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Abstract

Estimating empirical measures of an individual's willingness to accept that are consistent with conventional economic theory, has proven difficult. The method of paired comparison offers a promising approach to estimate willingness to accept. This method involves having individuals make binary choices between receiving a particular good or a sum of money. Willingness to accept can be inferred from the ranking of dollar amounts and the good of interest. Using the paired comparison approach, mean (median) willingness to accept for a private good is estimated at $59($52). Contingent valuation estimate of willingness to pay for the same good yields a mean (median) of $28($28). While these estimates are statistically different, the ratio of willingness to accept to willingness to pay is less than in most previous studies and closer to ratios found in actual cash experiments. Published by Elsevier Science B.V.

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1. Unexplained divergences between welfare measures

Changes in economic well-being arising from changes in the quantity of public goods can be measured by compensating or equivalent surplus measures. When the public has a legal right to the current quantity of a public good and that quantity is reduced by a third party, compensating surplus is a willingness to accept monetary compensation measure of the loss. However, existing approaches for measuring willingness to accept, whether survey or experiment-based, frequently provide empirical estimates that appear inconsistent with certain tenets of economic theory.

Economic theory suggests that willingness to pay will be a good proxy for willingness to accept when the benefits from the good make up a small percentage of the income (Willig, 1976) or when the good has ample substitutes (Hanemann, 1991). However, experiments designed to test the relationship between these two measures have frequently found estimates of willingness to accept to be 2–10 times larger than the willingness to pay even with 'trivial' market goods such as coffee mugs which make up a small part of income and have numerous substitutes. The large divergence persists even with actual cash experiments as shown by Welsh (1986) and when goods are actually exchanged as shown by Knetsch and Sinden (1984). Kahnemann et al. (1990) explain these large disparities in terms of endowment effects and loss aversion. Horowitz et al. (1996), however, find only limited support for these explanations. Lucero (1995) offered another interpretation of the divergence. She argued that it arises from the experimental design involving estimating willingness to pay for individuals not in the market for the good and willingness to accept for a good, individuals received at no cost in the experiment. At this time, the consensus remains (Mitchell and Carson, 1989; Arrow et al., 1993) that current benefit estimating approaches such as contingent valuation do not appear capable of reliably measuring willingness to accept. Thus the hazard of underestimation of public good benefits remains an important practical issue.

In this paper we use the method of paired comparison to estimate a lower bound on willingness to accept. An individual is asked to make a binary choice between two alternative gains, for example, $50 or an additional quantity of a good. If the good is selected, then the lower bound for willingness to accept for the good is greater than $50. The chooser reference point avoids the apparent loss aversion associated with the standard contingent valuation because the individual is comparing two alternative gains (Kahnemann et al., 1990; Franciosi et al., 1993). The purpose of this paper is to determine if the paired comparison method can provide a valuation that reduces the gap between willingness to accept and willingness to pay.

2. Using paired comparison to measure willingness to accept

The theory of paired comparison goes back to Fechner (1860) and was first formalized by Thurston (1927). David (1988), Kendall and Gibbons (1990) provide rigorous treatment of the probability theory of comparative judgment that underlies the method. Paired comparison can be applied to valuation by specifying a choice set that consists of carefully defined public or private goods (including one or more target goods of special interest) and sums of money.

