Where You Stand Affects the Risks You Take: Socially Reference-Dependent Risk Attitudes

Jaimie W. Lien† Jie Zheng‡

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Abstract[1]

How does an individual's position within a social distribution influence their desire to take risk? Reference-dependent loss aversion (Kahneman and Tversky, 1979; Koszegi and Rabin, 2006, 2007) adapted to a social distribution setting, suggests that individuals could find risk more appealing at the tails of the distribution. We analyze this question in a laboratory experiment which allows subjects to take risks at different locations in the social distribution, against a realistic backdrop of real effort. Among subjects randomly assigned to low expected earnings, we find a convex relationship between risk-taking and social position consistent with a reference-point near the social median. However, for subjects assigned to high expected earnings, risk-taking tends to be concave in social position, consistent with having a reference-point near the top of the distribution. We find additional support for this empirical pattern using the National Longitudinal Survey of Youth (NLSY 97), in which similar patterns of convex and concave self-reported risk attitudes across the income distribution are documented among individuals with lower and higher expected lifetime earnings, respectively. The survey data results suggest that the risk-taking patterns found in the controlled laboratory setting have external validity in broader contexts. Finally, our finding that social reference points differ among individuals based on their expected earnings is consistent with a hypothesis of expectations-based reference point selection.

JEL codes: D01, D03, D31, D81

Keywords: social preferences, risk attitudes, reference-dependence, reference point selection

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[1] † Lien: Department of Decision Sciences and Managerial Economics, The Chinese University of Hong Kong, Hong Kong SAR, China; Department of Economics, School of Economics and Management, Tsinghua University, China, jaimie.academic@gmail.com ; ‡ Zheng: Department of Economics, School of Economics and Management, Tsinghua University, China, jie.academic@gmail.com ; We acknowledge the National Institute for Fiscal Studies at Tsinghua University for funding the Tsinghua SEM Economic Science and Policy Experimental Laboratory (ESPEL). This research was supported by Tsinghua University (Project #2012z02182) and the National Natural Science Foundation of China (Project #71303127). We thank QIAO Yuanbo, WANG Wei, XU Haoyi, and YOU Yang for excellent assistance in running the experiments. We are especially grateful to Julie Cullen and Ginger Jin for their detailed comments which helped us improve the manuscript. For helpful comments and conversations we also thank Nanyang Bu, Vincent Crawford, David Eil, John Hamman, Daniel Houser, Botond Koszegi, Pinghan Liang, Xiaocai Lin, Juanjuan Meng, William Neilson, Kang Rong, Curtis Simon, Jason Shachat, Cheng Wang, Zhijian Wang, Patrick Warren, Daniel Wood, Guiying Wu, Bin Xu, Chunlei Yang, Maoliang Ye, many seminar participants, as well as participants in the Economic Science Association World Congress 2013, Society for the Advancement of Behavioral Economics 2013 meeting, the 2014 Conference on Economic Dynamics at Fudan University, and the Econometric Society World Congress 2015. All errors are our own.

1. Introduction

Does individual risk-taking depend on a person's relative position in society? Anecdotal and academic evidence has suggested links between relative income levels and risk-taking, although classical economic theory has rarely discussed this issue.[2] Such links if they exist, have important consequences for our understanding of a variety risk-related behaviors across the income distribution, from occupational choice, financial and human capital investment decisions, insurance decisions and health-related behaviors.

Much of the social preference literature (for example, Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000) implies some form of reference-dependence, but the discussion largely focuses on individuals' preferences over distributions of resources between self and others, without calling particular attention to what such models imply about risk-taking behavior. The theoretical reference-dependent preferences literature on the other hand (ex. Kahneman and Tversky, 1979; Koszegi and Rabin, 2006, 2007), has focused primarily on making predictions about risk-taking behavior and effort provision, without directly discussing the role of socially-generated reference points. Our study lies at the intersection of these two literatures, which are heavily interrelated with one another in social settings which also involve risk – a scenario which describes most real-life important decisions under uncertainty.

We adopt a model of reference-dependent loss averse utility following Koszegi and Rabin (2006 2007), which takes an individual's relative social standing within a distribution of outcomes held by other individuals as its main input. In considering the distribution of outcomes in society, a decision-maker cares about his ordinal ranking, holding some specific position in society as his reference point. Being below this reference point causes the individual more disutility than the utility he obtains from being above it. This is a simplification for potentially more complex preferences, capturing the idea that individuals care heavily about how they themselves are doing relative to a benchmark social position such as the median, top or bottom position. A main appeal of adopting reference-dependent loss aversion as a potential framework for social preferences is its generalizability, although other social preference models may indeed have greater predictive ability in specific situations.

Adopting reference-dependent loss aversion to the social setting implies that risk aversion is highest near the location of a social reference point, and diminishes the farther individuals are from the reference point in either direction, ie. the social gains or social loss domains. Our experiment and empirical analysis allows the existence and location of the reference point to be confirmed or refuted in the data. We find that among individuals who have relatively low expected earnings, a simple socially reference-dependent loss aversion model with a reference point near the social median, accurately describes risk-taking behavior. That is, the propensity to take risk tends to be V-shaped across the social distribution for subjects with low expected earnings. Among high expected earnings individuals on the other hand, risk-taking patterns are more consistent with a reference point located near the top of a distribution. In other words, we generally find a concave relationship between risk-taking and social position among subjects with high expected earnings.

These differences in the shape of risk-taking behavior across the experimental social income distribution can be explained using a reference point selection argument, under the case where individuals care heavily about their social position compared to their nominal earnings. If low expected earnings subjects select the social median as their reference point, a loss aversion framework implies a propensity to take risk which is V-shaped in their social position. On the other

[2] For example, see Rubenstein and Scafidi (2002) regarding higher purchases of lottery products by lower income households, and Oster (2004) regarding regressivity of lottery games. One hypothesis in the health literature is that low income individuals have lower health outcomes due to higher risky behaviors in the health domain (see Lantz et al. (1998) for a discussion and analysis of this hypothesis).

hands if high expected earnings subjects select a top social position as their reference point, we can expect them to be very risk averse near the top of the social distribution, if nominal monetary earnings weigh relatively lightly in their utility function compared to relative social position. In finding different influential reference points for low expected earners and high expected earners, our results contribute to the emerging literature on reference point selection (see Hoffmann, Henry and Kalogeras, 2013, which finds aspirations as reference points in early temporal decisions, while finding lagged status quo reference points in later stages).

We check for external validity and supporting evidence of our experimental findings using the US National Longitudinal Survey of Youth (NLSY) 2010 risk module, which asks respondents about their willingness to take on risks. This serves as cross-check on the external validity of our experimental design. We use whether the head of household has graduated from college, as a proxy for future expected earnings opportunities. The qualitative pattern of responses regarding willingness to take general and financial risks across the income distribution in the NLSY is similar to what we find in the experiment. Among non-college graduates in their late 20s, who have lower expected lifetime earnings (see Oreopoulos and Petronijevic, 2013 for a survey of evidence), self-reported risk taking in generic and financial domains is largely V-shaped across the national income distribution. Among college graduates in the same age range, we observe the highest self-reported risk-taking directly below the social median, generally following a concave shape across the national income distribution.

Our study contributes to an emerging literature investigating the effect of relative social position on individual risk-taking. The most closely related study to ours, to our knowledge, is Kuziemko, Buell, Reich and Norton (2014) which establishes Last Place Aversion (LPA), and explores the consequences for risk-taking, with particular attention to explaining individual attitudes towards income redistribution policies. They hypothesize and find strong evidence of LPA in both risk and redistributive choices, proposing a utility function which drops off very steeply when an individual is in last place. When subjects are socially ranked last, they are more likely to choose gambles which have the possibility of moving them immediately out of last place, than they are when placed in other parts of the distribution. Furthermore, subjects ranked second-to-last are least likely to give money in a dictator game to the subject ranked directly below them.[3] In the dynamic version of their experiment, the authors also find evidence that the second to last subject also has a tendency to accept more risk than players of other ranks. In the section of their paper describing consequences of Last Place Aversion for risk-taking specifically, they find that risk taking tends to be monotonically decreasing as social rank increases. Our results differ from theirs in that we find convex or concave relationships between risk-appetite and social rank, depending on a subject's earnings expectations. In the case of low expected earners, our results are consistent with Last Place Aversion, in that individuals near last place tend to be most likely to accept riskier prospects. In a related study focusing on the effort domain, Gill, Kissova, Lee and Prowse (2019) find that workers' effort provision is U-shaped in their rank order in performance. Subjects in their experiment increase their effort most substantially after being ranked either first or last. Although we do not examine subjects' effort in this paper, our findings in the risk-attitude domain are consistent with theirs.

A number of related studies address social effects on risk-attitudes but focus primarily on two-person social settings (see Linde and Sonnemans, 2011; Schwerter, 2016; Muller and Rau, 2019), or on individuals' preferences over the lotteries faced by others (see Rohde and Rohde, 2011, 2014; Cappelen, Konow, Sorensen and Tungodden, 2013).[4,5] Our study is aligned with these previous

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[3] Kuziemko et al (2014) propose that Last Place Aversion is one reason why individuals at bottom of the US income distribution do not support income redistribution policies as much as one might expect.

[4] Linde and Sonnemans (2012) find that subjects in a two-person setting are more risk averse in the social loss frame compared to the social gains frame. Linde and Sonnemans (2011) find no significant social effects on risk attitudes. Schwerter (2016) finds that subjects in the social loss frame are more risk-seeking. Muller and Rau (2019) test and find

studies focusing on two-person settings, in that we are also interested in testing the predictions of social loss aversion. However, our focus differs in that we are primarily interested in the ability of social loss aversion to serve as a general descriptive model of behavior in a larger distribution of individuals, in contexts where a single reference individual is not necessarily obvious in the decision-maker's objective. With regard to the latter line of literature, in this paper, we do not attempt to answer questions related to how individuals value social lotteries which distribute resources across individuals, instead focusing primarily on how individuals react with risky choices to being in various locations in the social distribution.

The remainder of the paper is organized as follows: Section 2 describes the implications of reference-dependent loss aversion on risk taking in the social context; Section 3 describes our experimental design; Section 4 summarizes basic features of subjects' behavior in the experiment, and discusses some validity tests of the experiment; Section 5 presents the main results for the distributional effects on risk-taking; Section 6 explores supporting evidence for the experimental results using the National Longitudinal Survey of Youth (NLSY) ; and Section 7 concludes.

2. Predictions of Reference-Dependence on Risk Taking in Social Context

Kahneman and Tversky (1979) and Koszegi and Rabin (2007) formalize reference-dependent loss averse preferences for non-social settings, in a manner which can readily accommodate social reference-dependence. The predictions of the individually-based reference-dependent model have been tested in various settings (see Camerer, 1998 for a survey, as well as Crawford and Meng, 2011, Pope and Schweitzer, 2011, Eil and Lien, 2014, and Lien and Zheng, 2015 for recent examples of such tests using field data; see also Imas, 2014 on the effect of realized versus paper losses on risk taking, and Imas, Sadoff and Samak, 2016 on implications of loss aversion for contract selection) - individuals' tendency to evaluate outcomes in relative terms, and to especially dislike outcomes in the loss frame, is increasingly well-established. Recent research suggests that loss aversion has its neurological basis in the amygdala (De Martino, Camerer, and Adolphs, 2010).

The same intuition of reference-dependent loss aversion can be applied to a setting with relative social comparisons, in which the reference point is determined by the performance outcomes of other individuals. That is, in evaluating their utility of outcomes, individuals compare their own outcome to that of other individual(s). We express social outcomes in terms of percentile ranking $p_i \in [0,100]$ for individual i, where the reference point $r \in [0,100]$ is also expressed in percentile ranking, so that utility is given by:

$$U(p_i \mid r) = \begin{cases} (p_i - r)^{\alpha} & p_i \geq r \\ -\lambda(r - p_i)^{\alpha} & p_i < r \end{cases}$$

A utility of nominal earnings term can also be accommodated such that for earnings w_i, total utility is given by $V(w_i, p_i \mid r) = \mu(w_i) + U(p_i \mid r)$, where μ satisfies typical assumptions about utility of nominal money, as in Koszegi and Rabin's (2006) gain-loss utility.

Figure 1 shows the standard piecewise linear (no curvature of gains and loss segments)

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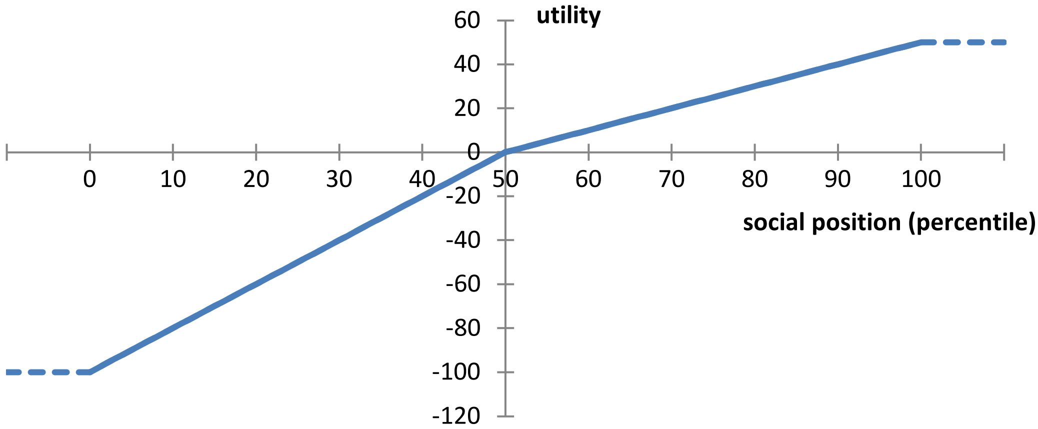
support for social risk-attitudes in an inequality aversion framework by eliciting individual risk and inequality averse preferences within-subject, in addition to risky decisions in the social context. Bault, Coricelli, and Rustichini (2008) conduct an experiment in which the social treatment allows a subject to observe the lottery choices of another subject, finding contrary to loss aversion that gains loom larger than losses. Trautmann and Vieider (2011) summarizes the literature on the social influences on risk attitudes.

[5] Rohde and Rohde (2011, 2014), explore whether subjects' risk attitudes depend on the lotteries faced by other players, and what preferences subjects have over the assignment of lotteries across other subjects. Cappelen, Konow, Sorensen and Tungodden (2013) focus on subjects' fairness views on risk-taking and their preferences for redistribution ex-ante and ex-post.

reference-dependent loss averse utility function, with relative social standing in percentiles as the input, and where social losses are twice as painful as social gains are beneficial ($\lambda = 2, \alpha = 1$). The case of a median (50th percentile) reference point is shown, though different values of the reference point in terms of social standing are also possible. Here we assume that the reference point is an order statistic of the social distribution – however, similar reasoning applies for other possible reference point candidates such as the social mean.[6]

Just as in the versions of the model with non-social sources of reference dependence, risk aversion decreases in either direction (social gain or loss) moving away from the reference point. The resulting prediction is that individuals are generally less risk averse as they travel further into the gains or losses domains, such as the top or bottom social positions.

Figure 1: Socially Reference-Dependent Loss Averse Utility, with Percentile Endpoints



When utility is framed in terms of percentile position as we propose here, there are two additional plausible kinks in the utility function, if one assumes that social position weighs heavily in an individuals' utility (in other words $\mu(w_i)$ is small compared to $U(p_i | r)$). Consider an individual near the 100th percentile at the very top of the social distribution. Supposing that such an individual cares a great deal about their social position, intuitively, he or she stands little to gain and a lot to lose by taking on additional risk. In other words, there may be an implicit kink at the 100th percentile around which individuals may be potentially even more risk averse compared to at a near-median reference point. Similarly, at the bottom of the social distribution, losing additional money may not decrease an individual's utility much further – the intuition is that being at the bottom of the distribution, an individual has little to lose by taking on large risks. The convex kink at the 0th percentile supports the hypothesis and findings in Kuziemko et al (2014), showing that individuals in last place are most risk-seeking, although our analysis suggests that this might be specific to individuals with relatively low earnings expectations.

Our empirical findings can be accounted for with a model which maintains linear gains and loss segments, but allows for local reference points at the very bottom and top of the distribution, as in Figure 1.[7] We find that the location of individuals' tendency to take the least risk depends on their

[6] The way in which the social information is presented to subjects in our experiment facilitates percentile comparisons rather than mean-based comparisons, although both are psychologically plausible depending on the information display used. As we discuss in Section 3, subjects in social information treatments are presented with histograms (distributions) of earnings. Thus it is easier for them to 'eyeball' their own relative position in terms of approximate percentiles, than it is to calculate a numerical average or other moments of the distribution, which could in principle serve as social reference points as well.

[7] Our results appear more supportive of a local reference point setting story among individuals of different opportunity levels, than a utility function with diminishing sensitivity of gains and loss segments. However, even if the placement of

earnings expectations – individuals with relatively *lower earnings expectations* tend to take the least risk at the *social median*, while individuals with *higher earnings expectations* tend to be more *risk taking* near the median of the distribution compared to at either of the social endpoints. This implies that low expectations on one's own earnings tends to make the social median a position of focus, while high expectations tends to make the top of the social distribution an important position of focus.

The social loss aversion model proposed here bears some similarities to prominent social preference models in that individuals care about their outcome relative to the outcome of others, but there are some key differences which we mention briefly here. One important difference is that our hypothesis focuses on subjects' relative standings in ordinal terms while many prominent social preference theories focus on individuals' preferences over allocation of cardinal payoffs among themselves and other individuals.[8]

Bolton and Ockenfels (2000) propose a model in which players derive utility from nominal earnings as well as their personal share or fraction of a total earnings pie (where equal division among all the players is a type of 'collective reference point' for allocation). Their model suggests, for example, that person C is indifferent between Scenario 1: person A receives 30, person B receives 30 and person C receives 40, and Scenario 2: person A receives 0, person B receives 60 and person C receives 40. In our hypothesized framework, person C will prefer the first scenario, since his/her social placement is highest in that case compared to others.

