior in experimental studies of individual choice (Trautmann and van de Kuilen 2015). It describes how much people perceive ambiguity in a given decision situation. The more they do, the more they treat all events alike, as one blur, resulting in lower discriminatory power towards different likelihood levels. As a result, insensitivity reduces a person's tendency to act based on her beliefs. We show that insensitivity also plays a significant role in the trust decision. Although people with more optimistic beliefs about others' trustworthiness decide to trust more, we find that people who have equally optimistic beliefs but are more insensitive decide to trust less often. On the other hand, for people with equally pessimistic beliefs about the other's trustworthiness the more insensitive people decide to trust more often. Thus, we find that ambiguity about the opponent's choice in a strategic game has a two-fold effect on behavior: it makes safe strategies more attractive to averse players, and it makes insensitive players less likely to act based on their beliefs.

Because our techniques allow us to properly measure beliefs, we can further contribute new evidence to a number of open issues in the literature. In particular, we consider the relationship between behavioral and survey measures of trust. We can confirm that introspective survey questions on trust, such as the ones included in the well-known and widely used World Values Survey (WVS) and General Social Survey (GSS), do capture trust in the commonly accepted sense of *belief* in trustworthiness of others. Some authors have suggested that people use their own trustworthiness as a signal, and therefore thrustworthy people are more likely to trust others. We show that this is indeed due to their *beliefs*: they believe others to be similar to themselves. This self-similar reasoning in belief formation may also explain why some previous studies found survey measures of trust—which, as argued before, capture people's beliefs about others—to be related to own trustworthiness (Glaeser et al. 2000). Trustworthiness, as we show, serves as a signal for forming beliefs about others.

[6] Corcos et al. (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 2018).

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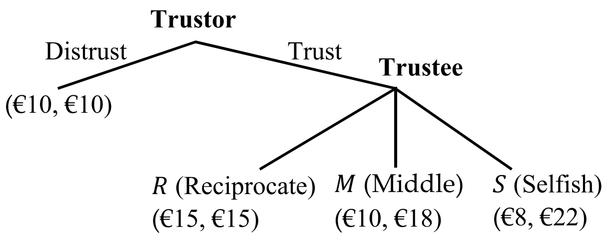

Fig. 1 Trust game

3 Method

Figure 1 shows the trust game used in our study. A trustor faces a binary choice. If she chooses the distrust option, both she and her trustee receive €10 for sure and there is no uncertainty. Alternatively, she can choose the trust option, whose outcome is uncertain. Then the amount she receives depends on the trustee's choice from three allocation options, where the first amount is the payment for the trustor and the second is for the trustee: R (Reciprocate) = (€15, €15), M (Middle) = (€10, €18), and S (selfish) = (€8, €22).

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

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} ($i \neq j$), is the union $E_i \cup E_j$ of two single events. For each event E (E_i or E_{ij}) and for a fixed outcome $X > 0$ ($X =$ €15 in the experiment), X_E0 denotes a—possibly ambiguous—prospect that pays X if event E happens and 0 otherwise. Similarly, X_q0 denotes a risky prospect that pays X with probability q and 0 with probability $1 - q$.

Definition 3.1 The matching probability m ($\mathrm{m_i}$ or $\mathrm{m_{ij}}$) of an event E ($\mathrm{E_i}$ or $\mathrm{E_{ij}}$) is the probability such that the decision maker is indifferent between prospects $\mathrm{X_E0}$ and $\mathrm{X_m0}$.

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 et al. (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. (2018b) added the control for unknown beliefs. We next briefly introduce the two indexes of Baillon et al. (2018b) that we use. Let $\overline{m_s} = (m_r + m_m + m_s)/3$ denote the average single-event matching probability

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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

$$b = 1 - \overline{m_s} - \overline{m_c}. \tag{3.1}$$

Definition 3.3 The a(mbiguity-generated)-insensitivity index is

$$a = 3 \times \left(\frac{1}{3} - \left(\overline{m_c} - \overline{m_s} \right) \right). \tag{3.2}$$

Under ambiguity neutrality, $\overline{m_s} = \frac{1}{3}$ and $\overline{m_c} = \frac{2}{3}$, so that both indexes are 0. The indexes have been normalized to have value 1 as maximum (under a regularity assumption). Note how we could calibrate ambiguity neutrality without knowing beliefs. This is key to this method. For an ambiguity averse person, the matching probabilities are low and accordingly the aversion index is high. She is willing to pay a premium (in winning probability) to avoid ambiguity. A maximally ambiguity averse person has all matching probabilities 0 and the aversion index is 1. For ambiguity seeking subjects, the aversion index is negative.

