Three Ships that Pass in the Night: Risk, Ambiguity and the WTP/WTA Disparity

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Introduction

There are at least three ships (of interest to environmental and resource economists), that pass in the night. On ship number one (The Risk) are economists who have adopted the conventional expected utility model (EUM) to address uncertainty and risk. On ship number two (The Ambiguity) are psychologists, decision theorists, and some renegade experimental and empirical economists. Ship two’s crew has concluded that individuals often express ambiguity about risks. On ship three (The Valuation) are economists who wish to estimate values to uncertain nonmarket goods or bads, e.g., health-risk reductions. The ships often seem to be oblivious to one another, but if they are carrying similar cargo and are headed in the same direction, it may be inefficient to see this situation continue. For example, combining forces might bring about a theoretically motivated and empirically defensible answer to the quandary about the disparity between an individual’s maximum willingness to pay (WTP) and his or her minimum willingness to accept compensation (WTA). This manuscript serves as a beacon of sorts, and we hope that those on board the three ships will see it.

The Ships’ Crews

The Risk’s crew has been sailing longer than anyone (e.g., von Neumann and Morgenstern 1944). They are comfortable with well-defined, objective, and unambiguous risk rather than Knight’s (1921) uncertainty, where probabilities are not known. The framework rests on strong linearity assumptions and other restrictive axioms. Crew one has tended to view violations of the framework as “phenomena” instead of “paradoxes” (Howard 1992).

The Ambiguity’s crew likely believes that we should incorporate what people think and believe rather than what scientists tell them is true (e.g., Slovic 1987). They have perhaps concluded that risks are ambiguous. The Ambiguity’s crew probably knows Ellsberg’s (1961) paradoxical outcome: when faced with two urns, one with a known proportion of red balls (50 percent) and the other with an unknown proportion, people generally prefer to bet on the unambiguous draw. Ellsberg’s result has led to competing explanations of ambiguity: Fox and Tversky (1995) favor the hypothesis that comparative ignorance creates ambiguity, whereas, Heath and Tversky (1991) argue that individuals who feel highly competent about a particular area (Joe knows sports) can overcome ambiguity (Joe bets on football game outcomes). Others on The Ambiguity are concerned with apparent nonlinear weighting of probabilities (e.g., Allais 1953), the apparent tendency for individuals to treat losses differently from gains (e.g., Kahneman and Tversky 1979; Loomes and Sugden 1982) and other phenomena that do not follow the strict structure of EUM.

The Ambiguity’s crew has proposed a number of alternatives to the basic EUM. Camerer and Weber (1994) distinguish a large class of models that allow for ambiguity via a second order probability density function (SOP). The Rank-Dependent Expected Utility (RDEU) model fits into this class (Quiggin 1993). The RDEU model is most easily presented in terms of a lottery in which there are n possible outcomes, \( x_i \); \( i=1,\ldots,n \), which are ordered from worst \( (i=1) \) to best \( (i=n) \). Each outcome \( x_i \) has a known probability \( p_i \) and the probability of achieving an outcome of \( x_i \) or worse is

\[
\sum_{j=1}^{i} p_j
\]

The RDEU functional is of the form:

\[
V(\{x,p\}) = \sum_{i=1}^{n} U(x_i)h_i(p)
\]

where

\[
(1) \quad h_i(p) = q(F(x_i)) - q(F(x_{i-1})).
\]

It is assumed that the function \( q \) is monotonic with \( q(0)=0 \) and \( q(1)=1 \). Note that the decision weight, \( h_i(p) \), is a function solely of the likelihood of \( x_i \) and its ranking position. The function \( q(\cdot) \) generalizes EU analysis. If \( q(F)=F \), then RDEU is equivalent to EU. However, RDEU preferences need not take the restrictive linear forms imposed by ship one’s EUM

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1 Several of these ideas are fleshed out in another paper (Zhao and Kling 2004).

2 If the subjective probability of state s is \( p(s) \), then the SOP is \( \Phi(p(s)) \).
crew. For example, some specifications make it possible to incorporate subjective probability estimates that involve missing information, as might be consistent with Zhao and Kling (2001). Another class of transformations results in an inverse-S function that is capable of explaining risk aversion to low-probability losses (the case of insurance) and risk seeking for gains with low probabilities (state lotteries) (Tversky and Kahneman 1992; Diecidue and Wakker 2001).

The Valuation’s crew is concerned with public policy and programs that are often advocated on the basis of the outcome of ex-ante benefit-cost analysis. For example, the Clean Air Act Amendments of 1990 require evaluation of the net benefits of pollution-control policies. The Valuation crew’s goal is to inform public policy by estimating these and other policy-related net benefits. Welfare theory supports using the WTP or WTA in assessing net benefits, corresponding to the compensating and equivalent variation measures of consumer’s surplus. However, these measures can diverge by several magnitudes in many instances (Horowitz and McConnell 2002). This WTP-WTA disparity has been of interest for quite some time (e.g. Thaler 1980; Knetsch and Sinden 1984). Zhao and Kling (2001) hypothesized that the difference can be attributed to a commitment cost. More information might be obtained later that would lead to a higher value, and individuals might set a higher current WTA to offset lost opportunities in the future. Zhao and Kling (2001, 2004) are mainly interested in the disparity between the WTA and WTP (see Hanemann 1991); they are on The Valuation, but their work incorporates ideas from the other ships.

