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Exposure to Risk and Risk Aversion: A Laboratory Experiment

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8 April 2014

EGC Report No: 2014/03

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April 2014

Abstract: We examine whether prior exposure to environments with a varying degree of risk affects individuals' risk-taking behavior. Using a laboratory experiment, we find that subjects exposed to a high risk environment exhibit higher levels of risk aversion than those who were exposed to a moderate or low risk environment. This effect is not driven by subjects' realized outcomes from the risk. The finding has implications for theoretical models of decision-making under uncertainty, and can speak to a few current policy debates.

Key Words: Risk; Risk Aversion; Laboratory Experiment
JEL Classification: D81, C91

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I. Introduction

In American writer Jack London's (1907) short story "Love of Life", a man named Jack set off into the wilderness alone. After he was rescued from coldness, starvation, and the threat of beasts, the man became extremely concerned about the storage of food:

> *He was haunted by a fear that the food would not last. He inquired of the cook, the cabin-boy, the captain, concerning the food stores. They reassured him countless times; but he could not believe them, and pried cunningly about the lazarette to see with his own eyes…. The scientific men were discreet. They let him alone. But they privily examined his bunk. It was lined with hardtack; the mattress was stuffed with hardtack; every nook and cranny was filled with hardtack. Yet he was sane. He was taking precautions against another possible famine - that was all.*

This anecdote in the short story showcases a change in risk attitude of an individual after experiencing a very risky environment. Traditional economic models on risk and uncertainty typically assume the stability of risk preferences and focus on characterizing (or axiomizing) "stable risk preferences". However, an equally plausible and important question is: How do natural, social and economic environments shape risk preferences? This question is not only of academic interest but can also provide insights into important policy issues. For instance, the state of welfare in many European nations significantly changes their risk environments. Through various social transfers, these societies create safety nets for its citizens. To what capacity do these welfare state policies affect people's risk attitude? Meanwhile, much attention has been drawn to the only child effect in Chinese families as a result of the "one child policy" implemented since late 1970s in China. People worry that these "spoiled little emperors/empresses" may behave differently after they grow up, as they were nurtured in an overly protective, sometimes risk-free environments (e.g. Fong, 2004).

A number of recent studies have investigated different aspects on how prior experiences in different environments influence individuals' risk preferences. Thaler and Johnson (1990) and Post et al. (2008) focus on the effect of experiencing realized lottery outcomes and they both find that individuals become more risk averse once they undergo negative outcomes but less risk-averse after positive ones. Malmendier and Nagel (2011) examine whether individuals' past experiences of macroeconomic shocks affect their risk attitude. They find that those who have experienced low stock-market returns throughout their lives either become less likely to participate in the stock market or invest a lower fraction of their liquid assets in stocks. Using financial professionals as experimental subjects, Cohn et al. (2013) find that financial professionals are more risk averse when primed with a financial bust than those primed with a boom, suggesting their past experiences and particular priming may play a role in determining their perception of risk during the experiment. Mengel, Tsakas and Vostroknutov (2012) find that past experiences in an environment with imperfect knowledge of state space make subjects more risk averse. Recent studies have started to explore how past traumatic life experiences, including violence (Callen et al., forthcoming), combats (Bogan et al., 2013), conflict (Voors et al., 2012) and natural disasters (Eckel et al., 2009), affect an individual's risk attitude. These studies suggest that the experiences may bias an individual's decision-making under uncertainty.

However, when examining the effect of an individual's past exposure to risky environments on his or her risk preferences, a potential confound could arise because past experiences include both personal outcomes which reflect the idiosyncratic realizations of risk, and the risky environment *per se* the individuals were exposed to. While previous studies, as mentioned above, have investigated how past experiences influence individuals' risk preferences, the effect of the exposure to certain environment with risk or uncertainty is inherently entangled with the effect of particular realizations of risk or uncertainty.[2] Little is known on the effect the environment itself has on an individual's propensity for risk.[3] This paper investigates the effect of previous exposure to risky environments on subsequent risk taking behavior in a well-controlled experiment. Subjects are first exposed to lotteries with varying degrees of risk --high, moderate, and low. Then all the subjects are asked to make decisions on an identical set of lotteries. To eliminate the effect of positive or

[2] For instance, in the experiment of Mengel, Tsakas and Vostroknutov (2012), the realized outcomes are revealed to subjects before they proceed to next round's decision-making.
[3]Besides, Mengel, Tsakas and Vostroknutov (2012) argue that for those field studies demonstrating the link between macroeconomic shocks or financial crises and risk taking behavior, it is difficult to establish whether such effects are due to an increase in risk aversion or to updated priors or other reasons.

negative outcomes, no information regarding the realization of lotteries is revealed until the end of the experiment.

