Trust as a Decision under Ambiguity

Chen Li, Erasmus School of Economics, Erasmus University Rotterdam, 3000 DR, the Netherlands

Uyanga Turmunkh, Erb Institute for Sustainable Enterprise, University of Michigan, Ann Arbor, USA

Peter p. Wakker, (corresp. author), Erasmus School of Economics, Erasmus University Rotterdam, 3000 DR, the Netherlands, 31.10.408.12.65 (O), 31.10.408.91.62 (F), wakker@ese.eur.nl; orcid:0000-0002-2936-5498

October 2017

Decisions to trust usually involve ambiguity (unknown probabilities). For a long time, ambiguity attitudes could be measured only for artificial events (Ellsberg urns or pre-specified probability intervals), and not for natural events such as opponents' strategy choices. Hence, studies have so far focused on how risk attitudes impact trust decisions, finding no relations. Recently, a method was introduced of measuring ambiguity attitudes for natural events in individual choice. We apply this method to (trust) games, finding that ambiguity attitudes, unlike risk attitudes, do play a role. Not only the often discussed ambiguity aversion, but also insensitivity, matters. We can now correct for confounding effects of ambiguity when studying other factors. For instance, whereas measurements of beliefs in experimental games as yet invariably assumed the empirically violated ambiguity neutrality, we can now properly measure beliefs. Preference data can now reveal that introspective survey measures capture trust in the commonly accepted sense of *belief* in trustworthiness of others. Trustworthy people are more trusting due to their *beliefs* that others are similar to themselves. This paper has demonstrated that ambiguity theory can be usefully applied empirically to game theory.

Key words: trust; ambiguity; belief measurement; strategic uncertainty; insensitivity
JEL-codes: C72, C91, D81

1 INTRODUCTION

Keynes (1921) and Knight (1921) emphasized the importance of developing models for ambiguity (unknown probabilities). Ambiguity is ubiquitous in economic decisions and everyday life. Ellsberg (1961) proved that ambiguity models indeed have to be fundamentally different from traditional risk (known probabilities) models. Despite the importance of ambiguity, it was not until the end of the 1980s that 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. Although traditional game theory invariably assumed that all uncertainties can be expressed in terms of Bayesian probabilities (e.g., Crawford, Costa-Gomes, and Iriberri 2013), in reality the Bayesian principles are violated and people are usually ambiguity averse. With the increased awareness in economics of the importance of ambiguity, 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 are available yet.[2] Even if one assumes that using such probabilities is rational[3], then still this assumption does not hold empirically.

---

[1] These 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.

[2] 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).

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

Some experimental studies have allowed for non-neutral ambiguity attitudes, and tested their effects on behavior in games.[4] However, in these studies the role of ambiguity is explored not by measuring ambiguity attitudes directly, but rather, by varying the level of ambiguity faced by players across treatments. Inference that can be drawn from this approach is unfortunately limited if ambiguity attitudes of subjects are heterogeneous. Furthermore, treatment differences aimed at manipulating levels of ambiguity about the opponent (e.g., matching subjects with foreign vs. domestic opponents in a game or matching subjects with a game theorist vs. a grandmother) are likely to produce confounds with changing beliefs about opponents' strategy choices, necessitating a control for beliefs, which cannot 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. It had been unknown how to do this for natural events. This is why ambiguity measurements have so far focused on artificial ambiguity using Ellsberg urns or experimenter-specified probability intervals, where control of beliefs is possible using symmetries introduced by the experimental design. Such symmetries are virtually never available for natural events, including moves of others in strategic situations. Baillon et al. (2016) resolved the aforementioned difficulty for individual choice. They introduced an ambiguity measurement method that works for all events without the need of artificial symmetries in beliefs. We show how Baillon et al.'s (2016) 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.

Trust received much interest in economics (Fehr 2009; Johnson and Mislin 2011; Li 2007; for an early review, see Camerer 2003 chapter 2). In the commonly accepted sense, trust represents people's belief in trustworthiness of others (Gambetta 2000). In deciding to trust others, however, not only people's beliefs but also their attitudes towards ambiguity matter because usually it is not certain whether their trust will be reciprocated. Previous studies focused on how people's risk attitude impacts their

---

[4] These include Di Mauro and Finocchiaro Castro (2011), Eichberger, Kelsey, and Schipper (2008), and Kelsey and le Roux (2017).

trust decisions, but found no clear relation (Eckel and Wilson 2004; Houser, Schunk, and Winter 2010). However, we almost never know an objective probability of others being trustworthy, and the decision to trust usually is 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 reckon with their ambiguity attitudes. To illustrate, assume that we observe that person A decides not to trust whereas B does, where both are risk neutral. Then it is still possible that A is just more ambiguity averse and not less trusting. Hence, a control for ambiguity attitude is needed. We provide this control. In particular, we are able to separate ambiguity attitudes from subjective beliefs and measure beliefs properly also if subjects are not ambiguity neutral.

