Education and Anomalies in Decision Making:
Experimental Evidence from Chinese Adult Twins

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This paper estimates the effects of education on two dimensions of decision making behavior – risk and time, beyond those considered to be normal-ranged to encompass behavioral anomalies with respect to the expected utility as well as time consistency. We conduct a number of incentivized choice experiments on Chinese adult twins to measure decision making behavior, and use a within-twin-pair fixed-effects estimator to deal with unobservable family-specific effects. The estimation results show that a higher level of education tends to reduce the degree of risk aversion toward moderate prospects, moderate hazards, and longshot prospects. For those anomalies under risk and uncertainty, university educated subjects exhibit significantly more Allais-type behavior compared to pre-high school subjects, while high school educated subjects also exhibit more ambiguity aversion as well as a preference for the familiarity relative to pre-high school subjects. For decision making involving time, a higher level of education tends to reduce the degree of impatience, and reduce behavioral anomalies including hyperbolic discounting, dread, and hopefulness. The experimental observations suggest that people with a higher level of education tends to exhibit more behavioral anomalies in risk attitude but less behavioral anomalies involving time, implying that education has multi-functions in preference formation and human capability building. This contributes to the understanding of the nature of these behavioral anomalies and the intriguing roles of education in human decision making.

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"*That theory, as formulated by the von Neumann-Morgenstern axioms, is normative in the sense that the theory is "absolutely convincing" which implies that men will act accordingly. If they deviate from the theory, an explanation of the theory and of their deviation will cause them to readjust their behavior.*" [Oskar Morgenstern, 1979]

1. Introduction

At the heart of economic analysis is our understanding of decision making behavior ranging from decision making under risk and uncertainty to decision making involving time. The classical models of expected utility and exponential discounted utility have been challenged by a number of behavioral anomalies.[1] In decision making under risk and uncertainty, Allais paradox (1953) and Ellsberg paradox (1961) are particularly well-studies and have inspired an active literature in non-expected utility models (see, e.g., Starmer, 2000, for a review) including the highly influential prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). There is a parallel literature on behavioral anomalies involving time, e.g., hyperbolic discounting (Laibson, 1997), incidence of consumption (Lowenstein, 1987), and the timing of uncertainty resolution (Kreps and Porteus, 1979; Chew and Ho, 1994).

In the literature on decision making, there have been debates on whether behavioral anomalies reflect the true preference of the decision makers or they are biases due to cognitive errors on the part of the decision makers.[2] The former view is reflected in the revealed preference approach which aims to deliver a more general preference framework to accommodate the supposed behavioral anomalies. The latter view is reflected in the opening quote from Oskar Morgenstern, which suggests that behavioral anomalies are more akin to errors that can be rectified via positive intervention such as education.

To arrive at a deeper understanding of the nature of behavioral anomalies, this paper studies the impact of education on a range of decision making behavior under risk and uncertainty and involving time. Among the factors influencing decision making behavior, education appears especially important given that we learn and develop different ways of thinking and acting besides being trained to acquire professional skills. For example, as Becker and Mulligan (1997) articulate"Schooling focuses students' attention on the future. Schooling can communicate images of

[1] In the preamble to a series of "Anomalies" in the Journal of Economic Perspectives, Richard Thaler wrote, "An empirical result qualifies as an anomaly if it is difficult to "rationalize", or if implausible assumptions are necessary to explain it within the paradigm." In this paper, "behavioral anomalies" refer to choice behaviors that are not compatible with the implications of classical preference theory.

[2] Savage (1954) argued that increased understanding ought to increase the frequency of the "truly" normative response; that preferences that initially contradict some normative principle may not survive thorough deliberation (what he termed "reflective equilibrium"). Moreover, a recent study by Charness et al (2010) shows that interaction with other subjects decrease frequency the conjunction fallacy and suggests that deliberating the alternative actions with other subjects helps improve the understanding of the decision problem and reduce decision errors.

the situations and difficulties of adult life, which are the future of childhood and adolescence. In addition, through repeated practice at problem solving, schooling helps children learn the art of scenario simulation. Thus educated people should be more productive at reducing the remoteness of future pleasures." In investigating how education may influence behavior, one of the key challenges is the problem of causality, which cannot be addressed using ordinary least squares estimation because unobservable family background and individual heterogeneity may simultaneously determine educational outcomes and preference formation. In other words, education may be correlated with unobservable family background and the effects of individual's endowment, which would render any correlation between education and behavioral spurious.[3]

Our primary goal in this paper is to empirically identify the causal effect of education on behavioral anomalies in addition to those considered to be normal-ranged including risk attitude across domains and time discounting factor. We first conduct a number of incentivized choice experiments on adult twins to observe their behavior. Then we use a within-twin-pair fixed-effects estimator to carry out the identification (Ashenfelter and Krueger, 1994; Behrman et al., 1996; Behrman and Rosenzweig, 1999; Oreopoulos and Salvanes, 2011). Given that twins have similar family backgrounds, and monozygotic twins are genetically identical,[4] the effects of unobserved family background and genetic endowment should be similar for both twins. Taking the within-twin-pair difference will reduce the unobservable family background and individual endowment effects which are the main causes for the bias in ordinal least squares estimation. Intuitively, by comparing experimentally observed choice behavior of twins with different educational attainments, we may be more confident that an observed correlation between education and behavior is not due to a spurious correlation between education and family background or an individual's endowment.

Our within-twin-pair fixed-effects estimates, based on the experimental data on adult twin pairs, indicate that education affects two important dimensions of decision making behavior – choice under risk and uncertainty and involving time. We find that a higher level of education tends to reduce the degree of risk aversion towards moderate prospects, moderate hazards, and longshot prospects. In terms of decision making anomalies, university educated subjects exhibit significantly more Allais type behavior compared to pre-high school subjects, while high school educated subjects also exhibit more ambiguity aversion as well as familiarity bias relative to pre-high school subjects. For decision making involving time, a higher level of education tends to reduce the degree of impatience, and

[3] The difficulty in identifying the causal relationship between education and behavior is similar to that of an unbiased estimation of economic returns to education. See, e.g., Card (1999), for a review of the econometric issues in estimating returns to education.

[4] Gorseline (1932) seems to be the first attempt to look at sibling data in economics. Not content with sibling data, Behrman and Taubman (1976), Taubman (1976a, 1976b), and Behrman et al. (1977) began to use twin data in the 1970s. Todd and Wolpin (2003) clarify different identification assumptions between within-sibling and within-twin-pair fixed-effects estimator. They conclude that within-twin-pair fixed-effects estimator needs much weaker identification assumptions than within-sibling fixed-effects estimator.

reduce a number of behavioral anomalies including hyperbolic discounting, dread, and hopefulness, except for anxiousness whose incidence is not sensitive to educational attainment.

The estimation results are robust with respect to sensitivity analyses (i) using the instrumental variables (IV) method to take care of potential measurement errors; and (ii) controlling for birth weight and restricting the estimation sample to include only monozygotic (MZ) twins to take care of possible biases arising from omitted variables. In summary, our experimental evidence from Chinese adult twins suggest that people with a higher level of education tends to exhibit more anomalous behavior in decision making under risk and less anomalous behavior in decision making involving time.

Our findings contribute to behavioral economics and labor economics in a number of aspects. First, our results shed light on whether the observed behavioral anomalies represent actual preference or reflect cognitive bias. Intuitively, education would increase our cognitive skills and reduce cognition errors. Hence behavioral anomalies are more likely to reflect actual preference if education increases the tendency to exhibit such behavior. Otherwise, they may likely reflect behavioral bias if education decreases the tendency to exhibit the observed choice behavior. Specifically, our results suggest that Allais and Ellsberg behavior are more likely to reflect preferences rather than cognitive errors of the decision makers, while anomalies in temporal decision making are likely to represent biases rather than preferences of the decision makers. Furthermore, these findings accord well with intuitions underpinning those prescriptive tools, such as the so-called save more tomorrow savings program (Thaler and Benartzi, 2003), which provide behavioral mechanisms to help individuals with time inconsistency problem make better decisions.

Second, this paper contributes to recent studies on the relationship between cognitive skills and experimentally observed behavior (e.g., Frederick, 2005; Dohmen et al., 2010; Benjamin et al., 2013; Burks et al., 2009). Frederick (2005) finds that student subjects who scored higher cognitive skills measured by the cognitive reflection tasks tend to be less risk averse and more patient. Dohmen et al. (2010) conduct experiments measuring risk aversion, impatience and cognitive ability with 1,000 German adults, and they find that high cognitive ability is associated with less risk aversion, and more patience. Using a sample of 1,000 trainee truckers, Burks et al. (2009) show that individuals with better cognitive skills are more patient in both short- and long-run, and also associated with a greater willingness to take calculated risks. However, these studies show a correlation rather than a causal relationship. Benjamin et al. (2013) similarly find that high school students with higher standardized test scores are less risk averse and more patient. Moreover, in order to demonstrate the causal impact, they further provide laboratory interventions on cognitive resources and show that cognitive ability affects risk attitude and temporal discounting. Here, we investigate the effect of education on decision making behavior on a wider range of behavior and adopt a twin design to address issues of causality.

Third, studying the relationship between education and decision making behavior sheds light on the literature on the determination or formation of preference. Stable preferences, maximizing behavior, and market equilibrium have been regarded as fundamental assumptions underpinning the analytic framework for economic analysis. While it may be reasonable to assume that basic preferences do not change rapidly over a short period of time, we need to allow preference to change gradually over an extended duration, e.g., it makes sense to treat preferences as being endogenous from a life-cycle perspective. [5] Previous studies have analyzed theoretically the processes of preference formation and preference change, and demonstrated their importance (e.g., Becker, 1992, 1996; Becker and Mulligan, 1997). Theories have been proposed about endogenous determination of preferences through wealth (Becker and Mulligan, 1997), market institutions (Bowles 1998), and culture (Bisin and Verdier, 2000).

Fourth, this paper also contributes to the broad literature on human capital. Integrating the new development in neuroscience, psychology, and behavioral science, the scope of human capital theory has expanded substantially in recent years (see, e.g., Rutter, 2006; Heckman, 2007; ter Weel, 2008). Non-cognitive skills or personality traits are now accepted as an important dimension of human capital (Heckman and Rubinstein, 2001; Borghans et al., 2008). Should preferences be also shaped by education, it would strengthen the view that preferences should be treated as endogenous in human capital theory. Our results thus suggest that a potentially fruitful direction in future research to explore the mechanisms underlying the relationship/interaction between human capital formation and economic behavior.

Finally, the estimation of the return to education has been one of the major subjects in economics for decades (Card, 1999). Yet, there have been limited studies to explore the mechanism underlying the relationship between education and socioeconomic success. Oreopoulos and Salvanes (2011) investigate non-pecuniary returns of education including job satisfaction, happiness, and preferences. In particular, using within-twin estimate and conditioning on income, they find that siblings with more schooling are less likely to be divorced, less likely to give birth as teenagers and more likely to be married to more educated spouses. Our identified relationships between educational attainments and decision making under risk and uncertainty and involving time will help enhance our understanding of the non-pecuniary return to education. Moreover, risk attitudes underpin a wide range of economic behavior such as portfolio choice and insurance purchase, and time preference has been linked to economic behavior such as saving and consumption as well as physical exercise and smoking. Should education affect behavior in these domains, it could have long-term economic consequences for individuals. To sum, our results support the notion that education has multiple functions in preference formation and human capability building.

[5] Stigler and Becker (1977) assumed that preferences are treated to be fixed and exogenous across individuals. Yet the more recent work by Becker (1992, 1996) and Becker and Mulligan (1997) rejects the assumption of stable preferences.

2. Review of Behavioral Decision Models and Related Evidence

This section reviews a number of choice models and related empirical studies on decision making involving risk and uncertainty as well as decision making involving time.

