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The Endowment Effect and Expected Utility

by

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Abstract

The endowment effect, which is well documented in the contingent valuation literature, alters people's preferences according to a reference point established in the elicitation question. Experimental results from the literature and from a study into the value of non-fatal road injuries are shown to be evidence that an endowment effect is also at work in standard gambles.

Acknowledgements

Some results discussed in this paper are from a study undertaken in 1991 for the UK Department of Transport and Transport Research Laboratory (see Jones-Lee et al 1995).

1. Introduction

Evidence has amassed supporting the existence of an endowment effect (or status quo bias) in contingent valuation studies (Thaler, 1980). The endowment effect is a reference point effect usually attributed to loss aversion (Kahneman and Tversky, 1979). Willingness to pay questions ask people to give up some money to acquire (more of) a good and willingness to accept questions ask them to give up (some of) a good in exchange for some money. As presented in Morrison (1998) the endowment effect can be incorporated in a utility function: U=*f*($, X, loss). That is, the utility that people place on a bundle is both a positive function of the quantities of the goods comprising the bundle, and a negative function of any loss (real or hypothetical) that the elicitation question asks them to incur. If an individual is asked to choose between two bundles, neither of which they own, then they have nothing to lose and the utility they ascribe to the bundles is simply a function of the goods in each. But, most preference elicitation methods used by economists require people to express their preferences for one good (bundle) in terms of their willingness to forego some of another good. Consequently, it is reasonable to expect that, and prudent to check whether, an endowment effect is also evident in other methods of preference elicitation such as von Neumann-Morgenstern's standard gambles.

2. Background

The endowment effect was offered as an explanation for the disparity frequently found between willingness to pay (WTP) and willingness to accept (WTA) measures of value (e.g., Knetsch and Sinden, 1984 & 1987; Knetsch, 1989). This disparity has persisted even when controlling for assorted other possible sources of divergence including income effects (e.g., Brookshire et al, 1987; McDaniels, 1992), Hanemann's (1991) substitutability argument (e.g., Bateman et al, 1997; Morrison, 1997a), learning (Coursey et al, 1987), incentives (using choice experiments (eg., Kahneman et al, 1990; Franciosi et al, 1996) and using Vickrey auctions (e.g., Coursey et al, 1987)), trophy effects (by using exchange goods (e.g., van Dijk et al, 1996)), and imprecise preferences (e.g., Dubourg et al, 1994 &1997; Morrison, 1998). Shogren et al's (1994) study is the only one that rejected an endowment effect in consumption goods (they rejected the endowment effect in favour of Hanemann's argument), but Morrison (1997b) showed that their results do no preclude the presence of an endowment effect.

Morrison 1997b illustrated this effect with a pivot of the indifference curve from the point of endowment, as in figure 1. This pivot effectively increases the level of utility associated with the endowment. In contingent valuation studies, the endowment effect manifests itself in people having to be paid more to give up a good once they own it than they would be willing to pay to acquire the good in the first place. That is, their willingness to accept exceeds their willingness to pay. If the point of endowment alters peoples' preferences such as illustrated in Morrison (1997b), then this may have serious implications for all preference elicitation techniques since the point of endowment is an, often arbitrary, component of the survey questions used. If an endowment effect is evident in other elicitation methods, then it is important that care is taken in choosing the endowments used in questionnaires so as not to introduce unnecessary and arbitrary bias into the results of economic evaluations.

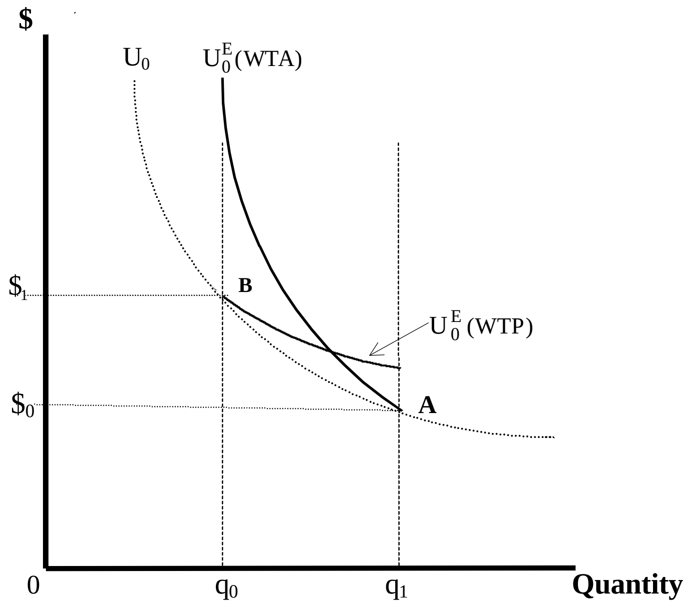

Figure 1. The endowment effect in contingent valuation. Before being endowed with either bundle A or B, the individual is indifferent between the two. Once endowed with a bundle their utility curve effectively pivots from the point of endowment (A or B) such that the endowment is now associated with a higher level of utility than the other bundle.

