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Willingness to Pay or Willingness to Accept: Determing the Appropriate Welfare Measure when Preferences are Reference-Dependent

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August, 2015

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WILLINGNESS TO PAY OR WILLINGNESS TO ACCEPT: DETERMINING THE APPROPRIATE WELFARE MEASURE WHEN PREFERENCES ARE REFERENCE-DEPENDENT

Jack L. Knetsch and Phumsith Mahasuweerachai

EXECUTIVE SUMMARY

Many recent experimental and field studies have provided strong evidence that people often value losses more substantially than gains. In addition, people also seem to value the changes in both gain and loss domains not as final states (as assumed in standard theory), but in terms of changes from their reference states. Therefore, positive changes may be either gains, which is appropriately measured by willingness to pay (WTP), or reductions of losses, which is appropriately measured by willingness to accept (WTA). Similarly, negative changes may be best measured by the minimum compensation that people require to accept losses, or their willingness to pay for avoiding them. The choice of measures is critically dependent on the reference states of people. This report describes how different values can be derived from using different reference states, and discusses the methodology of defining reference states by using data from a study on the risks of riverbank erosion conducted in the northeast region of Thailand.

1.0 INTRODUCTION

It has generally been agreed that positive changes in entitlements to a good are to be regarded as gains. The monetary measure of the increase in welfare from such moves is most accurately assessed by the maximum sums people are willing to pay (WTP) for them (the WTP measure); the negative changes are taken as losses, which is most accurately measured by the minimum compensation people are willing to accept (WTA) for them (the WTA measure). Conventional theory assumes that the differences in estimates yielded by the two measures can only be the result of income or wealth effects, and will therefore be inconsequential for most measurements. As quoted from Henderson (1941, p. 121) "….we shall normally expect the results to be so close together that it would not matter which we choose." Thus, the WTP measure has been and continues to be the near universal choice for valuing both gains and losses on the grounds of convenience and ease of estimation.

It is generally accepted in standard theory that WTA and WTP for the same entitlement will yield similar values. This leads to the universal agreement that WTP is applied in valuing nonmarket goods in both gain and loss situations because it is easier and more convenient to be estimated than its counterpart (i.e., WTA) (US-EPA 2000). However, much evidence from hypothetical survey studies, replicated controlled real-exchange experiments, and natural experiment studies have clearly suggested that these two values may actually be different; and the median ratio of WTA and WTP valuations could reach at least 2.5 times (Hammack and Brown 1974; Knetsch and Sinden 1984; Kachelmeier and Shehata 1992; Odean 1998; Rabin 1998; Horowitz and McConnell 2002; Thaler and Benartzi 2004; Einio, Kaustia, and Puttonen 2008). Therefore, applying WTP to measure the values of losses may result in underestimated welfare changes, which may provide biased policy advice.

In addition, widely reported behavioral findings have made it clear that people value many gains and losses not as final states, as assumed in standard theory and in valuation practice. Instead, people value them in terms of changes from a neutral reference state, which may or may not be the status quo. Likewise, losses and reductions of losses are commonly valued much more than commensurate gains or decreases in gains (Kahneman, Knetsch, and Thaler 1990; Putler 1992; Kahneman 2003; Einio, Kaustia, and Puttonen 2008; Knetsch and Wong 2009; Kahneman 2011; Pope and Schweitzer 2011; Knetsch, Riyanto, and Zong 2012). This seriously undermines the propriety of the current common practice of using the WTP measure to assess the value and reduction of losses as well as the presumption that people consider all positive changes as gains and all negative ones as losses.

To the extent that valuations are based on a reference state, which may or may not be the status quo, a positive change can be either a gain or a reduction of a loss. If the valuation of the change is based on a reference of the before-change entitlement, then it is a gain. This can be appropriately measured by the compensating variation of WTP (WTP^{cv}),[1] which is the measure of the maximum sum an individual would be willing to pay for it. However, if the valuation is based on a reference of the after-change entitlement, then it is most accurately assessed by the equivalent variation of WTA (or WTA^{ev}),[2] which is the measure of the minimum sum the individual would accept to forgo the positive change.

Similarly, a negative change can be either a loss or a complete or partial elimination of a gain, depending on the nature of the change relative to the neutral reference state considered by the individual. Valuations of negative changes based on before-change entitlements can be taken as losses. It is most accurately assessed by the compensating variation of WTA (or WTA^{cv}), which is the measure of the minimum sum an individual requires to accept such loss. If the individual's valuation of the negative change is based on after-change entitlement, then it can be treated as a forgone gain. Accordingly, it can be assessed with the equivalent variation of WTP (or WTP^{ev}), which is the measure of the maximum amount the individual would pay to avoid such a loss.

The distinction between the measures might be crudely illustrated by a hypothetical case of valuing both a physical assault on an individual and an intervention that puts a halt to such action. It seems reasonable to assume that people would regard not being beaten as their normal expectation; therefore, it is their reference state for valuing any changes relative to it. Consequently, initiating an assault would be taken by the individual as a negative change from this reference. This would be valued in terms of a loss from their normal situation of not being assaulted. The appropriate monetary measure of the welfare loss imposed by the beating would then be the WTA^{cv} of the minimum compensation necessary to accept it. Once an assault is underway, the positive change of stopping it could be taken and valued as either a gain or a reduction/elimination of a loss. This is can be assessed by the WTP^{cv} measure if it is considered as a gain, and by the WTA^{ev} if it is a reduction/elimination of a loss. The distinction depends on the reference state.