Fig. 1 illustrates the relationship between willingness to pay and paired comparison derived willingness to accept. The individual starts at Point A with two units of the private good and four units of the public good. Then the individual is offered a choice between three more units of the private good or three more units of the public good. If the increment in the private good is chosen over the increment of the public good, the individual's minimum willingness to accept to forego the gain of AB units of the public good is less than the value of the added units of the private good. In Fig. 1, AC is the minimum additional amount of the private good that would provide the same level of utility as the addition of AB units of the public good (i.e. Equivalent Variation or EV in Fig. 1). By asking whether the individual would choose a given increment of the public good or differing amounts of money, the method of paired comparison can bracket willingness to accept within two different dollar amounts. For example, in Fig. 1, one
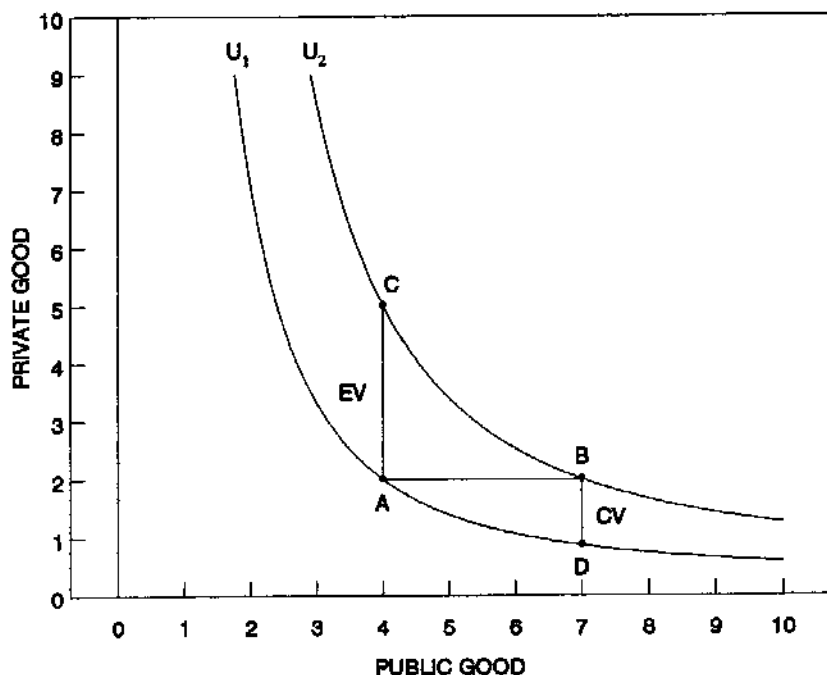

Fig. 1. Comparing Equivalent Variation (EV) and Compensating Variation (CV).

could identify the point of indifference by asking the individual if they would choose two *more* units of money or three *more* units of the public good and a second choice between four more units of money or three more units of the public good. The 'No' response to two more units and the 'Yes' response to four more units would allow the analyst to bracket the minimum willingness to accept (WTA) between two and four units of money.

Fig. 1 also illustrates willingness to pay (WTP) for the gain in AB units of the public good. In this case the individual is asked to state the maximum amount of private good they would sacrifice to obtain AB, holding utility constant at the original level (U_1). This is a Compensating Variation, an amount equal to BD. In this example, therefore Compensating Variation is less than Equivalent Variation, which implies that WTA>WTP. However, the difference between the two in this choice experiment is not expected to be as large as the difference between WTP and WTA measured in past experiments. This is because the chooser reference point apparently avoids loss aversion and any observed difference between WTA and WTP should be due to the income effect. Kahnemann et al. suggest loss aversion occurs if the minimum compensation a person would require to move from an existing endowment at point B with seven units of the public good to four units of the public good is greater than AC units of the private good. In Kahnemann et al.'s view, the individual's indifference curve would actually be kinked at the endowment point B and rise more steeply than U_2.

An important issue is whether compensation beyond AC amount of the private good to include loss aversion is a legitimate part of the welfare change. That is, should the public be compensated for both the change in utility of the good foregone (AC) and the reduction in utility due to loss aversion, independent of the value of the good itself? The appropriate answer depends upon several issues. One is whether the public has a legal property right to the current level of the good. Another is that the 'consumer sovereignty' view that individuals are their own best judge of their well being would suggest that both sources of the reduction in utility should be included in the welfare measure (Kahnemann et al.). The counter view would be that the economic theory of rational choice suggests that other than income effects, gains and losses are viewed equivalently. Observed differences between WTP and WTA from experiments that are larger than the income effect are thus believed to be due to the question framing (Kenz et al., 1985). We believe the method of paired comparison may be a way around the question framing issue, but recognize that the legitimacy of including loss aversion as a component of the willingness to accept is yet another unresolved issue in this area.

