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Small stakes risk aversion in the laboratory: A reconsideration

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HIGHLIGHTS

- Prior laboratory experiments provide evidence of low stakes risk aversion (RA).
- Certain assumptions applied to the data imply implausible levels of high stakes RA.
- We conduct an experiment to directly test one of these assumptions.
- The assumption is rejected for a large sample from a population of college students.
- Implausible predictions of large stakes RA do not hold for this population.

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ABSTRACT

Evidence of risk aversion in laboratory settings over small stakes leads to *a priori* implausible levels of risk aversion over large stakes under certain assumptions. One core assumption in statements of this calibration puzzle is that small-stakes risk aversion is observed over all levels of wealth, or over a "sufficiently large" range of wealth. Although this assumption is viewed as self-evident from the vast experimental literature showing risk aversion over laboratory stakes, it actually requires that lab wealth be varied for a given subject as one evaluates the risk attitudes of the subject. We consider evidence from a simple design that tests this assumption, and find that the assumption is strikingly *rejected* for a large sample of subjects from a population of college students. We conclude that the implausible predictions that flow from these assumptions do not apply to one specialized population widely used to study economic behavior in laboratory experiments.

1. Introduction

Debate surrounding theories of decisions under risk and uncertainty has renewed interest in the arguments of the utility function over event outcomes. The local measure of risk aversion proposed by Arrow (1971) and Pratt (1964) for expected utility theory (EUT) is based on terminal wealth being the argument. However, there is nothing in the axiomatic foundation of EUT that requires one to use terminal wealth as the argument: Vickrey (1945) used income instead of terminal wealth; von Neumann and Morganstern (1953, p. 15–31) were agnostic; and Luce and Raiffa (1957, ch.2) discussed alternatives such as scalar amounts of terminal wealth or income or, alternatively, vectors of commodities. Arrow (1964), Debreu (1959, ch.7) and Hirshleifer (1966) developed models in which the arguments of utility functions are vectors of contingent commodities.

The choice of arguments of the utility function can have important consequences for the inferences one can plausibly draw from empirical estimates of risk attitudes. Many economics experiments present participants with gambles over relatively small stakes and find that such gambles are frequently turned down in favor of less risky gambles with smaller expected values. If the argument of the utility function is terminal wealth, then some patterns of small stakes risk aversion have implausible implications for preferences over gambles where the stakes are no longer small. One example

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from Rabin (2000) is that the expected utility of terminal wealth model implies that an agent who turns down a 50/50 bet of losing \$100 or gaining \$110, at all initial wealth levels between \$100 and \$300,000, will also, at initial wealth of \$290,000, turn down a 50/50 bet with possible loss of \$2000 even when the gain is as large as \$12 million. Although primarily used as an argument against EUT, it is now well-known that this logic applies to a much wider range of models that assume the argument of the utility function to be terminal wealth (Cox and Sadiraj, 2006; Safra and Segal, 2008). Hence the methodological implications run much deeper than whether EUT is a useful descriptive model of behavior.

Given the importance of understanding the arguments of the utility function, the absence of empirical tests is remarkable. We focus squarely on the specific and influential claim that evidence of small stakes risk aversion in the laboratory generates implausible risk aversion implications for any model in which terminal wealth is the argument of the utility function.[1] We refer to this claim as the HRC, for "Hansson–Rabin calibration," acknowledging Hansson (1988) and Rabin (2000). We build on a simple theoretical test and experimental design originally developed by Cox and Sadiraj (2008), and independently later by Wilcox (2013); our design follows theirs. Although this design has wider implications, we focus on implications for calibration puzzles defined over terminal wealth models, which are the models that initiated the modern debate.

We present direct evidence that *the empirical premiss underlying the HRC claim is false for the typical subjects of laboratory experiments*: students in a first-world university.[2] These subjects exhibit risk aversion for small stakes lotteries for the initial terminal wealth that they bring to the lab, but as we increase the terminal wealth of the subjects they exhibit risk neutrality. We make no claim that this finding generalizes to other populations, fully expect that it could vary from population to population, and encourage tests with different populations.[3]

We review the theoretical statement of the usual calibration puzzle in Section 2, using the simple example from Hansson (1988) since it is not widely known and illustrates the basic points. The generalization by Rabin (2000) can then be quickly stated. Our experimental design is presented in Section 3, and follows Cox and Sadiraj (2008). We evaluate the resulting empirical evidence from 28 binary choices times 590 student subjects in Section 4.