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

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

Our elicitation method allows for extrapolating a-neutral probabilities p_i. These can be interpreted as the beliefs of an ambiguity neutral twin of the decision maker, who is exactly the same as the decision maker except that she is ambiguity neutral. That is, a-neutral probabilities are additive subjective probabilities that result after correcting for ambiguity attitudes. Online Appendix C shows that, under certain assumptions:

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

The Appendix provides numerical examples to illustrate that ambiguity attitudes can confound measurements of social preferences, and that it is desirable to correct for it.

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We summarize our predictions:

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

4 Experimental design

4.1 Subjects

In total, 182 subjects (56% male) were recruited from the subject pool of the experimental laboratory at Erasmus School of Economics.

4.2 Incentives

The experiment was computer-based[7] and consisted of seven sessions. It was incentivized using a modification of the prior incentive system (Prince; Johnson et al. 2015), avoiding income effects (Blanco et al. 2010). At the beginning of each session (with n subjects), one volunteer was invited to randomly select $n/2$ pairs of sealed envelopes. The experimenter then unpaired the envelopes in the selected pile (by removing the clips holding each pair together). Next each subject would draw one envelope from the pile.

It was explained to each subject that, throughout the experiment, she would be paired with a partner whose subject ID was inside the envelope. During the experiment, she would face different decision situations, where her payments depended on both her own and her partner's decisions. One of these decision situations was inside the envelope, and this was the only one that mattered for the real payment at the end. Each subject earned €5 participation fee, plus the earnings from the decision situation inside her envelope. Including the participation fee, an average subject earned €14.87 in our experiment.

[7] The online appendix presents 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.

The following may be inside your envelope.

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

Option 1: Follow your partner's instruction for payment

Option 2: Pay **€10** to each of you

If you instruct the experimenters to give you Option 1,

your partner's instruction will determine the payments for the two of you. Your partner can instruct the experimenters to give you one of the following three options:
Option A: Pay **€15** to each of you;
Option B: Pay you **€10**, pay him/her **€18**;
Option C: Pay you **€8**, pay him/her **€22**.
So if your partner has instructed to give Option A, you and your partner will get €15 each. If your partner has instructed to give Option B, you will get €10 and your partner €18. Finally, if your partner has instructed to give Option C, you will get €8 and your partner €22.

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).

Fig. 2 Trust game: trustor decision situation

4.3 Stimuli

During the experiment, subjects were confronted with three types of decision situations. They were also asked to answer some demographic and introspective survey questions, which were not incentivized. Each subject first faced the trustor decision of the trust game (Fig. 2). It was explained to her that her own and her partner's choice as a trustee would determine their final payment if this decision situation was in her envelope.

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

An example with an explanation of the typical decision situation was presented to the subjects before they made their decisions. To check whether they understood the procedure, subjects had to answer four questions correctly before they could

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Fig. 3 A typical ambiguity decision situation

proceed.[8] They could also click on a reminder button to view the description of the trust game again.

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

In the third part of the experiment subjects made a decision as the trustee in the same trust game as before. Figure 5 shows the trustee decision situation.

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?".

[8] 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 three times did not affect the findings of this paper.

[9] 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 matters is predetermined 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. When measuring beliefs in game situations, it is especially desirable to ensure that the belief measurements do not distort the game (Heinemann et al. 2009, pp. 189–190).