3. Mechanics of the method of paired comparison

Paired comparison can be applied to valuation by specifying a choice set that consists of carefully defined public or private goods (including one or more target goods of special interest) and sums of money. The presentation of a series of paired comparisons between a good and a sum of money is automated by means of an interactive computer program that presents pairs of goods (or a good and a sum of money) from the chooser reference

point and requires the respondent to make a choice.[2] To control for order effects, the program presents the binary choices in random order to each individual. The computer program automatically records for each respondent an ordered matrix of binary choices, the sequence in which the respondent sees the pairs and the number of circular triads produced by the respondent's choices.[3] With four goods and ten sums of money, given that choices between sums of money were not asked, the respondent makes 46 choices. The individual chooses between the two goods or the good and the sum of money by pressing the right arrow key for the good on the right or the left arrow key for the good on the left. The right/left order between goods and money was randomly varied so that a particular good or amount of money could appear on the right or left side of the screen.

In our paired comparison experiment, four private goods, including a signed wildlife art print, an ATT cordless phone, dinner and beverage for two at a local restaurant and two tickets to one local college football game (seats on the 20 yard line), were described on a 'product sheet' that was given to each participant. For two of the goods, the wildlife art print and phone, the actual goods were displayed in the room. For the other two goods, the restaurant dinner and football tickets, the actual menu and football tickets (along with upcoming football schedule) were mounted on poster boards. The boards and goods were shown up close to the participants and remained on display during the session. Twelve different dollar amounts ranging from $4 to $295 were included in the paired comparisons.

There are at least three conceptual advantages of paired comparison relative to the traditional or single bound dichotomous choice contingent valuation method. First, an individual is asked to value one good within the context of a bundle of goods. The number of goods in the bundle and the type of competing goods can be varied by the researcher to make the respondent aware of the policy relevant trade-offs. If the government can only provide one or two public goods or services, the choice set could include these possibilities. This should make valuation of the good of interest reflect the presence of other choices. Most contingent valuation method (CVM) surveys consider just one good, or at most three (Hoehn and Loomis, 1993). Second, the repetitive choices between different dollar amounts and the good provide the opportunity to bracket the individual's valuation of the good between a lower and upper dollar amount. This allows for more precise valuation than with a single bound dichotomous choice CVM (Hanemann et al., 1991), although there is some concern about how to statistically analyze multiple responses from the same individual (Cameron and Quiggin, 1994; Alberini, 1995). Third, such repeated choices with randomized bid amounts allow for exploring the incidence and nature of intransitive choice.

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[2] The program is written in Fortran but was compiled to run on nearly any DOS-based machine with 640K of RAM and a hard disk.

[3] A circular triad is the product of inconsistent choice. Preference for A over B, B over C and C over A produces a circular triad (i.e. A>B>C>A). On face value a circular triad implies failure of the transitivity axiom of the utility theory. As is well understood by psychologists and probability theoreticians, however, the apparent intransitivity may be random or systematic. Random intransitivity may occur when the individual is indifferent between elements in a pair. Since paired comparison does not allow for an 'indifference choice' we believe the transitivities are switching behavior on the indifferent choices and do not violate the transitivity axiom in expected outcome sense.

4. Treatments and hypothesis tests

The laboratory experiment reported here obtains three measures of value using three independent treatments for a private deliverable good. The three treatments are:

#1: Mean WTP (estimated from respondents' take-it or leave-it statements) in the hypothetical payment situation (Hypothetical Dichotomous Choice or Hyp-DC)

#2: Mean Cash WTP (estimated from respondents' take-it or leave-it statements) in the real cash payment situation (Cash-DC)

#3: Mean WTA using Paired Comparison (PC) in the hypothetical payment situation (Hyp-PC).

The good of interest, a signed (but not limited edition) commercially available art print, has many substitutes. For most people, expenditures on unframed art prints such as ours represent a small fraction of their household's income. Given multiple substitutes and a small fraction of income devoted to the purchase of unframed art prints, economic theory suggests equality of WTA and WTP (Randall and Stoll, 1980; Hanemann, 1991). The null hypotheses to be tested are:

$$H_o^1 : \text{WTP(Cash-DC)} \quad = \quad \text{WTA(Hyp-PC)}$$
$$H_o^2 : \text{WTP(Hyp-DC)} \quad = \quad \text{WTA(Hyp-PC)}$$

If we reject H_o^1 and H_o^2 and find that WTP<WTA, a practical issue remains whether the ratio of WTA (Hyp-PC) to WTP (Hyp-DC) is comparable to what has been found in past studies. If this ratio is smaller than found in earlier studies, we may conclude that the method of paired comparison may represent an improvement over standard dichotomous choice CVM and merits further research.