Inequity-averse preferences as proposed in Fehr and Schmidt (1999) are formulated so that players may suffer a utility reduction whose degree depends on nominal positive or negative gaps between other players' earnings and their own. Our framework on the other hand, implies that individuals strictly prefer to be doing better than others (and even more strongly prefer not to be doing worse than others), and that they care primarily about the ordering among individuals rather than the magnitudes of the earnings gaps.

While there are many real-world situations in which the above social preference models could do a better job predicting behavior than social loss aversion, one key benefit of the social loss aversion model is in its simplicity when dealing with large numbers of individuals and their outcomes. We leave the further study of the relationship between the prominent social preference models and socially reference-dependent loss aversion for future work. Additionally, we will focus in this paper on individuals' willingness to take risk, so we do not address individuals' preferences over resource allocations among other individuals in the current study.

3. Experiment Design

Our experiment is a 2-by-3 design, with two social information conditions (No information, Information), and three possible expected earnings levels (Low, High and Mixed). Each treatment consists of 80 rounds, in which subjects are in each round, randomly assigned to one of two possible tasks: an Effort Task which pays a positive piece rate each time the subject completes the task correctly, paying zero otherwise; and a Lottery Task in which subjects must choose among a fixed set of zero expected value gambles.

Subjects' likelihood of receiving each type of task in any given round of the experiment, is randomly determined by their assigned "Rate", which is their ex-ante probability of receiving the piece-rate Effort Task. Conditional of performing all their assigned Effort Tasks correctly, subjects Rate will determine their expected earnings. We interpret subjects' rate assignment as their economic *opportunity*, which we define here as having-the ability to earn a piece rate wage in exchange for

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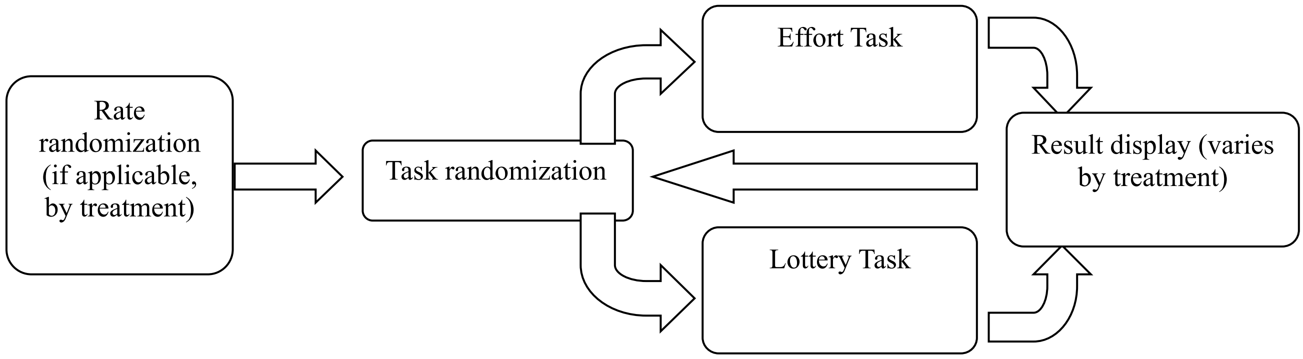
the reference point does not accord with our benchmark hypothesis, we are able infer the reference point from the data, based on where in the social distribution are individuals *least likely* to take risk.

[8] Sobel (2005) provides a survey of much of the existing theoretical literature on social preferences.

known exerted effort. We note that there are other plausible interpretations and implementations of the concept of opportunity, such as the ability to earn a higher wage for identical effort. We chose the former definition in order to maintain a sense of task fairness across participants, conditional on effort exerted.[9]

High opportunity individuals in our setup have a 60% chance of receiving the Effort task and 40% chance of receiving a Lottery Task. Low opportunity individuals only have a 40% chance of receiving an Effort task and 60% chance of receiving a Lottery Task. Figure 2 shows the sequence of events within each treatment.

Figure 2: Sequence of Events within a Treatment



Due to the specified randomization structure, the Lottery Task affects the *variance* of subjects' earnings realizations, but does not affect their earnings in expectation. We consider these two possible rates, 0.6 and 0.4, which reflect (in expectation) receiving 60% Effort Tasks or receiving 60% Lottery Tasks respectively. Subjects with the 0.4 rate indeed have lower expected earnings, but due to the high variance in total earnings, they still maintain a substantial chance of obtaining earnings comparable to or exceeding the expected earnings of the high opportunity type. A subject's rate remains assigned to him or her throughout the entire experiment.

Prior to each round's assigned task, a screen appears which shows subject's Rate, as well as the random number draw from the Uniform (0,1) distribution which determines which task, the subject will face next.[9] Subjects earnings throughout the experiment are expressed in Experimental Currency Units (ECU) which are exchanged for local currency at 2 ECU = 1 Chinese Yuan (about 0.16 USD).

3.1 Effort Task

Our Effort Task is framed as a "Counting Task" which shows subjects a 7-by-7 matrix of single digit numbers (0 through 9), and specifies two particular numbers in this same set which subjects must count. If they enter the correct number of relevant digits appearing in the matrix, subjects earn 2 experimental currency units (ECU). If subjects enter an incorrect answer, or fail to enter an answer in 30 seconds, they receive 0 ECU in that round. This Effort Task maintains a constant difficulty level throughout the experiment, and was designed with the intention that all subjects can correctly complete the task by exerting a moderate amount of effort.

[9] In a set up where different piece rate payments are received by different participants for completion of the same effort task, fairness concerns regarding workers receiving "unequal pay for equal work" could additionally motivate risk-taking aside from relative income standing factors. While this is also an important issue, we abstract from it here.

Figure 3: Effort Task (example)

Count the number of times "8" and "1" appear in the grid below.

0	8	6	5	4	2	1
3	3	4	6	5	7	8
2	5	2	6	9	7	4
7	9	2	5	1	3	6
2	3	6	9	4	2	1
9	8	9	3	5	2	3
9	7	5	8	2	1	3

This real effort task is nearly identical to that used in Abeler, Falk, Goette and Huffman (2011), in which subjects count the number of 1's appearing in a matrix of 1's and 0's. We used digits 0 through 9 in order to decrease the ease of recognition of target digits by shape, increasing the visual and concentration effort needed.[10]

2.2 Lottery Task

Our Lottery Task is framed as a "Lottery Task", which asks subjects to choose between two different zero expected value gambles, which stay fixed throughout the 80 rounds. The safer gamble generates a payoff of 1 ECU with 1/2 probability, and generates a payoff of -1 ECU with 1/2 probability. The riskier gamble generates a payoff of 4 ECU with 1/2 probability, and generates a payoff of -4 ECU with 1/2 probability. We avoid providing subjects with a risk-free option so that all subjects face some uncertainty when confronted with the lottery task, avoiding the possibility of a preference for certainty itself.[11]

Lottery Task:

Choose which option you prefer (select one and click the submit button):

O Win 4 ECU with probability 1/2, lose 4 ECU with probability 1/2

O Win 1 ECU with probability 1/2, lose 1 ECU with probability 1/2

Payoffs in the lotteries are such that the large lottery option gives subjects the opportunity to earn or lose double what they could in the Effort Task, while the small lottery gives the opportunity to only risk half of the earnings attainable in the Effort Task.[12,13] Since the riskier gamble is merely a mean-preserving spread of the safer gamble, an Expected Utility maximizing individual with concave utility over the domain of possible outcomes of large gamble incorporated with their existing earnings, will prefer the safer lottery gamble.[14]

After completing the task in each round, a screen appears which shows subjects their personal payoff for that round and their total personal earnings so far. The final earnings for each subject is the accumulation of their net payoffs over all 80 rounds. We note that in expectation, subjects cannot

[10] Another reason for the variation in digits in each round and using two different digits was to reduce possible monotony by subjects. Unlike in Abeler et al. (2011), our subjects were not being asked to choose how long they wished to work, thus we wanted to create a working condition which was not too repetitive.

[11] For example, see Andreoni and Sprenger (2012).

[12] Given that effort is required in the Counting Task to earn 2 ECU, the safe lottery option may have particular appeal for subjects who do not want to risk losing all of the most recent counting task's earnings effort.

[13] An individual-computerized random number draw then determines the subject's payoff in that round based on the lottery choice.

[14] If the subject does not make a choice after the 30 second time limit, the small gamble is implemented by default.

manipulate their social ranking upwards in the experiment. The only thing they can do is to increase their expected earnings is to perform the effort task correctly each time it randomly arrives - yet this provides no guarantee about an increase in their social ranking which depends heavily on the outcomes of other subjects in that round.[15]

In addition, due to the dual-layered stochastic structure of the payoff distribution and lack of labeling of individual participants in the information displays (for treatments in which social information is provided), it is difficult for subjects to keep track of how their social ranking might change from round to round.[16] Subjects also cannot tell who is currently above or below them in ranking, but can only infer their own position in the distribution by matching their current earnings to the relevant location in the information display. Subjects' risk choices should thus be a utility-based reaction to where they *currently* stand in the distribution.

3.3 Heterogeneity in Opportunity within Treatments

In the Isolated Treatments (denoted by "H" or "L") *all* subjects in a particular session were assigned the High rate or high earnings opportunity role, or the Low rate or low earnings opportunity role exclusively, so that all subjects in the session were commonly known to have the same ex-ante opportunity at the piece rate effort task. In the isolated treatments, no mention was made of other possible rate levels. These treatments are denoted as Isolated High Rate (henceforth denoted by "H") or Isolated Low Rate (henceforth denoted by "L") in our data analysis. A total of 44 subjects received the Isolated treatment of which 23 in total received the High rate and 21 in total received the Low rate.

In the Mixed Treatments (denoted by "M"), all subjects first clicked on one of two boxes on the screen labeled "Rate A" or "Rate B", representing a 50% chance of being assigned each possible opportunity role. The rates 0.6 and 0.4 were randomly assigned to each box on a subject by subject basis so that preferences over labeling would play no role in the final determination of rates. Once subjects had the rate assigned to them, they were notified of the result. Thus, opportunity is heterogeneous across subjects in this treatment, and subjects are made aware of this fact in the instructions. A total of 65 subjects received the Mixed treatment.

3.4 Information Conditions within Treatments

In the No Information Treatments (denoted by "N"), subjects were told only of their own payoff after each round and their cumulative net earnings earned thus far. No information was provided about the earnings performances of others. All subjects then progressed together to the next round.

In the Information Treatments, subjects are additionally shown the concurrent distribution of earnings among participants in the session via histogram displays. Anonymity is preserved in that in no subject's identity (real or experimental) is ever associated with his or her earnings in the display. Subjects thus have no way of tracking the individual performance of others over the course of the session and can only make generic comparisons. Thus any positional effects we find can be attributed to subjects' internal valuation of their social position, and not due to social image concerns or competition with a particular subject in the session.

We chose the histogram display due to its appeal in allowing subjects to easily digest the entire

[15] Downward manipulation of social ranking, conditional on other subjects wanting to perform well, can of course be deliberately achieved by failing to complete the effort tasks correctly. However, results from the effort task strongly indicate that subjects were trying to complete the effort tasks correctly (see Figure 4).

[16] Kuziemko et al (2014) also consider a level-k analysis of subjects' decisions, in which players form beliefs about whether other subjects in the session will take gambles to increase their social position, checking that under last place aversion, the last place individual will still have incentive to take risk if he takes strategic concerns into consideration. Since the randomization structure in our experiment is more complex, it is arguably even less likely that subjects will be able to think beyond one or two iterations of strategic considerations.

current distribution of earnings. Further, the histogram does not make any specific suggestion of how they should compare their earnings to the social distribution but provides them with all the information they would need to form a possible reference point. For each information treatment, an example histogram was provided, along with instructions on how to read it. Examples of the information screens are shown in the instruction manuals in the Appendix.[17]

In the (Detailed) Information Treatments (denoted by "D"), histograms for *each* rate type in the session, were shown to each subject in between rounds. In the Mixed version of these treatments, subjects are able to distinguish between high opportunity earners and low opportunity earners in the histogram display. In the Isolated Treatments, the social information histogram is "detailed" by default, since there is only a single opportunity level involved. In addition to reminding subjects of their own current earnings, subjects were also reminded of their own opportunity rate.

We also conducted an Aggregated Information Treatment (for the Mixed Treatment only, denoted with "A"), in which a single histogram was provided which aggregated the distribution of high and low opportunity subjects. We focus our analysis primarily on the Detailed Information treatments and corresponding No Information control treatments. We also analyze the Aggregated Information treatment, although we do not have an analogous treatment in the isolated opportunity case.

A summary of the main similarities and differences of our experimental design compared to the other related papers is listed in Table 1:

Table 1: Comparison of Experimental Features in Closely Related Research on Social Risk Attitudes

	Single reference individual vs distribution	*One shot vs. repeated*	*Effort Task*	*Anonymity*
Linde and Sonnemans (2012)	Single	One shot	No	No
Kuziemko, Buell, Reich and Norton (2014)	Distribution	One shot and repeated	No	Screen ID
Schwerter (2016)	Single	One shot	No	Yes
Muller and Rau (2019)[18]	Single	One shot	No	Yes
Current experiment	Distribution	repeated	Yes	Yes

To summarize, our design differs from the existing related studies in three main features, which we briefly describe here.

1. *Incorporation of effort:* Each of the aforementioned studies asks subjects to make decisions only over different lotteries, but no design thus far to our knowledge asks subjects to exert real effort for the experimental earnings which are the basis for their gambling choices.

A growing literature emphasizes the use of real effort in experiments to more closely mirror labor market settings in the real world (see for example, Gneezy and List, 2006). Our intention in including

[17] While we made no direct suggestion on how subjects should use the information in the display, subjects could often be observed by the experimenters checking their own current earnings (shown at the top of the information display) against the corresponding social position on the x-axis of the histogram, using their mouse.

[18] Muller and Rau (2019) additionally elicit social and risk preferences separately from the social risk decision to gauge within-person effects.

effort in the design is that requiring subjects to be psychologically vested in the consequences of their risk choices through more than monetary outcomes, might significantly alter incentives compared to a purely risky setting.

2. *Repeated interactions:* One issue in determining whether social placement affects risk-taking is that behavior in a one-shot decision may deviate significantly from long-run actual behavior. Kuziemko, Buell, Reich and Norton (2014) also address this concern by implementing both a one-shot and a repeated (cumulative earnings) version of their experiment, in order to better reflect realism. The other aforementioned studies focus on settings which are static.

Our experiment asks subjects to make a series of decisions under uncertainty, in between randomly assigned rounds of real effort tasks. At the same time, our design incorporates both external uncertainty (based on the assignment of tasks) and strategic uncertainty (based on the choices of other subjects) regarding a player's rank from round to round. We show that a participant in our experiment is unable to manipulate his or her social ranking, except by deliberately failing in the effort tasks, which subjects do not appear to do. Although the repeated nature of decisions does make the causal interpretation of results more complex than in the simpler one-shot case, we show that the risk-taking patterns we find in the aggregate are robust to individual subject heterogeneity and non-linear time trends. Across 20 round intervals, the patterns can often be visually confirmed in aggregate statistics on the appeal of the risky gamble. Together the results suggest that subjects' risky choices in the experiment were a reaction to their current status.

3. *Neutral information presentation:* In the experiment, we do not make any explicit suggestion about how subjects might value their earnings relative to the earnings of others. Crucially, each participant's performance is private information in the sense that it is completely anonymous and unlabeled in the information display. This contrasts slightly with the approach in Kuziemko et al (2014) in which due to the use of screen names in the experiment, risky choices *might* potentially be influenced by image concerns.[19]

Our design attempts to isolate subjects' internal valuations apart from other psychological factors. We provide subjects with a rich amount of information regarding how others are doing, in the form of a distribution display, without giving any suggestion about which social comparisons they might want to make. Importantly, in our design only each individual subject knows how he or she measures up to the other subjects. With this approach we aim to isolate the intrinsic risk preference at different points in the social distribution, apart from potential alternative explanations related to social image, such as embarrassment, prestige and etc.

3.5 Experimental Procedure

Experimental sessions were conducted in Tsinghua University's Economic Science and Policy Experimental Laboratory (ESPEL), and 109 subjects were recruited from the campus-wide subject pool using the ORSEE recruiting system.[20] The experiment was run using the software z-Tree (Fishbacher, 2007). The experimental sessions were run on April 6th 2013 and April 13th 2013. Each subject participated in only one treatment, in order to avoid subject fatigue, cross-treatment spillovers or ordering effects.

All subjects in the experiment were given a 10 RMB (20 ECU) show up fee. Subjects were restricted from having final net earnings of less than 5 RMB. We enforced this constraint by restricting the periods that subjects could be assigned the Lottery Task conditional on their earnings; specifically, we imposed the Effort Task on subjects whenever they dropped below net earnings of 10 ECU. Subjects were clearly informed of this rule in the instructions, and were reminded of it the first

[19] In their study, real names were not used, but subjects had screen names which served as anonymous identifiers in the public information display in each round of play.

[20] Our number of subjects is comparable to the related experiments in the literature.

time (if applicable) they dropped into the range of the constraint. This bankruptcy rule is analogous to having to work one's self out of debt.[21]

In all treatments subjects are clearly informed in the beginning of the experiment that their final earnings are determined only by their own outcomes. Thus, any significant effects of social position on risk taking that we find in the Information treatments, which we do not find in the No Information control groups, indicate behavioral effects induced by social knowledge.

Across all sessions, subjects were paid an average total of 48 RMB, with the lowest payment 8.5 RMB, and the highest payment 81.5 RMB. One session of each opportunity-information treatment combination implied by Sections 2.3 and 2.4 was conducted. Instruction manuals for each treatment provided to respective subjects at the beginning of each session, are provided in the Appendix.

4. Aggregate Summary Statistics

Table 1 shows summary statistics on counting performance and lottery choices for each session by treatment. We make a few general observations.

First, the large gamble for most treatments was slightly more popular than the small gamble, surpassing our expectations of subjects' willingness to take the large gamble. This is also striking given the possibility of subjects' loss aversion after completing a Effort Task, in that choosing the large gamble risks losing the earnings from the most recent two Effort Tasks completed correctly. In the Random mixed treatments the rate of take-up of the large lottery is significantly different among high types compared to low types. The remainder of the paper explores more precisely when the large gamble tends to be popular.

