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Gain and Loss Domains and the Choice of Welfare Measure of Positive and Negative Changes

Jack L. Knetsch, Yohanes E. Riyanto, and Jichuan Zong

Abstract

Mounting evidence continues to suggest that people value changes in terms of a neutral reference state and that those in the domain of losses are commonly valued far more than those in the gains. Consequently, both negative and positive changes in the domain of losses, including mitigation of losses such as restoring environmental quality and reducing accident rates, may be more accurately valued with the minimum acceptable-compensation (WTA) measure, those in the domain of gains are more accurate with the maximum willingness-to-pay (WTP) measure. Current practice, that assumes equivalence and that all positive changes are considered as gains, is therefore likely to often seriously mislead.

KEYWORDS: gain and loss domains, value disparity, reference state, willingness-to-pay, willingness-to-accept, welfare measurement

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1. Introduction

It is widely accepted that the monetary measure that most accurately assesses an individual's change in economic welfare resulting from a gain is the maximum sum the person is willing to pay (WTP) for it; and the most accurate monetary measure of the negative impact on welfare resulting from a loss is just as widely acknowledged to be the minimum amount an individual would demand to accept it (willing to accept, or WTA). However, empirical evidence suggesting that people commonly evaluate outcomes in terms of changes from a neutral reference state rather than as end states – "...the effective stimulus is not the new level of stimulation but the difference between it and the existing adaptation level" (Kahneman, 2003, p.704) – implies that, contrary to nearly all current practice, many positive changes may be regarded as reductions of losses rather than gains. Such changes are therefore more accurately assessed with the WTA measure. In an analogous manner, some negative changes may be viewed as foregone gains and therefore best assessed with the WTP measure.¹

Thus, stranded motorists may well view clearing a road of debris from an overturned truck and reopening it to traffic as a return to a reference state of a normal passable route rather than as a gain from a reference of being stuck behind spilled freight. To the extent that this is the case, the more accurate measure of the monetary value of the clean-up is then the minimum compensation these motorists would require to attain the level of well-being that would accompany reopening of the road, and not the maximum sum they are willing to pay to have it done – the WTA to forego clearing the road. The present near universal habit of choosing the WTP measure to assess the welfare implication in nearly all such cases requires the presumption that the reference state changes when a loss occurs so that all remedial works become changes in the domain of gains.

Given the evidence of the pervasiveness and usually large size of the disparity between estimates of WTA and WTP values that are likely for most changes for which valuations are commonly made – Horowitz and McConnell (2002) reviewed 200 or so studies and found the median ratio of WTA to WTP valuations to be over two and a half times² – the improper choice of measure, exemplified by almost all current practice, can be expected to result in seriously biased guidance. It may be, for example, that the costs of controlling air pollution in the Los Angeles basin, in the US, outweighed the benefits when these were

¹ The choice of measure has, of course, important implications for methods of estimating particular values, but that is another issue from the one of specifying the conditions for which WTA and for which WTP are the appropriate measures of the value of welfare changes, which is the concern here.

² The mean of these ratios was 6.7.

based on “ascertaining individuals’ willingness to pay for a reduced incidence of illness and adverse symptoms” (Krupnick and Portney, 1991, p. 524), but this conclusion might well have differed had estimates of the benefits been based instead on what might well in this case be the more accurate willingness to accept measure.³ Similarly, irrespective of the usefulness of comparing methods of eliciting WTP values (Ruzzi and Ortuzar, 2006), the resulting estimates of the value of reducing the risks of road accidents may well be considerably understated with this measure if these values are better reflected in the sums demanded to forego the safety measures.

The choice of measure in each particular case appears to turn, in large part, on the reference being the state before or after the change – on distinctions between compensating and equivalent variation measures.

2. Compensating Variation Measures of Welfare Change

The usual Pareto measures of WTP for a gain and WTA for a loss and their dependence on the reference state can be usefully illustrated by indifference curves (Figure 1) of a representative individual who derives utility, $U = U(W, Q)$, from consuming a numeraire good, wealth (W), and some other good, say, environmental quality, (Q).

To the extent the present level of environmental quality serves as an individual’s reference or basis of comparison in valuing positive and negative changes from this state, these values are then most accurately assessed by the compensating variation measures of the maximum willingness to pay for a gain and the minimum compensation demanded for a loss.

In the case of a gain, the individual’s initial levels of wealth and environmental quality can be assumed to be W_0 and Q_0 , yielding a welfare level of $U_0(W_0, Q_0)$, represented by point C on U_0 in Figure 1. An improvement in environmental quality from Q_0 to Q_1 is a change above or beyond the reference state of the present level (Q_0) – a change in the domain of gains. The compensating variation maximum willingness-to-pay measure (WTP^{cv}) of its value is given by the reduction in wealth that leaves the individual indifferent between the reference state of the before change quantity Q_0 and wealth W_0 (point C, on U_0), to which the position after the change is compared, and paying to obtain the gain – moving to quantity Q_1 and wealth W_1 (point A, also on U_0). Thus,

$$U_0 [W_0 - WTP^{cv}, Q_1] = U_0 (W_0, Q_0) \quad [1]$$

³ Without estimates of WTA values there is, of course, no possibility of any conclusion on this matter – the point is that an inappropriate choice of measure will often leave the issue in doubt regardless of the quality of the estimates.

with $WTP^{cv} = (W_0 - W_1)$ and equal to BA in Figure 1. Again, the assessment of the change in welfare is based on a comparison of the changed state with the reference state – it is the monetary sacrifice for a positive change in the domain of gains, which might be exemplified by a new neighbourhood recreation centre where the value of the acquisition of the centre is measured from the reference of the present lack of such a facility.