5. Statistical analysis

5.1. Estimating the logit equation and calculating WTP and WTA

Maximum WTP is not directly observed in the dichotomous choice CVM approach nor is minimum WTA directly observed in the paired comparison method. For dichotomous choice CVM, there are two standard approaches for estimating maximum willingness to pay: the Hanemann (1984) utility difference approach and the Cameron (1988) compensation function. McConnell (1990) has shown that these two approaches are equivalent with linear specifications of the random utility model and constant marginal utility of income. We adopt Hanemann's as a matter of computational convenience. Hanemann views respondents using a utility difference approach when they decide whether to answer 'yes' or 'no' at the stated bid amount ($BID). If the utility difference is logistically distributed, a logit model of the probability of a 'YES' response is related to the amount the respondent is asked to pay ($BID) and attitude/demographic variables (Z) as in Eq. (1):

$$\log[\text{Prob}\,(YES)/(1 - \text{Prob}\,(YES))] = B_0 + B_1(BID) + B_2\,(Z_1) + \ldots + B_n\,(Z_n) \quad (1)$$

WTP is the area under the cumulative distribution function (g($BID)) between zero and infinity:

$$\text{WTP} = \int_0^\infty [1 - g(BID)]dBID \text{ when WTP} > 0 \qquad (2)$$

To calculate the mean WTP from the truncated logistic distribution the formula for the mean of a non-negative random variable is used (Hanemann, 1989, p. 1059):

$$\text{Mean WTP} = 1/B_1^* (\ln(1 + \exp(Bo + (B_i(Z_i))))) \qquad (3)$$

The median is provided by:

$$\text{Median WTP} = (Bo + (B_i(Z_i)))/B_1 \qquad (4)$$

where B_i is the vector of coefficients associated with the attitude and demographic variables and Z_i is a vector of sample means of the associated independent variables and B_1 is the coefficient on $BID.

Calculation of willingness to accept from paired comparison data can be approached in at least two ways. First, one could analyze the data using a non-parametric approach. Since the method of paired comparison orders preferences among the goods and the dollars, WTA is between the lowest amount the individual said she would accept and the highest amount she would not accept for the good of interest. One could also construct an empirical cumulative distribution function from the raw responses and then use it to identify the median and calculate the mean.

The parametric approach for estimating minimum WTA from the paired comparison data allows inclusion of covariates and explicitly incorporates deterministic and stochastic elements of the choice process. The approach used in this paper is an adaptation of the multiple bounded method developed by Welsh and Bishop (1993). With this method each individual's responses are scanned to find the two dollar amounts where the individual switched from a no (N) would not choose that amount of money over the good, to a yes (Y), would choose the money instead of the good. As shown below, there are essentially three possible outcomes: (a)Y_1; (b) $N_{(\$x)}$ $Y_{(\$z)}$; (c) N_u. Category (a) arises when the individual chooses the lowest amount of money offered ($4 in our experiment) over the art print; category (b) is where the individual's WTA is bracketed between the highest dollar amount the respondent rejected in favor of the art print ($x) and the lowest amount they would accept ($z), where $x<$z; in category (c) the individual prefers the art print to the highest dollar amount, which was $295 in this experiment. Assuming that the signed art print was not repulsive to the individual, response category (a) is bracketed from below by zero (i.e., if offered the print or zero dollars, they would choose the print) and by $4. This bracketing along the real number line is illustrated below:

0	$4	$x	$z	$295
	lowest	highest	lowest	highest
	$ amt	$ amt rejected	$ amt	$ amt
			accepted	
(a)< −Y_1− >		< ---(b)$N_{(\$x)}$ $Y_{(\$z)}$ --- >		(c) N_u---- >

Response category (c), where the respondent states she would not choose the highest

dollar amount offered over the good, does not provide an upper bound on the individual's WTA. However, we do know, with probability=1, that the respondent's WTA is larger than the upper dollar amount. (Welsh and Bishop, 1993, p. 339–340) use this observation to program the log likelihood function for this response category.

Using a multiple bounded approach to calculate a sample average WTA involves summing the estimated probability density function over the interval where the individual's response lies.