In this case, it seems unlikely that initiating the assault would change people's expectations or normal reference state from one of not being beaten to one of being assaulted. Therefore, the reference would remain the state of not being assaulted. The appropriate monetary valuation is then the compensation necessary to forgo a cessation of the beating, which is the WTA^{ev} measure.

Thus, there can be different measures of the values of both positive and negative changes whenever valuations are reference-dependent. Positive changes can be either gains (best assessed with a WTP measure) or a reduction of a loss (best assessed with a WTA measure). Again, depending on the reference state, negative changes can be either losses (for which a WTA measure is appropriate) or forgoing of a gain (calling for a WTP measure).

The possibility that one or any of these alternative measures would lead to a more accurate assessment raises the neglected issue of "which of these measures is the most appropriate choice of measure for certain assessments?" Some circumstances may be similar to the assault example in terms of gaining an easy consensus on the appropriateness of choice.[3] Others are likely to be less so and often are far less so. For example: Is medical treatment of an injury a gain to be valued with a WTP measure? Or is it a reduction of a loss better assessed with a WTA measure? Is reduction of ambient pollution a gain or reduction of a loss? Is an unexpected tax on a lottery winning, a loss or forgoing of a gain? Thus, making a more objective set of criteria in choosing the appropriate measure is very important.

This study presents whether such values of changes are different when preferences are reference-dependent. In particular, the research team conducted an extensive survey of farmers who have been facing erosion-related problems along the Mekong River in the northeast region of Thailand. A total of 189 farmers who enjoyed the benefits of erosion-control measures and 204 farmers who did not composed the sample. Through monetary and nonmonetary ranking and scaling, the respondents were asked to indicate their

[1] Compensating variation is the value required to maintain a person's satisfaction or economic welfare at the level it was at before the change.

[2] Equivalent variation is the value required to maintain a person's satisfaction or economic welfare at the level it would be at after a change.

[3] However, even in such cases of an obvious advantage of the use of a WTA measure, such as for the clean-up of toxic spills, valuation studies, and justifications for remedial actions, they continue to be framed in terms of people's willingness to pay for them.

valuation of the relative importance of positive and negative changes in the availability of erosion-control measures. This provided insights into whether there were disparities between the changes in the gain and loss domains as well as within each domain. In addition, this data also allowed the researchers to test the effect of reference states on the disparities.

The results would help to develop a more objective empirical means of determining a more appropriate valuation measure that can be used in a wide array of frequently studied cases, including studies that assess the values of medical interventions, changes in environmental quality, justifications for heritage preservations, the design of financial regulations, the provision of recreational and other amenity facilities, and changes to transportation infrastructure.

This report is constructed as follows: Section 2 discusses the methodology used in this study while Section 3 discusses the analysis and results. Section 4 composes the discussion and conclusions.

2.0 METHODOLOGY

2.1 Study Sites and Selection of Sample Households

Riverbank erosion is a big problem for farmers who have land located on or near the Mekong riverbank. To mitigate this problem, dikes have been constructed to protect the riverbank from erosion. Farmers understand the effects of riverbank erosion on their farms and homes, and can link the risk of erosion with the availability or unavailability of riverbank dikes.

The respondent communities in this study were selected from a sample frame of eligible communities in six provinces in the northeast region of Thailand. The six provinces were selected based on the information of riverbank erosion and protection occurring in the provinces. The Mekong River passes through this part of Thailand. The region is divided into three parts: upper, middle, and lower. The upper part has two provinces, Loei, and Nong Khai. The middle part has Nakhon Phanom and Bueng Kan provinces, while the Mukdahan and Amnat Charoen provinces are in the lower section.

There were two main groups of sample households; households with protection from riverbank erosion by dikes and those with no such protection. Villages with some parts protected by a dike were selected first because they contained similar households with protection and without protection. However, the number of samples provided by this type of village was not enough; thus, the research team also selected villages with all parts protected by a dike and villages that were completely unprotected in the same geographical areas as the first type of village.

The sample households were then selected based on the age of the participants representing the households; they had to be aged between 30 and 65 years. This was to ensure that those who participated in the survey were mature enough to make decisions for their household. Next, the lists of selected participants were given to the heads of the villages to check whether the recommended participants were currently living in the villages or not. If any of the selected participants had migrated to other areas or refused to participate in the survey, the research team then randomly selected neighbour-participants as substitutes. A total of 393 households participated in this study; 189 respondents comprised the protected group and 204 respondents were in the unprotected group.

After having the complete lists of participants, letters were sent to the village heads inviting them to special group sessions that would be held on specific dates at a central location in each village. Each group session had 8–10 participants. Each participant was one-on-one interviewed by a trained enumerator using a comprehensive questionnaire consisting of four main sections plus an informed consent page. The sections covered: (1) the contingent valuation (CV) questions; (2) the situation of riverbank erosion and its impacts on the participant household; and (3) socioeconomic information.

There were two sets of questionnaires with different CV questions. The unprotected group of respondents were assigned to answer the questionnaire on the situations of hypothetical Farmers A and B, while the questionnaire on the situations of Farmers C and D was assigned to the protected group respondents.

