Asset Integration, Risk Taking and Loss Aversion in the Laboratory

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Abstract

We report on a laboratory experiment testing for the presence of loss aversion, as separate from risk aversion, utilizing an asset integration protocol designed to ensure that a loss of cash provided by the experimenter is viewed as a real loss by experimental participants. Our experimental design augments the Holt-Laury risk preference elicitation methodology to assess how individuals choose between a safe option and a riskier lottery. When the money at stake is viewed as the individual's own money, one of the lottery outcomes is in the domain of losses. Our results confirm that individuals display an additional reluctance to participate in a mixed domain lottery beyond that predicted by risk aversion. We show that only preference functions incorporating loss aversion are able to generate predicted behaviour that matches our results.

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1. Introduction

In this paper we report on a laboratory experiment designed to assess the influence of loss aversion separate from risk aversion. To implement loss aversion in the laboratory we use an *asset integration protocol* developed in Morrison and Oxoby (2013) to guarantee that our treatment group participants regard a loss of money from funds provided by the experimenter as a real loss in our incentivized decision task. Using this protocol in conjunction with the well-known risk-preference elicitation framework of Holt and Laury (2002, 2005), our results provide evidence of behaviour that exhibits loss aversion separate from risk aversion, a conclusion that is reinforced by assessing the predictive power of four different preference function specifications. In considering these alternative depictions of preferences, only those that incorporate loss aversion are consistent with our results.

The asset integration protocol in our experiment, which influences the reference point of participants, falls in line with research that has explored how the reference point is determined under prospect theory. For example, Koop and Johnson (2012) and Lehenkari (2012) have identified how individuals may use multiple reference points and that reference points may become particularly salient when the outcome involves self-justification. Further research has explored the cognitive and neuropsychological underpinnings of this important part of prospect theory (Trepel et al, 2005; Tom, et al, 2007).

The descriptive inadequacy of expected utility theory has been the subject of ongoing research in both Psychology (Lopes, 1987; Slovic, 1995; Booij and Kuilen, 2009) and Economics (Allais, 1953; Kahneman and Tversky, 1979; Rabin,2000; Barberis, 2013). In particular, prospect theory and loss aversion (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991; Kahneman, Knetsch and Thaler, 1991) and rank dependent (probability weighted) utility theory (Quiggin, 1982; Prelec, 1998; Gonzalez and Wu, 1999) have sought to correct for the predictive shortcomings of expected utility. However, there still exist questions regarding the extent to which one can disentangle the role of loss aversion from more general aspects of risk averse behaviour as characterized by the concavity of a utility function or biases in assessing probabilities in risky prospects.

Despite theoretical issues regarding preference specifications, current research continues to point to the importance of loss aversion and reference-dependent preferences. Recently, Dimmock and Kouwenberg (2010), Lehenkari (2012), Leung and Tsang (2013), Rees-Jones (2014) and Engstrom et al (2015) have found significant evidence of loss aversion in household portfolio decisions and tax compliance. Engstrom et al (2015) and Rees-Jones (2014) demonstrate how loss aversion can lead taxpayers to shift their finances and claim deductions, behaviour that is independent of audit probabilities and has the potential of pushing losses into future consumption. From a macroeconomic perspective, Bowman et al (1999) find that loss aversion can affect consumption and savings patterns, a mechanism that Santoro et al (2014) argue can affect the efficacy of monetary policy with respect to output and inflation. Arora and Kumari (2015) find that the impact of age and gender on the risk-taking behavior of investors operates through loss aversion and regret. From a policy perspective, Thaler and Bernartzi (2004) and Lusardi (1999) have articulated the importance of taking the effects of loss aversion into account in the design of retirement policies and employee savings programs.

However, isolating and identifying loss aversion is difficult in practice because loss aversion may interact with risk and time preferences, making it difficult to ascertain its role and influence on behaviour. For example, saving for retirement requires delaying present consumption (an intertemporal decision), reducing consumption below current levels (an aspect that may involve loss aversion) and potential risk in future consumption (an aspect that may involve risk aversion and probability weighting). Given these elements are observed in a single savings decision, it is unclear whether inferred discount rates are purely related to time preferences or also have aspects of loss aversion, probability weighting and risk aversion embedded in them. This has led various researchers (e.g., Booij and van de Kuilen, 2009) to develop alternate measurement methods to disentangle loss aversion from other motivations. The problem of separate loss aversion from risk and time preferences becomes even more complicated when one introduces other factors such as decision-making time pressure or emotions into a decision environment (e.g., Young et al, 2012; Faraji-Rad and Pham, 2017).

While, laboratory experiments are an attractive means of separating different behavioural influences on decisions involving risk, the concept of loss aversion poses problems for experimental research as the resources used to incentivize experiments are provided by the experimenter. As a consequence, there is a need for a protocol where individuals can experience a real sense of loss.

2. Risk Aversion, Loss aversion and Asset Integration

To understand the context of the role of loss aversion, consider the following example: define Decision 1 as a choice between receiving $20 (with certainty) or entering a lottery with a 70% chance of winning $35 and a 30% chance of winning $3.50. Since all outcomes are in the domain of gains, there is no role for loss aversion. However a risk averse individual faced with Decision 1 may choose $20 rather than the lottery (which has an expected value of $25.55).

Now define Decision 2 as a choice between purchasing or not purchasing a $20 lottery ticket using your own money, where the lottery is the same as in Decision 1 (i.e. a 70% chance of winning $35 and a 30% chance of winning $3.50). Faced with Decision 2, an individual is likely to recode the lottery prizes, taking the cost of the lottery ticket into account; that is, the individual will view the lottery as a 70% chance of winning $15 ($35-$20) and a 30% chance of losing $16.50 ($3.50-$20). When coded this way, the lottery has mixed domains; one prize is in the domain of gains and one is in the domain of losses. Consequently, if the individual chooses not to purchase the lottery ticket, it is now possible that loss aversion played a role in motivating the decision.

Consider a utility function over risky money prospects of the form

$$\begin{aligned} U^{+} &= p^{\alpha}.\left(\frac{m^{1-x}}{1-x}\right);\ \forall m \geq 0 \\ U^{-} &= \lambda.p^{\beta}.\left(\frac{m^{1-x}}{1-x}\right);\ \forall m < 0 \end{aligned} \qquad (1)$$

where p and m represent probability and money income and parameter x is the coefficient of constant relative risk aversion. We can use this function to represent four distinct preference functions; two functions in which there is only risk aversion and two in which there is both risk and loss aversion. For parameter values $\alpha = \beta = \lambda = 1$, eqn. (1) becomes a standard constant relative risk aversion (CRRA) preference function and for

$\alpha = \beta \neq 1$ and $\lambda = 1$, the function represents rank dependent (RD) expected utility in which objective probabilities are weighted according to an individual's optimism or pessimism. Both of these utility functions give rise to preferences where loss aversion plays no role. However, letting $\alpha = \beta = 1$ and $\lambda > 1$ we obtain a 'constant loss aversion' (CLA) preference function in which parameter λ is the coefficient of constant loss aversion. Finally, if $\alpha \neq 1, \beta \neq 1, \ \alpha \neq \beta \ and \ \lambda = 1$, we then allow for probability-weighted loss aversion (PWLA) whereby the weights applied to objective probabilities are different in the domain of losses relative to the domain of gains.[3]

What choices do these different specifications of the utility function predict in the two decisions described above? In Decision 1, since both lottery outcomes are in the domain of gains, the prediction of a CLA preference function is equivalent to a CRRA function. Similarly, the prediction of a PWLA preference function is equivalent to an RD function. That is, even if loss aversion parameters are present in an individual's preferences, they will play no active part in the individual's choice in Decision 1 because there are no losses to consider. Thus, irrespective of the choice made in Decision 1, it is possible to pick parameter values for all four functions that will predict observed behaviour. However, in Decision 2, the (recoded) lottery has one outcome in the domain of losses. Thus, the parameter values λ and β in the CLA and PWLA functions generate alternate predictions of an individual's choice relative to CRRA and RD functions.