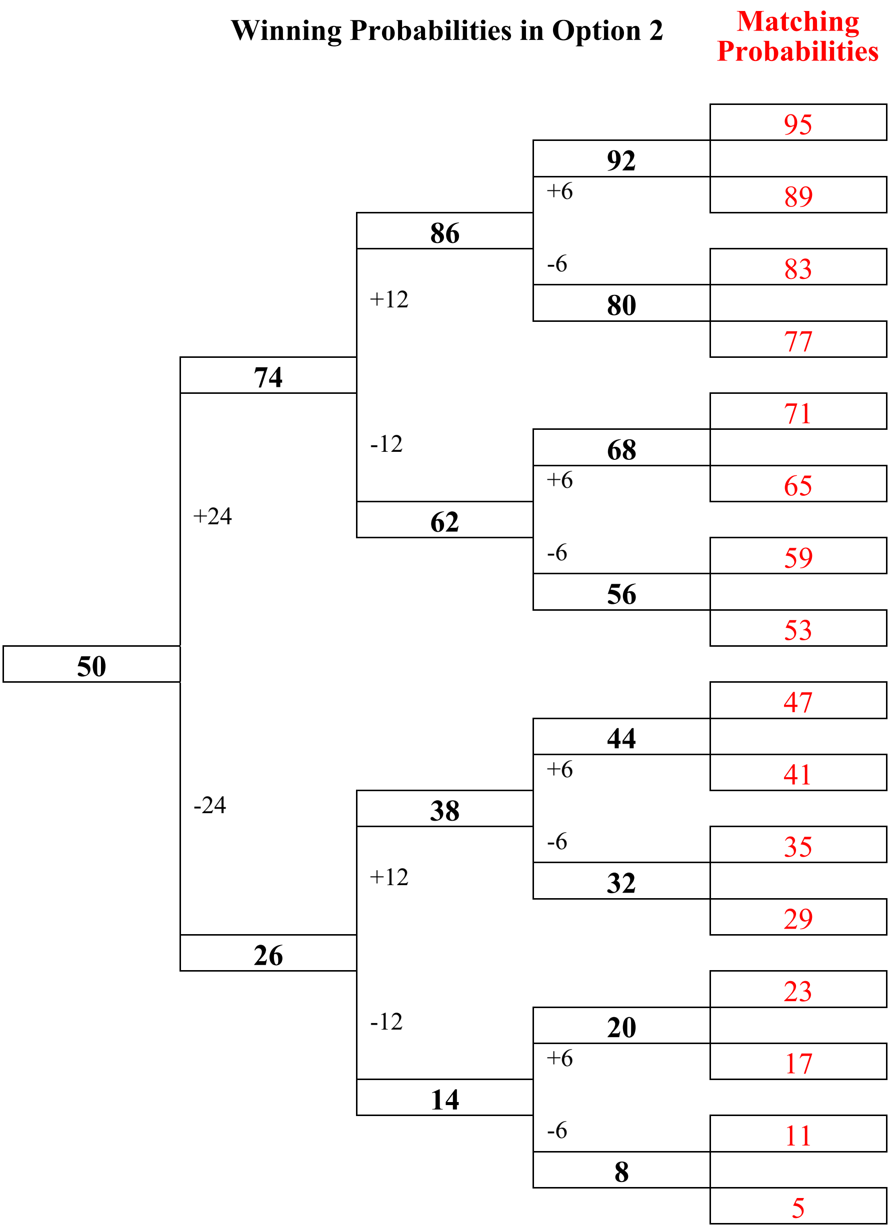

Fig. 4 Determination of probabilities in the bisection method. *Notes* For each event, the winning probability of the first decision situation is always 50%. At each node, if the subject chooses option 1 (2), the probability on the upper (lower) branch is used as the winning probability in option 2 in 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

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The following may be inside your envelope.

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

Option A: Pay **€15** to each of you
Option B: Pay you **€18**, pay your partner **€10**
Option C: Pay you **€22**, pay your partner **€8**

Your partner can instruct the experimenters to give you one of the following two numbered (1 and 2) options:

Option 1: Follow your instruction for payment
Option 2: Pay **€10** to each of you

The experimenters will follow your instruction only if your partner instructed to give you Option 1. If your partner instructed Option 2, then you and your partner will get €10 each, and your instruction will play no role.

Fig. 5 Trust game: trustee decision situation

In each question, subjects could either 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.