3. The Endowment Effect in Standard Gambles

To test for the presence of an endowment effect in standard gambles, it is first necessary to consider how it would affect responses.[1] Standard gambles involve decisions regarding a state or bundle that can be held for certain, and a gamble typically with a "winning" outcome better than and a "losing" outcome worse than the certain state. The various forms of standard gambles ask respondents to determine different components of the choice set illustrated in figure 2. Farquar (1984)

[1] The endowment effect discussed here with respect to expected utility estimates is distinct from the "pseudo-endowment" effect of Prelec (1990) which concerns the "probabilistic endowment" of lottery tickets. Prelec refers to the situation where one endowed with several lottery tickets has a higher probability of winning *something* and consequently will take more risk of a loss (i.e., increase their chance of winning nothing) in order to increase the payoff if they win.

describes the four different formulations of standard gamble questions. Only the Probability Equivalent and Certainty Equivalent forms of question are examined here because the relevant empirical evidence is restricted to these.

First consider the case of probability equivalence questions. Probability equivalence (PE) questions endow a respondent with a bundle that they can have for certain, and asks the respondent to choose the probability that makes them indifferent between the certain bundle and the gamble. This decision is illustrated in figure 2 with x being the certain state, W and L being the winning and losing pay-outs of the lottery respectively, and p being the probability of winning.

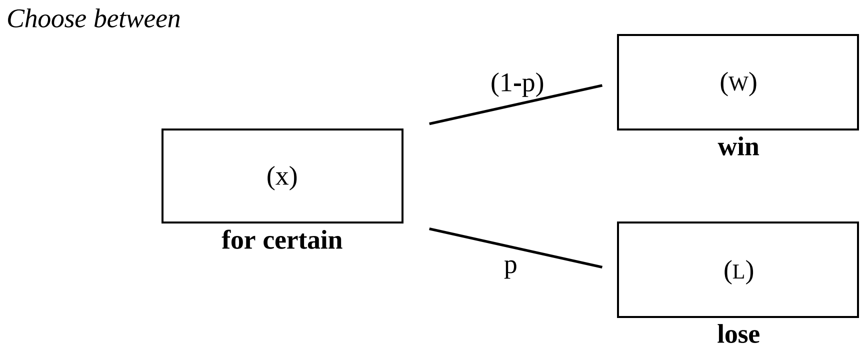

Figure 2. Standard gamble questions. The objective of all forms of SG questions is to find a certain state and a gamble that are associated with the same level of utility. Typically, the winning payout, W, exceeds the amount that can be held for certain, x, which in turn exceeds the payout associated with losing the gamble, L. Respondents are asked to determine one component of the decision problem (x, p, L, or W) such that it makes them indifferent between having the certain state or the gamble—that is, such that (x) ~ (p, L; (1- p), W).

An endowment effect essentially increases the utility of an owned good relative to alternative goods. So, if an endowment effect is at work, then once endowed with x that individual will require a better gamble (i.e., one with a higher expected value) in order to be persuaded to swap their endowment, x, for the gamble. So they will reject some gambles that they would have chosen over x had they not been endowed with x. Figures 3(a) and 3(b) illustrate PE and CE responses relative to a fair gamble, respectively. Each point on the 45º line (certainty line) represents a gamble for which the outcome associated with winning is the same as for losing. Points above the certainty line are irrelevant because they represent gambles for which the winning outcome is worse than the losing outcome.

First consider a PE question that endows an individual with x for certain (figure 3a). The starting point of the question (i.e., the endowment) corresponds to point **A** on the certainty line. The response (i.e., choice of gamble) is illustrated by a ray from the starting point, **A**, to a point below the certainty line. A ray from point **A** to the horizontal axis represents a gamble for which the "lose" outcome is the "lowest" outcome considered in the analysis. This can be greater than, equal to, or less than zero. Ray **AN** is the locus of fair gambles—the iso-expected value line. Any response with an expected value of less than (more than) $X indicates a risk seeker (risk averter). For clarity, consider a risk neutral individual. Given the choice between $X for certain and a gamble with an expected value of $X, they will be indifferent between the two. So they should be willing to swap their $X for any gamble along the ray **AN**. However, since an endowment effect increases the utility of an owned good relative to alternatives, it would lead the respondent to reject all of the fair gambles. They would require a gamble with an expected value greater than $X (i.e., a gamble to the right of line segment **AN**). This would be misinterpreted to mean that our risk neutral individual is risk averse. The same rationale applies to individuals with other risk attitudes. They would reject gambles that they would have accepted had they not been endowed with x, thus implying a higher degree of risk aversion than is the case.