To illustrate with an example, suppose we observe an individual who chooses \$20 over the lottery in Decision 1. A CRRA preference function with $x = 0.8$ or an RDU function with $x = 0.5, \ \alpha = 1.3$ will give rise to a utility of \$20 received with certainty that exceeds the expected utility of the lottery, which is thus consistent with the observed behaviour. Similarly, a CLA preference function with $x = 0.8$ and λ=2.2 or a PWLA preference function with $x = 0.5, \ \alpha = 1.3$ and $\beta = 0.4$ will predict a choice consistent with

[3] Our characterization of RD and PWLA preference functions makes use of a power function to represent probability weighting. As such these are simplified versions of a probability weighting function proposed by Prelec (1998) as: $w(p) = \exp\left\{-\delta(-\ln p)^{\gamma}\right\}$. Our specification is a special case of this function which reduces to $w(p) = p^{\delta}$ when $\gamma = 1$. This means that our probability weighting functions do not exhibit 'subproportionality'; i.e. they cannot take an inverse-S shape whereby lower probabilities are overestimated and higher probabilities are underestimated, which occurs for $0 < \gamma < 1$. However, our simplification does not inhibit the generality of later analysis and results. Alternate approaches to assessing these functions include Booij and van de Kuilen (2009).

the observed behaviour because the only parameters relevant to the domain of gains are x and α. Having calibrated the preference functions with observed behaviour in Decision 1 we can now apply them to predict behaviour in Decision 2. Using the same parameter values as above, the CRRA and RD preference functions applied to Decision 2 now yield an expected value of purchasing the lottery that exceeds the expected value of not doing so. However, in the CLA and PWLA functions, the additional loss aversion parameters (λ and β) generate the opposite prediction. Later, we employ this calibration approach to assess the results of our experiment in order to ascertain whether one or more of these preference functions are capable of predicting decision-making in mixed domain outcome environments as well as environments in which all outcomes are in the domain of gains.

To link the above discussion to our experimental design, consider an experiment in which participants receive \$20 from the experimenter and are asked whether they wish to keep this money or enter a lottery with a 70% chance of winning \$35 dollars and a 30% chance of winning \$3.50. If the participants do not integrate the \$20 they have received from the experimenter into their own wealth, they will perceive they are making decisions with someone else's money, and therefore will not view reductions in cash (received from the experimenter) as real losses. This is often referred to as 'house money' bias.[4] Consequently in the absence of asset integration, participants will frame the choice they are being asked to make in Decision 1. If however, participants do integrate the money they have received into their own wealth, they will regard giving up \$20 as a real loss of their own money and will thus frame the choice as Decision 2.

In our experiment, participants in our Treatment Group follow an asset integration protocol (Morrison and Oxoby, 2013) designed to ensure that the cash which is placed at stake in the incentivized task is truly regarded as their own money. We are thus able to present them with choices involving mixed domain lotteries of the type illustrated by Decision 2. Participants in our Control Group do not follow this asset integration protocol and are thus hypothesized to view the decisions being presented to them as involving outcomes which lie only in the domain of gains (as illustrated by Decision 1).

[4] See for example Clark (2002), Harrison (2007), Spraggon and Oxoby (2009) and Oxoby and Spraggon (2013) who demonstrate how house money effects can influence decision-making in public goods experiments.

3. 'House Money' Bias and Asset Integration Protocols

To control for 'house money' bias, several authors have employed protocols requiring participants to earn or hold on to financial resources for an extended period of time prior to completing the tasks of interest. Such studies include Bosch-Domenenech and Silvestre (2010), Rosenboim and Shavbit (2012), Morrison and Oxoby (2013) and Cardenas et al (2014).[5] In particular, Cardenas et al (2014) use this approach to test whether 'house money' bias affects measures of risk aversion. They find that individuals who were endowed with money 21 days in advance of the experiment and who spent a portion of it (35% on average) prior to the experiment demonstrated greater reluctance to bear risk compared to those who had not spent any of the endowment. Cardenas et al (2014) argue that spending some portion of the cash advanced to them by the experimenter signals that some amount of asset integration has occurred. Importantly, in their analysis, an inference that a reluctance to engage in risker choices means a higher level of risk aversion (rather than loss aversion) rests on the assumption that individuals have CRRA utility functions.[6]

In a recent study, Harrison and Swarthout (2016) conduct a large series of experiments to test whether cumulative prospect theory (i.e., preferences influenced by loss aversion) is a better predictor of decision-making compared to a number of risk preference functions, including CRRA and RD. Their experimental design includes three classes of lottery prize domains: (i) all prizes in the domain of gains, (ii) all prizes in the domain of losses, and (iii) mixed domain lotteries. While they find weak support for preference functions incorporating loss aversion, their overall conclusion is that that the RD expected utility function is the best predictor of individual decision-making. To address house money bias, Harrison and Swarthout (2016) implement a procedure whereby some participants earn money by completing a quiz prior to making incentivized lottery choices.[7]

5 Other researchers have explored the ways in which house money effects and loss aversion can affect decision-making in experiments. For example, Cherry et al (2002) and Oxoby and Spraggon (2008) find that legitimizing assets significantly reduces contributions in a dictator game.

6 Cardinas et al (2014) focus exclusively on the CRRA preference function and do not consider other specifications.

7 Earning money is a commonly used mechanism to create a sense of asset legitimacy in the laboratory; see,

This earned money is at stake in a lottery decision. They find that decisions with earned money increases the predictive performance of preference functions allowing for loss aversion. However, such procedures may not guarantee a sufficient degree of asset integration with participants' own wealth, something which could account for the lack of support for loss aversion found in the study.

A key finding in Morrison and Oxoby (2013) is that earning money in the laboratory does not yield decisions that are significantly different from those made with house money. Morrison and Oxoby (2013) conduct an experiment to elicit intertemporal discount rates in which individuals are asked to choose between a sum of money to be paid immediately and a larger sum to be paid three weeks later. Control group participants were simply endowed with money while a first treatment group of participants earned money by completing a quiz (a similar approach to Harrison and Swarthout, 2016). A second treatment group earned money by completing a quiz but then, before completing the incentivized intertemporal decision task, they were paid their earnings and told to return in one week's time to compete the experiment where they would use their earnings. In the subsequent session, participants brought an amount of cash equal to their previous earnings and were then asked if they were willing to exchange the money they had brought with them for a larger sum paid in three weeks. Morrison and Oxoby (2013) found a large and significant difference in the elicited discount rates of the second treatment group relative to the control group and first treatment group. However, they found no statistically significant difference in the elicited discount rates of the control group and the first treatment group, suggesting that (in the context of intertemporal decision making) earning money in the lab produces the same behaviour as being given the money.