Using our techniques, we can reveal how ambiguity affects trust. Whereas risk attitudes may be unrelated to trust decisions, ambiguity attitudes play a significant role. They contaminate trusting decisions indeed as would be predicted by ambiguity theories: because the decision to trust involves making oneself vulnerable to the trustworthiness of another, which is ambiguous, the more a person dislikes ambiguity the less attractive she will find the trusting option. Thus, we empirically confirm that given same beliefs in trustworthiness of the other, the more ambiguity averse people are less trusting, for the first time controling all these components.

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 works to reduce a person's tendency to act in accordance with her beliefs. We show that insensitivity also plays a significant role in the trust decision. Although more optimistic beliefs about the other's trustworthiness lead to more trusting, we find that for people with equally optimistic beliefs the more insensitive people are less trusting. On the other hand, for people with equally pessimistic beliefs about the other's trustworthiness the more insensitive people are more trusting. Thus, we find that ambiguity about the opponent's choice in a strategic game has a two-fold effect on behavior. Ambiguity makes safe strategies more attractive to (averse) players, and it makes (insensitive) players less likely to act in accordance with their beliefs.

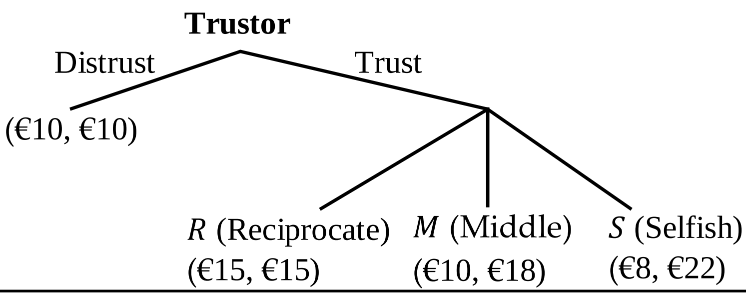
Because our techniques allow us to properly measure beliefs, we can also contribute new evidence to a number of open issues in the literature. In particular, we consider the relationship between survey and behavioral measures of trust. We can confirm that introspective survey questions on trust, such 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. We further show that these survey measures of trust are not related to ambiguity attitudes. Thus, the influence of ambiguity attitudes on trust decisions, shown in our main findings, may be a reason for why behavioral and survey measures of trust do not robustly correlate with each other. Some authors have suggested that people use their own trustworthiness as a signal, and therefore are more likely to trust others. We show that this is indeed due to their *beliefs*: they believe others to be similar to themselves, and this is a genuine instance of false consensus. 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. This, as we show, serves as a signal for forming beliefs about others.

2 METHOD

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

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) to choose from. 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 as to be able to observe ambiguity-generated insensitivity (defined later), for which at least three events are needed (Baillon et al. 2016).

FIGURE 1. Trust game



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 2.1. 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. (2016) added the control for beliefs. We next briefly introduce the two indexes of Baillon et al. (2016) 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 2.2. The a*mbiguity aversion index* is

$$b = 1 - \overline{m_s} - \overline{m_c}. \tag{2.1}$$

DEFINITION 2.3. The a*(mbiguity-generated)-insensitivity index* is

$$a = 3 \times \left(\frac{1}{3} - (\overline{m_c} - \overline{m_s})\right). \tag{2.2}$$

Under ambiguity neutrality, $\overline{m_s} = \frac{1}{3}$ and $\overline{m_c} = \frac{2}{3}$, so that both indexes are 0. Note how we could calibrate this without knowing beliefs. This is key to our method. For an ambiguity averse person the matching probabilities are low and the aversion index accordingly 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 captures 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. The index also captures cognitive discriminatory power. Baillon et al. (2016) showed that our indexes provide a common generalization of many existing ambiguity indexes in the literature, proposed under various ambiguity theories.[5]

[5] Papers with such proposals include Schmeidler (1989) and Dow and Werlang (1992) for Choquet expected utility, Abdellaoui et al. (2011) and Dimmock, Kouwenberg, and Wakker (2016) for prospect theory, and Dimmock et al. (2015) and Epstein and Schneider (2010) for multiple priors.

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. Baillon et al. (2016) showed that, under certain assumptions:

$$p_i = \frac{3(\overline{m_c} - \overline{m_s}) + 3m_i - 3m_{jk} + 2(1-a)}{6(1-a)}, \text{ where } \{i, j, k\} = \{r, m, s\}. \quad (2.3)$$

3 EXPERIMENTAL DESIGN

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

Incentives. The experiment was computer-based[6] 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. Then the envelopes in the selected pile were un-paired by the experimenter (by removing the clips holding each pair together). Each subject would then 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.