2.2 Survey

The research team conducted the survey between August and November 2013. Four measures of positive and negative changes relating to the availability and unavailability of river erosion-control measures were formulated in two different sets of survey questionnaires to assess what farmers thought about the availability and unavailability of riverbank erosion-control measures and what they were worth to them. In addition to the four-rating scale questions, two additional monetary questions involving either positive changes in the gain domain or negative changes in the loss domain were included.

There were two groups of farmers sampled: those who were provided with riverbank erosion-protection measures and those who were not. The research team asked those farmers enjoying the benefits of erosion control to value the two negative changes of (1) the elimination of effective control measures, and (2) the loss of a temporary dike. Meanwhile, the other group of farmers without current erosion protection was asked to compare and value the two positive changes of (1) a gain of erosion control, and (2) replacement of ineffective control measures.

For the paired comparison, both farmer groups were asked to consider the erosion situations of two hypothetical farmers who had land located on the Mekong riverbank like they did. The situations of the two hypothetical farmers were different, which would give rise to different reference states.

The situations presented to the farmers without erosion protection measures consisted of the situations of one farmer (Farmer A) who had never had erosion protection, and another farmer (Farmer B) who had enjoyed access to erosion protection for some time, but just lost it last year when the dike became inoperative. The farmers in this group were asked to compare which farmer would value the construction of a new dike more, followed by a rating-scale question that asked the farmers to rate the value levels of Farmer A and Farmer B regarding the dike. They were also asked to state their WTP for constructing the dike. The situation setup in this question was related to their current situation, and sought to ascertain how much villagers like them would pay to have a dike constructed.

In analogous fashion, the farmers with dike protection were also given hypothetical scenarios about two farmers. The first hypothetical farmer (Farmer C) had never had the benefit of a dike before, but a temporary dike that would last only for one year had just been built. On the other hand, the second hypothetical farmer (Farmer D) had had the benefit of erosion protection by a dike for several years, but the useful life of the dike would come to an end the following year. The farmers in this group were asked to compare which farmer would value the construction of a new dike more, followed by a rating scale question that asked the farmers to rate the value levels of Farmers C and D regarding the dike. They were also asked to state the WTA values of the two farmers. This question was related to their own situation in which the dike currently protecting their land had reached the end of its useful life, and sought to find out how much money they would be willing to accept if the dike was not reconstructed.

2.2.1 Survey questions

All the survey questions contained an identical initial paragraph as given below, describing the following context:

As you know, fluctuations in the water level of the Mekong River caused serious riverbank erosion in the past and have severely damaged lands such as yours.

Questions for unprotected respondents. The paired-comparison question for the unprotected farmers was designed in such way to elicit the values of positive changes in the gain and loss domains, which are presented by the moving of WTA^{EV} and WTP^{CV} in Figure 1.

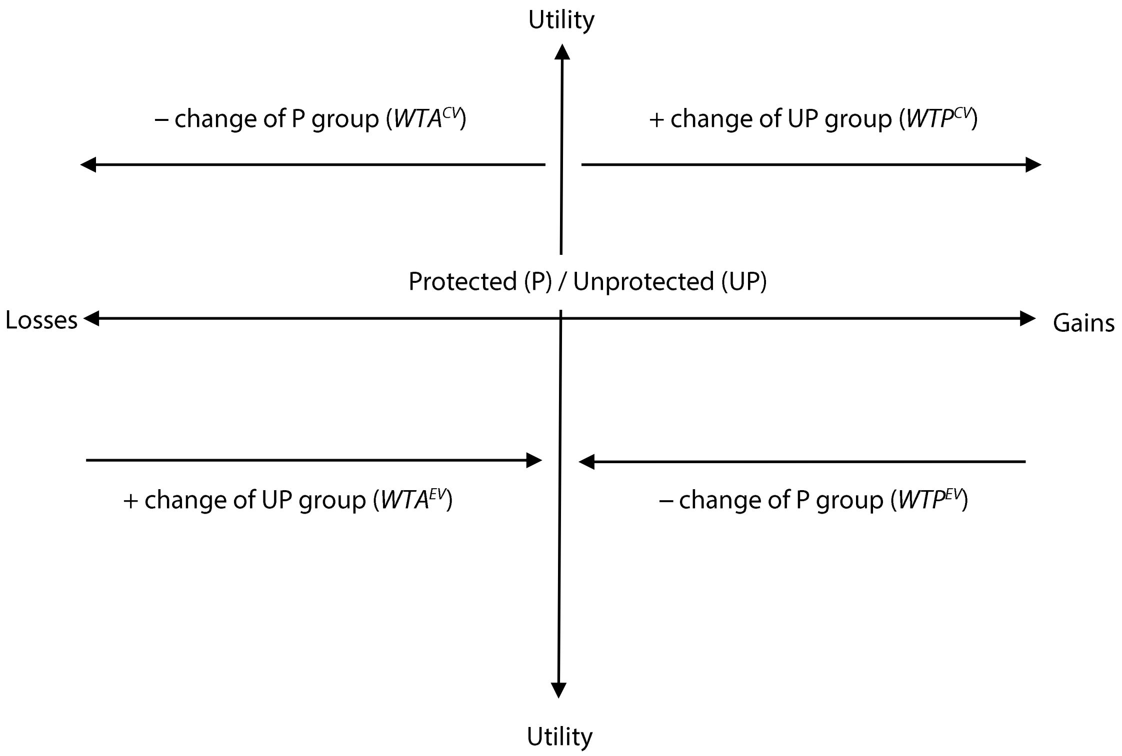

Figure 1. Valuations of gains and losses from the base reference states of the hypothetical farmers

Accordingly, the question went as follows:

Your land is not and has not been protected from erosion by the construction of a dike near your land. However, such dikes have a limited lifetime and once this is reached, they can no longer offer any protection from erosion.

