The development of risk aversion and prudence in Chinese children and adolescents

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This study experimentally evaluates the risk preferences of children and adolescents living in an urban Chinese environment. We use a simple binary choice task that tests risk aversion as well as prudence. This is the first test for prudence in children and adolescents. Our results reveal that subjects from grades 5 to 11 (10 to 17 years) make mostly risk averse and prudent choices. With respect to risk aversion behavior of 3rd graders (8 to 9 years) does not differ statistically from risk neutrality. We also find 3rd graders to make mostly prudent choices. We also find evidence for a transmission of preferences: risk aversion is significantly correlated between children and their parents. Also, prudence is significantly correlated between girls (but not boys) and their parents.

Keywords: risk aversion, prudence, transmission of preferences, age effects, experimental economics, children
JEL Codes: C93, D81, J13

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1 Introduction

A basic tenet and component of most economics models is that individuals have stable and exogenous preferences. In problems of decision making under risk, models often rely upon individuals' preferences exhibiting risk aversion; which implies utility functions are concave in an expected utility framework. Increasingly researchers have identified a wide class of risky decisions in which behavior is driven by individuals' preferences exhibiting prudence (Kimball, 1990); which implies that marginal utility functions are concave in an expected utility framework.[1] We turn our attention to when and how these two key traits – risk aversion and prudence – emerge and are shaped in children and adolescents. We do this by experimentally testing for the presence of these traits in 362 Chinese children and adolescents aged 8 to 17 years and then examining the correlation of these results with same tests for their parents – collected as hypotheticals in a survey – as well as with cognitive abilities and household attributes.

The direct measurement of higher-order risk preferences, such as prudence, has been sparked by the lottery-based and model-free definition by Eeckhoudt and Schlesinger (2006) (see also Eeckhoudt and Schlesinger, 2013, for a comprehensive review.) For an individual with initial positive wealth W they define risk aversion and prudence (as well as higher-order risk preferences more generally) in terms of preferences over pairs of lotteries. Each lottery has two potential outcomes x and y and is denoted by $[x; y]$. Eeckhoudt and Schlesinger (2006) define risk aversion as weakly preferring a lottery $[W\text{-}k_1; W\text{-}k_2]$ over a lottery $[W\text{-}k_1\text{-}k_2; W]$, where $k_1>0$ and $k_2>0$ are sure losses. They define prudence as weakly preferring a lottery $[W\text{-}k_1; W+\varepsilon]$ over a lottery $[W\text{-}k_1+ \varepsilon; W]$, where ε is a zero-mean risk (i.e., a lottery with an expected value of zero). While risk-averse individuals like to disaggregate two sure losses, prudent individuals like to disaggregate a sure loss and an additional zero-mean risk. In other words, risk aversion corresponds to a preference for a lower spread in payoffs and prudence to a preference for facing additional risk in better states of the world (prudence is therefore sometimes also called downside risk aversion).

Based on these definitions, risk aversion and prudence have been measured in a series of papers which Trautmann and van de Kuilen (2018) survey. Most of these papers elicit risk preferences in

[1] For example, Leland (1968) and Sandmo (1970) show that the sign of the third-order derivative of the utility function drives precautionary savings. Other examples include auctions for objects of uncertain value (Esö and White, 2004); bargaining (White, 2008); and the uptake of preventive health measures (Courbage and Rey, 2006, 2016).

the gain domain using choices between lottery pairs (Ebert and Wiesen, 2011; Noussair et al., 2014; Deck and Schlesinger, 2014; Breaban et al., 2016; Haering et al., 2017; Ebert and van de Kuilen, 2017; Baillon et al., 2018). Some alternatively elicit risk and prudence premia using a multiple price list (Ebert and Wiesen, 2014; Heinrich and Mayrhofer, 2018) or elicit preferences in the loss domain (Maier and Rüger, 2013; Bleichrodt and van Bruggen, 2018). With respect to the loss domain the evidence is ambiguous, but with respect to the gain domain most find a majority of choices to be risk averse and prudent for binary choices as well as for a multiple price list.[2] For the sake of comparability with the majority of studies, we opt to elicit risk preferences in the gain domain using binary lottery choices.