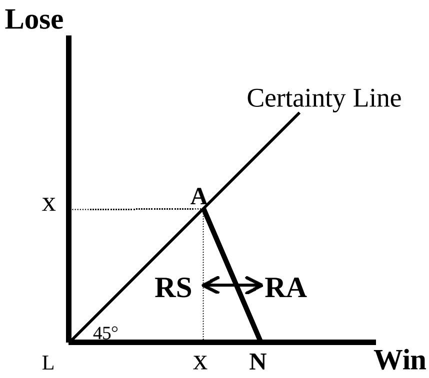

Figure 3(a). PE responses in relation to a fair gamble.

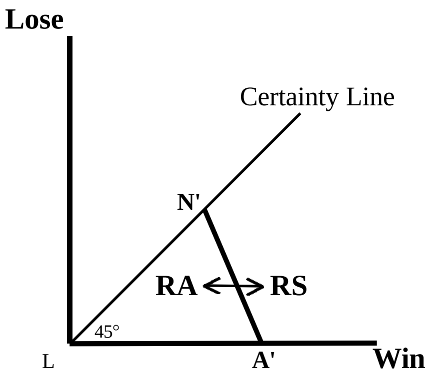

Figure 3(b). CE responses in relation to a fair gamble

All gambles on the certainty line have the same payoff for a win as for a loss. Payoffs associated with 'winning' a gamble are measured on the horizontal axis, and those associated with a loss are measured along the vertical axis. The starting point (i.e., the endowment) for the PE question is point A in figure 3(a), while the starting point for a CE question is illustrated as point A' on the horizontal axis. Line segments AN and A'N' are the iso-expected value (iso-EV) lines. All points along this line represent gambles with probabilities of winning and losing such that their expected value is equal to x. Therefore a risk neutral individual will be indifferent between any gamble along this line.

Conversely, CE questions endow people with a gamble and then ask them to indicate the certainty equivalent of the gamble. That is, the values of p, W, and L in figure 2 are given, and the respondent is asked to assign a value to the certain state (x) that would make them indifferent between keeping the gamble and trading it for x. Where point **A'** represents the starting point for a CE question in figure 3(b), the ray **A'N'** is the iso-expected value line and, so, depicts a risk neutral response. An endowment effect increases the utility of an owned good relative to other available goods, and in this case the endowment is a gamble. Therefore, respondents will require a higher certainty equivalent as compensation for giving up the gamble with which they were endowed. In this case our risk neutral individual would state a CE indicating that they are risk seeking or, a risk averse individual would appear less risk averse than they really are.

3.1 The endowment effect and the PE-CE disparity

From this we can form predictions of the over-all pattern of standard gamble responses in the presence of an endowment effect: one for paired PE and CE questions, and one for chained standard gamble questions. First consider the situation in which the same individuals are asked to answer “mirrored” PE and CE questions. The questions are “mirrored” in that the response to one question serves as a fixed starting point for the other. If an endowment effect is the driving force behind the PE-CE disparity, then within subject comparisons of PE and CE responses should reveal that people are relatively more risk averse in their PE responses than in their CE responses. If an endowment effect is the sole or main source of inconsistency in standard gambles, then this relationship should hold regardless of which form of question was asked first and regardless of whether the questions are in the gain or loss domain.

Results obtained by Hershey et al (1982 & 1985) fit in with the endowment effect predictions for both CE and PE questions. Hershey et al (1982) found that between subject experiments revealed different risk attitudes for the same gamble depending on whether it was presented as a PE or CE question. In particular, responses to CE questions exhibit more risk seeking than PE responses (they found this to be significant at $p<.01$). This result would be stronger if within subject comparisons were considered. Hershey et al (1985) did so using four groups of respondents and asking four paired PE-CE questions of each.

Figure 4(a) depicts the pattern of within subject inconsistency they observed between mirror image PE and CE responses where the PE questions were asked first. The representative PE responses are illustrated by the movement from point **A** on the certainty line to point **B** on the horizontal axis (the dotted ray). This movement is to the right of ray **AN**, the risk neutral line, as it is a risk averse response. The corresponding representative CE response is shown by the movement from point **B** to a point such as **C** back on the certainty line (the solid ray). Since the CE response is less risk averse, but not risk seeking, point **C** must lie somewhere between points **A** and **D**. (The implications of Hershey et al's (1985) results for the Healthy Years Equivalent measure of health (Gafni et al, 1991) which uses both PE and CE questions to obtain a single measure of an individual's state of health are discussed in Morrison (1997c).) Similarly, figure 4(b) illustrates the pattern of responses when the CE question was asked first. The representative CE response is risk seeking (hence the ray **A'B'** is to the right of the line indicating risk neutrality, **A'N'**) and the response to the mirror image PE question is more risk averse.