Research in economics and psychology points to two opposite directions. On the one hand, subjects who are first exposed to high (low) risk lotteries may become used to the high (low) volatility and thus become less (more) risk averse than those who were exposed to moderately risky lotteries. On this subject, Cameron et al. (2013) document that those who are the only child in a family are more risk-averse than those who are not. This suggests that the safe environment an only child is exposed to could contribute to his or her unwillingness to take risk. Nguyen (2011) combines administrative and experimental data in Vietnam finding that fishermen, who are presumably exposed to a risky work environment, appear less risk averse than those with other occupations. On the other hand, previous discomfort (e.g. stress, fear) that arose from exposure to a high risk environment may make individuals exhibit more risk averse behavior in later decision-making situations. Callen et al (2014) document that individuals who experienced violence exhibit a preference for certainty when primed with fearful recollections. The above studies indicate a possible link between prior experience in risky environments and future risk attitude. However, not only are the results rather mixed, but we still lack a systematic investigation on how individuals' risk preferences are influenced by their prior risk environments. Furthermore, we also lack results that exclude the compounding effect from previous personal outcomes. This paper reports experiments that fill this gap of information. Subjects are exposed to controlled environments varying in risk; then their reactions to an identical set of lotteries are compared to identify the casual link between prior risky environments and current risk attitude.

We found that previous exposure to a low risk environment did not affect subsequent risk taking behavior. However, subjects exposed to a high risk environment exhibited higher degrees of risk aversion than those exposed to a moderate risk environment. We explain these results from both psychological and evolutionary perspectives and discuss its theoretical, empirical and policy implications.

The rest of this paper is organized as follows: Section 2 describes our experimental design and procedures. Section 3 presents and discusses our empirical results. Section 4 concludes with a discussion on theoretical and policy implications.

II. Experimental Design and Procedures

All subjects participate in the main experiment for a total of 12 rounds. We employ the multiple price list method developed by Holt and Laury (2002). In each round, subjects are presented with a menu of 13 choices (rows) between a lottery (option Left) and a sure outcome (option Right), as shown in Figure 1. (Figures and tables are relegated to Appendix I.) Options Left differ across rounds; within one round, Option Left is kept fixed while Options Right differ across rows.

To examine through experiment how an individual's attitude towards risk reacts to changes in risk environment, the experiment is composed of three treatments: HM, LM and control treatment MM. Each treatment consists of two sets of lotteries. In the first 6 rounds, subjects in treatment HM, LM, and MM are exposed to a set of 6 lotteries with high risk (set H), low risk (set L), and moderate risk (set M), respectively, with one lottery in each round. In the last 6 rounds, subjects in all treatments are exposed to the set of 6 lotteries with moderate risk, set M. Since these lotteries are the same across all treatments in the second half of the experiment, we can make between-subject comparison. This will determine whether prior exposure to high or low risk lotteries has an effect on subsequent risk taking behavior, when compared with prior exposure to moderately risky lotteries.

In each lottery, the subject will obtain x experimental tokens with half probability and obtain $400-x$ tokens with half probability. Specifically, the 6 lotteries' outcomes are (400, 0), (395, 5), (390, 10), (385, 15), (380, 20), and (375, 25) respectively in set H, (310, 90), (305, 95), (300, 100), (295, 105), (290, 110), and (285, 115) respectively in set M, and (230, 170), (225, 175), (220, 180), (215, 185), (210, 190), and (205, 195) respectively in set L. Note that all lotteries have an equal mean of 200 with 50% probability receiving the better outcome (x) and 50% probability receiving the worse outcome ($400-x$). We use the balanced Latin square technique to counterbalance potential order effect.[4] In addition, subjects were presented with lotteries algebraically without any specified values in the instructions to avoid possible expectation effect. (See the experimental instruction in Appendix II for details.)

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[4] Balanced Latin square is a partial counterbalancing technique which assures that every condition of the study occurs equally often in every sequential position.

In a round, the subject chose between the lottery and a sure outcome in 13 rows. In row i, if the sure outcome is chosen, the subject receives z_i tokens, for any $i \in \{1,2,\dots,13\}$. Given x, the better outcome of the lottery in the round, the following equation shows how the values of $z_i's$ are determined.

$$z_i = \begin{cases} 400 - x + \dfrac{200 - (400 - x)}{10} \cdot i, & if\ i \leq 10 \\ 200 + \dfrac{(x - 200)}{5} \cdot (i - 10), & if i > 10 \end{cases}$$

Therefore, $z_i's$ are listed in an ascending order, with $z_i \leq (\geq) 200$ for $i \leq (\geq) 10$.[5] As a result, a risk neutral individual would choose the lottery in rounds 1-9 and choose the sure outcomes in rounds 11-13, and indifferent in round 10; risk averse individuals would switch to sure outcomes earlier than risk neutral agents.

