Peer Effect and Risk Aversion

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Abstract

This paper examines the impact of peer effect on risk aversion using experimental economics methodology at the Experimental and Behavioral Economics Laboratory at the University of California, Santa Barbara. Data on the risk preference of individuals were collected through eliciting risk behaviors with the Holt-Laury measurement. Comparing distributions of the risk preference among different groups of subjects with or without observing others' risk behaviors, I find no significant peer effect on risk aversion. Similarly, there is no observed gender difference in the peer effect on risk aversion. Distinct from existing literature, my findings provide innovative insights for financial institutions such as investment banking and stock brokers to study the risk attitude of their investors and clients.

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1 Introduction

In economics and finance, risk aversion is the behavior of humans (especially consumers and investors), who, when exposed to uncertainty, attempt to lower that uncertainty (Simpson 2013). Risk aversion varies with individuals and their environment. Existing literature shows that genetics explains only 20% of the cross sectional variation in risk aversion (Cesarini et al. 2008, 2009). Therefore, risk aversion is strongly determined by environmental forces (Ahern et al. 2014). As peer effect plays a distinctive role in the financial market and economic outcomes, including stock market activity (Hong, Kubik, and Stein 2004,2005; Ivković and Weisbenner 2007; Brown et al. 2008), retirement and planning, and entrepreneurship (Lerner and Malmendier 2013), researchers are intrigued to explore its impact on human risk attitude. Studying longitudinal survey of MBA students at the University of Michigan, Ahern found strong evidence of positive peer effects on risk aversion. In specific, after the first year of the MBA program, the difference between an individual and her peers' average risk aversion has shrunk by 41% (Ahern et al. 2014).

In this study, I conducted multi-session experiment at the UCSB Experimental and Behavioral Economics Laboratory (EBEL) to obtain the risk preferences of subjects either before or after perceiving the risk behaviors of their peers. I used the Holt-Laury measurement as an incentive to elicit risk behaviors. I found no significant peer effect on risk aversion. In addition, no observed gender peer effect on risk aversion was identified.

This paper addresses the peer effect on risk aversion through the experimental methodology. Distinct from existing literature which tends to identify peer effects from social interactions, the experiment in this study does not involve interactions at the individual level. Rather, it examines peer effect in an aggregate context. In specific, participants were given information on the risk behaviors of a random sample drawn from the population. The minimal interactions among the subjects of the experiment and one-time risk behavior of each participant differentiate this project from the previous literature.

The remainder of this paper is organized as follows. I discuss the Holt-Laury measurement - the risk incentive for this project in Section 2 along with its corresponding model for risk aversion. The experimental design is contained in Section 3, followed by the experiment outcomes and results in Section 4. In Section 5, I present the analytical framework of the risk aversion distributions and conclude that there is no detectable "shift" in the risk aversion distribution after two independent treatments were implemented.

2 Measurement of Risk Aversion

Among all measurements of risk aversion in the previous literature, one of the most convincing methods is proposed by Charles A. Holt and Susan K. Laury. The Holt-Laury measurement provides a robust estimation of the risk aversion level by eliciting risk behaviors based on a specific lottery system. The system consists of ten different pairs of options: Option A and Option B. Option A starts with lower risk and converges to Option B in risk sense. Since the expected payoff is closest to zero at the fourth option, a risk neutral person would choose Option A four times before switching to Option B. As the payoff for Option B is strictly greater at the tenth option, even the most risk-averse people would switch to Option B by the last option.