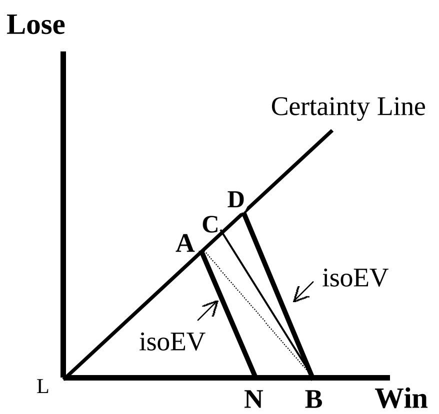

Figure 4(a). PE question asked first.
1) PE: Risk Averse; 2) CE: less Risk Averse.
The thick lines illustrate risk neutral responses. The average response to the PE question is shown by the movement from point **A** to point **B**, and the follow-up CE average response by the movement from point **B** to a point such as **C**. Since the CE responses tended to be risk averse but less risk averse than the PE responses point **C** will lie on the certainty line between points **A** and **D**. A CE response to the right of line segment **BD** would indicate risk seeking behaviour.

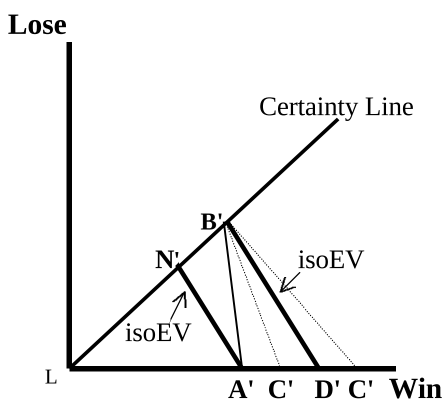

Figure 4(b). CE question asked first.
1) CE: Risk Seeking; 2) PE: more Risk Averse.
The thick lines illustrate risk neutral responses. The average response to the CE question is shown by the movement from point **A'** to point **B'**, and the follow-up PE average response by the movement from point **B'** to point **C'**. Since the PE responses tended to be more risk averse than the CE questions, **C'** will be to the right of **A'** on the horizontal axis. If the PE response is (more risk averse but) still risk seeking, then **C'** will lie between **A'** and **D'**. If the PE response exhibits risk aversion, then **C'** will lie to the right of **D'**.

The mapping of the utility functions elicited from respondents that are less risk averse in their CE responses than in their PE responses will correspond to figure 5. In this figure the value function is held to be the same with respect to the PE and CE responses and it is assumed that the observed pattern of inconsistency holds for all values of the good. It shows that when endowed with a certain state (as in a PE question) an individual will attach a higher utility to that state than if they had instead been endowed with a gamble (as in a CE question). This has been termed the utility evaluation effect (Machina, 1989).

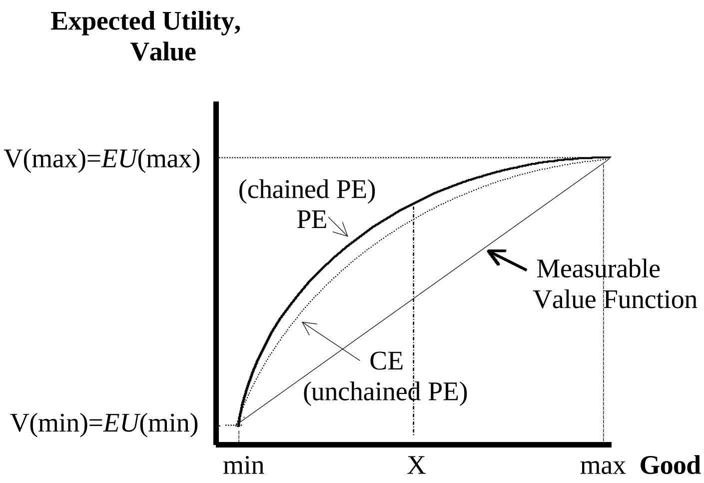

Figure 5. The Utility Evaluation Effect:
utility functions elicited from PE and CE questions
and from chained and unchained PE questions

Setting the value function relevant to the PE and CE questions to be equal, the expected utility functions arising from these two methods will be different. PE responses tended to be more risk averse than CE responses. This suggests that when endowed with a certain state or good, as in the PE questions, an individual places a higher utility on that certain good than if they had instead been endowed with a gamble. Similarly, the utility functions arising from chained and unchained PE questions will be different.

To summarise, in the gain domain and in the loss domain, those asked CE questions first were relatively more risk averse in their PE responses, and those asked PE questions first were relatively less risk averse in their CE responses. As Hershey et al (1985) conclude, "This means that for both gains and losses, the PE-CE subjects were relatively less risk-averse in the CE mode. This pattern holds true for all questions, being statistically significant ($p<.05$) for 14 out of 16 cases under an exact binomial test for asymmetry" (p. 1222). Although those authors briefly address the endowment effect as a possible source of the disparity, they reject it stating that, "According to this explanation, a subject would overestimate the adjustment needed to make the two options equally attractive, because the preferred option is seen as more attractive once owned…The net effects correspond neither in magnitude nor in pattern to the empirical data" (p.1228). The endowment effect attaches a premium to the owned option—if they own a gamble then they require a better certainty equivalent to give it up, and if they own the certain state they require a better gamble (here a probability equivalent) to part with that. This is what Hershey et al's (1985) results showed for 14 of the 16 cases, with the remaining two cases being skewed in the anticipated direction but not statistically significant. The pattern observed in responses, is that predicted for the presence of an endowment effect.