2.1 Decision Making under Risk and Uncertainty

Attitude towards economic risk constitutes a well-studied primitive in economics. Central to decision making under risk is the question how people evaluate a gamble. The pioneering contributions of von Neumann and Morgenstern (1944) and Savage (1954) provide an axiomatic foundation of the expected utility model, where the value of a gamble equals the mean of utility of monetary outcomes. Despite its tractability, the EU model is unsatisfactory in many aspects. Its descriptive validity was challenged by Allais (1953) who suggested a choice situation in which subjects' choices tend to violate EU's independence axiom.[6]

Second, the EU model cannot account for the fourfold pattern of risk attitudes. In their 1979 seminal paper on prospect theory (PT) and the rejoinder in 1992, Kahneman and Tversky posit the notion of status quo relative to which gains and losses are defined. Risks are referred to as prospects (hazards) when they are oriented toward gains (losses). Risks can be further distinguished between those whose contingencies have moderate probabilities and those whose contingencies are highly unlikely or have longshot probabilities. For instance, insurance and state lotteries represent longshot hazards and longshot prospects while financial assets may be viewed as moderate prospects. Market evidence points to the prevalence of risk aversion towards longshot hazards and, to some extent, risk tolerance for longshot prospects. Kahneman and Tversky also point out the less reported tendency for people to be risk tolerant when it comes to moderate hazards, e.g., when people find themselves in insecure or unsafe situations prompting them to take a chance (Kunretither and Ginsberg, 1978). This is the so called fourfold pattern of risk attitudes – being risk averse (tolerant) toward moderate prospects (hazards) and risk tolerant (averse) towards longshot prospects (hazards). Specifically, the fourfold pattern of risk attitudes consists of comparing a lottery of the form of a q chance of receiving an outcome x and a $1-q$ chance of receiving zero, denoted by (x,q), versus receiving its expected value, xq, for sure. PT assumes a *loss-averse* value function v that is concave over gains, convex over losses, and vanishes at the status quo, represented by zero. The implication of adopting such a loss-averse utility function for an EU decision maker is immediate. For positive (negative) x, the EU of receiving the lottery (x,q) is given by $qv(x)$, which is always less (greater) than the utility $v(qx)$ of receiving its expected value qx for sure. Such an EU decision maker would be risk averse for all prospects and risk preferring for all hazards, leaving it unable to concurrently exhibit risk preference

[6] The independence axiom is a key characteristic of this model, which follows from the additive structure of EU. It means that for the strict preference relation $\succ$ over any lotteries *F* and *G*, $F \succ G$ if and only if $\alpha F + (1-\alpha)H \succ \alpha G + (1-\alpha)H$, for any probability α in *(0, 1)* and any lottery *H*.

for longshot prospects and risk aversion for longshot hazards. In introducing a probability weighting function which overweights small probabilities and underweights moderate to high probabilities, PT can concurrently account for the fourfold pattern of risk attitudes.

Third, there are anomalies such as ambiguity aversion and familiarity bias, which cannot be accounted for by any utility model which relies on probabilistic sophistication, i.e., lotteries with the same distribution are worth the same. Ambiguity aversion was first suggested by Keynes (1921) in his Treatise on Probability in which he stated– "If two probabilities are equal in degree, ought we, in choosing our course of action, to prefer that one which is based on a greater body of knowledge?" He illustrated this observation with an example of two urns, one containing fifty black balls and fifty red balls while another contains one hundred balls of either color. This example reappeared in Ellsberg (1961) which observed that people tend to be ambiguity averse in preferring to bet on the urn with known probabilities rather than one with unknown probabilities. The phenomenon of ambiguity aversion is puzzling. People tend to be indifferent between betting on red or black for either urn so that drawing either color ought to have the same subjective probability of one-half, regardless of the urn used. More recently, it has become increasingly recognized that decision making under uncertainty depends not only on probabilities, but also on how uncertainty itself arises. This has been specifically referred to as source dependence or familiarity bias (Fox and Tversky, 1995). In particular, they echoed Keynes in proposing that people tend to favour the familiar in preferring to bet on risks arising from a more familiar source of uncertainty.

Over the past several decades, these anomalies have inspired an active literature in decision theory going beyond probabilistic sophistication by using a non-additive capacity over events (Schmeidler, 1989; Tversky and Kahneman, 1992), by assuming that decision makers have non-unique priors (Gilboa and Schmeidler, 1989), and by allowing non-indifference over identically distributed risks arising from different sources of uncertainty (Chew and Sagi, 2008; Ergin and Gul, 2009).

Different methods to elicit risk attitude have been reported in the experimental economics literature. An increasingly used elicitation procedure, known as the price list design (Holt and Laury, 2002), entails giving the subject on an ordered array of binary choices. The relationship between education and risk preference has been reported in some experimental papers. For example, Dohman et al. (2006) conducted a study with a representative sample of roughly 22,000 individuals in Germany, using a question that asks about willingness to take risks on an 11-point scale. They found that willingness to take risks is positively related to parental education. In a sample of 660 customers of a German car manufacturer, Gachter et al. (2007) showed that education decreases loss aversion, while higher income and higher wealth are both positively correlated with loss aversion. Using a Dutch sample of 1935 subjects, Booij et al. (2009) found that older people are more risk averse in the gain domain, but other social, economic, and demographic variables such as education did not appear to have a significant effect on their risk attitudes for risks over gains as well as over losses. In a study of Allais paradox using a large sample of 1426 subjects, Huck and Müller (2012) found considerable heterogeneity in the population and that violation of expected utility tend to be prevalent among subjects who were less educated, poor, or unemployed.

2.2 Decision Making involving Time

The standard additively separable model for time preference was first proposed by Samuelson (1937), assuming a constant discount rate with a utility function for within-period consumption. There has been accumulating evidence showing a lack of descriptive validity of this exponential discounting model.[7] In particular, people tend to exhibit hypobolic discounting preference in being more impatient across consumptions in the immediate future than in the more distant future. Laibson (1997) introduced a two-parameter model to account for this phenomenon.

Another dimension of decision making over time concerns the timing of consumption, specifically, the idea of anticipation and dread (Loewenstein, 1987). In his experiment, subjects indicated how much they would pay to obtain (avoid) outcomes that would occur either immediately or after one of several delays. A robust difference emerged in the comparison of timing preferences for desirable and aversive outcomes. For obtaining a kiss from the movie star of one's choosing, subjects considered it almost twice as valuable if it was set to occur in three days rather than immediately; for receiving a non-lethal electric shock, subjects were willing to pay almost twice as much to avoid shocks in ten years as the same shock immediately. Loewenstein attributed this to the utility that people expect to derive during the period of waiting: anticipating a pleasant outcome versus dreading an unpleasant one.

The timing of uncertainty resolution is another dimension of decision making over time. Timing may matter for two reasons: planning advantage of early resolution (Kreps and Porteus, 1978) and anticipatory feelings such as hopefulness in case of late resolution (Chew and Ho, 1994). Chew and Ho conduct an experimental test, and find that hopefulness, i.e., a preference for late resolution of uncertainty, is more prevalent when there is a small probability of receiving a sizable gain; while anxiousness, a preference for early resolution, becomes more prevalent when there is there is good chance of receiving the sizable gain. Similar results are reported subsequently in Lovallo and Kahneman (2000) and Hopfensitz et al. (2011). There are also some experimental studies reporting the link between education and decision making over time. Kirby et al. (2002) collected field data from 154 Tsimane Amerindians 10–80 years of age and found that discount rates are positively correlated with age, negatively correlated with education and income, but not with wealth. In a study of Vietnamese villagers, Tanaka et al. (2010) combined survey information with experimentally elicited measures of preferences to study risk attitudes and time preferences. Their found lower discount rates to be associated with both higher household incomes and average village incomes but they did not find a statistically significant relationship between the discount rate and education.

[7] See, Frederick et al., (2002) for a survey.

3. Experimental Design Involving Adult Twins

The data sets that we use in this study are combined from two sources. One is derived from the Chinese Adult Twin Survey (CATS) which was conducted in 2002. The other is derived from the experiments that were conducted in 2008 on a subsample of the twins in CATS. This section describes the CCTS, the experiments, and the summary statistics.

3.1 The Chinese Adult Twins Survey

The socioeconomic variables in our analysis are derived from the CATS.[8] It was conducted by the Urban Survey Unit (USU) of the National Bureau of Statistics (NBS) in June and July 2002 in five cities in China, Chengdu, Chongqin, Harbin, Hefei, and Wuhan. Based on existing twin questionnaires from the United States and elsewhere, CATS covers a wide range of demographic, social, and economic information. The questionnaire was designed by one of the authors of this paper in close consultation with Mark Rosenzweig and Chinese experts at the NBS. Adult twins aged between 18 and 65 were identified by the local statistical bureaus. The questionnaires were completed through face-to-face personal interviews. One of the authors made several site checks of the survey work and closely monitored the data input process. Thus, the survey was carefully conducted.

The CATS is the first socioeconomic twin survey in China and perhaps the first in Asia. There is rich socioeconomic information in the data set. We consider a pair of twins to be identical (monozygotic, MZ) or non-identical (dizygotic, DZ) based on whether they have identical hair, color, looks, and gender. Thus, we can distinguish whether the twins in the sample are identical or non-identical. There are a total of 3,002 individuals who are twins. We have complete information on education and other variables for both twins in 964 pairs (1928 individuals). Of these, 488 pairs (976 individuals) are MZ twins.

3.2 Decision Making Experiment

The measures of preferences are derived from the experiments. In June and July 2008, one of the authors conducted a set of experiments on a subsample of twins in the CATS.[9] The subjects of the experiments are from the CATS data. However, due to budget constraint, we conducted the experiments in two cities: Hefei and Wuhan, the respective capitals of Anhui and Hubei provinces. We were not able to reach a substantial proportion of twins who have changed their addresses and contact information during the period of 2002-2008. Furthermore, because participation in the experiments was voluntary, some individuals in the CATS did not take part in the experiments. Eventually, we recruited 70 pairs (140 individuals) of twins for our experiments. As the identification

[8] Li et al. (2007), Huang et al. (2009), Li et al. (2010), Li et al. (2012) and Rosenzweig and Zhang (2013) gave a detailed description of the CATS data.

[9] We also hired several experiment assistants in conducting the experiments.

of the causal effect is based on within-twin variations, the selection of the twins in the experiment is not a major problem.

In the experiment, each individual who took part in the experiment was paid RMB60 as show-up fee.10 In addition, there were various payoffs in each experiment. We incentivized the choices of the subjects on risk attitude towards moderate prospect, moderate hazard, and longshot prospect, ambiguity aversion and familiarity bias, but we did not provide incentives for the rest including attitude toward longshot hazard, Allais paradox, impatience, hyperbolic discounting, dread, anticipation, anxiety and hopefulness, due to the difficulty in implementations. Most individuals completed the experiment within one hour. The maximum time spent is close to one and a half hours. The money was paid in cash after participants finished the experiment. On average, they earned RMB42 in addition to the basic show-up fee. This is higher than the average hourly wage in these two cities of RMB9.5 (NBS, 2009). The experimental design and instructions are presented in Appendix I.

Attitudes toward Fourfold Risks

In assessing risk attitude toward moderate prospects (Game 1 in Appendix I), subjects choose between an even-chance lottery between receiving RMB40 and receiving zero, versus receiving the expected outcome of RMB20 for sure. Subjects were incentivized for their choice in this comparison. Based on their decisions, subjects' valuation of the gamble is categorized as follows: risk aversion if certainty is chosen; risk seeking if lottery is chosen. Correspondingly, in assessing risk attitude toward moderate hazards (Game 2 in Appendix I), subjects begin by choosing between a lottery which involves losing RMB10 and losing zero with equal probability versus losing RMB5 for sure. Subjects were incentivized, i.e., losses were deducted from subjects' show-up fees. Based on their decisions, subjects' valuation of the gamble is categorized as follows: risk averse over losses if certainty is chosen; risk tolerant over losses if lottery is chosen.

For longshot prospects (Game 3 in Appendix I), subjects order the value of three items: (A) RMB2 lottery ticket which has a very small chance of winning 5 millions, (B) RMB2 lottery ticket which have small chance of winning 0.1 million, and (C) RMB2 for sure. We paid subjects their most preferable choice as incentive. Subjects are classified as exhibiting longshot preference, when A is preferred to B which is in turn preferred to C. For longshot hazards (Game 4 in Appendix I), subjects are classified as being disposed to insure if they prefer losing RMB2 for sure than losing RMB2000 with 0.1% chance. For the Fourfold Risks, subjects were incentivized for their choice for Game 1- 3, but not for Game 4.

Allais-type behavior

We adopt two of the four pairs – called the H (high) and L (low) pairs – of binary choices in Chew and Waller (1984) designed to test the independence axiom's parallelism implication on the behavior

[10] The exchange rate is US $1≈RMB ¥6.8 in 2008.

of indifference curves in a probability triangle (Game 5 in Appendix I). They find the highest incidence of Allais-type behavior, i.e., non-parallelism, based on subjects' choices in the H (high) and the L (low) pairs of binary choices. In our design, the H pair involves subjects choosing between receiving a high outcome of RMB100 with a 80% chance and receiving an intermediate outcome of \$0 with 20% chance (Option A) versus receiving RMB100 with 90% chance and receiving a low outcome of losing RMB80 with 10% chance (Option B). The L pair involves subjects' choosing between losing RMB80 with 80% chance and receiving \$0 with 20% chance (Option A) versus losing RMB80 with 90% chance and receiving RMB100 with 10% chance (Option B). We classify subjects as expected utility type if they choose either A or B in both pairs as implied by the independence axiom. Otherwise, we classify subjects as being Allais type if they exhibit the choice pattern – choose A in the H pair and choose B in the L pair – which imply that their indifference curves fan out in the probability triangle, i.e., satisfying Machina's (1982) Hypothesis II. The Allais-type behavior was put in the questionnaire part without actual incentive.

