Predictive Powers of Tests of Risk and Loss Aversion in a Principal-Agent Context: an Experiment

by

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Abstract

The goal of this experimental study is to demonstrate that the test of loss-aversion has a superior predictive power than the standard test of risk-aversion over behavior in risky situations that involve potential losses, e.g. agent's decision in a principal-agent context. Since participant's loss-aversion and risk-aversion affect the results of the loss-aversion test in one direction, the results of that test contains combined information on agent's preferences regarding risks and losses. On the other hand, test of risk-aversion only reflects the attitude towards risks and becomes redundant for prediction of agent's behavior in principal-agent setting when test of loss-aversion is conducted. A three-stage experiment consisted of eliciting a proxy for the curvature of agent's utility curve over wealth, eliciting a proxy for the loss-aversion of an agent, and eliciting the willingness of an agent to take a costly action for an uncertain reward.

Contents

1 Introduction

Behavioral economics has brought fresh insights by incorporating previously disregarded common human psychological features into classical economic models. One of these features that are present in human behavior is loss-aversion, which has become one of the most important theories of individual decision-making. Loss-aversion captures people's characteristic that losses generally have a much larger psychological impact than gains of the same size. Although standard risk-aversion also implies that, loss-aversion's approach involves comparing the outcome with a reference point, which allows loss-aversion to capture a richer description of risk preferences and explain "irrational" behavior in people's economic decisions.

The usual tests of loss-aversion involve comparisons of prospects with uncertainty, where some outcomes incur losses. For example, in Abeler, Falk, Gotte and Huffman's experiment (2011) participants chose six times between a fixed payment of 0 and a gamble. The gamble was a 50/50 chance of winning 6 euros or losing X, where X varied from 2 to 7 euros across 6 gambles. The more gambles a person rejects, the more loss-averse that person is considered. However, risk-aversion by expected utility theory also can be associated with rejecting these gambles. In fact, both loss-aversion and risk-aversion have a monotonic relationship with the number of rejected gambles in this test. For a given number of rejected gambles there are many combinations of compatible preferences, including "risk-neutral, but loss-averse" and "risk-averse, but loss-neutral". Two people with the same level of loss-aversion might choose different number of gambles because of differences in regard to risk. Risk and loss aversion have additive effects on the number of rejected gambles, therefore the number of rejected gambles in the test of loss-aversion also contains the information on that person's willingness to take risks.

The goal of this paper is to demonstrate that the test of loss-aversion has a superior predictive power than the standard test of risk-aversion over decisions about situations that involve potential losses, e.g. agent's decision in principal-agent context. Principal-agent model describes a situation when an agent chooses an action that is not directly observable by a principal, but the agent's decision affects the probability distribution of the output, which principal can observe and which determines the principal's payoff. Therefore, the principal offers an agent a contract contingent on the output. A common example is employer-worker relationship, where a worker decides whether to exert a costly effort in her work, which partially determines the level of output, and where an employer determines the payment depending on the output. Since the output does not solely depend on the effort of the worker, the worker is not sure that she will get rewarded for her effort. The worker can "invest" by taking a costly action and hope that the output will be higher to get a higher reward, or she can refuse to take that action. The decision of an agent in such situation is certainly affected by her attitude towards risk, because the decision involves comparing prospects with uncertainty. Also, it is affected by her attitude towards loss, since agent's realized reward might not cover her cost of that action. This paper provides an evidence that both these attitudes can be captured by the usual test of loss-aversion, and the usual test of risk-aversion does not give additional predictive power of the agent' decision on top of test of loss-aversion.

To demonstrate loss-aversion test's greater predictive power over agent's decision, I conducted a three-stage experiment. In the first stage I elicited proxies for individual levels of risk-aversion according to the standard expected utility theory. In the second stage I elicited proxies for individual levels of loss-aversion using a test similar to the example above. Finally, in the third stage I modeled an example of principal-agent setting and elicited willingness of agents to take a costly action with a stochastic reward. The results say that the result of the test of the second stage predicts the agent's behavior much better than the one of the first stage. Moreover, I observe that if I know the degree of loss-aversion of an agent, knowledge of risk-aversion does not give any additional predictive power of agent's behavior.