So, just as the endowment effect results in willingness to accept (WTA) exceeding willingness to pay (WTP), it also results in EU estimates from PE questions exceeding those obtained from CE questions. That is, the upward (downward) bias on WTA (WTP) responses and the upward (downward) bias on PE (CE) responses, imposed by an endowment effect, is a source of the WTP-WTA and PE-CE disparity.

3.2 The endowment effect and chained gambles

Next, consider chained gambles. Chained gambles combine responses to two or more PE questions to obtain one expected utility estimate (other forms of standard gamble questions could be used, but this author is only aware of PE questions being chained). The independence axiom of expected utility dictates that changing the outcomes used in the gamble should not change the utility elicited. Therefore, chained and unchained gambles should yield equal EU estimates. However, as previously noted, an endowment effect will lead individuals to give PE responses that suggest they are more risk averse than they really are. If an endowment effect is present in PE responses, then it would be present in both (all) stages of the chained gamble. So we would expect an endowment effect to suggest a higher degree of risk aversion than is the case, and we would expect that effect to be compounded across every stage of the chained gamble. Consequently, in the presence of an endowment effect, the pattern of responses that we would expect to emerge is that EU estimates from chained gambles should exceed those from a single gamble.

PE questions are frequently used to quantify health states to estimate health gains from treatments or health lost through injuries (Torrance, 1986; Hornberger et al, 1992; Stiggelbout et al, 1994; Jones-Lee et al, 1995; Jansen et al, 1998). Typically, respondents are asked to state the probability of success or failure (winning or losing) that would make them indifferent between remaining in a (generally hypothetical) state of ill health and accepting a risky treatment that could improve or could worsen that state of health. In this context if the EU of a health state, X, is estimated using a PE question, then the endowment effect in effectively making the individual more risk averse will increase the estimated EU of state X. That is, state X would appear to be closer to 'full' or 'normal' health. And if a chained gamble is used, then the endowment effect would be compounded across the gambles leading to the chained gamble estimate exceeding the unchained estimate.

Indeed, this is the pattern that emerges (*e.g.*, Llewellyn-Thomas *et al*, 1982; Rutten-van Mölken *et al*, 1995; Bleichrodt, 1996; Morrison, 1996). Chained and unchained PE responses were used to estimate the EU of three common non-fatal road injuries (one permanent, two temporary) in a study conducted by Jones-Lee and Loomes for the UK Department of Transport and Transport Research Laboratory (for a fuller description of the study see Jones-Lee et al (1995)). The unchained gambles used "normal health" for the success outcome (assigned a utility of 100) and "immediate death" for the failure outcome (assigned a utility of 0), while the unchained gambles also used normal health for the success outcome but for the failure outcome a non-fatal but more serious injury is used.[2] If an endowment effect is present in PE responses, then EU estimates obtained from unchained gambles should be less than those obtained from 2-link chain gambles, which should be less than those from 3-link chains, which in turn should be less than those from 4-link chains. That is, if there is an endowment effect, then the inclusion of each additional link should reveal a higher utility function.

The standard gamble data from the UK DoT/TRL study (which surveyed a random sample of 414 people) can be used to test this hypothesis. There are 3 cases in which EU estimates elicited from an unchained and a 2-link chain can be compared. In addition there are 4 cases in which a 2-link and a 3-link chain can be compared, and one in which to compare a 3-link and 4-link chain. Only gambles with the same "root path" are compared. For example, say we want to estimate the EU of X, where X is better than Y, Y is better than Z, and Z is better than death. In the first gamble of a 2-link chain X is the certain state and Y is the failure state; in the second gamble Y is the certain state and death is the failure state. The 3-link chain with

[2] For a 2-link chain, the EU of the non-fatal failure outcome is estimated from an unchained gamble (i.e., one with a fatal failure outcome). A 3-link chain would have a non-fatal failure outcome in the first gamble, that non-fatal outcome would be evaluated using a gamble with a more serious non-fatal failure outcome, and the EU of that more serious non-fatal failure outcome would be estimated with an unchained gamble. And so on.

which it is compared has the same first gamble, the second gamble has Y as the certain state and Z as the failure state, and finally the third gamble has Z as the certain state and death as the failure state. Table 1 presents the results of within subject pair-wise tests investigating the hypothesis that the greater the number of links in a chain the greater the estimated EU. A non-parametric test is used because individuals indicated their responses on an answer sheet with a payment scale—this may have effected the distribution of responses. Specifically, one-tailed Wilcoxon matched-pairs signed-ranks tests were used to test the null that the number of links in a chain does not affect the estimated EU against the alternative that a chain with *(m+1)* links would obtain an EU estimate exceeding that from a chain with only *m* links. In all eight cases, the null that the two estimates are equal has to be rejected (at α=.05) in favour of the alternative that the addition of a link increases the estimated EU. In fact in seven of those cases, the null is rejected at the 1% level of significance. These results are consistent with the presence of an endowment effect.