It is apparent from these studies that requiring experimental participants to retain money earned in the lab for some period of time (during which they may spend it) prior to the incentivized task is a key element in asset integration. In the experiment described below, we employ the Morrison and Oxoby (2013) asset integration protocol to ensure that outcomes in the incentivized task which fall within the domain of losses are coded as such by participants.

for example, Cherry et al, (2002).

4. Experiment

The overall design and asset integration protocol for our experiments is presented in Figure 1 below.

FIGURE 1 ABOUT HERE

All participants began by completing a twenty-question quiz consisting of questions from the Graduate Record Exam. Participants were informed that they would earn $20 if they correctly answered at least ten questions and $10 otherwise. This threshold was chosen (based on experience in previous experiments) to ensure participants earned $20 while requiring they exert significant effort in the exam.[8]

The control group for the experiment was split into two sub-groups: Control Group 1 and Control Group 2. Participants in Control Group 1 completed all tasks in a single session and were paid in cash at the conclusion of the incentivized task including a $5 show-up fee (which was independent of any decisions they made). Participants in Control Group 2 engaged in the same sequence of tasks as Control Group 1 up to the completion of a hypothetical decision table. At this point, Control Group 2 participants were told to return in one week's time for a second session when they would be paid their earnings from the quiz and complete another task, with the possibility of receiving more cash plus a $5 show-up fee. When they returned for the second session, Control Group 2 participants were paid $20 (their earnings from session 1) and were then asked to complete an incentivized task. Afterwards, they were paid in cash plus a $5 show-up fee.

In summary, both control groups received their $20 earnings from the quiz immediately prior to completing the incentivized task, with the incentivized task being delayed one week for Control Group 2. The rationale behind splitting the control group in this way is to be sure that the one-week delay between sessions is not driving the behaviour of control group participants.

Treatment Group participants were paid $20 in cash immediately after completing a hypothetical decision table and were asked to return in one week's time for a second

[8] All participants did sufficiently well on the quiz to earn $20.

session bringing $20 in cash with them. They were also told that they would have the opportunity to receive additional money at the second session and that they would receive a $5 show up fee at the end of the second session. Treatment Group participants thus had their $20 cash payment in their possession for one week, thereby enabling them to integrate money from the experimenter with their own wealth.

When Treatment Group participants returned for session 2, they were asked to put the $20 they brought with them into an envelope labeled with their participant ID and this was collected by the experimenter. Treatment Group participants were also asked if the $20 cash they put in the envelope was the actual cash they had received a week earlier. As our focus is on creating a sense of ownership over the money, this question sought to identify if participants retained the actual cash from the first session or spent that money and brought their own funds to session 2. Treatment Group participants then completed the incentivized task and were paid in cash plus a $5 show-up fee.

Four elements in our experiment are common to all conditions: (i) earning money via the quiz, (ii) answering two asset legitimacy questions, (iii) completing a hypothetical decision table and (iv) completing an incentivized task using the resources earned in the quiz. The key difference between our treatments is the timing of the payment of quiz earnings and the timing of the incentivized task.

After completing the quiz and being informed that they would be paid $20, all participants were asked to indicate on a Likert scale ranging from 1 [strongly disagree] to 7 [strongly agree] whether they agreed with two asset legitimacy statements:

Statement 1: I am entitled to the money I received for participating in the experiment.
Statement 2: I earned the money I am receiving for participating in the experiment.

These statements were used to assess the extent to which participants believed they had legitimacy over the earned resources.

After answering the asset legitimacy questions, all participants completed a hypothetical, scaled-up version of a risk preference elicitation decision table from the original study by Holt and Laury (2002) as shown below.[9]

TABLE 1 ABOUT HERE

In this task, participants made choices between ten pairs of lotteries, where the first lottery (Option A) had a smaller spread relative to the second lottery (Option B). The defining feature of the Holt and Laury (2002) mechanism is that expected values in early decisions favor Option A while the expected values in later decisions favor Option B, thus providing a predicted ‘cross-over point’ for risk neutral individuals. Individuals whose cross-over point occurs at a later decision in the table are inferred to exhibit risk aversion. In their initial experiment, Holt and Laury (2002) find approximately two thirds of participants display risk-averse preferences, even over small dollar amounts. In Table 1, the expected value of Option A exceeds that of Option B in decisions 1-4 and falls below that of Option B in decisions 5-10. We utilized this hypothetical exercise to create a benchmark measure of risk preferences across all our treatments, completed at the same point in the order of tasks by all participants. This provides an indication of whether there are any fundamental differences in risk preferences across groups prior to the implementation of our protocols and completion of the incentivized task.

Our incentivized decision task also followed the Holt and Laury (2002, 2005) methodology by asking participants to make ten decisions between two options where Option A was defined as keeping the $20 earned earlier in the experiment and Option B was a lottery with two prizes ($35 and $3.50) with probability of receiving the higher cash amount increasing linearly with each decision. The decision table for our incentivized task is shown below in Table 2. In the incentivized task participants were told their payment for the experiment would be based on their response to a randomly selected decision from Table 2.

TABLE 2 ABOUT HERE

[9] See Holt and Laury (2002); Table 1, p1645 for the original decision table.

5. Results

We recruited participants from the student population at a large Canadian university using the recruiting system by Greiner (2004). The experiments were conducted using the software developed by Fischbacher (2007).

Seventy-three individuals participated in the experiment, with 24, 18 and 31 participants in Control 1, Control 2 and Treatment groups. Power tests confirm that statistically significant effects identified in our data was not due to limited statistical power.[10] All participants expressed a high degree of ownership over the $20 they earned in the quiz, as represented by their responses to the asset legitimacy statements: mean scores (standard deviation) in the control and treatment conditions were 5.27 (0.79) and 5.42 (0.84) and we find no differences in the distribution of these responses across conditions (Wilcoxon $p>0.40$). All participants in the Treatment groups indicated that the $20 cash they brought to the second session was not the same cash they had received in the first session, suggesting that the money they had earned had been spent in the intervening week.[11]

Table 3 compares the results for the two control groups with p-values indicating that we cannot reject the hypothesis that decisions in both the hypothetical and incentivized tasks are drawn from the same distribution.[12]

TABLE 3 ABOUT HERE

Given that we find no differences between Control Groups 1 and 2, we combine the data from both groups for the purposes of comparison with the Treatment Group. These results are summarized in Table 4 and illustrated in Figures 3 and 4.

[10] Using the effect sizes form similar studies (Morrison and Oxoby, 2013, Harrison and Swarthout, 2016) we conducted a two-tailed power test with $(1-\beta)=0.80$ and $\alpha=0.05$. On the basis of these means, a sample size of 16 participants per treatment was necessary.
[11] Participants were between the ages of 17 and 26 (average 20.8) and 55% were male. In an analysis of the data with respect to demographic information we found no gender or age differences (cf. Coller and Williams, 1999; McLeish and Oxoby, 2007). Three participants in the Treatment groups only participated in the first session, an attrition rate of 7.6%.
[12] For the null results with respect to the comparison of the Control 1 and Control 2 samples, between group effects yield $(1-\beta)=0.84$. , The null results between these two conditions are consistent with effect magnitudes in previous studies where asset integration was not considered (e.g. Morrison and Oxoby, 2013).

