

Book Review

Expected versus Nonexpected Utility: The State of the Art

WARD EDWARDS (Ed.). *Utility Theories: Measurements and Applications*.
Boston: Kluwer Academic, 1992. Pp. 300. \$89.95 (paperback, \$29.95).

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Savage (1954) may have provided this century's major step forward in decision theory. He formulated conditions for decisions under uncertainty that imply expected utility (*EU*) maximization and that are more convincing than conditions given before. Savage's work convinced many that *EU* is the correct, "normative," way for making optimal decisions, and "decision analysts" have developed advanced technologies on the basis of it. Empirically, however, people frequently and systematically deviate from *EU*, and during the last decade several models have been developed to describe those deviations; examples are the rank-dependent models and the betweenness models. Empirical deviations from *EU* as such need not compromise *EU* applications. They can even be taken as arguments in favor of *EU* because, apparently, *EU* has something to offer in addition to natural decision making.

A few authors have also assigned a normative status to non-*EU* models; see, for instance, Allais (1953) and Machina (1989). In the majority of works in non-*EU* theory, however, the normative status is not discussed. Thus, should the development and application of technologies for *EU* be continued, or should it be stopped and alternatives developed? Ward Edwards invited major workers in non-*EU* theory as well as those in *EU*-based decision analysis to a conference in Santa Cruz, California, in June 1989 to discuss this question. The conclusions have been laid down in the book reviewed here. The conference started with the following

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question. (Concerning notation, I prefer for simplicity not to distinguish between subjective expected utility (*SEU*) and *EU* in this review.)

Do you consider *SEU* maximization to be the appropriate normative rule for decision making under risk or uncertainty?

Remarkably, the answer was unanimous, and it was “yes” (see Preface and Chapter 10). I hypothesize that for some of the participants the next word they would have added, if they could, would have been “but.” Let me now turn to the specific contributions of the participants. The order of chapters discussed here deviates somewhat from the order in the book. First I review Chapters 1–3, 5, and 6 that mainly discuss axioms within the realm of *EU*.

In the first chapter, Robin Keller gives a survey of properties of *EU* theory. The survey is accessible because it avoids discussions of details. In a final section, a discussion of dynamic principless is given. I note one potential cause for confusion in this domain. Dynamic consistency is defined in Keller’s work, as well as in several other works, in a weak sense: future choices agree with what they are presently foreseen to be, even if they are not presently preferred. In this sense, sophisticated choices satisfy dynamic consistency. In Wakker (1988), as well as in several other works, dynamic consistency is taken in a more restrictive sense: future choices agree with what they are presently preferred to be. Sophisticated choices need not satisfy dynamic consistency in this more restrictive sense.

Chapter 2 contains a plea for *EU* by Ron Howard. He not only formulates preference conditions that imply *EU*, but he also makes the underlying conceptual principles clear. For instance, Property 1 on p. 35 states that “probability must stand on its own epistemically.”

In Chapter 3, Ralph Keeney puts into perspective the role of axioms and modeling in the decision process. He argues that in multi-person decisions, deviations from *EU* are appropriate because of equity considerations.

In Chapter 5, LaValle proposes an argument in favor of *EU*. He argues that there is no basic difference between elementary consequences and acts-conditional-on-events. Thus, he requires preferences over acts-conditional-on-events, “independent of everything else.” It does not matter for the indifference class of an act-conditional-on-an-event what the act yields conditional on the complement of the event. Then monotonicity with respect to these preferences over acts-conditional-on-events is equivalent to the sure-thing principle. The clearest account is given by LaValle on p. 123, fourth paragraph.

Chapter 6, by Rakesh Sarin, presents conditions for sequential choices. The “principle of optimality” is equivalent to what is also called consequentialism, and the principle of “economic equivalence” entails both dynamic consistency and the reduction of compound lotteries axiom. Sarin demonstrates that these conditions imply *EU* maximization. This had been known before, mainly through the seminal work by Hammond (1988). Sarin’s presentation is, however, more accessible than previous ones. Next, deviations from *EU* are discussed. It is pointed out that people may consciously deviate from *EU* to alleviate psychological concerns.

