March 25, 2008

Value and Outcome Uncertainty as Explanations for the WTA vs WTP Disparity: Theory and Experimental Evidence

William Neilson*

Michael McKee**

Robert P. Berrens***

April 2007

---

* Department of Economics, University of Tennessee, ** Department of Economics, Appalachian State University, *** Department of Economics, University of New Mexico. Address correspondence to Michael McKee, Department of Economics, Appalachian State University, Boone, NC 28608; mckeemj@appstate.edu. An earlier version of this paper was presented at Oak Ridge National Laboratory. We thank the seminar participants for helpful comments. We also thank Paul Brown for helpful comments and discussions. The usual caveat applies.

Value and Outcome Uncertainty as Explanations for the WTA vs WTP Disparity

Abstract: This paper contributes to the widespread discussion of the sources of the divergence between WTA and WTP values. The paper reports on theoretical and empirical investigations which show that value and outcome uncertainty offer an explanation for this disparity. Given a set of hypotheses generated by the theory, the paper investigates the disparity using an induced-value experimental laboratory setting. The incentive-compatible Becker-DeGroot-Marshak mechanism is employed to elicit the WTP and WTA values. Two conclusions can be drawn from the empirical results. First, the WTA - WTP difference is generally increasing in both value and outcome uncertainty. Second, a re-contracting option reduces the disparity when it arises from value uncertainty.

Keywords: Experimental, Uncertainty, WTP-WTA disparity.

JEL Codes: C9, D8

I. Introduction

The frequently observed divergence between an individual's maximum willingness to pay (WTP) and minimum willingness to accept compensation (WTA) for the same quantity change in a good or service has been the topic of considerable investigation and inquiry.[1] Repeated findings from numerous survey-based contingent valuation field studies are that people report WTA and WTP values that are different, with WTA typically much higher than WTP.[2] These results, obtained in hypothetical valuation exercises, have been corroborated by various experimental laboratory investigations using real monetary payoffs. In the field surveys studies have, for example, reported that the WTA for various types of hunting permits is four to five times higher than the corresponding WTP; and, laboratory experiments that elicit values for coffee mugs, chocolate bars and lottery tickets report that WTA is approximately two to four times higher than WTP. The persistence of such disparities, across a variety of settings, has defied any single explanation and is considered a behavioral anomaly. The issue also has considerable policy implications, as in the case of natural resource damage assessment and liability cases (Brown and Gregory, 1999) as well as in civil law cases (Rachlinski and Jourden, 1998).

[1]Horowitz and McConnell (2002) report on an investigation of some 45 studies in which significant disparity between WTA and WTP values were reported. Similarly Plott and Zeiler (2005) report the results of several laboratory experiments investigating the disparity.

[2] The contingent valuation (CV) method employs constructed markets to elicit valuations from individuals for changes in nonmarket goods. As such, the good is often relatively unfamiliar to many of the respondents, as is the constructed market transaction itself. The CV method describes the posited change in the good and the essential elements of the pseudo-market transaction to the respondent, and then elicits valuation responses in the form of maximum willingness to pay or minimum willingness to accept compensation for the change. There are many different types of elicitation formats, the two most common are the open-ended , as in "state the maximum amount you would be willing to pay," and the dichotomous choice, as in "would you be willing to pay $x for the good". The WTP - WTA disparity has been observed across the various elicitation formats.

Researchers have offered a number of competing explanations for why WTA is observed to exceed WTP. Common explanations for the disparity include the income effect from standard consumer theory (Willig, 1976), an availability-of-substitutes argument (Hanneman, 1991; Shogren et al., 1994), "endowment effects" (Knetsch, 1989; Kahneman, Knetsch, and Thaler, 1990), and reference dependence preferences or "loss aversion" (Bateman, et al, 1997).[3] These explanations, and the endowment effect argument in particular, rely on the idea that when WTA is elicited the individual owns the good and is giving it up, and when WTP is elicited the individual does not own the good and must purchase it. The consumer theory explanations relies on the income effect from owning the good versus not owning it, or the availability of substitutes when the good is sold. The loss aversion explanation relies on the psychological finding that losses matter more than foregone gains (Thaler, 1980). More recently, Kolstad and Guzman (1999) argue that information acquisition for an unfamiliar good is costly and this drives a wedge between the buying and selling price of a good. Horowitz and McConnell (2002) use data from 45 studies to test between these explanations, and they find that the evidence does not support the consumer theory explanation. But, they report an important pattern in the data -- the WTA/WTP ratio is higher the less ordinary (or familiar) the good. We will return to this point shortly.

While it has never been tested, one can confidently predict that if a researcher were to elicit the value of a deterministic amount of money, WTA and WTP would be identical. This is because the most an individual is willing to pay for $$x$ is $$x$, and the least the individual is

[3] More specifically, Willig (1976) argues that for price changes in a market good, and given limits on the size of expected income effects, we should expect WTP - WTA disparities to be relatively small. Extending the case to quantity or quality changes in a nonmarket good, Hanemann (1991) and others have argued that WTP -WTA disparities may be substantial in some cases (e.g., absence of good substitutes).

willing to accept for $*x* is $*x*. So, for WTA and WTP to differ, the good must have non-deterministic values at the time the valuation is elicited. Since individuals may not know the utility they will receive from unfamiliar (non-market or market) goods, WTA - WTP disparities may be attributable to uncertainty.[4]

Let us consider this point further. An individual may experience a loss of utility by paying too much to buy (or accepting too little to sell) and subsequently learning discover the good was worth less (more). Thus, a risk averse individual faced with the requirement to purchase an unfamiliar good which cannot be returned for refund or exchanged will respond by bidding a lower to price to increase the chance that the purchase yields surplus. A similar argument can be applied if the individual is selling a good for which the true value is not yet known.