A total of 103 undergraduate students at Nanyang Technological University, Singapore participated in the experiment in November and December of 2013. 30 participated in the HM treatment; 35 participated in the LM treatment and 38 participated in the MM treatment. No subject participated in the experiment more than once. Each session lasted for roughly 30-35 minutes and proceeded as follows: once subjects arrived at the computer lab, they were brought into a randomly assigned seat. After all subjects signed the consent form, they were given computerized instructions while the experimenter read them aloud. Then, the main experiment began. A post-experiment questionnaire was given to collect information on demographic characteristics. The outcomes of the lotteries chosen by the subject were not realized and disclosed to the subject until the end of the experiment. At the end of the experiment, subjects were paid by one randomly chosen round, at the exchange rate of 200 experimental tokens equal to one Singapore dollar (S$1).[6] The average monetary earning was S$16.36 including the guaranteed S$3 participation fee. The experiment was programmed using Z-tree (Fischbacher, 2007).

III. Experimental Results

For each round, if he or she prefers receiving a sure outcome z_i to the lottery, a rational player should also prefer receiving any other sure outcome $z_j > z_i$ to the

[5] For instance, given x=210, the $z_i's$ are 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 202, 204, 206 respectively.

[6] Laury (2006) shows that whether to pay all decisions in the round or to randomly pay one decision in the round does not make a difference. We adopt the former way of payment for the randomly selected round. S$1 was equivalent to about US$0.8 at the time of experiment.

lottery. Therefore, for a round, any rational choices would exhibit a pattern like (*Left*, …, *Left*, *Right*, …, *Right*), where *Left* indicates that the player chooses the lottery (option Left) while *Right* indicates that the player chooses the sure outcome (option Right). In other words, the choice of *Left* will not reappear after the first occurrence of *Right*. We define a variable *Rational* which equals zero if the subject's choices violate this property in the round, and one otherwise. Overall, about 92.15% of the observations are considered "rational".[7]

In the three treatments, the subjects experience all six lotteries with moderate risk (set M), in the second half of the session. We will focus on the choices under these common lotteries in our analysis. Given rational choices, the number of "*Left*s" (i.e., the risky choices) chosen by the player in one round indicates the (relative) risk attitude of the player. The more *Left*s chosen, the less risk averse the player is. Figure 2 reports the average numbers of *Left*s chosen in each lottery during the second half of the session by treatment. Figure 2(a) includes "rational" observations only while Figure 2(b) includes all observations. Whether we exclude "non-rational" choices or not, the average numbers of *Left*s chosen under the HM treatment are lower than those under the MM and LM treatments. The difference is statistically significant using the Mann-Whitney tests. Given rational choices, the average number of *Left*s chosen in a round, across the lotteries, is 7.08 in the HM group, 8.14 in the MM group and 7.93 in the LM group. Using the Mann-Whitney test, the differences are statistically significant between the HM and MM groups (p values<0.001) and between the HM and LM groups (p values<0.001) whereas the difference between the MM and LM groups is statistically insignificant. The above results show that, after experiencing highly risky environments (the HM group), subjects become less likely to choose risky options compared to those who experienced moderate risk or low risk environments. Note that the results are free from the effects of the realization of lottery outcomes, as subjects do not observe the realized outcomes until the end of the experiment.

The above results still hold true when we partition the whole dataset by lottery without pooling them, for rational choices or all choices. In two of the six lotteries (with x equal to 310 or 315), the numbers of *Left*s chosen under treatment HM are

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[7] Experimental studies which use the multiple price list method to elicit risk or time preferences find that some subjects can switch back and forth from row to row, known as the multiple switch points (Andersen et al., 2006).

significantly lower than those under treatment MM (p values<0.05, Mann-Whitney tests), and also significantly lower than those under treatment LM (p values<0.1, Mann-Whitney tests). Although the difference turns insignificant in the other four lotteries, the qualitative results persist. There is no significant difference in the number of *Left*s chosen between treatment LM and treatment MM in any of the six lotteries. All of these results confirm our finding that subjects who had previous exposure to high risk environment appear to be more risk averse than those who were exposed to moderate risk or low risk environments.