4.4 Payment

After all subjects had completed 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 determined her final payment. If the envelope contained a matching probability decision situation that she had encountered during the experiment, her partner's trustee decision determined her final payment if she had chosen the ambiguous option 1. Otherwise, the winning probability of option 2 decided her payment.[10] The same matching probability decision situation was in her partner's envelope, so that her trustee decision determined her partner's final payment if her partner had chosen the ambiguous option 1. It could also happen that the subject had not encountered the matching probability decision situation that was in her envelope. We then inferred the subject's choice in the new situation from her choice in a similar situation by dominance. For instance, suppose the subject had chosen option 1 in the decision situation in Fig. 3, but a decision situation with a winning probability of 26% was in her envelope. Because of the bisection procedure, she could not have encountered

[10] 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.

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Table 1 Summary statistics

	Mean	Median	SD	Min	Max	Interquartile range
Trustor	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]

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

this situation during the experiment. We would then explain to the subject that, since she preferred the ambiguous option 1 to an even better option 2 (with 50% winning chance), we inferred that she would also prefer option 1 in the decision situation where option 2 gives 26% winning chance. We would then implement option 1.

5 Results

5.1 Description of data

Of the 182 participants, we removed 20 (11.0%) who failed monotonicity checks[11] at least twice. Table 1 shows summary statistics. 54% of trustors chose to trust their trustees. Of the trustees, 22% reciprocated the trust by choosing option *R*, 25% chose the middle option *M*, and 53% chose the selfish option *S*. There was substantial heterogeneity in the trustors' ambiguity attitudes and beliefs. The median trustor was ambiguity indifferent ($b = 0$; contrary to prediction 1a), a-insensitive (prediction 1b), and believed that the trustee was equally likely to choose any of the three options. In addition to these variables elicited from subjects' choices, Table 1 also

[11] 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%.

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Table 2 Regression: what contributes to the decision to trust?

	Dependent variable				
	Trustor				
	(1)	(2)	(3)	(4)	(5)
Ambiguity aversion	−2.09**		−2.39**	−2.56**	−2.56**
	(1.04)		(1.18)	(1.17)	(1.27)
A-insensitivity	0.51		0.72	−0.07	−0.34
	(0.68)		(0.74)	(0.79)	(0.86)
$p_r - p_s$		1.96***	2.10***	3.81***	3.90***
		(0.46)	(0.49)	(0.92)	(0.95)
A-insensitivity * ($p_r - p_s$)				−5.96***	−6.34***
				(2.25)	(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

162 subjects remained after removing those who failed monotonicity checks at least twice. Model 2–5 have 161 observations because one subject's matching probabilities for all events were the same so that her a-neutral probabilities were not identifiable

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

describes subjects' responses to the introspective survey questions about general trust, gender, drinking habits, nationality, subjective well-being (happiness), and number of siblings.

We did not find any gender effects and therefore do not report statistics on them. Unsurprisingly, trustees' decisions were not related to their ambiguity aversion ($\rho = 0.3, p = 0.75$) nor to their a-insensitivity ($\rho = 0.08, p = 0.40$). We now turn to trustors.

5.2 Ambiguity attitudes and beliefs as determinants of trust decisions

Table 2 presents binary logistic regressions of our subjects' decisions to trust on their ambiguity attitudes and beliefs. Model 1 includes as explanatory variables the two indexes (aversion and insensitivity) describing subjects' ambiguity attitudes. Model 2 includes a variable that measures subjects' beliefs about their trustees' trustworthiness, ($p_r - p_s$), with higher values corresponding to more optimistic beliefs. Model 3 combines Models 1 and 2. Model 4 adds an interaction between beliefs and a-insensitivity, and Model 5 adds demographic controls.

Because the decision to trust involves choosing an ambiguous prospect over a certain prospect, the more ambiguity averse a trustor is, the less attractive she is expected to find the trusting option. More ambiguity averse subjects indeed decided to trust less often (prediction 2a). Subjects' beliefs also mattered for their decisions to trust. Subjects who were more optimistic about their trustees' trustworthiness were more likely to decide to trust (prediction 3). However, this positive effect of optimistic beliefs on trusting behavior was dampened by subjects' a-insensitivity—the second component of ambiguity attitude (prediction 2b). Subjects who were more insensitive distinguished less between different levels of likelihoods, so that their decisions were less impacted by those differences and their acts were less based on their beliefs. The negative interaction effect between insensitivity and beliefs (in Models 4 and 5) confirms this prediction.