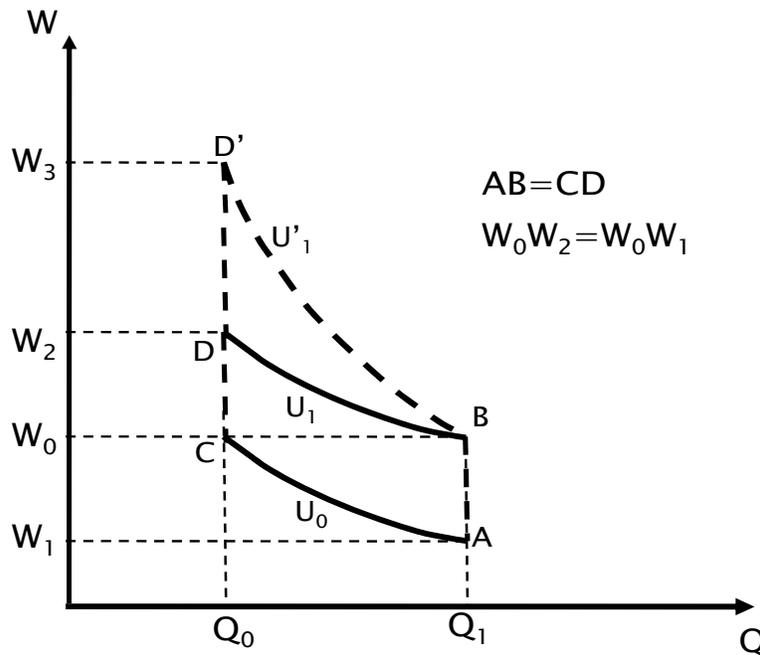


Figure 1. Indifference Curves and Values of Positive and Negative Changes with Dashed Line Reflecting Significant Valuation Disparity.

The case of a loss can, for illustrative simplicity, also be shown with the same indifference curves of Figure 1, where the individual can again be assumed to have the same initial level of wealth at W_0 but, in this case an initially higher level of environmental quality of Q_1 , giving a welfare level of U_1 (W_0, Q_1), represented by point B on U_1 . Given the reference of this before change state, Q_1 , a deterioration of environmental quality from Q_1 to Q_0 is a change in the domain of losses. The compensating variation measure (WTA^{cv}) of its value is given by the increase in wealth necessary to leave the individual indifferent between the reference state (the basis of comparison), of having the before change level of wealth of W_0 and environmental quality at Q_1 (point B on U_1), and accepting this sum together with a lower level of environmental quality – moving to wealth W_2 and quantity Q_0 (point D, with its level of welfare on U_1 as well), implying:

$$U_1 [W_0 + WTA^{cv}, Q_0] = U_1 (W_0, Q_1) \quad [2]$$

with $WTA^{cv} = (W_2 - W_0)$ and equal to CD in Figure 1. This is the monetary measure of sacrifice for a negative change in the domain of losses, perhaps exemplified by an oil spill that fouls local foreshores the value of which is assessed on the basis of the reference state of an absence of such a spill.

3. Disparities between the Measures

Current practice is overwhelmingly to assess the welfare impacts of nearly all changes with the willingness-to-pay measure – commonly in terms of an individual’s WTP for a gain and WTP to avoid, or to reduce, a loss. This divergence of practice from agreed principle to assess losses with the WTA measure has been justified by the empirical assertion of standard economic theory that the two measures will result in fully equivalent valuations, except for an ordinarily inconsequential small difference due to an income effect – “...we shall normally expect the results to be so close together that it would not matter which we choose” (Henderson, 1941, p. 121). Given this expectation of equivalence, the choice of measure has been largely left as a matter of convenience or ease of measurement, with seemingly little attention given to the appropriateness of the choice – “In practice, the WTP is generally used to value benefits because it is often easier to measure and estimate” (US Environmental Protection Agency, 2000, p. 61).⁴ The equivalence assumption is also fully ingrained in text and manual synopses, such as “Specifically, the harm caused by imposing the bad equals the victim’s willingness to pay to be free from it” (Cooter and Ulen, 1997, p. 310); “Willingness to pay to reduce the risk of experiencing an illness is the preferred measure of value for morbidity effects” (US Environmental Protection Agency, 2000, p. 94).