Given that our multiple-period experiment generates a balanced panel dataset and that other independent variables may disturb our results, we conduct a regression analysis to further investigate the effect of prior exposure to risky environments on risk aversion. In doing so, we focus solely on rational choices in the last six periods of the experiment. We define two dependent variables, *CE* and *RRA*. Suppose, in a round, a rational player chooses the lottery for any $z \leq z_k$, and the sure outcome z for any $z \geq z_{k+1}$. If $k \in \{1, 2, \ldots, 12\}$, let $CE = \frac{z_k + z_{k+1}}{2}$; if *k=0*, let $CE = \frac{(400-x)+z_1}{2}$; if *k=13*, let $CE = \frac{x+z_{13}}{2}$. Therefore, *CE* indicates the *expected* certainty equivalence of the lottery for the player. *RRA* is defined by the following equation,

$$\frac{x^{RRA} + (400-x)^{RRA}}{2} \equiv CE^{RRA}.$$

Assuming constant relative risk aversion, *RRA* thus measures the degree of risk aversion. In the second halves of the sessions (with moderately risky lotteries), the average *CE* is 184.4 (standard deviation: 28.3) and the average RRA is 0.65 (standard deviation: 2.6).

Tables 1 and 2 report regression results. In Table 1, the dependent variable is the natural logarithm of *CE*.[8] In column (1), we regress the natural logarithm of *CE* on two dummy variables which indicate treatments LM and HM respectively, and x of the lottery. Column (2) further controls for demographic variables indicating gender (equal to 1 if male and 0 otherwise), ethnicity (equal to 1 if Chinese, the main ethnic group in Singapore, and 0 otherwise), major (equal to 1 if economics and 0 otherwise), and experience (equal to 1 if the subject has previous experience in financial investment and 0 otherwise).[9] Column (3) employs random effect panel

[8] Using *CE* as the dependent variable instead does not change the regression results qualitatively.

[9] Of our subjects, 54% are male, 91% are Chinese, 37%'s major is economics, and 12% have previous experience in financial investment.

model estimation instead of OLS estimation, controlling for individual effects. Columns (4)-(6) repeat the regressions in the first three columns, further including dummy variables indicating round fixed effects.[10] In all these regressions, the coefficients for the dummy variable *LM* are never significant at conventional levels, suggesting that previous exposure to a low risk environment, compared to exposure to moderate risk, does not affect the certainty equivalence of a lottery for players. Interestingly, the coefficients for the dummy variable *HM* are invariably significantly negative (with p values<0.05) in all the specifications. The coefficients suggest that, compared to previous exposure to moderate risk, previous exposure to high risk lotteries reduces players' certainty equivalence of the lotteries (with moderate risk) by at least 6%. Subjects who were exposed to high risk lotteries seem to exhibit a higher level of risk aversion in subsequent decision-making. We also find other results from Table 1. First, as expected, the variable x, which indicates the riskiness of a lottery, is negatively associated with certainty equivalence, and this relation is significant in some regressions.[11] Second, consistent with the findings in the literature on gender difference in risk aversion (eg. Sapienza et al., 2009), female subjects are more risk averse than male subjects although this association is not robust in all the specifications.

Table 2 reports regression results using *RRA* as the dependent variable, assuming constant relative risk aversion. We adopt the same specifications as used in Table 1, except that we do not include x as an explanatory variable. The above construction of *RRA*, the estimated degree of risk aversion, shows that *RRA* is independent of the riskiness of a lottery. We have qualitatively similar findings as those in Table 1. The coefficients of the LM dummies are insignificant, indicating that prior exposure to low risk environments has no effect on the subjects' risk aversion. However, the coefficients of the HM dummies imply that previous exposure to high risk lotteries significantly increases the degree of relative risk aversion by at least 0.8.[12] This relation is statistically significant at conventional levels for all the specifications. These results confirm the main finding of this paper, as summarized below.

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[10] Including a variable indicating time trend instead does not change the results in Tables 1 and 2 qualitatively.

[11] Note that the standard deviation of a lottery is $\sqrt{2}(x-200)$, which is linear and increasing in x.

[12] In the second halves of the sessions, the average RRA is 1.25 for treatment HM, and 0.40 for treatments MM and LM.