Option A	Option B	Expected payoff difference
1/10 of $2.00, 9/10 of $1.60	1/10 of $3.85, 9/10 of $0.10	$1.17
2/10 of $2.00, 8/10 of $1.60	2/10 of $3.85, 8/10 of $0.10	$0.83
3/10 of $2.00, 7/10 of $1.60	3/10 of $3.85, 7/10 of $0.10	$0.50
4/10 of $2.00, 6/10 of $1.60	4/10 of $3.85, 6/10 of $0.10	$0.16
5/10 of $2.00, 5/10 of $1.60	5/10 of $3.85, 5/10 of $0.10	−$0.18
6/10 of $2.00, 4/10 of $1.60	6/10 of $3.85, 4/10 of $0.10	−$0.51
7/10 of $2.00, 3/10 of $1.60	7/10 of $3.85, 3/10 of $0.10	−$0.85
8/10 of $2.00, 2/10 of $1.60	8/10 of $3.85, 2/10 of $0.10	−$1.18
9/10 of $2.00, 1/10 of $1.60	9/10 of $3.85, 1/10 of $0.10	−$1.52
10/10 of $2.00, 0/10 of $1.60	10/10 of $3.85, 0/10 of $0.10	−$1.85

Table 1: Holt-Laury measurement (1)

Supposing an agent has consistent risk preference, we can obtain her risk aversion (r) from the empirical model of the Holt Laury measurement. Particularly, the model is derived from a generic utility function:

$$u(x) = x^{1-r}$$

Besides, Holt-Laury measurement provides the distribution of risk aversion in the table below:

Number of safe choices	Range of relative risk aversion for $U(x) = x^{1-r}/(1-r)$	Risk 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	$1.37 < r$	stay in bed

Table 1: Holt-Laury measurement (2)

The measurement contains 9 classifications of risk preferences in total. Each classification provides a different interval of the risk aversion r. In particular, people are considered “risk loving” when their r have negative values and “risk averse” when their r have positive values. Additionally, the level of risk aversion is positively correlated with r. When r falls into the interval between -0.15 and 0.15, the person is risk neutral.

3 Experimental Design

3.1 Primary Assumptions

The design of the experiment is based on two major assumptions:

1. Law of Large Numbers: randomly selected samples from a population have independent and identical distribution of risk aversion;

2. Rationality in Economic Behavior: People make rational choice in the laboratory environment the same way as they do in the real-life context and have no special reasons to suppress their true willingness.

3.2 Experiment Design

The experiment utilizes Holt-Laury measurement of risk aversion as an incentive to elicit risk behaviors from the experimental subjects. The design of the experiment consists of a control treatment and two actual treatments. The actual treatments were implemented to examine the overall peer effect and the gender peer effect, respectively.

Control Treatment:
49 participants were randomly selected from the UCSB economics laboratory research subject pool. Participants were informed of a minimum $3 show-up payment at the beginning of the experiment, regardless of their choices during the experiment. Next, participants were provided instructions on making investment according to the lotteries of the Holt-Laury measurement. The 10 lotteries were presented collectively on the same page of an online survey on the computer terminals. At the end of the survey, demographic information including gender, race, whether the subject is pursuing a quantitative field of study, and the level of investment experience was collected for analysis. Generally, the control treatment is used to obtain an overall risk aversion distribution from the population. It serves as a baseline and reference group for the following two actual treatments.

Treatment 1:
Another group of 41 participants were randomly selected from the UCSB economics laboratory research subject pool. Both the risk incentive and the payment structure are the same as the control treatment. However, prior making their selections, subjects were given information on the most common choice of the control treatment. Particularly, the following statement was provided in the instructions as well as the online survey:

FYI: We have already conducted sessions in which participants made choices like the ones you face today. **Most of the previous participants selected A in the first four investment choices and then selected B in the following six investment choices.**

At the end of the survey, demographic information including gender, race, whether the subject is pursuing a quantitative field of study, and level of investment experience was collected for analysis.

The first treatment is implemented to determine whether there is a peer effect on overall risk aversion of the population. I hypothesized that observing risk behaviors from peers will shift the risk aversion of individuals towards their peers. The statement on the most common behaviors of the previous group implies the most common risk preference among the population. If peer effect exists, the risk aversion distribution from the treatment group will become more concentrated around the mode.