The objective of this paper is to further explore, theoretically and empirically, the implications of the argument that WTA - WTP disparities arise because of individual uncertainty regarding the true value of the good. We consider both value and outcome uncertainty and examine behavior under two classes of utility functions that are particularly susceptible to losses (loss aversion and rank dependent expected utility). The empirical investigation uses data obtained from an induced-value experimental laboratory setting. The incentive compatible Becker-DeGroot-Marshak (BDM) mechanism is employed to elicit the WTP and WTA values

---

[4] It may be asserted that goods such as coffee mugs (as in Kahneman et al, and Morrison) would not engender much uncertainty. However, we are speaking of subjective valuation here – how much individuals actually value a good. While a coffee mug may a have a certain (market) price, how much you actually value the good is unique to you. If an experimenter hands you a mug and then offers to buy it back the subject must deal with the potential for disappointment should she agree to sell it and then later regret the transaction (perhaps she later thinks the mug would look good on her desk). This is consistent with Horowitz and McConnell's (2002) finding that WTA/WTP ratios are higher when the good is less like an ordinary market good.

from the subjects.[5]

We find several interesting results. First, two models of behavior under uncertainty – expected utility with loss aversion (LA) and rank-dependent expected utility (RDEU) – make very similar predictions concerning the divergence between WTA and WTP. These predictions relate to the *difference* between WTA and WTP.[6] Second, the WTA-WTP difference increases with the degree of uncertainty and our experimental results support this hypothesis. Fitting a single choice parameterization of the loss aversion model to all of the data does not work so well, though, as WTA - WTP differences in one treatment conflict with those from the other treatments. Third, if subjects are allowed to insure ex post, thereby reducing the amount of uncertainty, WTA - WTP differences fall.

II. Theory and Hypotheses

Suppose an individual is asked to report a valuation for the random variable $\tilde{z}$. Under the WTA scenario, the individual is endowed with $\tilde{z}$ and is asked for the least amount for which she would be willing to sell it. Thus, *WTA* solves

$$WTA - \tilde{z} \sim 0, \qquad (1)$$

where "~" denotes the indifference relation and "0" denotes the degenerate lottery which pays zero with probability one. In contrast, under the WTP scenario the individual is not endowed

[5] The BDM mechanism is not without critics and we take up this discussion when we discuss our experimental design.

[6] The analysis here is in terms of the difference (WTA-WTP) rather than the ratio. There is some debate on this issue (see Brown, 1994). As will be clear from the theoretical discussion, the case for WTP being below the individual valuation is as strong as the case for WTA being above. Use of the ratio implies that the WTP value is valid and this is not likely the case. We feel the difference specification is more general. It is, of course, obvious that if WTA exceeds WTP, the ratio of WTA to WTP will be greater than one.

with $\tilde{z}$ but is asked for the most she is willing to pay to purchase it. Thus, *WTP* solves

$$\tilde{z} - WTP \sim 0. \qquad (2)$$

Obviously, if $\tilde{z}$ is deterministic, *WTA* and *WTP* are identical. If $\tilde{z}$ is not deterministic, *WTA* - *WTP* disparities arise. We derive properties of *WTA* - *WTP* differences for two different models and for two different types of probability distributions.

Loss aversion has been a prominent explanation for explaining *WTA* - *WTP* differences since Kahneman et al. (1990) published their study. Basically, loss aversion states that losses matter more than foregone gains. In its most simplistic formulation,[7] loss aversion can be captured by a preference function with the form

$$V(\tilde{x}) = p_1 u(x_1) + p_2 u(x_2),$$

where

$$u(x) = \begin{cases} x & \text{if } x \geq 0 \\ \lambda x & \phantom{\text{if }} x < 0 \end{cases}$$

In this loss aversion specification, risk attitudes are determined solely by the parameter λ which measures how much losses matter more than corresponding gains.

Suppose that $\tilde{z}$ is a binary random variable with outcomes $z_H > z_L$ and corresponding probabilities p_H and p_L. From (1), *WTA* solves

[7] Usually loss aversion is incorporated into a preference function with probability weights, such as RDEU, as in Tversky and Kahneman (1992). We use the expected utility formulation here to isolate the impact of loss aversion. Also, studies with loss aversion typically assume that utility is S-shaped, i.e. that utility is concave over gains and convex over losses. We eliminate this feature so that all of the action comes from loss aversion alone and to allow closed form solutions in the calculations.

$$\lambda p_h[WTA - z_H] + p_L[WTA - z_L] = 0,$$

or

$$WTA_{LA} = \frac{\lambda p_H z_H + p_L z_L}{\lambda p_H + p_L}.$$

From (2), WTP solves

$$\lambda p_L[z_L - WTP] + p_H[z_H - WTP] = 0,$$

which yields

$$WTP_{LA} = \frac{p_H z_H + \lambda p_L z_L}{p_H + \lambda p_L}.$$

Note that *WTA* places greater emphasis on the higher outcome z_H and WTP places greater emphasis on the lower outcome z_L. Subtracting the two, we get

$$WTA_{LA} - WTP_{LA} = \frac{p_H p_L(\lambda^2 - 1)}{(\lambda p_H + p_L)(p_H + \lambda p_L)}[z_H - z_L]. \qquad (3)$$

This expression shows that when decision makers are loss averse, the difference between WTA and WTP for binary lotteries is proportional to the difference between the high and low payoffs.

