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Framing and Loss Aversion Tested in the Context of an Academic Examination

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Abstract

This paper examines the effects of framing a bonus question on an exam as a potential gain or as a potential loss. Prospect theory shows that an individual's value function is commonly concave for gains and convex for losses. Students in our experiment were randomly divided into two treatments and were asked to answer a bonus problem at the end of an economics exam. Half of the students were told that they will gain 5 bonus points if they answer the question correctly while the others were told that they received 5 bonus points for completing the first part of the test and would lose these points if they do not successfully answer the question. We find that students in the Loss treatment spend a significantly longer time answering the question. Our research implies that educators can motivate students to work harder on assessments by framing their poor performance as a loss instead of framing their satisfactory performance as a gain.

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1. Introduction

Which prospect would motivate you to work harder, the possibility of gaining $100 if you succeed, or the threat of losing $100 if you fail? Are you more likely to gamble with a $100 that you earned through hard work or with $100 that you found on the sidewalk? Prospect theory is a behavioral economic theory that describes the way people choose between probabilistic alternatives that involve risk. It shows that individuals are typically risk-averse and receive a higher disutility from a loss than they receive utility from an equal gain.

Our paper contributes to the literature on prospect theory by examining its validity in an educational setting. We investigate whether students exert more effort on an exam if the instructor frames success as gaining points or as avoiding losing points. Previous papers examined how framing the students' class grades would affect their performance during the term. This is the first paper to examine how framing the performance on a test question as a potential loss or gain affects students' effort. Additionally, while other researchers examined the students' effort indirectly by looking at their test results, our paper examines effort more directly by recording the amount of time that students spend on a question.

We find that students spend more time working on a bonus problem when they are told that they will lose bonus points if they do not provide the correct answer than when they are told that they would gain bonus points if they provide the correct answer. Our research implies that educators can motivate students to work harder on assessments by framing their poor performance as a loss instead of framing their satisfactory performance as a gain.

There is considerable literature on prospect theory. Kahneman and Tversky (1979) find that consumers' value functions are commonly concave for gains and convex for losses. Thus, most individuals would choose $500 with certainty over a gamble that would give them $0 or $1,000 with .50 probabilities; however, they would select a gamble that would cost them $1,000 or $0 with .50 probabilities over losing $500 with certainty. They also find that individuals' value function is steeper for losses than for gains. This means that most individuals would work harder to avoid losing $1,000 than they would to gain $1,000. Based on the existing literature on prospect theory, we hypothesize that students would work harder on a test question if they thought that they would be losing bonus points if they did not answer the questions correctly than if they thought that they would gain bonus points by answering the question correctly.

Thaler (1980) shows that individuals place more value on items that are incorporated into their endowment. Knetsch and Sinden (1984) show that an endowment effect persists even when individuals choose between a certain award and a lottery ticket. Samuelson and Zeckhauser (1988) introduce the term "status quo bias" to describe people's tendency to place more value on things that they possess. Knetsch (1989) and Kahneman, Knetsch, and Thaler (1990) demonstrate that participants place greater value on items that are endowed to them, even when this endowment is random. In their experiments, they randomly give mugs to half of the participants and chocolate to the other half. They find that the vast majority of participants choose to keep the object that they are endowed with instead of trading for the other object. Tversky and Kahneman (1991) expand on their earlier work by demonstrating that individuals' indifference curves depend on their point of reference. Abdellaoui et al (2016) show that the premises of prospect theory hold under ambiguity by using a non-parametric value function.

Tversky and Kahneman (1981, 1986) recognize that framing the same problem differently leads individuals to respond differently. In treatment A of their experiment, participants are told that they must choose between (A1) receiving $500 with certainty or (A2) receiving $0 or $1,000 with a .50 probability. In treatment B, participants are told that they are given $1,000 and must

choose between (B1) losing $500 with certainty or (B2) losing the $1,000 or not losing anything with a .50 probability. The majority of participants choose option A1 in treatment A but option B2 in treatment B even though options A1 and B1 have an identical payoff. Merely framing something as a loss will make individuals less likely to choose it.