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

5.3 What do introspective survey questions measure?

In the literature on trust, an oft addressed and still unresolved issue concerns the validity of attitudinal survey questions on trust. For instance, experiments by Ashraf et al. (2006), Glaeser et al. (2000) and Lazzarini et al. (2005) found that, instead of measuring people's trust in others, attitudinal survey questions captured people's own trustworthiness. Fehr et al. (2002), however, found that trustworthiness was unrelated to attitudinal trust, and that trusting behavior did in fact correlate with some of the survey questions on trust. In Sapienza et al. (2013), attitudinal trust was related to both trust and trustworthiness behaviors. These authors argued that trust decisions are affected by other-regarding preferences and risk aversion—preference components other than people's belief in the trustworthiness of others—whereas survey questions may mainly capture the belief component. (Fehr et al. 2002 also suggested that attitudinal trust may relate to trust behavior through the belief component.)

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

Table 3 Regression: What is the general trust survey measuring?

	Dependent variable			
	General trust			
	(1)	(2)	(3)	(4)
Trustor	0.11**			
	(0.06)			
Trustee		−0.05		
		(0.04)		
Ambiguity aversion			−0.27	−0.20
			(0.17)	(0.17)
A-insensitivity			0.05	0.09
			(0.12)	(0.12)
$p_r - p_s$			0.15**	0.13**
			(0.07)	(0.06)
Demographic controls	No	No	No	Yes
Observations	161	125	160	160
R^2	0.02	0.01	0.05	0.10

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

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

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

Subjects' responses to the survey questions were positively correlated with their decisions to trust, but had no relation with their decisions as the trustee (trustworthiness behavior).[12] These findings are reflective of the mixed results obtained in previous studies. Models 3 and 4 offer an insight. In our sample, subjects with more optimistic beliefs about their trustees' trustworthiness scored higher in the survey measure of trust, whereas their ambiguity attitudes were unrelated to the scores in the survey measure. These results show that the survey questions about general trust do capture people's beliefs. They also suggest an added reason for why the survey

[12] The same holds if we include the trustee decisions as separate dummy variables in the regression.

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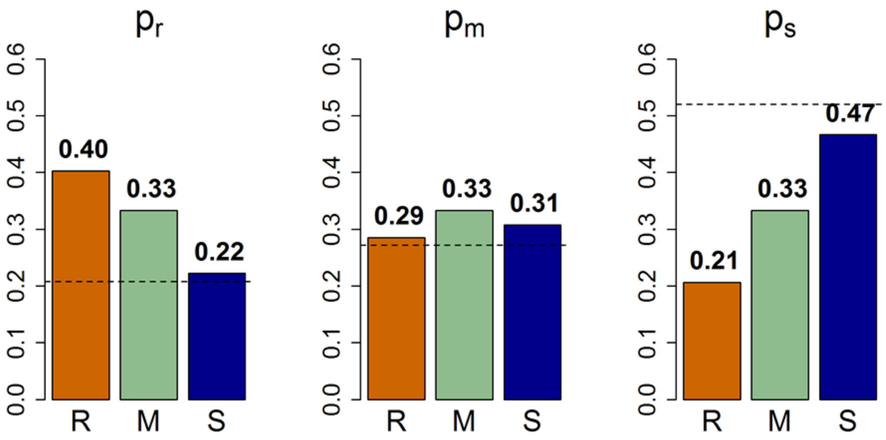

Fig. 6 Belief about partner by own trustworthiness. *Notes* Each panel in Fig. 6 presents the median a-neutral probabilities of an event (*R*, *M*, or *S*) split by subjects' own trustee decisions. The dashed horizontal line indicates the actual frequency

measure of trust may not robustly relate to trusting behavior in the trust game: trusting behavior is affected by people's beliefs and ambiguity attitudes, whereas the survey measure captures beliefs alone and is not distorted by ambiguity attitudes.

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

If survey questions capture beliefs about others' trustworthiness and if beliefs about others are based on own trustworthiness, then it is plausible to expect a correlation between the survey measure and people's own trustworthiness. However, as shown in Table 3 (Model 2) there was no significant relationship between trustworthiness and the survey measure of trust in our sample.

