Economics Letters 120 (2013) 40–44

Contents lists available at SciVerse ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Which decision theory?

Pavlo Blavatskyy *

Gramart strasse 153, 6020 Innsbruck, Austria

HIGHLIGHTS

- A new laboratory study to identify the best descriptive decision theories.
- We use a representative sample of binary choice problems.
- We use a lottery set with a small number of outcomes and probabilities.
- We find that a simple heuristic, rank-dependent utility and expected utility theory provide the best goodness of fit.

ARTICLE INFO

Article history:
Received 22 October 2012
Received in revised form
11 March 2013
Accepted 22 March 2013
Available online 28 March 2013

JEL classification:
D81

Keywords:
Decision theory
Risk
Expected utility theory
Rank-dependent utility
Heuristic

ABSTRACT

A new laboratory experiment is designed to identify the best theories for describing decisions under risk. The experimental design has two noteworthy features: a representative sample of binary choice problems (for fair comparison across theories) and a lottery set with a small number of outcomes and probabilities (for ease of non-parametric estimation). We find that a simple heuristic, rank-dependent utility and expected utility theory provide the best goodness of fit.

1. Introduction

The aim of this paper is to identify descriptive decision theories that provide the best goodness of fit to experimental data. This experimental study has two noteworthy features. First, we use a representative sample of binary choice problems (*i.e.*, experimental questions are not selected by an experimenter). A design where an experimenter selects choice problems might not be optimal for comparing different decision theories. A decision theory may fit better for certain types of choice problems and over- or under-representation of these problems leads to over- or under-estimation of the theory's goodness of fit. Second, we use a set of lotteries with a small number of outcomes and probabilities. This allows us to estimate all decision theories without any parametric assumptions.

The paper is organized as follows. Section 2 describes the design and implementation of our experiment. Section 3 summarizes ten decision theories considered in this paper. Section 4 presents our econometric model of discrete choice based on a latent dependent variable. Section 5 outlines our estimation procedure. Section 6 summarizes the results.

2. Experiment

We designed our experiment to facilitate non-parametric estimation of various theories. Specifically, all risky alternatives used in the experiment have a small number of outcomes and probabilities. We restrict risky alternatives to have no more than four possible outcomes. These four outcomes are €5, €20, €25 and €40. Using only probability values 0, 0.25, 0.5, 0.75 and 1, it is possible to construct 23 distinct probability distributions over these outcomes. Using only these 23 lotteries, it is possible to construct a total of 140 binary choice problems where none of the alternatives stochastically dominates the other.[1]

The experiment was conducted as a paper-and-pencil classroom experiment. Subjects received a booklet with 140 decision

[1] In fact, a power test shows that for all model comparisons considered in this paper it is sufficient to use only 86 binary choice problems for the false negative rate (probability of a Type II error) 0.2.

* Tel.: +380 322 96 29 84; fax: +380 322 96 29 84.
E-mail address: pavlo.blavatskyy@uibk.ac.at.

0165-1765/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.econlet.2013.03.039

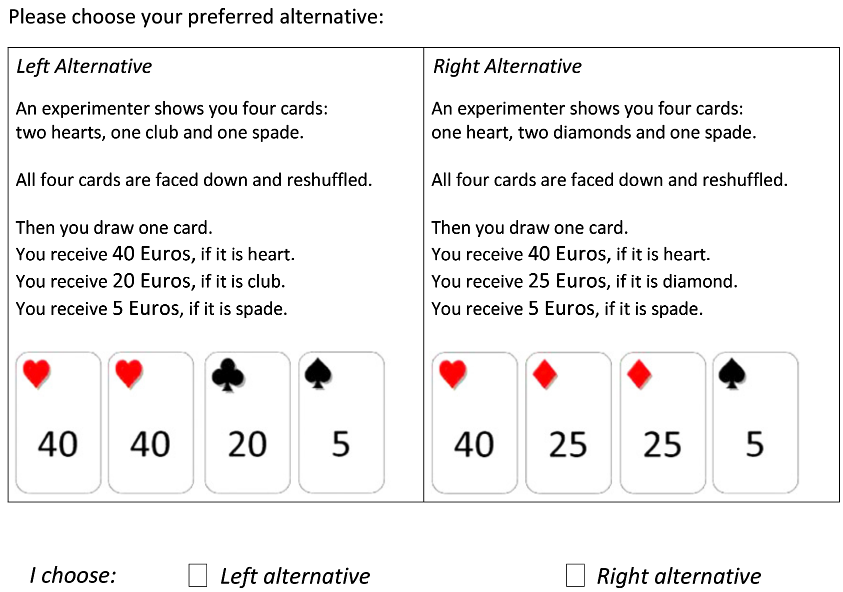

Fig. 1. An example of a decision problem as displayed in the experiment.

problems. Each problem was printed on a separate page. For each subject, pages with 140 problems were rearranged in a random order. Probability information was explained through the distribution of standard playing cards. Fig. 1 shows an example of one decision problem as it was displayed in the experiment.