Main finding: *While previous exposure to low risk lotteries does not affect subjects' risk attitudes, players with previous exposure to high risk lotteries appear to be more risk averse.*

Discussion

We find asymmetric effects of previous exposure to different risk environments on the risk attitude of subjects. Exposure to a high risk environment makes players exhibit a higher level of risk aversion in later decision-makings. One factor possibly accountable for this effect is the stress or fear that arises under a high risk environment. Psychological literature shows that uncertainty constitutes a powerful stressor (e.g. Monat, Averill and Lazarus, 1972; Zakowski, 1995) and stress modulates risk behavior, thus resulting in subjects less willing to take risk (e.g. Porcelli and Delgado, 2009; Mather, Gorlick, and Lighthall, 2009). In our experiment, the high risk environment may make subjects feel stressed and possibly even fearful about the outcome. Such emotional reactions may carry over to the second half of the session when subjects face moderate risk. This explanation is in line with Callen et al's (2014) finding that exposure to a violent (risky) environment, together with fearful recollections, causes a preference for certainty rather than risk. They name this phenomenon "certainty premium". In our experiment, subjects exposed to a high risk environment more frequently choose sure outcomes in later decision-makings.

A deeper thought over our main finding suggests that the higher level of risk aversion from subjects exposed to high risk might reflect a *survival strategy* developed in a high risk environment during the long evolutionary process of the mankind. Recall that in our treatment HM, the first 6 lotteries mimic a situation of very high risk: with 50% probability, the payoff would be no higher than 25, which is 12.5% of the expected payoff, 200. In one lottery, the lower payoff is as low as 0. In terms of the degree of risk, this environment smacks the *jungle* described by English philosopher Thomas Hobbes, where men have to protect themselves from losing lives as beasts in the jungle do. In the dangerous jungle, survival, rather than expected return maximization, is the top priority for players. A higher level of risk aversion, which prevents the players from risking their lives, would be a better surviving strategy in the presence of very high risk.[13] In contrast, in the first half of treatments LM and MM, the outcome under bad luck ranges from 85 to 195, 42.5%-97.5% of the expected return, where "survival" does not loom as large as in the treatment HM. Therefore, in such situations, expected return maximization becomes relatively more important for players, whereas a high level of risk aversion, which keeps players away from risky options, may not be as useful as in the treatment HM.[14]

The above discussion provides an explanation on the asymmetric effects of exposure to environments with different degrees of risk reported in our experiment. We do not argue that a few of rounds of decision-making in our experiment can permanently affect subjects' risk attitude. Nevertheless, our experimental findings suggest that when subjects are primed in an environment of high risk, they tend to exhibit more risk-averse behavioral patterns in later decisions. This "behavioral anomaly" may be deeply rooted, stemming from the evolutionary process where human beings had to struggle for survival in very dangerous environments.

Our findings and discussions above also point to the importance of disentangling the effect of the riskiness of the environment *per se* from the effect of personal experience from risky environments (i.e. idiosyncratic realization of outcomes), the main motivation of this paper. As discussed in the Introduction, a significant of literature focuses on how individuals' previous experiences from financial crises, violence, combats, etc. shape risk attitude. The effects of personal experiences suggest that individuals are able to "learn" from personal (negative) realizations of risk. However, this may not be sufficient for survival in a highly dangerous (risky) environment where one single negative realization of risk may lead to the end of the game (e.g. *death*). By contrast, the ability to learn from and adapt to the environment itself would be more crucial for survival in a highly dangerous (risky) environment. In our experiment, subjects do not observe the realizations of their decisions until the end of the session. Therefore, they are unable to learn from their personal idiosyncratic realization of outcomes. The effect we report from the experiment is thus suggestive of the subjects' capability to learn from the environment *per se*: the riskiness of an environment itself could shape risk attitude.

[13] From a functional-evolutionary perspective, Ohman (1986) shows that fear originates in a predatory defense system whose function is to allow animals to avoid and escape predators. This suggests that the emotions associated with high risk, like fear and stress, are also evolutionarily adaptive strategies conducive to survival in a high risk environment.

[14] Of course, the subjects in our treatment HM did not have the survival concern. But we argue that the pattern they showed in the experiment may reflect a fitting strategy in evolution.

IV. Conclusion and Implications

To summarize our main result, let us refer to the casino example in Thaler and Johnson (1990):

> *Imagine that you are attending a conference in Las Vegas, and you walk into a casino. While passing the slot machines, you put a quarter into one machine and, surprisingly, you win $100. Now what? Will your gambling behavior for the rest of the evening be altered?*

Our main finding suggests that by just putting a quarter into one machine, which exposes you to a volatile environment, may your gambling behavior have been altered.

Before we extrapolate implications from our results, questions regarding external validity need to be discussed. The risk involved in the experiment is the uncertainty of lottery outcome. Not only were the incentives involved rather small but the subjects were also exposed to the risky environment for a very short time period. These settings may lack some elements of real-world risky environments. However, we were able to observe changes in subjects' risk behaviors even within a short-lived, laboratory setting. Thus we can expect the impact to be even larger in a real-world risky environment.