Finally, we note that the self-similar reasoning in belief formation provides insight into previous findings on earnings in trust games, namely, that trusting people lost money on average (Berg et al. 1995; Ashraf et al. 2006). In our sample, the actual frequencies of trustee decisions (21, 27, and 52% choosing option *R*, *M*, and *S*, respectively) were closest to the median beliefs of the most prevalent type: the selfish trustees who chose option *S*. The self-similar reasoning in belief formation would predict this. Applying the same reasoning, the other two types ended up being

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overly optimistic about others' trustworthiness. Because trusting behavior is driven by (overly) optimistic beliefs, trusting subjects lost money on average.

6 Discussion and related literature

We used the indexes of Baillon et al. (2018b) for ambiguity attitude measurements. We briefly discuss features and validity of these indexes here. See Baillon et al. (2018a) for more details. Indexes can never completely capture complex phenomena, and cannot be valid for all theories. For instance, the popular relative risk aversion index $-aU''(a)/U'(a)$ varies with wealth under constant absolute risk aversion, and with probability under prospect theory (Wakker 2008). Baillon et al. (2018a) explain that their ambiguity indexes are valid under all "uni-separable" ambiguity theories. This includes Ghirardato and Marinacci's (2001) biseparable utility and, thus, Gilboa and Schmeidler's (1989) maxmin expected utility, Gilboa's (1987) and Schmeidler's (1989) Choquet expected utility, Tversky and Kahneman's (1992) prospect theory for gains (as in our case), and α-maxmin utility (Ghirardato et al. 2004; Luce and Raiffa 1957, Sect. 13.5). Non-biseparable theories include Einhorn and Hogarth (1985). Baillon et al.'s indexes agree with, and thus unify and generalize (e.g., by not assuming expected utility for risk) many indexes proposed in papers before, including those of Dow and Werlang (1992) and Schmeidler (1989) for Choquet expected utility, Abdellaoui et al. (2011) and Dimmock et al. (2016) for prospect theory, Ghirardato et al. (2004) and Luce and Raiffa (1957, Sect. 13.5) for α-maxmin expected utility, and Dimmock et al. (2015) and Epstein and Schneider (2010) for ε-contamination multiple priors. Baillon et al. (2018a) also showed that, whereas the aversion index could be estimated from two matching probabilities, we need six for the insensitivity index.

The aforementioned theories have in common that ambiguity attitudes are modeled through event dependence; i.e., functions operating on events. The utility function of outcomes is assumed invariant across different contexts. This assumption underlies the use of matching probabilities.[13] Another kind of ambiguity theories capture ambiguity attitudes through functions on outcomes, Klibanoff et al.'s (2005) smooth model being the most popular one. Under these theories, our indexes become outcome dependent, in the same way as the relative index of risk aversion can be wealth or probability dependent. Outcome dependence is, indeed, characteristic of such theories. It also holds for more general theories including Gul and Pesendorfer (2015) and Maccheroni et al. (2006).

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

[13] For specialists: this is implied by Savage's (1954) P4 axiom.

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Many theoretical studies, and some empirical studies (see introduction), recently incorporated ambiguity into game theory. We are aware of two studies that measured aversion towards strategic ambiguity (Camerer and Karjalainen 1994; Ivanov 2011). However, these studies did not use ambiguity attitudes to predict strategic behavior, but, conversely, devised special games with the purpose of deriving ambiguity attitudes from strategic behavior. They did not derive beliefs from revealed preferences, but Ivanov (2011) controled for beliefs by deriving them from introspection. Both studies only considered ambiguity aversion, and not insensitivity. Our measurements of ambiguity attitudes, carried out in trust games, can be used in all game situations, are independent from the actual behavior in the games so that they can be used to predict game behavior, are entirely revealed preference based, and also consider insensitivity. It is not surprising that prediction 1a (ambiguity averson) was not confirmed. Many recent studies found that ambiguity aversion is less prevalent than thought a decade ago; see Kocher et al. (2018) and their references.