The following sections consist of literature review, theoretical background, experimental design, description of the data, analysis, and conclusion.

2 Literature Review

Kahneman and Tversky presented the prospect theory in 1979 as an alternative to the expected utility theory, which was criticized to be inconsistent with empirical evidence of people's decisions in situations that involve uncertainty. One example of these inconsistencies is that people tend to choose a fixed payment of 500 over a lottery of getting 1000 with 0.5 chance and 0 with 0.5 chance. However, if people are firstly given 1000 and offered fixed loss of 500 or 0.5 chance of losing 1000, people tend to opt for a gamble. By expected utility theory, where only the final outcomes matter, these two situations are equivalent, but experiments showed that people's decisions are systematically dependent of *how* choices are framed. Unlike expected utility theory, the prospect theory states that people evaluate a situation not by it's absolute outcome, but by a change relative to some "reference point". The change can be either a gain or a loss relative to the reference point, and loss-aversion reflects the feature that losses affect the overall utility greater than similar-sized gains. Moreover, the utility curve by the prospect theory is concave in the gain domain and convex in the loss domain. Therefore in the example above in the first case decisions are made on the gain domain and in the second case decisions are made on the loss domain due to the change of the reference point. As the utility curve that the prospect theory suggests, people are risk-averse in gain domain and risk-seeking in loss domain, which explains the behavior of people in the example.

The model of reference point dependence and loss-aversion was extended to riskless choices (Tversky and Kahneman 1991), which explained several more phenomena. For example, an experiment by Kahneman, Knetsch, and Thaler (1990) documented that people value an object more, once it is in their possession. They demonstrated that by randomly dividing a group into two and giving a mug to each participant of one group. Then they asked the participants who had a mug for what price they would sell the mug (willingness to accept, WTA), and asked another group for which price they would buy the mug (willingness to pay, WTP). Prediction of the classical theories would be that average responses of two groups would be similar, but the results were that the owners on average valued the mug for 7.12 USD, and buyers' mean price to offer was 3.12 USD. The difference was attributed to the "endowment effect". Loss-aversion explains the endowment effect, because the status quo for the group who had the mug included the mug, meaning that their reference point was having the mug. For these people, potential loss of the mug would bring more disutility than the amount of utility that people from the other group would gain from getting the mug, which is reflected in their answers.

In the endowment effect experiment the experimenters manipulated the reference point, which is the status quo, but the reference point is not always determined by a status quo. As Kahneman and Tversky (1979) stated, "the location of the reference point, and the consequent coding of outcomes as gains or losses, can be affected by the expectations of the decision maker". For example, a worker who expected a 10,000 USD increase in her salary will not be happy if she gets a 5,000 USD increase, because she will consider 5,000 USD increase as a loss compared to her expectation. Köszegi and Rabin (2006) proposed a loss-aversion model where a reference point is a rational *expectation* according to agent's full probabilistic beliefs. In other words, agent's gain-loss utility is composed of comparisons of her payoff with all other possible payoffs. Crawford and Meng (2011) use the model to explain New York City cab drivers' labor supply puzzle. Moreover, Abeler, Falk, Goette, Huffman (2011) conducted a lab experiment where participants worked on a tedious and repetitive task, and each participant decided when to stop working. Each participant's payment was randomly chosen between a fixed payment and their accumulated piece rate earnings. The experimenters randomly divided participants into two groups and told that the fixed payment is 3 USD to one group, and 7 USD to another group. By expected utility theory, treatment and control groups should have statistically indifferent average levels of effort. According to models with loss-aversion with *status quo* as a reference point, the amount of fixed points also should not affect the exerted level of effort. However, the result of the experiment was that the average level of effort provision of the first groups was statistically significantly lower than the second group, which is the prediction of the loss-aversion model with *expectation-based* reference point.