Ambiguity Aversion and Familiarity Bias

Most experimental studies on the original Ellsberg paradox involve choosing between betting on the urn with known probability distribution and betting on that with unknown probability distribution. Betting correctly in either case would pay the same. It is found that people tend to bet on the urn with known probability distribution (see, e.g., Camerer and Weber, 1992). In order to generate a more even split of individual difference between those preferring to bet on the "known" urn versus those preferring to bet on the "unknown" urn, we increase the payoff associated with betting on the unknown urn. This calls for a judicious choice of a threshold difference. In the ambiguity aversion task (Game 6 in Appendix I), subjects choose between betting on a "known" deck consisting of 10 red cards and 10 black cards, and an "unknown" deck consisting of 20 cards without knowing the composition of the red and black cards. For the known deck, a correct bet pays RMB10. For the unknown deck, a correct bet pays RMB12 with an increase of RMB2 as a result of pretests.

In the original experiment on familiarity bias in Fox and Tversky (1995), the bet is on whether the temperature in San Francisco/Istanbul is above or below a specific temperature. In our design, subjects choose between betting on whether Beijing temperature at a specific historical day would be odd or even, and similarly betting on Tokyo temperature (Game 7 in Appendix I). Our design induces the same objective probability (Machina, 2004) of one half for odd versus even regardless of the city chosen. To generate an even split between those betting on Beijing and those betting on Tokyo, betting correctly on Beijing temperature pays RMB11 which is RMB2 less than betting on Tokyo temperature. We incentivized subject's choice for the tasks of ambiguity aversion and familiarity bias.

Impatience and Hyperbolic Discounting

In experimental studies, binary choice is a commonly used method to elicit discount rates in which subjects choose between a smaller and more recent reward versus a larger but more delayed reward.

Other methods include matching tasks, rating tasks, and pricing tasks (see, e.g., Frederick et al. 2002). We make use of a simple hypothetical choice task (Game 8 in Appendix I). In Situation 1, subjects choose between getting RMB100 today (A) and getting RMB120 seven days later (B). In Situation 2, subjects choose between getting RMB100 91 days later (A) and getting RMB120 98 days later (B). If subjects choose A in the first case, they are impatient. If in addition they choose B in Situation 2, they exhibit hyperbolic discounting behavior. The time discounting task was put in the questionnaire part without actual incentive.

Anticipation and Dread

We adopt a similar design as in Loewenstein (1987) for timing-of-consumption preference with both desirable and aversive outcomes: having dinner with the movie star of one's choice, and receiving a non-lethal electric shock (Games 9 and 10 in Appendix I). Subjects are asked whether they prefer to have the dinner today or three days later. If they choose 3 days later, we classify them as experiencing anticipation. Subjects are asked whether they prefer to receive a non-lethal electric shock today or 6 months later. If they choose today, we classify them as experiencing dread. We did not incentivize subject's choice for these two tasks.

Hopefulness and Anxiousness

We adopt a similar design as in Chew and Ho (1994) and Lovallo and Kahneman (2000) for the timing of uncertainty resolution (Games 11 and 12 in Appendix I). In one task, subjects state whether to delay the resolution of uncertainty about the gender of the baby by paying RMB2 under the supposition that one of his/her relatives is pregnant. We classify the subjects as experiencing hopefulness if they prefer to pay to delay the resolution of uncertainty. In another task, subjects state when they prefer to pay RMB2 to resolve uncertainty immediately on the prospect of receiving RMB1000 with 90% chance and receiving zero otherwise versus waiting until two weeks later to resolve this uncertainty. If they choose to resolve now, we classify them as experiencing anxiousness, though there may be some value for planning. Naturally, we did not incentivize subject's choice for these two tasks.

3.3 Definitions of Variables and Summary Statistics

Appendix II defines experimental measures of preferences. All variables are 0-1 dummy variables and are all self-explanatory. Summary statistics of the variables are reported in Tables 1a and 1b. Table 1a first reports the individual's education levels and other socioeconomic variables. The educational attainments are categorized into five levels. The first three concerns general education followed by the next two involving professional education. We use education levels rather than years of education because education years between high school and technical school are incomparable. In other words, education year is not a cardinal variable in the Chinese education system. Specifically, in China, the student faces two choices after graduating from middle school: technical school or high school. If the student enters into technical school, she will get four years of vocational education and then go to work. If the student enters into high school, she will receive three years of general education before taking the college entrance examination. If she passes the examination, then she goes to college. Otherwise, she will seek employment.[11] Since high school education is examination oriented, few technical school graduates will take the college entrance examination. The qualitative difference between technical school and high school is confirmed by Li, Liu, and Zhang (2010). Using the CATS data, they find that the economic return to high school education is much lower than the economic return to technical school. The return to high school education is bounded between 4.0-4.5 percent. In contrast, the return to technical school education is between 20.6% and 22.5%. Finally, given that there were few with only primary education, we group them with subjects with middle school and treat them as a single baseline group.

The adult twins in the sample are quite old with a mean age of 46 and a minimum age of 28. Thus, it makes sense to use education attainment in the CATS of 2002 because those twins who had attended colleges would have graduated by 2002. In the OLS regression, we include parental education levels to check how the family background affects individual's preferences. All twin siblings are of same gender and 47% are males. By comparing the OLS estimates with and without parental education levels and the within-twin-pair fixed-effects estimates, we are able to infer how the family background and individual heterogeneity affect adult preferences.

As a robustness check, we include birth weight to control for pre-birth differences between the twins.[12] To detect the channels by which education affects preference, we include family annual income and health in the regression.[13] It has been suggested that education attainments increase incomes and demonstrated that higher educated people have better health (Grossman, 1975). Since income and health may affect preference, we study whether education affects preferences through income or health.

Table 1b reports the summary statistics for the experimentally observed measures of preferences. The last column of Table 1b gives the percentage of within-twin-pair variation to the total variation for each preference variable. We find that the within-twin-pair variations account for about one third to one half of the total variations, ranging from the lowest 34.50% to the highest 54.39%, for all preference variables.

4. Empirical Strategy

Our empirical analysis focuses on the estimation of the following equations:

$$y_{1i} = \alpha + E_{1i}\beta + X_i\gamma + Z_{1i}\delta + \mu_i + \varepsilon_{1i}, \tag{1}$$

[11]Appendix III depicts the Chinese education system.

[12]Recently, it is found that birth weight affects a series of short- and long-run individual outcomes, including health, academic performance, education attainments and earnings (Behrman and Rosenzweig, 2004).

[13]In CATS, the self-reported health status is rated into 5 levels. They are poor, fair, good, very good, and excellent. We categorize health into a dummy variable. It equals one if the individual reported the health status good, very good, or excellent. Otherwise, it equals zero.

$$y_{2i} = \alpha + E_{2i}\beta + X_i\gamma + Z_{2i}\delta + \mu_i + \varepsilon_{2i}, \qquad (2)$$

where y_{ji} ($j = 1,2$) is the experimentally observed of choice behavior of the first and second twin in family i.[14] E_{ji} ($j = 1,2$) is a vector containing dummies for education levels of twin j in family i; X_i is the set of family background variables that are observable and varying across families but not across twins; Z_{ji} ($j = 1,2$) is a set of observed variables that vary across the twins. μ_i represents a set of unobservable variables at the family level that may also affect preferences.

The OLS estimate β of the educational effect on preference in Equation (1) (or Equation (2)) is generally biased. The bias arises because normally we do not have a perfect measure of μ_i, which is likely to correlated with E_{ji} and y_{ji} simultaneously. Thus, we apply a within-twin-pair fixed-effects estimator for twins based on the first difference between (1) and (2):

$$y_{1i} - y_{2i} = (E_{1i} - E_{2i})\beta + (Z_{1i} - Z_{2i})\delta + \varepsilon_{1i} - \varepsilon_{2i}. \qquad (3)$$

Both observed and unobserved family effects, i.e., X_i and μ_i are differenced out in Equation (3). Because μ_i has been removed, we can apply the OLS method to Equation (3) without worrying about having a bias being caused by the omitted variable μ_i.

It is noteworthy that the identification assumption of Equation (3) is that differences in within-twin-pairs educational attainments result from random deviations from the optimum schooling level in the same family. In other words, the within-twin-pair differences in schooling levels are uncorrelated with any omitted variables, which may themselves affect preferences formation in the future. The assumption of within-twin-pair random deviation from optimal schooling with the within-twin-pair fixed-effects estimator has been extensively examined and discussed in Ashenfelter and Rouse (1998). We will systematically examine the robustness of the within-twin-pair fixed-estimates in Section 6 below.

The small size of our sample of 140 subjects may cast doubt on the validity of the results from classical tests such as the $t-$ and $F-$statistics. Micceri (1989) offers an extensive survey and concludes that classical test statistics may be unreliable when the sample size is small. We address the potential problem of small sample size using the permutation-based inference procedure known to be valid in small samples (Freeman and Lane, 1983; Heckman et al., 2010). Specifically, the permutation tests are based on Monte Carlo simulations. All reported $t-$statistics below are computed using 3,000 draws under the random permutation procedure.

[14] Since all experimentally measured preference behavior (dependent variables) are dummies, a logit model would seem to be a natural choice. However, a linear probability model can better facilitate our within-twin-pair fixed-effects estimation and the interpretation the estimated coefficients.

5. Results on Education and Preferences

This section reports and discusses our estimation results. We present successively the estimated effects of education on decision making under risk and uncertainty and on decision making involving time.

5.1 Education and Decision Making under Risk and Uncertainty

Table 2 reports both the OLS and within-twin-pair fixed-effects estimates of education and fourfold pattern of risk attitudes. As discussed above, we categorize educational attainments into four groups. The estimated coefficients on the three educational groups in the regression equation are relative to the omitted baseline group of middle-school-and-below, respectively. Columns (1)-(3) report the estimation results with risk attitude toward moderate prospects. From the OLS estimates in Column (1), we find that higher education increases risk tolerance marginally, although the estimates are statistically insignificant. Controlling for father and mother's educational levels, Column (2) reveals an increase in the magnitude of the estimated coefficients on technical school and college level experience. In Columns (3) of the within-twin-pair fixed-effects estimation, both observed and unobserved family characteristics are cancelled out. In this case, we find that the education level at college-and-above significantly increases risk tolerance toward moderate prospects.

Column 2 of Table A1 in Appendix IV shows that the effects of father's education are opposite that of mother's education on risk attitude toward moderate prospect.[15] Father's education increases risk tolerance while mother's education decreases it. This finding may help rationalize a bargaining or collective household model rather than a unitary household model involving a dictator or a dominant preference in the family.[16] From the magnitudes of the estimated coefficients, the negative effect of mother's education seems to dominate the positive effect of father's education on the child's risk attitude toward moderate prospects.

Columns (4)-(6) of Table 2 report the estimation results with risk attitude toward moderate hazards. Similar to the results with moderate prospect, the within-twin-pair fixed-effects estimates in Column (6) indicate that the education level of college-and-above significantly increases subjects' risk tolerance for moderate hazards. In Columns (4)-(5) of Table A1 in Appendix IV, the age effect on risk attitude toward moderate hazards seems nonlinear. Age increases risk tolerance in the beginning, and then declines with old age. This nonlinear pattern of age effect exists also in the estimation of risk attitude toward moderate prospects (Columns (1)-(2) of Table A1), although the estimated coefficients are only marginally significant. The estimated nonlinear relationship between age and attitude toward moderate risks may help reconcile a controversy in the literature.

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[15] To save space, we have only reported the estimated coefficients on education levels in the paper, while the estimated coefficients on other variables are reported in Appendices IV and V.

[16] For a survey, see, e.g., Behrman (1997).

Columns (7)-(12) report the estimates relating to attitudes toward longshot prospects and longshot hazards. Similar to the effects on moderate prospects and moderate hazards, the fixed-effects estimation results in Column (9) show that the education level of college-and-above significantly increases risk tolerance for longshot prospects. On the contrary, Column (12) does not show a significant effect of education on people's risk attitude toward longshot hazards.

Table 3 reports both the OLS and within-twin-pair fixed-effects estimates of education and decision making anomalies under risk and uncertainty. We first look at the estimation results with Allais-type behavior in Columns (1)-(3). It is interesting to find that more educated persons are more likely to exhibit Allais-type behavior. The within-twin-pair fixed-effects estimate is statistically significant for the group with college-and-above education. Columns (4)-(9) present the estimated results with ambiguity aversion and familiarity bias. Comparing with the baseline group with middle-school-and-below education, the fixed-effects estimates in Columns (6) and (9) show that more educated people are consistently more ambiguity averse as well as more biased toward familiarity. Interestingly, the effect of education on ambiguity aversion and familiarity bias seems to be nonlinear. The group with high school education is estimated to exhibit the strongest ambiguity aversion and familiarity aversion. In Column (17) of Table A1 in Appendix IV, the effect of father's education on the child's familiarity bias is opposite to that of mother's education. Father's education decreases the child's familiarity bias, while mother's education increases it. This finding further supports a bargaining or collective household model rather than a unitary household model.