In contrast to these traditional views, the now widely reported empirical evidence indicates pervasive large disparities between people’s valuations of gains and valuations of otherwise commensurate losses, calling both the assertion of equivalence between the WTA and WTP measurements and the prescription that all positive and all negative changes should be assessed with the same measure, sharply into question.

Evidence of large differences between people’s valuation of gains and losses from a neutral reference state comes from the results of a wide array of

⁴ This has been particularly the case when contingent valuation or other stated preference methods have been used to estimate values, as the perceived difficulty of having respondents give meaningful answers to questions asking for how much compensation they would demand to accept a loss has resulted in the use of WTP estimates in essentially all such studies regardless of the gain or loss nature of the change.

survey studies and laboratory and natural experiments conducted and reported over the past three decades (reviewed in, for example, Kahneman, Knetsch, and Thaler, 1990; Rabin, 1998; and Horowitz and McConnell, 2002). Most of these have provided tests of compensating variation measures of people's valuations of gains and losses.⁵

An example of the real exchange laboratory evidence is the finding that the maximum sum individuals were willing to pay for a 50% chance to win \$20 was an average of \$5.60, but the mean of the minimum compensation the same people would accept to give up such a chance was \$10.87 (Kachelmeier and Shehata, 1992). Another example is the widely cited study of the risks of injury from the use of pesticides in which consumers were found to demand nearly nine times more compensation to accept a small increase in the risk of injury (their WTA) than they were willing to pay for an equivalent decrease in this risk – and these were only a quarter of the participants who were willing to make any trade-off at all of a decrease in price for an increase in risk (Viscusi, Magat, and Huber, 1987).

Similar results have been reported for people making common choices in non-experimental settings, such as in their purchasing eggs on regular shopping trips, in which they showed more sensitivity (a price elasticity of -1.10) to price increases which impose losses, than to price decreases (elasticity of only -0.45) which provide gains (Putler, 1992). Investors in company shares have also been found to demonstrate a greater value of losses than to gains by their reluctance to realise a loss by selling those that are trading at less than their purchase price – a practice that resulted in lower returns as the “winners” they sold earned an average of 3.4% more than the “losers” they retained (Odean, 1998). A persuasive further example involving very large stakes and experienced professions engaging in hundreds, and often thousands, of repetitions, is the finding that the world's leading golfers putt significantly more accurately to prevent a loss (score a bogey) than to achieve a gain (a birdie) (Pope and Schweitzer, 2011).⁶

⁵ Zhao and Kling (2004) suggest correctly that a divergence between the WTA and WTP measured valuations may be present when people are asked to value goods the value of which will become better known to them at some later time. However, such hedging activity does little to explain the more usual observed disparities when no opportunities for further learning are possible.

⁶ Demonstrations of contrary results provided by, for example, Plott and Zeiler (2005, 2007) address only a small portion of the accumulated evidence of the valuation disparity, and at that appear to be largely, if not entirely, attributable to unintended experimental design induced shifts in the reference state of their experimental participants (Koszegi and Rabin, 2006; and, with a confirming empirical test, Knetsch and Wong, 2009). In somewhat the same manner, the absence of a disparity among merchants and other frequent traders appears to have more to do with their customary reference state as traders, on which valuations are based, than on the suggested cause of

Such empirical findings of significant disparities between people's valuations of gains and losses suggest a typical value function schematically illustrated in piece-wise linear form⁷ in Figure 2, in which, importantly for the distinctions underlying the choice of measure being made here, valuations are commonly made in terms of gains and losses relative to a reference state, R, rather than in terms of final states as commonly assumed in current valuation practice.⁸ Losses from the reference and reductions of losses, such as from R to L or L to R, are, given the reference R, valued along the steep portion in the domain of losses giving rise to their generally greater importance or value. Gains and reductions-of-gains, such as from R to G or G to R, are valued on the less steep portion in the domain of gains. It is the changes differing relative to the relevant reference that give rise to the observed valuation disparities⁹ (Kahneman and Tversky, 1979).

This difference between the measures can be expressed with the use of a loss aversion coefficient, λ , as:

$$WTA^{cv} = \lambda WTP^{cv} \quad [3]$$

with λ usually substantially greater than one for entitlements that are not held for trade and that are commonly the subject of valuation exercises.¹⁰ Hence, in the case, for example, of the value of a negative change from the reference state, Q_1 , to Q_0 (Eq. [2] above);

$$\begin{aligned} U_1 [W_0 + WTA^{cv}, Q_0] &= U_1 (W_0, Q_1) \\ U_1 [W_0 + \lambda WTP^{cv}, Q_0] &= U_1 (W_0, Q_1) \\ U_1 [W_0 + \lambda (W_0 - W_1), Q_0] &= U_1 (W_0, Q_1) \end{aligned} \quad [4]$$

simply their greater experience (for example, List, 2003), a suggestion further undermined by the recorded behaviour of profession golfers noted above.

⁷ As the focus here is on the implications of the disparity between valuations of gains and losses, the further diminishing effect characteristic of valuations, which imply non-linearity of both segments, is omitted.