The log likelihood function is:

$$\ln\left(\text{Likelihood}\right) = \sum_{i=1}^{n} \ln\left(Pi_{(\$x)} - Pi_{(\$z)}\right) \tag{5}$$

where, $Pi_{(\$x)}$ and $Pi_{(\$z)}$ are the probabilities that the respondent i would reject \$x and accept \$z, respectively and n is the number of respondents.

For ease in computing the log likelihood function, the probability density function of WTA is often assumed to be logistically distributed. The log likelihood function is maximized with respect to the vector of coefficients (B) explaining the pattern of responses observed using a Gauss program developed by Welsh and Bishop. One of the variables must be the dollar amount the individual is asked to accept. Additional variables may include responses to attitude questions or the respondent's demographic characteristics such as age and education. The vector of the first order conditions for maximum likelihood is shown in Eq. (6):

$$\frac{\partial \ln\left(\text{Likelihood}\right)}{\partial B} = \sum_{i=1}^{n} \frac{1}{Pi_{(\$x)} - Pi_{(\$z)}} * \left[\frac{\partial Pi\left(\$x\right)}{\partial B} - \frac{\partial Pi\left(\$z\right)}{\partial B}\right] = 0 \tag{6}$$

Using the coefficients estimated in Eq. (6), mean and median WTA can be calculated from Eqs. (3) and (4), respectively.

The parametric approach is used in this paper for an important reason, actual cash WTP is calculated from a binary choice logit model. Therefore to provide comparability between distributional assumptions when comparing WTP derived using contingent valuation and WTA derived using the method of paired comparison a logit-based parametric approach is adopted for the paired comparison analysis.

5.2. Statistically testing differences between WTP and WTA

The equality of WTP and WTA is tested using three independent samples. To compare WTP (Cash-DC) and WTA (Hyp-PC) we estimate and compare confidence intervals based on the approach of Park et al. (1991). If the confidence intervals do not overlap, we conclude that WTA and WTP are statistically different.

6. Data collection procedures

6.1. Participants

College clerical and administrative staff in academic and non-academic units were recruited and paid \$20 for attending one of the 45-minute sessions held on campus. The

sessions were conducted before work, at lunch and after work. The hypothetical dichotomous choice contingent valuation treatment had a total sample of 52 people. The actual cash dichotomous choice treatment had 55 participants. The paired comparison experiment involved 103 individuals in 14 sessions (the sessions were smaller due to the limited number of laptop computers available).

6.2. Nature of the comparison good

While the contingent valuation and paired comparison would typically be applied to estimate the economic value of public or governmentally provided goods, private goods were chosen in this study. To facilitate the cash treatments the goods had to be deliverable and portable enough that the winning bidder could easily take it with him or her. We used a signed wildlife art print as our good. The purchase price of the print was $35.

Several pre-test sessions were conducted with the university staff to fine-tune the procedures for the paired comparison and contingent valuation methods. From these sessions, revisions were made to procedures and instructions until we were satisfied that the respondents would understand the task before them in each treatment.

6.3. Structure and conduct of the paired comparison sessions

The paired comparison experiments were run with 6–9 people per session. All sessions were led by the principal investigator who followed a written script. The paired comparison sessions involved choosing between receiving one of 12 sums of money and one of four goods, shown just two at a time (choices between two different amounts of money were omitted as being trivial comparisons). As described in detail in the previous section, these goods were the wolf print, an ATT Cordless phone, two college football tickets and a meal for two at a local restaurant. The investigator led the participants through the experiment and provided instructions on using the computers. The basic format of each session involved the paired comparison exercise, followed by debriefing questions and finally socio-economic questions. The entire experiment lasted about 40–50 minutes and was performed on the laptop computers.

Every individual who began the session completed the session, although they were told (in writing) they could leave at any time. Participants were careful to follow directions and did not discuss their choices with others during the experiment. Observation of participants suggested they put a great deal of thought into their choices. Comments after the session suggested they were stimulated by the experience. The exact wording of the introduction to the paired comparison choice process was: When the choice appears on the screen, please choose the one that you would like to receive if it were to be actually offered to you. Consider each choice independently, as if it were the only choice you had to make. While these choices are hypothetical and you will not actually receive either of the goods, make your choices as if you would actually receive one of the two goods.