The experiment was conducted in the University of Innsbruck. Altogether, 38 undergraduate students took part in two experimental sessions, which were conducted on the same afternoon. Twenty out of 38 subjects (52.6%) were female. The average age of experimental participants was 21.5 years (minimum age was 18, maximum age was 34). Fourteen out of 38 subjects (36.8%) were economics majors. All subjects had no previous experience with economic experiments.

Subjects were allowed to go through experimental questions at their own pace with no time restriction. After answering all 140 questions, each subject was asked to spin a roulette wheel. The number of sectors on the roulette wheel corresponded to the total number of questions asked in the experiment. The question randomly selected on the roulette wheel was played out for real money.

Subjects who opted for a sure monetary payoff in the selected question simply received this amount in cash. Subjects who opted for a lottery were shown the corresponding composition of playing cards. The cards were subsequently reshuffled and subjects had to draw one card. Depending on the suit of their drawn card, they received the corresponding payoff. Upon observing the suit of their drawn card, subjects inspected all remaining cards to verify that card composition did not change after reshuffling.

Each experimental session lasted about 1.5 h. About one third of this time was spent on using physical randomization devices at the end of the experiment. On average, subjects earned €25. Two subjects earned €5, 19 subjects earned €20, 8 subjects earned €25 and 9 subjects earned €40.

3. Decision theories

Let $X = \{€5, €20, €25, €40\}$ denote the set of possible outcomes and let $Q = \{0, 0.25, 0.5, 0.75, 1\}$ denote the set of probability values. Let $L : X \to Q$ denote a typical lottery used in the experiment, *i.e.*, $L(x) \in Q$ for all $x \in X$ and $\Sigma_{x\in X} L(x) = 1$. For any lottery L, the cumulative distribution function $F_L(x)$ is defined as $F_L(x) = \Sigma_{y\in X, x\geq y} L(y)$, for all $x \in X$. Similarly, the decumulative distribution function $G_L(x)$ of lottery L is defined as $G_L(x) = \Sigma_{y\in X, y\geq x} L(y)$, for all $x \in X$.

$$U(L) = \begin{cases} \dfrac{[L(€20)\cdot u(€20) + L(€25)\cdot u(€25)]\cdot(1+\beta) + L(€40)}{1+\beta\cdot[L(€5)+L(€20)+L(€25)]}, \\ \quad \text{if } 0 \leq U(L) \leq u(€20) \\ \dfrac{L(€20)\cdot u(€20)\cdot(1+\beta) + L(€25)\cdot u(€25) + L(€40)}{1+\beta\cdot[L(€5)+L(€20)]}, \\ \quad \text{if } u(€20) \leq U(L) \leq u(€25) \\ \dfrac{L(€20)\cdot u(€20) + L(€25)\cdot u(€25) + L(€40)}{1+\beta\cdot L(€5)}, \\ \quad \text{if } u(€25) \leq U(L) \leq 1. \end{cases} \quad (1)$$

For each subject we estimated 9 decision theories that are presented in Table 1. We also consider the possibility of decisions to be driven by some simple heuristic. At least two observations point in this direction. First, despite a large number of questions, subjects cope with the experiment very quickly. Typically, they need about 30 s for each decision. Only fast and frugal heuristics can result in such speedy decision making.

Second, the best fitting parameters of EUT and RDU reveal that quite a few subjects behave as if maximizing an extremely risk averse utility function $u(€5) = 0$ and $u(€20) = u(€25) = u(€40) = 1$. These subjects apparently minimize the probability of the lowest outcome. This is the second step in the priority heuristic (Brandstätter et al., 2006). Yet, the priority heuristic itself cannot be estimated on our dataset (the priority heuristic is inconclusive in a decision problem depicted on Fig. 1). In the context of our experiment, it is very easy (*i.e.*, with little cognitive effort) to apply the following simple rule of thumb (abbreviated as H):

(a) pick a lottery with a smaller probability of the lowest outcome €5;
(b) if two lotteries yield the lowest outcome €5 with the same probability, then pick a lottery with the highest probability of the greatest outcome €40.

Note that there is no concept of utility value in H (as it is typical in the psychological literature on heuristics). There are no subjective parameters to be estimated in H. H is not nested in any other decision theory.

4. Econometric model of discrete choice

Each of 140 decision problems used in the experiment is a binary choice between two lotteries L and R. Existing literature