⁸ The intuition of a reference state strongly influencing valuations is perhaps more starkly conveyed in Kahneman's (2011, p. 275) hypothetical of Jack, who had 1 million yesterday and 5 million today, being obviously happier than Jill who has an equal 5 million today but had 9 million yesterday – today's equality can be expected to be overshadowed by the opposite direction of the change from yesterday's wealth.

⁹ There is no reason to expect the value of a loss from, for example, R to L to be exactly equal to the value of reducing a loss from L to R, and similarly for changes in the domain of gains, as implied by the use of the same simple diagram to illustrate valuations for both directions. The evidence is only clear that the values of changes in the domain of losses are generally larger than comparable ones in the domain of gains.

¹⁰ The choice of the correct measure is an issue even in the absence of a significant reference, or endowment, effect – when λ is approximately equal to one – but its practical importance is minimal given the near equivalence of the valuations that would then result from use of either measure.

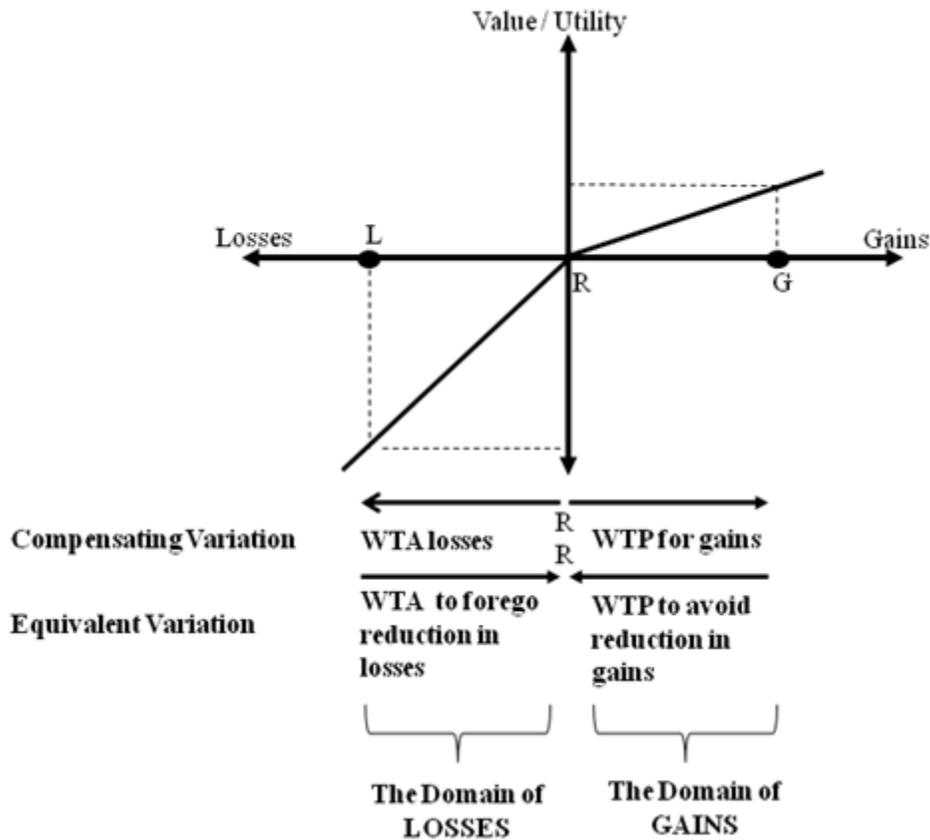


Figure 2. Valuations of Gains and Losses from the Reference State (R) WITH Piece-wise Linear Value Function.

4. Equivalent Variation Measures of Welfare Change

As others have suggested (Zerbe, 2001, also noting implications of the disparity between the values of gains and losses on valuations; and Pearce, 2002), and consistent with most views of standard economic theory, people do not value all changes on the basis of a comparison between the welfare level of a before change reference state and the welfare level after the change – the compensating variation measure. In many cases, the reference people use as the basis for comparison will be the state after the change to be valued has taken place – the equivalent variation measure. In such instances, individuals value the change in terms of a comparison between the welfare level of the present and that of the normal or reference state attained after the change. Thus, when a positive change is viewed by individuals, not as a gain, but as a reduction of a previous loss from

the reference state, the more accurate valuation is then the WTA to forego the superior reference state (the WTA^{ev} measure). Correspondingly, when a negative change is taken not to be a loss, but to be a giving up of a prior gain beyond the reference state, the more accurate valuation is the WTP to avoid a return to the inferior reference state (the WTP^{ev} measure).