TABLE 4 ABOUT HERE

Figure 2 presents the percentage of participants choosing the safe option (Option A) in the hypothetical decision task for the control and treatment groups. While all participants displayed risk-aversion, we cannot reject the hypothesis that responses in the control and treatment conditions are drawn from the same distribution (Wilcoxon $p > 0.4$). In other words, all participants displayed similar risk preferences in the hypothetical decision task. [13]

FIGURES 2 AND 3 ABOUT HERE

However, as indicated in Table 4 and Figure 3, we find a striking difference in responses to the incentivized decision table and can reject the hypothesis that responses in the control and treatment conditions are drawn from the same distribution (Wilcoxon $p < 0.01$). That is, relative to the control condition, participants in our treatment condition were much less willing to give up the $20 in their possession to participate in a lottery, even when the lottery offered a higher probability of receiving $35. This type of behaviour is consistent with individuals coding their previously earned $20 as a potential loss in the lottery, consequently requiring significantly larger returns to bear risk in the lottery. This result is also consistent with previous literature exploring loss aversion, asset legitimacy, and risky choice (e.g., Bosch-Domenenech and Silvestre, 2010, Rosenboim and Shavbit, 2012).

Discussion

Given our results, we now return to our aforementioned preference specifications (CRRA, CLA, RD, and PWLA) to consider which (if any) of these preference specifications can consistently predict the behavior exhibited by our control and treatment groups in both the hypothetical and incentivized decision tasks. To do so, we must first

[13] Considering our treatment and combined control groups, a ex-post power test on the basis of the current samples and the identified between-group effects yields $(1-\beta)=0.99$.

consider whether the lottery presented to participants in the incentivized decision table is an 'all gains' lottery or a mixed domains lottery. Our results support the proposition that the Control Group viewed their incentivized decision table as containing choices between \$20 and an 'all gains' lottery (prizes of \$35 and \$3.50) while the Treatment Group viewed their incentivized decision table as containing choices between no change in their current income (\$0) and a mixed domain lottery (prizes of \$15 and -\$16.50).[14]

For each of the four candidate preference functions, we can now calculate the parameter values necessary to generate the utility of each option in a decision table such that the theoretically predicted cross-over point [i.e. the first decision where $U(Option \text{ B}) > U(Option\ A)$] matches our observed cross-over point in the experiment. For example, in our hypothetical decision table, we observed that the average cross-over points for the Control Group and Treatment Group were 5.79 and 5.29 respectively. Consequently for each 'candidate' preference function, we must calculate the set of parameter values such that $U(Option \text{ B}) > U(Option\ A)$ for the first time at decision 6. Table 5 summarizes our calibration results for each preference function in conjunction with each decision table.

TABLE 5 ABOUT HERE

As indicated in Table 5, it is possible to identify ranges of parameter values for all four preference functions such that theoretical predictions regarding the cross-over points for the hypothetical decision table and the incentivized task completed by the control group are consistent with our observed cross-over points. However, as shown in the bottom two rows of the table, only those preferences which explicitly include loss aversion are also able to generate predictions that are consistent with the behaviour of Treatment Group participants in their incentivized task.[15] Thus, while all four specifications are capable of

[14] Since all participants earned the money they received from the experimenter, one might consider the possibility that asset integration occurred for both Control and Treatment Groups, in which case the Control Group would also view their incentivized decision table as containing a mixed domain lottery. However, if this was the case, we should have observed no difference in the choices made by Control Group 2 and the Treatment Group in the incentivized task – a prediction that was contradicted by our results.

[15] The appendix (not intended for publication) provides an illustration using specific parameter values that lie

explaining the observed when outcomes lie in the domain of gains, only the CLA and PWLA functions can also predict the observed behaviour in the mixed domain decision environment.[16]

6. Conclusion

A key element of our experimental design has been the implementation of an asset integration protocol whereby Treatment Group participants took possession of money received from the experimenter for a period of one week before completing the incentivized task. Importantly, as a result this protocol, all Treatment Group participants in our experiment completed the incentivized task using their *own money* and thus faced the real possibility of losing this money if they accepted the lottery option in the decision table.[17] We view this as complete asset integration of the resources provided by the experimenter. The consequence was that Treatment Group participants displayed a significantly increased reluctance to bear risk in a lottery compared to the Control Group, driven by the possible loss of their own money rather than the riskiness of the prospect.

Our main results provide support for the proposition that loss aversion, separate from risk aversion, is a motivating factor in individual decision-making environments involving risk, where some outcomes lie in the domain of losses. To the extent that the experiment involved modest stakes, the results can also be interpreted as providing experimental support for the views expressed in Rabin (2000) on the importance of loss aversion in assessing decision making under uncertainty. From an experimental design perspective, our results suggest that experimenters should pay serious attention to the subtleties of asset integration especially when the experimenter wishes participants to experience possible or actual losses.

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within the ranges given in Table 5. Each set of diagrams show the theoretical utility values of each choice option for a decision table as generated by the four candidate preference functions with the implied cross-over point.

[16] As mentioned in an earlier footnote, our characterization of the RD and PWLA preference functions have probability weighting functions which are not subproportional, Nevertheless, the results of our calibration exercise are robust for weighting functions that do exhibit subproportionality. as outlined in Prelec (1998).

[17] This differs significantly from Cardenas et al (2014) where treatment group participants used (on average) 65% of the money provided by the experimenter to complete the incentivized tasks.

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Figures

FIGURE 1: EXPERIMENT DESIGN

	CONTROL GROUP 1	**CONTROL GROUP 2**	**TREATMENT GROUP**
SESSION 1	COMPLETE QUIZ – EARN $20 ↓ ASSET LEGITIMACY QUESTIONS * ↓ COMPLETE HYPOTHETICAL DECISION TABLE ↓ PAYMENT OF $20 ↓ COMPLETE INCENTIVIZED DECISION TABLE CONCLUSION AND FINAL PAYMENT (INCLUDING $5 SHOW-UP FEE)	COMPLETE QUIZ – EARN $20 ↓ ASSET LEGITIMACY QUESTIONS * ↓ COMPLETE HYPOTHETICAL DECISION TABLE ↓	COMPLETE QUIZ – EARN $20 ↓ ASSET LEGITIMACY QUESTIONS * ↓ COMPLETE HYPOTHETICAL DECISION TABLE ↓ PAYMENT OF $20 ↓
SESSION 2 (one week after Session 1)		PAYMENT OF $20 ↓ COMPLETE INCENTIVIZED DECISION TABLE ↓ CONCLUSION AND FINAL PAYMENT (INCLUDING $5 SHOW UP FEE)	PARTICIPANTS BRING $20 COMPLETE INCENTIVIZED DECISION TABLE ↓ CONCLUSION AND FINAL PAYMENT (INCLUDING $5 SHOW UP FEE)