The same qualitative relationship between the WTA - WTP difference and the spread of the random variable holds for uniform random variables. Suppose that the random variable $\tilde{z}$ is distributed uniformly on $[z_L, z_H]$. Following the same logic as above, we find that

$$WTA_U = [\lambda z_H - z_L - \lambda^{1/2}(z_H - z_L)]/(\lambda - 1)$$

$$WTP_U = [\lambda^{1/2}(z_H - z_L) - (z_H - \lambda z_L)]/(\lambda - 1)$$

yielding

$$WTA_U - WTP_U = \frac{\lambda^{1/2} - 1}{\lambda^{1/2} + 1}[z_H - z_L]. \tag{4}$$

Once again, the difference between WTA and WTP depends on the spread of the random variable. In both (3) and (4), if there is no loss aversion ($\lambda = 1$), WTA and WTP are identical.

Surprisingly, this proportional relationship between the WTA - WTP difference and the spread of a binary random variable also holds for another class of preferences - rank dependent expected utility (RDEU) preferences. Suppose that an RDEU maximizer faces a binary lottery with payoffs $x_1 < x_2$ and corresponding probabilities p_1 and p_2. The RDEU preference function has the form

$$W(\tilde{x}) = g(p_1)u(x_1) + (1 - g(p_1))u(x_2),$$

where $g(p)$ is a probability weighting function with $g(0) = 0$, $g(1) = 1$, and $g'(p) \geq 0$ for all p, and $u(x)$ is a utility function. The key feature of RDEU is that the probability of the *lower* of the two outcomes is weighted according to the function g, and then expected utility is computed using the weighted probability. As with the loss aversion case, assume that $u(x) = x$ so that all of the individual's risk attitudes are determined by the probability weighting function, which is the distinguishing characteristic of RDEU.[8] Preferences are risk averse if $g(p) \geq p$ for all p, although this is not the pattern found in most experimental studies of the weighting function.[9]

---

[8] Under this assumption preferences match those in Yaari's (1987) dual theory.

[9] Studies of RDEU preferences have found that $g(p)$ typically overweights probabilities less than about 0.4 and underweights probabilities above 0.4 (Tversky and Kahneman, 1992; Camerer and Ho, 1994; Wu and Gonzalez, 1996; Prelec, 1998).

Now suppose that $\tilde{z}$ is a binary random variable with outcomes $z_H > z_L$ and corresponding probabilities p_H and p_L. From (1), *WTA* solves

$$g(p_H)[WTA - z_H] + [1 - g(p_H)][WTA - z_L] = 0,$$

which yields

$$WTA_{RD} = g(p_H)z_H + [1 - g(p_H)]z_L.$$

From (2), *WTP* solves

$$g(p_L)[z_L - WTP] + [1 - g(p_L)][z_H - WTP] = 0,$$

which yields

$$WTP_{RD} = g(p_L)z_L + [1 - g(p_L)]z_H.$$

Note that WTA uses the transformed probability of the high outcome, $g(p_H)$, and WTP uses the transformed probability of the low outcome, $g(p_L)$. We get

$$WTA_{RD} - WTP_{RD} = [g(p_H) + g(p_L) - 1][z_H - z_L]. \quad (5)$$

According to (5), the WTA - WTP disparity increases with the spread in the payoffs, and will be positive if preferences are risk averse so that $g(p) \geq p$ for all p.

An implication of the arguments made here is that stated WTP *understates* the individual's true willingness to pay while stated WTA *overstates* the individual's true willingness to accept. In all the cases above WTA places more emphasis on the highest outcome of the lottery (or its probability) and WTP places more emphasis on the lowest outcome. This is slightly different than the usual argument that WTA values are biased upward while WTP values are more likely to be true (Coursey, Hovis, and Schulze, 1986). This class of uncertainty is important if the transaction is irreversible. Why should the irreversibility matter? The above uncertainties can be overcome if the transaction is reversible at low cost (the risk is covered). If the transaction is irreversible, then the bid price (WTP) will be too low and the ask price (WTA) will be too high. A further implication is that, if we do not observe a difference here, uncertainty is not the cause of the disparity between WTA and WTP.

Our first hypothesis arises directly from equation (4).

H1: *An increase in the spread of a uniform random variable increases WTA – WTP.*

This is our most basic hypothesis – that increases in risk lead to increased WTA - WTP differences. The second hypothesis is that behavior in different choice settings should arise from the same underlying choice model.

H2: *WTA - WTP differences in different treatments are consistent with the same value of the loss aversion parameter* λ.

Finally, allowing subjects to re-contract by paying a small fee to reverse a decision after the uncertainty is resolved reduces the uncertainty subjects face. If WTA - WTP differences are caused by uncertainty, reductions in uncertainty should reduce the differences.

H3: *WTA - WTP differences are lower in the re-contracting treatments.*

Since it protects against irreversibility, to some extent the opportunity for re-contracting might be viewed as mimicking the substitution-availability argument (Hanemann, 1991). In the neutral context of an induced-value lab setting, where the treatments do not change the existence of substitutes, re-contracting is better characterized as reducing the ex ante uncertainty surrounding a given choice.

III. Related Literature

We do not have the space to exhaustively discuss the vast literature on the topic of WTA - WTP disparities. It will be useful to briefly review some of the studies that are more relevant to our argument. Table 1 summarizes the results from a subset of the literature. Large differences arise when the quality of the good and/or the subjective utility is likely to be uncertain ex ante. Many of the field studies focus on hunting permits and find that the compensation demanded (WTA) substantially exceeds the WTP value. Since the eventual outcome of a given hunting trip is highly uncertain, the value to the individual is subject to wide variation. In addition, there are generally few opportunities to purchase a replacement permit if you sell yours. Even in the laboratory, the types of lottery tickets offered are generally unique and the range of possible payoffs quite large. Thus, there is considerable uncertainty and the reported WTA-WTP differences reflect this.[10] In sum, the evidence provided by the literature on contingent valuation field studies and previous experimental work is consistent with our argument that the disparity is due to uncertainty regarding the value of the good.