In the case of a positive change valued in terms of the after change state, the individual's initial level of wealth can be taken (again in Figure 1) to be W_0 and the initial, or present, level of environmental quality to be Q_0 . However, in this case the reference state of environmental quality, and basis for comparing the value of the change, is not the present Q_0 but is instead Q_1 – a state considered to be the normal or expected quantity or level. This could be the state of, for example, not being stalled by a road blockage, not having possessions taken in a robbery, not being beaten, not being seriously ill, or not suffering the impact of a recent toxic spill. Given that the reference in such cases is the state attained after the change (having the blockage cleared, the possessions returned, the beating stopped, the illness cured, and the spill cleaned up), the equivalent variation measure (WTA^{ev}) then provides the more accurate value of the positive change to go from the present Q_0 to the reference, Q_1 – in this case the minimum compensation the individual would accept to forego this increase in quantity or quality. It is the sum that leaves the individual indifferent between the welfare U_1 yielded by the reference state of W_0 Q_1 (point B), and remaining at Q_0 level of environmental quality but with the increase in wealth from W_0 to W_2 (point D, also on U_1). Thus,

$$U_1 [W_0 + WTA^{ev}, Q_0] = U_1 (W_0, Q_1) \quad [5]$$

with $WTA^{ev} = (W_2 - W_0)$ and equal to CD in Figure 1.¹¹

In the case of a negative change, the individual's initial level of wealth is again W_0 . However, in this case the initial or present quantity is Q_1 a level higher than the reference state of Q_0 . The value of the change from Q_1 to Q_0 (that is, the quantity or quality loss) is the equivalent variation measure (WTP^{ev}) of the sum that leaves the individual indifferent between the reference state (point C on U_0), which forms the basis of comparison, and paying to remain at the present quantity (point A, also on U_0). As before, this implies:

$$U_0 [W_0 - WTP^{ev}, Q_1] = U_0 (W_0, Q_0) \quad [6]$$

with $WTP^{ev} = (W_0 - W_1)$ and equal to BA in Figure 1.

¹¹ There is, here too, no reason for the WTA^{ev} value to be exactly equal to the WTA^{cv} value for changes involving any particular entitlement, as implied by their illustration using the same Figure 1, and similarly for the compensating and equivalent variation WTP measures.

5. Valuing Changes in the Domain of Gains and in the Domain of Losses

The conclusion from a review of the alternative measures of welfare change that is most relevant to the choice of measure is that when people value actions in terms of changes relative to neutral reference states is taken into account, there are then (1) two alternative measures of the value of a positive change, the WTP^{cv} for a gain, for a positive change in the domain of gains above or beyond the reference, and the WTA^{ev} to forego a positive change in the domain of losses below the reference; and (2) similarly, two alternative measures of the value of a negative change, the WTA^{cv} to accept a loss, for a negative change in the domain of losses, and the WTP^{ev} to avoid a change to an inferior reference state for a negative change in the domain of gains. The alternative measures and their relationship to the reference are summarised in Table 1.

Table 1. The Reference State and Measures of the Value of Positive and Negative Changes.

| Reference State | Basis of Measure | Measure of Value | |
|-----------------|-------------------|--------------------|--------------------|
| | | Positive Change | Negative Change |
| Before Change | Compensating Var. | WTP to Improve | WTA to Accept Loss |
| After Change | Equivalent Var. | WTA to Forego Ref. | WTP to Avoid Ref. |

The two alternative measures of the value of a positive change and the two measures of a negative change, and possible differences in valuations between them, are clearly illustrated by the results of a recent study of people’s valuations of changes in the risk of an adverse outcome in which all four measures were used (Zong and Knetsch (2013), in press.).¹² This was done by asking students at a university in the People’s Republic of China to value either an increase or a decrease in the probability of having a bicycle stolen from lots on their university campus.¹³ The four valuation questions framed the outcomes in a common context of specified expected changes in risk related to the expenditures on bicycle security. The same interval in the change in the expected probability of suffering

¹² Nearly all studies of disparities between people’s valuation of gains and loss compare a single measure of a positive change with a single measure of a negative change – usually the compensating variation measures.

¹³ Consistent with the difficulties of accurately assessing people’s valuations of such proposed changes with the use of hypothetical survey questions (for example, Kahneman, Ritov, and Schkade, 1999), the intent of this study was to test for and demonstrate the *pattern* of valuations resulting from the various measures rather than to estimate more specific, or definitive, values associated with these particular changes in the risks of having a bicycle stolen.

the loss of a bicycle, of being between 5% and 15%, was used in all of the questions to ensure that the same good, with the same change in risk level over the same range, was being valued in all cases. Alternative reference states were induced by descriptions of differing previous long-standing risk levels.

Table 2. Alternative Welfare Measures (in ¥) of Change in the Risk of Having a Bicycle Stolen.

| Measure | Mean | Median |
|--|-------|--------|
| Positive Change: | | |
| WTP ^{CV} for Risk Reduction (<i>N</i> = 31) | 20.19 | 12 |
| WTA ^{EV} to Forgo Risk Reduction (<i>N</i> = 35) | 46.49 | 30 |
| Negative Change: | | |
| WTA ^{CV} for Risk Increase (<i>N</i> = 37) | 41.59 | 30 |
| WTP ^{EV} to Avoid Risk Increase (<i>N</i> = 32) | 16.53 | 11 |

The responses to the four valuation questions are summarised in Table 2. The major result of the survey is the very large – more than twice as large – and statistically significant (*Z*-stat = -5.427 , *p* = 0.0000) difference between valuations from the two WTP questions (Q1 and Q4) and the two WTA questions (Q2 and Q3). The two measures of the value of a positive change differed, and differed greatly, as did the two measures of a negative change.