	Pattern of Responses			Wilcoxon	mean (std dev)	
	m+1 > m	=	*m+1 < m*	1-tailed	*m*	*m+1*
Unchained vs 2-link chain						
case 1	210	146	35	p < .01	84.6 (21.8)	93.9 (13.0)
case 2	86	258	55	p < .01	94.1 (16.8)	96.2 (10.6)
case 3	79	253	64	p < .01	94.1 (16.8)	97.1 (8.8)
2-link vs 3-link chain						
case 4	113	259	25	p < .01	96.2 (10.6)	98.0 (6.8)
case 5	52	313	30	p < .05	98.4 (7.0)	98.7 (5.5)
case 6	51	317	27	p < .01	98.4 (7.0)	99.1 (4.7)
case 7	74	315	7	p < .01	97.4 (9.7)	98.6 (6.9)
3-link vs 4-link chain						
case 8	70	314	10	p < .01	98.7 (5.5)	99.3 (4.0)

Table 1. Comparison of *m*-link and *(m+1)*-link chains.
Case 1 concerns a permanent injury, while the rest concern temporary injuries.
In comparing unchained and a 2-link chain, m refers to the unchained and *(m+1)* to the 2-link chain; for a comparison of 2- and 3-link chains, m refers to the 2-link and *(m+1)* to the 3-link; and so on.
p values are for 1-tailed Wilcoxon matched-pairs signed-ranks tests.

These results indicate that using different failure outcomes in gambles will recover different utility functions as in figure 5. Each link added to a chain reveals a higher (implying more risk averse) utility function. This is the same as McCord and de Neufville's (1983) finding that different utility functions are retrieved when different probability distributions are used with the certainty equivalent method—higher levels of probability associated with the best outcome yield higher levels of utility. This has been termed the "utility evaluation effect."

The results in table 1 suggest that an endowment effect results in utility estimates of health states being biased upward. This presents a problem for policy making. If the purpose of obtaining EU estimates is to measure health gained from a treatment or health loss prevented by new safety measures, then—given that an endowment effect effectively pushes the estimates of all health states up toward "full" health—estimated benefits of such programmes will be biased downward. Thus, an endowment effect in PE responses that is not accommodated could lead to some types of health care or safety measures being incorrectly rejected as being too costly relative to the health gained or injuries prevented. This problem is likely to be exacerbated if chained PE questions are used.

The notion of an endowment effect in standard gamble questions is similar in some respects to Gafni and Torrance's (1984) "gambling effect." Gafni *et al* (1984) propose that people are afraid of gambling *per se* and therefore require a risk premium to compensate for having a gamble rather than a certain state. But such a 'gambling effect' in probability equivalence responses would lead risk neutral people to choose a certain state over a gamble, *even when answering a CE question*. This combined with the acceptance that people are generally risk averse with respect to health and money, illustrates that the 'gambling effect' is inconsistent with responses obtained by

Hershey *et al* (1985) when they presented people with CE questions first (i.e., they were risk seeking). (The same must be said of Wakker *et al's* (1995) argument that inconsistencies in SG are predicted by Rank-dependent utility). However, both the PE-CE disparity and the internal inconsistency in chained PE questions do conform with predictions for the presence of an endowment effect.

Conclusion

Biases such as the endowment effect and embedding have received much attention in the contingent valuation literature and has lead some to reject that method as a means of quantifying costs and benefits in favour of other methods of preference elicitation such as standard gambles (e.g., Jones-Lee et al, 1995). However, internal inconsistencies in the standard gamble method that have been noted in the economics literature have been shown here to conform to Thaler's notion of an endowment effect. Both the PE-CE disparity and the frequent observation that chained EU estimates exceed the corresponding unchained estimates are predicted by the presence of an endowment effect. EU has already taken a battering in the literature, hence the emergence of the many non-EU models, however a series of experiments conducted Hey and Orme (1994) found that the best model of responses is EU plus white noise. Expected utility is the common model for decision making under uncertainty, and standard gambles are the standard approach to obtaining EU estimates. The evidence presented here is not intended as an additional argument against EU (and hence the use of standard gambles), but rather as a warning and as a starting point for removing bias from EU estimates. That is, if an endowment effect is present in standard gamble responses, then care must be taken to accommodate this effect when interpreting results for the purposes of policy making.

Identifying the presence of an inconsistency is the first step to understanding, estimating, and accommodating that inconsistency. The evidence presented here is at least sufficient to identify the presence of and the direction of a bias in standard gambles and to show that this bias is, at least *prima facie*, of the same nature as the endowment effect found in contingent valuation experiments. Since both contingent valuation and standard gambles have been used to evaluate health and health care in recent years, it is important that we ensure that biases present in one method are not present in the other before using such biases as evidence of one method's superiority.

