Test of Order Effects in Ambiguity Attitude Measurement

Christian König-Kersting and Stefan T. Trautmann
University of Heidelberg

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Within-person measurement of ambiguity attitudes

Experimental measurements of ambiguity attitude suggest a fourfold pattern of attitudes, with ambiguity aversion found for moderate/high likelihood gains and low likelihood losses, and ambiguity seeking (closer to neutrality) being observed for low likelihood gains and moderate/high likelihood losses (e.g., Trautmann and van de Kuilen, 2015, for a review). While many studies have employed a between-subjects design across these domains (likelihood range × outcome range), the pattern has typically been interpreted as a within-person variation of attitudes depending on the domain of the prospects. A full description of an individual person's preferences for ambiguous prospects therefore requires the elicitation of attitudes in multiple domains.

Measuring attitudes within-subjects involves the sequential observation of multiple decisions in the different domains of interest. Because of this structure, earlier decisions may potentially affect subsequent ones by establishing anchors, contrasting parameterizations or by tempting participants to differentiate their choices in an effort to meet presumed experimenter demands. If such cross-task influences affect the elicited preferences, they do not represent the decision maker's true attitudes. If the true attitudes are required as an input to decision analyses or to the prediction of economic behaviors, they may consequently perform poorly, leading to wrong decisions or low predictive power.

A test of order effects in the domain of gains

To inform about the role of order effects in multi-domain ambiguity attitude measurements, we provide here the results of a measurement of ambiguity attitude in the domain of gains, for low and for moderate likelihood events. The data regards the baseline ("for-self") condition of an experiment on for-self vs. for-others decision making under ambiguity, reported in König-

Kersting and Trautmann (2016). In this condition, in which individuals make decisions for their own account (as in most Ellsberg urn experiments), one half of the participants first take the decision in the moderate likelihood and subsequently in the low likelihood setting. The other half takes the decisions in opposite order, i.e. they first encounter the low likelihood condition followed by the moderate-likelihood one. Data from this counterbalanced experimental setting allows us to test for the occurrence of order effects in the elicitation of ambiguity attitudes in the Ellsberg paradigm. In particular, it allows us to assess whether the gain part of the fourfold pattern is robust to order effects. In the absence of order effects, the data allow us to identify different types of participants and their relative prevalence in the population studied.

A detailed description of the experiment and lab details is given in König-Kersting and Trautmann (2016). Here we focus on the main aspects only. In each task (moderate vs. low likelihood task), participants are asked to choose between betting on the color drawn from an ambiguous bag and betting on the color drawn from a risky bag, for a prize of €10. Participants are fully informed about the number of chips in each bag and the distribution of winning and losing chips in the risky one. In contrast, participants do not know the distribution of chips in the ambiguous bag. In the moderate likelihood task the bags are filled with chips of two different colors while in the low likelihood task the bags are filled with chips of ten different colors. In each the two tasks, participants make a total of seven decisions between a risky option and the ambiguous option. These seven decisions differ in the composition of the risky urn, implementing the risky winning probabilities of .5, .35, .65, .40, .60, .45, and .55 in the 2-color task, and .10, .01, .19, .04, .16, .07, .13 in the 10-color task. Decisions were presented in the given order (thus starting with the ambiguity-neutral risky probability) on separate screens. That is, choice-list effects cannot influence the decisions in our task, although within-task order effects may be present for decisions 2 to 7. Decisions were incentivized using the random lottery incentive method: one of the two tasks was randomly selected at the end of the experiment for all subjects in the sessions. Subsequently, for each participant separately one of the seven decisions from this task was randomly selected and paid according to the participant's choices and the random draw of a color form the chosen bag.[1]

Initial choices in each task provide a simple measure of ambiguity attitude. Moreover, participants' multiple choices at various known winning probabilities of the risky prospect

[1] Note that participants could choose the color they wanted to bet on in the ambiguous option.

allow calculating individual *probability equivalents* for the ambiguous prospect as a more fine grained measure of ambiguity attitudes (details are given in König-Kersting and Trautmann, 2016). We present results for both the binary choices in the initial decisions, and for probability equivalents.

Results: Attitudes and Order Effects

The upper panel of Table 1 shows percentages of participants choosing the ambiguous option in the initial decision item in the moderate and low likelihood tasks. Columns FIRST and SECOND restrict the analysis to participants who played the respective tasks first or second in the experiment. Column POOLED provides results for the aggregated data. For the moderate likelihood task we find ambiguity aversion across the board. Starting with a tendency in FIRST, the attitude is highly significant in SECOND and with pooled observations. In the low likelihood task, we find behavior consistent with ambiguity seeking. While the attitude does not reach significance in FIRST, it becomes significant and highly significant in analyses SECOND and POOLED. There are no significant differences in the number of risky and ambiguous choices between tasks being played first or second (2-color task, p=0.693; 10-color task, p=0.714; Fischer's exact tests, two-sided).