The model of expectation-based loss-aversion allowed researchers to incorporate loss-aversion in economic models that involve uncertainty such as auctions (Eisenhuth, 2018) and strategic interactions (Dato, Grunewald, Müller, Strack, 2017). Herweg, Müller, Weinschenk (2010) applied loss-averse preferences in principal-agent model and found that binary payment contract are optimal in case of loss-averse agents. This finding explains why in the real world we so often observe *bonus* contracts, e.g. a salesman gets a bonus if the sales hit the threshold amount. The bonus contract is not optimal with risk-averse agents, instead the optimal one is fully-contingent contract, which would imply different wages for salesman for different amounts of sales (Hölmstrom, 1979).

Moreover, the model of expectation-based loss-aversion made it possible to estimate individual loss-aversion using lotteries. Experiments by Fehr and Gotte (2007), Gachter, Johnson, Herrmann (2007), and Abeler, Falk, Goette, Huffman (2011) are some examples. In my study I also use this model of loss-aversion with expectation-based reference point to elicit a proxy for loss-aversion on individual level.

I also deal with practical issues with elicitation of degrees of loss-aversion. To begin with, ethical concerns do not allow experimenters make participants lose their own money in the experiments, which is why usually loss-aversion elicitation tests are hypothetical. However, Holt and Laury (2002) demonstrated with risk-aversion elicitation tests that participant act differently when the experiment is hypothetical than when the participants make decisions that will affect their payoffs. Some experimenters tried to solve the issue by giving some amount of cash to participants in the beginning of the experiment, but Clark (2006) and Harrison (2007) showed that this method brings up the problem of “found money bias”, where participants regard the resource provided by the experimenter as a “windfall gain”. I designed my experiment to be free of these concerns (see experimental design section).

3 Theoretical Background

The standard measure of risk-aversion in expected utility theory is the curvature of the utility function, and the first stage of the experiment involves eliciting a proxy for it. The Arrow-Pratt measure of relative risk-aversion in expected utility theory is defined as

$$R(x) = -\frac{xU''(x)}{U'(x)},$$

so, for example, for a CRRA utility function $U(x) = x^{1-r}/(1-r)$, the measure of relative risk-aversion is r. The larger is r, the faster the marginal utility over money decreases, i.e. the more risk-averse is the person. In this study I use a test developed by Holt and Laury, which is aimed at eliciting elicited a proxy for r.

To elicit a proxy for the level of loss-aversion in risky settings I use the model of loss-aversion with expectation-based reference points by Köszegi and Rabin (2006), where the overall utility is given by

$$u(x|p) \equiv f(x) + \mu\big(f(x) - f(p)\big),$$

where $f(x)$ is consumption utility over money x (or intrinsic utility), and $\mu\big(f(x) - f(p)\big)$ is gain-loss utility. The reference point p is defined by the *expectation* of the payoff. The consumption utility function is assumed to be strictly increasing and linear if the attitude toward risk is neutral, in case of which the overall utility function looks like

$$u(x|r) = x + \mu(x - p).$$

The gain-loss utility function $\mu(.)$ takes the form of

$$\mu(m) = \begin{cases} m, & for \quad m \geq 0 \\ \lambda m, & for \quad m < 0, \end{cases}$$

where $\lambda \geq 1$ characterizes the degree to which "losses loom larger than gains". In my experiment I use a loss-aversion test that is used to elicit a proxy for λ, and the agent is considered loss-averse if $\lambda > 1$. The higher is λ, the more loss-averse is the person.

4 Experimental Design

The objective of the experiment is to determine whether the results of the test of risk-aversion or of loss-aversion better predicts the behavior of an agent in principal-agent context. To satisfy the ethical requirements for experiments with eliciting proxies for degrees of loss-aversion, and avoid the problems of "hypothetical choice bias" and "windfall gain effect", I conducted my experiment in two sessions that were a week apart. On the first session participants solved an IQ test and received a guaranteed fixed amount of 2200 KZT. The purpose of the first session was to give the money to participants with the expectation that this sum enters their "status quo" until the next week. This developed participants' sense of ownership over the money, which allowed us to measure loss-aversion accurately.

The main part of the experiment was the second session, which consisted of eliciting proxies for participant's degrees of risk-aversion and loss-aversion, and their willingness to take a costly effort to participate in the given lottery. All elicitation tests consisted of 10 questions where participants chose between two options. Participants were informed that one of their choices would be randomly chosen and played for real (if it's a lottery) to determine their payment for the second session of the experiment.