---

[6] Instructions and the online experiment can be found at http://www.peterwakker.com/trustnew/begin.php. For testing, use as a subject ID any 4-digit number starting with the digit 6 (e.g. 6067).

FIGURE 2. Trust game: trustor decision situation

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).

Stimuli. During the experiment, subjects encountered three types of decision situations. Subjects, further, answered some demographic and introspective survey questions, which were not incentivized. Each subject first faced the trustor decision of the trust game (Figure 2). It was explained to her that her own and her partner's choice as a trustee would be used to determine their final payment if this decision situation came out of 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 might 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. Subjects had to answer four questions checking their understanding correctly before they could proceed. Subjects 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 Figure 3. If she chose option 1, in the next decision situation the winning probability in option 2 increased; 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.[7] Figure 4 shows how the probabilities for later decision situations and ultimately the event's matching probability were determined given 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 6 blocks. The blocks appeared in a random order, and between two consecutive blocks, a demographic question[8] was asked to refresh subjects' thinking mode. The demographic questions also appeared in a random order.

FIGURE 3. A typical ambiguity decision situation

The following may be inside your envelope.

You can instruct the experimenters to give you one of the following two options:

Option 1: Pay you **€15** if your partner chose option **A**, pay **€0** otherwise

Option 2: Pay you **€15** with **50%** chance, pay **€0** otherwise

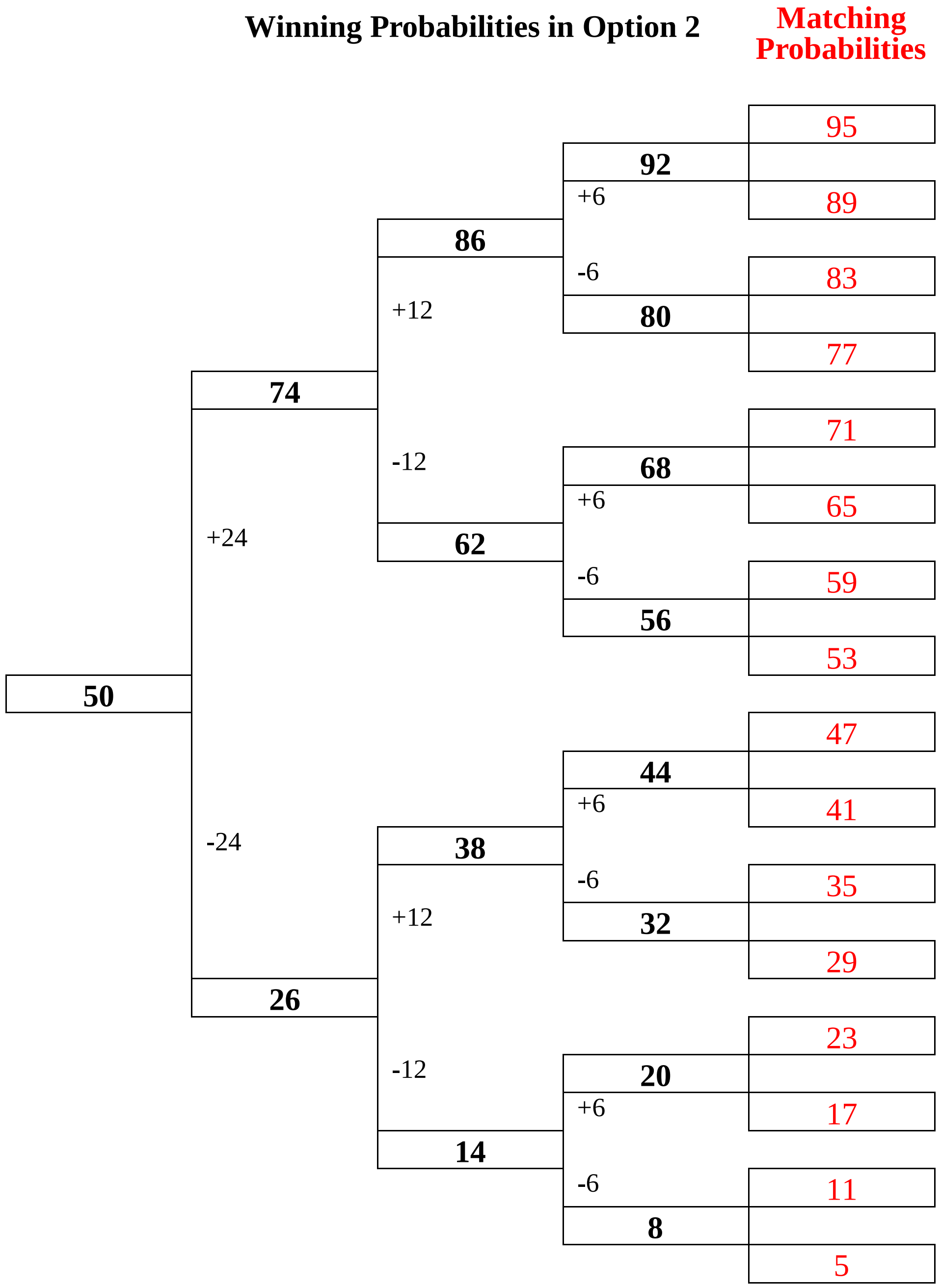
Click to see the reminder of the options for your partner .