FIGURE 2: PERCENTAGE OF PARTICIPANTS CHOOSING THE LESS RISKY OPTION IN HYPOTHETICAL DECISION TABLE

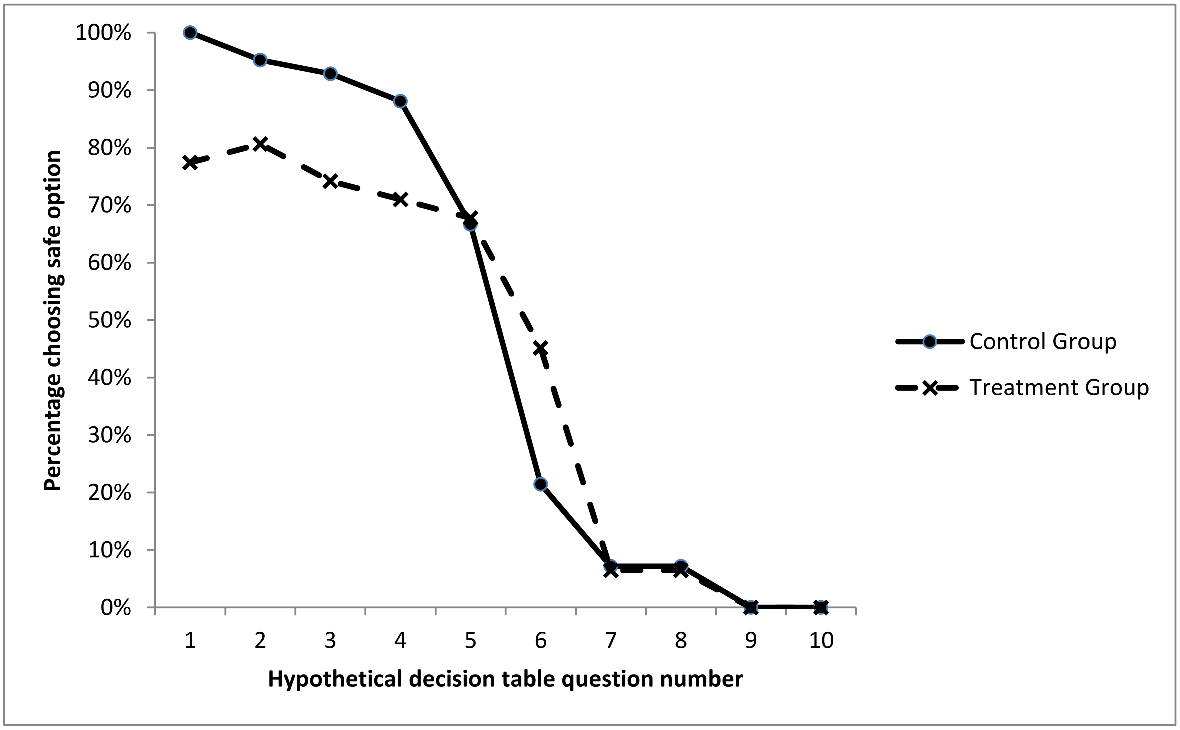
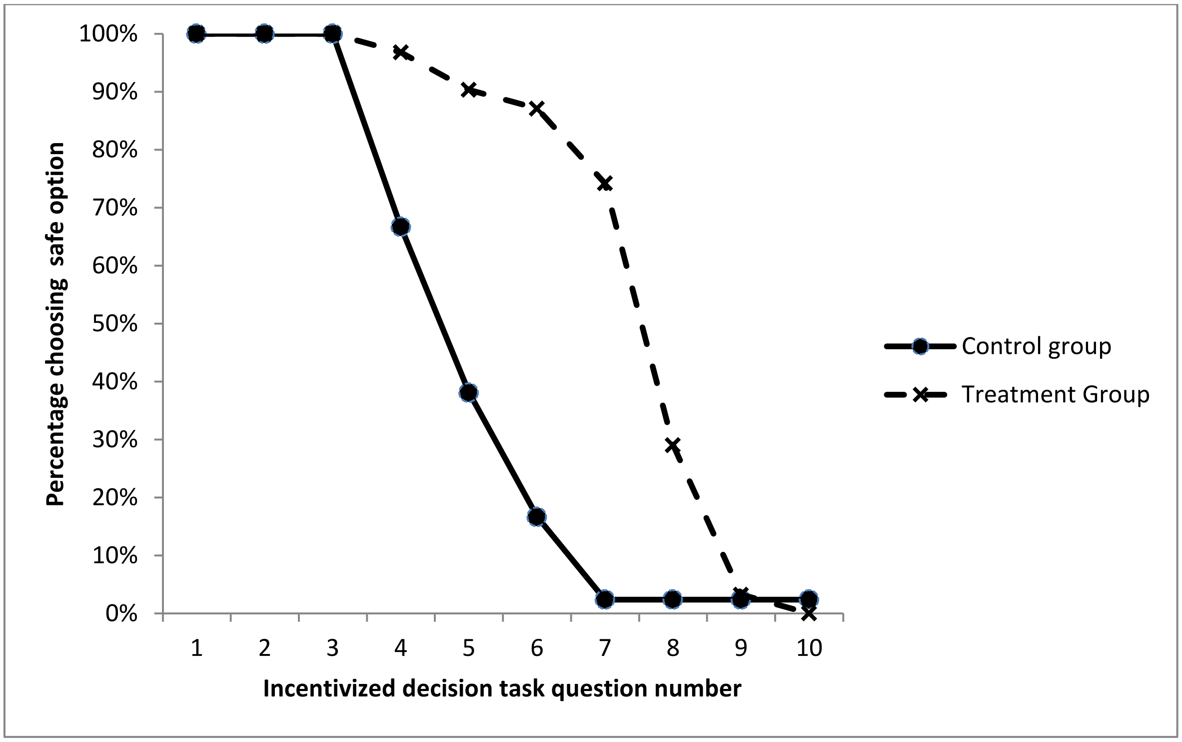


FIGURE 3: PERCENTAGE OF PARTICIPANTS CHOOSING THE SAFE OPTION IN INCENTIVIZED DECISION TABLE.



Tables

TABLE 1: HYPOTHETICAL SCALED-UP VERSION OF THE HOLT-LAURY (2002) DECISION TABLE.