4.1 Test of Risk-Aversion

I elicit proxies for participants' level of risk-aversion using a simple lottery-choice test developed by Holt and Laury (2002), where participants choose ten times between *safe* (Option A) and *risky* (Option B) lotteries. The questions are presented in Table 6.

I assume that the participants' utility function with constant relative risk aversion for money x to be $U(x) = x^{1-r}/(1-r)$ and the questions in the elicitation test are designed to estimate the parameter r, or the concavity of the utility function according to expected utility theory. Each choice of a participant between two options can be translated to an inequality. For example, a person who switches from choosing Option A over Option B after the sixth question have the following two inequalities in regard to her preferences:

$$\frac{6}{10} \times \frac{2000^{1-r}}{1-r} + \frac{4}{10} \times \frac{1600^{1-r}}{1-r} > \frac{6}{10} \times \frac{3850^{1-r}}{1-r} + \frac{4}{10} \times \frac{100^{1-r}}{1-r}$$

$$\frac{7}{10} \times \frac{2000^{1-r}}{1-r} + \frac{3}{10} \times \frac{1600^{1-r}}{1-r} < \frac{7}{10} \times \frac{3850^{1-r}}{1-r} + \frac{3}{10} \times \frac{100^{1-r}}{1-r}$$

From these inequalities I can determine a closed interval for which solution for r exist. For this example, r is estimated to be around 0.82. $r > 0$ implies risk-aversion, $r = 0$ implies risk-neutrality, and $r < 0$ implies preference for risk. A risk-neutral participant would switch from Option A to Option B after fourth question in the test that I use. If a participant switches earlier, that implies that she prefers taking risks. If a participant switches later, then she is assumed to be risk-averse. Thus, the number of Option A's that the agent chooses is a proxy for the parameter r. A more detailed interpretation of the number of chosen Option A's (or when a participant switches) and an estimations for r are presented in Table 8.

4.2 Test of Loss-Aversion

Next, I elicit proxies for participants' degrees of loss-aversion using the modified version of the test used by Abeler, Falk, Goette, Huffman (2011). The difference from the original test is that I increased the number of pairs of choices from six to ten, and decreased the "steps" between the choices. I ask participants to choose ten times between a fixed payment of zero and a lottery (see Table 7).

Again, each decision of a participant can be translated in an inequality. I use the model by Köszegi and Rabin, and if I assume risk-neutrality of participants, i.e. linearity of the consumption function, and if a participant chooses Option A in fourth question and Option B in fifth question, I have the following two inequalities with a reference point of 400 in the fourth lottery and 300 in the fifth lottery:

$$\frac{1}{2}\big(1800 + (1800 - 400)\big) + \frac{1}{2}\big(- 1000 + \lambda(-1000 - 400)\big) > 0$$

$$\frac{1}{2}\big(1800 + (1800 - 300)\big) + \frac{1}{2}\big(- 1200 + \lambda(-1200 - 300)\big) < 0$$

From the inequalities above I can estimate the λ to be around 1.5, which is a measure the level of loss-aversion. Loss-aversion is implied when $\lambda > 1$ and loss-neutrality is implied when $\lambda = 1$. A person is considered loss-neutral if she chooses Option A seven or eight times. The more a participant chooses Option B, the higher λ she has, therefore the former is the proxy for the latter. A more detailed interpretation of the number of chosen Option B's and an estimations for λ are presented in Table 9.

4.3 Elicitation of Agent's Willingness to Take a Costly Action

Finally, I measure the willingness of an agent to take a costly effort for an uncertain reward. I use a simple example with two levels of effort for an agent and two possible levels of output. The principal makes a one-period contract offer to an agent and the agent accepts the contract because the reservation utility of the agent is chosen to be zero, which is the least amount of utility that the agent can get from accepting the contract. Then the agent chooses between two levels of effort (high or low) that determines the probability distribution of two levels of output (high and low). The principal cannot observe the level of effort, but can observe the level of realized output. The actions of an agent and probability distribution of outputs dependent on agent's effort are presented as in Table 1.