Summarizing Tables 2-3, we first conclude that education increases subjects' risk tolerance toward moderate prospects, moderate hazards, and longshot prospect. Second, more educated people are more likely to deviate from the prediction of the expected utility theory. They are more likely to display Allais-type behavior. High school educated subjects also exhibit more ambiguity aversion as well as familiarity bias relative to pre-high school subjects. Finally, the big differences between the OLS estimates and within-twin-pair fixed-effects estimates for each preference measure in Tables 2-3 confirm that it is important to control for the cross-family heterogeneity.

5.2 Education and Decision Making Involving Time

The OLS and within-twin-pair fixed-effects estimates of education on decision making involving time are shown in Table 4. From Column (3), we first find that subjects with college-and-above education are significantly more patient than other groups. In addition, Column (6) shows that the group with college-and-above education is less likely to exhibit hyperbolic discounting. In other words, their decisions are more likely to be time consistent.[17] It is interesting to note, from Columns (1)-(2) and (4)-(5) in Table A2 of Appendix V, that males are more patient and less disposed to exhibiting hyperbolic discounting than females. The estimated coefficients on gender (male indicator) are highly

[17] In our experiment, 95% of the subjects who are time inconsistent, 95% exhibit hyperbolic discounting.

significant. Column (9) in Table 4 shows that education does not have a statistically significant effect. By contrast, Columns (12) and (15) in Table 4 indicate that having more education significantly decreases both dread and hopefulness. Finally, subjects with college-and-above educational attainments are less likely to be anxious, though the estimates are not statistically significant (Column (18)).

In summary (see Table 4), in terms of the signs of the estimated coefficients, the within-twin-pair fixed-effects estimates show that education decreases impatience, hyperbolic discounting, dread, and hopefulness, as well as anxiousness, with anticipation being the only exception. While education seems to increase anticipation, its fixed-effects estimate is statistically insignificant. In contrast to choice under risk and uncertainty, people with higher level of education tend to exhibit less "bias" preference regarding time. Table 4 also indicates that there are big differences between OLS estimates and within-twin-pair fixed-effects estimates regarding decision making involving time. This finding corroborates the importance in addressing the causality between education and preferences.

6. Robustness

This section reports the results from a robustness analysis. To deal with potential measurement errors with educational attainments, we first conduct an instrumental variable estimation. Second, to examine possible biases with our within-twin-pair fixed-effects estimates induced by omitted variables, we conduct the estimation controlling for pre-birth endowment of birth weight and restricting our sample to MZ twins. Third, we estimate the effects of educational attainments on preferences controlling for income and health. Fourth, we check the possibility of reversal causality. Fifth, we check the robustness with an enlarge sample. Finally, we examine any remaining potential biases in the within-twin-pair estimates.

6.1 Measurement Errors

The measurement error problem is a primary concern with the within-twin-pair fixed-effects estimator (Ashenfelter and Krueger, 1994). The classical measurement error in education leads to a downward biased (in terms of absolute value) estimate. The fixed-effects model exacerbates such measurement error bias. This paper follows Ashenfelter and Krueger (1994) to obtain good instrumental variables to deal with possible measurement error problem. Specifically, in the CATS we asked each twin to report both their own education and their co-twin's education. If there is a risk of measurement error in the self-reported education, the cross-reported education is potentially a good instrument. The reason is that the cross-reported education should be correlated with the true education of a twin but should not directly affect the latter's left-hand-side variables.

The instrumental variable approach is applied as follows. Denote E_j^k for twin $k's$ report of twin $j's$ education level. We can then use $E_1^2 - E_2^1$ to instrument $E_1^1 - E_2^2$ in Equation (3). This approach is valid in the presence of common family-specific measurement error because family effects are eliminated in the within-twin-pair difference. However, as Ashenfelter and Krueger (1994) demonstrated, the measurement error term in $E_1^2 - E_2^1$ and that in $E_1^1 - E_2^2$ may be correlated. In this case, the instrumental variable estimate using $E_1^2 - E_2^1$ is also biased. This consideration motives us to use $E_1^1 - E_2^1$ as the regressor and $E_1^2 - E_2^2$ as the instrumental variable. This method is valid even in the presence of correlated measurement errors because the individual-specific component of the measurement error in the estimation is swept out.

Before directly going to the IV estimates, we have compared the individual's self-reported education with co-twin's reported. It is found that there are only six individuals among the whole sample whose self-reported educations are different from those reported by co-twins. It means that the potential rate of misreports of education is only 4.29%, which is lower than the misreport rate in Ashenfelter and Krueger (1994). Considering the low misreport rate, we expect that the IV estimates will not be much different from the within-twin-pair fixed-effects estimates reported in the previous section. This prediction is confirmed by Table 5, which reports the instrumental variables within-twin-pair fixed-effects estimates of education and preferences. From this table, we find that the pattern of the education effects on various preferences still remains. In summary, our within-twin-pair fixed-effects estimates of the education effects on preferences are robust to the measurement errors problem.

6.2 Omitted Variables

While twin siblings share similar family environment, there may exist unobservable heterogeneity across them. For example, twin siblings may be different in nutrition intakes before birth and have different birth weights. Recent studies find that birth weight affects a series of short- and long-run outcomes such as health, education, and income (Behrman and Rosenzweig, 2004). Therefore, we include birth weight to control for pre-birth endowment as a robustness test. It is also interesting to examine the effects of birth weight on preferences. Table 6 reports the within-twin-pair fixed-effects estimates controlling for the variable of birth weight. It is found that the estimated effects of educational attainments on preferences are very similar to those in Tables 2, 3 and 4, indicating that our results are robust to the inclusion of birth weight as a control variable. In Table 6, we further find that birth weight does not have a statistically significant effect on preferences.

Given the small sample size, we have included both the MZ and DZ twins in our estimation above. Although DZ twins share identical family environment, they only share half the genetic endowments. Thus, it may be argued that the within-twin-pair fixed-effects estimation is not as clean. Table 7 reports the within-twin-pair fixed-effects estimates when we restrict the estimation sample to MZ twins only. Although there are only thirty six pairs of MZ twins, the pattern of the effects of educational attainments on preferences in the basic estimation remains similar to that reported in the previous section. Despite the small sample size, the education level at college-and-above significantly increases the risk tolerance toward moderate prospect and decreases impatience.

6.3 Estimates Controlling for Income and Health Status

It has been argued that socioeconomic variables such as incomes and health affect preferences, while education affects income and health. Thus, we have included income and health in the regression to check whether the effects of education on preferences may be acting through income or health. Tables 8 and 9 report the within-twin-pair fixed-effects estimates of educational attainments on preferences by controlling for income and health, respectively. We do not find any significant change in the pattern of the estimates.

6.4 Reversal Causality

Another potential problem with our within-twin-pair fixed-effects estimates is reversal causality bias. Although the unobservable family factors and individual heterogeneity may have been well taken care of by using the within-twin-pair fixed-effects estimator, there may be a reversal causality problem running from preference to educational attainments. However, for our subjects, preferences are experimentally measured at, on average, 45 years of age while education is finished before age 22.[18] Moreover, our within-twin-pair fixed-effects estimates are less likely to be biased by the reversal causality problem. Since twin siblings, particular MZ twin siblings, share common family background and genetic endowments, it is less likely for them to have differences in preferences at the early stages of their lives to influence their subsequent educational attainments.

6.5 Additional Sample

We test the robustness of our results with a larger sample. Prior to the experiments reported in the main results, we conducted some of the experimental measurements for 63 pairs of twins using other channels such as twin festivals (see Zhong et al., 2009 for details). The experimental measurements include moderate prospect, moderate hazard, longshot prospect, longshot hazard, impatience, and time inconsistency with the same experimental instructions, while we did not include the other measurements on time preferences for this sample. Including this additional sample, we have 133 pairs of the twins, and the results remain qualitative the same as reported in the paper. The estimation results are reported in the Web Appendix VI.

6.6 Potential Biases of Within-Twin-Pair Fixed-Effects Estimates

Ashenfelter and Rouse (1998) emphasize that there are no genetic differences between identical twins except measurement errors. They argue that different schooling levels of identical twins are mainly

[18] Re-schooling may be a potential threat to our within-twin-pair fixed-effects estimator because preference at the adult stage may affect the subject's re-schooling choice and education level. However, we find that there are only 4 subjects in our sample (140 subjects) who had received education after age 25.

due to random deviations that are not related to the determinants of schooling choices. However, within-twin-pair estimation may not completely eliminate the bias of conventional cross-sectional estimation, although our within-twin-pair fixed-effects estimates are consistently robust in a series of sensitive analyses discussed above. The reason is that the within-twin-pair difference in ability may remain in $\varepsilon_{1i} - \varepsilon_{2i}$ in Equation (3), which may be correlated with $E_{1i} - E_{2i}$. If unobserved within-twin-pair heterogeneity contributes to endogenous variation in education, then within-twin-pair estimation is still subject to an endogeneity bias. Thus, the major issue of concern of the within-twin-pair estimate is whether it is less biased than the cross-sectional level-OLS estimate, and is correspondingly a better estimate.

Note that the bias in the cross-sectional level-OLS estimator depends on the fraction of variance in education that is accounted for by variance in unobserved ability that may also affect earnings, that is, $\frac{\mathrm{cov}(E_i, \mu_i + \varepsilon_i)}{\mathrm{var}(E_i)}$. Similarly, the ability bias of the fixed effects estimator depends on the fraction of within-twin-pair variance in education that is accounted for by within-twin-pair variance in unobserved ability that also affects earnings, that is, $\frac{\mathrm{cov}(\Delta E_i, \Delta\mu_i + \Delta\varepsilon_i)}{\mathrm{var}(\Delta E_i)}$. If the endogenous variation within a family is smaller than the endogenous variation between families, the fixed effects estimator is less biased than the cross-sectional level-OLS estimator. In that case, we can credit the within-twin-pair estimates as being better than OLS estimates.

Ashenfelter and Rouse (1998) suggest a correlation analysis to examine whether the within-twin-pair estimate is less biased than the cross-sectional estimate. Using the CATS data, Li et al. (2012) conducted a correlation analysis similar to that of Ashenfelter and Rouse. They use the correlations of average family education over each twin pair with the average family characteristics that may be correlated with individual heterogeneity to indicate the expected omitted bias in a cross-sectional level-OLS regression. They then use the correlations of the within-twin-pair differences in education with the within-twin-pair differences in these characteristics to indicate the expected omitted bias in a within-twin-pair regression. If the correlations in the cross-sectional level case are larger than those in the within-twin-pair case, then the bias in the cross-sectional level-OLS regression is likely to be larger than the bias in the within-twin-pair regression. Li et al. (2012) find that the between-family correlations all exceed the within-twin-pair correlations, suggesting that within-twin-pair estimation of the return to education may indeed be less affected by omitted individual heterogeneity than the cross-sectional level-OLS estimation.[19] Given that we also use the CATS data, Li et al. (2012) provide suggestive evidences that our within-twin-pair fixed-effects estimates are less biased than cross-sectional level-OLS estimates.

[19] Table A4 in Appendix VII cites the between-families and within-twin-pair correlations of education and other variables in Li et al. (2012).

7. Discussion and Concluding Remarks

Using survey and experimental data, the paper presents a systematic empirical study of the effect of educational attainment on two dimensions of decision making behavior – risk and time. To control for unobserved family environment and to minimize individual endowment heterogeneity, we conduct a number of economic experiments on adult twin pairs and use within-twin-pair fixed-effects estimators to carry out the identification of the effect of education on these two dimensions of preference behavior. Our fixed-effects estimates indicate that people with a higher level of education are less risk averse toward moderate prospects, moderate hazards, and longshot prospects. These findings are in line with previous findings about risk attitude and cognitive ability (Frederick, 2005; Dohmen et al., 2010; Benjamin et al., 2013; Burks et al., 2009) and extend the findings to moderate hazards and longshot prospects. In addition, we find that more educated people tend to be more disposed to exhibit Allais-type behavior and ambiguity aversion.

In terms of preference involving time, our findings suggest that people with higher education tend to be more patient and exhibit less hyperbolic discounting. These results are more compatible with the notion of behavioral anomalies as decision making bias suggested by Morgenstern in the opening quote. In the domain of risk preferences, we find that education increases both Allais behavior and Ellsberg behavior. Should anomalies reflect the limitation of cognitive ability, increased understanding of anomalies ought to increase the frequency of "truly" normative response (Savage, 1954), and decision makers may then benefit from prescriptive measures to correct their own behavior. Contrary to Morgenstern's view, our results suggest that these violations of expected utility reflect the decision maker's actual preference. The contrast between the more anomalous decision making behavior under risk and uncertainty and the less anomalous decision making behavior over time, as exposure to education increases, suggests that they may have distinct underlying mechanisms. This suggests that education has multiple functions in preference formation and human capability building. Future work would be desirable to investigate the mechanisms driving the differential effects of education on anomalous decision making behavior in the two dimensions of risk and time.