Our experiment has a similar framing effect to the one described by Tversky and Kahneman (1981). We tell one group of students that they can earn 5 bonus points by answering a question correctly while we tell the other group that they earned 5 bonus points by completing the first part of the test and would lose them if they do not answer the question correctly. In reality, both groups face the same payoff structure, but their perception of the payoff may differ. Thus, our alternative hypothesis is that participants in the Loss treatment will exert more effort on the test question than participants in the Gain treatment.

Thaler (2008) recognizes that consumers keep a mental account of their gains and losses and are more reluctant to risk a loss if they already had several losses. Thaler also argues that consumers prefer to segregate gains (get $20 and then another $10) and integrate losses (pay $30 all at once). Furthermore, Thaler (1980), Peng, Miao, and Xiao (2013), and others show that individuals are more likely to gamble with money that was won in previous gambles than with money that was allotted to them.

Despite its popularity, prospect theory is not without criticism. Wu and Marke (2008) examine individuals' choices between two gambles with two uncertain outcomes and claim that gambles' minds are complex and that they cognitively process uncertain outcomes differently than certain outcomes. Furthermore, Vendrik and Woltjer (2007) find, using a longitudinal study, that individuals compare their income to others, and, contrary to prospect theory, their utility from income is concave with respect to both gains and losses. Since the outcome from answering a test question is uncertain, it is not clear whether students would exert more effort if we frame not answering the question successfully as a loss. Thus, our null hypothesis is that participants in the Loss treatment will not exert more effort than participants in the Gain treatment.

Although prospect theory has been studied extensively, only a few researchers looked at its application in education as we do in this paper. Bereby-Meyer, Meyer, and Flascher (2002) show that students who expect a higher grade are less likely to guess on multiple-choice exams even if the expected value of guessing was positive. Moreover, students were more likely to guess on an exam if the exam had more questions, which diversified the risk of guessing. Wüst and Beck (2012) find that students use hyperbolic discounting when preparing for a test, giving more weight to immediate small gratification over long-term benefits. They find, using a survey, that the students' planned studying time falls as the semester progresses.

Some researchers examined the differences in risk aversion between males and females with mixed results. Cardenas, et al (2014) conclude that people are more willing to gamble money that was easily earned. They also report that men are more risk-seeking than women. Ecker, et al (2012) find that girls are more risk-averse in an education environment, while non-white minorities tend to be more risk-seeking. Booth, Cardona-Sosa, and Nolen (2014) find that women are less willing to take a risk than men in a mixed-sex environment, but the gap between the two genders decreases when students are placed in single-sex classes. Sarin and Wieland (2016) found that women are more risk-averse than men under objective probabilities, but that there were no differences between the genders under uncertain probabilities. Our paper also examines if there is a behavioral difference between males and females across the two treatments. While we find that, on average, the difference in effort between the Gain and Loss treatments is higher for males, this result is not statistically significant.

Our experiment contributes to the literature on prospect theory by focusing on the impromptu effort that participants exert. Most experiments on prospect theory require participants to choose among items or lotteries with different perceived values. Because gains and losses evoke certain levels of joy and pain, they should also influence incentives and, consequently, effort. Our experiment investigates if it is possible to generate different levels of instantaneous effort simply by framing an identical problem as a potential gain or a potential loss.

Our results support and supplement the findings of McEvoy (2016) who found that students can be nudged towards better grades over a term when made to try to avoid losing points as opposed to gaining them. His research results were largely consistent with those of Smith et al. (2019) who replicated his general findings that loss aversion can induce students to produce better grades over a term. The results of both studies, however, were not in line with those of a study by Apostolova-Mihaylova, et al (2015) who, in a similar experimental setup, found that there was not an observable general effect of loss aversion on grades among students. Their paper finds gender differences regarding the response of students to a loss treatment, with male students performing better under the influence of a loss treatment while female students were better incentivized by the gain treatment. Neither McEvoy (2016) nor Smith et al. (2019) report gender differences.

