Utility and Subjective Probability: Empirical Studies

In the last few decades, empirical studies of choice, probability assessment, and certainty equivalents have demonstrated that utilities are not independent of subjective probabilities. People are often pessimistic about the odds of a possible outcome if the outcome is bad. Rank-dependent theories and configural-weight theories can describe these interactions by allowing decision weights to vary with the rank orders of outcomes. Holding objective probability constant, however, weights associated with outcomes can vary with the rank orders of outcomes. Furthermore, changes have more than two outcomes. Choices are consistent with configural-weight theories. However, configural-weight theories cannot account for interactions across options. Regret theories describe these interactions in emotional terms, but there are probably many reasons for the interactions. An important challenge for future theorists is to describe both types of interactions within a single theoretical framework. For further reading on utility theories and empirical tests, see Edwards (1992) and Luce (2000).

1. Prospect Theory

In a now classic paper on risky choice, Kahneman and Tversky (1979) proposed an alternative to expected utility theory called prospect theory. Rational rules were replaced with psychological principles. The value function in prospect theory applied to changes in wealth, not total wealth. Furthermore, changes had diminishing marginal value, such that a change from $0 to $10 had greater impact than an identical change from $1000 to $1010. Finally, negative changes had greater impact than positive changes of equal magnitude, an asymmetry known as loss aversion.

Prospect theory also made psychological assumptions about decision weights. Decision weights were nonlinearly related to objective probabilities; weights for small probabilities were larger than objective probabilities, and weights for large probabilities were smaller. In addition, weights at the endpoints were discontinuous. An event with no chance of occurring was psychologically different from an event with a one percent chance of occurrence (e.g., contracting a horrible disease), and a sure thing was psychologically different from an event with a 99 percent chance of occurring (e.g., winning a million dollars in the lottery).

Prospect theory accounted for a variety of empirical phenomena. One example was the reflection effect, which suggested that risk attitudes varied around the status quo. Consider a choice between a gamble with an 80 percent chance to win $4,000 and a sure win of $3,000. Most people prefer the sure thing. Now consider a choice between a gamble with an 80 percent chance to lose $4,000 and a sure loss of $3,000. Most people prefer the gamble. Although expected utility theory assumed that risk attitudes were constant across all levels of wealth, prospect theory asserted that the shape of the value function differed in the gain and loss domains. Preferences were risk averse in the gain domain and risk seeking in the loss domain. Despite its success, prospect theory had a major drawback. It predicted that people would violate stochastic dominance. Stochastic dominance implies that a decision maker will select the alternative that is as good or better in all respects than other alternatives. Prospect theory predicted that, in some cases, people would choose the inferior option. Despite evidence that people violate stochastic dominance, there was a strong desire to find a general representation that served both normative and descriptive needs. Interest turned to cumulative rank-dependent theories.

2. Cumulative Rank-dependent Theories

In cumulative rank-dependent theories, the decision weights associated with outcomes can vary with the rank orders of outcomes. Furthermore, weights are cumulative or decumulative probabilities, an assump-
tion that makes violations of stochastic dominance impossible. Several versions of cumulative rank-dependent theories were proposed, three of which are presented in more detail.

2.1 Rank- and Sign-dependent Utility Theory

Luce (1991) and Luce and Fishburn (1995) proposed an account called rank- and sign-dependent utility theory. This version was built on the assumption of joint receipt (the simultaneous receipt of two or more objects, such as gambles). Luce and his colleagues tested several of the axioms, including segregation, duplex decomposition, and the additivity of certainty equivalents over joint receipt. Segregation implied that the value of a gamble with positive outcomes was equal to the value of the joint receipt of the gamble with the lowest outcome subtracted from all outcomes and the value of the lowest outcome. Duplex decomposition asserted that the value of a gamble with mixed outcomes was equivalent to the joint receipt of a subset of the gamble with all positive outcomes and a subset of the gamble with all negative outcomes. Finally, additivity of certainty equivalents over joint receipt implied that the certainty equivalent for positive outcomes was combined additively with that of negative outcomes.

Tests were conducted with judged certainty equivalents and choice certainty equivalents. Judged certainty equivalents are indifference prices between a sure thing and a gamble, and choice certainty equivalents are indifference points that are inferred from choices between sure things and gambles. Segregation was supported by one measure, duplex decomposition was supported by both measures, and additivity of certainty equivalents was supported by neither measure. In sum, the tests yielded mixed results.