Although the relationships between demographic and socioeconomic variables, cognitive and non-cognitive skills, and risk attitudes have been extensively investigated in the literature, the issue of causality has rarely been addressed. Our overall results suggest that the OLS estimated correlations between education and preferences are far from being causal. The substantial differences between OLS estimates and within-twin-pair fixed-effects estimates for each category of preference imply that some omitted variables relating to family background may confound those observed correlations between educational attainments and preferences.

While this paper seems, to the best of our knowledge, to be the first study exploring the causal effect of education on decision making behavior, it has its limitations. One concerns the small sample size of 140 subjects (70 pairs of twins), despite our proper treatment of the problem using a permutation-based inference procedure. As a field experiment on adult twins, 140 subjects seem moderate in size, relative to other behavioral and experimental studies in the literature. As an empirical study, we do not attempt to model the mechanism through which education affects individuals' decision making under risk and uncertainty and involving time. We anticipate that our new empirical findings would give rise to further research to explore the theoretical mechanisms underpinning the interplay between education and preference formation in general, and between education and decision making anomalies in particular.

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Table 1a: Summary Statistics of Educational Attainments and Other Variables

Variables	# Obs.	Mean	S.D.
Education level			
Primary school	140	0.06	0.25
Middle school	140	0.19	0.40
High school	140	0.35	0.48
Technical school	140	0.16	0.37
College-and-above	140	0.23	0.42
Parental education level			
Father primary school	140	0.46	0.50
Father middle school	140	0.22	0.42
Father high school	140	0.09	0.28
Father technical school	140	0.04	0.19
Father college-and-above	140	0.19	0.40
Mother primary school	140	0.64	0.48
Mother middle school	140	0.16	0.37
Mother high school	140	0.09	0.28
Mother technical school	140	0.07	0.26
Mother college-and-above	140	0.04	0.20
Control variables			
Age	140	45.74	11.93
Male	140	0.47	0.50
Birth weight (kg)	140	2.47	0.73
Family annual income (RMB1000)	140	22.51	18.04
Health indicator (good=1)	140	0.56	0.50

Table 1b: Summary Statistics of Experimental Measures of Decision Making Behavior

Variables	# Obs.	Mean	S.D.	Min	Max	% within-twin variation
Decision Making under Risk and Uncertainty						
Moderate prospect	140	0.64	0.48	0	1	37.33%
Moderate hazard	140	0.73	0.45	0	1	44.42%
Longshot prospect	140	0.57	0.50	0	1	40.83%
Longshot hazard	128	0.57	0.50	0	1	36.66%
Allais-type Behavior	122	0.18	0.38	0	1	44.37%
Ambiguity aversion	140	0.62	0.49	0	1	44.02%
Familiarity bias	140	0.79	0.41	0	1	50.91%
Decision Making over Time						
Impatience	140	0.54	0.50	0	1	47.39%
Hyperbolic discounting	140	0.23	0.42	0	1	52.65%
Anticipation	130	0.43	0.50	0	1	34.50%
Dread	136	0.73	0.45	0	1	42.69%
Hopefulness	128	0.41	0.49	0	1	35.62%
Anxiousness	140	0.76	0.43	0	1	54.39%

Note: Appendices I and II give experimental instructions and variable construction. The last column gives the percentage of within-twin-pair variation to the total variation for each behavioral variable.

Table 2: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Fourfold Pattern of Risk Attitudes

	Dependent variables					
	Moderate prospect			Moderate hazard		
	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)
High school	-0.087	-0.099	0.081	-0.130	-0.073	-0.057
	(0.80)	(0.89)	(0.42)	(1.28)	(0.70)	(0.29)
Technical school	0.002	0.074	0.199	-0.090	0.042	0.183
	(0.02)	(0.53)	(0.87)	(0.74)	(0.32)	(0.79)
College-and-above	0.004	0.060	0.438**	-0.060	0.016	0.386*
	(0.034)	(0.43)	(2.03)	(0.54)	(0.12)	(1.77)
Parental education	No	Yes		No	Yes	
Observations	140	140	140	140	140	140
Twin pairs			70			70
R-squared	0.11	0.19	0.08	0.11	0.17	0.09

	Longshot prospect			Longshot hazard		
	OLS		FE	OLS		FE
	(7)	(8)	(9)	(10)	(11)	(12)
High school	0.094	0.129	0.202	-0.187	-0.167	-0.331
	(0.85)	(1.13)	(0.96)	(1.60)	(1.43)	(1.55)
Technical school	0.180	0.234	0.338	0.0186	0.081	-0.165
	(1.36)	(1.62)	(1.36)	(0.14)	(0.57)	(0.67)
College-and-above	0.061	0.158	0.482**	-0.085	-0.064	-0.061
	(0.50)	(1.10)	(2.06)	(0.69)	(0.44)	(0.26)
Parental education	No	Yes		No	Yes	
Observations	140	140	140	128	128	128
Twin pairs			70			64
R-squared	0.14	0.21	0.03	0.14	0.25	0.05

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below; age, age square, gender, and a city dummy are included in each OLS estimation. The four dependent variables are dummy ones. They equal one if the subject is risk tolerant toward moderate prospects, moderate hazard, longshot prospect, and longshot hazard; they equal zero if the subject exhibits risk aversion. See Appendix II for experimental variable construction.

Table 3: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Anomalies under Risk and Uncertainty

	Dependent variables								
	Allais-type behavior			Ambiguity aversion			Familiarity bias		
	OLS		FE	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
High school	0.092	0.094	0.295	0.176	0.077	0.372*	0.080	0.0923	0.319*
	(0.97)	(0.96)	(1.64)	(1.56)	(0.67)	(1.72)	(0.85)	(0.98)	(1.65)
Technical school	0.064	0.056	0.274	0.369***	0.240*	0.242	-0.160	-0.171	0.065
	(0.59)	(0.47)	(1.33)	(2.73)	(1.66)	(0.95)	(1.43)	(1.43)	(0.28)
College-and-above	0.177*	0.206*	0.417**	0.213*	0.230	0.175	-0.125	-0.093	0.007
	(1.77)	(1.73)	(2.15)	(1.73)	(1.60)	(0.73)	(1.22)	(0.78)	(0.03)
Parental education	No	Yes		No	Yes		No	Yes	
Observations	122	122	122	140	140	140	140	140	140
Twin pairs			61			70			70
R-squared	0.15	0.21	0.08	0.07	0.17	0.05	0.10	0.21	0.06

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below; age, age square, gender, and a city dummy are included in each OLS estimation. The three dependent variables are dummy ones. The dependent variable of Allais equals one if the subject exhibit Allais-type behavior in the experiment. It equals zero if the subject exhibit expected utility behavior. The dependent variable of ambiguity aversion equals one if the subject exhibits ambiguity aversion in the experiment; otherwise, it equals zero. The dependent variable of familiarity bias equals one if the subject exhibit familiarity bias in the experiment; otherwise, it equals zero. See Appendix II for experimental variable construction.

Table 4: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Involving Time

	Dependent variables								
	Impatience			Hyperbolic discounting			Anticipation		
	OLS		FE	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
High school	0.047	0.017	-0.004	-0.064	-0.055	-0.133	0.068	0.058	0.048
	(0.42)	(0.15)	(0.02)	(0.66)	(0.53)	(0.66)	(0.61)	(0.51)	(0.23)
Technical school	-0.133	-0.177	-0.413	0.010	-0.004	-0.057	0.127	0.058	0.136
	(1.00)	(1.19)	(1.56)	(0.09)	(0.03)	(0.24)	(0.98)	(0.41)	(0.56)
College-and-above	-0.211*	-0.214	-0.520**	-0.116	-0.188	-0.382*	0.290**	0.152	0.208
	(1.73)	(1.44)	(2.09)	(1.09)	(1.45)	(1.70)	(2.49)	(1.09)	(0.92)
Parental education	No	Yes		No	Yes		No	Yes	
Observations	140	140	140	140	140	140	130	130	130
Twin pairs			70			70			65
R-squared	0.13	0.16	0.10	0.07	0.10	0.07	0.23	0.31	0.02

	Dread			Hopefulness			Anxiousness		
	OLS		FE	OLS		FE	OLS		FE
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
High school	-0.301***	-0.284**	-0.220	-0.201*	-0.186	-0.225	-0.062	-0.069	-0.130
	(2.84)	(2.55)	(1.14)	(1.71)	(1.51)	(1.08)	(0.64)	(0.67)	(0.60)
Technical school	-0.215*	-0.233	-0.515**	-0.367***	-0.336**	-0.440*	0.011	-0.013	0.036
	(1.70)	(1.65)	(2.22)	(2.64)	(2.15)	(1.80)	(0.09)	(0.10)	(0.14)
College-and-above	-0.132	-0.214	-0.389*	-0.069	-0.145	-0.478**	0.079	0.044	-0.085
	(1.17)	(1.56)	(1.81)	(0.56)	(0.99)	(2.14)	(0.74)	(0.34)	(0.35)
Parental education	No	Yes		No	Yes		No	Yes	
Observations	136	136	136	128	128	128	140	140	140
Twin pairs			68			64			70
R-squared	0.08	0.11	0.07	0.14	0.19	0.07	0.11	0.14	0.01

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below; age, age square, gender, and a city dummy are included in each OLS estimation. The six dependent variables are dummy ones. If the subject exhibits impatience, hyperbolic discounting behavior, anticipation, dread, hopefulness, and anxiousness in the experiments, all six variables equal one. See Appendix II for experimental variable construction.

Table 5: Instrumental Variables Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Behavior

	Dependent variables						
	Decision making under uncertainty						
	Moderate prospect	Moderate hazard	Longshot prospect	Longshot hazard	Allais-type behavior	Ambiguity aversion	Familiarity bias
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High school	0.066	0.040	0.177	-0.308	0.430**	0.450*	0.390*
	(0.32)	(0.19)	(0.80)	(1.37)	(2.21)	(1.87)	(1.94)
Technical school	0.153	0.287	0.231	-0.079	0.286	0.110	0.131
	(0.60)	(1.10)	(0.85)	(0.30)	(1.26)	(0.37)	(0.53)
College-and-above	0.461**	0.493**	0.509**	-0.128	0.521**	0.056	-0.098
	(2.00)	(2.08)	(2.07)	(0.54)	(2.52)	(0.21)	(0.44)
Observations	140	140	140	128	122	140	140
Twin pairs	70	70	70	64	61	70	70
R-squared	0.09	0.08	0.07	0.05	0.07	0.01	0.10

	Decision making involving time					
	Impatience	Hyperbolic discounting	Anticipation	Dread	Hopefulness	Anxiousness
	(8)	(9)	(10)	(11)	(12)	(13)
High school	-0.169	-0.220	0.084	-0.238	-0.205	-0.021
	(0.69)	(1.00)	(0.38)	(1.11)	(0.89)	(0.089)
Technical school	-0.511*	-0.043	0.042	-0.530*	-0.500*	0.205
	(1.71)	(0.16)	(0.15)	(2.00)	(1.80)	(0.71)
College-and-above	-0.504*	-0.244	0.186	-0.347	-0.492**	-0.028
	(1.86)	(1.00)	(0.76)	(1.47)	(2.03)	(0.11)
Observations	140	140	130	136	128	140
Twin pairs	70	70	65	68	64	70
R-squared	0.08	0.04	0.01	0.05	0.06	0.01

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below. The notes under Tables 2-3 give the definitions of each dependent variable.