Recently, Plott and Zeiler (2005) have shown that the endowment effect class of arguments for the divergence is perhaps less robust than the accumulated literature would suggest. Through careful introduction of various experimental controls, Plott and Zeiler are able to eliminate the divergence that is argued to be due to the endowment effect and they attribute previous findings to "subject misconception". This study is especially relevant to ours since we employ most of the Plott and Zeiler controls but find that uncertainty regarding the ultimate

[10] Note that we have developed our arguments in terms of the difference between WTA and WTP values. The literature has largely relied on reporting the ratios although Adamovicz et al. (1993) also conduct their analysis using differences.

value of the good can result in a divergence between WTA and WTP. This uncertainty can be resolved if the individual is able to reverse the transaction upon learning the true value.

Absent sunk cost errors, the availability of near substitutes for the good being valued, will also reduce the divergence as Hanemann's (1991) argument demonstrates concerning the role of substitution possibilities as an explanation of the WTA-WTP disparity. Adamovicz et al. (1993) investigate Hanneman's argument. In their experimental setting, the subjects are asked to state their hypothetical WTP and WTA (within-subjects design) values for a good for which the closeness of substitutes is determined by personal (observable) characteristics. Similar to Shogren et al. (1994), they find that increased substitution possibilities *reduces* the disparity between WTA and WTP but does not *eliminate* it. They conclude that something else is contributing to this disparity. As already noted, we argue that it may be uncertainty concerning the good. In Adamovicz et al. (1993), the two goods are movie tickets to a one time showing of a film and tickets to a NHL playoff hockey game in Edmonton. In both cases, the individual's ultimate enjoyment of the event is uncertain at the time the purchase or sale decision is made. Thus, there is uncovered uncertainty. Eisenberger and Weber (1995) investigate the behavior of the WTA/WTP ratio under varying conditions of uncertainty and ambiguity in lottery payoffs. They find no interaction between ambiguity and WTA/WTP ratios. The experimental setting of Eisenberger and Weber differs from ours in several respects.[11]

---

[11] Their subjects were all graduate students in economics and business. It is likely that these subjects are prone to computer expected values since they have been trained to do so. The BDM procedure in their study used fairly coarse distribution of random prices. Their design elicited responses to a set of decisions before the results of a randomly drawn event was revealed. Although the subjects were told that one decision would be drawn, it is possible that this was not fully understood with the result that the subjects adopted a portfolio of decisions which would have damped differences in WTA and WTP.

IV. Experimental Design

In order to empirically test our hypotheses, we implement an induced-value laboratory experiment, with real payoffs (i.e., not hypothetical). In the experimental market the good is an asset (neutral) with an uncertain redemption value or outcome (good vs. bad state of nature).[12] Subjects are given the value or outcome distribution in the form of a uniform distribution of values over an announced range or in the form of a lottery over two outcomes. Experimental treatments are the level of uncertainty using a mean-preserving spread, or variance in the lottery outcome, and whether the transaction is reversible. Reversibility is introduced via a re-contracting option that is offered at a cost. The primary null hypothesis is that the WTA vs. WTP disparity is increasing in uncertainty. A second null hypothesis is that the disparity between WTA and WTP declines when the transaction is reversible.

The experimental investigations are conducted in a computerized laboratory in which the subjects make individual decisions and enter these at a computer terminal.[13] The experiments employ a within-subject design to increase the statistical power of the data by controlling for subject effects. Each subject is asked both the WTP and the WTA question. To control for order effects we randomly assign subjects to a setting in which some face the WTA setting first while others face the WTP setting first. This is a quantity change setting; the subjects either purchase a unit of the laboratory good (a coupon to be redeemed at the end of the experiment) or they sell a

[12] A pure induced-value setting is employed to reduce extraneous effects. Since the good has no intrinsic value, we are able to limit the effects of unease to those inherent in the transaction itself.

[13] Instructions are available from the corresponding author.

unit of the laboratory good.[14] Due

to the within-subject design, subjects are initially sellers (to experimenter) and then buyers (from experimenter) or initially buyers and then sellers.[15] After the subjects have bought or sold the "good" the true value is revealed. At that point, if re-contracting is permitted the subject can choose whether to pay the cost of re-contracting to reverse the transaction.

To induce incentive compatibility the Becker-DeGroot-Marshak (BDM) mechanism is employed to elicit the WTP and WTA values from the subjects. This mechanism has been extensively investigated by Harrison (1986), McKee (1988), and by Irwin et al. (1998) and found to be incentive compatible at the low payoffs used in the laboratory and also cognitively transparent. Further, as Irwin et al. show, WTA and WTP values converge under the BDM when there is no uncertainty concerning the payoff from the good. Thus, if there are observable differences between WTA and WTP values in the experiments reported here, these are not due to the use of the BDM mechanism.[16]

As per Plott and Zeiler (2005) we take care to ensure that the subjects understand the

---

[14] We are following the classic induced value methodology (Smith, 1976) in which the laboratory commodity has zero intrinsic value. The value the subjects place on the good is induced by the fact that the experimenters will exchange the good for cash at the end of the session.

[15] To check for possible order effects an ABA design was conducted for some subjects. The results were unchanged and are not reported here since the sample sizes were small.

[16] The BDM mechanism is not without critics. Horowitz (2006) shows that it is not always incentive compatible and some argue that it can be unstable in the lab. Horowitz (2006) shows that it is not always incentive compatible and some argue that it can be unstable in the lab. On the other hand, with care (see Plott and Zeiler, 2005), it does work very well in the lab (Irwin, et al, 1998) and, for the class of utility functions investigated here (loss aversion and rank dependent expected utility), Horowitz notes that the BDM is theoretically incentive compatible.

BDM mechanism. We conduct practice rounds.[17] We draw the random buy (sell) prices from bingo cages that are in plain view of the subjects and we show the drawn ball to all subjects. The ball is clearly replaced after each draw. Our subjects make several paid decisions in each setting: WTA and WTP.