Treatment 2:

Another group of 39 participants, consisting of 17 males and 22 females, are randomly selected from the UCSB economics laboratory research subject pool. Both the risk incentive and the payment structure are the same as the previous two groups. However, prior making their selections, subjects were given information on the difference between male and female choices from the control treatment. Specifically, the following statement was provided in the instructions as well as the online survey:

FYI: We have already conducted sessions in which participants made choices like the ones you face today. **In the past sessions, women tend to select Option A more than men do.**

At the end of the survey, demographic information including gender, race, whether the subject is pursuing a quantitative field of study, and level of investment experience was collected for analysis.

The second treatment is implemented to determine whether there is a gender peer effect on risk aversion. In specific, I am interested in finding how individuals of different sex respond to the gender difference in the risk aversion. It is the common belief that women tend to be more risk averse more male. Providing a statement on this phenomenon, I hypothesized that women in the treatment group will behave in a more risk averse manner while male in a more risk-loving manner.

3.3 Payment to Subjects

The payment to subjects comprises a fixed as well as a variable component. There is a minimum show-up payment of $3 which is guaranteed to the participants. The remainder of the payment varies partly based on individual decisions and partly based on luck. The structure of the variable payment follows the real return of the Holt-Laury measurement. The number of sessions that we conducted for the three treatments are 3, 2, 2, respectively. For each session, we randomly selected one option from ten for all participants. Next, we conducted another randomization for each subject to determine whether s/he will receive the lower or the higher payoff from the Holt-Laury measurement. For instance, in the first session of the control treatment, we randomly selected lottery 6 to pay all subjects. For someone who selected option B, we carried out a randomization with the predetermined probability of 60% versus 40%. As the event of 60% chance happened, the subject received a variable payment of $3.85 and a total payment of $6.85. With this payment structure, there are only four possible payment amount, which are $6.00, $4.60, $6.85, and $3.1. Of all seven sessions that we ran on a total of 129 subjects, the average earnings for each subject is $5.25.

4 Outcomes and Results

Control Treatment:

The baseline group consists of a total observation of 49 students from the University of California, Santa Barbara, among whom 33 (67%) are female subjects and 16 (33%) are male subjects. 27% of the subjects claimed that they had previous investment experience and 73% claimed that they did not. Besides, 31% of the subjects are majoring in a quantitative field.

The number of subjects selecting Option A and Option B at each question is shown in the barplot below.

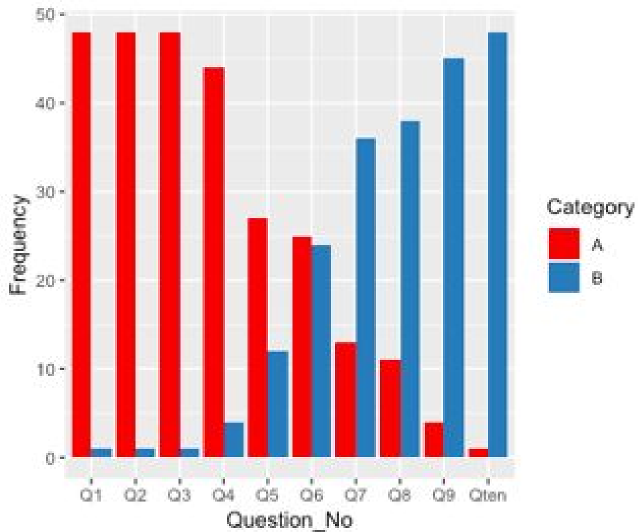

Figure 1: Distribution of choices - Control Treatment

Among the 49 subjects in the control group, most of them made consistent choices across the ten lotteries. In other words, most participants started with selecting Option A at lottery 1 and switched solely once from Option A to Option B during the experiment. Only 7 people (lower than 15%) switched between Option A and Option B more than once. This proportion is lower than the result from the Holt-Laury study (fewer than one-fourth), suggesting that most subjects have consistent risk preferences and made rational choices during the experimental process. For subjects who made inconsistent choices, their risk aversion levels are seemingly ambiguous. However, I kept all observations but applied a wider interval to measure the risk aversion of people who made multiple switches. For instance, for one female subject who switched from Option A to B at lottery 5 and switched back to Option A for the following two lottery, and again switched to Option B at lottery 8, I consider her risk preference ranges from risk neutral to very risk averse, where r lies in an interval of -0.15 to 0.97.