Our main finding identifies a direction future research could pursue. In the models of decision-making under uncertainty, risk aversion is typically exogenously determined and independent of the volatility of the risky environment individuals are exposed to. (For example, the expected utility theory assumes that risk aversion is only determined by the curvature of the utility function.) However, our key finding suggests a potential link between these two variables: experiencing a high risk environment may directly influence attitudes toward risk. Theoretical economists may consider incorporating this relationship in models involving decision-making under uncertainty. Additionally, this interaction may provide insights into one of the major puzzles in financial economics--that risk premium varies strongly and systemically over time. The equity premium seems especially high during recessions compared to during expansions (Cohn et al., 2013).[15] Our results suggest that individuals may become more risk-averse and require a higher equity premium after experiencing a volatile environment. This occurs more frequently during economic downturns.

Our finding that individuals exposed to a low risk environment are not significantly different from those exposed to a moderate risk environment speaks to policy debates concerning the consequences of the welfare states in western and northern European countries and the "one-child" policy in China, a most radical approach to limiting population growth. A welfare state provides a safety net for its people, significantly reducing risk in many aspects of life. One may thus wonder whether the policies of the welfare state would make people more averse to risk. Due to the "one-child" policy in China, the only child in a family is typically extremely protected against risk. Although this may be an optimal decision for the risk-averse parents of only children, many worry about the potential adverse effects that may result with such "spoiled children". For instance, Cameron et al (2013) report that only children in China are more risk averse and possess less entrepreneurship skills than children with siblings. Although it may be appealing to attribute these results to the environment in which only children grow up, our findings suggest that the environment of very low risk *per se* is probably not sufficient to change people' risk attitude. In this sense, we contribute to the policy debates by providing a reassuring finding.

[15] Some asset pricing models assume countercyclical risk aversion to account for this pattern (Campbell and Cochrane, 1999; Pastor and Veronesi, 2005).

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Appendix I Figures and Tables

Figure 1: Screen shot of a round with a lottery of high risk (H)

Figure 2: The frequency of choosing risky options under different treatments

Figure 2(a)

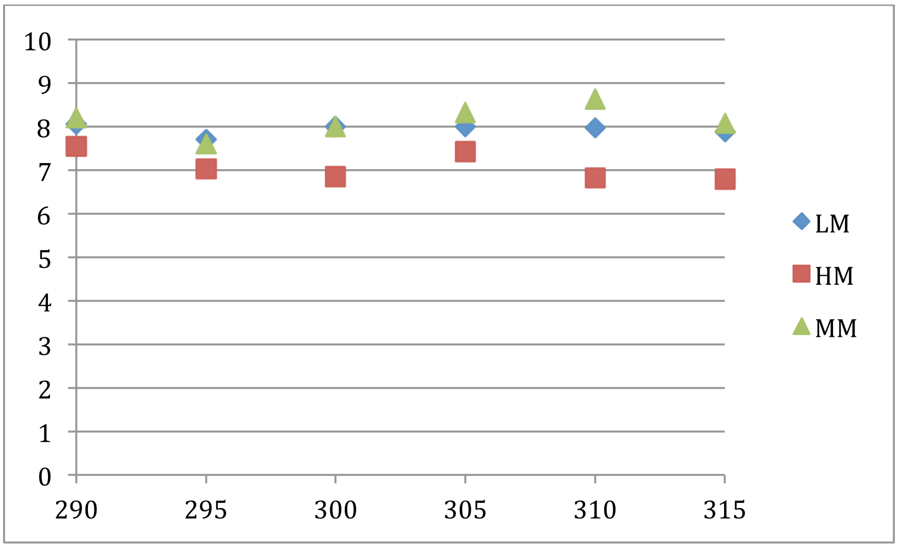
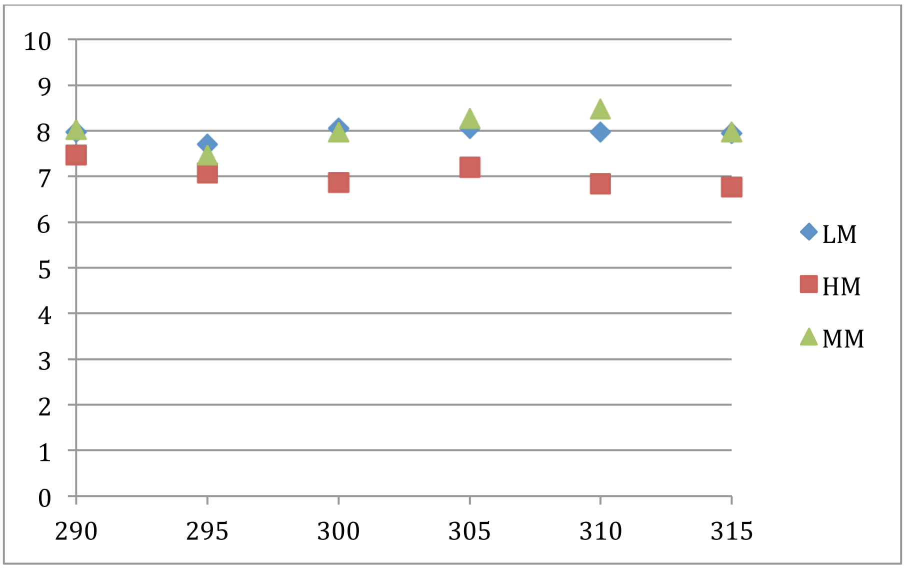