Assume that there are two farmers, Farmer A and Farmer B, who also have property along the Mekong River where erosion can damage their land unless it is protected by a dike. They are exactly alike, except

1. *Farmer A's land has never been protected from erosion damage by a dike. Building a dike would prevent Farmer A's land from being damaged by erosion.*
2. *Farmer B's land has always been protected from erosion damage by a dike until a year ago when the useful life of the dike ended. Building a new dike to replace the old one would again protect Farmer B's land from erosion.*
3. *Both Farmer A and Farmer B would benefit from the construction of a new dike that would protect their land. However, which farmer do you think would value construction of a protective dike more? (a) Farmer A, who has land that has never been protected from erosion by a dike or (b) Farmer B, who has land that has, until this past year, always been protected by a dike, and a new dike would restore the long-term protection from erosion.*

This question was deliberately framed to expose unprotected farmers to two situations that would provide different reference states of the hypothetical farmers. The reference state of Farmer A would be the *no erosion protection from the dike* as represented by "has never been protected ….". The proposed change would be an improvement from this reference state, which is a positive change in the gain domain. On the other hand, the situation of Farmer B would set the reference state of *being protected from erosion by the dike*, as represented by "has always been protected … until a year ago when the useful life of the dike ended." The proposed change for this farmer would then be viewed as a reduction or elimination of the loss from the reference state of being protected. This would be a positive change in the domain of losses as presented by WTA^{EV} in Figure 1. After answering the paired-comparison question, the respondents were asked to rate (from a score of 0 to 20) the value of the new dike for each farmer as shown below.

Farmers such as you, as well as those like Farmer A and Farmer B, value many personal, family, and community facilities and opportunities such as comfortable housing, higher crop yields, roads and other transportation links, access to healthcare for family members, and education for children.

Relative to the value of such things, how would you rate Farmer A's valuation of a dike that would protect Farmer A's land? Please rate on a scale from 0 to 20, in which the score of 0 indicates that construction of such a dike would have no value to Farmer A and a score of 20 indicates that you think a dike would have would have very great value to Farmer A.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

No value → Very great value

Similarly, and again relative to other things like comfortable housing, roads, and other such things, how, on the same 0 to 20 scale, would you rate Farmer B's valuation of a dike that would protect Farmer B's land?

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

No value → Very great value

Questions for protected respondents. The following question was used to elicit the protected farmers' values of the new dike.

Farmer C's land has never been protected from erosion damage by a dike. However, a temporary dike to test new building methods was constructed last year, which provided protection for a one-year trial period. Building a regular, more permanent dike would prevent Farmer C's land from again being damaged by erosion.

Farmer D's land has always been protected from erosion damage by a dike, which was built many years ago. However, the useful life of the dike will soon end and it will no longer provide any protection from erosion. Building a new dike would continue the protection of Farmer D's land.

Both Farmer C and Farmer D would benefit from construction of a new dike that would protect their land. However, which farmer do you think would value the construction of a protective dike more?

In this question, protected farmers were deliberately exposed to two different situations of two hypothetical farmers who had different reference states. The reference state of Farmer C would be *no protection from the dike* based on the words "Farmer C's land has never been protected ….". The proposed change for this farmer would be a negative change in the gain domain, which is a move of WTP^{EV} in Figure 1.

On the other hand, Farmer D's situation set the reference state of this farmer as *being protected from erosion* based on the words "has been always protected …. by a dike," which reflected the respondents' situations and reference states. The change in the reference state of this hypothetical farmer was a negative change in the loss domain, from being protected to being unprotected from erosion, as measured by WTA^{CV} in Figure 1.

The protected farmers were also required to estimate how much the hypothetical farmers would value the construction of the new dike on a scale of 0–20 after choosing which farmer would value the construction of the dike more. This was presented as follows:

Farmers such as you, as well as those like Farmer C and Farmer D, value many personal, family, and community facilities and opportunities such as comfortable housing, higher crop yields, roads and other transportation links, access to healthcare for family members, and education for children.

Relative to the value of such things, how would you rate Farmer C's valuation of a dike that would protect Farmer C's land? Please rate on a scale from 0 to 20, in which a score of 0 indicates that the construction of such a dike would have no value to Farmer C and a score of 20 indicates that you think a dike would have would have very great value to Farmer C.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

No value → Very great value

Similarly, and again relative to other things like comfortable housing, roads, and other such things, how, on the same 0–20 scale, would you rate Farmer D's valuation of a dike that would protect Farmer D's land?

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

No value → Very great value

2.3 Methods of Valuation

2.3.1 Valuation of the dike

The sets of questions described in the previous section were framed to get both groups of respondents to provide the value of protection from erosion via a dike, anchored by their own reference states and those of the hypothetical farmers presented to them. The four values of the dike could be different or similar. In this study, the authors assumed that the respondents associated the availability of a dike with lower risk of erosion and the unavailability of a dike with higher risk of erosion.