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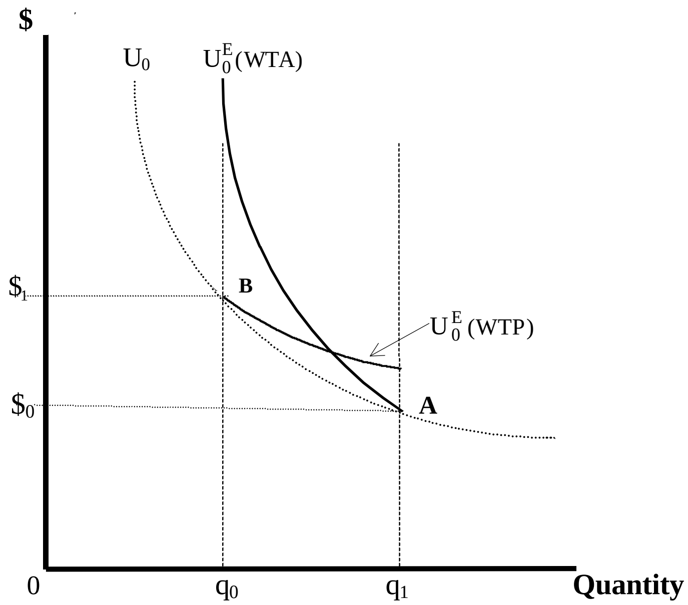

Figure 1. The endowment effect in contingent valuation. Before being endowed with either bundle A or B, the individual is indifferent between the two. Once endowed with a bundle their utility curve effectively pivots from the point of endowment (A or B) such that the endowment is now associated with a higher level of utility than the other bundle.

Choose between

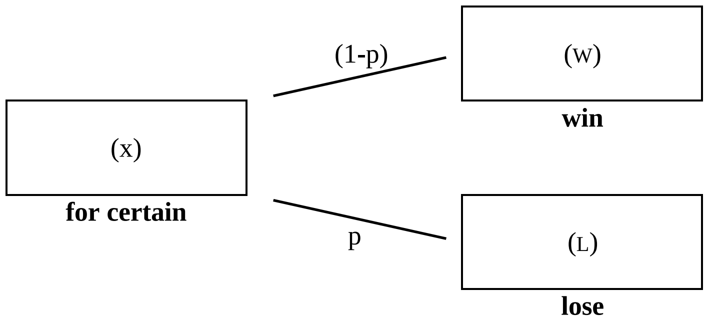

Figure 2. Standard gamble questions. The objective of all forms of SG questions is to find a certain state and a gamble that are associated with the same level of utility. Typically, the winning payout, W, exceeds the amount that can be held for certain, x, which in turn exceeds the payout associated with losing the gamble, L. Respondents are asked to determine one component of the decision problem (x, p, L, or W) such that it makes them indifferent between having the certain state or the gamble—that is, such that (x) ~ (p, L; (1- p), W).

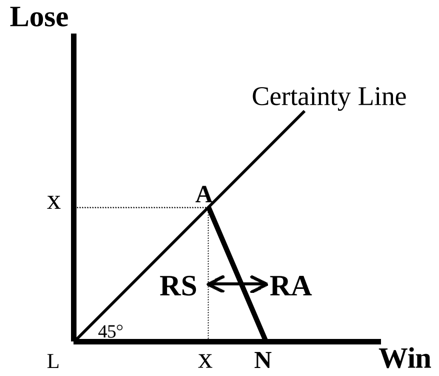

Figure 3(a). PE responses in relation to a fair gamble.

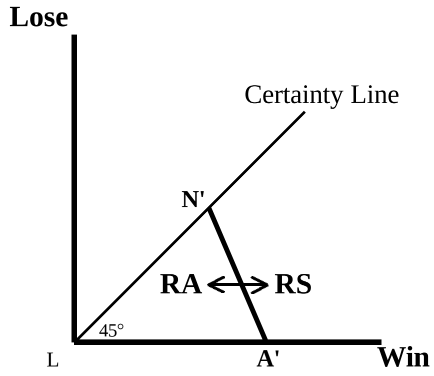

Figure 3(b). CE responses in relation to a fair gamble

All gambles on the certainty line have the same payoff for a win as for a loss. Payoffs associated with 'winning' a gamble are measured on the horizontal axis, and those associated with a loss are measured along the vertical axis. The starting point (i.e., the endowment) for the PE question is point A in figure 3(a), while the starting point for a CE question is illustrated as point A' on the horizontal axis. Line segments AN and A'N' are the iso-expected value (iso-EV) lines. All points along this line represent gambles with probabilities of winning and losing such that their expected value is equal to x. Therefore a risk neutral individual will be indifferent between any gamble along this line.