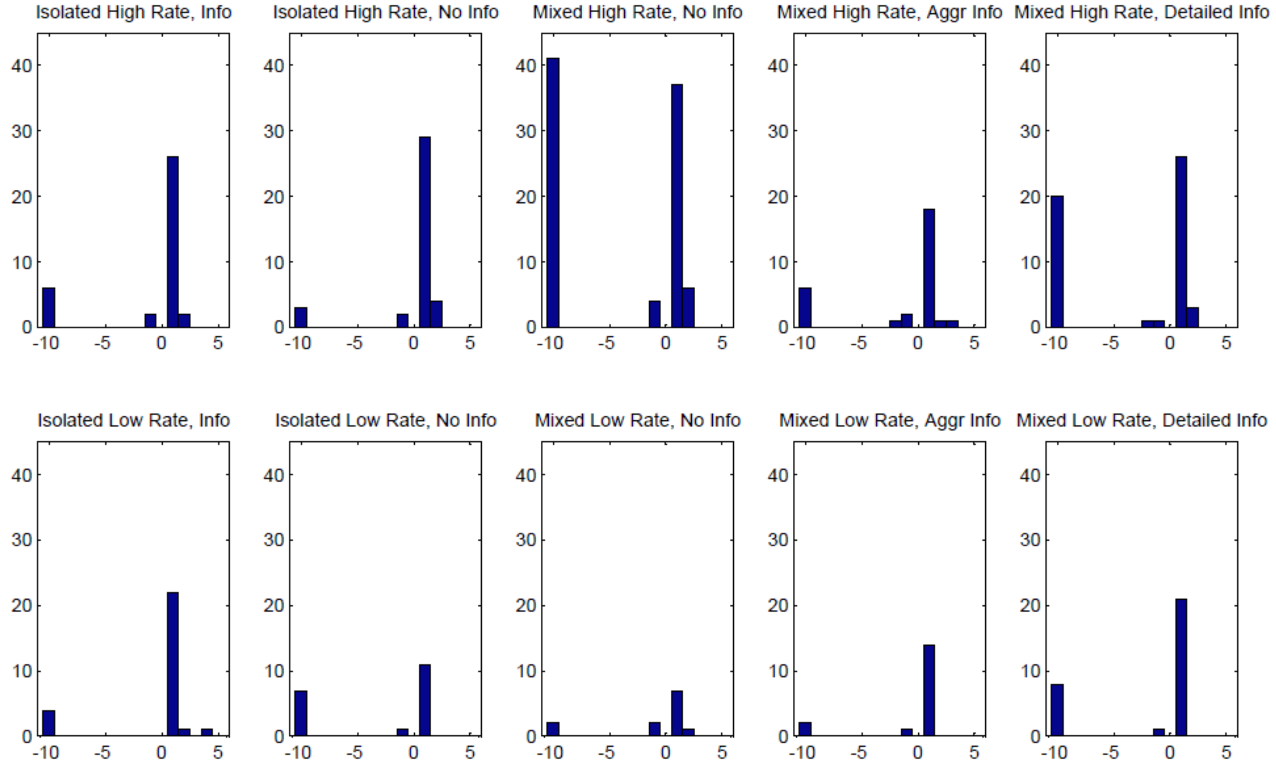
Table 2: Summary Statistics by Treatment

	Isolated High rate, No information (HN)	Isolated Low rate, No information (LN)	Isolated High rate, Detailed information (HD)	Isolated Low rate, Detailed information (LD)	Mixed rate, No information (MN)	Mixed rate, Aggregate information (MA)	Mixed rate, Detailed information (MD)
% incorrect, Effort Task - High rate	7.1	-	6.2	-	15.9	9.8	15.6
% incorrect, Effort Task - Low rate	-	6.8	-	7.3	4.8	3.3	5.7
% Large lotteries chosen - High rate	64.2	-	48.9	-	63.1	52.9	74.1
% Large lotteries chosen - Low rate	-	46.3	-	60.7	69.7	62.2	66.8
High opportunity	11	-	12	-	18	9	11
Low opportunity	-	9	-	12	5	11	11
Total subjects	11	9	12	12	23	20	22

[21] Our bankruptcy rule provides some degree of insurance to subjects against losses incurred in the lottery tasks. However, even though subjects are guaranteed effort tasks to work out of the debt, it is reasonable to think that subjects are sufficiently motivated to earn beyond the lower bound amount.

Figure 4: Frequency of mistake types in the Effort Task

(bars represent frequencies of correct answer – subject answer; -10 indicates answers left blank)



Subjects were mostly accurate in the effort task, with at least 85% of counting tasks being answered correctly in any given session. This indicates that success in the Effort Task was achievable for all subjects. We did not find signs of fatigue driven errors; subjects generally increased their accuracy in the effort task over time. In the mixed rate treatments, the error rate in the Effort Task was notably higher for the high rate individuals, compared to the error rate of the low rate individuals.

Figure 4 shows the tabulations of the types of mistakes (correct answer minus subject's answer) made in the Effort Task. For comparison purposes, answers left blank are coded with a value of -10. No answer supplied was off by more than 3. Notice that in each treatment, the bar directly to the right of zero is higher than the bar directly to the left, which implies that most mistakes were a result of *missing one* of the requested target digits rather than over-counting. The fact that most of the incorrect answers were 'close', implies that pure guessing was rare.

4.1 Experimental Validity

In order for our experiment to be valid *within treatment*, we need to show that social rankings are essentially exogenously determined in the experiment. To do this, we need to address two main points: 1. Are subjects' choices in prior rounds correlated with their current social position? 2. Are subjects who rank especially high and especially low socially, merely those subjects who choose the large gamble most frequently?

Question 1 is addressed in Appendix A. The main result is that subjects' previous choices in either the Effort Task answers or the lottery selection, are not significantly or consistently correlated with their current social position at any point in the experiment. However, subjects' current choice in the lottery task is significantly correlated with their social position one period ago (as further explored in Section 5).

Question 2 is addressed in Appendix B. The main insight is that even though theoretically speaking, if we offer *only* Lottery Tasks in the experiment, subjects with higher risk-taking will be placed in the tails of the distribution in the limit, this is actually not true in our experiment. The primary reason is that our treatments include effort tasks which (behaviorally) interact with the Lottery Tasks such that theoretical intuition in the case of exclusive Lottery Tasks does not hold. The secondary reason is that there are generally not enough Lottery Tasks per person for this limiting argument to hold. Thus the empirical results we find in the data are robust to time trends.

While these robustness checks do address these two questions systematically, we point out that our main econometric analysis in Section 5.2 relies on cross-treatment identification. Any endogeneity concerns regarding effects found within specific treatments cannot explain the differential effects found between the social information and non-information treatments.

5. Social Positional Effects on Risk-Taking

Our main analysis focuses on the effect of subjects' concurrent placement in the social distribution on their propensity to take the large gamble in the Lottery Task. We calculate the concurrent percentile ranking of subjects within their relevant cohort by ranking subjects each period by their current earnings, then applying the formula: $percentile\,rank_{i,t} = \frac{earnings\,order_{i,t}}{N}$, where N is the relevant number of subjects in the cohort. If two or more subjects tie for the n^{th} highest earnings level, they are both ranked n^{th}. Percentile rank is our main explanatory variable of interest. We also estimate specifications which control for nominal earnings and possible time trends in risk-taking.

Appendix B shows time path of percentile rank for individual subjects for selected information treatments.[22] Subjects were likely to have found themselves in different percentile rank positions during the experiment. While there is significant variation in percentile ranking within subject over time, there is also visible path dependence by subject. As discussed in Section 4.1 and the Appendix, these percentile outcomes are assigned randomly across subjects. Our identification of the effect of percentile rank on risk-taking can thus be derived from both across person variation in percentile outcomes, or within person variation across time. To capture these two sources of variation, we consider both logit specifications with and without subject fixed-effects, where the specifications with subject fixed-effects rely *only* on the within-subject variation.

5.1 Results by Treatment

We first report regression results for each treatment separately. In Section 5.2, we combine the data from all treatments together to test the marginal impact of the various treatment conditions. Throughout, our main explanatory variable of interest is subjects' percentile rank in the social distribution.

We include both a linear term for percentile rank and the squared percentile rank, which estimates the possible concave or convex relationship between social ranking and risk-taking. If the reference-dependent loss aversion hypothesis with reference point near the social median holds, we would expect to see a quadratic relationship where the coefficient on the squared ranking term is *significantly positive*. In this case, the coefficient value on the linear term indicates the location of the reference point in the social ranking space.

We also considered a specification which instead of treating ranking as a continuous variable, divided the percentile ranks into quantiles (0% to 20%, etc.), including indicator variables for placement into each quantile. The results are similar, and we report the continuous variable results here since they provide a more comprehensive description of the average risk-taking pattern across the distribution.

[22] Out of space concerns we include only profiles from the information treatments, however the profiles of the no information treatments are similar.

Tables 3 through 6 show the results by treatment, separated by Low opportunity and High opportunity subjects. Out of space considerations, we show only the regressions with subject fixed effects in the text - the analogous regressions without subject fixed effects can be found in the Appendix, showing similar results. For each table, the panel on the left shows the information treatment, while the panel on the right shows the analogous no information estimates.

The first result of note is that there was no significant effect of the ranking or ranking squared variables in any of the no information treatments (Tables 3 through 6). Differences in coefficient estimates between the information and no information treatments indicate an effect of the social information provided.

A second observation is that when the quadratic term on ranking was precisely estimated for Low opportunity subjects, it was *positive* in value, while for the High opportunity subjects, the quadratic coefficient was *negative*. Thus, subjects placed into Low opportunity roles had risk taking tendencies which were convex in social ranking, as predicted by the presence of a reference point somewhere near the middle of the distribution. Subjects placed into the High opportunity roles, had risk taking estimated as being concave in social ranking. In particular, (as Section 5.3 shows) subjects tended to be conservative at the top of the distribution. This is consistent with high opportunity subjects holding a reference point near the top of the social distribution.

Since our main analysis focuses on the no information and (detailed) information treatments, we relegate the analogous treatment regression results for the aggregate (mixed opportunity) information session to the Appendix. In summary, no particular robust pattern in risk-taking was found in this treatment. Further work is needed to understand the role that the level of information detail plays in risk-taking behavior.

Table 3: Fixed Effects Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	Low opportunity, with information						***Low opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	-0.3937**	*0.050*	-0.3919*	*0.061*	-0.0131	*0.963*	-0.1836	*0.427*	0.0932	*0.721*	-0.1232	*0.724*
	(0.2005)		(0.2096)		(0.2853)		(0.2311)		(0.2605)		(0.3492)	
rank squared	0.0219	*0.159*	0.0256	*0.126*	0.0086	*0.651*	0.0171	*0.447*	-0.0067	*0.792*	0.0082	*0.781*
	(0.0156)		(0.0167)		(0.0191)		(0.0224)		(0.0254)		(0.0294)	
current earnings			-0.0275*	*0.098*	-0.1295**	*0.021*			-0.0425**	*0.021*	-0.0065	*0.876*
			(0.0166)		(0.0559)				(0.0184)		(0.0414)	
current earnings squared			0.0002	*0.376*	0.0008**	*0.047*			0.0005**	*0.04*	0.0002	*0.536*
			(0.0002)		(0.0004)				(0.0002)		(0.0004)	
round					0.0761*	*0.099*					-0.0392	*0.291*
					(0.0462)						(0.0371)	
round squared					-0.0004	*0.268*					0.0003	*0.322*
					(0.0004)						(0.0003)	
subject fixed effects?	yes		yes		yes		yes		yes		yes	
N	9		9		9		9		9		9	
Observations	432		432		432		439		439		439	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Table 4: Fixed Effects Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	High opportunity, with information						***High opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	0.4074*	*0.086*	0.4106*	*0.096*	0.5058*	*0.085*	-0.3141	*0.262*	-0.3283	*0.256*	0.0810	*0.815*
	(0.2371)		(0.2466)		(0.2933)		(0.2802)		(0.2891)		(0.3467)	
rank squared	-0.0406**	*0.030*	-0.0407**	*0.044*	-0.0413*	*0.059*	0.0252	*0.356*	0.0227	*0.416*	0.0030	*0.920*
	(0.0187)		(0.0202)		(0.0218)		(0.0273)		(0.0280)		(0.0303)	
current earnings			-0.0037	*0.796*	-0.0381	*0.422*			0.0030	*0.864*	-0.1421**	*0.039*
			(0.0145)		(0.0475)				(0.0175)		(0.0687)	
current earnings squared			0.0000	*0.828*	0.0001	*0.798*			0.0000	*0.868*	0.0007*	*0.080*
			(0.0001)		(0.0002)				(0.0002)		(0.0004)	
round					0.0269	*0.636*					0.1604**	*0.036*
					(0.0569)						(0.0764)	
round squared					0.0001	*0.768*					-0.0008	*0.162*
					(0.0004)						(0.0006)	
subject fixed effects?	yes		yes		yes		yes		yes		yes	
N	10		10		10		9		9		9	
Observations	313		313		313		287		287		287	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Table 5: Fixed Effects Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	Mixed Low opportunity, with information						***Mixed Low opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	-0.7825***	*0.001*	-0.8014***	*0.002*	-0.9740***	*0.002*	0.7362	*0.312*	0.7969	*0.329*	0.5182	*0.596*
	(0.2442)		(0.2639)		(0.3134)		(0.7283)		(0.8169)		(0.9775)	
rank squared	0.0508**	*0.021*	0.0598**	*0.015*	0.0745***	*0.005*	-0.1122	*0.416*	-0.0601	*0.699*	-0.0331	*0.843*
	(0.0219)		(0.0246)		(0.0264)		(0.1379)		(0.1553)		(0.1670)	
current earnings			-0.0163	*0.251*	0.0068	*0.838*			-0.0499	*0.123*	-0.0312	*0.519*
			(0.0142)		(0.0331)				(0.0323)		(0.0483)	
current earnings squared			0.0001	*0.753*	-0.0002	*0.490*			0.0004	*0.328*	0.0003	*0.519*
			(0.0002)		(0.0002)				(0.0005)		(0.0005)	
round					-0.0564**	*0.047*					-0.0115	*0.767*
					(0.0284)						(0.0387)	
round squared					0.0006*	*0.056*					0.0000	*0.941*
					(0.0003)						(0.0004)	
subject fixed effects?	yes		yes		yes		yes		yes		yes	
N	10		10		10		4		4		4	
Observations	476		476		476		197		197		197	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Table 6: Fixed Effects Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	Mixed High opportunity, with information						***Mixed High opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	0.5556*	*0.061*	0.7753**	*0.015*	0.4776	*0.307*	0.1749	*0.203*	0.1352	*0.350*	0.0386	*0.808*
	(0.2966)		(0.3200)		(0.4672)		(0.1375)		(0.1447)		(0.1590)	
rank squared	-0.0525**	*0.041*	-0.0711***	*0.010*	-0.0561*	*0.096*	-0.0095	*0.195*	-0.0060	*0.441*	-0.0035	*0.673*
	(0.0257)		(0.0277)		(0.0337)		(0.0074)		(0.0078)		(0.0083)	
current earnings			-0.0450*	*0.057*	0.0131	*0.810*			0.0043	*0.719*	0.0277	*0.192*
			(0.0236)		(0.0546)				(0.0119)		(0.0213)	
current earnings squared			0.0003	*0.206*	-0.0001	*0.769*			-0.0001	*0.361*	-0.0001	*0.302*
			(0.0002)		(0.0003)				(0.0001)		(0.0001)	
round					-0.1144*	*0.079*					-0.0209	*0.462*
					(0.0651)						(0.0285)	
round squared					0.0010**	*0.037*					0.0000	*0.969*
					(0.0005)						(0.0003)	
subject fixed effects?	yes		yes		yes		yes		yes		yes	
N	7		7		7		15		15		15	
Observations	218		218		218		454		454		454	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

5.2 All Data Regression

Thus far we have considered each treatment separately in our regression analyses in order to test whether the risk-taking patterns within each treatment hold. We would like to check whether these patterns remain robust in a single regression in the pooled data across treatments, with indicator variables and interaction terms to estimate the effect of social ranking under the different experimental conditions.

Table 7 shows four Logit specifications, which include the data from all no information and detailed information treatments. We consider specifications with subject fixed effects (columns (2) and (4)) as well as specifications without fixed effects (columns (1) and (3)). Columns (1) and (2) include earnings and earnings squared terms as control variables, while columns (3) and (4) include the analogous terms for the number of rounds played thus far. As Table 6 shows, the number of rounds played is included in the regression, the coefficients on current earnings are no longer significant.

Across the specifications we observe the same signs and approximately similar magnitudes of coefficients on the relevant variables. The main results can be seen by focusing on the rows showing the coefficients on the interaction of rank squared and information (*rank squared*information*), and the interaction of rank squared, information, and the indicator variable for low opportunity type (*rank squared*information*lowtype*). The clearest results are seen from the regressions with subject fixed effects (columns 2 and 4). While rank and rank squared themselves are statistically insignificant in the regressions, the interaction terms on rank and social information are significant, showing that the presence of social information significantly influenced risk-taking, whereas no such effects were present when subjects did not possess social ranking information.

As in the previous section, we are especially interested in the squared interaction terms. The interaction on rank squared, information, and low opportunity (*rank squared*information*lowtype*) yielded a significantly positive coefficient, while the interaction on rank squared and information alone (*rank squared*information*) yielded a significantly negative coefficient. This is consistent with our treatment-specific regressions in the previous section which found that the likelihood of taking the large lottery tends to be convex in social position for low opportunity subjects, and concave in social position for high opportunity subjects. Thus, the results are indeed robust in the aggregate, and tend to be stronger when controlling for individual subject fixed effects.