Using the Holt-Laury measurement, I obtained a risk aversion distribution of the control treatment, which represents the distribution of the population. I utilized the mean of each risk aversion interval for analysis. For instance, the risk aversion r for risk neutral individuals has an interval of (-0.15, 0.15).

Thus, I used the mean 0 as the risk aversion for all subjects who are in this classification. The median of switch from Option A to Option B is at lottery 6, suggesting the risk preferences for half of the sample range from "highly risk loving" to "slightly risk averse" and the other half from "slightly risk averse" to "stay in bed". The mode of switch from Option A to Option B is at lottery 5, indicating the most common risk preference of the sample is risk neutral. Among the control group, the risk aversion of 72% subjects ranges from "risk neutral" to "risk averse", denoting that there are relatively more risk averse individuals compared to risk loving individuals in the population.

In addition, I compared the risk aversion of male and female subjects by obtaining the proportion of subjects selecting Option A and Option B at each lottery. From option 5 to option 9, the proportion of males selecting Option B (the riskier option) is greater than female. While for the remaining 5 options, the proportion of females selecting Option B is greater. The proportion difference at each lottery between male and female is inconsiderable. Besides, I also obtained the total percentage of Option B selected by each gender. Surprisingly, the percentage for males is merely 1% greater than the percentage for females. Contradictory to common belief, the result suggests that males are not much more risk averse than females. Similar outcomes also appear in the following two treatment groups.

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Male	0	0	0	0.0625	0.5	0.5625	0.75	0.8125	0.9375	0.9375
Female	0.0303	0.0303	0.0303	0.0909	0.394	0.4545	0.7272	0.7576	0.9091	1

Table 2: Proportion of riskier option chosen by male and female

Treatment 1:

In Treatment 1, I obtained the risk aversion distribution of 41 newly drawn subjects from the UCSB economics laboratory research subject pool. Given information on where most previous subjects switched from Option A to Option B, subjects in Treatment 1 made significantly more consistent choices. Only 3 out of the 41 subjects switched between Option A and Option B over once. This leads to a significant drop in the percentage of inconsistent choices from 14% to 7%. In addition, both the median and the mode of switch from Treatment 1 are identical to the Control Treatment. The distributions of risk preference from the Control Treatment, Treatment 1, as well as the Holt-Laury study are presented in the table below.

	Proportion of choices		
risk preference classification	**Holt-Laury**	**Control Treatment**	**Treatment 1**
highly risk loving	0.01	0.02	0
very risk loving	0.01	0	0.05
risk loving	0.06	0.02	0.05
risk neutral	0.26	0.31	0.245
slightly risk averse	0.26	0.205	0.22
risk averse	0.23	0.205	0.245
very risk averse	0.13	0.06	0.1
highly risk averse	0.03	0.14	0.02
stay in bed	0.01	0.04	0.07

Table 3: risk preference proportion distribution

Treatment 2:

In Treatment 2, I obtained a sample of 39 observations, of which 17 are male and 22 are female. Since the statement that we provided on gender risk behaviors has no implications about the consistency of choices, 8 subjects switched between Option A and Option B more than once. The 8 subjects, comprising 5 females and 3 males, result in a 20.5% inconsistency of choices. Analyzing inconsistent choices from all three treatments, I find that most inconsistent choices were made by female subjects who are majoring in a non-quantitative field. However, there is no evident correlation between inconsistent choices and race or previous investment experience.

5 Empirical Analysis

Treatment 1:

To compare the risk preference distributions from Control Treatment and Treatment 1, I conducted a Kolmogorov-Smirnov test (ks-test) for the cumulative distribution, a t-test for the sample mean, and an F-test for the sample variance. In order to verify the result from the t-test, I also conducted a permutation test at a level of 10,000 simulations.