---

[7] 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.

[8] 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.

Following the matching probability decision situations, 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.

FIGURE 5. Trust game: trustee decision situation

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.

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 trust 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 probability decision situation that she had encountered during the experiment, her partner's trustee decision determined her final payment had she chosen the ambiguous option 1. Otherwise, the winning probability of option 2 decided her payment.[9] It could also happen that the subject had not encountered the matching probability decision situation that came out of her envelope. In case this happened, we 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 Figure 3, but a decision situation with a winning probability of 26% came out of her envelope. Because of the bisection procedure, she could not have encountered 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 in the decision situation where option 2 gives 26% winning chance, she would also prefer option 1. We would then implement option 1.

4 RESULTS

4.1 Description of data

Of the 182 participants, we removed 20 (11.0%) who failed monotonicity checks[10] 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 trustors' ambiguity attitudes and beliefs. The median trustor was ambiguity neutral, a-insensitive, 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 describes subjects' responses to the introspective survey questions about general trust, gender, number of siblings, nationality, subjective well-being, and drinking habits.

[9] 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.

[10] 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%.

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]

NOTES: trusted = 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.

4.2 Ambiguity attitudes and beliefs as determinants of trust

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 the less attractive she is expected to find the trusting option. More ambiguity averse subjects were indeed less trusting. Subjects’ beliefs also mattered for their decisions to trust. Subjects who were more optimistic about their trustees’ trustworthiness were more likely to trust. However, this positive effect of optimistic beliefs on trusting behavior was dampened by subjects' a-insensitivity—the second component of ambiguity attitude. The more insensitive a decision maker, the less she distinguishes between different levels of likelihoods, the less her decisions are impacted by those differences, and the less she acts in accordance with her beliefs. The negative interaction effect between insensitivity and beliefs (in Models 4 and 5) confirms these predictions.

The regression results in Table 3 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 8 percentage point decrease in the subject's predicted probability of trusting. As beliefs became more optimistic (one standard deviation increase in $p_r - p_s$), subjects' (insensitivity index value 0) probability of trusting increased by 26 percentage points. But for subjects with 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 trusting—22 and 15 percentage point increases, respectively.

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

	Dependent variable:				
	trusted				
	(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

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

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

4.3 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 Glaeser et al. (2000), Lazzarini et al. (2005), and Ashraf, Bohnet and Piankov (2006) found that, instead of measuring people's trust in others, attitudinal survey questions captured people's own trustworthiness. Fehr et al. (2003), however, found trustworthiness to be unrelated to attitudinal trust and that trusting behavior did in fact correlate with some of the survey questions on trust. In the study by Sapienza, Toldra-Simats, and Zingales (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 capture mainly the belief component (Fehr et al. 2003 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 (perception) attitudes toward ambiguity. We've thus shown an additional preference-based component affecting trusting behavior. Below, we show further that, while people's decisions in the trust game are affected by both their beliefs and their ambiguity attitudes, their trust survey responses are positively correlated with their beliefs only, and not with their ambiguity aversion or insensitivity. Thus, we can provide evidence confirming that survey questions on trust are measuring trust in the commonly accepted sense of belief in others' trustworthiness, expressed for instance 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."

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. In all regressions the dependent variable is 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 their trusting behavior. In Model 3 we include as explanatory variables subjects' ambiguity attitudes and beliefs, which were found to determine trusting behavior. Model 4 adds our demographic controls to Model 3.

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

	Dependent variable:			
	general trust			
	(1)	(2)	(3)	(4)
trusted	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

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

NOTES: 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.

