

Recent Developments in Modeling Preferences: Uncertainty and Ambiguity

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Key words: ambiguity, uncertainty, Ellsberg paradox, nonexpected utility

Abstract

In subjective expected utility (SEU), the decision weights people attach to events are their beliefs about the likelihood of events. Much empirical evidence, inspired by Ellsberg (1961) and others, shows that people prefer to bet on events they know more about, even when their beliefs are held constant. (They are averse to *ambiguity*, or uncertainty about probability.) We review evidence, recent theoretical explanations, and applications of research on ambiguity and SEU.

In the last 40 years the leading theories of choice in economics and psychology have been the expected utility (EU) theory of von Neumann and Morgenstern (1947) and the subjective expected utility (SEU) theory of Savage (1954). Empirical violations have led to reexaminations of both kinds of theory. In Weber and Camerer (1987), we reviewed the evidence, axioms, and application of alternatives to EU. Here we do the same for SEU.

EU assumes that the probabilities of outcomes are known. If preferences follow a set of simple axioms, they can be represented by a real-valued utility function—preferred choices have higher utility numbers—and the utility of a choice is the expected utility of its possible outcomes, weighted by their probabilities.

In SEU, probabilities are *not* necessarily objectively known, so SEU applies more widely than EU. (Indeed, it is hard to think of an important natural decision for which probabilities *are* objectively known.) In SEU, decision makers choose acts, which have consequences that depend on which of several uncertain “states” occurs. People are

*Thanks to Jonathan Baron, James Dow, Peter Fishburn, Itzhak Gilboa, Gordon Hazen, Howard Kunreuther, Tomas Phillipson, David Schmeidler, Amos Tversky, the editor, and several anonymous referees for corrections and helpful comments. Camerer’s contribution to this work was supported by the National Science Foundation, grant no. SES 88-09299. Weber’s contribution was supported by the Deutsche Forschungsgemeinschaft, grant no. WE 993/5-1.

assumed to have subjective, or “personal,” probabilities of the states (which may legitimately differ across people). The SEU axioms show the conditions under which preferences can be represented by a numerical expected utility that uses subjective probabilities of states to weight consequence utilities. The theory combines the von Neumann and Morgenstern (1947) EU approach with de Finetti’s (1937) calculus of subjective probabilities.

Much of the empirical evidence against SEU (as a description of choices) concerns precisely the distinction between whether probability is known or unknown. This basic distinction goes by many names: risk vs. uncertainty (Knight, 1921); unambiguous vs. ambiguous probability (Ellsberg, 1961); precise or sharp vs. vague probability (Savage, 1954, p. 59), epistemic reliability (Gärdenfors and Sahlin, 1982), and so forth. We generally use the term *ambiguity*, purely from tradition.

In SEU the distinction between known and unknown probability is pointless, because subjective probabilities are never unknown—they are always known to decision makers (or inferable from their choices). But empirical evidence suggests that how much people know about a state’s probability *does* influence their willingness to bet on the state.

For example, suppose you must choose between bets on two coins. After flipping the first coin thousands of times, you conclude it is fair. You throw the second coin twice; the result is one head and one tail. Many people believe both coins are probably fair ($p(\text{head}) = p(\text{tail}) = .5$) but prefer to bet on the first coin, because they are more confident or certain that the first coin is fair. Ambiguity about probability creates a kind of risk in betting on the second coin—the risk of having the wrong belief.¹ SEU effectively requires that decision makers be indifferent toward such a risk.

Most of the research we review either tests whether SEU is a good *descriptive* theory or suggests alternative descriptions. There is relatively little discussion about whether SEU is *normatively* adequate.² We suspect that most alternatives to SEU are meant to be normative improvements too, but unclear standards for what makes a theory normative inhibit such claims. Clearer standards and more debate would be useful.

Our goal in this article is to review recent literature on ambiguity in decision making. We will cover both empirical and theoretical work, and we will try to point out the relevance of ambiguity for a wide range of professions and disciplines. There are many important related areas we ignore. We will not review generalizations of EU. We will also ignore the literatures on probability elicitation (e.g., Spetzler and von Holstein, 1975), psychology of probability judgments (e.g., Kahneman, Slovic, and Tversky, 1982), organizational choice under ambiguity (e.g., March and Olsen, 1976), and ambiguity intolerance as a personality trait (e.g., Budner, 1963). More technical reviews include Fishburn (1988b, pp. 190–193; 1989), Karni and Schmeidler (1990), and Kischka and Puppe (1990). Smithson (1989) offers an eclectic, broad review. The articles compiled in Edwards (1992) address prescriptive aspects of generalizations of EU and SEU.

This article proceeds as follows. Section 1 is a brief formal overview of SEU. Section 2 reviews empirical work demonstrating ambiguity effects in individual decisions. Some conceptions and sources of ambiguity are mentioned in section 3. Recent generalization of SEU are described in section 4. Applications of these recent developments to several areas, mostly in economics and business, are discussed in section 5. Some conclusions and suggestions for future research are drawn in section 6.