Table 1: Probability Distribution of Outputs Depending on Agent's Choice

	Low output	High output
Low effort	1	0
High effort	0.5	0.5

The principal offers the contract contingent on the output and suppose that the principal would like an agent to chose high level of effort (e_H). In case of high output the principal pays high wage (w_H), and in case of low output the principal pays low wage (w_L). Therefore if an agent chooses low effort (e_L), she gets low wage (w_L) for sure. However, if she chooses high effort (e_H), then she can get a high (w_H) or a low wage (w_L) with equal probability .

In the example that I use in the experiment w_L is 1000 KZT, and w_H is 3000 KZT. Also, the cost of providing low effort (c_L) for the agent is 1000 KZT. I measure the willingness of an agent to take a high effort by eliciting the maximum value for (c_H) when an agent is willing to exert high effort. In other words, I elicit the amount that an agent is willing to pay to participate in the lottery that is described by the situation when an agent chooses high effort. Possible answers are numbers in an increasing order from 1000 to 2800 divisible by 200. At some point most agents switch from participating in the lottery to the fixed payment of zero. The later an agent switches (i.e the more an agent choose Option A's), the more she is willing to take a costly effort for an uncertain reward in a principal-agent context. The test is presented in Table 10.

5 Data

In total 80 undergraduate non-economics students of Nazarbayev University participated in the experiment and received on average 3476 KZT (10.5 USD) for their participation. Four participants switched too much or never switched in the tests, so these observations were removed from the sample. Eleven more participants switched more than once in the risk-aversion elicitation test, which seemed like a mistake that I corrected and included in the sample. Removing these ten observations does not affect the main results of the experiment.

My three main variables of interest are proxies for degrees of risk-aversion and loss-aversion, and agent's willingness to take a costly action. The proxy for the measure of the risk-aversion is the number of Option A's in Table 6 chosen by the participant and the proxy for the measure of the loss-aversion is the number of Option B's in Table 7 chosen by the participant. The willingness of the agent to take a costly effort to participate in the lottery is estimated by the number of Option A's in Table 10 chosen by the participant.

My sample's mean number of Option A's in the risk-aversion test is 5.6, which corresponds to the parameter $r \sim 0.41$, and Table 8 describes these preferences to be classified somewhere between "slightly risk-averse" and "risk-averse". Similarly, an average number of Option B's in loss-aversion test is 6.9, which corresponds to the parameter $\lambda \sim 1.57$, and Table 9 describes these preferences to be classified somewhere between "rather loss-averse" and "loss-averse".

My control variables are gender, expenditure per month, and IQ test score. Gender is defined by a dummy variable that takes the value of "1" if a participant is female. Expenditure per month is an ordinal variable that takes the value of "1" if the amount is less than 30,000 KZT (∼90 USD), "2" if the amount is between 30,000 and 60,000 KZT, "3" if the amount is more than 60,000 KZT. IQ test scores are defined by the number of correct answers to an IQ test containing 20 questions.

I present the descriptive statistics in Table 2, Pearson's correlation chart in Table 3 the frequency distribution of the main three variables in Graph 1 to demonstrate the sample's substantial heterogeneity in attitude towards risk and loss.

The sign of correlation between risk-aversion and female/expenditure is consistent with previous studies (Borghans, Heckman, Golsteyn, Meijers (2009), Dohmen, Falk, Huffman, Sunde, (2010)), given than monthly expenditure is a proxy for income.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Risk-aversion	76	5.57	1.70	2	9
Loss-aversion	76	6.95	2.43	0	10
Agent's decision	76	4.04	1.72	1	10
Female	76	0.47	0.50	0	1
Expenditure	76	2.09	0.34	1	3
IQ	76	6.63	1.97	3	11

Table 3: Pearson's Correlations Between the Variables

Variable	1	2	3	4	5	6
1. Risk-aversion	-					
2. Loss-aversion	0.27	-				
3. Agent's decision	-0.21	-0.80	-			
4. Female	0.26	0.08	-0.11	-		
5. IQ	-0.24	-0.26	0.24	-0.14	-	
6. Expenditure	-0.26	0.05	0.02	-0.22	0.03	-