While most of the research connecting loss aversion and education focuses on the effects on students, there is also research on the supply side of teaching. Fryer et al (2012) study how loss aversion could be employed to foster teacher performance. They found that setting up a bonus system for teachers in which bonuses are handed out before teaching takes place and then asked back ("lost") when students' performances were not reaching predefined targets worked better than the traditional bonus system with bonuses given after the students' achievements.

Our paper uses a controlled experiment that focuses entirely on the instantaneous, impromptu effect of the prospect of gaining or losing points for a single question instead of on long-term behavior over an academic term. We show that loss aversion affects even impromptu decisions of students on their perseverance in solving a single problem. While the design of our experiment precludes us from concluding the didactical long-term usefulness of loss aversion in education, we can, nevertheless, conclude that it can be used as a transitory tool to encourage students to exert more effort on a task.

2. Experimental Design

Our experiment examines whether students are more likely to exert effort on a test question if the instructor frames success as gaining bonus points or as avoiding the loss of bonus points. We conducted this experiment in a Macroeconomics course at Coastal Carolina University, which is located in Conway, South Carolina. Students were asked to complete a bonus problem on Moodle, which is a Learning Management System, after they completed the regular part of a midterm examination. The students were not aware of the existence of a bonus problem before beginning the exam. Points from successfully answering the questions were added to the students' test scores as bonus points. Thus, students did not need to complete the question in the experiment to achieve a perfect score on the test.

A total of 74 students participated in the experiment, which was presented as the second part of a midterm exam. Students were not aware that they were participating in an experiment. All the participants were business majors at Coastal Carolina University. 31% of the participants were females and 69% were males. The students were randomly divided by Moodle into a Gain treatment and a Loss treatment. When students opened the bonus question, they were randomly

assigned by Moodle to one of the two treatments using a random number generator, so they had an equal probability of ending in either treatment regardless of their performance in the first part, gender, or any other variables.

All 74 students in the course opened the bonus question after completing the first part of the midterm. They spent between 0.95 to 72.53 minutes working on the bonus problem. Since 100% of the students at least attempted to work on the bonus problem, we do not anticipate any self-selection bias in the data. Students were not aware of what grade they received in the first part of the test when they opened the bonus problem. Their grade on the exam was only revealed at the end of the day. Furthermore, the bonus points had equal weight on the students' class grades, regardless of their grade in part I of the test.

Both groups were asked to complete the same question. However, the instructions in the Gain treatment stated, "If you solve this problem correctly you will get 5 bonus points" while the instructions in the Loss treatment stated, "You received 5 bonus points from completing part I of this test. You will lose your 5 bonus points if you do not attempt this question or if you do not answer this question correctly." We measured the students' effort by examining the amount of time that each student spent working on the question, which is recorded by Moodle. Students were allowed to use up to 90 minutes to answer the question. None of the students in the experiment used all of the allotted time.

We used a question that was based on the class material. However, students had to exert effort to solve the problem since one of the needed values had to be calculated first from other given values. Specifically, the students had to obtain the Marginal Propensity to Consume from the consumption function to solve the expenditure multiplier equation. Though the students used both the consumption function and the expenditure multiplier equation previously in class, they were never asked to combine these equations before. The students were allowed to use their notes and a calculator, which means that some students were able to solve the problem by exerting effort even if they did not already know how to solve it at the start of the test.

3. Results and Analysis

Half of the students, 37 students, were randomly assigned to the Gain treatment while the other half were assigned to the Loss treatment. 13 of the 37 participants in the Gain treatment and 10 of the 37 participants in the Loss treatment were females. The average score on the first part of the test was 61.47%. Participants in the Gain treatment had an average test score of 60.89 and participants in the Loss treatment had an average score of 62.05. A two-tail t-test with an equal variance yields a .7963 probability that the mean score of the two treatments is the same. Therefore, there is no evidence that the average test performance on the first part of the test was significantly different between the two treatments.