6.4. Dichotomous choice WTP

The wording of the dichotomous choice contingent valuation question was: You are being asked to participate in a *hypothetical* sealed bid auction for this art print. We would

like to know if you would pay the dollar amount in question #4 below to take this art print with you at the end of this session, if this one art print were actually for sale. At this time in the survey, we are not asking what you think the art print might sell for in a store or what you think its fair price is. Rather, we want to know whether you would honestly be prepared to pay the dollar amount stated in question #4 below right now to buy the art print you are being shown, if you would really be required to pay your bid amount with cash, write a check today, or sign a Promissory Note payable on or before August 19. Please take into consideration your budget and what you can afford to pay. If the price in question #4 is different from what you judge a fair price to be, that is OK. We want to know if you would actually be prepared to pay the price listed in question #4 for the art print. Take a few moments to think about whether you honestly would be prepared to pay the printed dollar amount for this art print if it were being offered for sale to you today. Although the question is hypothetical, we want you to answer as if it were for real – as if you were participating in a real sealed-bid auction and would really be required to pay the printed dollar amount. If only one person answers YES, he or she would have obtained the print at the stated price on the survey. If there is more than one person stating YES we will have additional questions to determine who would have been the highest bidder.

4. Would you really be prepared to pay $BID for this art print? ——————— YES, I would pay this amount. ——————— NO, I would not pay this amount. The prelude to the WTP question is different from those of most previous CVM questions (particularly those dealing with market goods) in that we asked respondents *not* to simply estimate what they think the good sells for and to act as if the commitment to pay was real. These two statements were included because debriefing sessions during the pretests revealed that respondents were using different criteria to answer the hypothetical WTP question as opposed to the cash WTP question.

The wording in the Cash-dichotomous choice question was: We are now going to conduct a *real* auction. If you wish to actually buy the art print at the price stated below, answer YES in question #4. If you are the only person who answers YES, you will be required to buy the art print at the stated price. If there is more than one person stating YES, we will have additional questions to determine the highest bidder. We will accept cash or check for your purchase. We understand that you may not have anticipated the need to bring cash or your checkbook with you today, so we will also accept a signed Promissory Note payable on or before August 19. In any case, the successful buyer will be able to take the art print with them at the end of this session. Now take a few moments to think about what having this art print would be worth to you. If you want to buy the art print at the stated price on the sheet, answer YES. If you don't want to purchase the art print at this price, answer NO. Are you prepared to pay $BID for this art print? ——— ——— YES, I will pay this amount. ——————— NO, I will not pay this amount.

6.5. Dollar bid amounts in the dichotomous choice contingent valuation and paired comparison

In both the Hyp-DC and Cash-DC each person's answer sheet contained one of the ten different prices ranging from $2 to $120, but centered around the mean of the pretest open-ended WTP responses, $38. In the PC data, the distribution of bids was similar to

those in the Hyp-DC and Cash-DC except the lowest amount was $4 and the highest was $295. The range of bids for the PC experiment was increased based on the results of the Hyp-DC experiments which were conducted prior to the PC experiment.

7. Statistical results

7.1. Comparison of demographics across sessions

Before testing for treatment effects, it is necessary to test whether the samples were significantly different or not in terms of standard demographics such as age, education and income. To test for this across our three treatments we performed one-way ANOVAs for education ($F=0.74$, $p=0.48$), age ($F=2.89$, $p=0.06$) and income ($F=0.88$, $p=0.42$). As indicated by the p values, the samples are not significantly different at the 0.05 level, although age was significantly different at the 0.1 level.