The BDM bidding mechanism is implemented as follows. An individual is asked to state her maximum willingness to pay (WTP) for a good. After the individual has stated a WTP value, a random buying price is drawn from a known distribution. If the random buying price is below the individual's stated WTP value, the individual buys the good at the random buying price. Otherwise, the individual does not buy the good. The BDM bidding mechanism can be shown to be incentive-compatible. The intuition is straightforward. It is not in the individual's interest to understate WTP; if the random buying price falls between the stated WTP and the true WTP, the individual has foregone a beneficial trade. It is not in an individual's interest to overstate true WTP; if the random buying price is greater than the true value but less than the stated value, the individual will be required to buy the good at a price greater than true WTP. The same argument holds for the WTA decision. A theoretical proof of incentive compatibility is reported in Irwin et al. (1998) where it is also shown that the BDM and the Vickrey auction have identical incentive properties.[18]

Thus, for each decision, the experimental setting progresses as follows:

(1) The subject is asked for a bid or ask price for the neutral asset.

---

[17] We do not pay on practice rounds. We feel that the incentive to learn from these rounds derives from the fact that subsequent earnings depend on understanding the experiment setting. Further, since these rounds do not impose a financial penalty, our subjects are free to experiment to learn the optimal strategy.

[18] Plott and Zeiler (Table 1) report on many previous studies. Of the 28 relying on an incentive compatible mechanism, 10 employed the BDM and 8 the Vickrey (second price) auction mechanisms.

(2) The selling (or buying) price is revealed (random draw over a known distribution).

(3) If the subject's price is higher (lower) than the buying price, the subject can buy (sell) the ticket at the drawn price, otherwise the round is over for the subject.[19]

(4) In the treatments where re-contracting is offered, after the value of the neutral asset revealed (this is common knowledge), the subject can avoid some losses by re-contracting at a (known) cost.

All random values are drawn from known uniform distributions and the mechanics are accomplished through the use of bingo cages. The BDM price is drawn from a bingo cage (cage 1) as is the true value (cage 2). All subjects observe the draws and the distribution of the ball values prior to the balls being placed into the bingo cages. In each round a single BDM price and true value are drawn and apply to all subjects in the session. Draws are made with replacement.

As noted above, value uncertainty is induced by means of a mean-preserving spread (Rothschild and Stiglitz, 1970) while outcome uncertainty is induced by means of a lottery payoff in which the probability of the positive payoff is varied (high versus low). Experimental treatments are the level of uncertainty and whether the opportunity to re-contract is offered. When available, the re-contracting costs is 70% of the expected surplus from the transaction. Thus, while re-contracting is offered, the cost of doing so is quite high. The experimental design is reported in Table 2. Since the uncertainty treatment is a mean preserving spread, the mean values for all uncertainty treatments are constant. Thus, absent LA or RDEU related effects, we predict that the WTP and WTA values will be the same and constant throughout a session.

[19] Steps 2 and 3 constitute the BDM mechanism used to elicit the preferences of the subjects.

Further, to allow comparisons under re-contracting we set the relative cost of re-contracting at a constant fraction of the possible surplus from the transaction. That is, the re-contracting cost is higher when the value spread is larger. The number of subjects participating in each treatment is reported in Table 2 (the first number is the number of subjects in the WTP-first sessions).

These experiments were conducted in a computerized lab at the University of XXXX. Subjects were randomly assigned to treatments and no subject was permitted to participate in more than one session. Subjects made several decisions in the WTA setting and in the WTP setting. Sessions lasted approximately an hour and earnings averaged approximately $15 exclusive of a show up fee of $3. The instructions were distributed to the subjects and were read aloud to ensure that the subjects knew that all had received the same information and were playing the same game. Two practice rounds were run and any remaining clarification questions were addressed. As noted earlier, the number of paid rounds varied slightly across sessions depending on the time available. But all subjects made a minimum of nine decisions in both the WTA and WTP space.

In terms of the hypotheses set out above, we may view increasing uncertainty as increasing the range of payoffs in the continuous case and as lower odds of the large payoff in the lottery case.[20] The re-contracting cost maps directly into the irreversibility argument. The higher the re-contracting costs, the less reversible the transaction. If no re-contracting is possible, the transaction may not be reversed and there is no covered uncertainty. This is the maximal uncertainty case.

[20] Of course, since the lottery yields a binary payoff, the maximum variance (a measure of uncertainty) occurs when the probability of success is 0.5. It remains an open question whether individuals view this as the maximum uncertainty case or whether they view the low probability of the high payoff as the setting with the greatest uncertainty.

V. Experimental Results

Tables 3 and 4 report summary statistics of the WTA - WTP disparities for the eight treatments. The first hypothesis (***H1***) concerns the change in the WTA - WTP difference when subjects are faced with two different uniform distributions. The hypothesis states that the difference should increase with the spread of the distribution, and the raw data in treatments T(1)2 and T(2)4 does not reject this hypothesis. The mean WTA - WTP difference for the uniform random variable over [0.31, 0.50] is 0.0195, and the mean difference for the uniform distribution over [0.11, 0.70] is 0.044. The uniform distribution with the larger domain generates a higher average WTA - WTP difference than the one with the smaller domain, consistent with our hypothesis.