Table 7: Logit regression, Dependent Variable: Large Lottery Taken Conditional on Lottery Task

	(1)		(2)		(3)		(4)	
	Coefficient	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*
current earnings	-0.0148***	*0.006*	-0.0130**	*0.016*	0.0071	*0.510*	0.0104	*0.338*
	(0.0054)		(0.0054)		(0.0108)		(0.0109)	
current earnings squared	0.0001*	*0.100*	0.0001	*0.182*	0.0000	*0.580*	-0.0001	*0.378*
	(0.0001)		(0.0001)		(0.0001)		(0.0001)	
round					-0.0312***	*0.010*	-0.0329***	*0.007*
					(0.0122)		(0.0122)	
round squared					0.0003**	*0.031*	0.0003**	*0.025*
					(0.0001)		(0.0001)	
information	0.8983	*0.154*			0.9166	*0.148*		
	(0.6300)				(0.6337)			
lowtype	0.6008	*0.290*			0.7382	*0.200*		
	(0.5680)				(0.5761)			
rank	0.0956	*0.238*	0.0829	*0.308*	0.0008	*0.993*	-0.0180	*0.845*
	(0.0811)		(0.0813)		(0.0920)		(0.0922)	
rank squared	-0.0032	*0.541*	-0.0034	*0.512*	0.0015	*0.786*	0.0015	*0.783*
	(0.0052)		(0.0052)		(0.0055)		(0.0055)	
rank*information	0.1646	*0.372*	0.3809*	*0.058*	0.1581	*0.393*	0.3810*	*0.059*
	(0.1844)		(0.2011)		(0.1853)		(0.2021)	
rank squared*information	-0.0271*	*0.070*	-0.0398**	*0.013*	-0.0258*	*0.085*	-0.0390**	*0.015*
	(0.0149)		(0.0160)		(0.0150)		(0.0161)	
rank*information*lowtype	-0.7036***	*0.001*	-1.0148***	*0.000*	-0.7104***	*0.001*	-1.0326***	*0.000*
	(0.2061)		(0.2400)		(0.2073)		(0.2412)	
rank squared*information*lowtype	0.0597***	*0.001*	0.0789***	*0.000*	0.0594***	*0.001*	0.0794***	*0.000*
	(0.0175)		(0.0196)		(0.0176)		(0.0197)	
subject fixed effects	No		Yes		No		Yes	
Obs	3363		2816		3363		2816	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

5.3 Time Persistence

Sections 5.1 and 5.2 showed that there were significant effects of social position and social information provision on risk-taking, which persisted once controlling for nominal earnings levels, possible time trends in risk-taking, and individual fixed-effects. While the regressions show our robust statistical results clearly, it may still be illustrative to view the raw data.

In this section we directly tabulate the fraction of large gambles taken, out of lottery tasks which were randomly assigned, by percentile ranking quantiles. We further divide these tabulations by 20 round intervals to check the robustness of the pattern across time. The patterns in the regressions can often be seen from these tabulations, in that coefficients that are estimated precisely typically have a time-persistent pattern.

This also provides a cross-check on potentially more complex path-dependent relationships between previous ranking statuses and risk choices. That is, one possible complication is that individuals incorporate not only their current ranking, but some function of *all their previous historical rankings* into their risk choice. If this is the primary driving factor behind the risk choices, we should not expect to see the same repeating pattern in risk choices across all quantiles in the time subsamples. Yet, if the pattern across quantiles is consistent in each time subdivision, there is a strong case that what we have picked up in the previous regressions is truly the impact of concurrently being placed in a particular quantile on the propensity to take on risk.

The panels below divide the 80 rounds into four sections, plotting the proportion of large lotteries taken during each 20 round section as a fraction of all lottery tasks offered during those rounds. Each chart is further subdivided by social distribution quantiles (labeled 1 through 5 on the x-axis). The right-most chart in each panel shows the total proportions over all 80 rounds.

Figure 5: Large gambles taken by ranking quantile: Low Opportunity

(top right: isolated treatment; top left: mixed treatment (own opportunity); bottom: mixed treatment (aggregate opportunity))

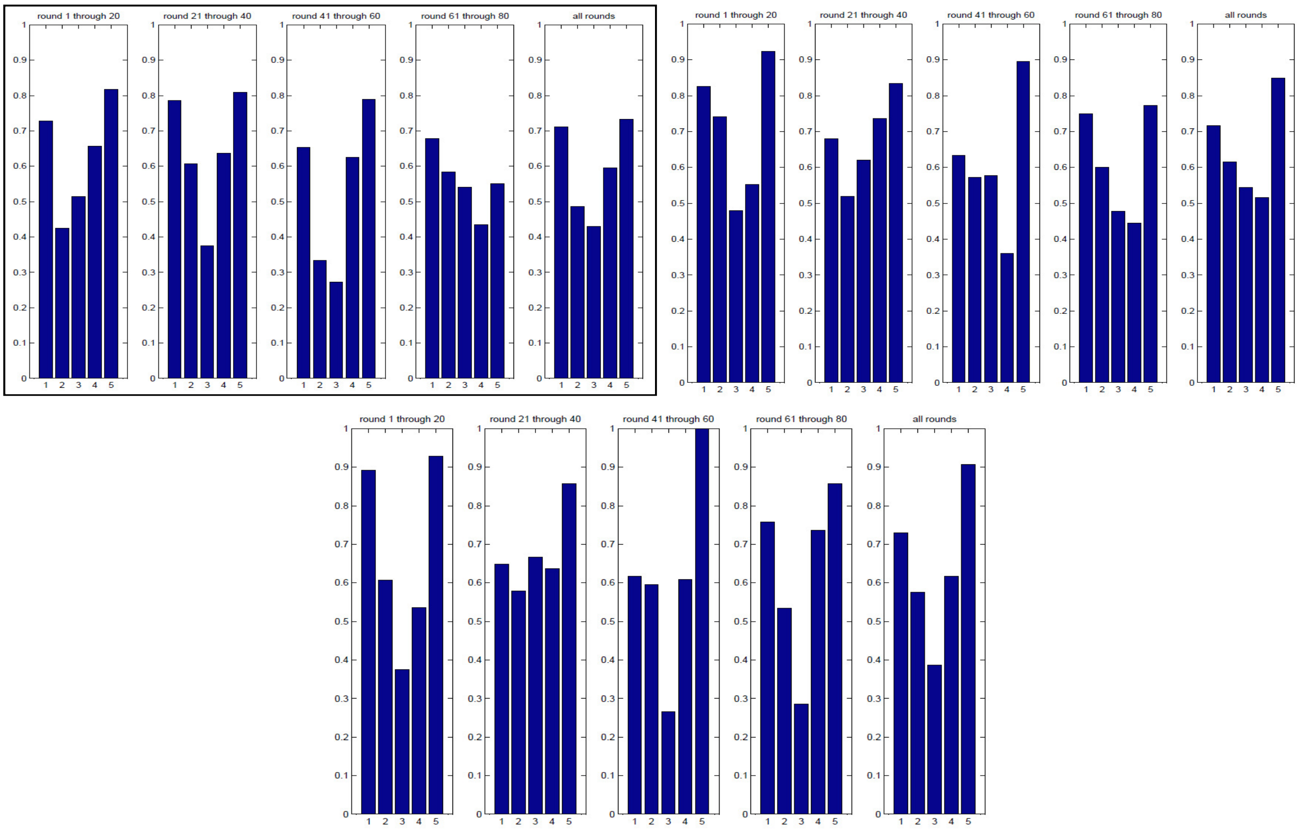


Figure 6: Large gambles taken by ranking quantile: High Opportunity

(top right: isolated treatment; top left: mixed treatment (own opportunity); bottom: mixed treatment (aggregate opportunity))

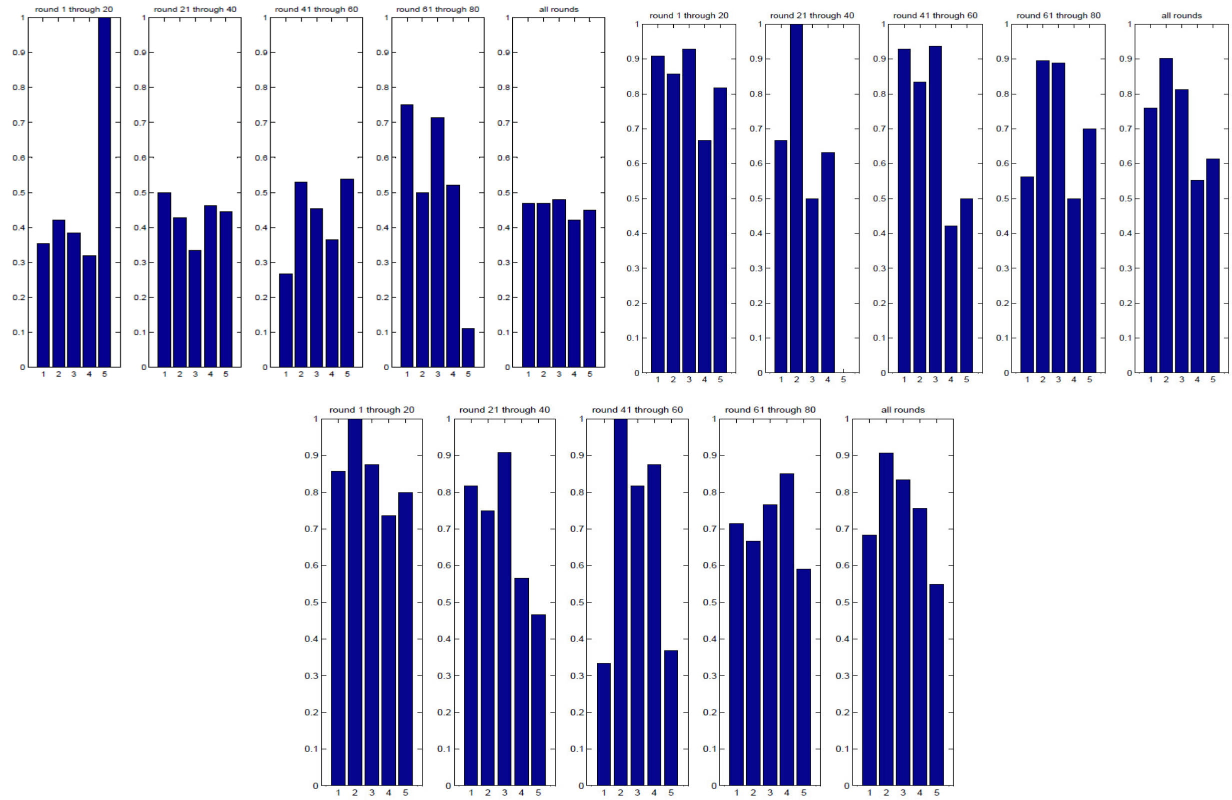


Figure 5 shows the quantile tabulations by time intervals for low opportunity subjects in treatments where social information was available, and Figure 6 shows the analogous charts for high opportunity subjects. The top-right and bottom panels plot data for identical sessions, but with different ranking criteria – the top-right panel considers rankings based on subjects' own opportunity levels, while the bottom panel considers aggregate rankings which include both opportunity levels. A caveat in interpreting these charts is that they are only tabulations of proportions of large lotteries taken, without denoting how many lottery tasks actually appeared in each quintile. The regressions, which condition on the arrival of a lottery task, are thus better suited to interpretation.

The figures show visually what was found in the regressions in the previous sections – that is, the convex relationship between social position and risk taking for low opportunity individuals, as well as the concave relationship for high opportunity individuals.

6. Supporting Evidence from the NLSY

We would now like to investigate whether our experimental results have external validity relative to the general population, under non-experimental measures of risk and opportunity. To explore this, we utilize the US National Longitudinal Survey of Youth (NLSY97), which asked respondents several questions about their attitudes towards taking risks in a 2010 module. We focus on the general risk question and the financial risk question since these are the concepts closest to what our context-free risk experiment is most likely able to measure.

While we cannot expect our results from NLSY to be as clean as in our more sterile experimental setting, the NLSY serves as a useful cross-check that behavior in the experiment mirrors some basic patterns about risk attitudes in the field as a function of social distribution position. We note that it would be difficult to draw conclusions about the relationship between risk-taking and social earnings position based on the NLSY data alone, due to many possible confounding factors such as selection effects, endogeneity of risk attitudes and earnings, and so on. Thus, the laboratory experiment serves as our primary method of this study, while the NLSY data serve as an external validity check.

In the general risk question, respondents were asked "Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Rate yourself from 0 to 10, where 0 means 'unwilling to take any risks' and 10 means 'fully prepared to take risks'. In the financial risk question, respondents were asked to rate their willingness to take risks on the exact same scale, except "in financial matters". We categorize respondents who replied 6 or above as "high risk-taking", and also consider respondents' direct response to the question as a measure.[23]

To proxy for the concept of opportunity (or expected earnings in our experiment), we use whether the respondent (ie. the head of household) possesses at least a 4 year college degree or higher level of education. Respondents were of ages between 26 and 30 at the time of the risk module, past the typical age of college students; so the higher education experience is likely to have already been completed (or not) at that time. Numerous studies show that in the US, having graduated from college predicts a substantially higher expected earnings level than graduating only from high school or below (see Oreopoulos and Petronijevic, 2013 for a survey of evidence). Thus, holding a 4 year college degree is a reasonable yet simple proxy for respondents' future expected earnings.

We assign households to income quantiles based on their labor and business incomes, and approximate the quantile categories of the US income distribution using income quantile figures provided by the US Census Bureau.[24] We limit the analysis to those urban households who provided responses to the NLSY free response questions about their income, as well as answering the risk questions in 2010, leaving a sample of 3479 households.[25] Social information is clearly a feature of our experiment which we cannot control in the field data. Our simple analysis assumes that in the field, respondents are largely aware of their relative position in the earnings distribution within society.

Figures 7 and 8 show the fraction of 'high risk' individuals across the income quantiles for the general risk and financial risk question, for non-college graduates (left panel) and college graduates (right panel). Two observations are apparent: First, the shape of risk seeking tendencies across the income distribution for college graduates is markedly different from the pattern for non-college graduates; Secondly, non-college graduates tend to show the highest risk-tendencies at the bottom and top of the income distribution, similar to the behavior of low opportunity subjects in the experiment. For college graduates in the NLSY, risk-seeing shows an overall, non-convex pattern, with the highest risk-taking tending not to take place at the extremes of the distribution. Our experimental results found that risk-taking is generally concave in social earnings position among high opportunity individuals. The survey results for college graduates are similar in that risk-taking is on average, more popular in the middle of the distribution than at the extremes.

Tables 8 and 9 show the significance levels of t-tests for differences in means for the high risk-taking variables across the different income quantiles. We conduct t-tests as well for the

[23] We used 6 as the cutoff due to the fact that it is above the halfway mark on the 0 to 10 scale, and also since empirically, 5 was a modal response for these risk questions. Although we also consider the raw reported risk level, individual heterogeneity in self-assessing risk attitudes may make the 'above 5' threshold a more reasonable measure.

[24] Specifically, we used the following rounded cutoffs from the Census: 1st quintile between 0 and 20,000; 2nd quintile between 20,000 and 38,000; 3rd quintile between 38,000 and 62,000; 4th quintile between 62,000 and 100,000; 5th quintile above 100,000 (source http://www.census.gov/hhes/www/cpstables/032011/hhinc/new05_000.htm).

[25] A small number of NLSY households who for some reason missed the risk module in 2010 were given the module in 2011. For simplicity, we examine only the 2010 respondents here.

difference in means for the level of stated risk taking (0 to 10). These results are similar and are shown in Appendix F.

Figure 7: High General Risk-Taking

(Replied 6 or more on a scale of 0 to 10; Left: non-college graduates, Right: college graduates; 95% confidence intervals in thin bars)

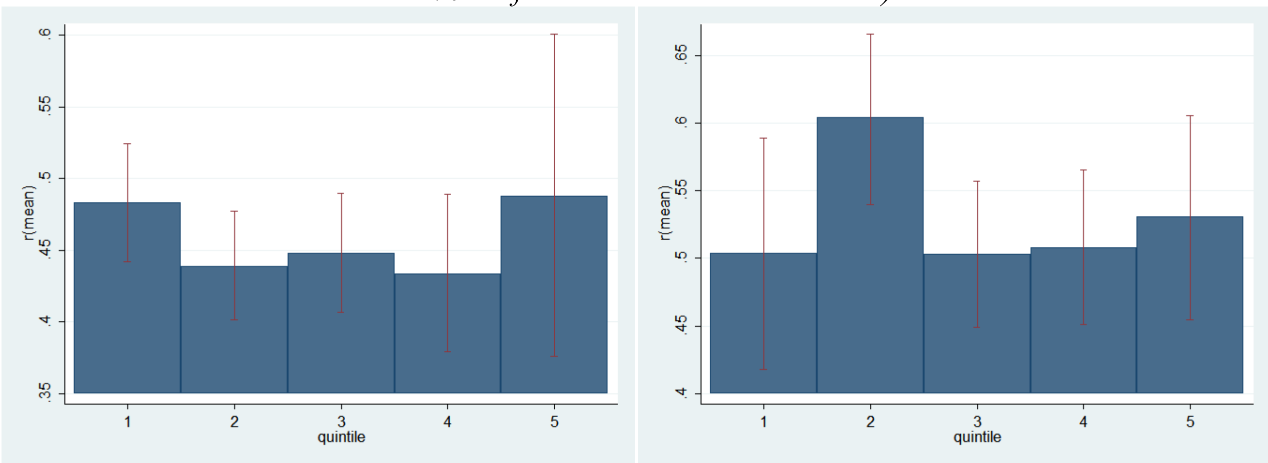


Table 8: High General Risk-Taking, Means tests by quantile pairs (p-values)

	High General Risk: Non-college graduates					*High General Risk: College graduates*				
	1	2	3	4	mean	1	2	3	4	mean
1					0.4831					0.5035
2	0.1144				0.4390	0.0569				0.6041
3	0.2310	0.7492			0.4480	0.9896	0.0146			0.5029
4	0.1459	0.8658	0.6706		0.4333	0.9290	0.0237	0.8945		0.5081
5	0.9369	0.4071	0.5035	0.3805	0.4878	0.6304	0.1335	0.5462	0.6305	0.5307

Figure 8: High Financial Risk-Taking

(Replied 6 or more on a scale of 0 to 10; Left: non-college graduates, Right: college graduates; 95% confidence intervals in thin bars)