7.2. Binary logit equations for WTP (Cash-DC) and WTP (Hyp-DC)

We hypothesized that WTP for the art print was positively related to how strongly respondents agreed with the statement that they were in the market for this type of art print (MARKET). This variable had response categories that ranged from 1–5 where 1 is not in the market and 5 strongly agree they were in the market. The MARKET variable had a mean of 3.2 and 2.9 in the Hyp-DC and Cash-DC treatments, respectively. How strongly they liked the art print (LIKE), was also rated on a 5-point scale, with 5 being they strongly agreed they liked the print. Income (INC) measured in thousands of dollars and AGE of the respondent were included as demographic variables. The dependent variable YPAY, is the log of the odds ratio ($\log[\text{Prob}\ (YES)/(1-\text{Prob}\ (YES))]$). Eqs. (7) and (8) give the logit equations for hypothetical and cash payments:

$$\text{YPAY (hyp)} = -10.77 \quad -0.2578\,(\$\,\text{BID}) + 1.96\,(\text{MARKET}) + 7.84\,(\text{LIKE}) \quad -0.537\,(\text{AGE}) \quad +0.09\,(\text{INC})$$
$$(t\ \text{statistics}) \qquad (-1.75) \quad (-2.38) \qquad\qquad (1.85) \qquad\qquad (2.27) \qquad\quad (-2.12) \qquad\quad (1.55)$$
$$(7)$$

We performed a test of the null hypothesis that all of the coefficients are equal to zero. The test statistic was equal to 56.6 which falls into the 0.01 rejection region of the chi-square with 6 degrees of freedom. We conclude that the coefficients are all jointly significant at the 0.01 level.

$$\text{YPAY (cash)} = -7.92 \quad -0.1787\,(\$\text{BID}) + 1.44\,(\text{MARKET}) + 1.37\,(\text{LIKE}) \quad -0.04\,(\text{AGE}) \quad +0.05\,(\text{INC})$$
$$(t\ \text{statistics}) \qquad (-2.05) \quad (\ 2.56) \qquad\qquad (2.47) \qquad\qquad (1.88) \qquad\quad (-0.88) \qquad\quad (1.36)$$
$$(8)$$

We also performed a test of the null hypothesis that all the coefficients in Eq. (8) are equal to zero. The test statistic was equal to 36.6 which falls into the 0.01 rejection region of the chi-square with 6 degrees of freedom. We conclude that the coefficients are all jointly significant at the 0.01 level.

Logit regressions Eqs. (7) and (8) indicate that $BID is significant and negatively related to the probability of a 'yes' response in both hypothetical and actual markets, whereas being in the market and liking the good increased the probability of a 'yes' response.

7.3. Multiple-bounded logit equations for WTA (Hyp-PC)

The same basic variable specification was used to analyze the paired comparison data using the multiple-bounded logit model. The specification included the dollar amount they were asked to accept (SBID), as well as income (INC), AGE and MARKET. Due to the way the multiple-bounded logit model is programmed, the dependent variable is coded as zero if the respondent did not choose the print and 1 if the respondent chose to accept the print instead of the dollar amount. Thus, as the dollar amount offered rises, the odds of accepting the print goes down. Individuals whose responses to the series of $BIDS contained circular triads (i.e. they agreed to accept a low amount of money instead of the art print and yet when offered a higher amount of money, chose the art print) were dropped from the analysis. As explained in Footnote 2, these circular triads may arise because the higher amount was offered first and then the lower amount or simply because the point of indifference between money and the art print had been reached causing the individual to randomly switch choices. Nonetheless, the multiple-bounded likelihood function cannot handle such inconsistencies as the individual appears simultaneously in several bid intervals, rather than just one. There were 24 individuals out of 103 responses or about 23 percent of participants that had circular triads for the art print.

Eq. (9) provides the coefficients and *t*-statistics of the multiple-bounded logit equation:

$$\begin{array}{llllll} \text{ACCEPT PRINT} & -2.47 & -0.285(\$BID)+ & 0.393\,(MARKET)+ & 0.78\,(AGE) & -0.015\,(INC) \\ (\textit{t statistics}) & (-2.63) & (\ 9.11) & (3.84) & (3.21) & (\ 1.84) \end{array} \quad (9)$$

The higher the dollar amount offered, the less likely the individual would accept the print instead of the money. The more strongly the individual agreed they were in the MARKET for the art print and the older they were, the more likely they would choose the art print over the money.