The respondents indicated that they were willing to pay (WTP^{CV}) an average of ¥20.19 for the positive change of reducing the risk from the reference state of 15% to 5%, but demanded a mean of ¥46.49 when the change was to reduce risk level from 15% to the reference of 5% (the WTA^{EV} measure). Similarly, they demanded an average of ¥46.49 for the negative change of an increase in risk from the reference state of 5% to 15% (the WTA^{CV} measure), but were willing to pay only a mean of ¥16.53 to avoid such a loss (the WTP^{EV} measure). It is not the case, at least in this study with these respondents, that people value a positive change in risk, or a negative change, the same regardless of the measure used to assess it, as typically assumed in present practice. Nor is it the case, here too, that people value a positive change, or a negative change, the same regardless of it being below or above the reference state.

The results of the bicycle study not only replicate the findings from many previous studies in showing a large difference between the WTP valuation of a gain and the WTA measure of the value of a loss, but they are also consistent with the pattern of valuations across all four welfare measures expected on the basis of

this disparity. In this case too, the evidence is inconsistent with the slope of U_1 in Figure 1 being parallel to U_0 as drawn with the solid line. Instead, it is more realistically illustrated by the dashed line U_1' so that the WTA measure of a loss is not the sum $W_0 W_2$ but is instead the much larger amount $W_0 W_3$ and similarly for the WTA to forego a positive change.

The findings also show that the measure that can be expected to most accurately assess the welfare consequences of a change depends not on its direction but on the nature of the change relative to the reference state people use to evaluate the outcome. Although determination of reference states and the gain and loss domains of changes is, at least for now, largely an empirical matter and may be somewhat ambiguous pending further study, this may be much less so for the many cases of more episodic changes that are so often the subject of valuation exercises. The large differences evident in these findings – like those in other studies – are also consistent with the choice of measure being a matter of considerable practical importance.

6. The Choice of Measure

The intuition for the appropriate choice of welfare measure and its dependence on the loss or gain domain of the change might be illustrated by a simple thought experiment involving a case of a physical assault. It may, first, with little doubt be safely assumed that the welfare of a person suffering from such an offensive and objectionable action would be reduced from the level of well-being in what is likely to be almost universally assumed to be the normal or reference state of not being beaten – a state which was enjoyed by the individual prior to the attack. The assault is therefore not only a negative change for this person but one in the domain of losses and not a foregone or reduced gain in the domain of gains – a negative change from R to L in Figure 2, and not one from G to R. The impact of the assault on the individual's welfare is, therefore, most accurately assessed by the minimum compensation the individual would demand to suffer the beating but be left at the same level of welfare enjoyed at the reference state (the WTA^{CV} measure, as in Eq. [2] above). The loss would in this case be inadequately assessed by the person's WTP to avoid the attack.¹⁴

Stopping an assault would be a positive change that would improve the victim's welfare. Here, as with many other cases, individuals may well, however, view this improvement not as a gain but as elimination of a loss and a return to the reference state of not being beaten – a positive change in the domain of losses, as, for example, a move from L to R in Figure 2. Its value is consequently most accurately assessed by the minimum compensation the individual would demand

¹⁴ Further, the individual would clearly not be made whole by such a sum offered as compensation for the loss.

to forgo cessation of the assault and allow the beating to continue (the WTA^{ev} measure of Eq. [5] above).

The alternative of using the WTP measure to assess the welfare change of an assault, or stopping of an assault – which, in practice, is the overwhelming choice for cases such as this – requires both negative and positive changes to be regarded as taking place in the domain of gains. This necessitates viewing suffering an assault as the norm or reference state. For it is only when a positive change is a gain from the reference (as in Eq. [1] above) that the WTP^{cv} accurately measures the welfare gain resulting from a cessation of the assault. Similarly, it is only when the willingness to pay to avoid an assault that would impose the reference state that this WTP^{ev} measure accurately assesses the welfare loss of initiating a beating (as in Eq. [6] above).

The choice between a positive change being either a reduction of a loss or a gain can be further illustrated in Figure 1. If not being assaulted, or not being robbed, or not experiencing the environmental degradation of an oil spill, is taken as the reference position, then when any of these occur an individual can be assumed to be moved to point C but with the reference remaining at point B. The value of a positive change of eliminating the loss, from C to B (that is, from Q_0 to Q_1) is then the sum that leaves the person indifferent between point D' and point B, both of which restore the welfare to the level of the reference – in legal parlance, they are made whole. If, however, being robbed, or being beaten, or having the spill, is taken as the reference state, the person is, with their occurrence, at point C which is, or then becomes, also the reference state. The value of the change from C to B would then be the sum that leaves the individual indifferent between C and A (the WTP^{cv}), both on U_0 . By definition, this measure of the loss resulting from being robbed, being beaten, or having oil spilled implies that the individual is left no better off than when suffering the harm – clearly a sum that does not make the person whole. Although, again, an empirical issue, changes that involve restorations of normal or expected circumstances – returning stolen property, stopping a beating, cleaning up the oil, and many others of a similar nature – may often be seen as reductions, or eliminations, of losses rather than as gains.