Table 6: Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Behavior Controlling for Birth Weight

	Dependent variables						
	Decision making under uncertainty						
	Moderate prospect	Moderate hazard	Longshot prospect	Longshot hazard	Allais-type behavior	Ambiguity aversion	Familiarity bias
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High school	0.065	-0.021	0.209	-0.284	0.293	0.369*	0.332*
	(0.33)	(0.11)	(0.98)	(1.33)	(1.60)	(1.68)	(1.68)
Technical school	0.186	0.212	0.343	-0.127	0.272	0.240	0.075
	(0.81)	(0.91)	(1.36)	(0.52)	(1.30)	(0.93)	(0.32)
College-and-above	0.415*	0.437*	0.491**	0.003	0.414**	0.171	0.025
	(1.88)	(1.97)	(2.04)	(0.013)	(2.08)	(0.69)	(0.11)
Birth weight	-0.076	0.171	0.030	0.206	-0.010	-0.013	0.061
	(0.55)	(1.24)	(0.20)	(1.46)	(0.08)	(0.09)	(0.44)
Observations	140	140	140	128	122	140	140
Twin pairs	70	70	70	64	61	70	70
R-squared	0.08	0.11	0.06	0.08	0.08	0.05	0.07

	Decision making involving time					
	Impatience	Hyperbolic discounting	Anticipation	Dread	Hopefulness	Anxiousness
	(8)	(9)	(10)	(11)	(12)	(13)
High school	0.021	-0.136	0.058	-0.228	-0.189	-0.116
	(0.092)	(0.66)	(0.27)	(1.16)	(0.90)	(0.53)
Technical school	-0.392	-0.060	0.143	-0.521**	-0.423*	0.048
	(1.47)	(0.25)	(0.58)	(2.22)	(1.73)	(0.18)
College-and-above	-0.485*	-0.387*	0.221	-0.400*	-0.437*	-0.065
	(1.91)	(1.68)	(0.95)	(1.82)	(1.93)	(0.26)
Birth weight	0.119	-0.016	0.042	-0.039	0.142	0.068
	(0.76)	(0.11)	(0.30)	(0.28)	(1.03)	(0.45)
Observations	140	140	130	136	128	140
Twin pairs	70	70	65	68	64	70
R-squared	0.11	0.07	0.02	0.08	0.09	0.02

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below. The notes under Tables 2-3 give the definitions of each dependent variable.

Table 7: Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Behavior Using MZ Twins Pairs

	Dependent variables						
	Decision making under uncertainty						
	Moderate prospect	Moderate hazard	Longshot prospect	Longshot hazard	Allais-type behavior	Ambiguity aversion	Familiarity bias
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High school	0.115	-0.141	0.128	-0.769***	0.308	0.359	0.641**
	(0.48)	(0.58)	(0.45)	(3.10)	(1.40)	(1.18)	(2.55)
Technical school	0.269	0.449	0.410	-0.462	0.385	-0.051	0.051
	(0.96)	(1.57)	(1.22)	(1.57)	(1.48)	(0.14)	(0.17)
College-and-above	0.462*	0.325	0.402	-0.077	0.231	-0.009	0.009
	(1.96)	(1.36)	(1.43)	(0.31)	(1.06)	(0.03)	(0.03)
Observations	72	72	72	68	64	72	72
Twin pairs	36	36	36	34	32	36	36
R-squared	0.12	0.16	0.07	0.29	0.09	0.07	0.22

	Decision making involving time					
	Impatience	Hyperbolic discounting	Anticipation	Dread	Hopefulness	Anxiousness
	(8)	(9)	(10)	(11)	(12)	(13)
High school	-0.026	-0.282	0.115	-0.064	-0.100	-0.179
	(0.08)	(1.22)	(0.43)	(0.24)	(0.37)	(0.64)
Technical school	-0.282	-0.103	0.269	-0.705**	-0.467	0.026
	(0.74)	(0.38)	(0.86)	(2.25)	(1.42)	(0.08)
College-and-above	-0.547*	-0.350	0.128	-0.368	-0.411	0.171
	(1.71)	(1.54)	(0.49)	(1.40)	(1.58)	(0.62)
Observations	72	72	70	70	66	72
Twin pairs	36	36	35	35	33	36
R-squared	0.11	0.09	0.02	0.17	0.10	0.05

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below. The notes under Tables 2-3 give the definitions of each dependent variable.

Table 8: Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Behavior Controlling for Income

	Dependent variables						
	Decision making under uncertainty						
	Moderate prospect	Moderate hazard	Longshot prospect	Longshot hazard	Allais-type behavior	Ambiguity aversion	Familiarity bias
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High school	0.046	-0.056	0.219	-0.309	0.240	0.372*	0.342*
	(0.24)	(0.28)	(1.03)	(1.42)	(1.33)	(1.70)	(1.75)
Technical school	0.135	0.185	0.368	-0.133	0.191	0.242	0.107
	(0.59)	(0.77)	(1.44)	(0.53)	(0.92)	(0.92)	(0.46)
College-and-above	0.404*	0.387*	0.498**	-0.042	0.368*	0.175	0.029
	(1.88)	(1.75)	(2.10)	(0.18)	(1.91)	(0.72)	(0.13)
Family annual income	0.150	-0.003	-0.069	-0.062	0.161	0.001	-0.099
	(1.49)	(0.03)	(0.62)	(0.53)	(1.67)	(0.00)	(0.97)
Observations	140	140	140	128	122	140	140
Twin pairs	70	70	70	64	61	70	70
R-squared	0.11	0.09	0.07	0.06	0.12	0.05	0.08

	Decision making involving time					
	Impatience	Hyperbolic discounting	Anticipation	Dread	Hopefulness	Anxiousness
	(8)	(9)	(10)	(11)	(12)	(13)
High school	0.005	-0.145	0.023	-0.222	-0.166	-0.091
	(0.021)	(0.71)	(0.11)	(1.13)	(0.79)	(0.42)
Technical school	-0.396	-0.080	0.110	-0.518**	-0.366	0.106
	(1.46)	(0.33)	(0.44)	(2.20)	(1.48)	(0.41)
College-and-above	-0.511**	-0.395*	0.191	-0.390*	-0.432*	-0.048
	(2.03)	(1.73)	(0.83)	(1.79)	(1.94)	(0.20)
Family annual income	-0.039	0.054	0.064	0.009	-0.162	-0.165
	(0.34)	(0.51)	(0.59)	(0.09)	(1.45)	(1.47)
Observations	140	140	130	136	128	140
Twin pairs	70	70	65	68	64	70
R-squared	0.10	0.07	0.02	0.07	0.11	0.05

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below. The notes under Tables 2-3 give the definitions of each dependent variable.

Table 9: Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Behavior Controlling for Health

	Dependent variables						
	Decision making under uncertainty						
	Moderate prospect	Moderate hazard	Longshot prospect	Longshot hazard	Allais-type behavior	Ambiguity aversion	Familiarity bias
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High school	0.083	-0.060	0.202	-0.333	0.292	0.375*	0.318
	(0.43)	(0.31)	(0.95)	(1.55)	(1.62)	(1.73)	(1.62)
Technical school	0.196	0.193	0.339	-0.160	0.282	0.233	0.068
	(0.85)	(0.83)	(1.35)	(0.65)	(1.37)	(0.91)	(0.29)
College-and-above	0.436**	0.390*	0.483**	-0.059	0.420**	0.171	0.008
	(2.01)	(1.78)	(2.04)	(0.25)	(2.17)	(0.71)	(0.038)
Health indicator	-0.052	0.133	0.008	0.073	0.124	-0.126	0.044
	(0.37)	(0.93)	(0.052)	(0.49)	(0.98)	(0.80)	(0.31)
Observations	140	140	140	128	122	140	140
Twin pairs	70	70	70	64	61	70	70
R-squared	0.08	0.10	0.06	0.06	0.09	0.05	0.06

	Decision making involving time					
	Impatience	Hyperbolic discounting	Anticipation	Dread	Hopefulness	Anxiousness
	(8)	(9)	(10)	(11)	(12)	(13)
High school	-0.007	-0.136	0.054	-0.214	-0.225	-0.133
	(0.031)	(0.67)	(0.26)	(1.12)	(1.09)	(0.62)
Technical school	-0.406	-0.048	0.122	-0.530**	-0.440*	0.045
	(1.53)	(0.20)	(0.50)	(2.30)	(1.82)	(0.18)
College-and-above	-0.518**	-0.379*	0.203	-0.395*	-0.478**	-0.082
	(2.07)	(1.68)	(0.90)	(1.85)	(2.16)	(0.34)
Health indicator	0.094	0.123	-0.183	-0.195	0.214	0.128
	(0.58)	(0.84)	(1.24)	(1.41)	(1.40)	(0.82)
Observations	140	140	130	136	128	140
Twin pairs	70	70	65	68	64	70
R-squared	0.11	0.08	0.04	0.10	0.10	0.02

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the omitted educational group is middle-school-and-below. The notes under Tables 2-3 give the definitions of each dependent variable.

Web Appendix for
"Education and Anomalies in Decision Making: Experimental Evidence from Chinese Adult Twins"

Contents

Appendix I: Experiment Instruction

Game One (Moderate Prospect)

We will randomly draw one card from a deck of 20 cards: 10 red and 10 black. You have two options.

- Guess the color of the card drawn. You will receive RMB40 if your guess is correct; and nothing if your guess is wrong.
- Receive a sure amount of money if you do not wish to guess.

Tick "√" your choice. Tick only one. You will be paid based on your decision.

1.) Guess: Red ___ Black ___
You will receive RMB40 if your guess is correct; and nothing if your guess is wrong.

2.) Receive RMB20 ___

Note: This is on risk attitude toward moderate prospects. If subjects choose 1), they are classified as risk tolerant, otherwise risk averse.

Game Two (Moderate Hazard)

We will randomly draw one card from a deck of 20 cards: 10 red and 10 black. You have two options.

- Guess the color of the card drawn. You will lose RMB10 if your guess is wrong; and nothing if your guess is correct.
- Lose a sure amount of money if you do not wish to guess.

Tick "√" your choice. Tick only one. You will be paid based on your decision.

1.) Guess: Red ___ Black ___
You will lose RMB10 if your guess is wrong; and nothing if your guess is correct.
2.) Lose RMB5 ___

Note: This is on risk attitude toward moderate hazards. If subjects choose 1), they are classified as risk tolerant, otherwise risk averse.

Game Three (Longshot Prospect)

You have the following three options:

"Pick 7 out of 36" The market price for this lottery ticket is RMB2. The maximal prize is 5 million

"Permutation 5" The market price for this lottery ticket is RMB2. The maximal prize is 0.1 million

"RMB2 for sure"

Tick "√" your choice. You will be paid based on your decision.

1.) ____ "One in 100"

2.) ____ "One in 10"

3.) ____ "RMB2 for sure"

Other than your first choice, tick "√" your choice from the two remaining. You will not be paid in this decision.

1.) ____ "One in 100"

2.) ____ "One in 10"

3.) ____ "RMB2 for sure"

Note: This is on risk attitude toward longshot prospects. We used real lottery tickets in the experiment. Subjects are classified as risk tolerant in the sense of exhibiting longshot preference, when 1 is preferred to 2, which is in turn preferred to 3.

Game Four (Longshot Hazard)

You have the following two options:

- Lose RMB2 for sure
- Draw one card randomly from a deck of 10 cards numbered from 1 to 10 for three times. If each time, you get the card with number 1, you lose RMB2000 and nothing if you do not get the card with number 1 each time.

Tick "√" your choice. Tick only one. This is a hypothetical choice.

1.) Lose RMB2 for sure

2.) Draw the cards

Note: This is on risk attitude toward longshot hazards. If subjects choose 1), they are classified as risk averse, otherwise risk tolerant.

Game Five (Allais-Type Behavior)

For either alternative, a card will be drawn at random from a deck of 10 cards numbered from 1 to 10. These are all hypothetical choice. Please choose the one you like.

1. Which would you prefer? Tick "√" your choice

A. Receiving RMB100 if #1 to #8 is drawn. Receiving 0 if #9 or #10 is drawn.

B. Receiving RMB100 if #1 to #9 is drawn. Paying RMB80 if #10 is drawn.

2. Which would you prefer? Tick "√" your choice

A. Receiving 0 if #1 or #2 is drawn. Paying RMB80 if #3 to #10 is drawn.

B. Receiving RMB100 if #1 is drawn. Paying RMB80 if #2 to #10 is drawn

Note: This is on Allais behavior. If subjects choose AA, or BB, we classify these subjects as expected utility type behavior. If subjects choose AB, we classify these subjects as Allais-type behavior. If subjects choose BA, we classify these subjects as counter Allais-type behavior.

Game Six (Ambiguity Aversion)

You have the following two options:

T1: Guess the color of a card we draw randomly from a deck of 20 cards – 10 red and 10 black. You will receive RMB10 if your guess is correct; and nothing if your guess is wrong.

T2: Guess the color of a card we draw randomly from a deck of 20 cards with unknown proportions red and black cards. You will receive RMB12 if your guess is correct; and nothing if your guess is wrong.

Tick "√" your choice. Tick only one. You will be paid based on your decision.

Participate in T1	Participate in T2
Red ___ Black ___	Red ___ Black ___

Note: This is on ambiguity aversion. If subjects bet on T1, they are ambiguity averse.

Game Seven (Familiarity Bias)

You have the following two options:

T1: Guess whether the high temperature recorded in Beijing on ____ 2008 was odd or even. You will receive RMB11 if your guess is correct; and nothing if your guess is wrong.

T2: Guess whether the high temperature recorded in Tokyo on ____ 2008 was odd or even. You will receive RMB13 if your guess is correct; and nothing if your guess is wrong.

Tick "√" your choice. Tick only one. You will be paid based on your decision.