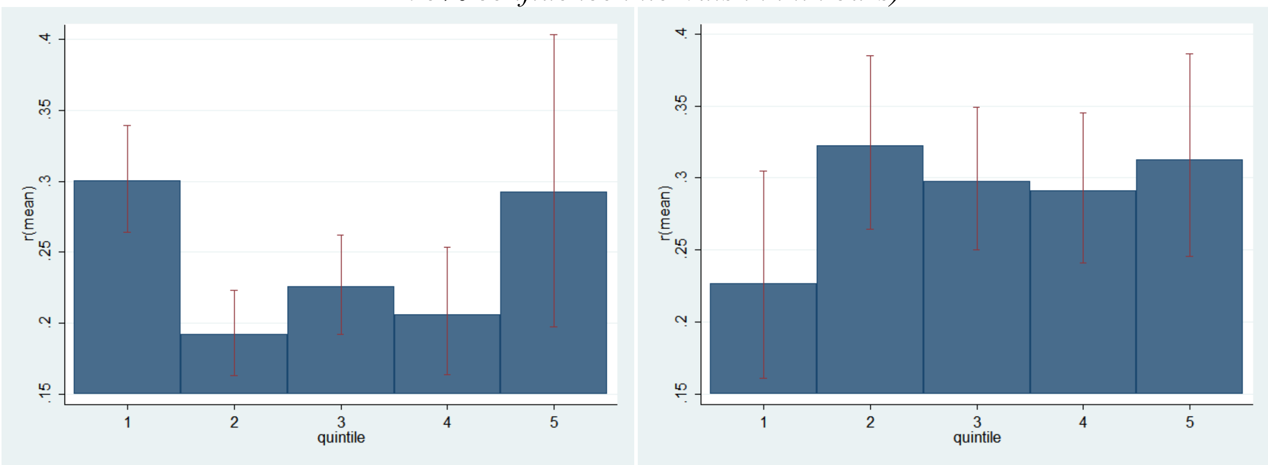


Table 9: High Financial Risk-Taking, Means tests by quantile pairs (p-values)

	High Financial Risk: Non-college graduates					*High Financial Risk: College graduates*				
	1	2	3	4	mean	1	2	3	4	mean
1					0.3007					0.2270
2	0.0000				0.1919	0.0402				0.3224
3	0.0037	0.1430			0.2257	0.1020	0.5231			0.2977
4	0.0013	0.5976	0.4882		0.2061	0.1436	0.4309	0.8573		0.2913
5	0.8825	0.0589	0.2140	0.1197	0.2937	0.0843	0.8343	0.7221	0.6187	0.3128

To check whether these patterns are robust once controlling for basic demographic characteristics, we run simple regressions controlling for household location variables (Census and MSA categorization), gender and age. We include dummy variables for each quantile of the income distribution, using the median quantile as the comparison group. We use the quantile approach instead of estimating a quadratic term as we did in the experimental data, due to the large variation in income levels across households which makes the field data less precise than data from the experiment. The regression results for both the high-risk respondent as the dependent variable, and for levels of reported risk, are shown in Appendix F.

Overall, the survey data support the notion that willingness to take risk varies significantly according to individuals' placement in a social earnings distribution. The data also support that the relationship differs according to one's expected earnings level, with the relationship tending to be more convex for individuals with lower expected lifetime earnings, while being more concave for those with higher expected lifetime earnings.

7. Conclusions

How does one's social position within a distribution affect the desire to take risks? We use reference-dependent loss aversion, with utility as a function of relative social position, as a starting hypothesis. An attraction of the reference-dependent model for social settings is that it provides a simple framework to potentially address a wide range of behaviors. If the social reference point is near the distributional median, we should find increased risk-taking moving away from the middle in either direction. By virtue of our experimental design, which considers both opportunity heterogeneity, and different levels of social information, we infer the reference point based on where subjects found the large lottery *least* attractive.

We find that the concept of opportunity levels, or expected 'lifetime' earnings, matters substantially in determining risk appetite across the social distribution. Low opportunity subjects largely adhere to the V-shaped risk-taking pattern predicted by loss aversion with a reference point located at the social median, with risk-taking being significantly more prevalent at either tail of the social distribution. High opportunity subjects on the other hand, estimated a significantly concave relationship in social position, with higher risks appearing more attractive near the middle of the distribution. These effects were not present in any of the control treatments without social information, and cannot be well-explained without some form of social reference-dependence.

A notable difference between social reference-dependence of the form we consider here, compared to reference-dependence with some form of relative *income* being considered, is that in our analysis there is a distinct upper and lower bound on one's relative position. An individual can do no worse in this framework than to be ranked in the lowest possible position (0^{th} percentile), and can do no better than to be ranked at the top of the distribution (100^{th} percentile). Thus if individuals care primarily about their social ranking, and their absolute earnings are a secondary concern yielding negligible marginal utility, then additional earnings which do not change an individual's social status can be represented by the dotted lines on the far left and right of Figure 1.

Figure 1 can explain why high opportunity individuals might be more risk averse at the top of the social distribution than at the median of the social distribution. Once such individuals are in the top social position, if additional money means relatively little to them, their existing social position becomes a point around which they are highly risk averse (concave kink around 100^{th} percentile). For loss aversion parameter values of around $\lambda = 2$, as frequently estimated in the literature on reference-dependent loss aversion, the kink at the 100^{th} percentile mark represents a greater marginal loss than falling from the kink at the median social value. When examining raw frequencies of selection of the large lottery, lower take-up of the large lottery at the top of the distribution was a driver of the concave estimated relationship for high opportunity subjects. While we did not observe this exact pattern in the NLSY data, particularly in the financial risk taking domain, it is possible that conservative attitudes may manifest in other decision contexts for high opportunity individuals in society near the top of the social distribution. We leave further exploration of this question for future work.

Figure 1 is also consistent with risk-taking behavior at the bottom of the distribution by low opportunity subjects. Low opportunity subjects were indeed more risk-loving at the bottom of the social distribution, as implied by the convex kink around the 0^{th} percentile, although loss aversion around the median is already sufficient to explain their increased risk-taking at the bottom of the distribution. Our findings among low opportunity subjects are consistent with the Last Place Aversion found in Kuziemko et al (2014), and suggest an additional reason why individuals in last place are especially risk-taking.

A key point is that we find the effects of these implicit reference (end) points only among the subjects of corresponding opportunity levels (the 100^{th} percentile endpoint for high opportunity subjects, and the 0^{th} percentile endpoint for low opportunity subjects), even though both endpoints in principle exist for all subjects. This suggests that expected earnings may be a critical factor in determining which of the possible reference point(s) people pay most attention to. Having lower opportunities to earn money may make individuals more sensitive to the presence of the 0^{th} percentile endpoint, while having higher earnings opportunity may make individuals more sensitive to the 100^{th} percentile endpoint. This suggests that incorporating real effort and opportunity into the experiment may have been instrumental in generating the results obtained.

An important future direction is to test the implications of social reference-dependence in the field in various contexts to reinforce the external validity of the findings beyond laboratory settings. While some evidence exists on risky behavior in the social distribution in the gambling and health domains, several other domains also carry important policy implications. In particular, knowing about individuals' risk preference as a function of their relative earnings status within society might be informative on how to target subsidies. For example, in the insurance realm, low earning individuals who expect to remain in the lower part of the earnings distribution may have less incentive to purchase insurance, if risk-seeking is indeed a consequence of a near-bottom position in society. On the other hand, individuals who are disadvantaged in terms of expectations, but near the top of their peer group might find entrepreneurship more attractive, all else equal. Such individuals, if liquidity constrained, may particularly benefit from small business loan subsidies or other encouragements to start up their own ventures. Relatively advantaged individuals at the top of their peer group, on the other hand, may hesitate on risky entrepreneurial endeavors, especially when they can compare themselves to their advantaged peers.

Our survey evidence from NLSY suggests that the findings from the experiment are not limited to the laboratory environment, but reflect actual differences in propensity to take risk across the income distribution. However, an obvious limitation of the NLSY analysis is that it is based on self-assessed risk attitudes rather than actual choices. Future work should explore risk attitudes across social distributions using actual decisions which are made naturally in different field contexts.

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Experiment Instruction Manual:

(For space concerns we have consolidated the instruction manuals for different treatments into one document. The parentheses after each boldfaced section heading specifies in which treatments those instructions appeared).

Participation Conditions: *(all treatments)* Thank you for your participation in this experiment, in which you will have an opportunity to earn money based on your choices made during this experimental session.

For scientific purposes, you are asked to refrain from talking aloud, disturbing other participants, accessing the internet, using cell phones, taking photographs, or reading other materials during the experiment. Any questions you have should be asked by raising your hand, and an experimenter will come to assist you privately. Participants who do not comply with these standards will be asked to leave the experiment, and may be barred from participating in future experiments.

By signing below, you agree to the conditions of participation. At the end of the session, you must return this Instruction Manual to the experimenters in order to receive your cash payment. Your show up payment is 10 RMB. The entire experiment will last approximately 1 hour and 30 minutes. Your personal identity in the experiment and any subsequent analysis of the experiment will remain anonymous.

X______________________________ Student ID ___________________________

Basic Information: *(for isolated rate treatment subjects only)* During this experiment you will be asked to perform two types of tasks where you will have the opportunity to earn money. One type of task is a counting task, where you will be paid for each correct answer you provide (we will call this the "Counting Task"). The other type of task is a lottery, where depending on your personal choice, you may win or lose money depending on the outcome of a random draw (we will call this the "Lottery Task").

In each round of the experiment, you will be asked to perform either the Counting Task or the Lottery Task, for a total of 80 rounds. Your likelihood of receiving each task type is determined randomly by a Rate 0.6 [0.4]. This will remain as your Rate for the entire experiment.

In each round, a combination of your Rate and a random number drawn from a uniform distribution on the [0,1] interval, in each period determine which task you will face in that round. The Rate of 0.6, means that in each round, you have a 60% chance of receiving a Counting Task, and a 40% chance of receiving a Lottery Task. [The Rate of 0.4, means that in each round, you have a 40% chance of receiving a Counting Task, and a 60% chance of receiving a Lottery Task.] Each period the likelihood of you receiving each task is fully independent of your choices and outcomes in previous periods, and is solely determined by the randomly generated number drawn in each period and your Rate. In particular, if your random number in a given period is equal to or below your Rate, you will receive the Counting Task, and if your random number is greater than your rate, you will receive the Lottery Task.

All earnings during the experiment are expressed in Experimental Currency Units (ECU). The conversion rate of ECU to Renminbi is 2 ECU = 1 RMB. Your earnings are solely determined by your individual choices, and outcomes in the experiment.

Each task will have a time limit of 30 seconds. If you do not make a selection by that time, a default will be selected for you in each task as described below.

At the end of 80 rounds, you will be asked to answer a short questionnaire. Do not enter any Chinese characters into the questionnaire as this will cause a major disruption to the server. Once you have finished the questionnaire you will be taken to the payment summary screen, which will summarize your earnings. You will then be called individually to receive your confidential payment for the session in cash.

Basic Information: *(for random mixed rate treatment subjects only)* During this experiment you will be asked to perform two types of tasks where you will have the opportunity to earn money. One type of task is a counting task, where you will be paid for each correct answer you provide (we will call this the "Counting Task"). The other type of task is a lottery, where depending on your personal choice, you may win or lose money depending on the outcome of a random draw (we will call this the "Lottery Task").

In each round of the experiment, you will be asked to perform either the Counting Task or the Lottery Task, for a total of 80 rounds. Your likelihood of receiving each task type is determined randomly by a Rate, either 0.6 or 0.4, to be determined randomly (with a 50% chance of each rate) in the first part of the experiment. This will remain as your personal Rate for the entire experiment.

In each round, a combination of your Rate and a random number drawn from a uniform distribution on the [0,1] interval, in each period determine which task you will face in that round. For example, if your Rate is 0.6, in each round, you have a 60% chance of receiving a Counting Task, and a 40% chance of receiving a Lottery Task. If your Rate is 0.4, in each round, you have a 40% chance of receiving a Counting Task, and a 60% chance of receiving a Lottery Task. Each period the likelihood of you receiving each task is fully independent of your choices and outcomes in previous periods, and is solely determined by the randomly generated number drawn in each period and your Rate. In particular, if your random number in a given period is equal to or below your Rate, you will receive the Counting Task, and if your random number is greater than your rate, you will receive the Lottery Task.

All earnings during the experiment are expressed in Experimental Currency Units (ECU). The conversion rate of ECU to Renminbi is 2 ECU = 1 RMB. Your earnings are solely determined by your individual choices, and outcomes in the experiment.

Each task will have a time limit of 30 seconds. If you do not make a selection by that time, a default will be selected for you in each task as described below.

At the end of 80 rounds, you will be asked to answer a short questionnaire. Do not enter any Chinese characters into the questionnaire as this will cause a major disruption to the server. Once you have finished the questionnaire you will be taken to the payment summary screen, which will summarize your earnings. You will then be called individually to receive your confidential payment for the session in cash.

Random Rate Selection: *(random mixed rate treatments only)* In the first stage of the experiment you will be asked to choose one of two buttons labeled “Rate A” and “Rate B”. Clicking on one of them will result in your Rate being 0.6, and clicking on the other will result in your Rate being 0.4. Which numerical Rate is associated with labels A and B is determined randomly and differs across individual participants. For each participant, the chance of getting each Rate is 50%.

Explanation of Tasks: *(all treatments)*

Counting Task:

If you receive a Counting Task, you will be asked to find the total number of two specified single digit numbers in a grid. If you answer correctly you will earn 2 ECU. If you answer incorrectly you will earn 0 ECU. If you do not enter an answer within 30 seconds, your response in that round will be marked as incorrect by default.

Example Counting Task: Please find the total number of “8” and “1” which appear in the grid below.
In this case, there are four 8’s and four 1’s, so the correct answer is 8.

0	8	6	5	4	2	1
3	3	4	6	5	7	8
2	5	2	6	9	7	4
7	9	2	5	1	3	6
2	3	6	9	4	2	1
9	8	9	3	5	2	3
9	7	5	8	2	1	3

Lottery Task:

Choose which option you prefer (select one and click the submit button):

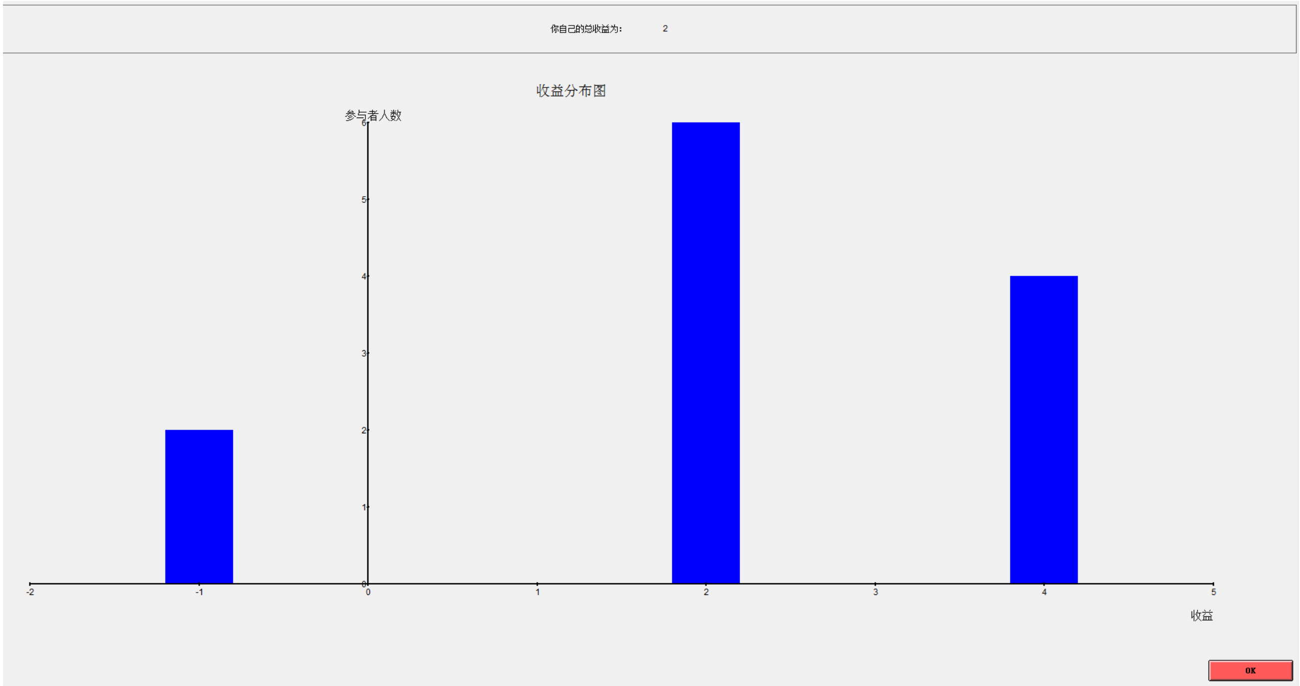
- o Win 4 ECU with probability 1/2, lose 4 ECU with probability 1/2
- o Win 1 ECU with probability 1/2, lose 1 ECU with probability 1/2

Based on your selection, the lottery will be conducted based on a random number draw, thus determining your earnings. If you do not make a selection and click “Submit” within 30 seconds, the second gamble (Win 1 ECU with probability 1/2, lose 1 ECU with probability 1/2) will be chosen for you as a default.

In some cases, the arrival of the Lottery Task and/or your selection of the lottery option within the task may lead to negative earnings. In this case, you will be allowed to risk up to 1/2 of your show up fee, or 10 ECU (5 RMB). If your total earnings in any particular period is at risk of dropping below this minimum level, you will be assigned a Counting Task, regardless of your Rate. This is in order to guarantee that each participant will receive a minimum payment for participation.

Information Display: *(mixed rate aggregate social information treatment, and isolated detailed social information only)* After each round, an information display will show the cumulative results in this experimental session so far, not including the show up payment. On the x-axis will be possible amounts of ECU earned. The y-axis displays the number of participants in the room who have current earnings of that particular amount of ECU. Your total earnings will be displayed at the top of the screen.