To the extent that people regard a change – an assault, a robbery, an oil spill, diagnosis of a serious illness, desecration of a heritage site – as a change in the domain of losses, then their occurrence, their mitigation, or their prevention are all then most accurately, and therefore most appropriately, valued with WTA measures. All involve either negative changes, to be measured by the compensating variation WTA measure to accept them (Eq. [2] above), or positive changes, to be measured by the equivalent variation WTA measure to forego them (Eq. [6] above).

Similarly, to the extent that people regard a change to be in the domain of gains – receiving money, proposed construction of a new community recreation centre, receiving a coffee mug – then their occurrence, their retention, their withdrawal, or any other change which involves such goods or access to them, are all probably most accurately valued with the WTP measure.

Just as the extent that victims of a physical assault are likely to regard cessation of the attack as a reduction in a loss from a reference of bodily integrity than a gain from the state of being beaten, and that victims of a theft of property view return of their belongings as a recovery of their reference state than a gain from a reference of unlawful dispossession of their property, a presumption of a similar lack of a shift in reference may be justified over a wide range of cases. Not only may people regard an unsoiled environment as the norm even after its loss brought about by an oil spill but they may also retain their original reference states after experiencing an accident, or encountering ill-health. For example, being “diagnosed with a particular illness that would, if untreated, put them in a specified impaired health state for the rest of their lives” (Pinto-Prades, Loomes, and Brey, 2009, p. 553) may well leave people in the domain of losses from which they would value treatment to restore their health as a reduction of the loss rather than leave them feeling that their reference state is one of illness and viewing treatment as a gain – to view the norm as a state of normal health rather than one of illness, and to view treatment as restoring their health rather than improving it. To the extent that this is the case, the WTA measure more accurately assesses the change in welfare associated with the treatment, not people’s willingness to pay, as is now the usual choice.

Assertions of shifts in reference states, implicitly made in the common practice of treating all positive changes as gains and therefore to be valued in terms of the WTP measure, and to regard all negative changes as losses to be valued by the WTA measure (even if the WTP measure is knowingly substituted for it in most cases), appear to be based on notions of people adopting or reconciling to changes.

It is no doubt common for people to at least partially adapt to many, if not most, adversities (for example, Oswald and Powdthavee, 2008). Overcoming or adapting to various physical disabilities or other limitations are widely observed and these coping actions may well lead to lower valuations of potential mitigating or remedial measures. However, such reductions in the value of mitigating actions may be due to the decreasing seriousness of the harm brought about by the success of the individual’s coping and adapting actions. Such a reduction in the loss does not, however, necessarily imply a shift in an individual’s reference state. Mitigation actions to reduce the harm are probably still changes in the domain of losses and their values are therefore still best assessed by the WTA measure. Possible adaptation and reconciliation does not change the reference, and

therefore does not call for a change in the measure that best assesses the value of the change.

Evidence consistent with the persistence of reference states is provided by the strong preference of survey respondents for a transportation project that reduced a loss over one that provided a gain. Both transportation experts and student respondents overwhelmingly indicated that eliminating a detour, made necessary by a past bridge failure, was more valuable than an equally costly road improvement that provided an equivalent reduction in travel time (Chin and Knetsch, in preparation). The difference suggests that the reference of a functioning bridge which gave rise to their framing the failure as a loss did not change with its demise as the replacement was viewed as a reduction of a loss and as such valued more highly than the gain provided by the other project.

As the bicycle theft study clearly demonstrated, it is somewhat possible to obtain plausible estimates of peoples' valuations of essentially the same changes using deliberately differing framings of the choice. This was famously done in the case of differing responses to identical numbers framed as either lives saved or lives lost (Kahneman and Tversky, 1984). Such demonstrations, however, provide no evidence calling for differing measures of welfare change. The appropriate measure remains a function of the change being in the domain of gains or of losses. In a similar manner, questions asking for WTP valuations are commonly used to assess losses in contingent valuation studies, but this does nothing to justify this as the most accurate or appropriate measure of the associated change in welfare.

In the case of valuing changes in the risks of having bicycles stolen, the choice of measure to most appropriately assess the feasibility of dealing with the problem here too turns on the reference state and whether changes are in the domain of gains or in the domain of losses. In this case, to the extent that maintaining possession of one's own bicycle is regarded as the norm, being dispossessed would then put people in the domain of losses. Consequently, the WTA appears to be the most accurate and, therefore, most appropriate measure of the changes of both cutting back security measures or of reinstating them. On the illustrative numbers obtained in the study (Table 2), an increase in the risks of bicycle theft resulting from the decreased security measures should be weighed at approximately ¥42 per student (the mean using the WTA^{cv} measure), and the value of a commensurate decrease in risk due to more security should be weighed at ¥46 per student (the mean using the WTA^{ev} measure of the compensation necessary to forego the decrease). These are both well over twice the WTP values that are usually used for valuing such changes in benefit-cost analyses and the like.