Participate in T1	Participate in T2
Odd ___ Even ___	Odd ___ Even ___

Note: This is on familiarity bias. If subjects bet on T1, they are familiarity biased. (Beijing is the capital of China, and Tokyo is the capital of Japan. We assume that our subjects are more familiar with Beijing than Tokyo)

Game Eight (Impatience and Hyperbolic Discounting)

The questions here are all hypothetical. Your decision will not have any real financial consequence. Please answer the following questions supposed you need to make decisions facing such situations.

1. Suppose that you can get RMB100 tomorrow, or you can get RMB 120 eight days later. Which one do you prefer:
   (1) Get RMB100 tomorrow;
   (2) Get RMB120 eight days later.

2. Suppose that you can get RMB100 91 days later, or you can get RMB120 98 days later. Which one do you prefer:
   (1) Get RMB100 91 days later;
   (2) Get RMB120 98 days later.

Note. This is on time discounting. If subjects choose RMB100 today in the first case, they are impatient, as the implied discount rate is 20% for one week. If they prefer RMB100 today over getting RMB120 seven days, and prefer getting RMB120 98 days later over getting RMB100 91 days later, they exhibit hyperbolic discounting behavior.

Game Nine (Anticipation)

Suppose you will have dinner with your favorite star. You could choose having it today, or three days later. You would choose:

(1) Today;

(2) 3 days later.

Note. This is on anticipation. If subjects choose 3 days later, they have preference of anticipation.

Game Ten (Dread)

Suppose you will take a non-lethal 110 volt shock. You could choose taking it today, or three months later. You would choose:

(1) Today;

(2) 3 months later.

Note. This is on dread. If subjects choose today, they have preference of dread.

Game Eleven (Hopefulness)

Suppose your relative is pregnant for three months. In a regular body check, the sex of the baby could be detected. You would prefer to:

(1) Know it immediately;

(2) Delay until it is born.

If you have to pay RMB2 in order to not to know the sex of the baby, would you choose to pay RMB2?

(1) Yes;
(2) No.

Note. This is on hopefulness. If subjects choose to pay RMB2 to delay, they have preference of hopefulness.

Game Twelve (Anxiousness)

Suppose you have 90% chance of winning RMB1000. The uncertainty is supposed to resolve today. Something happens, so it is delayed until 2 weeks later. If you pay RMB2, you could resolve the uncertainty immediately. Would you pay RMB2?

(1) Yes;

(2) No.

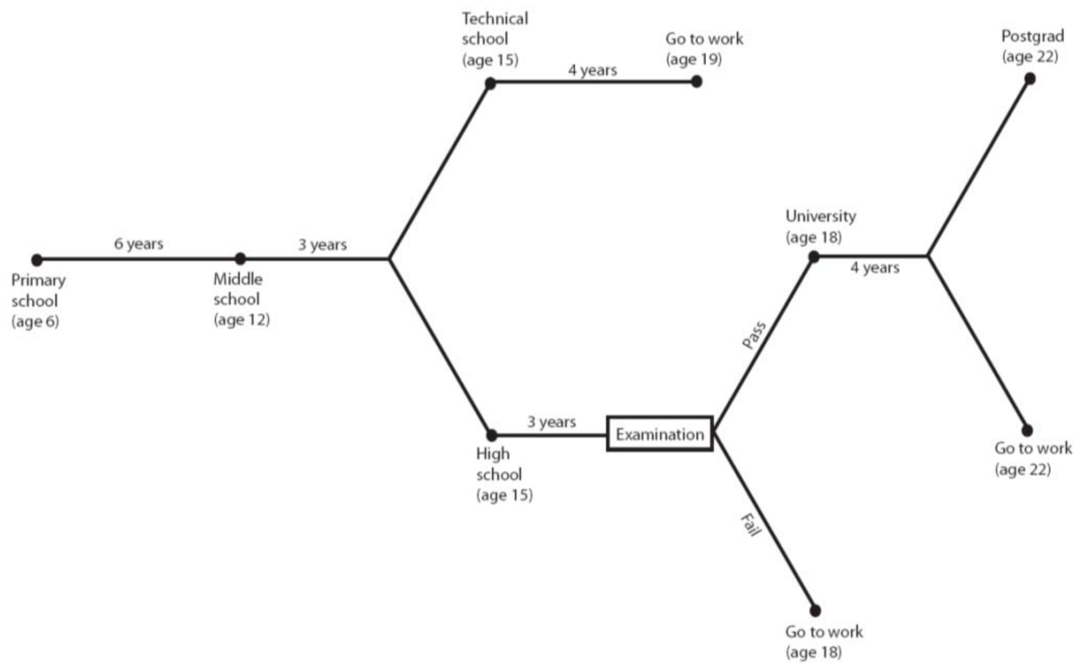
Note. This is on anxiousness. If subjects choose to pay, they have preference of anxiousness.

Appendix II: Experimental Variable Construction

Behavior	Instruction	meaning	binary coding 0 and 1
Decision Making under Uncertainty			
Moderate Prospect	GAME ONE	1 risk tolerant; 2 risk averse	0 risk averse; 1 risk tolerant
Moderate Hazard	GAME TWO	1 risk tolerant; 2 risk averse	0 risk averse; 1 risk tolerant
Longshot Prospect	GAME THREE	First choice 1 and second choice 2, 1; otherwise 0	0 risk averse; 1 risk tolerant
Longshot Hazard	GAME FOUR	1 buy insurance; 2 risk tolerant	0 risk averse; 1 risk tolerant
Allais-type Behavior	GAME FIVE	0: AA or BB, expected utility; 1 otherwise.	0 expected utility behavior; 1 otherwise
Ambiguity Aversion	GAME SIX	1 ambiguity averse; 2 not ambiguity averse	0 not ambiguity averse; 1 ambiguity averse
Familiarity Bias	GAME SEVEN	1familiarty bias; 2 not familiarity bias	0 not familiarity bias; 1familiarty bias
Decision Making over Time			
Impatience	GAME EIGHT	0 if choosing (1) in Question 1, patient; =1 otherwise, impatient	0 patient; 1 impatient
Hyperbolic Discounting	GAME EIGHT	0 others, 1 if choosing (1) in Question 1, and 2 in Question 2	0 others; 1 hyperbolic
Anticipation	GAME NINE	1 no anticipation; 2 anticipation	0 no anticipation; 1 anticipation
Dread	GAME TEN	1 dread; 2 no dread	0 no dread; 1 dread
Hopefulness	GAME ELEVEN	1 no hope; 2 hope	0 no hope; 1 hopefulness
Anxiousness	GAME TWELVE	1 anxiety; 2 not anxiety	0 no anxiousness; 1 anxiousness

Note: Appendix I gives the experiment instructions.

Appendix III: The Education System in China



Note: (a) the entrance age for primary school is not fixed at 6. Most of children enter at primary school at age 5-7. (b) Before 1986, the primary education was 5 years in most areas; after 1986, the country began to promote a 6-years primary education system. In the early 1990s, almost all areas adopted the 6-year primary education system. (c)There are some high school graduates entering into technical school. In our sample, 36% of the technical school graduates have studied high school before entering technical school. The remaining 64% technical school graduates only studied middle school before entering technical school.

Appendix IV: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making under Risk and Uncertainty

Table A1: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making under Risk and Uncertainty

	Dependent variables					
	Moderate prospect			Moderate hazard		
	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)
High school	-0.087	-0.099	0.081	-0.130	-0.073	-0.057
	(0.80)	(0.89)	(0.42)	(1.28)	(0.70)	(0.29)
Technical school	0.002	0.074	0.199	-0.090	0.042	0.183
	(0.02)	(0.53)	(0.87)	(0.74)	(0.32)	(0.79)
College and above	0.004	0.060	0.438**	-0.060	0.016	0.386*
	(0.034)	(0.43)	(2.03)	(0.54)	(0.12)	(1.77)
Age	0.033	0.055		0.064**	0.072*	
	(1.00)	(1.41)		(2.05)	(1.97)	
Age-squared	-0.041	-0.066*		-0.081**	-0.091**	
(1/100)	(1.18)	(1.65)		(2.48)	(2.41)	
Male	0.0330	-0.029		0.004	-0.017	
	(0.39)	(0.33)		(0.06)	(0.21)	
Father middle school		0.012			-0.193*	
		(0.10)			(1.68)	
Father high school		0.159			0.098	
		(0.79)			(0.51)	
Father technical school		0.143			-0.282	
		(0.60)			(1.26)	
Father college or above		0.302*			-0.029	
		(1.83)			(0.19)	
Mother middle school		-0.194			0.007	
		(1.41)			(0.06)	
Mother high school		-0.377**			-0.294*	
		(2.12)			(1.75)	
Mother technical school		-0.520***			-0.089	
		(2.65)			(0.48)	
Mother college or above		-0.201			0.046	
		(0.83)			(0.20)	
Observations	140	140	140	140	140	140
Twin pairs			70			70
R-squared	0.11	0.19	0.08	0.11	0.17	0.09

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group is middle school and below, and the omitted educational group for parental education is primary school; a city dummy is included in each OLS estimation.

Table A1: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making under Risk and Uncertainty (Cont.)

	Dependent variables					
	Longshot prospect			Longshot hazard		
	OLS		FE	OLS		FE
	(7)	(8)	(9)	(10)	(11)	(12)
High school	0.094	0.129	0.202	-0.187	-0.167	-0.331
	(0.85)	(1.13)	(0.96)	(1.60)	(1.43)	(1.55)
Technical school	0.180	0.234	0.338	0.0186	0.081	-0.165
	(1.36)	(1.62)	(1.36)	(0.14)	(0.57)	(0.67)
College and above	0.061	0.158	0.482**	-0.085	-0.064	-0.061
	(0.50)	(1.10)	(2.06)	(0.69)	(0.44)	(0.26)
Age	0.031	0.013		0.041	0.044	
	(0.90)	(0.33)		(1.17)	(1.07)	
Age-squared	-0.048	-0.034		-0.057	-0.064	
(1/100)	(1.35)	(0.82)		(1.55)	(1.52)	
Male	-0.029	-0.008		-0.042	-0.076	
	(0.34)	(0.095)		(0.46)	(0.81)	
Father middle school		-0.193			-0.150	
		(1.56)			(1.16)	
Father high school		-0.073			-0.229	
		(0.35)			(0.97)	
Father technical school		-0.446*			0.244	
		(1.83)			(1.02)	
Father college or above		-0.340**			0.321*	
		(2.01)			(1.86)	
Mother middle school		-0.059			-0.137	
		(0.42)			(0.92)	
Mother high school		0.051			0.004	
		(0.28)			(0.024)	
Mother technical school		0.049			-0.225	
		(0.24)			(1.13)	
Mother college or above		0.296			-0.406*	
		(1.19)			(1.67)	
Observations	140	140	140	128	128	128
Twin pairs			70			64
R-squared	0.14	0.21	0.03	0.14	0.25	0.05

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group is middle school and below, and the omitted educational group for parental education is primary school; a city dummy is included in each OLS estimation.

Table A1: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making under Decision Making under Risk and Uncertainty (Cont.)

	Dependent variables					
	Allais behavior			Ambiguity aversion		
	OLS		FE	OLS		FE
	(13)	(14)	(15)	(16)	(17)	(18)
High school	0.092	0.094	0.295	0.176	0.077	0.372*
	(0.97)	(0.96)	(1.64)	(1.56)	(0.67)	(1.72)
Technical school	0.064	0.056	0.274	0.369***	0.240*	0.242
	(0.59)	(0.47)	(1.33)	(2.73)	(1.66)	(0.95)
College and above	0.177*	0.206*	0.417**	0.213*	0.230	0.175
	(1.77)	(1.73)	(2.15)	(1.73)	(1.60)	(0.73)
Age	-0.060**	-0.098***		0.020	0.020	
	(2.11)	(2.84)		(0.59)	(0.50)	
Age-squared	0.070**	0.107***		-0.017	-0.018	
(1/100)	(2.32)	(3.00)		(0.47)	(0.44)	
Male	-0.128*	-0.134*		-0.075	-0.076	
	(1.73)	(1.71)		(0.85)	(0.85)	
Father middle school		0.107			0.303**	
		(1.03)			(2.44)	
Father high school		-0.246			-0.033	
		(1.28)			(0.16)	
Father technical school		-0.034			0.112	
		(0.18)			(0.46)	
Father college or above		0.037			0.055	
		(0.26)			(0.32)	
Mother middle school		-0.125			-0.191	
		(1.05)			(1.36)	
Mother high school		-0.108			0.184	
		(0.75)			(1.01)	
Mother technical school		0.145			-0.353*	
		(0.90)			(1.75)	
Mother college or above		-0.098			-0.083	
		(0.50)			(0.33)	
Observations	122	122	122	140	140	140
Twin pairs			61			70
R-squared	0.15	0.21	0.08	0.07	0.17	0.05

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group is middle school and below, and the omitted educational group for parental education is primary school; a city dummy is included in each OLS estimation.