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

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

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

Our finding that optimistic beliefs about others' trustworthiness (after correcting for ambiguity attitudes) increase trust decisions is similar to the findings of Ashraf et al. (2006) and Sapienza et al. (2013). They used a variation of Berg et al. (1995) investment game, in which trustors could choose which part of their endowment to send to their trustee. The amount sent to the trustee would then be tripled, and the trustee decided how much of the amount received to send back to the trustor. To elicit subjects' beliefs about their trustees' trustworthiness, they asked subjects to estimate the amount their trustee would return. They found a positive correlation between subjects' estimations of the amount returned and the amount that subjects sent.

Our measure of belief is directly expressed in terms of probabilities rather than indirectly through a point estimate of a money amount, and is directly derived from revealed preferences with incentivization. Sapienza et al. (2013) rewarded accurate estimates of average amounts that would be sent back by trustees, but their implementation was not fully incentive compatible. First, because minimal distances between the estimates and the actual amounts sent were rewarded, subjects did not have the incentive to truthfully reveal extreme expectations. Second, because subjects were rewarded for accurate estimates for each possible amount sent and sent back, hedging through strategic (and not truthful) guesses was possible.

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

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

Interestingly, the aforementioned result indicates that prevalence of own type may determine the accuracy of beliefs about others in strategic interactions and, hence, it may also determine the earning of players acting on those beliefs. In our sample, the beliefs of the most prevalent type—the non-trustworthy one—are indeed closest to the actual distribution of trustworthiness. Previous findings that, on average, trusting

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people lost money (Berg et al. 1995; Ashraf et al. 2006) may be explained by the trustworthy types not being prevalent in the samples considered.

7 Conclusion

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

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

Appendix: Numerical illustration

This appendix illustrates numerically how ignoring ambiguity attitudes can lead to wrong conclusions about social preferences in the trust game. To focus on ambiguity and simplify the analysis, we assume that both players maximize expected utility for risk. Many social preference models have been used to analyze the trust game and to justify non-selfish choices by the trustee (Cox et al. 2007; Galizzi and Navarro-Martínez 2017; Smith and Wilson 2017). Because of its simplicity, we use Fehr and Schmidt's (1999) inequity aversion model. The trustee is affected by inequality aversion, so that she may, for instance, prefer (15, 15) to (10, 18). She is also affected by guilt, inducing an extra dislike of outcomes for the trustor below 10 that cause the trustor to suffer from having trusted. Depending on the strength of these effects, she

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may prefer either of R, M, or S, and the trustor is uncertain about this.[14] We focus on the trustor's decision in what follows. We assume that the trustor likes to gamble as much on R, M, and S, so that these events have the same matching probability. If the trustor is ambiguity neutral, maximizing expected utility, then the subjective probabilities of these events are 1/3, and so are their matching probabilities and decision weights. Her utility function is

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

with a her aversion to being richer and b her aversion to being poorer.[15] In this game, a is irrelevant because the trustor is always poorer. We assume $a=0$. We first present four cases and then discuss them.

Case 1 [no aversion to inequality and ambiguity neutrality]. The trustor is ambiguity 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 chosen.

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

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

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14 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.

15 We assume that the trustor, unlike the trustee, does not perceive any guilt in outcome 8.

16 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 if, for instance, the set of priors is the following set of probability vectors: $\left\{ \lambda_1(1,0,0) + \lambda_2(0,1,0) + \lambda_3(0,0,1) + \lambda_4\left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right) : \lambda_j \geq 0 \forall j; \lambda_4 = 1 - \lambda_1 - \lambda_2 - \lambda_3 \geq \frac{1}{2} \right\}$, where the maxmin expected utility results from $\lambda_3 = \frac{1}{2} = \lambda_4$. This is the special case of α-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 Kahnneman'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 $\frac{1}{2}$.

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Case 4 [aversion to inequality and a-insensitivity]. Here $b = 0.15$. The trustor perceives ambiguity. Now, because of ambiguity, she reckons more with deviations in both directions (favorable and unfavorable), rather than only with unfavorable directions as in Case 2. It is like increasing variance rather than decreasing expectation. She assigns extra weight 0.25 to the favorable *R*, extra weight 0.25 to the unfavorable *S*, and only weight 0.50 to the expected utility of Case 2.[17] The utility of trust is $0.25 \times 5.9 + 0.25 \times 15 + 0.50 \times 9.9 = 10.18 > 10$. Trust is chosen.

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

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[17] 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 α-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.

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