Decision	Option A Details								Option B Details								Difference in expected values
1	A	10%	chance of	$200	and a	90%	chance of	$160	A	10%	chance of	$385	and a	90%	chance of	$10	$116.50
2	A	20%	chance of	$200	and a	80%	chance of	$160	A	20%	chance of	$385	and a	80%	chance of	$10	$83.00
3	A	30%	chance of	$200	and a	70%	chance of	$160	A	30%	chance of	$385	and a	70%	chance of	$10	$49.50
4	A	40%	chance of	$200	and a	60%	chance of	$160	A	40%	chance of	$385	and a	60%	chance of	$10	$16.00
5	A	50%	chance of	$200	and a	50%	chance of	$160	A	50%	chance of	$385	and a	50%	chance of	$10	-$17.50
6	A	60%	chance of	$200	and a	40%	chance of	$160	A	60%	chance of	$385	and a	40%	chance of	$10	-$51.00
7	A	70%	chance of	$200	and a	30%	chance of	$160	A	70%	chance of	$385	and a	30%	chance of	$10	-$84.50
8	A	80%	chance of	$200	and a	20%	chance of	$160	A	80%	chance of	$385	and a	20%	chance of	$10	-$118.00
9	A	90%	chance of	$200	and a	10%	chance of	$160	A	90%	chance of	$385	and a	10%	chance of	$10	-$151.50
10	A	100%	chance of	$200	and a	0%	chance of	$160	A	100%	chance of	$385	and a	0%	chance of	$10	-$185.00

TABLE 2: INCENTIVIZED DECISION TABLE

Decision	Option A	Option B								Option B Expected value	Difference in expected values
1	$20.00	A	0.1	chance of	$ 35	and a	0.9	chance of	$3.50	6.65	$13.35
2	$20.00	A	0.2	chance of	$ 35	and a	0.8	chance of	$3.50	9.80	$10.20
3	$20.00	A	0.3	chance of	$ 35	and a	0.7	chance of	$3.50	12.95	$7.05
4	$20.00	A	0.4	chance of	$ 35	and a	0.6	chance of	$3.50	16.10	$3.90
5	$20.00	A	0.5	chance of	$ 35	and a	0.5	chance of	$3.50	19.25	$0.75
6	$20.00	A	0.6	chance of	$ 35	and a	0.4	chance of	$3.50	22.40	-$2.40
7	$20.00	A	0.7	chance of	$ 35	and a	0.3	chance of	$3.50	25.55	-$5.55
8	$20.00	A	0.8	chance of	$ 35	and a	0.2	chance of	$3.50	28.70	-$8.70
9	$20.00	A	0.9	chance of	$ 35	and a	0.1	chance of	$3.50	31.85	-$11.85
10	$20.00	A	1.0	chance of	$ 35	and a	0.0	chance of	$3.50	35.00	-$15.00

TABLE 3: COMPARING CONTROL GROUPS

	Control Group 1	Control Group 2
Hypothetical decision average crossover point	5.63	6.00
Wilcoxon P values	p > 0.5	
Incentivized decision average crossover point	5.42	5.11
Wilcoxon P values	p > 0.6	

TABLE 4: COMPARING CONTROL AND TREATMENT GROUPS

	Hypothetical Holt-Laury Decision Task		Incentivized Decision Task	
Group	Control	Treatment	Control	Treatment
Average Crossover point	5.79	5.29	5.35	7.81
Wilcoxon P values	p > 0.5		p < 0.01	

TABLE 5: PREFERENCE FUNCTION CALIBRATION

		Preference Functions			
Decision Table	Cross-over point	**CRRA** $x \in [0.16, 0.32]$	**RD** $x \in [0.16, 0.36]$ $\alpha \in [0.81, 0.99]$	**CLA** $x \in [0.16, 0.32]$ $\lambda^- \in [2.2, 3.7]$	**PWLA** $x \in [0.16, 0.36]$ $\alpha \in [0.81, 0.99]$ $\beta \in [0.16, 0.35]$
		Cross-over Point			
Hypothetical: Control Group	Predicted	5.5	5.5	5.5	5.5
	Observed	5.6			
Hypothetical: Treatment Group	Observed	5.3			
Incentivized: Control Group (Domain of gains)	Predicted	5.5	5.5	5.5	5.5
	Observed	5.4			
Incentivized: Treatment Group (Mixed domains)	Predicted	5.5	5.5	7.5	7.5
	Observed	7.8			

The figures below provide an illustrative example of the utility values generated by our four candidate preference functions for each of the decision tables in our experiment. The utility values are determined by assuming specific parameter values for each preference function all of which fall within the ranges stated in Table 5.

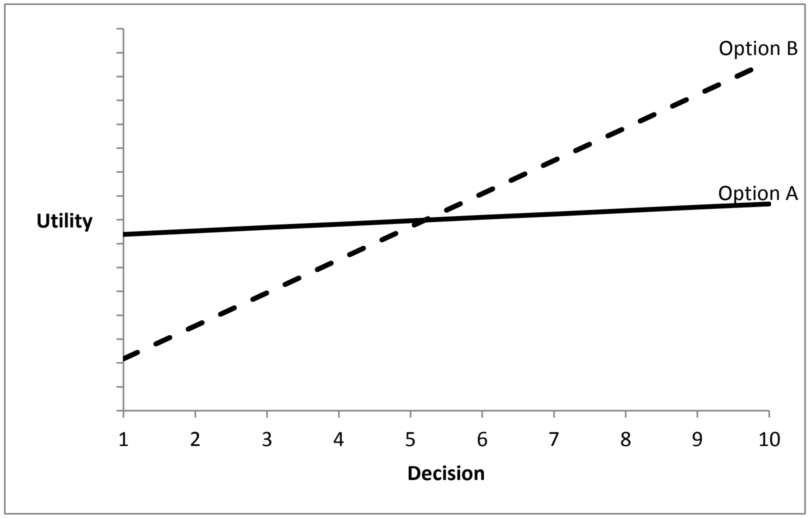
Figures A1 and A2 indicate that for the specific stated parameters all four preference functions yield utility values that predict the switch over point to occur between decision 5 and decision 6 for the hypothetical decision table and the incentivized decision table, conditional upon both lottery outcomes in the incentivized decision table being in the domain of gains.

Figure A3 shows that for the stated parameter values the preference functions yield different predictions of the cross over point in the incentivized decision table when the lottery has mixed domains. Specifically, the CRRA function continues to predict the cross over between decisions 5 and 6, while the RD function predicts an earlier crossover between decisions 4 and 5. Both the loss aversion functions (CLA and PWLA) predict a significantly later cross over point between decisions 7 and 8.

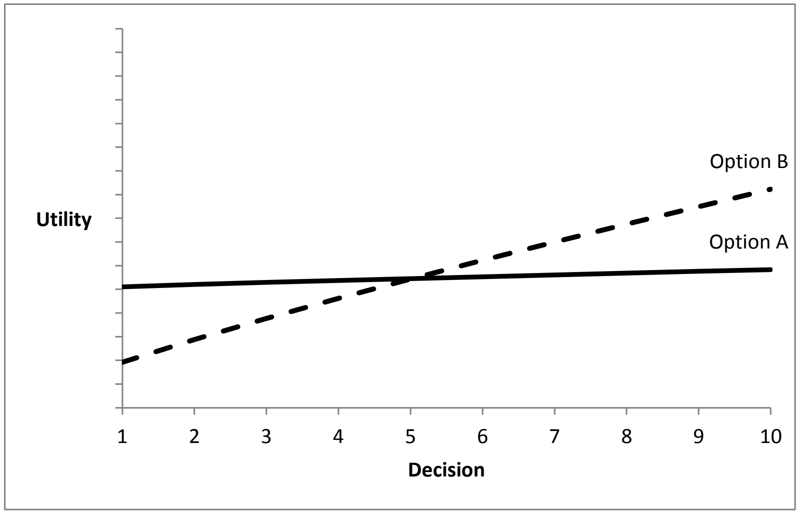
APPENDIX (not intended for publication)

Figure A1: Utility values of candidate preference functions - hypothetical decision table:

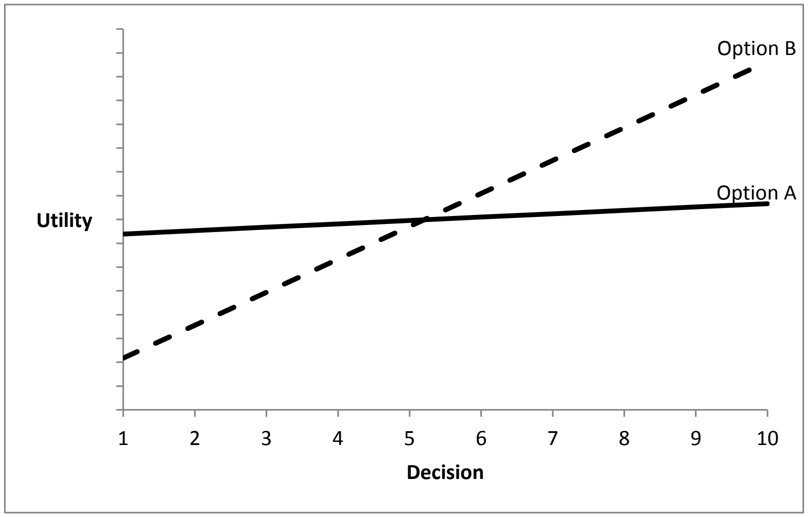
choice between Option A (lottery outcomes: \$200 or \$160) and Option B (lottery outcomes: \$385 or \$10)



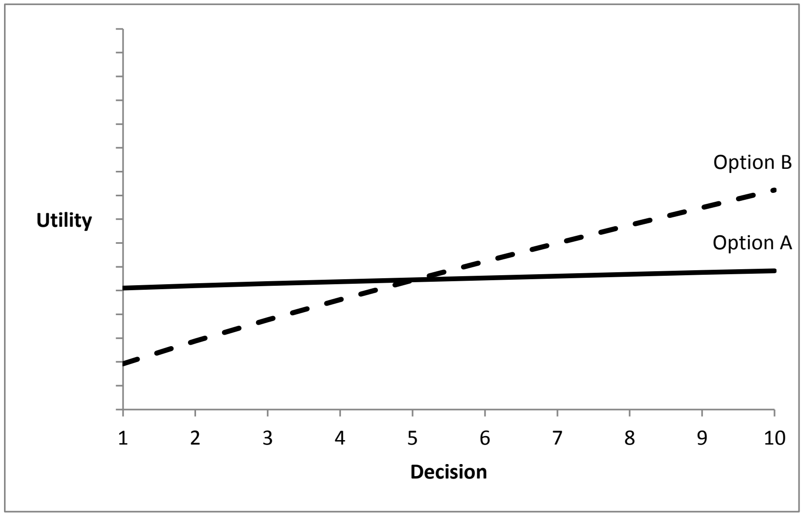
CRRA preference function: $x = 0.2$



RD preference function: $x = 0.3$; α=0.85



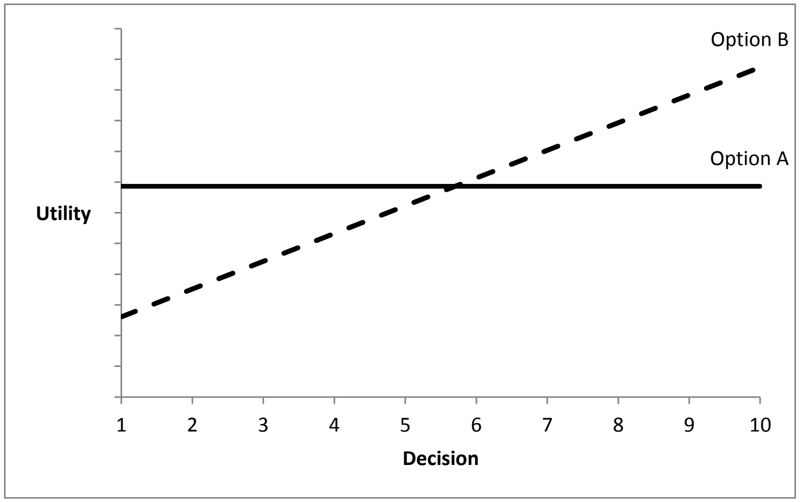
CLA preference function: $x = 0.2$; $\lambda = 2.2$



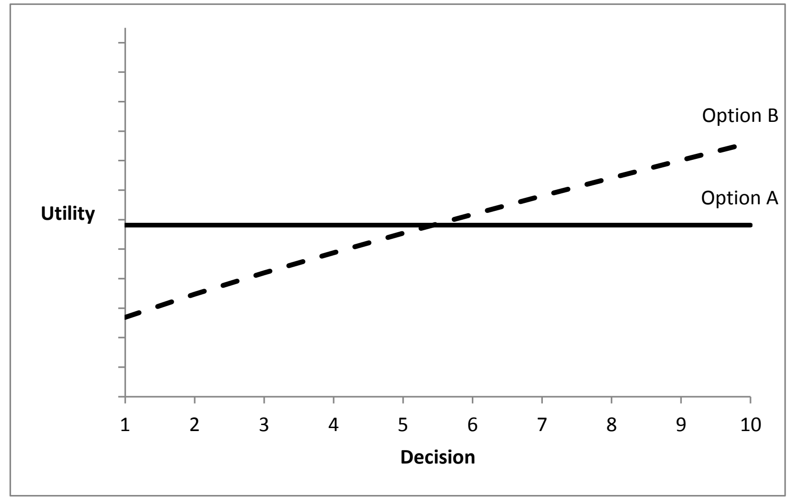
PWLA preference function: $x = 0.3$; $\alpha = 0.85$; $\beta = 0.25$

APPENDIX (not intended for publication)

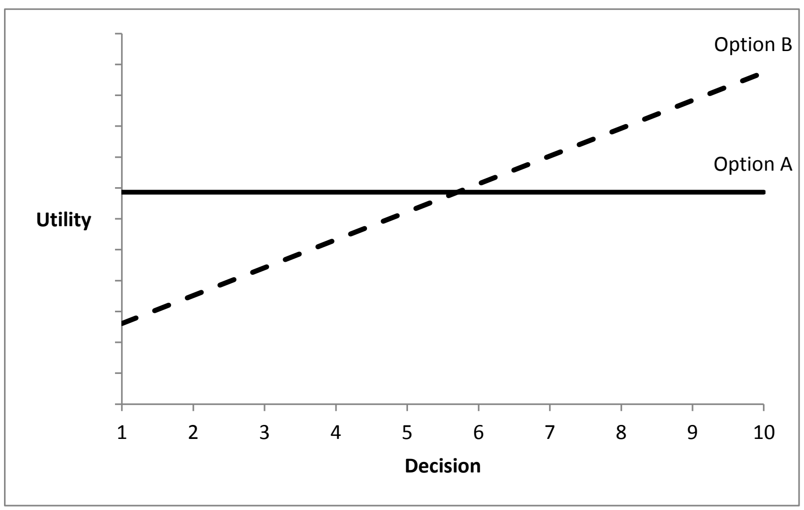
Figure A2: Utility values of alternative preference functions - incentivized decision task (domain of gains): choice between Option A ($20) and Option B (lottery outcomes: $35 or $3.50)