Table A1: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making under Risk and Uncertainty (Cont.)

	Dependent variables Familiarity bias		
	OLS		FE
	(19)	(20)	(21)
High school	0.080	0.092	0.319*
	(0.85)	(0.98)	(1.65)
Technical school	-0.160	-0.171	0.065
	(1.43)	(1.43)	(0.28)
College and above	-0.125	-0.093	0.007
	(1.22)	(0.78)	(0.032)
Age	0.001	-0.004	
	(0.032)	(0.12)	
Age-squared	0.009	0.0161	
(1/100)	(0.31)	(0.48)	
Male	0.0176	0.0845	
	(0.24)	(1.14)	
Father middle school		-0.081	
		(0.79)	
Father high school		0.047	
		(0.28)	
Father technical school		-0.139	
		(0.69)	
Father college or above		-0.380***	
		(2.73)	
Mother middle school		0.050	
		(0.43)	
Mother high school		0.264*	
		(1.76)	
Mother technical school		0.287*	
		(1.73)	
Mother college or above		0.115	
		(0.56)	
Observations	140	140	140
Twin pairs			70
R-squared	0.10	0.21	0.06

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group is middle school and below, and the omitted educational group for parental education is primary school; a city dummy is included in each OLS estimation.

Appendix V: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making Involving Time

Table A2: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Anomalies in Decision Making Involving Time

	Dependent variables					
	Impatience			Hyperbolic discounting		
	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)
High school	0.047	0.017	-0.004	-0.064	-0.055	-0.133
	(0.42)	(0.15)	(0.020)	(0.66)	(0.53)	(0.66)
Technical school	-0.133	-0.177	-0.413	0.010	-0.004	-0.057
	(1.00)	(1.19)	(1.56)	(0.088)	(0.032)	(0.24)
College and above	-0.211*	-0.214	-0.520**	-0.116	-0.188	-0.382*
	(1.73)	(1.44)	(2.09)	(1.09)	(1.45)	(1.70)
Age	-0.011	-0.011		-0.002	0.001	
	(0.33)	(0.27)		(0.08)	(0.03)	
Age-squared	0.015	0.015		-0.007	-0.009	
(1/100)	(0.42)	(0.35)		(0.23)	(0.24)	
Male	-0.256***	-0.248***		-0.178**	-0.175**	
	(2.93)	(2.69)		(2.33)	(2.17)	
Father middle school		0.059			0.024	
		(0.46)			(0.22)	
Father high school		-0.148			0.045	
		(0.69)			(0.24)	
Father technical school		0.075			0.072	
		(0.30)			(0.33)	
Father college or above		0.044			0.099	
		(0.25)			(0.65)	
Mother middle school		0.003			0.050	
		(0.020)			(0.39)	
Mother high school		0.210			0.073	
		(1.11)			(0.44)	
Mother technical school		-0.028			0.187	
		(0.14)			(1.03)	
Mother college or above		-0.221			-0.160	
		(0.86)			(0.72)	
Observations	140	140	140	140	140	140
Twin pairs			70			70
R-squared	0.13	0.16	0.10	0.07	0.10	0.07

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group is middle school and below, and the omitted educational group for parental education is primary school; a city dummy is included in each OLS estimation.

Table A2: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Anomalies in Decision Making Involving Time (Cont.)

	Dependent variables					
	Anticipation			Dread		
	OLS		FE	OLS		FE
	(7)	(8)	(9)	(10)	(11)	(12)
High school	0.068	0.058	0.048	-0.301***	-0.284**	-0.220
	(0.61)	(0.51)	(0.23)	(2.84)	(2.55)	(1.14)
Technical school	0.127	0.058	0.136	-0.215*	-0.233	-0.515**
	(0.98)	(0.41)	(0.56)	(1.70)	(1.65)	(2.22)
College and above	0.290**	0.152	0.208	-0.132	-0.214	-0.389*
	(2.49)	(1.09)	(0.92)	(1.17)	(1.56)	(1.81)
Age	-0.046	-0.028		-0.008	-0.008	
	(1.34)	(0.70)		(0.25)	(0.21)	
Age-squared	0.042	0.021		0.002	-0.000	
(1/100)	(1.17)	(0.50)		(0.053)	(0.0024)	
Male	0.155*	0.111		0.017	-0.015	
	(1.73)	(1.22)		(0.20)	(0.18)	
Father middle school		-0.053			0.022	
		(0.42)			(0.19)	
Father high school		0.010			0.029	
		(0.051)			(0.14)	
Father technical school		-0.169			-0.345	
		(0.73)			(1.49)	
Father college or above		0.252			0.135	
		(1.43)			(0.82)	
Mother middle school		0.014			0.018	
		(0.11)			(0.14)	
Mother high school		0.350**			0.054	
		(2.03)			(0.31)	
Mother technical school		-0.139			0.057	
		(0.72)			(0.30)	
Mother college or above		-0.009			0.068	
		(0.037)			(0.29)	
Observations	130	130	130	136	136	136
Twin pairs			65			68
R-squared	0.23	0.31	0.02	0.08	0.11	0.07

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group is middle school and below, and the omitted educational group for parental education is primary school; a city dummy is included in each OLS estimation.

Table A2: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Anomalies in Decision Making Involving Time (Cont.)

	Dependent variables					
	Hopefulness			Anxiousness		
	OLS		FE	OLS		FE
	(13)	(14)	(15)	(16)	(17)	(18)
High school	-0.201*	-0.186	-0.225	-0.062	-0.069	-0.130
	(1.71)	(1.51)	(1.08)	(0.64)	(0.67)	(0.60)
Technical school	-0.367***	-0.336**	-0.440*	0.011	-0.013	0.036
	(2.64)	(2.15)	(1.80)	(0.09)	(0.10)	(0.14)
College and above	-0.069	-0.145	-0.478**	0.079	0.044	-0.085
	(0.56)	(0.99)	(2.14)	(0.74)	(0.34)	(0.35)
Age	-0.003	0.014		-0.010	-0.017	
	(0.08)	(0.32)		(0.34)	(0.48)	
Age-squared	0.000	-0.018		0.021	0.028	
(1/100)	(0.00)	(0.39)		(0.65)	(0.75)	
Male	0.252***	0.191*		-0.021	-0.039	
	(2.72)	(1.93)		(0.28)	(0.48)	
Father middle school		0.012			0.141	
		(0.089)			(1.26)	
Father high school		0.086			0.112	
		(0.40)			(0.60)	
Father technical school		0.113			-0.144	
		(0.46)			(0.66)	
Father college or above		0.337*			0.054	
		(1.89)			(0.35)	
Mother middle school		0.047			-0.030	
		(0.33)			(0.24)	
Mother high school		-0.179			-0.169	
		(0.97)			(1.03)	
Mother technical school		-0.052			0.012	
		(0.25)			(0.064)	
Mother college or above		-0.153			0.172	
		(0.61)			(0.77)	
Observations	128	128	128	140	140	140
Twin pairs			64			70
R-squared	0.14	0.19	0.07	0.11	0.14	0.01

Note: Absolute values of t-statistics computed based on the permutation procedure (Freedman and Lane, 1983) are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group is middle school and below, and the omitted educational group for parental education is primary school; a city dummy is included in each OLS estimation.

Appendix VI: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Decision Making with a Large Sample

Table A3-1: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Risk Attitudes

	Dependent variables					
	Moderate prospect			Moderate hazard		
	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)
High/vocational school	0.046	0.059	0.256**	0.069	0.076	0.139
	(0.076)	(0.076)	(0.128)	(0.072)	(0.072)	(0.129)
College and above	0.192**	0.207**	0.418***	0.012	0.061	0.333**
	(0.090)	(0.098)	(0.140)	(0.085)	(0.093)	(0.141)
Age	0.032**	0.034**		0.017	0.017	
	(0.016)	(0.017)		(0.015)	(0.016)	
Age-squared (1/100)	-0.045**	-0.048**		-0.030*	-0.030*	
	(0.019)	(0.019)		(0.018)	(0.018)	
Male	0.004	-0.021		0.037	0.026	
	(0.059)	(0.060)		(0.056)	(0.057)	
Father technical school		0.075			0.005	
		(0.096)			(0.091)	
Father college or above		0.143			0.017	
		(0.107)			(0.102)	
Mother technical school		-0.189*			-0.163*	
		(0.099)			(0.094)	
Mother college or above		-0.119			-0.055	
		(0.134)			(0.127)	
Observations	266	266	266	266	266	266
Twin pairs			134			134
R-squared	0.155	0.170	0.064	0.082	0.097	0.044

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group for the individual is middle school and below, and the omitted educational group for parental education is middle school and below; the city dummies are included in each OLS estimation.

Table A3-1: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Risk Attitudes (cont.)

	Dependent variables					
	Longshot prospect			Longshot hazard		
	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)
High/vocational school	0.159**	0.147*	0.240	-0.079	-0.050	0.023
	(0.081)	(0.081)	(0.159)	(0.090)	(0.089)	(0.176)
College and above	0.112	0.202*	0.445**	-0.057	-0.124	0.110
	(0.095)	(0.104)	(0.173)	(0.108)	(0.120)	(0.188)
Age	0.048***	0.043**		0.059**	0.067***	
	(0.017)	(0.018)		(0.024)	(0.024)	
Age-squared (1/100)	-0.062***	-0.056***		-0.070***	-0.079***	
	(0.020)	(0.020)		(0.026)	(0.026)	
Male	0.022	0.043		0.044	-0.008	
	(0.062)	(0.064)		(0.076)	(0.077)	
Father technical school		-0.143			0.056	
		(0.102)			(0.126)	
Father college or above		-0.243**			0.412***	
		(0.113)			(0.139)	
Mother technical school		-0.039			-0.101	
		(0.105)			(0.123)	
Mother college or above		0.158			-0.368	
		(0.142)			(0.231)	
Observations	266	266	266	184	184	184
Twin pairs			134			92
R-squared	0.124	0.150	0.049	0.097	0.143	0.005

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group for the individual is middle school and below, and the omitted educational group for parental education is middle school and below; the city dummies are included in each OLS estimation.

Table A3-2: OLS and Within-Twin-Pair Fixed-Effects Estimates of Education and Time Preference

	Dependent variables					
	Impatience			Time Inconsistency		
	OLS		FE	OLS		FE
	(1)	(2)	(3)	(4)	(5)	(6)
High/vocational school	-0.052	-0.055	-0.128	-0.055	-0.056	-0.170
	(0.084)	(0.086)	(0.163)	(0.076)	(0.076)	(0.151)
College and above	-0.333***	-0.346***	-0.514***	-0.152	-0.235**	-0.447***
	(0.104)	(0.117)	(0.178)	(0.093)	(0.104)	(0.165)
Age	-0.006	-0.007		0.018	0.025	
	(0.023)	(0.023)		(0.020)	(0.021)	
Age-squared (1/100)	0.009	0.010		-0.026	-0.033	
	(0.025)	(0.026)		(0.022)	(0.023)	
Male	-0.167**	-0.161**		-0.139**	-0.142**	
	(0.072)	(0.074)		(0.064)	(0.066)	
Father technical school		-0.057			0.117	
		(0.118)			(0.105)	
Father college or above		0.027			0.140	
		(0.137)			(0.122)	
Mother technical school		0.116			0.123	
		(0.121)			(0.107)	
Mother college or above		-0.221			-0.187	
		(0.229)			(0.204)	
Observations	196	196	196	196	196	196
Twin pairs			98			98
R-squared	0.120	0.132	0.093	0.055	0.085	0.075

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; the omitted educational group for the individual is middle school and below, and the omitted educational group for parental education is middle school and below; the city dummies are included in each OLS estimation.

Appendix VII: Between-Families and Within-Twin-Pair Correlations of Education and Other Variables

Table A4: Between-Families and Within-Twin-Pair Correlations of Education and Other Variables

Between-family correlations		Within-twin-pair correlations	
	Education		ΔEducation
Married	-0.1445***	ΔMarried	-0.0173
	(<0.01)		(0.70)
Spousal education	0.6172***	ΔSpousal education	0.1518**
	(<0.01)		(0.02)
Party member	0.2571***	ΔParty member	0.1166**
	(<0.01)		(0.02)
Working in foreign firm dummy	0.0904*	ΔWorking in foreign firm dummy	0.0214
	(0.06)		(0.66)
Tenure	-0.2614***	ΔTenure	-0.1253***
	(<0.01)		(0.01)

Notes: The significance levels are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The between-family correlations are the correlations between average family education (average of the twins) and average family characteristics, and the within-twin-pair correlations are the correlations between the within-twin-pair differences in education and the within-twin-pair differences in other characteristics.

Source: Li, H.; Liu, P. and Zhang, J. "Estimating Returns to Education Using Twins in Urban China." 2012, *Journal of Development Economics*, 97(2): 494-504.