Let the initial situation of erosion be characterized by erosion risk P_0 and income Y_0. The farmer has an indirect utility function $U(Y)$, where $U'(Y) > 0$ and $U''(Y) \leq 0$. The former is the first derivative of utility with income, which indicates utility increase with income increase. The latter is a derivative that shows that utility increases with income at a diminishing rate. The expected utility $V(P_0, Y_0)$ of the initial erosion situation would be

$$V(P_0, Y_0) = (1 - P_0)\, U(Y_0)\,. \qquad \text{Equation (1)}$$

Assume that the erosion situation has changed and the farmer perceives a higher risk of erosion, which is $P_0^* > P_0$. The farmer turns to consider the availability of a protective dike that may reduce the risk of erosion to P_1 and income to Y_1. The new erosion situation, with a protective dike and no change in reference state, will be desirable if the new situation satisfies the following equation:

$$V(P^*_0, Y_0) = (1 - P_1)\, U(Y_1) = V(P_1, Y_1)\,. \qquad \text{Equation (2)}$$

The unprotected farmer who has never been protected by a dike may be willing to pay some of his income to construct a dike to reduce the risk of erosion. The trade-off between income and risk of erosion, which reveals the value of dike, can be calculated using Equation (3) below:

$$\frac{\partial P_1}{\partial Y_1} = \frac{U(Y_1)}{(1\text{-}P_1)U'(Y_1)}\,. \qquad \text{Equation (3)}$$

In the case of protected farmers, Equation (3) would reveal their willingness to accept the increased risk of erosion due to the loss of the dike. Thus, without reference state effects, the WTP^{CV} and WTP^{EV} of the unprotected farmers would be the same as the WTA^{CV} and WTA^{EV} of the protected farmers.

2.3.2 Unprotected farmers: positive changes and reference states

The unprotected respondents were asked to consider the situations of two hypothetical farmers, Farmer A and Farmer B, whose reference states were (1) no protection from erosion (no dike) and (2) protection from erosion (having dike), respectively.

In the situation of Farmer A, the direction of change from the construction of the dike would be WTP^{CV}. In this case, the risk of erosion in the reference state is higher than that in the situation with the dike, $P_0 > P_1$, and the utility of Farmer A from this change was calculated using Equation (4):

$$V(P_1, Y_1) = (1 - P_1)\, U(Y_1)\,. \qquad \text{Equation (4)}$$

Equation (4) reveals that to move from being unprotected to protected, Farmer A would be willing to sacrifice some of his income, which represents the value of the dike in significantly reducing his risk of erosion. There are no reference state effects in the trade-off between income and risk of erosion using Equation (3). The value of the dike for Farmer A given by the unprotected respondents is the same as that using Equation (3).

In the case of Farmer B, the question was deliberately framed to set his reference state as being protected from erosion by a dike. Losing protection from the dike just a year ago would induce loss aversion, even to an unprotected respondent, because the risk of erosion would significantly increase relative to the risk in the reference state, therefore, $P_1 > P_0$. To model this case, a reference utility loss of $\lambda(P_0\text{-}P_1)$, associated with the increased risk of erosion due to not having a protective dike anymore would include the expected utility from Equation (4). This is shown in Equation (5) as follows:

$$V(P_1, Y_1, \lambda) = (1 - P_1)\, U(Y_1) - \lambda(P_0\text{-}P_1). \qquad \text{Equation (5)}$$

The value of the dike for Farmer B, based on the income and erosion risk trade-off, was calculated using Equation (6):

$$\frac{\partial P_1}{\partial Y_1} = \frac{U(Y_1)+\lambda}{(1\text{-}P_1)U'(Y_1)}\,. \qquad \text{Equation (6)}$$

As a result, the relative dike value between Farmer A and Farmer B with the effects of differing reference states and loss aversion was measured using Equation (7):

$$\frac{WTA^{EV}}{WTP^{CV}} = \frac{U(Y_1)+\lambda}{U(Y_1)} > 1. \qquad \text{Equation (7)}$$

The ratio between WTA^{EV} and WTP^{CV} is greater than 1 because the effects of loss aversion due to losing the protective dike increased the WTA^{EV}.

2.3.3 Protected farmers: negative changes and reference states

Protected respondents were also asked to consider two hypothetical farmers, Farmer C and Farmer D, with different reference states. Farmer C's base reference state was that of being unprotected from erosion by a dike, and the direction of change was to avoid moving back to this inferior reference state, measured by WTP^{EV}.

The current risk of erosion with the temporary dike (P_1), was less than the risk in the reference state; therefore, $P_1 < P_0$. In addition, the change from lower risk of erosion to higher risk was likely to induce an additional utility decrease by λ' ($P_0 - P_1$) as Farmer C was currently protected by a temporary dike. Therefore, the utility of Farmer C for this change was consequently

$$V(P_1, Y_1, \lambda') = (1(1 - P_1)\,U(Y_1) - \lambda'(P_0\text{-}P_1)\,. \qquad \text{Equation (8)}$$

The value of the dike for Farmer C, as perceived by the protected respondents, was calculated using Equation (9) below:

$$\frac{\partial P_1}{\partial Y_1} = \frac{U(Y_1)+\lambda'}{(1\text{-}P_1)U'(Y_1)}\,. \qquad \text{Equation (9)}$$

Farmer D's situation was framed to resemble that of the protected respondents (i.e., being protected from erosion by a dike). The risk of erosion in the reference state was less than that in the new situation of having no dike ($P_1 < P_0$). The direction of change was away from the base reference state in the loss domain arising from a loss aversion. The additional utility loss was measured by λ'' ($P_0 - P_1$). The expected utility of Farmer D for this change was calculated using Equation (10) as follows:

$$V(P_1, Y_1, \lambda'')=(1 - P_1)U(Y_1) - \lambda''(P_0\text{-}P_1)\,. \qquad \text{Equation (10)}$$