[translation of screenshot: (top row): Your current earnings; (graph title): earnings distribution; (x-axis): earnings; (y-axis): number of participants]

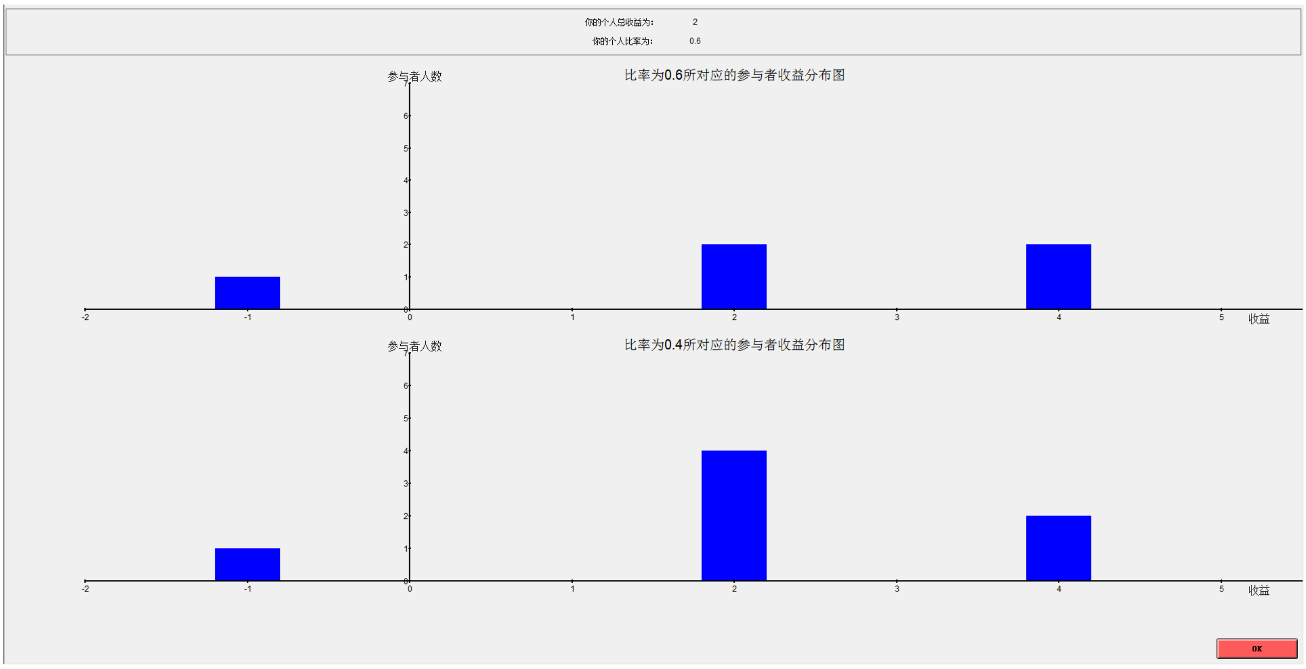


In this hypothetical example with 12 participants in the session, 4 participants have earned 4 ECU, 6 participants have earned 2 ECU, and 2 participants have a negative balance of -1 ECU. Your earnings are included in the histogram. Thus, in this example where you have total earnings of 2 ECU, you are one of the 6 participants shown in the 2 ECU column.

The display is to provide information regarding how other participants are doing, but your earnings for the experiment depend *only* on your own choices. You may press "OK" to proceed to the next round.

Information Display: *(mixed rate detailed social information treatment only)* After each round, an information display will show the cumulative results in this experimental session so far for participants in each Rate category, not including the show up payment. On the x-axis will be possible amounts of ECU earned within a particular Rate group. The y-axis displays the number of participants in the room who have current earnings of that particular amount of ECU. Your total earnings and your Rate will be displayed at the top of the screen.

[translation of screenshot: (top row): Your current earnings ___, your rate___; (top graph title): earnings distribution for 0.6 rate participants; (top x-axis): earnings; (top y-axis): number of participants; (bottom graph title): earnings distribution for 0.4 rate participants; (bottom x-axis): earnings; (bottom y-axis): number of participants]



In this example, among participants with a Rate of 0.4, 2 participants have earned 4 ECU, 4 participants have earned 2 ECU, and 1 participant has a negative balance of -1 ECU. Among participants with a Rate of 0.6, 2 participants have earned 4 ECU, 2 participants have earned 2 ECU, and 1 participant has a negative balance of -1 ECU. Since your Rate is 0.6, your earnings are included in the 0.6 Rate histogram. Thus, in this example where you have total earnings of 2 ECU, you are one of the 2 participants shown in the 2 ECU column.

The display is to provide information regarding how other participants are doing, but your earnings for the experiment depend *only* on your own choices. You may press “OK” to proceed to the next round.

Starting: *(all treatments)* If you encounter any difficulty with your computer during the session, or if you have a question about the experiment at any point, raise your hand and an experimenter will assist you privately. Please note that in between rounds, you may have to wait for other participants to make their choices before proceeding to the next round. If you have been waiting an especially long time and are concerned that your computer may be stuck, please raise your hand. If there are currently no questions, let us get started.

Appendix A : Experiment Validity

I. Correlation between previous choices and current social position

We might expect that an individual's history of correct Effort Task answers provided is positively correlated with his current social position. However, given the highly stochastic nature of realized payoffs in the design, we may or may not find such a relationship in the data. To show that our experiment is valid in randomly assigning social rankings in each round, we need to show that in each period there is *little if any* correlation between subjects' previous choice variables and their concurrent social position.

Figure A1 plots the period by period correlation between the proportion of a subject's Effort Tasks correct by round t-1 and his or her social position in t. A separate panel is shown for each treatment and opportunity level. The blue line denotes the value of the correlation coefficient, while the green line shows the corresponding p-value. To provide a benchmark, the green line falling below the red horizontal line indicates a p-value of at least 10%.

Figure A1: Correlations: Proportion of Effort Tasks correct by t-1, Social ranking in t

(blue line denotes correlation coefficient, green line denotes p-value, red line denotes 10% threshold)

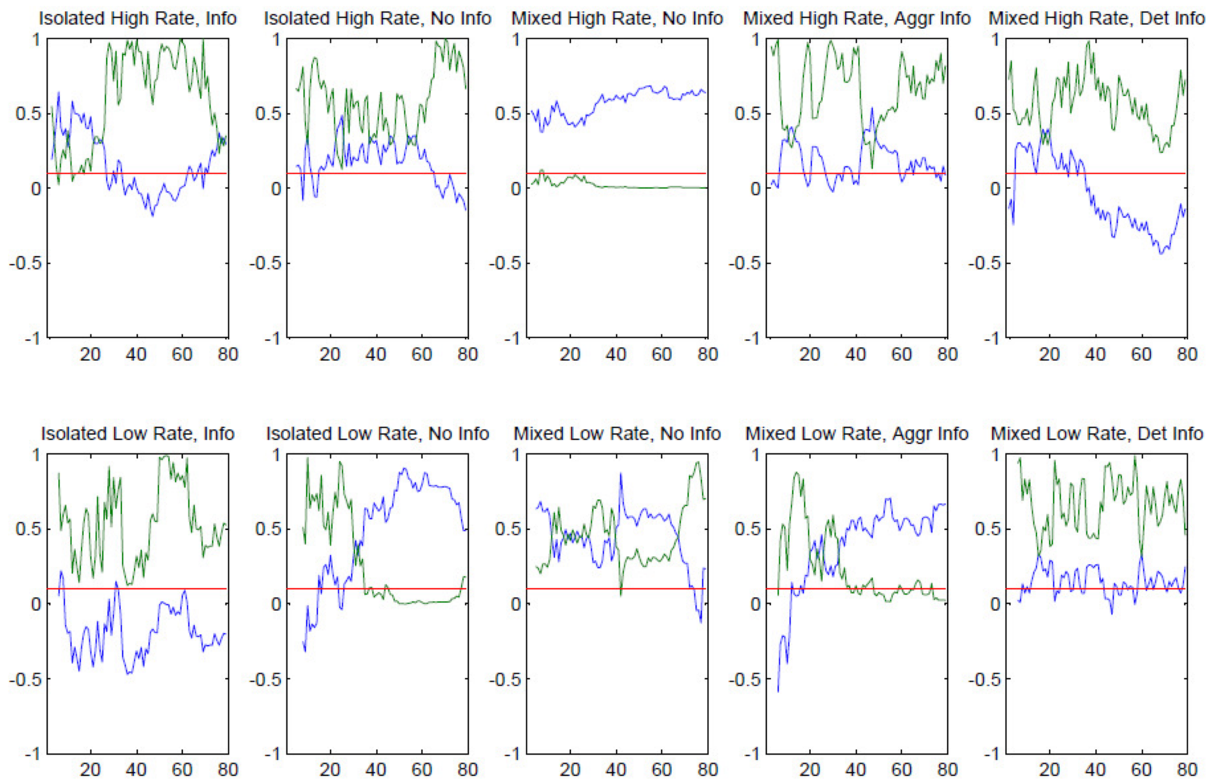


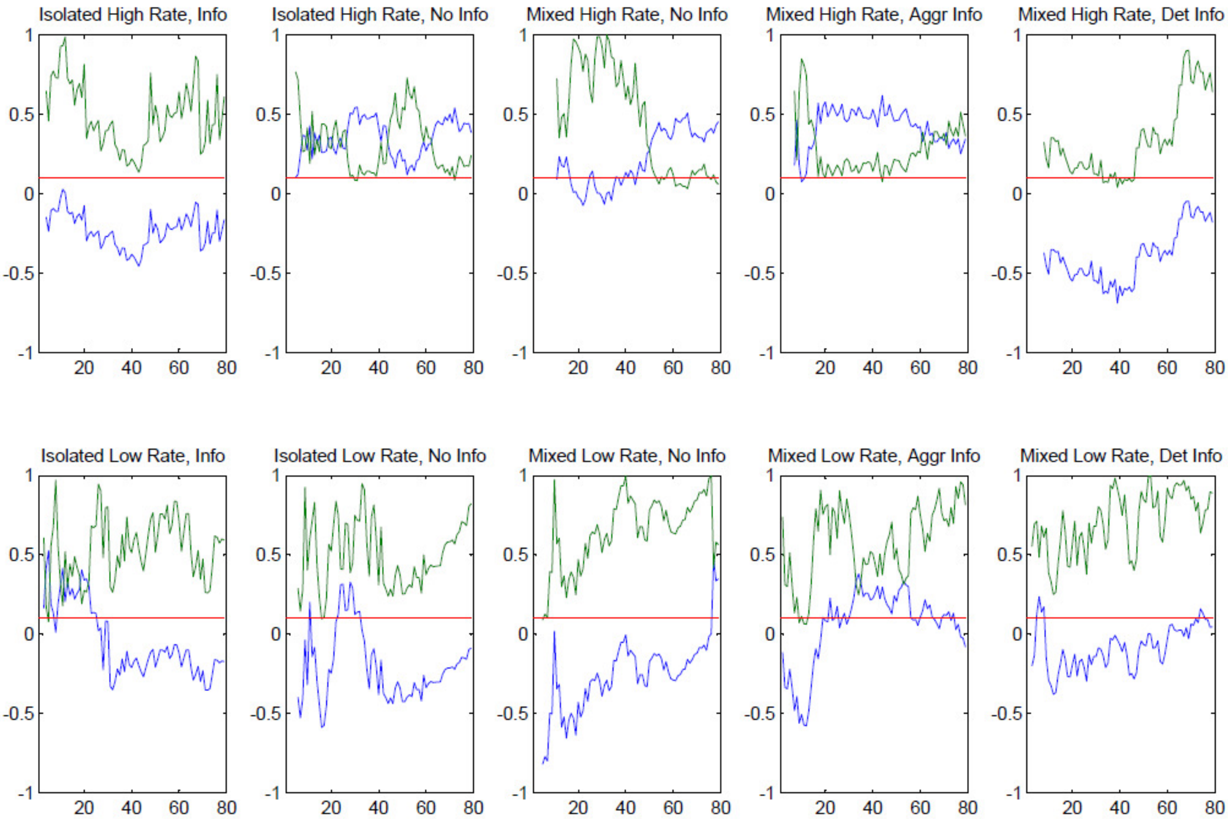
Figure A1 shows that only three of the treatments had a significant and persistent correlation between past correct answers and current ranking: The Mixed treatment High rate subjects with no information (top row, 3rd panel), the Isolated Low rate treatment with no information (bottom row, 2nd panel), and the Mixed treatment Low rate subjects with aggregated information (bottom row, 4th panel). Two of these treatments are without social information, where we might expect rankings to be relatively well-determined by success rates in the effort task since there are no social stimuli to alter subjects' risk preferences. The correlation between past correct answers and current social position is not regular or significant for the other treatments (with the exception of the low opportunity subjects in the aggregate information treatment).

Next we want to be sure that the proportion of large lotteries selected in the past is uncorrelated with subjects' current social rankings. Theoretically, the two variables should not be correlated since either lottery chosen by subjects provides only variance in earnings. Figure 6 shows the analogous correlations for the proportion of large lotteries selected in the past. Although occasionally in some periods the correlation between previous large lotteries taken and current ranking hits the 90% significance threshold, the pattern is not persistent across time (the possible exception being the Mixed High Rate, No Information subjects). This is what we should expect, since both lotteries are merely mean preserving spreads of current earnings.

Taken together, Figures A1 and A2 demonstrate that subjects had little actual control over their social rankings, although they may have certainly had preferences over their social statuses. In fact, the experiment was designed so that there should be negligible correlation between past choice variables and current social ranking outcomes. Figures A1 and A2 serve as a cross-check that this feature of the design works properly.

Figure A2: Correlations: Proportion of large lotteries selected by t-1, Social ranking in t

(blue line denotes correlation coefficient, green line denotes p-value, red line denotes 10% threshold)



II. Effect of previous social position on current lottery choice

Now that we have seen that past decisions and current ranking are essentially uncorrelated in our experiment, we investigate the *reverse* question: Is the previous round's social ranking significantly correlated with the selection of the large lottery in the current round? Here, we hope to find a positive answer, since the reference-dependent theory applied to social settings implies that such effects should exist.

One difficulty in constructing similar graphs to Figures A1 and A2 to answer this question is that in each period, some individuals encounter the Lottery Task while others encounter the Effort Task.

Rather than restrict the correlations to those facing the Lottery Task in a given period, we merely conduct the final correlation across all periods for which a Lottery Task occurred for subjects. This is equivalent to the right-most observation point in each of the small graphs in Figures A1 and A2.

Table A1: Correlations: Social ranking in t-1, Selection of large lottery in t

	Isolated,- Detailed Info (D)	Isolated -No Info (N)	Mixed- No Info (N)	Mixed Aggregated Info (A)	Mixed Detailed Info (D)
High Opportunity	-0.1351*** (0.0091)	0.1729*** (0.0013)	0.1413*** (0.0009)	0.1406** (0.0160)	-0.3219*** (0.0000)
Low Opportunity	-0.1104*** (0.0082)	0.0065 (0.8924)	-0.0558 (0.3838)	0.0912** (0.0398)	-0.1145*** (0.0087)

***significant at 5% level; ***significant at 1% level; p-values in parentheses*

Table A1 shows the result of these correlations, with p-values in parentheses. With the exception of the Low Opportunity, No information treatment, all correlation coefficients in this direction are significant. The more precise empirical relationship is discussed in Section 5.

Appendix B: Experiment Validity: Proportion of Large Lotteries Taken and Extreme Rankings

An intuitive concern in our multi-round design is that certain subjects are simply attracted to the large gamble regardless of their social position, while other subjects are similarly only attracted to the small gamble, independently of social position.

Suppose that we merely gave each subject T lottery tasks to play in sequence, eliminating the effort task. If this were the case, for large T (in the limit), we could expect to see a cross-sectional pattern of subjects taking the large gamble most often, occupying the top-most and bottom-most positions in the social distribution. Under this scenario, the V-shaped prediction of social reference-dependence under these conditions would theoretically appear in the data, even without any social reference effects.

There are a few key reasons why we do not see this pattern realized, even in the No Information treatments. First, only a small number of subjects exclusively took either the small or the large gamble in practice (see summarizing titles of each graph in Appendix C). Second, with an average of just 32 (high opportunity) or 48 (low opportunity) lottery tasks, which are furthermore uncoordinated across individual participants due to stochastic arrival of the different types of tasks, T may not be large enough in practice for this convergence to occur. Third, an important feature of our design is that effort is included via the stochastic arrival of the counting tasks. In the case where subjects' risk attitudes are potentially dependent on the arrival of effort tasks and their success in those effort tasks, the limiting argument above is even less likely to be realized.

The plots of subjects' final rankings and individual propensities to take the large lottery for individuals in the No Information (Figure B1) and Detailed Information (Figure B2) treatments. The filled circles denote the top 3 and bottom 3 ranked individuals within each session. If the aforementioned pattern of concern were to hold in our data, we would expect to see the filled circles concentrated in the top right and bottom right areas of each panel. The figures show that the top and bottom most ranking individuals were in practice, not particularly associated with individuals who took the large gamble most frequently.

Finally, any possible side-effects which may occur in the data as a result of the experimental structure are controlled for in our design using the no-information treatments. The estimated comparison between treatments can be found in Section 5.2, Table 7.