Table 1 – Composition of Treatments

	Gain	Loss	Combined
Participants	37	37	74
Females	13	10	23
Test Score in Part I	60.89	62.05	61.47

The time that the participants worked on the question varied from 0.95 minutes to 72.53 minutes with a mean of 21.48 minutes and a median of 9.67 minutes, implying a positively

skewed distribution. The standard deviation was 22.42 minutes. Participants in the Gain treatment spent, on average, 13.14 minutes working on the question with a standard deviation of 15.44 minutes. Participants in the Loss treatment spent, on average, 29.83 minutes working on the question with a standard deviation of 25.26 minutes. As shown in Table 2, students spent more time working on the question in the Loss treatment regardless of whether they answered the question correctly or not.

Table 2 – Time Spent Answering Question

Time in Minutes			
	Gain	Loss	Overall
Right	10.06	21.97	15.42
Wrong	17.64	37.28	28.62
Overall	13.14	29.83	

A one-tail F-test shows that there is only a 0.0020 probability that the variances of the two treatments are the same. Therefore, we conclude with a .05 level of significance that the two treatments have a different variance. Next, we use a one-tail t-test with different variances to investigate whether the mean of the two treatments is significantly different. A t-test with different variances shows that there is only a 0.0006 probability that the two treatments have the same mean. We, therefore, reject the null hypothesis that the two treatments have the same mean in favor of the alternative hypothesis that participates in the Loss treatment spent more time working on the question. The results of the t-test are shown in Table 3 below.

Table 3 – T-test with Different Variances

Treatment	Obs	Mean	Std. Err	Std. Dev.	95% Conf. Interval	
Gain	37	13.1368	2.5381	15.4388	7.9891	18.2843
Loss	37	29.8295	4.1528	25.2606	21.40716	38.2518
Combined	74	21.4831	2.6067	22.4241	16.2879	26.6784
Difference		-16.9927			-26.4296	-6.9559

t = -3.4298 Ha: diff < 0 Ha: diff = 0

Pr(T < t) =0.0006 Pr(|T| > |t|) = .0011

To provide robustness to our analysis, we also examined the data using a Wilcoxon rank-sum test, which is a non-parametric test and, therefore, does not depend on the distribution. This test provides further evidence that participants in the Loss treatment spent more time working on the question. The results of this test are provided in Table 4 below.

Table 4 – Wilcoxon Rank-Sum Test

Treatment	Obs	Rank Sum	Expected
Gain	37	1145.5	1387.5
Loss	37	1629.5	1387.5
Combined	74	2775	2775

z > - 2.616 Prob > |z| = .0089 Exact Prob = .0084

The Wilcoxon rank-sum test shows that there is only .0089 probability that the participants in the Gain treatment spent the same time as the participants in the Loss treatment on the question.

Therefore, we conclude with great confidence that participants in the Loss treatment spent more time working on the bonus questions

Next, we investigated if there are behavioral differences between males and females. Overall, there was little difference in effort between males and females, with both sexes exerting around 21 minutes on average as shown in Table 5 below. However, men, on average, spent less time than women in the Gain treatment, but more time than women in the Loss treatment.

Table 5 – Time Spent by Gender

	Female	Male
Gain	18.00	10.50
Loss	24.91	31.65
Combined	21.01	21.70

While both genders spent more effort in the Loss treatment, males appear to be less motivated than females under the Gain treatment but more motivated than females under the Loss treatment. Males, on average, increase the amount of time spent working on the problems by a factor of more than 3 between the Gain and Loss treatments, while females only increase the amount by around 40%. To investigate if gender has a statistically significant effect on effort spent, we ran an OLS regression with Effort, measured in minutes spent on the question, as the dependent variable and the Treatment (Loss = 1, Gain = 0), Gender (female = 1, male = 0), and an interaction variable between gender (Female_Loss) as independent, dummy variables. The results of our analysis are provided below.