Thus, the value of the dike for Farmer D was estimated as

$$\frac{\partial P_1}{\partial Y_1} = \frac{U(Y_1)+\lambda''}{(1\text{-}P_1)U'(Y_1)}. \qquad \text{Equation (11)}$$

The relative value between the values of the dike for Farmer C and Farmer D can be seen from Equation (12) as

$$\frac{WTA^{CV}}{WTP^{EV}} = \frac{U(Y_1)+\lambda''}{U(Y_1)+\lambda'}. \qquad \text{Equation (12)}$$

The relative value can be equal to or greater than 1 depending on the values of λ'' and λ'. If these two parameters are equal, then WTA^{CV} and WTP^{EV} would be the same. If λ'' is higher than λ' or λ' is zero, then WTA^{CV} would be higher than WTP^{EV} and the ratio between these two values would be greater than 1.[4]

2.3.4 Hypotheses

In summary, the authors tested the following hypotheses:

1. Same change in different domains

$$\frac{WTA^{EV}}{WTP^{CV}} = \frac{U(Y_1)+\lambda}{U(Y_1)}, \qquad = 1, \lambda = 0 \qquad >1, \lambda >0$$

$$\frac{WTA^{CV}}{WTP^{EV}} = \frac{U(Y_1)+\lambda''}{U(Y_1)+\lambda'}, \qquad = 1, \lambda''=\lambda' \qquad >1, \lambda''>\lambda'$$

2. Gain domain

$$\frac{WTP^{EV}}{WTP^{CV}} = \frac{U(Y_1)+\lambda'}{U(Y_1)}, \qquad = 1, \lambda'=0 \qquad >1, \lambda'>0$$

[4] Testing for $\lambda'=0$ can be done by comparing the WTP^{EV} to the WTP^{CV}. If the WTP^{EV} is significantly higher than the WTP^{CV}, then λ' would be greater than 0.

3. Loss domain

$$\frac{WTA^{CV}}{WTA^{EV}} = \frac{U(Y_1)+\lambda^{''}}{U(Y_1)+\lambda}, \qquad \begin{aligned} &= 1, \lambda^{''} = \lambda \\ &> 1, \lambda^{''} > \lambda \\ &< 1, \lambda^{''} < \lambda \end{aligned}$$

3.0 ANALYSIS AND RESULTS

3.1 Comparison between Changes in the Gain and Loss Domains

3.1.1 Positive changes

The responses of unprotected respondents to the paired-comparison questions are summarized in Table 1. The unprotected respondents were asked to compare the situations of hypothetical Farmers A and B, and were required to select which farmer would value the dike more or if both would value the dike the same.

Table 1 shows that the difference between the number of respondents who thought that Farmer B would value the dike more than Farmer A, and those who thought Farmer A would value the dike more than Farmer B is very large. A total of 193 respondents, which is 94.61% of the total number of unprotected respondents, thought that Farmer B (whose reference state was being protected from erosion by a dike) would value the dike more than Farmer A (whose reference state was being unprotected from erosion by a dike). Only one respondent said that both farmers would value the dike the same.

Even though the changes of both farmers were in the positive direction, the reference states setup for them caused the respondents to think that the farmers would value the dike differently. The reference state of Farmer B (with protection) and his current situation led the unprotected respondents to think in terms of the loss domain. On the other hand, the reference state and current situation of Farmer A (with no protection) led the unprotected respondents to the area of the gain domain. The result indicates that with the same amount of change, a positive change in the loss domain is worth more to people than one in the gain domain.

Table 1. Results from the paired comparison questions

Choice	No. of Respondents	Percentage of Respondents (%)
Unprotected respondents		
Farmer A would value the dike more	10	4.90
Farmer B would value the dike more	193	94.61
Both would value the dike the same	1	0.49
Total	**204**	**100.00**
Protected Respondents		
Farmer C would value the dike more	6	3.17
Farmer D would value the dike more	179	94.71
Both would value the dike the same	4	2.12
Total	**189**	**100.00**

3.1.2 Negative Changes

In analogous fashion, the protected respondents were also asked to compare the situations of two hypothetical farmers, Farmers C and D, and to state which farmer would value the dike more. Farmer C's situation led the respondents to the gain domain. A change in his situation presented the value of avoiding going back to his original reference state of being unprotected from the current good situation of having a temporary dike. On the other hand, Farmer D's case led the respondents to think in terms of a negative change in the loss domain. The value of the dike would lie in the change from being protected to being unprotected from erosion.

The results are also presented in Table 1 and are very similar to the unprotected respondents' results. Most of the protected respondents thought that Farmer D (with protection), who faced a negative change in the loss domain, would value the dike more than Farmer C (without protection originally), who faced a negative change in the gain domain. The proportion of protected respondents who thought that Farmer D would value the dike more was 94.71% as compared to only 3.17% who stated that Farmer C would value the dike more.

3.2 Comparisons of the Rating Scale Results

This section provides the regression results of the rating-scale questions, which allowed the authors to test the hypotheses in Section 2.3.4. Every regression model controlled for total land loss, gender, age, and monthly household income.