Table 1: Ambiguous Choices in First Decision Item and Probability Equivalents

	FIRST (N=19)[a]		SECOND (N=19)[a]		POOLED	
Binary choice percentages						
Moderate likelihood (2-color task)	26.3%	AA*	15.8%	AA***	21.1%	AA***
Low likelihood (10-color task)	68.4%	AS^{ns}	78.9%	AS**	73.7%	AS***
Median probability equivalents (means in parentheses)						
Moderate likelihood (2-color task)	0.475 (0.442)	AA**	0.475 (0.44)	AA***	0.475 (0.441)	AA***
Low likelihood (10-color task)	0.115 (0.112)	AS**	0.115 (0.117)	AS**	0.115 (0.115)	AS***

Notes: Choice entries give % of ambiguous prospect chosen; Binary choice: two-sided binomial test against $p = 0.5$; Probability equivalents: Wilcoxon-test against 0.5 / 0.1; *, **, *** denotes significance at 10%, 5%, 1%. Direction of effect: AA = ambiguity averse; AS = ambiguity seeking. a: Because of non-monotonicity in the seven choices, probability equivalents could not be calculated for all participants (see König-Kersting and Trautmann, 2016, for details).

The lower panel of Table 1 shows probability equivalents. As in the analysis of the binary choice decisions, we again find significant ambiguity aversion in the moderate likelihood task as well as significant ambiguity seeking in the low likelihood task. The directions of effects hold irrespective of pooling observations or analyzing the two distinct orders separately. In neither task is there a statistically significant difference between probability equivalents depending on the task order in the experiment (2-color task, $p=0.845$; 10-color task, $p=0.782$; Mann-Whitney tests).

Overall, the gain part of the fourfold pattern for ambiguity emerges clearly in both binary choice and probability equivalents. There is no indication of an order effect. The pattern shows strongly in both task orders of the within-person design. While statistical null effects should always be interpreted with caution in low-powered lab experiments, the absence of any qualitative differences between orders is obvious from the results presented in Table 1. Moreover, we are able to statistically confirm the expected, typical preference patterns for moderate and high likelihoods, showing that power is large enough to identify relevant behavioral effects.

Results: Types of Decision Makers

Having established the absence of order effects, we now turn to the classification of different types of decision makers using the within-person data. Table 2 presents absolute and relative frequencies of ambiguity averse and seeking choices in the low and moderate likelihood tasks based on the respective first binary decision items. *Ambiguity avoiders* choose the risky option in both likelihood ranges. This group constitutes 24% of our sample. In contrast, *ambiguity seekers*, who constitute 18% of the sample, always choose the ambiguous option independently of likelihood range considered. Quite clearly, there is no general attitude towards ambiguous prospects independent of the likelihood range considered. The largest group (55% of our participants) consists of participants behaving consistently with ambiguity seeking if a low likelihood prospect is considered and with ambiguity aversion if a moderate likelihood prospect is considered. This type thus reveals the gain part of the fourfold pattern at the individual level. Only one participant is characterized by ambiguity aversion for low likelihoods but ambiguity seeking for moderate likelihoods. The difference in frequencies between the latter two types is highly significant ($p < 0.01$, McNemar's test), lending support

to the interpretation of choices as a deliberate reaction to the different likelihood ranges encountered, rather than noisy random choice.

Table 2: Within-Person Ambiguity Attitudes

	Moderate likelihood					
	seeking		averse		total	
Low likelihood						
seeking	7	18%	21	55%	28	74%
averse	1	3%	9	24%	10	26%
total	8	21%	30	79%	38	100%

Notes: Categorization based on initial binary choice item; all observations pooled; participants choosing the ambiguous (risky) prospect are ambiguity seeking (averse); percentages are based on total number of observations.

References

König-Kersting, C., and Trautmann, S. T. (2016). Ambiguity Attitudes in Decisions for Others. *Economics Letters* 146, 126-129.

Trautmann, S. T., and G. van de Kuilen (2015). Ambiguity Attitudes. In: G. Keren and G. Wu (eds.), *The Wiley Blackwell Handbook of Judgment and Decision Making*, Blackwell, Chapter 3, 89-116.