Next I review Chapters 4, 7, and 8; these explicitly discuss theoretical models that deviate from *EU*. In Chapter 4, Miyamoto presents his generic utility model; it shows how to extend *EU* characterizations of special multiattribute utility forms to all non-*EU* theories that transform probabilities.

In Chapter 7, Uzi Segal presents his ideas on the reduction of compound lotteries axiom. He argues that what is traditionally considered the independence axiom actually consists of two conditions. The first condition is the reduction of compound lotteries axiom, the second is the compound independence axiom (replacing a gamble in a mixture by a better gamble should improve the overall gamble). Segal argues that the reduction axiom is, both descriptively and normatively, the most questionable of the *EU* axioms. A similar view underlies Luce's work, discussed next.

In this conference, Duncan Luce and Amos Tversky independently presented the first full-blown versions of rank-dependent models that also incorporate sign-dependence. Earlier, such a model had been proposed, but not elaborated, in Starmer and Sugden (1989). Tversky and Kahneman (1992) describe the model presented at the conference by Tversky. Luce's presentation is given in Chapter 8, which is the best introduction to Luce's innovative and original ideas concerning the basic paradigm of decisions under uncertainty: In practice, the "joint receipt" of \$10 and then \$2 need not be the same as the receipt of \$12; similarly, a lottery described as (0.25, \$7; 0.75, \$3) can be perceived differently than a lottery described as (0.75, \$3; 0.25, \$7). Subjects deviate in many other respects from normative theories at the basic level of perception of lotteries. Although it may seem impossible to exactly model such "irrational" phenomena, Luce has made a first step in that direction.

Chapter 9, by Colin Camerer, is the final independent contribution of an author. It is a description of the extensive empirical work to test non-*EU* theories in the probability triangle (all lotteries over three fixed outcomes). Camerer presents six "stylized" facts. First, *EU* is not violated within the triangle (the second and third facts are not described here because they involve technical terms); fourth, betweenness does not hold; fifth, *EU* violations depend on outcomes of the probability triangle; and sixth and last, nonhuman animals exhibit violations of *EU* similar to those of humans. All together, the data do not give a very clear preference for any of the non-*EU* theories, as all of them are violated in some systematic manner. Camerer interprets the evidence as most favorable to prospect theory and claims that nonlinear weighting theories have the "most empirical promise" and betweenness-based theories have the least. This conclusion is primarily based on the first stylized fact (*EU* violations occur primarily near the border of the triangle) which suggests probability transformations near 0 and 1. It is useful to realize here that the restrictions imposed by betweenness theories can very well be tested within the probability triangle, but the restrictions imposed by probability weighting theories only show up in other domains and give only few predictions, and thus cannot be tested critically, in the probability triangle.

Finally, there are two summarizing chapters: one by possibly the most experienced person in the field, the other by young researchers just entering the field. In Chapter 10, Edwards proposes two bottom lines for decision science: first, that *EU* is the proper normative model, and second, that it is not the proper descriptive model. Implications for decision science are discussed.

In Chapter 11, a discussion of the material of the conference is presented by five authors, mainly graduate students and recent Ph. D.'s (Thomas Eppel, David Matheson, John Miyamoto, George Wu, and Stuart Eriksen). The formulation on p. 284, "uncover the hidden psychological carriers of value," captures much of the deviations from *EU*.

I add here a Darwinian view on the progression of science. This Darwinian view says that *human beings have no secret intuitions for discovering absolute truths*. People simply gamble on ideas, and only time will decide what is the best theory, that is, what is the fittest theory that will survive the others. So we discussants in the *EU*-non-*EU* controversy should simply gamble on our favorite theory, and only time will tell which theory proves better for mankind or its successors.

This book is not a routine proceedings record of a regular conference, organized by someone who thinks an edited book will look good on her/his *CV*, attended by people who want a quick proceedings score that does not take any creativity and bought by libraries that cannot discriminate. We have seen too many books and journals of that kind. The book reviewed here is different. Ward Edwards, one of the most experienced persons in the field, organized the conference on the *EU*-non-*EU* question that is at the center of the future of decision analysis and thus at the center of his heart. He gathered together leading experts and directed them all toward the *EU*-non-*EU* question as much as possible. This book defines for future decision theorists what the status of such theories was in 1992.

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