But not all of the evidence was mixed. Tests of an axiom called event commutativity were supportive. Event commutativity implies that the order of events should not matter as long as the outcomes arise under the same conditions. Results were consistent with rank- and sign-dependent utility theory. Camerer and Ho (1994) found more supporting evidence with an axiom called betweeness. Betweeness is a weakened form of the independence axiom and states that a preference for a probability mixture of two gambles should fall between the preferences for the two separate gambles. Violations of the axiom were robust and consistent with cumulative rank-dependent theories.

2.2 Cumulative Prospect Theory

Tversky and Kahneman (1992) developed a theory called cumulative prospect theory. It was axiomatized differently from rank- and sign-dependent utility theory, and it also made different assumptions about values and decision weights. Decision weights had an inverse S-shape form. The value function was a concave power function for gains and a convex power function for losses with a steeper slope for losses than gains.

Empirical tests of cumulative prospect theory were done with global fits to data, and results were generally supportive. One-parameter versions of the S-shaped weighting function provided good fits to median data (Camerer and Ho 1994, Wu and Gonzalez 1998, Prelec 1998). More recently, two-parameter weighting functions that describe individual differences in discriminability and gambling preference were proposed.

2.3 Security Potential/Aspiration Theory

Lopes (1990) developed a cumulative rank-dependent theory called security potential/ aspiration theory. She argued that participants making risky choices were both security minded (i.e., they wanted to avoid the worst outcomes) and potential minded (i.e., they wanted to achieve the best outcomes). An S-shaped weighting function reflected the ‘optimism’ that people feel with smaller probability outcomes and the ‘pessimism’ they feel with larger probability outcomes. Security potential/aspiration theory described choice as a combination of rank-dependent utilities and consideration of an aspiration level. Results were generally supportive.

3. Configural-weight Theories

Birnbaum and his colleagues turned to another class of theories called configural-weight theories. In these accounts, decision weights were noncumulative and permitted violations of stochastic dominance. Birnbaum and McIntosh (1996) and Birnbaum and Navarrete (1998) provided additional evidence of such violations by showing that people select the dominated option when making choices with certain three-outcome gambles. Configural-weight theories predicted the results.

Birnbaum (1999) also demonstrated that choice behavior violated a property called coalescing. Coalescing, also called event splitting, applies to probability-outcome combinations with identical outcomes. Cumulative rank-dependent theories predict that probability-outcome combinations with identical outcomes should be equivalent regardless of whether they are presented separately or as a sum. For example, a 20 percent chance of $10 and a 15 percent chance of $10 should be equivalent to a 35 percent chance of $10. Birnbaum showed that choices differed with the two modes of presentation. Identical outcomes presented separately had greater impact than identical outcomes presented together. Again, configural-weight theories predicted the results.

Cumulative rank-dependent theories and configural-weight theories differ in several respects. Configural-weight theories allow decision weights to vary
4. Interactions across Options

Not only do utilities and subjective probabilities interact within an option, but several studies show that utilities and subjective probabilities interact across options. Chechile and Cooke (1997) and Chechile and Luce (1999) presented participants with a reference gamble and two outcomes of a comparison gamble. Participants adjusted the probability of the better outcome until the comparison gamble and the reference gamble seemed equivalent. Chechile and his colleagues showed that rank-dependent theories could be represented as linear functions with invariant slopes across reference gambles. Results showed that the slopes systematically varied; the utilities of reference gambles depended on the comparison gambles with which they were paired. Mellers and Biagini (1994) also demonstrated interactions across options in the form of strong stochastic transitivity violations and similarity effects. They represented the interactions in terms of attribute weights and argued that people shifted their attention from attributes with similar levels to those different levels to best discriminate among options.

Regret theories also describe interactions across options. People often anticipate the regret they will feel if their outcome turned out to be worse than the outcome of another choice. Theories of regret assume that people avoid such feelings when making choices (Loomes and Sugden 1982, Bell 1982). Numerous developments have occurred along these lines (Mellers 2000), and results are promising. Although no single unifying theory has been suggested yet, future theorists will undoubtedly provide a general representation of the interactions both within and across options.

See also: Characterization Theorems in Random Utility Theory; Decision and Choice: Paradoxes of Choice; Decision and Choice: Random Utility Models of Choice and Response Time; Decision Research: Behavioral; Heuristics for Decision and Choice; Utility and Subjective Probability: Contemporary Theories

Bibliography

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Utopias: Social

‘Utopia’ refers to fictions or essays which purport to describe an ideal and feasible community at some, generally undefined, future date. ‘Utopia’ is a doubly