The ks-test is utilized to compare the cumulative distributions of risk aversion r from both samples. The null hypothesis for the test is that the two samples are from the same population. As the ks-test in the statistical softwares is problematic with identical values which are referred to "ties", I generated random values from each risk aversion interval to carry out the test. I obtained a test statistic D of 0.12 and a p-value of 0.89, both of which are highly insignificant. Examining the graph of the cumulative distribution from two samples, I find the distribution of Treatment 1 (marked in red) is greatly overlapping with the distribution of Control Treatment (marked in black) , especially around the center of the distribution.

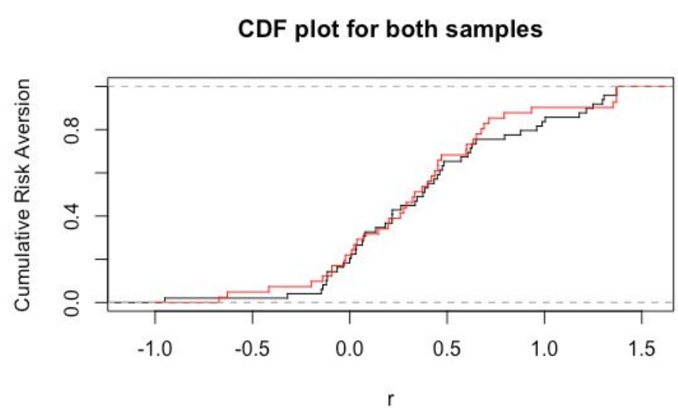

Figure 2: Cumulative Distributions of r for Control Treatment and Treatment1

The difference in the mean of risk aversion r from the control group and the treatment group is 0.06. To determine whether this difference is significant, I conducted a two-sided t-test. The p-value of this test is 0.54, which is also insignificant. In order to verify this result, I conducted a permutation test to shuffle the observations in the control and treatment group and resampled them. The p-value at 10,000 simulations is 0.55, which is essentially the same as the p-value of the t-test. Besides, from the histogram of the permutation test, the difference in the sample means (0.06) is within all conventional confidence intervals.

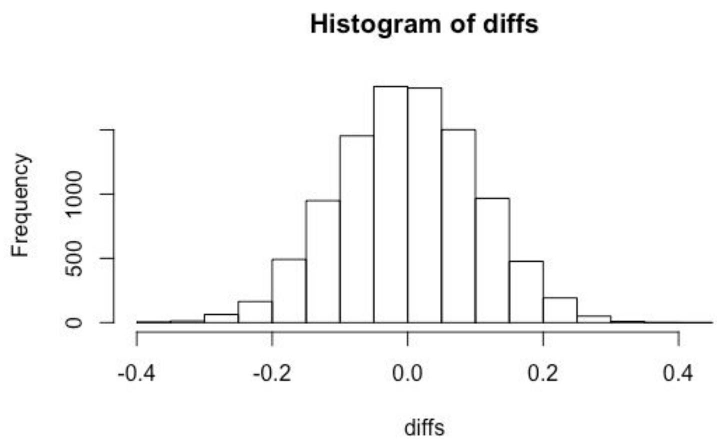

Figure 3: difference of sample means in the permutation test

If peer effect exists, the variance of risk aversion would be smaller for the treatment group than the control group, as subjects in the treatment group converge to their peers in risk preferences. In reality, the variance of r for the treatment group is 0.2383 and for the control group is 0.2428. The slightly smaller variance of the treatment group suggests peer effect may play a role. In determining whether the decrease in the variance is significant, I conducted a F-test to compare the variances from Treatment 1 and the control group. As the ratio of variances (F-statistic) is 1.019, which is highly close to one, it is plausible to conclude that the treatment and the control group demonstrate equal variance in the risk aversion distribution.