Figure B1: No Information Treatments

Top 3 and bottom 3 ranked subjects in each treatment marked with filled circles

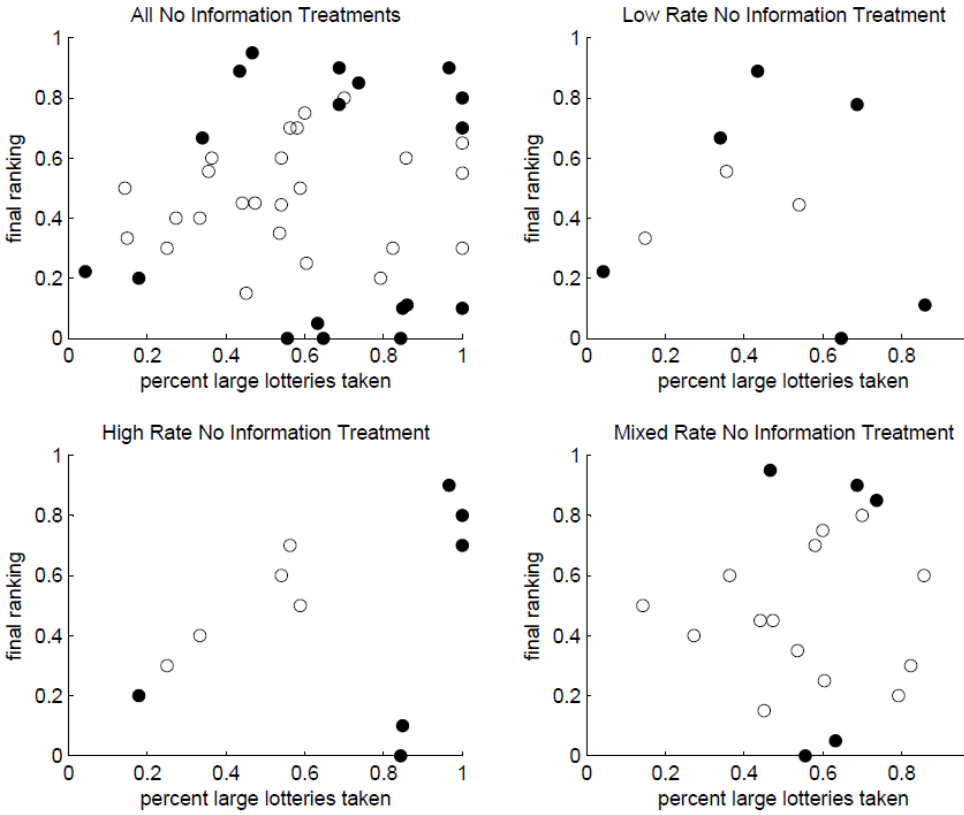
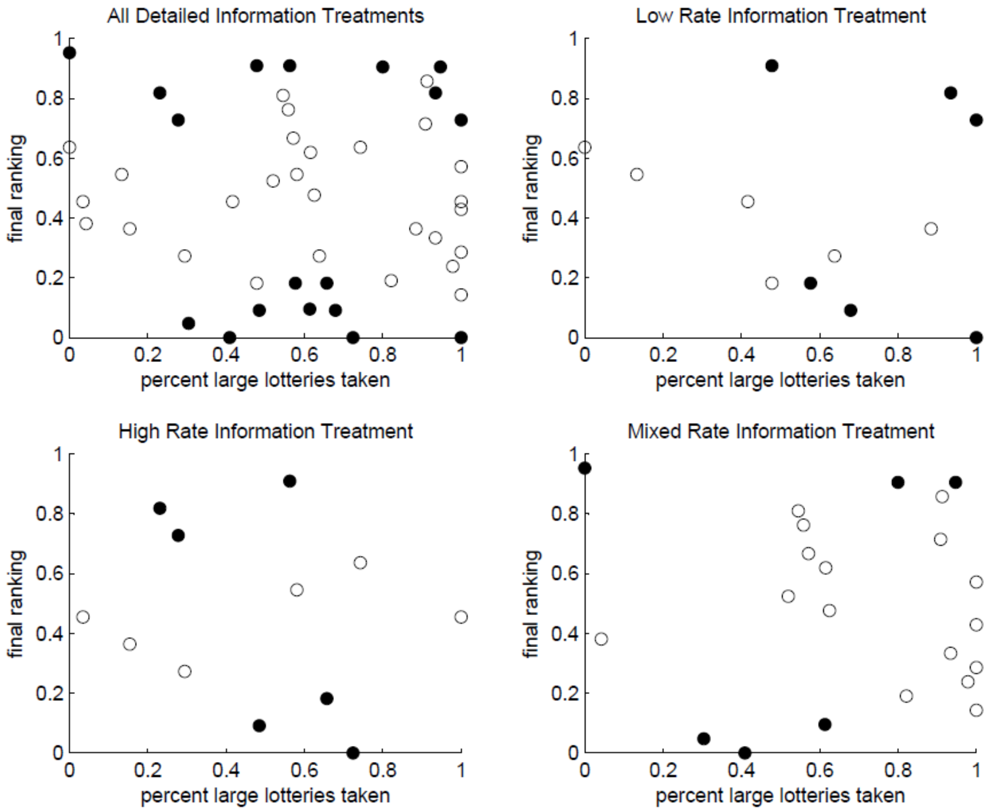


Figure B2: Detailed Information Treatments

Top 3 and bottom 3 ranked subjects in each treatment marked with filled circles


All Detailed Information Treatments
Low Rate Information Treatment
High Rate Information Treatment
Mixed Rate Information Treatment
final ranking
percent large lotteries taken
0
0.2
0.4
0.6
0.8
1

Appendix C: Social Ranking Time Paths, by Treatment

(displayed for treatments with information only, no information treatments available on request)

Figure C1: Ranking time path, isolated low opportunity, with information (LD)

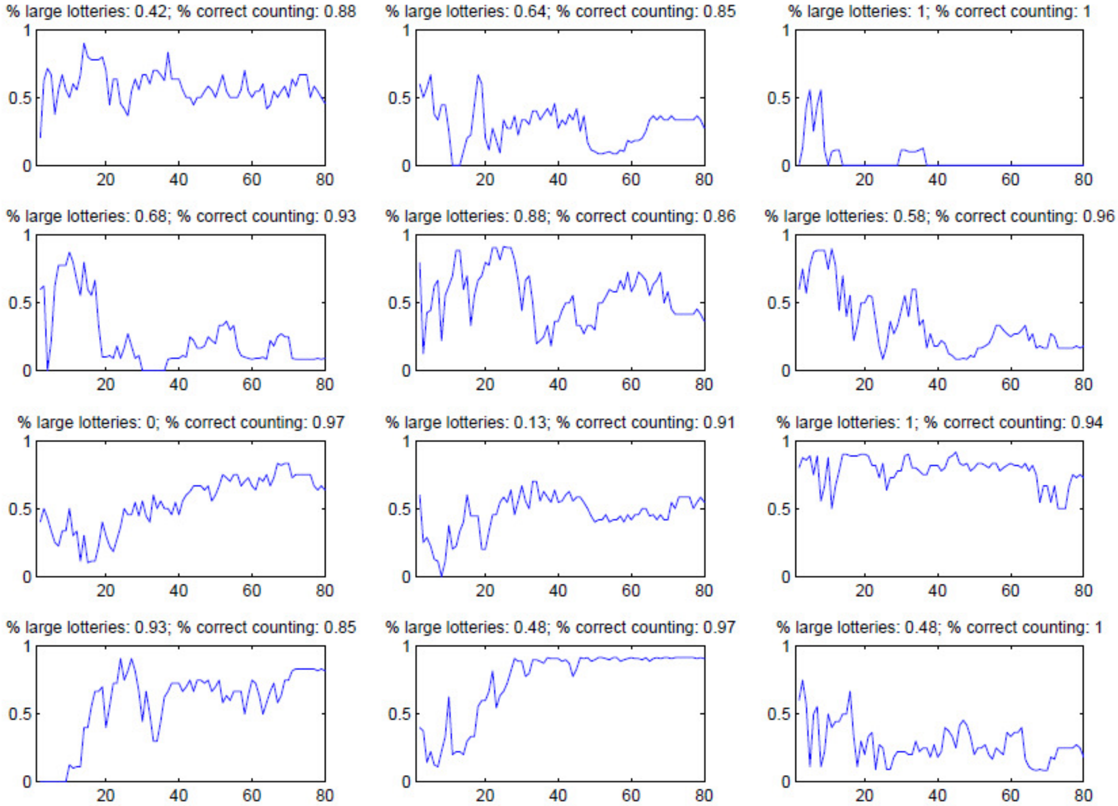


Figure C2: Ranking time path, isolated high opportunity, with information (HD)

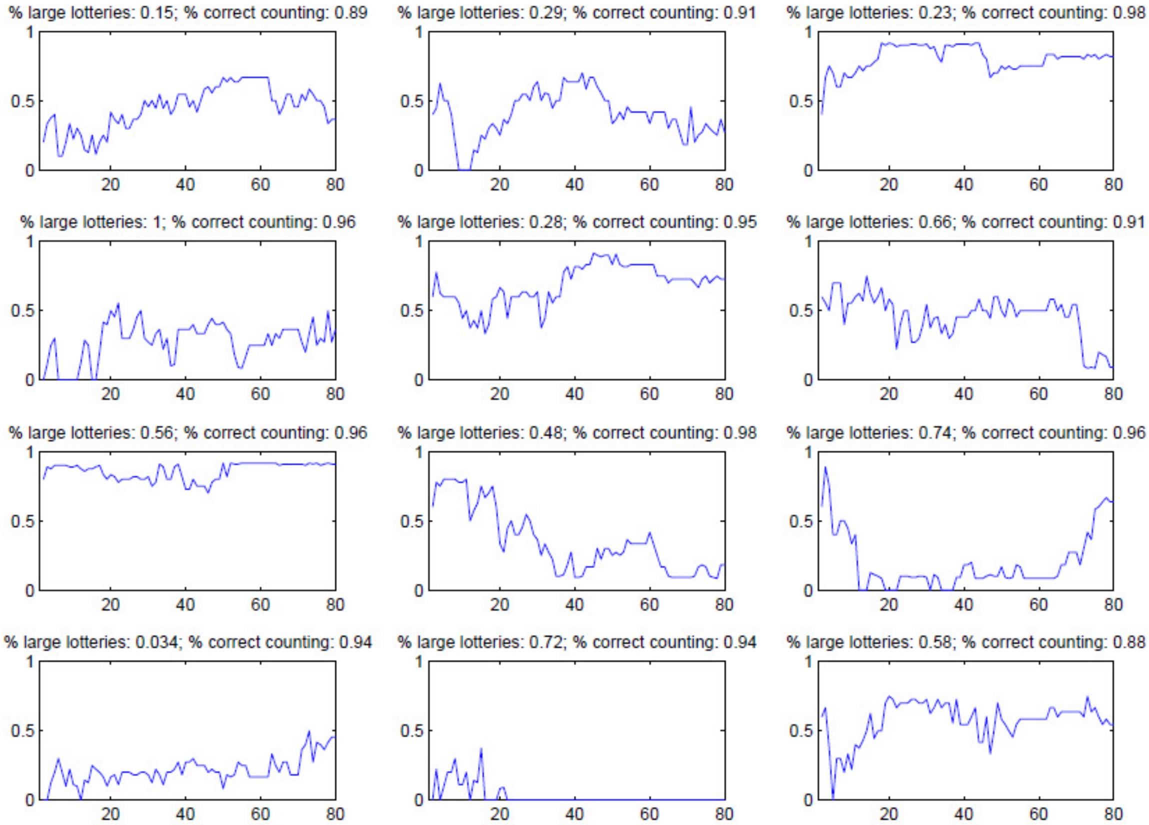


Figure C3: Ranking time path, low opportunity, aggregate information (RA)

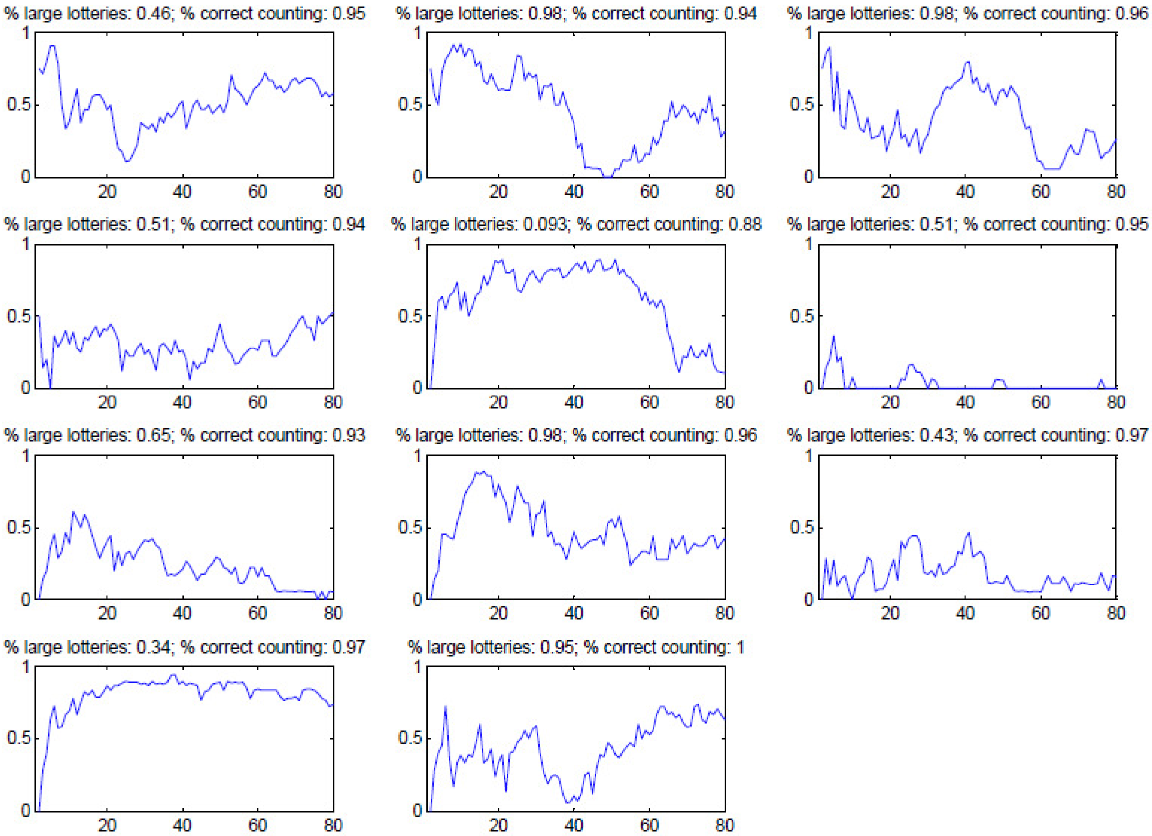


Figure C4: Ranking time path, high opportunity, aggregate information (RA)

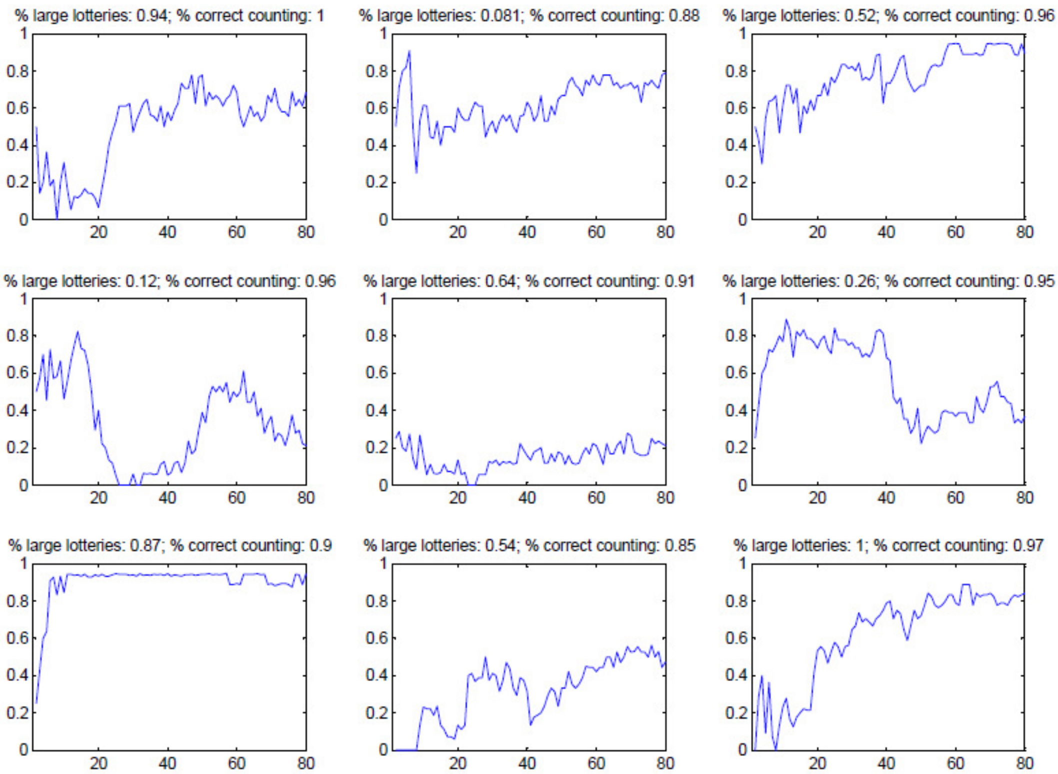


Figure C5: Ranking time path low opportunity, detailed information (RD)

(dark blue: detailed ranking; light blue: aggregate ranking)