Figure 2(b)



Notes: Figure 2(a) shows the average number of "*Lefts*" (the risky choices) chosen by the subject under each lottery (with x shown on the horizontal axis) for each treatment in the second half of the session, given rational choices; Figure 2(b) shows the numbers for all the (rational and non-rational altogether) choices.

Table 1: Effects of Previous Exposure to Risk on Certainty Equivalence

	(1)	(2)	(3)	(4)	(5)	(6)
LM	-0.016	-0.0072	-0.0166	-0.0159	-0.0071	-0.0164
	(0.0124)	(0.0136)	(0.0316)	(0.0125)	(0.0137)	(0.0316)
HM	-0.0724***	-0.0631***	-0.087**	-0.0723***	-0.0629***	-0.0865**
	(0.0182)	(0.0195)	(0.0394)	(0.0183)	(0.0195)	(0.0394)
x	-0.001	-0.001	-0.001**	-0.001	-0.001	-0.001**
	(0.0007)	(0.0007)	(0.0004)	(0.0007)	(0.0007)	(0.0004)
Male		0.0363**	-0.0275		0.0365**	-0.0264
		(0.0149)	(0.0443)		(0.015)	(0.0443)
Chinese		0.0005	0.0113		0.0004	0.0109
		(0.0196)	(0.0356)		(0.0197)	(0.0354)
Economics		0.0138	-0.0654		0.014	-0.0635
		(0.0134)	(0.043)		(0.0134)	(0.0426)
Experience		-0.0275	0.0101		-0.0274	0.0099
		(0.0202)	(0.0421)		(0.0203)	(0.0424)
Panel data model	No	No	Yes	No	No	Yes
Round effects controlled for	No	No	No	Yes	Yes	Yes
Observations	581	581	581	581	581	581
R^2	0.0411	0.0547	0.0695	0.0431	0.0568	0.0668

Notes: Column (1) regresses *ln(CE)* on dummy variables *LM* and *HM*, and *x*, for rational choices under the second halves of the sessions; column (2) includes demographical variables; column (3) uses random effect panel data model in estimation, controlling for individual effects; columns (4)-(6) repeat the regressions in columns (1)-(3), further controlling for round effects. Within R squared is reported for columns (3) and (6). Heteroskedasticity robust standard errors are presented in parentheses. *, **, and *** represent significance at 10%, 5%, and 1% levels, respectively.

Table 2: Effects of Previous Exposure to Risk on Degree of Risk Aversion

	(1)	(2)	(3)	(4)	(5)	(6)
LM	0.195	0.0784	0.2313	0.1939	0.0769	0.2313
	(0.1847)	(0.2029)	(0.4383)	(0.182)	(0.2046)	(0.4509)
HM	0.9391***	0.847**	1.168*	0.9387***	0.8464**	1.175*
	(0.331)	(0.3366)	(0.6444)	(0.3311)	(0.3368)	(0.6526)
Male		-0.382	0.5002		-0.3833	0.5087
		(0.2691)	(0.7712)		(0.2695)	(0.7905)
Chinese		0.0708	-0.0521		0.0701	-0.0609
		(0.2178)	(0.4198)		(0.2182)	(0.4234)
Economics		-0.0299	0.9605		-0.0305	0.9893
		(0.22)	(0.6714)		(0.2196)	(0.681)
Experience		0.4983	-0.0057		0.4982	-0.0136
		(0.3827)	(0.901)		(0.3841)	(0.9176)
Panel data model	No	No	Yes	No	No	Yes
Round effects controlled for	No	No	No	Yes	Yes	Yes
Observations	581	581	581	581	581	581
R^2	0.0227	0.0291	0.094	0.0245	0.0309	0.0634