**The Benefit of the Beacon**

Most of the Valuation’s crew are acquainted with The Risk crew’s ideas: Graham (1981) uses the EUM to define the option price (OP) as the point where contingent payments over two random states are equalized. Assume there are two states of nature, denoted by 0 and 1, with probabilities \( \pi \) and \( 1-\pi \), respectively. Let \( x^0 \) denote the original level of \( x \) and \( x^1 \) denote a lower level. If \( x \) are prices, then the individual is assumed better off after the price decrease. Let \( m \) be income. The OP is:

\[
\pi U_o(x^0, m + \text{WTA}) + [1 - \pi] U_i(x^0, m + \text{WTA}) = \\
\pi U_o(x^1, m + \text{OP}) + [1 - \pi] U_i(x^1, m + \text{OP})
\]

The analysis of those applied economists sailing on the Valuation has been strengthened substantially by careful consideration of choices under risk, although the crew does not always follow the Risk into the most difficult waters. Although Graham’s framework is rarely completely applied in actual valuation exercises, it is agreed that strong theory provides the foundations upon which valuation under risk should be carried out. Yet there remain issues that have not yet been resolved by attention to this traditional literature, issues that might be resolved by paying attention to crews on other ships.\(^3\)

**Ship Number Two and the WTA-WTP Disparity**

Despite the efforts of some of the strongest members of its crew, the WTP-WTA disparity continues to bog down ship three. Horowitz and McConnell (2003) show that the income effect (Hanemann 1991) alone is not a credible explanation for this. As such, many scholars have sought other explanations, such as the transactions costs (Zhao and Kling 2001, 2004). The Ambiguity’s crew may succeed in offering explanations of the WTP-WTA disparity where ship three’s crew has failed.

Consider first, the issue of ambiguity. Valuation exercises often involve goods and services for which individuals may have little knowledge. Decision makers are faced with not only uncertainty over the value of the good, but ambiguity as to the probability distribution over the values. Segal (1987) shows that under ambiguity, decision makers give greater weight to less desirable outcomes thereby defying the linearity assumption of EUM. Following a similar line of thought, Eisenberger and Weber (1995) argue that such ambiguity will lead individuals to favor the status quo: “When buying (selling) an uncertain lottery, the decision maker will evaluate the lottery with the probability distribution that yields the lowest (highest) expected utility possible. Thus, ambiguity would increase the tendency to stick to the status quo” (p. 225). They hypothesize, therefore, that ambiguity would tend to deflate WTP values and inflate WTA values. Dow and Werlang derive similar results, but find that preference is given to the “safe allocation” rather than the status quo. Further theoretical support is provided by Basili and Fontini (2005) who show that when a decisionmaker

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\(^3\) For example, Nielsen (2001) notes that some difficulties in the EU cannot be overcome, and in fact are worse under the RDEU. Riddel and Shaw (2006) estimate values empirically, with a model that allows for ambiguity.
exhibits aversion to ambiguity, a “bid-ask spread” emerges, equivalent to a gap between WTP and WTA. Although the experimental data from Eisenberger and Weber (1995) do not support the conclusion that ambiguity explains the WTP-WTA disparity, they conclude that there is need for such analysis “outside the laboratory.”

Others on The Valuation have explained the WTP-WTA disparity using regret theory. Loomes and Sugden (1982) proposed that individuals choose A by factoring in their regret from not making the choice B. Relevant is the following WTP:

\[
E \left[ u(x_i, y - WTP) - u(x_0, y) \right] + R \left[ u(x_i, y - WTP) - u(x_0, y) \right] - R \left[ u(x_0, y) - u(x_i, y - WTP) \right] = 0
\]

where \( E \) is the expectation operator and \( R \) is a regret function. The corresponding WTA would be

\[
E \left[ u(x_0, y + WTA) - u(x_i, y) \right] + R \left[ u(x_0, y + WTA) - u(x_i, y) \right] - R \left[ u(x_i, y) - u(x_0, y + WTA) \right] = 0
\]

When the function \( R \) is linear the predictions of regret theory and utility theory are equivalent and the divergence between WTP and WTA can be attributed to the income effect (Hanemann 1991). When \( R \) is convex, the gap between WTA and WTP will tend to increase.

Dubourg, Jones-Lee and Loomes (1994) find evidence that imprecise preferences do explain part, but not all of the disparity between the WTP and WTA values for changes in the risk of nonfatal road injuries. They offer no theory, but conduct experiments allowing individuals to favor lower or upper ends of a range of offered monetary sums tied to risk reductions, depending on whether they were having to pay, or were being compensated.

Conclusion

Those who sail on The Valuation have to provide a solid theoretical foundation for their valuation work. Many do so, using the conventional EUM. It is clear that this framework cannot explain all observed choices. Those on The Valuation should begin to pay more attention to what is going on as volleys are still being fired between The Risk and The Ambiguity, taking note of alternative models of economic behavior and their strengths and weaknesses (e.g., Neilsen 2001). Doing so will lead to an improved understanding of economic choices based on a more coherent and model of choices, and a better representation of social welfare changes.4

References


4 For valuation economists who want to know some more about what the crews of the Risk and The Ambiguity are thinking, see Shaw and Woodward (2007).