When comparing risk aversion across age groups, the evidence from previous experiments does not show a clear age effect. In an initial study, Harbaugh et al. (2002) analyze risk aversion of children and adolescents aged 5 to 20 as well as of adults aged 21 to 64. They observe no correlation between age and a preference for gambles over certain amounts of equal expected value. Levin et al. (2007) compare the risky choices by 9 to 11 year old children to the choices the same children made 3 years earlier. They find a significant within-subject correlation but also no age effects for risk aversion. Furthermore, Sutter et al. (2013) do not observe age effects in their study with children and adolescents ranging from 10 to 18 years. Khachatryan et al. (2015) find a gender-dependent age effect. They study risk aversion of boys and girls in two age groups (7 to 12 years and 12 to 16 years). In their sample risk aversion of boys decreases with age while girls' risk aversion stays constant.[3]

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[2] Note that higher-order risk preferences have also been elicited within the expected utility theory framework by Tarazona-Gomez (2004) and by Krieger and Mayrhofer (2012, 2017).

[3] A large literature in psychology pioneered by Slovic (1966) and surveyed in a meta-study by Defoe et al. (2015) also considers risk taking by children and adolescents. Many studies in this field are motivated by the question why adolescents are more likely than adults to engage in behavior which is commonly regarded as "risky" like reckless driving or experimenting with drugs (see, e.g., Dahl, 2004, Steinberg, 2007). Defoe et al. (2015) analyze the results of 25 experimental studies. They find that children (5 to 10 years) do not differ in their risk taking from early adolescents (11 to 13 years). But early adolescents take more risk than older adolescents (14 to 19 years). However, as they point out, the employed tasks vary by whether they elicit preferences on the gain or loss domain and by whether probability distributions over payoffs are known or unknown. Also, many of the studies in this field are not incentivized or do not systematically differentiate between the different moments of probability distributions.

Several survey based investigations have found positive correlation between the risk aversion of adult children and that of their parents (see, e.g., Kimball et al., 2009, Dohmen et al., 2011, Necker and Voskort, 2014), providing evidence for the intergenerational transmission of risk aversion. In addition, experimental studies that correlate decisions in incentivized tasks observe correlations between children's and their parents risk aversion: Levin and Hart (2003) find a significant correlation between the risk aversion of 6 to 8 year old children and that of their parents (79% of them mothers). However, this correlation is insignificant in their follow-up study with the same subjects three years later, as reported in Levin et al. (2007). Alan et al. (2017) study risk aversion of 7 to 8 year old children and their mothers. They find that the risk aversion of girls (but not of boys) correlates with their mother's risk aversion.

There is evidence that a considerable part of variability of decision making under uncertainty is determined genetically as documented, for example, in twin studies on risk aversion (Cesarini et al., 2009; Zhong et al., 2009; Zyphur et al. 2009) and on financial investments (Cesarini et al., 2010; Barnea et al., 2010). Heritability may explain the transmission of risk preferences from parents to their children. However, the environment also appears to be an important driver of risk taking. A recent study by Black et al (2017) on adoptees finds that the portfolio risk adoptees take on is more strongly correlated with that of their adoptive than their biological parents (see also Fagereng et al., 2018). In addition, a number of studies suggest that risk preferences are influenced by the general characteristics of the household within which children grow up. Deckers et al. (2017) observe that 7 to 9 year old children who grow up in households of parents with low income or low education are less risk averse than other children. Falk and Kosse (2016) interpret breastfeeding duration as a measure of quality of the early childhood environment. In a sample of preschool children aged 5.9 years on average, they find that shorter breastfeeding is associated with lower risk aversion (and lower levels of patience and altruism).

