Assessment and Estimation of Risk Preferences
(Outline and Pre-summary)

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Abstract

This paper surveys the rapidly growing literature in which risk preferences are measured and manipulated in laboratory and field experiments. The most commonly used measurement instruments are: an *investment task* for allocations between a safe and risky asset, a *choice menu task* for eliciting probability indifference points, and a *pricing task* for eliciting certainty equivalents of a lottery. These methods are compared in a manner that will help the practitioner decide which one to use, and how to deal with methodological issues associated with incentives, stakes, and the structure of choice menus. Applications involve using inferred risk preferences to document demographic effects, e.g. gender, and to explain the effects of risk aversion on observed behavior in economic in settings, e.g. bargaining, auctions, and contests. Some suggestions for evaluating the separate effects of utility curvature and probability weighting are provided.

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I. Introduction

A primary advantage of experimentation in economics is the ability to *induce or manipulate* payoff structures with specific theoretical predictions. The calculation of optimal decisions for individuals or game-theoretic predictions for groups, however, requires assumptions about aspects of preferences that are beyond the direct control of the experimenter, e.g. other-regarding preferences or risk aversion. Notions of risk and risk aversion pervade many areas of economics, especially insurance, contract theory, finance, and business cycle theory (especially post 2008), and obtaining measures of risk aversion is important for interpreting observed data patterns. This survey deals with the large literature on experimental methods for measurement of attitudes toward risk.

Background and early insights based on introspection and informal surveys

The earliest thinking about risk aversion may be Daniel Bernoulli's (1738) paper, which even predates the birth of economics and psychology as distinct fields of inquiry. Bernoulli's point was that the maximization of the expected value of monetary payoffs is not a reasonable description of actual behavior because it takes no account of risks associated with small probabilities and low payoffs. He considered a lottery in which a fair coin is flipped repeatedly, with no payoff made until "heads" is first obtained. The possible money payoff starts at 2 and is doubled, 4, 8, etc., after each Tails is observed. The expected value of this lottery is $(1/2)2 + (1/4)4 \ldots + (1/2^n)2^n + \ldots$, which is an infinite sum of ones. The Bernoulli paradox is that people would not be willing to pay large amounts of money in exchange for a random lottery with an infinite expected value. His resolution was to suggest that the utility function is non-linear, with a concave shape that under-weights high payoffs.

Milton Friedman, who had been working on decision theoretic and statistical issues during World War II, returned to this issue in collaboration with Leonard Savage, one of the founders of decision theory. Their 1948 paper argued that the von Neumann-Morgenstern utility function for wealth should contain both convex and concave segments to explain why some people simultaneously purchase insurance and lottery tickets for large gains.

Harry Markowitz, who studied under both Friedman and Savage at Chicago, had always been fascinated with the tradeoff between risk and return. His 1952 *Journal of Finance* paper on portfolio theory formalized the decision theory behind the construction of a portfolio based on a tradeoff between expected return and risk (measured by variance). Although, this paper was the primary basis for a Nobel Prize forty years later. there was another more relevant paper that Markowitz published in the same year in the *Journal of Political Economy*. The earliest stirrings of experimental economics were emerging in those years, and Markowitz (1952b) devised a *structured* series of binary lottery choices with scaled payoffs for both gains and losses. For example, one question that he would pose to his friends and colleagues was whether a person would rather owe a penny for sure or have a 1/10 chance of owing a dime (most people were risk averse, preferring the sure loss of a penny). These losses were scaled up by a factor of 10 or more, e.g. to dimes and dollars, for subsequent questions. He found that people switched from risk aversion to risk preference for large losses, e.g. preferring a 1/10 chance of losing $10,000 to a sure loss of $1,000. The opposite pattern was observed for gains above "customary wealth." In particular, people tended to take small, fair gambles, e.g.

they preferred a 1/10 chance of $10 to a sure $1. But risk aversion was prevalent for large gambles; everyone preferred a sure million dollars to a 1/10 chance of ten million. Markowitz concluded that the utility function had to have convex segments in order to explain the risk-seeking responses that he was encountering for small gains or large losses from the present wealth position. His paper contains a graph of a utility function (Figure 5, p. 154) with several convex and concave segments, positioned around the origin ("o") at present wealth. He concluded that utility should be a function of gains and losses *from this level*, not a function of final wealth as implied by "asset integration." Even more remarkable was the fact that Markowitz' informal questions also turned up a strong hint of loss aversion:

> "Generally people avoid symmetric bets. This suggests that the curve falls faster to the left of the origin than it rises to the right of the origin. (I.e. $U(X) > |U(-X)|$, $X >$ o.)" (Markowitz, 1952, p. 154)

His utility graphs were explicitly constructed to be monotonic but bounded, in order to avoid the Bernoulli paradox. This tradition of considering a reference point that is affected by present or customary wealth levels has been followed by psychologists and experimental economists ever since.