2. Theory

What if an individual always rejects a 50:50 lottery offering x and x+\$3 in favor of x+\$1 for certain? Without loss of essential generality, assume indifference, so that $u(x+1) = \frac{1}{2}\,u(x) + \frac{1}{2}\,u(x+3)$. One solution to this equation is the utility function $u(x) = 1 - a^x$ for $a \approx 0.618$. It is useful in the sequel to note that this is a bounded function, since $u(x) \to 1$ as $x \to \infty$. Now consider increments in utility from x:

$$u(x+1) - u(x) \approx 0.382a^x \quad (1)$$

$$u(x+\infty) - u(x) = 1 - (1 - a^x) = a^x. \quad (2)$$

If (1) and (2) are true, then we can construct "trick lotteries" that make this decision maker look silly. For instance, the decision maker must prefer a certain gain of 1 to a $0 < p < 0.382$ chance of an arbitrarily large gain $X \gg x$. For instance, $p = 1/4$, since $1/4a^x < 0.382a^x$, and $X = \$1$ million.

More general conditions for this implausible prediction are now established. If the utility function is bounded on $(0, \infty)$ then that is a sufficient condition for implausible risk aversion in large stakes (e.g., Cox and Sadiraj, 2008; Proposition 2, p.20). Indeed, the only empirical example offered by Rabin (2000) uses a bounded CARA function. On the other hand, small-stakes risk aversion over a *large enough finite* interval is a sufficient condition for implausible risk aversion for large stakes, whether or not the utility function is bounded.

The HRC puzzle may be stated in terms of four propositions:

- P $\models$ "the agent is a risk averse EUT maximizer"
- Q $\models$ "EUT implies full asset integration"
- R $\models$ "the agent turns down small-stakes gambles in favor of a certain amount with a slightly lower expected value, and does so over a large enough[4] range of wealth levels W"
- S $\models$ "the agent turns down large-stakes gambles in favor of a certain amount with a significantly lower value, and looks silly".

The calibration puzzle is the claim that if P, Q and R are true, then S follows. Since the behavior implied by proposition S is *a priori* implausible from a thought experiment, there must be some inconsistency among these propositions. Rabin (2000) draws the implication that P must then be false, and that one should employ models of decision-making under risk that relax proposition Q, such as Cumulative Prospect Theory. As a purely logical matter, of course, this is just one way to resolve this calibration puzzle.

3. Experimental design

All of the evidence claimed to support the premiss that decision makers in experiments exhibit small stakes risk aversion for a large enough finite interval comes from designs in which subjects come to the lab with varying levels of wealth and are faced with small-stakes lotteries. This is actually indirect evidence, even if it might be suggestive, since we do not know that different decision-makers have varying levels of wealth, and there is nothing in EUT that would lead one to assume that they have the same utility function. What is needed is an experimental design that varies the wealth of a given decision-maker, who can be presumed to behave consistently with one utility function during the lab session.[5]

Cox and Sadiraj (2008, p.33) propose an elegant design to test this claim correctly. Give the agent a choice between a safe lottery of w for sure, and a risky lottery of a 50:50 chance of $w - x$ or $w + y$, where $w - x \geq 0$ and $y > x > 0$. The key idea is to vary w in the lab.[6] Consider values of w that can be denoted

[1] Neilson (2001) and Safra and Segal (2008) also provide concavity calibration claims for terminal wealth models.

[2] There have been comparable tests of the premisses of the calibration claims by Cox et al. (2013). One of their experiments involved subjects in Calcutta, India; another involved a casino in Europe and some experimental procedures that are non-standard (in effect, the lab wealth was extremely risky wealth, and plausibly hypothetical wealth from the *ex ante* perspective of the subject). Wilcox (2013) independently derived similar tests in the laboratory.

[3] We now incorporate these simple lottery choices in most batteries we use in the lab and the field for new populations.

[4] The expression "large enough" is deliberately vague, since it depends on the degree of risk aversion exhibited under proposition P, and the lotteries in proposition S that *a priori* seem to generate silly behavior.

[5] Thought experiments along these lines were developed by Watt (2002) and Palacios-Huerta and Serrano (2006), and showed that the implied risk aversion underlying proposition R are *a priori* implausible. Despite minor errors in some of the calculations of the latter, noted at http://www.econ.brown.edu/Faculty/serrano/disclaimers/2006EL91dis.html, the message does not change.

[6] Cox and Sadiraj (2008, p.32) explain why one cannot test proposition R by only asking one lottery choice question of this kind at only one level of lab wealth, as in Barberis et al. (2006, p. 1071) and Schechter (2007). In response to Watt (2002), Rabin and Thaler (2002, p.230) make exactly this mistake in misunderstanding the existing experimental literature: "We refer any reader who believes in risk neutrality to pick up virtually any experimental test of risk attitudes. Dozens of laboratory experiments show that people are averse to far more favorable bets for smaller stakes. The idea that people are not risk neutral in playing for modest stakes is uncontroversial; indeed, nobody to our knowledge interprets the existing evidence as arguing that expected-value maximization (risk neutrality) is a good fit". The tests proposed here address the hypothesis of expected-value maximization for the relevant theoretical proposition R.