8. Results of hypothesis tests

Table 1 presents the means, medians and 95 percent confidence intervals for WTP calculated from the dichotomous choice responses and WTA calculated from the paired

Table 1
Hypothetical and actual WTP versus hypothetical WTA from paired comparison

Treatment	sample size	Mean (Median) WTP or WTA by treatment [95% CI of mean]		
		WTP		WTA
		Dichotomous choice 125		Paired comparison
		Hypothetical payment	Real payment	Hypothetical MB logit
1	52	28 (28) [20–37]		
2	55		11 (9) [6–22]	
3	79			59 (52) [39–66]

comparison. In terms of the first hypothesis, mean WTA (Hyp-PC) exceeds actual cash WTP (Cash-DC) by a factor of 5. The non-overlapping confidence interval suggests that these differences are significantly different at conventional levels suggesting the rejection of null Hypothesis 1. Since this ratio encompasses both differences between hypothetical and real commitments as well as WTA vs WTP it is not surprising that it is large. Nonetheless, this ratio is smaller than many ratios of either hypothetical/actual or WTA/WTP found in the literature. In particular, the (Welsh, 1986, p. 153) study is one of the few that elicits both hypothetical and actual WTA *and* WTP using the dichotomous choice question format. He found WTA (Hyp-DC)/WTP (Cash-DC) to be 14 in the 1984 Sandhill deer hunting permit dichotomous choice experiments. Our reduction in the ratio of WTA/WTP is similar to what Franciosi et al. found in their endowment experiments when individuals were endowed with the right to choose either a coffee mug or money. Thus, it appears that WTA elicited using a chooser reference point (WTA (Hyp-PC)) produces smaller divergences from WTP (cash-DC) than WTA (Hyp-DC) does, but obviously more replications are necessary to determine if this result is robust.

In terms of our second hypothesis, mean WTA (Hyp-PC) is $59 while mean WTP (Hyp-DC) is $28. The non-overlapping 95 percent confidence intervals suggest that we reject the null hypothesis that the two are equal. The ratio of mean WTA (Hyp-PC) to mean WTP (Hyp-DC) is 2.1 ($59/$28). This result is identical to what was obtained using a non-parametric approach for WTA (Hyp-PC).[4] The difference in the median WTA (Hyp-PC) and median WTP (Hyp-DC) is smaller. Thus, the disparity is reduced when comparing the medians.[5]

While the ratio of mean WTA (Hyp-PC) to mean WTP (Hyp-DC) is 2:1, this ratio is less than those reported in most other studies. As summarized by (Kahnemann et al., 1990, p. 1327), hypothetical mean WTA/hypothetical mean WTP is in the range of 2.6–16, averaging 5.38 across the seven studies cited. Our (median WTA/median WTP) is 1.85 as compared to 3.5 in the three studies cited by Kahnemann et al.

Our ratio of mean WTA (Hyp-PC) to mean WTP (Hyp-DC) is about the same value as the ratio other researchers find using deliverable goods and actual cash. In particular, Boyce et al. (1992) found the ratio of WTA (cash)/WTP (cash) to range from 1.66 to 2.36. Kahnemann et al.'s summary of four previous cash experiments had an average ratio of 4.5 for WTA (cash)/WTP (cash).

While there is just a small number of studies for comparison, this pattern of results suggests the possibility that the method of paired comparison may be a promising approach for providing more valid estimates of hypothetical WTA than standard dichotomous choice contingent valuation method.

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[4] Taken on face value, the number of rejections for each dollar amount describes the empirical (sample) WTA demand function for the art print. The sample mean of this empirical distribution is $59, identical to the logit estimate.

[5] Using the same empirical distribution calculated in Footnote 4, the sample median is $39. The median is lower than the median estimated from the logit model because the empirical distributions are skewed.

9. Conclusions and further research

This study has presented an alternative approach to estimate an individual's willingness to accept. A chooser reference point is taken so that the estimate of willingness to accept avoids the loss aversion or endowment effects that apparently elevate estimates of willingness to accept beyond the income effect. The case study application to valuation of a wildlife art print suggests that the method of paired comparison does provide estimates of hypothetical willingness to accept that are closer in magnitude to hypothetical willingness to pay than found in most of the past experiments. The ratio of hypothetical willingness to accept estimated using the method of paired comparison to willingness to pay estimated using dichotomous choice contingent valuation was closer to the ratios obtained in experiments where real cash changed hands. Thus, our exploratory case study suggests that the method of paired comparison may be a promising approach to measure willingness to accept. We hope these findings stimulate further research in this area by our colleagues.

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