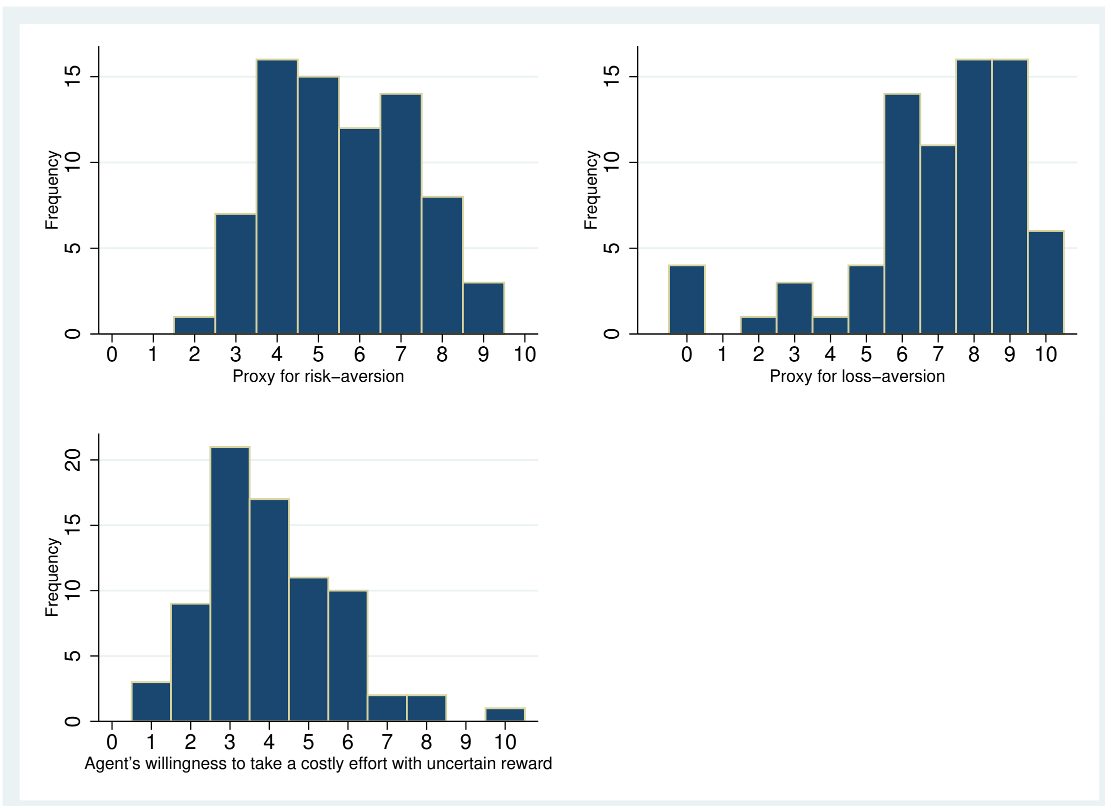

Figure 1: Frequency Distribution of Main Variables

6 Analysis

I run OLS and ordered probit regressions. For OLS regression I use the following model:

$$Will_i = \beta_0 + \beta_1 RA_i + \beta_2 LA_i + \beta_3 Female_i + \beta_4 Expenditure_i + \beta_5 IQ_i + u_i$$

where $Will$ is the willingness of an agent to take a costly action for an uncertain reward, measured by the number of Option A's in Table 10. RA is the proxy for risk-aversion and LA is the proxy for loss-aversion, measured by the number of Option A's in Table 6 and the number of Option B's in Table 7 respectively.

The dependent variable might arguably be considered as an ordered categorical variable, where I do not observe the exact level of willingness of an agent to take a costly effort. The model with exact dependent variable can look as the following

$$Will_i^* = \beta_0 + \beta_1 RA_i + \beta_2 LA_i + \beta_3 Female_i + \beta_4 Expenditure_i + \beta_5 IQ_i + u_i$$

where the error term is normally distributed with zero mean and unit variance, conditioning on regressors.