The summary statistics from all four hypothesis tests are displaced in the following table:

	ks-test	F-test	t-test	Permutation test (n=10,000)
	Cumulative Distribution	Sample Variance	Sample Mean	Sample Mean
Test statistic	0.123	1.019	0.608	—
p-value	0.8885	0.9581	0.5448	0.5508

Table 4: test statistics - Treatment 1

Treatment 2:
In the second treatment, the participants were notified that in the previous sessions, women tended to choose Option A more than men do before making their investment. The statement implies that women are more risk averse, and thus, are more likely to select the less riskier choices. Though the data collected in the control group show that male participants only select about 1% more Option B than female participants, I would like to see how such a statement would affect the risk aversion of male and female subjects distinctively.

Alike the first treatment, I conducted a ks-test, F-test, t-test, as well as a permutation test to compare the sampling distributions of the treatment and the control group. In particular, I compared the risk aversion distributions of each gender before and after the treatment separately. Results from all tests suggest that there is no detectable difference in the risk aversion distributions before and after the treatment. Knowing their female peers are more risk averse, the female participants in the treatment group did not demonstrate a greater risk aversion than the female participants in the control group. Similarly, being aware of that female peers are less likely to take risks than themselves, male participants did not become bolder at risk taking as anticipated. Instead, each gender sticks with their risk aversion before observing the risk aversion of their peers.
The summary statistics from hypothesis tests are displaced in the following tables:

	ks-test	F-test	t-test
	(cumulative distribution)	(sample variance)	(sample mean)
	Female Ctrl vs Female Trt	**Female Ctrl vs Female Trt**	**Female Ctrl vs Female Trt**
test statistic	0.227	1.289	1.102
p-value	0.4603	0.5496	0.2760
	Male Ctrl vs Male Trt	**Male Ctrl vs Male Trt**	**Male Ctrl vs Male Trt**
test statistic	0.283	0.557	-0.091
p-value	0.4092	0.2643	0.9284

Table 5: test statistics - Treatment 2 (1)

One interesting result arises when I compared the variance of risk aversion in female over male in the treatment group. Conducting F-test on the variances, I obtained an F-statistic of 0.421 and a p-value of 0.065. This p-value is fairly close to the significance level of 0.05. This somewhat significant result indicates that after observing the risk behaviors of the other gender, the variance in the female risk aversion distribution becomes smaller. Conversely the variance in the male risk aversion distribution becomes larger. Therefore, the statement has an opposite impact on female and male subjects. Especially, it makes risk loving males more risk loving and risk averse males more risk averse. However, the treatment makes risk aversion distribution or females converge to its mean.

	F-test (variance)
	Female Trt vs Male Trt
test statistic	0.421
p-value	0.0650

Table 6: test statistics - Treatment 2 (2)

6 Conclusion

Employing experimental method and the Holt-Laury measurement, I find no significant peer effect on risk aversion with subjects from the UCSB economics research subject pool. In similarity, there is no significant indication of gender peer effect on risk aversion. This finding is distinct from existing literature which identified strong evidence of peer effect on risk aversion. The contrasting result may stem from the difference in the experimental designs. Previous research recognizes peer effect through social interactions, while this project only provides subjects with information on risk behaviors of peers, rather than induce social interactions. It is highly probable that the true peer effect develops from, especially, long-term social interactions. As people may not recognize those who are not familiar as their "peers", they will not regard the reasoning behind others' choice as preferable and worthy of following. Therefore, for financial institutions who would like to provide information to impact the choice of their investors, an aggregate result from the general public might not be influential.

Appendices

Appendix 1 - Instructions

Welcome

You are about to participate in a session on decision-making, and you will be paid for your participation with cash, privately at the end of the session. What you earn depends partly on your decisions and partly on chance. Please turn off mobile phones now. The entire session will take place through computer terminals. Please do not talk or in any way try to communicate with other participants during the session.

We start with a brief instruction period. During the instruction period you will be given a description of the main features of the experiment and will be shown how to use the computers. If you have any questions, feel free to ask after we finish reading the instructions.