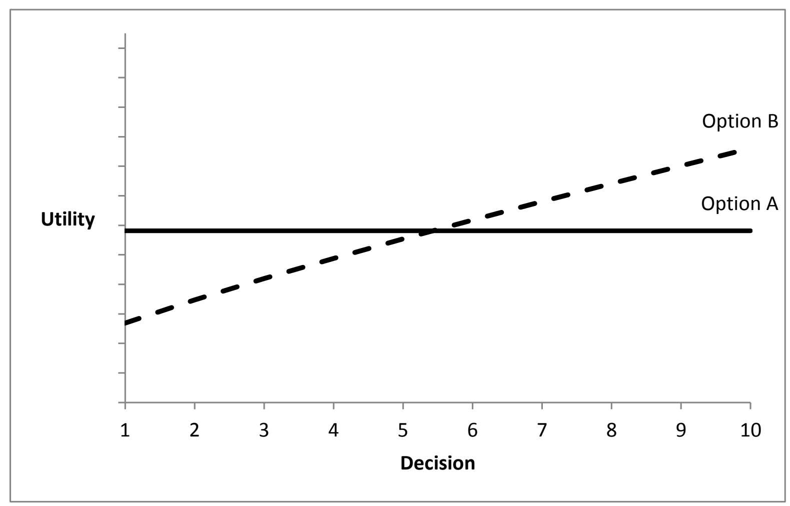
CRRA preference function: $x = 0.2$



RD preference function: $x = 0.3$; α=0.85

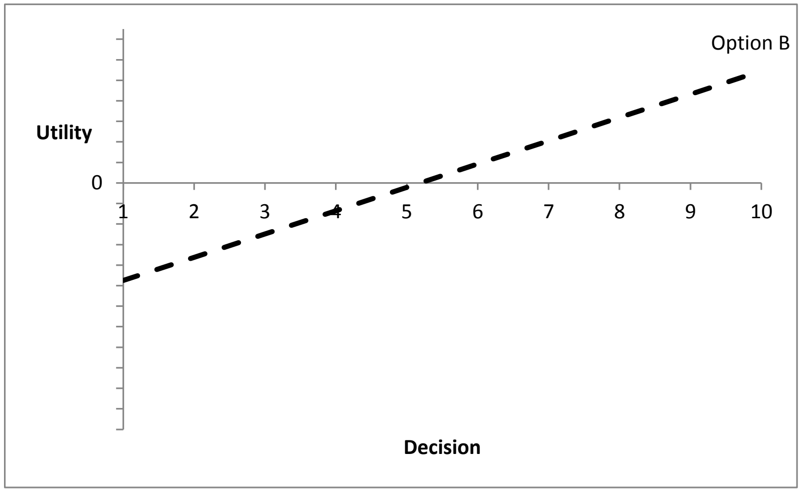


CLA preference function: $x = 0.2$; $\lambda = 2.2$

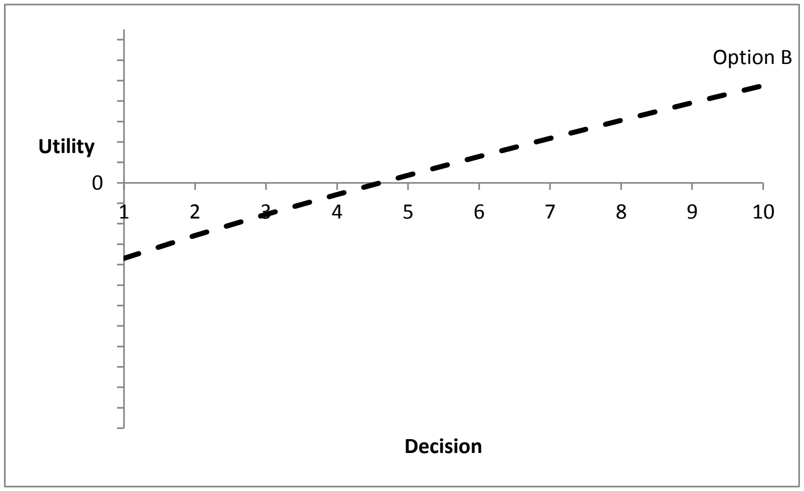


PWLA preference function: $x = 0.3$; $\alpha = 0.85$; $\beta = 0.25$

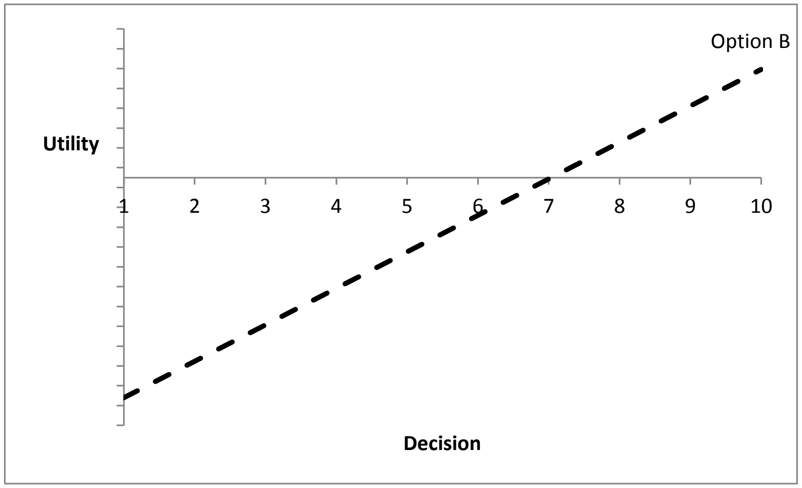
Figure A3: Utility values of alternative preference functions - incentivized decision task (mixed domain): choice between Option A ($0) and Option B (lottery outcomes: $15 or -$16.50)



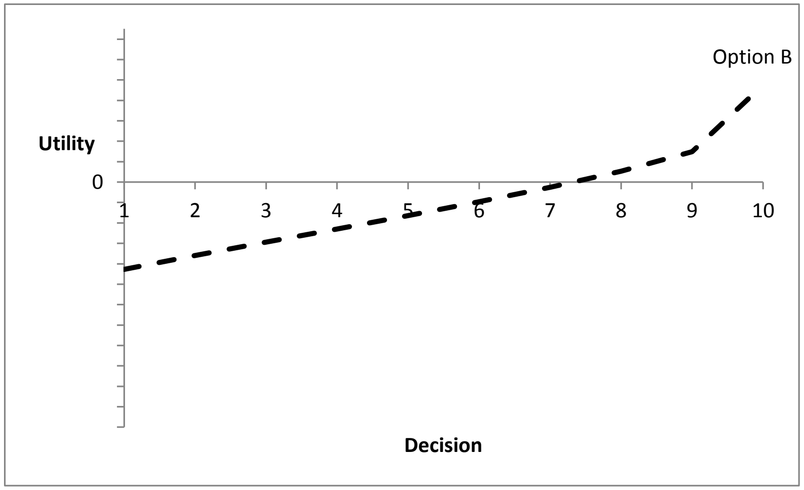
CRRA preference function: $x = 0.2$



RD preference function: $x = 0.3$; α=0.85



CLA preference function: $x = 0.2$; $\lambda = 2.2$



PWLA preference function: $x = 0.3$; $\alpha = 0.85$; $\beta = 0.25$