The conclusion of the WTA measure being more appropriate for most changes in the domain of losses and the WTP measure for those in the domain of

gains appears to hold with equal force for partial moves ending short of the reference state. For example, the partial clean-up of an oil spill, rather than complete elimination of the harm, would also be valued by a WTA sum. In this case too, it would be the amount that leaves the individual at the same welfare level as that of the reference – the minimum sum the individual would demand not to have the partial clean-up take place (as in Eq. [5] above). The size of the spill is simply a dimension or characteristic of what is still a harm.

In a similar way, it appears that the predictability of an event is also a characteristic of the change and has equally little role in the appropriate choice of measure. Drivers may be perfectly aware that driving on a road from A to B involves a non-zero risk of having an accident. Yet, it may well not be this awareness of the possibility of an accident that determines the reference for purposes of choosing a measure for valuing accidents; the reference may instead remain not having an accident and if an accident occurs it then puts drivers in the losses and it is this that dictates that the WTA measure be used to assess their change in welfare, and the value of undertakings to reduce accidents.

Another implication of this distinction is that to the extent the value of a statistical life is based on people's valuations of a change in the probability of a premature death, this calculation too is best made in terms of the WTA valuation of this change. This use of WTA stems from the presumption that individuals regard premature death to be a change in the domain of losses and should therefore be measured in terms of people's willingness to accept compensation for an increase in such risks or in the sum they demand to forego a decrease. Apart from formidable problems of estimation, valuation of differences in wages paid for riskier work is, at least in principle, a more appropriate measure of the value of a statistical life as they attempt to measure the payment necessary to compensate for enduring the greater probability of premature death. Estimates based on survey responses to questions asking people for their WTP for a reduction in the risk level lack this justification and their use will almost certainly result in understating the value of life.

7. Conclusions

Estimates of the gains and losses associated with projects, changes in policies, and a myriad of other things that have an impact on people's well-being are often used to provide guidance in judging their desirability or in setting priorities in their implementation. This is the case not only in more formal means of benefit-cost analyses, risk assessments, settings of compensation awards, and the like but also in the more informal ways in which problems are identified and alternative resolutions are proposed. Although there is wide agreement that WTP measures are to be used for gains, with WTA ones used to assess losses, in practice the

former are used to assess the gain or loss of welfare, or value, of nearly all changes regardless of the nature of their impact. Further, little or no distinction in choice of measure is usually made between positive changes that provide gains and positive changes that reduce losses.

Given the evidence of a large and pervasive difference between the WTP measure of a gain and the WTA measure of an otherwise commensurate loss, and given the extent to which assessments are used to guide decisions involving losses and mitigation of losses, such measurements are very likely to provide seriously distorted guidance. The bias introduced by this near-universal use of the WTP measure of all changes encourages activities that impose losses and greater risks of harms, and discourages mitigation of losses and reductions in the risks of harms. Weighing the value of an intervention that would reduce the risk of injury, the incidence of serious illness, or the occurrence of environmental harm, in terms of how much people would be willing to pay for it, would, for example, almost certainly understate the justification for actions that would prevent such outcomes. The actual change in welfare would be more readily apparent with a more accurate assessment based on how much people would demand to be denied such changes. More generally, a more realistic assessment of changes in people's welfare that would accompany greater use of the WTA measure where called for would in all likelihood lead to greater attention to interventions leading to greater deterrence and fewer losses and more mitigation of losses, relative to provisions of gains.¹⁵

Evidence of the common disparity between people's valuations of gains and losses, and the consequent greater recognition of the larger impact that losses have on people's welfare, also appears to be consistent with findings that it is overwhelmingly losses or the risks of losses that have the greater influence on people's self-assessments of well-being, or happiness. Such surveys consistently find that issues, such as loss of employment, illness of family members, family break-up, and the risks of such losses, have a dominant influence over feelings of well-being (for example, Helliwell, 2006). This apparent relationship between feelings of well-being and freedom from losses would seem to be better recognised by wider use of the more appropriate WTA measure to assess the

¹⁵ An often cited reason for continuing the use of the WTP measure, even in cases in which it is acknowledged to be inappropriate, is the current lack of generally acceptable means to estimate WTA values. Although, again, the point here is the choice of measure, it may not be unreasonable to suggest that analysts could do worse than, as an interim measure, multiply their estimates of WTP values by the 2.6 that Horowitz and McConnell (2002, p. 433) found as the median WTA/WTP ratio in the many studies they reviewed. This would both improve on the empirically unsupported assertion that this ratio is equal to one, and its arbitrariness might provide needed incentive to develop more useful WTA estimation methods – an incentive that acceptance of current practice has undermined.

extent of losses and the value of mitigating them or reducing the risks of their occurrence.

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