Notes: Column (1) regresses *RRA* on dummy variables *LM* and *HM*, for rational choices under the second halves of the sessions; column (2) includes demographical variables; column (3) uses random effect panel data model in estimation, controlling for individual effects; columns (4)-(6) repeat the regressions in columns (1)-(3), further controlling for round effects. Within R squared is reported for columns (3) and (6). Heteroskedasticity robust standard errors are presented in parentheses. *, **, and *** represent significance at 10%, 5%, and 1% levels, respectively.

Appendix II

Experimental Instructions

Thanks for your participation. This session consists of the main experiment and a questionnaire. I expect the whole thing to take about 30 minutes.

Depending on your decisions and the luck, you will be able to earn money in addition to the $3 guaranteed for your participation.

Please read the following instructions carefully.

NO communication between participants is allowed at any time during the experiment. If you have any questions, please raise your hand and I will come to assist you privately.

Please now turn off your mobile phone and any other electronic devices. These must remain off until you leave this room.

During the experiment, your earnings will be calculated in "tokens". You will be paid in Singapore dollars at the following conversion rate:

200 tokens = S$1

To ensure anonymity, your decisions in this session are linked to your Participant ID number and at the end of this session you will be paid by Participant ID number. All payments will be put in an envelope. No other participants will see how much you have been paid. Please do not reveal your choices to any other participant in the experiment.

Instructions (continued)

Your Tasks

The main experiment consists of 12 rounds. In each round, you will make a series of decisions on choosing between a lottery and a certain amount of tokens for sure. The following table shows an example of a round.

Each row in the table corresponds to one decision that you will make. For each row, you will choose between Option Left and Option Right. For instance, in Row 1, if you choose Option Left (by checking the circle next to "left" in the row), you will receive x tokens with 50% probability and y tokens with 50% probability; if you choose Option Right (by checking the circle next to "right" in the row), you will receive z_1 tokens with certainty. After you make all 13 decisions in the table and click "Submit", you will proceed to the next round. The completion of the 12th round entails the end of the experiment. **In the experiment, x, y and z will be assigned real values.** Note that Options Left differ across rounds; and for each round, Options Right differ across rows. So please read carefully the options presented to you when making decisions.

	Left	Right	Decision
1	50% of receiving x, 50% of receiving y	Receiving z_1 for sure	Left ☐ Right ☐
2	50% of receiving x, 50% of receiving y	Receiving z_2 for sure	Left ☐ Right ☐
3	50% of receiving x, 50% of receiving y	Receiving z_3 for sure	Left ☐ Right ☐
4	50% of receiving x, 50% of receiving y	Receiving z_4 for sure	Left ☐ Right ☐
5	50% of receiving x, 50% of receiving y	Receiving z_5 for sure	Left ☐ Right ☐
6	50% of receiving x, 50% of receiving y	Receiving z_6 for sure	Left ☐ Right ☐
7	50% of receiving x, 50% of receiving y	Receiving z_7 for sure	Left ☐ Right ☐
8	50% of receiving x, 50% of receiving y	Receiving z_8 for sure	Left ☐ Right ☐
9	50% of receiving x, 50% of receiving y	Receiving z_9 for sure	Left ☐ Right ☐
10	50% of receiving x, 50% of receiving y	Receiving z_{10} for sure	Left ☐ Right ☐
11	50% of receiving x, 50% of receiving y	Receiving z_{11} for sure	Left ☐ Right ☐
12	50% of receiving x, 50% of receiving y	Receiving z_{12} for sure	Left ☐ Right ☐
13	50% of receiving x, 50% of receiving y	Receiving z_{13} for sure	Left ☐ Right ☐

Instructions (continued)

Your Payment

After you finish your decisions in all the 12 rounds, one round will be randomly selected as the payment round. For this randomly selected round, you will be paid by your decision in each row. For example, suppose you choose Option Left in Row 1, Option Right in Row 2, ……. For Row 2, since you choose Option Right, you will receive z_2 tokens for sure. For Row 1, since you choose Option Left, you will receive either x tokens or y tokens with equal probabilities. The computer will randomly determine the outcome for this lottery.

Your earning in this experiment is the sum of the earnings in each row of the payment round. The earnings will be transformed to Singapore dollars using the 200 tokens=S$1 conversion rate and be paid to you in addition to the S$3 participation fee.