3.2.1 Econometric estimates of WTA^{EV} and WTP^{CV} (positive changes)

The first rating comparison was between WTA^{EV} and WTP^{CV}. The estimation model used was as follows:

$$R_i^{UP} = \alpha_1 + \alpha_2 WTA^{EV} + \beta X_i + e_i \qquad \text{Equation (13)}$$

where:

R_i^{UP}	=	rating level given by the unprotected respondents for hypothetical Farmers A and B,
WTA^{EV}	=	dummy variable representing hypothetical Farmer B,
X_i	=	vector of interaction variables between WTA^{EV} and individual characteristics using Farmer A as the reference, and
α_1	=	average value of the dike for Farmer A as given by the unprotected respondents.

In this model, α_2 was tested to see if it was significantly greater than 0. If α_2 was significantly greater than 0, then $\lambda > 0$, which would reveal the existence of a loss aversion and that a positive change in the loss domain from the reference state is worth more than the change in the gain domain.

The WTA^{EV} and WTP^{CV} columns in Table 2 show the results of Equation (13). The constant term, which is the average value of the dike for Farmer A, α_1, was significant with a value of about 8.78. This means that on average, the value of the dike for Farmer A was 8.78 in a scale of 20. In addition, the coefficient of WTA^{EV}, which captures the different values of the dike for Farmer A and Farmer B, was also significantly different from 0.

The one-tailed test of whether α_2 was greater than 0 was also performed. The result showed that α_2 was significantly greater than 0 at 1% significance level. Therefore, $\lambda > 0$; this means loss aversion and that a positive change in the loss domain is perceived as being worth more than the change in the gain domain. The results also indicated that the unprotected respondents thought the Farmer B would value the dike more than Farmer A; α_2 was 5.37, thus the value of dike for Farmer B was 14.15.[5]

[5] $\alpha_1 + \alpha_2$ as α_1 was the base for comparison here, and α_2 captured how much Farmer B valued the dike more than Farmer A.

Table 2. Estimated results of the rating scale models

Variable	WTA^{EV} and WTP^{CV}	WTA^{CV} and WTP^{EV}	Pooled Model[a]
WTA^{CV}		5.99*** (4.30)	6.65*** (4.55)[b]
WTA^{EV}	5.37*** (4.06)	–	5.34*** (4.20)
WTP^{EV}	–	–	0.16 (0.11)
Constant	8.78*** (29.09)	9.45*** (32.68)	8.79*** (30.34)
R^2	0.44	0.52	0.48
N	414.00	374.00	788.00

Notes: (1) [a] WTP^{CV} was used as the base reference state. (2) [b] The coefficients of WTA^{CV} and WTA^{EV} were not significantly different at 1% significance level. (3) The numbers in parentheses are t-statistics. (4) *** indicates a 1% significance level.

3.2.2 Econometric estimates of WTA^{CV} and WTP^{EV} (negative changes)

Next, the authors compared the negative changes between the WTA^{CV} and WTP^{EV} of hypothetical Farmers C and D as valued by the protected respondents. The estimated model was similar to the one used for the unprotected group with some differing variables, as presented in Equation (14):

$$R_i^P = \beta_1 + \beta_2 WTA^{CV} + \delta X_i + e_i \qquad \text{Equation (14)}$$

where:

R_i^P	=	rating score given by the protected respondents,
WTA^{CV}	=	dummy variable representing the rating score for Farmer D using Farmer C as the base reference,
β_1	=	average level of importance that the respondents gave to the negative change that Farmer C incurred, and
β_2	=	added value or importance that the respondents gave to a negative change in the domain of loss.

The main focus of this model is β_2. If β_2 is significantly greater than 0, then it could be concluded that $\lambda'' > \lambda'$. This means that a negative change in the loss domain is worth more than the change in the gain domain.

The estimated results of Equation (14) is shown in the column "WTA^{CV} & WTP^{EV}" in Table 2. The coefficient of the constant term, β_1, was significant suggesting that, on average, the value of the dike for Farmer C (as given by the respondents) was about 9.45. The coefficient of WTA^{CV} was also statistically significant and the one-tailed test found that it was greater than 0 at 1% significance level. These results showed that $\lambda'' > \lambda'$, which means that a negative change in the loss domain was worth more than a change in the gain domain.

However, this model could not provide information on whether λ', which represents a loss aversion in Farmer A, was equal to or greater than 0. This hypothesis could only be tested when the data from both groups of respondents is pooled.

3.2.3 Econometric estimates of comparisons within domains

The next hypothesis tested was to compare the changes that occurred in the same domain but in different directions. The estimation model used was Equation (15) to test whether $WTP^{EV} = WTP^{CV}$ and $WTA^{EV} = WTA^{CV}$ or $\lambda' = 0$ and $\lambda'' = \lambda$, respectively. This is similar to Equation (13). Equation (15) is expressed as

$$R_i = \gamma_1 + \gamma_2 WTA^{CV} + \gamma_3 WTA^{EV} + \gamma_4 WTP^{EV} + \textstyle\sum_{i=1}^{3} \mu_j X_i + e_i \qquad \text{Equation (15)}$$

where:

$$\sum_{j=1}^{3} \mu_j X_i \quad = \quad$$ set of interaction variables for hypothetical Farmers A, B and D, with individual characteristics j = 1, 2, 3 interacting with dummy variables WTA^{CV}, WTA^{EV}, and WTP^{EV} (Farmer C's information was used as the reference thereby excluded from the equation).