Formal hypothesis tests confirm these conclusions. Comparing T(1)2 vs T(2)4, the *t*-statistic for difference of means is 1.28 (p-value = 0.100) and thus we cannot reject the hypothesis (at the 10% level) that the disparity is increasing in the level of uncertainty.[21]

The second hypothesis (***H2***) concerns whether all four treatments with no re-contracting could have been generated from the same underlying model; that is, is the data consistent with a single value of the loss aversion parameter λ. This hypothesis is addressed using Table 5. The first row of the table reports the means and standard errors for the no re-contracting treatments. These values are then used to construct 95% confidence intervals for each of the treatments, under the assumption that the data is distributed normally. These confidence intervals are reported in the second row. Each of the means is consistent with a value of λ which can be

---

[21] For the case in which the WTA question is asked first, the *t*-statistic is 2.25. Thus the value of WTA-WTP is greater in T(2)4 than T(1)2. The divergence between WTA and WTP is increasing in the level of the uncertainty. The results are similar for the case in which the WTP question is asked first. The *t*-statistic is 3.31 and T(2)4 > T(1)2.

found using equation (4) for the uniform distribution treatments, T(1)2 and T(2)4, and using equation (3) for the binomial treatments, T(3)6 and T(4)8. The implied values are $\lambda = 1.51$ in treatment T(1)2, $\lambda = 1.35$ in T(2)4, $\lambda = 1.02$ in T(3)6, and $\lambda = 1.18$ in T(4)8. Each of these values can in turn be used to predict the WTA - WTP disparities in the other treatments, and the predicted WTA - WTP differences are shown in the last four rows of the table. The bold entries correspond to the predicted value in the treatment used to identify that row, and the bold entries should closely resemble the entries in the top row in the table.

If a predicted WTA - WTP difference lies outside of the 95% confidence interval for that treatment, we can reject the hypothesis that the data in that treatment was generated by a model with the given loss aversion parameter. So, for example, the parameter $\lambda = 1.02$ was implied by the data in treatment T(3)6, but it predicts values outside of the 95% confidence intervals for all three of the other treatments. We can, therefore, reject the hypothesis that all of the data was generated by a model with parameter $\lambda = 1.02$. The table shows that the data in T(1)2, T(2)4, and T(4)8 could have been generated by the same parameter λ (= 1.18, implied by treatment T(4)8), but that the data in T(3)6 is inconsistent with any other treatment.[22]

Ex ante uncertainty may be offset through the opportunity to *re-contract* out of the transaction. In effect, the re-contracting offers a form of contingent contract (albeit with a cost) that can overcome value or outcome uncertainty concerning the utility the good may provide.

[22]The lottery in T(3)6 has been studied extensively in the context of preference reversal experiments. In those, a $-bet with a low probability of a high payoff, like T(3)6, is compared to a P-bet with a high probability of a low payoff, with the two gambles having the same mean (see, for example, Grether and Plott, 1979). Preference reversals occur because subjects generally prefer the P-bet to the $-bet in a direct comparison but assign a higher value to the $-bet. Tversky, Slovic, and Kahneman (1990) determine that preference reversals are not caused by intransitive preferences, but instead by subjects overvaluing the $-bet. Their study suggests that valuations of lotteries like T(3)6 might be computed differently by subjects than valuations of other lotteries.

The treatments T(5)1, T(6)3, T(7)5, and T(8)6 allowed the subjects to renege, for a fee, upon the realization of the value or outcome. Consider the case in which the uncertainty and re-contracting cost are low versus the case with low uncertainty but no re-contracting option. This involves comparing T(1)2 vs T(5)1. The hypothesis is that the difference between WTA and WTP will be smaller in T(5)1. The *t*-statistic is 3.402 which is significant at the 0.0004 level; thus, the evidence support the hypothesis ***H3***; re-contracting lowers the WTA-WTP difference.

In the high uncertainty case, comparing T(2)4 vs T(6)3 the result is similar. The *t*-statistic is 1.981 (p-value = 0.024); thus, the evidence again supports hypothesis ***H3***. In both cases, the value uncertainty is at least partially resolved by the opportunity to re-contract out of a bad purchase or sale. Further, the WTA-WTP spreads for T(5)1 and T(6)3 are not significantly different from zero. For value uncertainty, the possibility of re-contracting statistically eliminates the disparity between WTA and WTP values.

In the case of outcome uncertainty, the results are much less clear. Comparing T(3)6 vs T(7)5 the *t*-statistic is 0.537; thus, there is no evidence of a statistical difference due to the presence of re-contracting options. Similarly, the *t*-statistic for T(4)8 vs T(8)7 is 0.677, and we again cannot reject the null that there is no statistical difference in the results of these two treatments. Thus, in our setting, there is mixed evidence concerning hypothesis ***H3***; outcome uncertainty would appear to be <u>unresolved</u> through the possibility of re-contracting.

V. Conclusions and Discussion

To summarize, two series of experiments were conducted to investigate the role of outcome and value uncertainty on the stated WTA and WTP values of individuals. The experiments are conducted in an induced value setting with real payoffs and an incentive compatible elicitation mechanism (BDM). Two conclusions can be drawn from the empirical results. First, the WTA - WTP difference is generally increasing in value and outcome uncertainty. Second, the re-contracting option reduces the disparity when it arises from value uncertainty. These results offer some support for the argument that uncertainties both in values and outcomes, can be a source WTP - WTA disparity.

It is interesting to note that our disparities between WTA and WTP are smaller than those reported in previous experimental literature. Most of the previous studies have investigated behavior over lotteries. In most cases, the range of gains in these lottery settings have been larger than those utilized here. The continuous setting is somewhat less common in the literature and so we have fewer comparisons. One explanation for the smaller disparities is that our setting is completely devoid of context. Even the "lottery ticket" setting downplays the gamble. The goals of the present investigation were to subject the hypothesis that outcome and/or payoff uncertainty underlies the divergence between WTA and WTP to a strong, clean test by limiting the context in the experimental setting and to determine whether the re-contracting opportunity offers a remedy to this divergence. Thus, context was minimized in the experimental setting. Further, the use of the BDM mechanism may contribute to smaller disparities since it induces incentive compatibility in preference revelation, while many previous studies have relied on hypothetical value settings (without incentive compatible mechanisms).