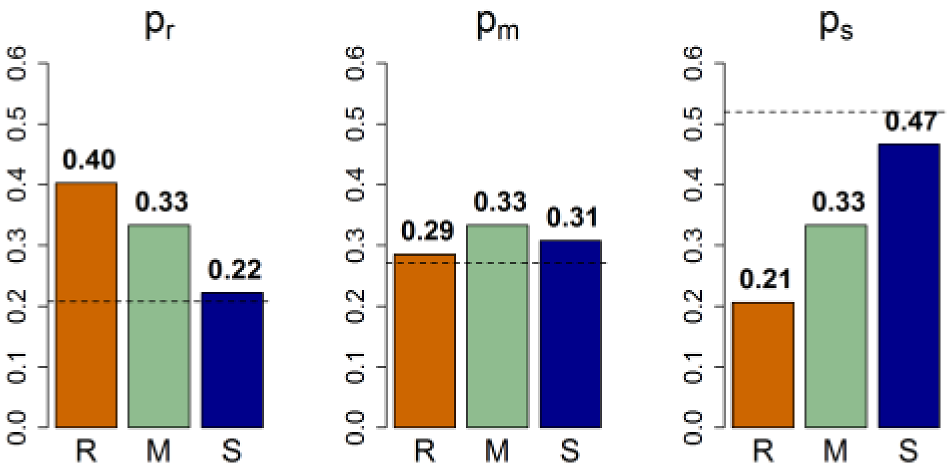
Subjects' responses to the survey questions were positively correlated with their decisions to trust, but had no relation with their decisions as the trustee (trustworthiness behavior).[11] These findings are reflective of the mixed results obtained in previous studies. Models 3 and 4 offer an insight. In our sample, subjects with more optimistic beliefs about their trustees' trustworthiness scored higher in the

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

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 measure of trust may not robustly relate to trusting behavior in the trust game: trusting behavior is affected by people's ambiguity attitudes in addition to their beliefs, 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 answers to survey questions on trust in others and their own trustworthiness behavior. People often form their beliefs about others based on their own types (Ross, Greene, and House 1977; Rubinstein and Salant 2016). They expect others to be similar to themselves. Consistent with this self-similar reasoning in belief formation, we find our subjects' beliefs in the trustworthiness of others to be strongly correlated with their own trustworthiness (Figure 7). Subjects who in the role of a trustee chose the reciprocating option R 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 not for option M.

FIGURE 7. Belief about partner by own trustworthiness



NOTES: Each panel in Figure 7 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.

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

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, Dickhaut, and McCabe 1995; Ashraf, Bohnet and Piankov 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. The other two types, by applying the same reasoning, ended up being overly optimistic about others' trustworthiness. Because trusting behavior is driven by (overly) optimistic beliefs, trusting subjects lost money on average.

5 DISCUSSION AND RELATED LITERATURE

Many theoretical studies recently incorporated ambiguity into game theory, and some empirical studies did (see introduction). 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.

Studies on decisions to trust have so far focused on relations between risk attitudes. Fehr (2009) reviewed the existing literature on trust 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 (Eckel and Wilson 2004; Ashraf, Bohnet, and Piankov 2006; Houser, Schunk, and Winter 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 show 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.

The ambiguity attitudes measured in this paper reflect differences between unknown probabilities and known probabilities and, thus, reflect a component conceptually distinct from risk attitude. Yet these two components may be related empirically and interact in their impact on trust decisions. Measuring both subjects’ risk attitudes and their ambiguity attitudes and then studying such interactions is a topic for future research.

Our methodology allows for separating preference-based ambiguity attitudes from the belief component. This opens up the possibility in future research for understanding whether differences in attitudes or beliefs drive observed trust differences, e.g., concerning culture, social groups, or gender. Studies of gender differences in trust and trustworthiness find that women tend to be more trustworthy but not more trusting than men.[12] Given the difference in trustworthiness, the self-similar reasoning in belief formation would suggest that women's beliefs ought to be more optimistic than men's. So why are women not more trusting than men? Social groups (Etang, Fielding, and Knowles 2011; Ferschtman and Gneezy 2001) and culture (Doney, Cannon, and Mullen 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 beliefs.

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

Our finding that optimistic beliefs about others' trustworthiness (after correcting for ambiguity attitudes) increase trust is similar to the findings of Ashraf, Bohnet and Piankov (2006) and Sapienza, Toldra-Simats, and Zingales (2013). They used a variation of Berg, Dickhaut, and McCabe's (1995) investment game, in which trustors could choose the 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 total 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, Toldra-Simats, and Zingales

---

[12] See Croson and Buchan (1999), Eckel and Grossman (1998), Andreoni and Vesterlund (2001), Zak, Kurzban, and Matzner (2004), Chaudhuri and Gangadharan (2007), Buchan, Croson, and Solnick (2008), and Ben-Ner and Halldorsson (2010). For a review, see Croson and Gneezy (2009).

(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 could also provide 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 could 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, Greene, and House 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 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 would be correlated with their beliefs about others.