The column "Pooled Model" in Table 2 shows the results of Equation (15). The results showed the disparity between the values in the gain and loss domains. The coefficients of WTA^{CV} and WTA^{EV} were significantly higher than those of WTP^{EV} and WTP^{CV}, as represented by the constant coefficient.

The null hypothesis of $WTP^{EV} = WTP^{CV}$ could not be rejected because $\lambda' = 0$, which indicates no loss aversion in the case of a negative change in the gain domain. In other words, even a negative change in the gain domain, moving from a better situation back to just a good situation, may be seen as a loss. The respondents did not seem to develop a loss aversion resulting in symmetrical values for the dike for both negative and positive changes in the gain domain. This may be due to the effect of the reference state of no protection from erosion by a dike, which did not make the availability of a temporary dike salient, resulting in a no loss aversion effect for the temporary dike. Therefore, moving back to the reference state of no protection was worth the same as moving beyond it (Bordalo, Gennaioli, and Shleifer 2012).

The coefficients of WTA^{CV} and WTA^{EV} were found to be significantly higher than 0 at 1% significance level. This confirms the existence of a loss aversion in both changes in the loss domain as estimated by Equations (13) and (14).

The next hypothesis tested was whether the values of the dike were equal, i.e., $WTA^{EV} = WTA^{CV}$. This was given by the unprotected and protected respondents for Farmers B and D, whose reference states were framed to be the same.

Although the coefficient of WTA^{CV} was higher than that of WTA^{EV}, the null hypothesis of equality between these two variables $\gamma_3 = \gamma_4$, could not be rejected at 1% significance level, which suggests that $\lambda'' = \lambda$. This result suggests that changes in the loss domain, either moving away from a better situation or moving back to one's reference state, may yield the same value.

4.0 DISCUSSION AND CONCLUSIONS

The empirical evidence presented in this study strongly indicates the existence of a loss aversion in the case of riverbank erosion protection, which results in the disparity between changes in the loss and gain domains. This study and previous studies on testing the existence of loss aversion have shown that choosing a measure that most accurately reveals the perceived welfare change of the people affected is very important.

In the case of riverbank erosion, introducing different reference states of hypothetical farmers to the respondents who were protected and unprotected from erosion provided insights into the values of changes in the different domains and the direction of these changes. Positive changes that occur in the loss domain were seen to be worth more than the same changes in the gain domain. In the same manner, negative changes in the loss domain were also valued more than the negative changes in the gain domain.

In addition to the disparity between the values of similar changes occurring in different domains, this study found that with the same reference state of protection from erosion by a dike, the values of positive and negative changes in the loss domain, WTA^{CV} and WTA^{EV}, were the same. This was also the case for negative and positive changes in the gain domain where the difference between the values of these two changes were insignificant.

The measures used to assess the welfare changes in this study depended on the reference states of the protected and unprotected respondents. During the interviews, the respondents in both groups were asked to describe the riverbank erosion situation in their areas. More than half of them revealed that in the past, erosion had been a cyclical event. Even if their land eroded in one year, it would be restored by sediment flow from the river in the next year or two. This cycle had continued until 15 years ago when the pattern of erosion in their areas changed. Erosion became very severe with a high level of land loss each year and with very little or no land restoration from sediment load. They said this was a new situation for them, and only riverbank dikes could prevent or at least mitigate erosion impacts.

For the protected respondents, no erosion and protection from erosion by dikes was the norm or reference state. Therefore, the welfare change for this group due to erosion impacts was appropriately measured in the loss domain from a state of no erosion to one of erosion. The authors used WTA^{CV} to measure the minimum compensation that the respondents would demand to accept the increased risk of erosion due to the loss of the protective dike, rather than using WTP^{CV} to measure their willingness to pay to get the dike.

In case of the unprotected respondents, unlike the protected group, their reference state was not easy to ascertain. Although the information provided by this group of respondents had seemed to suggest that their original reference state was one of no erosion, it was possible that they had changed this to one of erosion because erosion patterns have changed in the last 15 years. If the reference state of this group was one of no erosion, then the desired welfare change would likely be a return to the reference state of no erosion by building a protective dike. The value of such a change would then be most accurately assessed by their willingness to forgo it (i.e., WTA^{EV}). However, if their reference state had already shifted to erosion, then building a dike to protect their land from erosion would represent a positive change in the gain domain, which is appropriately measured by WTP^{CV}.

The case of the unprotected respondents firmly supports the importance of applying appropriate reference states to different situations. Different assumptions of reference states would lead to different measures being used, which in turn would yield significantly different results.

In addition to determining the right choice of measures, reference states also play a role in testing for disparity between values in the gain and loss domains. This study suggests that people seem to provide the same values for negative and positive changes in the same domain. In the case of both groups of respondents in this study, for example, if the reference state of unprotected and protected respondents was truly “no erosion,” then the appropriate measures for both groups would be WTA^{EV} and WTA^{CV}, respectively. This would result in a ratio of WTA^{CV} to WTA^{EV} being equal to 1. However, if the reference state of the unprotected group was mistakenly assumed to be erosion and the measure used was WTP^{CV} rather than WTA^{EV}, then the ratio of WTA^{CV} to WTP^{CV} would be equal to 1. This would yield a wrong conclusion of equality between the values of changes in the gain and loss domains indicating no loss aversion, which would not be accurate.

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