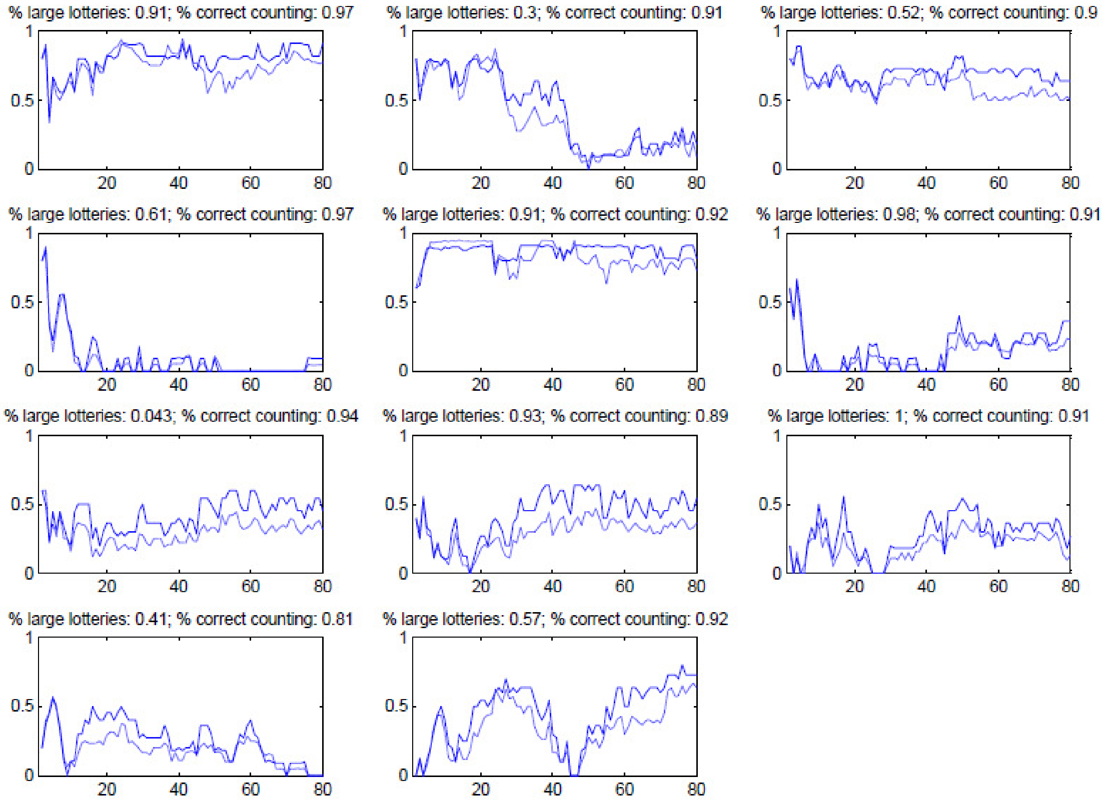
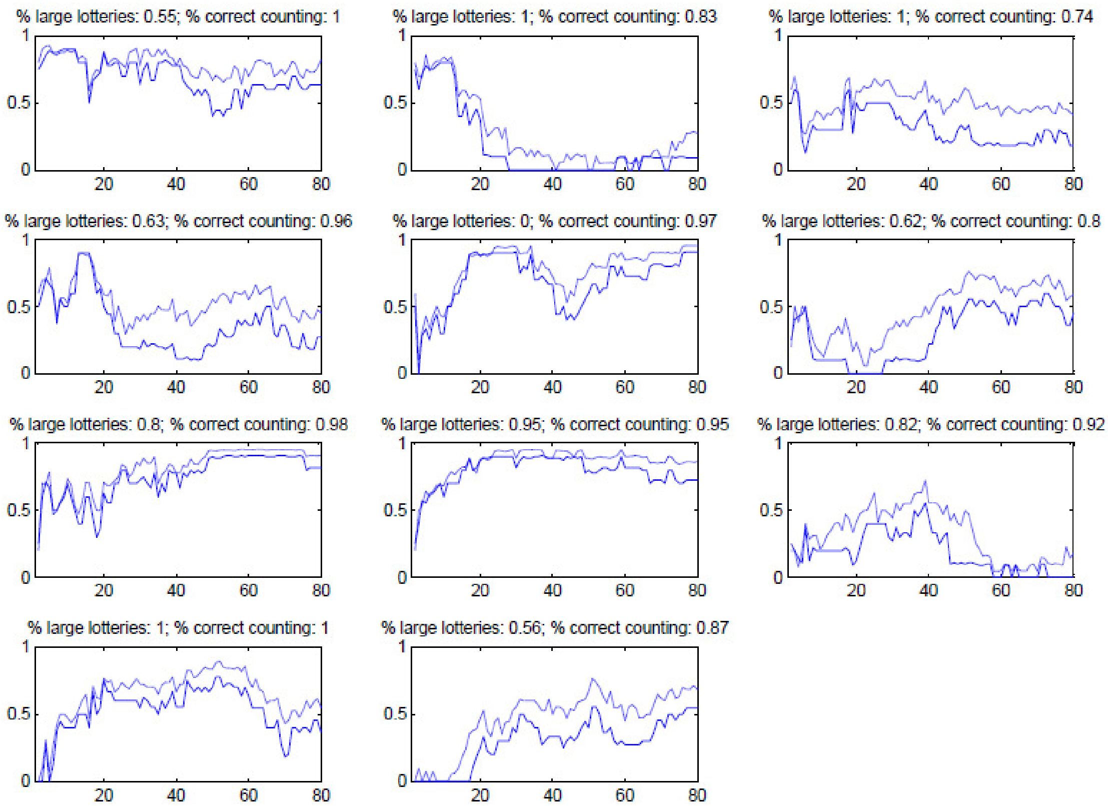


Figure C6: Ranking time path high opportunity, detailed information (RD)

(dark blue: detailed ranking; light blue: aggregate ranking)



% large lotteries: 0.55; % correct counting: 1
% large lotteries: 1; % correct counting: 0.83
% large lotteries: 1; % correct counting: 0.74
% large lotteries: 0.63; % correct counting: 0.96
% large lotteries: 0; % correct counting: 0.97
% large lotteries: 0.62; % correct counting: 0.8
% large lotteries: 0.8; % correct counting: 0.98
% large lotteries: 0.95; % correct counting: 0.95
% large lotteries: 0.82; % correct counting: 0.92
% large lotteries: 1; % correct counting: 1
% large lotteries: 0.56; % correct counting: 0.87

Appendix D: Treatment Logit Regressions without Subject Fixed Effects

Table D1: Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	Low opportunity, with information						***Low opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	-0.4379**	*0.029*	-0.4330**	*0.039*	-0.0486	*0.864*	-0.2147	*0.349*	0.0548	*0.832*	-0.1383	*0.690*
	(0.2011)		(0.2099)		(0.2838)		(0.2292)		(0.2575)		(0.3470)	
	0.0253	*0.106*	0.0290*	*0.083*	0.0117	*0.538*	0.0207	*0.356*	-0.0021	*0.934*	0.0115	*0.694*
	(0.0156)		(0.0167)		(0.0191)		(0.0224)		(0.0253)		(0.0293)	
current earnings			-0.0280*	*0.095*	-0.1304**	*0.018*			-0.0429**	*0.019*	-0.0107	*0.796*
			(0.0168)		(0.0550)				(0.0183)		(0.0414)	
current earnings squared			0.0002	*0.377*	0.0008**	*0.044*			0.0005**	*0.042*	0.0002	*0.510*
			(0.0002)		(0.0004)				(0.0003)		(0.0004)	
round					0.0763*	*0.093*					-0.0365	*0.324*
					(0.0455)						(0.0370)	
round squared					-0.0004	*0.266*					0.0003	*0.334*
					(0.0004)						(0.0003)	
subject fixed effects?	no		no		no		no		no		no	
N	12		12		12		9		9		9	
Observations	572		572		572		439		439		439	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Table D2: Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	High opportunity, with information						***High opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	0.3855*	*0.094*	0.3894	*0.104*	0.4863*	*0.089*	-0.4120	*0.133*	-0.4130	*0.143*	-0.1144	*0.734*
	(0.2304)		(0.2394)		(0.2857)		(0.2741)		(0.2823)		(0.3368)	
rank squared	-0.0393**	*0.032*	-0.0395**	*0.046*	-0.0395*	*0.064*	0.0397	*0.133*	0.0364	*0.179*	0.0225	*0.441*
	(0.0183)		(0.0197)		(0.0213)		(0.0264)		(0.0271)		(0.0291)	
current earnings			-0.0035	*0.812*	-0.0390	*0.406*			0.0005	*0.977*	-0.1059	*0.111*
			(0.0145)		(0.0469)				(0.0172)		(0.0665)	
current earnings squared			0.0000	*0.848*	0.0001	*0.806*			0.0000	*0.775*	0.0005	*0.147*
			(0.0001)		(0.0002)				(0.0002)		(0.0004)	
round					0.0276	*0.623*					0.1204	*0.107*
					(0.0561)						(0.0747)	
round squared					0.0001	*0.760*					-0.0006	*0.249*
					(0.0004)						(0.0005)	
subject fixed effects?	no		no		no		no		no		no	
N	12		12		12		11		11		11	
Observations	372		372		372		342		342		342	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Table D3: Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	Mixed Low opportunity, with information						***Mixed Low opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	-0.8372***	*0.001*	-0.8510***	*0.001*	-1.0353***	*0.001*	0.8160	*0.253*	0.9524	*0.240*	0.7125	*0.457*
	(0.2436)		(0.2627)		(0.3105)		(0.7139)		(0.8110)		(0.9572)	
rank squared	0.0568***	*0.009*	0.0655***	*0.007*	0.0800***	*0.002*	-0.1364	*0.307*	-0.1021	*0.499*	-0.0820	*0.610*
	(0.0217)		(0.0242)		(0.0258)		(0.1334)		(0.1511)		(0.1608)	
current earnings			-0.0170	*0.231*	0.0090	*0.783*			-0.0484	*0.127*	-0.0315	*0.509*
			(0.0142)		(0.0328)				(0.0318)		(0.0477)	
current earnings squared			0.0001	*0.724*	-0.0002	*0.476*			0.0004	*0.341*	0.0003	*0.508*
			(0.0002)		(0.0002)				(0.0004)		(0.0005)	
round					-0.0579**	*0.042*					-0.0085	*0.824*
					(0.0284)						(0.0382)	
round squared					0.0006*	*0.057*					0.0000	*0.999*
					(0.0003)						(0.0004)	
subject fixed effects?	no		no		no		no		no		no	
N	11		11		11		5		4		5	
Observations	524		524		524		246		197		246	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Table D4: Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

	Mixed High opportunity, with information						***Mixed High opportunity, No information***					
	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	0.5375*	*0.064*	0.7791**	*0.014*	0.4274	*0.359*	0.1874	*0.155*	0.1575	*0.259*	0.0401	*0.798*
	(0.2899)		(0.3173)		(0.4658)		(0.1317)		(0.1396)		(0.1563)	
rank squared	-0.0529**	*0.036*	-0.0722***	*0.009*	-0.0535	*0.107*	-0.0095	*0.184*	-0.0063	*0.405*	-0.0031	*0.707*
	(0.0252)		(0.0274)		(0.0332)		(0.0072)		(0.0076)		(0.0081)	
current earnings			-0.0481	*0.040*	0.0163	*0.766*			0.0025	*0.833*	0.0301	*0.162*
			(0.0234)		(0.0548)				(0.0119)		(0.0215)	
current earnings squared			0.0003	*0.149*	-0.0001	*0.801*			-0.0001	*0.445*	-0.0001	*0.306*
			(0.0002)		(0.0003)				(0.0001)		(0.0001)	
round					-0.1197*	*0.070*					-0.0262	*0.360*
					(0.0660)						(0.0286)	
round squared					0.0011**	*0.036*					0.0000	*0.958*
					(0.0005)						(0.0003)	
subject fixed effects?	no		no		no		no		no		no	
N	11		11		11		18		18		18	
Observations	324		324		324		544		544		544	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Appendix E: Treatment Logit Regressions, Aggregate Information Treatments

Table E1: Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

Aggregate information Treatment, Low Opportunity Subjects

(left panel: with subject fixed-effects; right panel: without fixed-effects)

	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	-0.0435	*0.763*	0.0275	*0.856*	-0.1219	*0.498*	-0.0190	*0.893*	0.0493	*0.739*	-0.1126	*0.523*
	(0.1444)		(0.1518)		(0.1801)		(0.1410)		(0.1480)		(0.1762)	
rank squared	0.0004	*0.958*	0.0000	*1.000*	0.0037	*0.673*	-0.0005	*0.951*	-0.0008	*0.927*	0.0032	*0.711*
	(0.0081)		(0.0085)		(0.0088)		(0.0079)		(0.0083)		(0.0086)	
current earnings			-0.0523***	*0.004*	0.0329	*0.500*			-0.0517***	*0.004*	0.0399	*0.412*
			(0.0180)		(0.0489)				(0.0180)		(0.0486)	
current earnings squared			0.0003	*0.141*	-0.0002	*0.448*			0.0003	*0.155*	-0.0003	*0.370*
			(0.0002)		(0.0003)				(0.0002)		(0.0003)	
round					-0.0997**	*0.017*					-0.1051**	*0.011*
					(0.0416)						(0.0415)	
round squared					0.0007**	*0.023*					0.0008**	*0.019*
					(0.0003)						(0.0003)	
subject fixed effects?	yes		yes		yes		no		no		no	
N	11		11		11		11		11		11	
Observations	508		508		508		508		508		508	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Table E2: Logit: Dependent variable: Large lottery chosen, conditional on Lottery Task arrival

Aggregate information Treatment, High Opportunity Subjects

(left panel: with subject fixed-effects; right panel: without fixed-effects)

	Coeff	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*	*Coeff*	*p-value*
rank	-0.3078*	*0.058*	-0.2887	*0.173*	-0.1790	*0.437*	-0.3127**	*0.050*	-0.2766	*0.179*	-0.1847	*0.412*
	(0.1626)		(0.2120)		(0.2305)		(0.1598)		(0.2058)		(0.2251)	
rank squared	0.0100	*0.210*	0.0129	*0.210*	0.0082	*0.444*	0.0113	*0.153*	0.0137	*0.171*	0.0087	*0.403*
	(0.0080)		(0.0103)		(0.0107)		(0.0079)		(0.0100)		(0.0104)	
current earnings			-0.0126	*0.595*	-0.0775	*0.229*			-0.0157	*0.501*	-0.0602	*0.341*
			(0.0237)		(0.0643)				(0.0233)		(0.0633)	
current earnings squared			0.0000	*0.863*	0.0005	*0.221*			0.0000	*0.930*	0.0004	*0.288*
			(0.0003)		(0.0004)				(0.0002)		(0.0004)	
round					0.1011	*0.112*					0.0813	*0.191*
					(0.0637)						(0.0622)	
round squared					-0.0010**	*0.068*					-0.0009*	*0.092*
					(0.0005)						(0.0005)	
subject fixed effects?	yes		yes		yes		no		no		no	
N	8		8		8		9		9		9	
Observations	272		272		272		293		293		293	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level*

Appendix F: Additional NLSY Results

I. NLSY General Risk Question

Table F1: Probit regression: Dependent variable: High General Risk Taking

	Non-College graduate		College graduate	
	Coeff	*p-value*	*Coeff*	*p-value*
Quantile 1	0.1445* (0.0753)	*0.055*	0.0115 (0.1273)	*0.928*
Quantile 2	-0.0086 (0.0721)	*0.905*	0.2339** (0.1072)	*0.029*
Quantile 4	-0.0167 (0.0883)	*0.850*	0.0394 (0.0997)	*0.693*
Quantile 5	0.1244 (0.1505)	*0.408*	0.0688 (0.1184)	*0.561*
Obs	2259		1220	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level; Regression includes age, Census region dummy variables (South, Midwest and West; Northeast omitted), MSA dummy variable (central urban; non-central urban omitted), and gender as control variables.*

Table F2: General Willingness to Take Risk, Means tests by quantile pairs (p-values)

	General Risk: Non-college graduates					*General Risk: College Graduate*				
	1	2	3	4	mean	1	2	3	4	mean
1					5.6419					5.5390
2	0.1009				5.3968	0.0122				6.0980
3	0.4834	0.3182			5.5344	0.7158	0.0039			5.6160
4	0.1830	0.9393	0.4478		5.4091	0.8400	0.0030	0.8343		5.5825
5	0.8846	0.2988	0.5919	0.3446	5.6829	0.4524	0.0382	0.5876	0.4793	5.7095

Table F3: Linear regression: Dependent variable: Reported General Risk

	Non-College graduate		College graduate	
	Coeff	*p-value*	*Coeff*	*p-value*
Quantile 1	0.1757 (0.1547)	*0.256*	-0.0607 (0.2073)	*0.770*
Quantile 2	-0.1211 (0.1369)	*0.377*	0.4248*** (0.1623)	*0.009*
Quantile 4	-0.0886 (0.1629)	*0.587*	0.0058 (0.1542)	*0.970*
Quantile 5	0.1929 (0.2740)	*0.482*	0.0662 (0.1723)	*0.701*
Obs	2259		1220	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level; Regression includes age, Census region dummy variables (South, Midwest and West; Northeast omitted), MSA dummy variable (central urban; non-central urban omitted), and gender as control variables*

II. NLSY Financial Risk Question Results

Table F4: Probit regression: Dependent variable: High financial Risk-Taking

	Non-College graduate		College graduate	
	Coeff	*p-value*	*Coeff*	*p-value*
Quantile 1	0.2624*** (0.0811)	*0.001*	-0.2135 (0.1398)	*0.127*
Quantile 2	-0.1129 (0.0810)	*0.163*	0.0230 (0.1124)	*0.838*
Quantile 4	-0.0580 (0.0986)	*0.556*	0.0055 (0.1062)	*0.959*
Quantile 5	0.2412 (0.1588)	*0.129*	0.0248 (0.1255)	*0.844*
Obs	2259		1220	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level; Regression includes age, Census region dummy variables (South, Midwest and West; Northeast omitted), MSA dummy variable (central urban; non-central urban omitted), and gender as control variables.*

Table F5: Willingness to Take Financial Risk, Means tests by quantile pairs (p-values)

	Financial Risk: Non-college graduates					*Financial Risk: College graduates*				
	1	2	3	4	mean	1	2	3	4	mean
1					4.1959					3.9433
2	0.0031				3.7253	0.0567				4.4244
3	0.0168	0.6653			3.7901	0.3876	0.1590			4.1445
4	0.0198	0.8496	0.8567		3.7576	0.1301	0.5413	0.3790		4.3009
5	0.3823	0.0109	0.0227	0.0212	4.4512	0.0215	0.6083	0.0565	0.2546	4.5419

Table F6: Linear regression: Dependent variable: Reported Financial Risk

	Non-College graduate		College graduate	
	Coeff	*p-value*	*Coeff*	*p-value*
Quantile 1	0.4852*** (0.1704)	*0.004*	-0.1850 (0.2282)	*0.418*
Quantile 2	-0.0390 (0.1490)	*0.793*	0.1970 (0.1939)	*0.310*
Quantile 4	-0.0157 (0.1800)	*0.931*	0.2072 (0.1730)	*0.231*
Quantile 5	0.6715** (0.2847)	*0.018*	0.3778* (0.2072)	*0.068*
Obs	2259		1220	

*Standard errors in parentheses, p-values in italics; ***significant at 1% level; **significant at 5% level; *significant at 10% level; Regression includes age, Census region dummy variables (South, Midwest and West; Northeast omitted), MSA dummy variable (central urban; non-central urban omitted), and gender as control variables.*