Interestingly, the aforementioned result indicates that prevalence of own type may determine accuracy of beliefs about others in strategic interactions and, hence, also 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 trusting people lost money on average (Berg, Dickhaut, and McCabe 1995; Ashraf, Bohnet and Piankov 2006) may be explained by the trustworthy types not being the prevalent type in the particular experimental samples.

6 CONCLUSION

Studies on decisions to trust have so far focused on relations between 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 (2016) new method to games. Thus, we could analyze (and correct for) ambiguity attitudes. In particular, we could correct belief measurements (e.g. of 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 the way to reckon with ambiguity attitudes when studying human behavior in strategic situations, and the desirability to do so.

REFERENCES

Abdellaoui, Mohammed, Aurélien Baillon, Laetitia Placido, and Peter P. Wakker (2011) "The Rich Domain of Uncertainty: Source Functions and Their Experimental Implementation," *American Economic Review* 101, 695–723.

Andreoni, James and Lise Vesterlund (2001) "Which is the Fair Sex? Gender Differences in Altruism," *Quarterly Journal of Economics* 116, 293–312.

Angelopoulos, Angelos and Leonidas C. Koutsougeras (2015) "Value Allocation under Ambiguity," *Economic Theory* 59, 147–167.

Armantier, Olivier and Nicolas Treich (2009) "Subjective Probabilities in Games: An Application to the Overbidding Puzzle," *International Economic Review* 50, 1013–1041.

Ashraf, Nava, Iris Bohnet, and Nikita Piankov (2006). "Decomposing Trust and Trustworthiness," *Experimental Economics* 9, no. 3: 193-208.

Baillon, Aurélien, Zhenxing Huang, Asli Selim, and Peter P. Wakker (2016) "Measuring Ambiguity Attitudes for All (Natural) Events," working paper.

Battigalli, Pierpaolo, Simone Cerreia-Vioglio, Fabio Maccheroni, and Massimo Marinacci (2015) "Self-Confirming Equilibrium and Model Uncertainty," *American Economic Review* 105, 646–677.

Ben-Ner, Avner and Freyr Halldorsson (2010) "Trusting and Trustworthiness: What are They, How to Measure Them, and What Affects Them," *Journal of Economic Psychology* 31, 64–79.

Berg, Joyce, John Dickhaut, and Kevin McCabe (1995) "Trust, Reciprocity, and Social History," *Games and Economic Behavior* 10, 122–142.

Blanco, Mariana, Dirk Engelmann, Alexander K. Koch, and Hans-Theo Normann (2010) "Belief Elicitation in Experiments: Is there a Hedging Problem?," *Experimental Economics* 13, 412–438.

Bohnet, Iris and Richard Zeckhauser (2004) "Trust, Risk and Betrayal," *Journal of Economic Behavior and Organization* 55, 467–484.

Bohnet, Iris, Fiona Greig, Benedikt Herrmann, and Richard Zeckhauser (2008) "Betrayal Aversion: Evidence from Brazil, China, Oman, Switzerland, Turkey, and the United States," *American Economic Review* 98, 294–310.

Bornhorst, Fabian, Andrea Ichino, Oliver Kirchkamp, Karl H. Schlag, and Eyal Winter (2010) “Similarities and Differences when Building Trust: The Role of Cultures,” *Experimental Economics* 13, 260–283.

Buchan, Nancy R., Rachel Croson, and Sara J. Solnick (2008) “Trust and Gender: An Examination of Behavior and Beliefs in the Investment Game,” *Jounal of Economic Behavior and Organization* 68, 466–476.

Camerer, Colin F. (2003) “*Behavioral Game Theory: Experiments in Strategic Interaction* (Roundtable Series in Behaviorial Economics).” Princeton University Press, Princeton, NJ.

Camerer, Colin F. and Risto Karjalainen (1994) “Ambiguity-Aversion and Non-Additive Beliefs in Non-Cooperative Games: Experimental Evidence,” *Models and Experiments in Risk and Rationality*, Springer, Netherlands, 325–358.

Chakravarty, Surajeet and David Kelsey (2016) “Ambiguity and Accident Law,” *Journal of Public Economic Theory* 18 doi:10.1111/jpet.12160.

Chaudhuri, Ananish and Lata Gangadharan (2007) “An Experimental Analysis of Trust and Trustworthiness,” *Southern Economic Journal* 73, 959–985.

Costa-Gomes, Miguel and Georg Weizsäcker (2008) “Stated Beliefs and Play in Normal-Form Games,” *Review of Economic Studies* 75, 729–762.

Crawford, Vincent P., Miguel Costa-Gomes, and Nagore Iriberri (2013) “Structural Models of Nonequilibrium Strategic Thinking: Theory, Evidence, and Applications,” *Journal of Economic Literature* 51, 5–62.