Table 6 – Regression with Gender & Treatment as Independent Variables

Source	SS	d.f.	MS
Model	5961.64	3	1987.21
Residual	30745.70	70	439.22
Total	36707.341	73	502.84

Variable	Coef.	St. Err	T	P > |t|	[95% Conf.	Interval]
Gender	7.5046	7.2172	1.04	.302	-6.8896	21.8988
Treatment	21.1519	5.8795	3.60	.001	9.4256	32.8782
Female_Loss	-14.2475	10.5961	-1.34	.183	-35.3807	6.8858
Constant	10.500	4.2780	2.45	.017	1.9678	19.0321

Obs = 74 R-square = .1624 Adj R-square = .1265 Root MSE = 20.958

While our analysis provides further support to our finding that participants in the Loss treatment exert more effort, gender and the interaction between gender and treatment are not statistically significant at the .05 level. Additionally, the R-square and adjusted R-square for our regression are relatively low, indicating that there is considerable stochasticity in the regression. This is not surprising since students' efforts strongly depend on individual characteristics. The lack of statistical significance may also be due partly to the relatively small number of females in the experiment. Further research is needed to determine if females and males respond differently to a framing effect.

While we are unable to observe the amount of time that students prepared for the exam, it is apparent that students, on average, increased the amount of effort that they exerted in the loss treatment. While some students in both treatments were able to solve the question fairly quickly,

the loss framing likely encouraged the students who were struggling to solve the problem to exert more effort. The higher level of effort in the loss treatment led to a higher percentage of the students answering the question correctly, as shown in Table 7 below.

Table 7 – Ratio of Students Who Answered Correctly

	Number Correct	Ratio of Correct Answers
Gain	18	48.7%
Loss	22	59.5%
Combined	40	54.1%

4. Conclusion

This paper reports an experiment on framing a bonus question on an exam as a potential gain or as a potential loss. In our experiment, half of the participants were told that they will gain 5 bonus points if they answer a question correctly while the other half were told that they received 5 bonus points for completing the first part of the test and would lose these points if they do not successfully answer the question. The students were not aware of the bonus problem when they began the exam, and it is not clear from our research how informing students about the bonus problem would influence their preparation time. We find that students in the Loss treatment spent a significantly longer time answering the question. This effect is true for both males and females, so both genders can potentially benefit from framing their unsatisfactory performance as a potential loss. We also observe that females appear to increase their effort by less than males when their performance on the assessment is framed as a potential loss. Nonetheless, this result is not statistically significant.

The increased effort in our experiment led to an improvement in test performance. This performance improvement occurred even though participants in the Gain and Loss treatments exhibited roughly the same level of academic performance in the first part of the exam. However, this improvement is likely to be transitionary rather than long-lasting. A more elaborate design such as the one utilized by McEvoy (2016) in which student either lost or gained points during an academic term is likely to lead to more significant and permanent improvements and performance since students can adjust their preparation before each exam and not merely the amount of effort that they invest in a problem during an exam. Our research focuses on the instantaneous, impromptu responses to two framing conditions. We can show that even the short-term behavior of students under the immediate influence of a momentary nudge can be targeted by framing. This result supplements and reinforces the findings of earlier research on the effects of loss aversion on students' decisions over a whole term.

It is clear from our experiment, that both males in females are motivated to work harder and exert more effort in the loss treatment. This effect is true, even though the participants in both treatments answered the same question and faced the same payoff for answering or failing to answer the question correctly. Our experiment indicates that educators can motivate students better by pointing out that poor performance will be associated with losses of available opportunities rather than telling students that good performance will result in gains. More research is needed to see how this framing effect works in other settings and if females and males respond to framing differently.

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