Instead of the latent variable I have the following:

$$Will = \begin{cases} 1 \text{ if } Will^* \leq \theta_1, \\ 2 \text{ if } \theta_1 \leq Will^* \leq \theta_2, \\ 3 \text{ if } \theta_2 \leq Will^* \leq \theta_3, \\ \dots \\ 10 \text{ if } Will^* \geq \theta_9. \end{cases}$$

Setting $\theta_0 = -\infty$ and $\theta_{10} = \infty$, the above can be expressed as Will=k iff $\theta_{k-1} \leq Will^* \leq \theta_k$. Therefore the conditional distribution of $Will$ is

$$P(Will = k|\mathbf{x}) = P(\theta_{k-1} < Will^* < \theta_k|\mathbf{x})$$
$$= \Phi(\theta_k - \beta_0 + \beta_1 RA_i + \beta_2 LA_i + \beta_3 Female_i + \beta_4 Expenditure_i + \beta_5 IQ_i)$$
$$-\Phi(\theta_{k-1} - \beta_0 + \beta_1 RA_i + \beta_2 LA_i + \beta_3 Female_i + \beta_4 Expenditure_i + \beta_5 IQ_i)$$

where Φ is the cumulative distribution function of the standard normal distribution, and parameters are estimated through maximum likelihood estimation.

Table 4 present the results of the regressions. In both regressions the coefficient for risk-aversion is insignificant, whereas the one for loss-aversion is negative and significant at 0.1 percent level. The results say that less loss-averse participants (i.e. choose less Option A's in the loss-aversion test) on average are more willing to take a costly action for an uncertain reward (i.e. choose more Option A's in the test of the third stage). Moreover, the proxy for degree of risk-aversion is redundant when I control for the proxy for measure of loss-aversion if I predict the behavior of an agent.

Table 5 presents marginal effects after ordered probit regression. The ninth column is empty because no person in the sample switched after ninth question in the third stage. The results say that only proxies for loss-aversion significantly affect the probabilities of certain outcomes of the dependent variable. Particularly, higher proxy for loss-aversion increases the chances of observing 2 or 3 and decreases the chances of observing 5 or 6 as the value of the willingness of an agent to take a costly action.

Table 4: OLS and Ordered Probit Regressions

Agent's Willingness to Take a Costly Action	OLS	Ordered Probit
Risk-aversion	0.03	0.04
	(0.08)	(0.08)
Loss-aversion	-0.57***	-0.58***
	(0.05)	(0.08)
Female	-0.16	-0.14
	(0.26)	(0.26)
Expenditure	0.15	0.18
	(0.20)	(0.20)
IQ	0.03	0.04
	(0.07)	(0.07)
Constant	7.47***	
	(0.92)	
Observations	76	76
R^2	0.65	0.26

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Marginal Effects After Ordered Probit Regression

	1	2	3	4	5	6	7	8	9	10
Risk-aversion	0.00	0.00	-0.01	0.00	0.01	0.01	0.00	0.00	-	0.00
Loss-aversion	0.01	0.05**	0.15***	-0.01	-0.11***	-0.08**	-0.01	0.00	-	0.00
Female	0.00	0.01	0.04	0.01	-0.03	-0.02	0.00	0.00	-	0.00
Expenditure	0.00	-0.02	-0.05	0.01	0.03	0.02	0.00	0.00	-	0.00
IQ	0.00	0.00	-0.01	0.00	0.01	0.00	0.00	0.00	-	0.00

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7 Conclusion

This study experimentally demonstrates that the test of loss-aversion has a greater predictive power than the test of risk-aversion over agent's decision in principal-agent context. Since participant's loss-aversion and risk-aversion affect the decision of how many gambles to choose in the loss-aversion test in one direction, the results of that test contains information on preferences regarding risks and losses combined. On the other hand, risk-aversion test reflects only attitudes towards risks and becomes redundant for prediction of agent's behavior in principal-agent setting when test of loss-aversion is conducted.

The result of this study is insightful in terms of methodology and serves as an additional evidence for prospect theory. People's risk-preferences change if gains are reversed to losses, and this paper demonstrates the chief importance of controlling for loss-aversion in predicting the decisions in risky settings with potential losses.