Croson, Rachel and Nancy R. Buchan (1999) “Gender and Culture: International Experimental Evidence from Trust Games,” *American Economic Review* 89, 386–391.

Croson, Rachel and Uri Gneezy (2009) “Gender Differences in Preferences,” *Journal of Economic Literature* 47, 448–474.

Dawes, Robyn M. (1990) “False Consensus Effect,” *Insights in Decision Making: A Tribute to Hillel J. Einhorn*, University of Chicago Press, Illinois, 179–199.

De Marcoa, Giuseppe and Maria Romaniello (2015) “Variational Preferences and Equilibria in Games under Ambiguous Belief Correspondences,” *International Journal of Approximate Reasoning* 60, 8–22.

Di Mauro, Carmela and Massimo Finocchiaro Castro (2011) “Kindness, Confusion, or … Ambiguity?,” *Experimental Economics* 14, 611–633.

Dimmock, Stephen G., Roy Kouwenberg, Olivia S. Mitchell, and Kim Peijnenburg (2015) "Estimating Ambiguity Preferences and Perceptions in Multiple Prior Models: Evidence from the Field," *Journal of Risk and Uncertainty* 51, 219–244.

Dimmock, Stephen G., Roy Kouwenberg, and Peter P. Wakker (2016) "Ambiguity Attitudes in a Large Representative Sample," *Management Science* 62, 1363–1380.

Doney, Patricia M., Joseph P. Cannon, and Michael R. Mullen (1998) "Understanding the Influence of National Culture on the Development of Trust," *Academy of Management Review* 23, 601–620.

Dow, James and Sérgio R.C. Werlang (1992) "Uncertainty Aversion, Risk Aversion and the Optimal Choice of Portfolio," *Econometrica* 60, 197–204.

Eckel, Catherine C. and Philip J. Grossman (1998) "Are Women less Selfish than Men?: Evidence from Dictator Experiments," *Economic Journal* 108, 726–735.

Eckel, Catherine C. and Rick K. Wilson (2004) "Is Trust a Risky Decision?," *Journal of Economic Behavior and Organization* 55, 447–465.

Eichberger, Jürgen and David Kelsey (2011) "Are the Treasures of Game Theory Ambiguous?," *Economic Theory* 48, 313–393.

Eichberger, Jürgen, David Kelsey, and Burkhard C. Schipper (2008) "Granny versus Game Theorist: Ambiguity in Experimental Games," *Theory and Decision* 64, 333–362.

Ellsberg, Daniel (1961) "Risk, Ambiguity and the Savage Axioms," *Quarterly Journal of Economics* 75, 643–669.

Epstein, Larry G. and Martin Schneider (2010) "Ambiguity and Asset Markets," *Annual Review of Financial Economics* 2, 315–346.

Etang, Alvin, David Fielding, and Stephen Knowles (2011) "Does Trust Extend beyond the Village? Experimental Trust and Social Distance in Cameroon," *Experimental Economics* 14, 15–35.

Fehr, Ernst (2009) "On the Economics and Biology of Trust," *Journal of the European Economic Association* 7, 235–266.

Fehr, Ernst, Urs Fischbacher, Bernhard von Rosenbladt, Jürgen Schupp, and Gert G. Wagner (2003) "A Nation-Wide Laboratory: Examining Trust and Trustworthiness by Integrating Behavioral Experiments into Representative Survey," working paper.

Ferschtman, Chaim and Uri Gneezy (2001) “Discrimination in a Segmented Society: An Experimental Approach,” *Quarterly Journal of Economics* 116, 351–377.

Gambetta, Diego (2000) “Can We Trust Trust,” *Trust: Making and Breaking Cooperative Relations*, electronic edition, University of Oxford, 213–237.

Gilboa, Itzhak (1987) “Expected Utility with Purely Subjective Non-Additive Probabilities,” *Journal of Mathematical Economics* 16, 65–88.

Gilboa, Itzhak, Fabio Maccheroni, Massimo Marinacci, and David Schmeidler (2010) “Objective and Subjective Rationality in a Multiple Prior Model,” *Econometrica* 78, 755–770.

Gilboa, Itzhak and David Schmeidler (1989) “Maxmin Expected Utility with a Non-Unique Prior,” *Journal of Mathematical Economics* 18, 141–153.

Glaeser, Edward L., David I. Laibson, Jose A. Scheinkman, and Christine L. Soutter (2000) “Measuring Trust,” *Quarterly Journal of Economics* 115, 811–846.

Grant, Simon, Idione Meneghel, and Rabee Tourky (2016) “Savage Games,” *Theoretical Economics* 11, 641–682.