The experiment will last about 15 minutes. You will receive a $3 show-up fee which is yours to keep. If you follow the instruction properly, you are guaranteed to earn more from the experiment. Your total dollar earnings will equal $3 show-up fee + money earned based on your own choices. As long as you follow the instructions, the earnings based on your choices are always positive.

Instructions

You will make 10 investment decisions. Each investment decision consists of a choice between one of two lotteries. To illustrate, consider a choice between Option A and Option B in the table below. We refer to a choice between these two options as an investment decision.

Option A You will receive	**Option B** You will receive
$2 with chances 50/100; $1.6 with chances 50/100	$2 with chances 50/100; $1.6 with chances 50/100

If you choose Option A, then your payoff will be $2 with chances 50/100 and $1.6 with chances 50/100. If you choose Option B, then your payoff will be $3.85 with chances 50/100 and $0.1 with chances 50/100.

You will actually observe a screen with 10 investment decisions. Each investment decision contains a choice between Option A and Option B. For each of the 10 investment decisions, you have to choose whether you prefer the lottery described in Option A or the lottery described in Option B. Only one option can be selected for each investment decision, and you can change your selection as many times as you would like before clicking the "→" button at the bottom of the page.

For payment, one of the 10 investment decisions will be selected. All investment decisions have an equal chance of being selected. Your earnings at the end of the experiment will be $3 + earnings from your randomly selected investment decision. Any questions?

Appendix 2 - Survey

For Q1 to Q10, you will make 10 investment decisions. Each investment decision consists of a choice between Option A and Option B. You should only select <u>one</u> option that you prefer for each investment decision, but you can change your selection as many times as you would like before clicking the "-->" button at the bottom of the page.

Q1 Which of the following portfolio would you like to invest in?

o A : 10% chance of earning $2 and 90% chance of earning $1.6

o B: 10% chance of earning $3.85 and 90% chance of earning $0.10

Q2 Which of the following portfolio would you like to invest in?

o A : 20% chance of earning $2 and 80% chance of earning $1.6

o B: 20% chance of earning $3.85 and 80% chance of earning $0.10

Q3 Which of the following portfolio would you like to invest in?

o A : 30% chance of earning $2 and 70% chance of earning $1.6

o B: 30% chance of earning $3.85 and 70% chance of earning $0.10

Q4 Which of the following portfolio would you like to invest in?

o A : 40% chance of earning $2 and 60% chance of earning $1.6

o B : 40% chance of earning $3.85 and 60% chance of earning $0.10

Q5 Which of the following portfolio would you like to invest in?

o A : 50% chance of earning $2 and 50% chance of earning $1.6

o B : 50% chance of earning $3.85 and 50% chance of earning $0.10

Q6 Which of the following portfolio would you like to invest in?

o A : 60% chance of earning \$2 and 40% chance of earning \$1.6

o B : 60% chance of earning \$3.85 and 40% chance of earning \$0.10

Q7 Which of the following portfolio would you like to invest in?

o A : 70% chance of earning \$2 and 30% chance of earning \$1.6

o B : 70% chance of earning \$3.85 and 30% chance of earning \$0.10

Q8 Which of the following portfolio would you like to invest in?

o A : 80% chance of earning \$2 and 20% chance of earning \$1.6

o B : 80% chance of earning \$3.85 and 20% chance of earning \$0.10

Q9 Which of the following portfolio would you like to invest in?

o A : 90% chance of earning \$2 and 10% chance of earning \$1.6

o B : 90% chance of earning \$3.85 and 10% chance of earning \$0.10

Q10 Which of the following portfolio would you like to invest in?

o A : 100% chance of earning \$2 and no chance of earning \$1.6

o B : 100% chance of earning \$3.85 and no chance of earning \$0.10

Page Break

Q11 What is your gender?

o Male

o Female

Q12 What's your ethnicity?

o Hispanic or Latino

o White

o Asian

o Black

o Others

Q13 Are you pursuing a major in the quantitative field?

o Yes

o No

Q14 What's your experience level with investment?

o No experience

o Intermediate

o Highly experienced

Q15 What is your experiment ID number?

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