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Table 6: Risk-Aversion Elicitation Test

	Option A	Option B
1	Get 2000 with 1/10 chance Get 1600 with 9/10 chance	Get 3850 with 1/10 chance Get 100 with 9/10 chance
2	Get 2000 with 2/10 chance Get 1600 with 8/10 chance	Get 3850 with 2/10 chance Get 100 with 8/10 chance
3	Get 2000 with 3/10 chance Get 1600 with 7/10 chance	Get 3850 with 3/10 chance Get 100 with 7/10 chance
4	Get 2000 with 4/10 chance Get 1600 with 6/10 chance	Get 3850 with 4/10 chance Get 100 with 6/10 chance
5	Get 2000 with 5/10 chance Get 1600 with 5/10 chance	Get 3850 with 5/10 chance Get 100 with 5/10 chance
6	Get 2000 with 6/10 chance Get 1600 with 4/10 chance	Get 3850 with 6/10 chance Get 100 with 4/10 chance
7	Get 2000 with 7/10 chance Get 1600 with 3/10 chance	Get 3850 with 7/10 chance Get 100 with 3/10 chance
8	Get 2000 with 8/10 chance Get 1600 with 2/10 chance	Get 3850 with 8/10 chance Get 100 with 2/10 chance
9	Get 2000 with 9/10 chance Get 1600 with 1/10 chance	Get 3850 with 9/10 chance Get 100 with 1/10 chance
10	Get 2000 with 10/10 chance Get 1600 with 0/10 chance	Get 3850 with 10/10 chance Get 100 with 0/10 chance

Table 7: Loss-Aversion Elicitation Test

	Option A	Option B
1	Get 1800 with 1/2 chance Lose 400 with 1/2 chance	Get 0
2	Get 1800 with 1/2 chance Lose 600 with 1/2 chance	Get 0
3	Get 1800 with 1/2 chance Lose 800 with 1/2 chance	Get 0
4	Get 1800 with 1/2 chance Lose 1000 with 1/2 chance	Get 0
5	Get 1800 with 1/2 chance Lose 1200 with 1/2 chance	Get 0
6	Get 1800 with 1/2 chance Lose 1400 with 1/2 chance	Get 0
7	Get 1800 with 1/2 chance Lose 1600 with 1/2 chance	Get 0
8	Get 1800 with 1/2 chance Lose 1800 with 1/2 chance	Get 0
9	Get 1800 with 1/2 chance Lose 2000 with 1/2 chance	Get 0
10	Get 1800 with 1/2 chance Lose 2200 with 1/2 chance	Get 0

Table 8: Interpretations of the Number of Option A's in Risk-Aversion Test

Number of Option A choices	Range of relative risk-aversion for $U(x) = x^{1-r}/1-r$	Preference classification
0,1	r < -0.95	highly risk loving
2	-0.95 < r <-0.49	very risk loving
3	-0.49 < r <-0.15	risk loving
4	-0.15 < r <0.15	risk neutral
5	0.15 < r <0.41	slightly risk averse
6	0.41 < r <0.68	risk averse
7	0.68 < r <0.97	very risk averse
8	0.97 < r <1.37	highly risk averse
9,10	1.37 < r	extremely risk averse

Table 9: Interpretations of the Number of Option B's in Loss-Aversion Test Assuming Risk-Neutrality

Number of Option B choices	Range of loss-aversion for $u(x\|r) \equiv x + \lambda(x-p)$ when $x < p$	Preference classification
0,1,2	$\lambda \leq 1$	loss seeking
3	1 < λ <1.12	almost loss neutral
4	1.12 < λ <1.25	somewhat loss averse
5	1.25 < λ <1.40	fairly loss averse
6	1.40 < λ <1.57	rather loss averse
7	1.57 < λ <1.77	loss averse
8	1.77 < λ <2.00	quite loss averse
9	2.00 < λ <2.27	very loss averse
10	2.27 < λ	extremely loss averse

Table 10: Elicitation of Willingness of an Agent to Participate in the Lottery

	Option A		Option B
1	Pay 1000 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
2	Pay 1200 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
3	Pay 1400 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
4	Pay 1600 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
5	Pay 1800 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
6	Pay 2000 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
7	Pay 2200 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
8	Pay 2400 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
9	Pay 2600 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0
10	Pay 2800 and	with 1/2 chance get 3000 with 1/2 chance get 1000	Get 0