The results support the argument that uncertainty is a potential cause of the WTA-WTP disparity. To the extent that uncertainty can be reduced through the ability to re-contract, the disparity seems to be reduced. An avenue of further research is the sensitivity of the disparity to the costs (opportunity) for re-contracting.

As an aside, the typical reporting of WTA vs WTP in the form of a ratio implicitly assumes that the WTP value is correctly stated by the respondent. Focusing on the difference, as we do here, highlights the fact that uncertainty on the part of the respondent will lead to biased values for both WTP and WTA. It is worth keeping this in mind when designing value elicitation surveys such as those used in contingent valuation studies.

References

Adamowicz, W., V. Bhardwaj, and B. Macnab, 1993, "Experiments on the Difference Between Willingness to Pay and Willingness to Accept," *Land Economics*, vol 69, pp 416-27.

Akerlof, G., 1970, "The Market for 'Lemons': Qualitative uncertainty and the market mechanism," *Quarterly Journal of Economics*, vol 84, pp 488-500.

Banford, N.D., J.L. Knetsch, and G.A. Mauser, 1979, "Feasibility Judgements and Alternative Measures of Benefits and Costs," *Journal of Business Administration*, vol 11, pp 25-35.

Bateman, I., A. Munro, B. Rhodes, C. Starmer, and R. Sugden, 1997, "A Test of the Theory of Reference Dependent Preferences," *Quarterly Journal of Economics*, vol 112(2), pp 479-505.

Bishop, R. and T. Heberlein, 1979, "Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?" *American Journal of Agricultural Economics*, vol 61, pp 926-930.

____________________, and M. Kealy, 1983, "Hypothetical Bias in Contingent Valuation: Results from simulated markets," *Natural Resources Journal*, vol 23, pp 619-633.

Brown, T.C., 1994, "Experiments on the Difference Between Willingness to Pay and Willingness to Accept: Comment," *Land Economics*, vol 70, pp 520-522.

___________, 2005, "Loss aversion without the endowment effect and other explanations for the WTA-WTP disparity," *Journal of Economic Behavior and Organization*, vol 57; pp 367-379.

__________ and R. Gregory, 1999, "Why the WTA-WTP Disparity Matters," *Ecological Economics*, vol 28, pp 323-335.

Camerer, C. and T.-H. Ho, 1994, "Violations of the Betweeness Axiom and Nonlinearity in Probability," *Journal of Risk and Uncertainty*, vol 8, pp 167-96.

Coursey, D., J. Hovis, and W. Schulze, 1986, "The Disparity Between Willingness to Accept and Willingness to Pay," *Quarterly Journal of Economics*, vol 102, pp 679-90.

Eisenberger, R. and M. Weber, 1995, "Willingness to Pay and Willingness to Accept for Risky and Ambiguous Lotteries," *Journal of Risk and Uncertainty*, vol 10, pp 223-233.

Grether, D. and C. Plott, 1979, "Economic Theory of Choice and the Preference Reversal Phenomenon," *American Economic Review*, vol 69, pp 623-38.

Hanneman, M., 1991, "Willingness to Pay and Willingness to Accept: How Much Can They Differ," *American Economic Review*, vol 81, pp 635-647.

Hammack, J. and G. Brown, 1974, *Waterfowls and Wetlands: Towards Bioeconomic Analysis*, The Johns Hopkins University Press (for Resources for the Future), Baltimore, MD

Harless, D., 1989, "More Laboratory Evidence on the Disparity Between Willingness to Pay and Compensation Demanded," *Journal of Economic Behavior and Organization*, vol 11, pp 359-379.

Harrison, G.W., 1986, "An Experimental Test for Risk Aversion," *Economics Letters*, vol 21, pp 7-11.

Horowitz, J., 2006, "The Becker-DeGroot-Marshak mechanism is not necessarily incentive compatible even for non-random goods," *Economics Letters*, vol 93, pp 6-11.

Horowitz, J. and K. McConnell, 2003, "Willingness to pay, willingness to accept and the income effect," *Journal of Economic Behavior and Organization*, vol 51, pp 537-545.

_______________, 2002, "A Review of WTA/WTP Studies," *Journal of Environmental Economics and Management*, vol 44, pp 426-447.

Irwin, J., G. McClelland, M. McKee, W.D. Schulze, and E. Norden, 1998, "Payoff Dominance vs. Cognitive Transparency in Decision Making," *Economic Inquiry*, vol 36, pp 272-285.

Kahneman, D. and A. Tversky, 1979, "Prospect Theory: An analysis of Decisions under Risk," *Econometrica*, vol 47, pp 263-291.

Kachelmeier, S. and M. Shehata, 1992, "Examining Risk Preferences Under High Monetary Incentives: Experimental Evidence from the People's Republic of China," *American Economic Review*, vol 82, pp 1120-41.

Kahneman, D., J. Knetsch, and R.H. Thaler, 1990, "Experimental Tests of the Endowment Effect and the Coase Theorem," *Journal of Political Economy*, 98, pp 1325-1348.

Karni, E. and Z. Safra, 1987, "'Preference Reversal' and the Observability of Preferences by Experimental Methods," *Econometrica*, vol 55, pp 675-685.

Knetsch, J., (1989), "The Endowment Effect and Evidence of Nonreversible Indifference Curves," *American Economic Review*, vol 79, pp 1277-84.

Knetsch, J. and J. Sinden, 1984, "Willingness to Pay and Compensation Demanded:

Experimental Evidence of an Unexpected Disparity in Measures of Value," *The Quarterly Journal of Economics*, 99, pp 507-521.

Kolstad, C. and R. Guzman, 1999, "Information and the Divergence Between Willingness to Accept and Willingness to Pay," *Journal of Environmental Economics and Management*, vol 38, pp 66-80.