The next key development was the Kahneman and Tversky (1979) paper on prospect theory. This paper was motivated by experimental evidence for gains and losses and high and low probability levels. In addition, they added a third element, the replacement of probabilities with weights (as proposed by Edwards, 1962), to the Markowitz insights about reference points and risk seeking in the loss domain. Another key component of prospect theory is the notion of "loss aversion," which they modeled as a kink in the utility function at the reference point, in contrast to the inflection point at the origin in the Markowitz graph. Kahneman and Tversky's paper is one of the most widely cited papers in the economics literature, and it was a primary impetus for Danny Kahneman's 2003 Nobel Prize.

This survey is focused on more recent work, mostly in experimental economics, which builds upon and refines the deep insights provided from the Bernoulli-Friedman-Savage-Markowitz-Kahneman-Tversky tradition, using real financial incentives instead of the hypothetical payoff questions that were generally used in previous work. Of course, there is a rich empirical econometric literature on behavior in insurance and financial markets in which estimates of risk aversion play a role. In contrast, the focus here is on measuring risk aversion directly, or alternatively, on making qualitative inferences about changes in levels of risk aversion (or preference) that result from changes in laboratory treatment variables and demographic characteristics.

Overview

Most of the papers that will be discussed here follow Markowitz in the sense of working with a set of related lottery choice tasks, or a set of choices that correspond to alternative investment portfolios. Section II will introduce these alternative approaches. The use of menus of related questions or options brings up issues of presentation, framing, and treatment-order effects. The possibility of using financial incentives also raises a number of considerations, e.g. controlling for wealth effects. These and other procedural issues are addressed in Section III. The fourth section surveys the wide variety of treatments that have been used in risk aversion experiments, e.g. group versus individual decisions, gains versus losses, and biological treatments. Section V, in contrast, pertains to factors that cannot be manipulated during an experiment, e.g. demographic effects of gender, age, income, cognitive ability, culture, etc. This is followed in section VI by a discussion of economic applications in the lab and in the field, based on selected examples in which risk aversion measures were elicited and used to obtain a deeper perspective on otherwise perplexing behavioral patterns, e.g. in tournaments and contests, bargaining, laboratory financial markets, and simple games. The final sections provide a summary of the main findings and their implications, both for theoretical work on decision theory and for practitioners interested in eliciting risk aversion in laboratory and field settings.

II. Assessment Approaches

Risk aversion can be inferred from choices between two alternatives, e.g. a sure payoff of $3 or a risky payoff that provides a 0.8 chance of $4 ($0 otherwise). A single choice like this can be used to separate individuals into two risk preference categories. Interval estimates can be refined by providing subjects with choices among more than two alternatives, or by letting subjects make multiple choices in a structured list. This section begins with a review of some results based on sets of binary choices, and then introduces the three main approaches that have been used to provide more structure for the elicitation of risk preferences. All three are motivated by the common intellectual framework that was outlined in the introduction, although key differences emerge.

1) The *investment portfolio* approach bases risk aversion inferences on a single choice that is made among alternative gambles, which typically correspond to different divisions of investment funds between safe and risky assets. Here, more risk aversion corresponds to investing less of one's stake in the risky asset.
2) The *lottery choice menu* approach is built around a structured list of distinct binary choices between safe and risky gambles, with risk aversion being inferred from the total number of safe choices, or the point at which a subject switches between the safe and risky gambles.
3) The *pricing task* approach involves the elicitation of a certainty equivalent money amount, e.g. by using Becker, Degroot, and Marshak procedures for obtaining a buying or selling price for a gamble. In this case, risk aversion is inferred from the difference between the expected value of the gamble and the elicited certainty equivalent value (no difference corresponds to risk neutrality).

(continued)
The full chapter will be available soon from Elsevier.