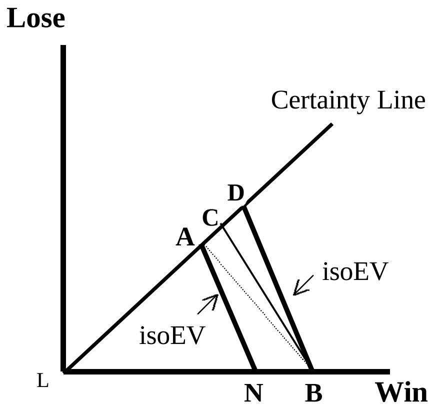

Figure 4(a). PE question asked first.
1) PE: Risk Averse; 2) CE: less Risk Averse.
The thick lines illustrate risk neutral responses. The average response to the PE question is shown by the movement from point **A** to point **B**, and the follow-up CE average response by the movement from point **B** to a point such as **C**. Since the CE responses tended to be risk averse but less risk averse than the PE responses point **C** will lie on the certainty line between points **A** and **D**. A CE response to the right of line segment **BD** would indicate risk seeking behaviour.

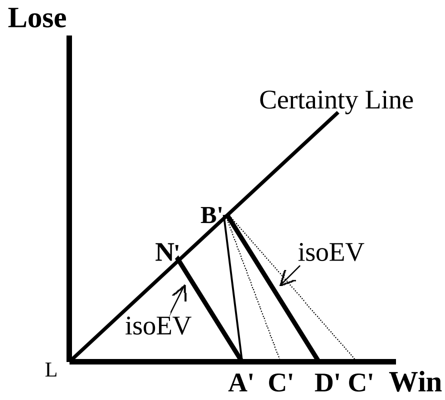

Figure 4(b). CE question asked first.
1) CE: Risk Seeking; 2) PE: more Risk Averse.
The thick lines illustrate risk neutral responses. The average response to the CE question is shown by the movement from point **A'** to point **B'**, and the follow-up PE average response by the movement from point **B'** to point **C'**. Since the PE responses tended to be more risk averse than the CE questions, **C'** will be to the right of **A'** on the horizontal axis. If the PE response is (more risk averse but) still risk seeking, then **C'** will lie between **A'** and **D'**. If the PE response exhibits risk aversion, then **C'** will lie to the right of **D'**.

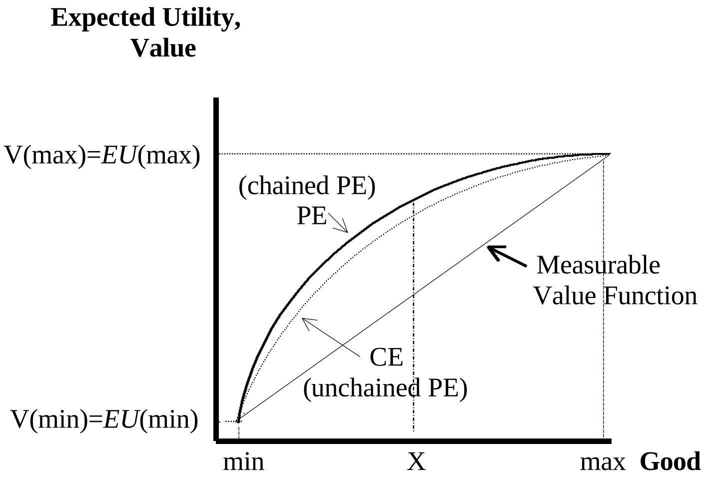

Figure 5. The Utility Evaluation Effect: utility functions elicited from PE and CE questions and from chained and unchained PE questions

Setting the value function relevant to the PE and CE questions to be equal, the expected utility functions arising from these two methods will be different. PE responses tended to be more risk averse than CE responses. This suggests that when endowed with a certain state or good, as in the PE questions, an individual places a higher utility on that certain good than if they had instead been endowed with a gamble. Similarly, the utility functions arising from chained and unchained PE questions will be different.

	Pattern of Responses			Wilcoxon	mean (std dev)	
	m+1 > m	=	*m+1 < m*	1-tailed	*m*	*m+1*
Unchained vs 2-link chain						
case 1	210	146	35	$p < .01$	84.6 (21.8)	93.9 (13.0)
case 2	86	258	55	$p < .01$	94.1 (16.8)	96.2 (10.6)
case 3	79	253	64	$p < .01$	94.1 (16.8)	97.1 (8.8)
2-link vs 3-link chain						
case 4	113	259	25	$p < .01$	96.2 (10.6)	98.0 (6.8)
case 5	52	313	30	$p < .05$	98.4 (7.0)	98.7 (5.5)
case 6	51	317	27	$p < .01$	98.4 (7.0)	99.1 (4.7)
case 7	74	315	7	$p < .01$	97.4 (9.7)	98.6 (6.9)
3-link vs 4-link chain						
case 8	70	314	10	$p < .01$	98.7 (5.5)	99.3 (4.0)

Table 1. Comparison of *m*-link and *(m+1)*-link chains.
Case 1 concerns a permanent injury, while the rest concern temporary injuries.
In comparing unchained and a 2-link chain, m refers to the unchained and *(m+1)* to the 2-link chain; for a comparison of 2- and 3-link chains, m refers to the 2-link and *(m+1)* to the 3-link; and so on.
p values are for 1-tailed Wilcoxon matched-pairs signed-ranks tests.