Heinemann, Frank, Rosemarie Nagel, and Peter Ockenfels (2009) “Measuring Strategic Uncertainty in Coordination Games,” *Review of Economic Studies* 76, 181–221.

Houser, Daniel, Daniel Schunk, and Joachim Winter (2010) “Distinguishing Trust from Risk: An Anatomy of the Investment Game,” *Journal of Economic Behavior and Organization* 74, 72–81.

Huck, Steffen and Georg Weizsäcker (2002) “Do Players Correctly Estimate What Others Do? Evidence of Conservatism in Beliefs,” *Journal of Economic Behavior and Organization* 47, 71–85.

Ivanov, Asen (2011) “Attitudes to Ambiguity in One-Shot Normal-Form Games: An Experimental Study,” *Games and Economic Behavior* 71, 366–394.

Johnson, Cathleen, Aurélien Baillon, Han Bleichrodt, Zhihua Li, Dennie van Dolder, and Peter P. Wakker (2015) “Prince: An Improved Method for Measuring Incentivized Preferences,” working paper.

Johnson, N. D., and Mislin, A.A. (2011). Trust games: A meta-analysis. *Journal of Economic Psychology, 32*(5), 865-889.

Kellner, Christian (2015) “Tournaments as a Response to Ambiguity Aversion in Incentive Contracts,” *Journal of Economic Theory* 159, 627–655.

Kelsey, David and Sara le Roux (2017) “Dragon Slaying with Ambiguity: Theory and Experiments,” *Journal of Public Economic Theory* 19, 178–197.

Keynes, John Maynard (1921) “*A Treatise on Probability.”* McMillan, London. 2nd edn. 1948.

Knight, Frank H. (1921) “*Risk, Uncertainty, and Profit.”* Houghton Mifflin, New York.

Lazzarini, Sergio G., Regina Madalozzo, Rinaldo Artes, and José de Oliveira Siqueira (2005) “Measuring Trust: An Experiment in Brazil,” *Brazilian Journal of Applied Economics* 9, 153–169.

Li, Wei (2007) “Changing One’s Mind when the Facts Change: Incentives of Experts and the Design of Reporting Protocols,” *Review of Economic Studies* 74, 1175–1194.

Neri, Claudia (2015) “Eliciting Beliefs in Continuous-Choice Games: A Double Auction Experiment,” *Experimental Economics* 18, 569–608.

Nyarko, Yaw and Andrew Schotter (2002) “An Experimental Study of Belief Learning Using Elicited Beliefs,” *Econometrica* 70, 971–1005.

Palfrey, Thomas R. and Stephanie W. Wang (2009) “On Eliciting Beliefs in Strategic Games,” *Journal of Economic Behavior and Organization* 71, 98–109.

Perea, Andrés (2012) “*Epistemic Game Theory: Reasoning and Choice*.” Cambridge University Press, New York.

Perea, Andrés (2014) “Belief in the Opponents’ Future Rationality,” *Games and Economic Behavior* 83, 231–254.

Prelec, Drazen (2004) “A Bayesian Truth Serum for Subjective Data,” *Science* 306, October 2004, 462–466.

Ross, Lee, David Greene, and Pamela House (1977) “The ‘False Consensus Effect:’ An Egocentric Bias in Social Perception and Attribution Processes,” *Journal of Experimental Social Psychology* 13, 279–301.

Rubinstein, Ariel and Yuval Salant (2016) “ “Isn't Everyone Like Me?”: On the Presence of Self-Similarity in Strategic Interactions,” *Judgment and Decision Making* 11, 168–173.

Rutström, Elisabet E. and Nathaniel T. Wilcox (2009) “Stated Beliefs versus Inferred Beliefs: A Methodological Inquiry and Experimental Test,” *Games and Economic Behavior* 67, 616–632.

Sapienza, Paola, Anna Toldra-Simats, and Luigi Zingales (2013) “Understanding Trust,” *The Economic Journal* 123, 1313–1332.

Schlag, Karl H., James Tremewan, and Joël J. van der Weele (2015) “A Penny for Your Thoughts: A Survey of Methods for Eliciting Beliefs,” *Experimental Economics* 18, 457–490.

Schmeidler, David (1989) “Subjective Probability and Expected Utility without Additivity,” *Econometrica* 57, 571–587.

Stauber, Ronald (2011) “Knightian Games and Robustness to Ambiguity,” *Journal of Economic Theory* 146, 248–274.

Trautmann, Stefan T. and Gijs van de Kuilen (2015) “Belief Elicitation: A Horse Race among Truth Serums,” *Economic Journal* 125, 2116–2135.

Zak, Paul J., Robert Kurzban, & William T. Matzner (2004) “The Neurobiology of Trust,” *Annals of the New York Academy of Sciences* 102, 224–227.