MacDonald, H.F., and J.M Bowker, 1994, "The Endowment Effect and WTA: A Quasi-experimental Test," *Journal of Agricultural and Applied Economics*, vol 26, pp 545-51.

McKee, M, 1989, "Intra-experimental Income Effects and Risk Aversion," *Economics Letters*, vol 30, pp 109-115.

Morrison, G.C., 1997, "Willingness to Pay and Willingness to Accept: Some Evidence of an Endowment Effect," *Applied Economics*, vol 29, pp 411-17.

Plott, C.R. and K. Zeiler, 2005, "The Willingness to Pay – Willingness to Accept Gap, the 'Endowment Effect,' Subject Misconceptions, and the Experimental Procedures for Eliciting Evaluations," *American Economic Review*, vol 95 (3), pp 530-545.

Prelec, D., 1998, "The Probability Weighting Function," *Econometrica*, vol 66, pp 497-527.

Rabin ref – note importance of loss aversion explanation

Rachlinski, J. and F. Jourden, 1998, "Remedies and the Psychology of Ownership," *Vanderbilt Law Review*, 51(6): 1541 - 82.

Rothschild, M. and J. Stiglitz, 1970, "Increasing Risk I: A Definition," *Journal of Economic Theory*, vol 2, pp 225-243.

Shogren, J., S.Y. Shin, D.J. Hayes, and B. Kliebenstein, 1994, "Resolving Differences in Willingness to Pay and Willingness to Accept," *American Economic Review*, 84, pp 255-270.

Smith, V., 1976, "Experimental Economics: Induced Value Theory," *American Economic Review, Papers and Proceedings*, vol 66, pp 274-9.

Thaler, R., 1980, "Toward a Positive Theory of Consumer Choice," *Journal of Economic Behavior and Organization*, vol 1, pp 39-60.

Tversky, A. and D. Kahneman, 1992, "Advances in Prospect Theory," *Journal of Risk and Uncertainty*, vol 5, pp 371-384.

Willig, R., 1976, "Consumer Surplus Without Apology," *American Economic Review*, vol 66, pp

589-597.

Wu, G. and R. Gonzalez, 1996, “Curvature of the Probability Weighting Function,” *Management Science*, vol 42, pp 1676-1690.

Table 1: WTA-WTP for Various Goods

Study-Authors	Good	WTA	WTP	WTA-WTP
Field Studies				
Hammack & Brown	waterfowl hunting	1044	247	797
Bishop & Heberlein	goose hunting permit	101	21	80
MacDonald and Bowker	industrial plant odor	735	105	630
Boyce and McCollum	bison hunting permit	12,233	215	12,018
Banford et al	fishing pier	120	43	77
Bishop et al	deer hunting permit	153	31	122
Laboratory Studies				
Knetsch & Sinden	lottery ticket	5.18	1.28	3.90
Harless	lottery ticket	na	na	2.7 (Ratio)
Kahneman et al.	coffee mug	5.78	2.21	3.57
Eisenberger & Weber	lottery ticket	6.11	4.23	1.88
Shogren et al.	food safety	3.50	0.90	2.60
Kachlemeier & Shehata	lottery ticket	11	6	5
Morrison	coffee mug	2.20	0.99	1.21

Source: Adapted from Brown and Gregory (1999). References appear in the bibliography.

Table 2: Experimental Design

	Uncertainty			
	Value Range		Lottery Probability	
	Low (.31-.50)	**High (.11-.70)**	**Low (.1) Win = 4.50**	**High (.5) Win = 0.90**
No Recontracting	T(1)2: 25, 26	T(2)4: 18, 26	T(3)6:20, 22	T(4)8: 29, 26
Recontracting Available	T(5)1: 29, 21	T(6)3: 21, 16	T(7)5:24, 23	T(8)7:21, 22
Recontracting Cost	0.07	0.21	0.07	0.21

Table 3 -- Value Uncertainty

Treatment	Description	WTA - WTP mean (std error) [% of Value Range]
T(1)2	Value Uncertainty - Low Range No Recontracting Offered	0.0195** (0.0076) [10%]
T(2)4	Value Uncertainty - High Range No Recontracting	0.0444** (0.0181) [7.5%]
T(5)1	Value Uncertainty - Low Range Recontracting Offered	-0.03799 (0.0391) [ns]
T(6)3	Value Uncertainty - High Range Recontracting Offered	0.03165 (0.1036) [ns]

Table 4 -- Outcome Uncertainty

Treatment	Description	WTA - WTP mean (std error)
T(3)6	Low Probability Success (.1) No Recontracting Offered	0.0169 (0.034)
T(4)8	High Probability of Success (.5) No Recontracting Offered	0.0733** (0.027)
T(7)5	Low Probability of Success (.1) Recontracting Offered	0.0157 (0.097)
T(8)7	High Probability of Success (.5) Recontracting Offered	0.0304 (0.121)

Table 5 – Actual vs. Predicted

	T(1)2	T(2)4	T(3)6	T(4)8
Actual WTA - WTP difference				
mean (std. error)	0.0195 (0.0076)	0.0444 (0.0181)	0.0169 (0.0340)	0.0733 (0.0270)
Confidence interval	(0.0043, 0.0347)	(0.0082, 0.0806)	(-0.0511, 0.0849)	(0.0193, 0.1273)
Predicted WTA - WTP difference (LA)				
λ = 1.02	0.0009	0.0029	**0.0160***	0.0089
λ = 1.18	0.0078*	0.0244*	0.1343	**0.0743***
λ = 1.35	0.0142*	**0.0442***	0.2447	0.1340
λ = 1.51	**0.0195***	0.0605*	0.3381	0.1829

5% confidence interval reported assuming normal distribution.
Bold corresponds to treatment used to determine λ.
Asterisks denote that the predicted value is within the observed confidence interval for that column.