In this study we connect the emerging literature on higher-order risk preferences with previous work on the development and transmission of risk aversion. We measure risk aversion and prudence in two primary schools, one middle school and one high school in the mainland Chinese sub-provincial city of Xiamen. For this purpose, we developed a simple preference elicitation task suitable for young children. We ran all experiments during the usual class time and are thus able to rule out self selection into the experiment. We also used a survey to collect the stated risk

preferences of parents and household information. Furthermore, we obtained additional information from the school records.

Our results with respect to the preferences of children and adolescents reveal that subjects from grades 5 to 11 (10 to 17 years) make mostly risk averse and prudent choices. With respect to risk aversion behavior of 3rd graders (8 to 9 years) does not differ statistically from risk neutrality. We also find 3rd graders to make mostly prudent choices, however, this effect is driven by one of the two primary schools we sampled from. We also find evidence for a transmission of preferences: risk aversion is significantly correlated between children and their parents. Also, prudence is significantly correlated between girls (but not boys) and their parents.

In section 2 we will describe our elicitation method and process of data collection. In section 3 we present the results. After describing the summary statistics, we first focus on the basic question of whether children and adolescents are risk averse and prudent. We then present our results on the transmission of risk preferences and consider the development of risk preferences with age. Section 4 concludes with a discussion of our findings.

2 Study design

2.1 Preference elicitation

Our goal is to test for risk aversion and prudence in a classroom setting. For this purpose, we need a method that can be explained quickly and is easy to understand for participants with little knowledge of mathematics. Nevertheless we also want to build on established methods so that our results are readily comparable to existing studies.

Various tools have been applied to measure risk preferences in experiments with adults (see Harrison and Rutström, 2008, Charness et al., 2013, and Haering and Heinrich, 2017, for overviews). We also use lottery pairs to measure risk preferences. As pointed out above, most studies on higher-risk preferences do so. Also, this approach fulfils our requirement of being simple and it also has been applied successfully with young children (Deckers et al., 2017).[4]

[4] Other simple risk elicitation tasks that have been used to elicit children's' risk preferences are the devil's task (Slovic, 1966) used by Falk and Kosse (2016) or the investment task by Charness and Gneezy (2010) used by An-

In the design of our elicitation method, we build on Deck and Schlesinger's (2014) study. They have developed 38 random lottery pairs that allow measuring first to sixth order risk preferences which are also used in subsequent studies (Deck and Schlesinger, 2018, Haering et al., 2017). We select seven of their lottery pairs: one first-order dominance task, three risk aversion tasks and three prudence tasks. Table 1 shows the parameters of the tasks.[5] We deviate from the task frame of Deck and Schlesinger (2014). Most lotteries in these pairs are compound lotteries. Deck and Schlesinger depicted and resolved uncertainty through a sequence of binary lotteries; represented as a series of random wheel spins. We presented the same lotteries in their reduced form, represented as random draw from an opaque bag containing four marbles of different colors.

Table 1: Parameters of the pair-wise lottery choice tasks

		Option A				Option B				D&S
Task Nr.	Order	Outcomes	Exp. Pay.	Var.	Skew.	Outcomes	Exp. Pay.	Var.	Skew.	Task Nr.
1	1	4; 4; 4; 4	4	0	0	7; 7; 7; 7	7	0	0	2
2	2	4; 4; 10; 10	7	9	0	7; 7; 7; 7	7	0	0	9
3	2	2; 2; 12; 12	7	25	0	4; 4; 10; 10	7	9	0	5
4	2	1; 1; 19; 19	10	81	0	10; 10; 10; 10	10	0	0	10
5	3	3; 7; 10; 10	7.5	8.25	-15	5; 5; 8; 12	7.5	8.25	15	11
6	3	1; 9; 10; 10	7.5	14.25	-60	5; 5; 6; 14	7.5	14.25	60	13
7	3	6; 10; 10; 10	9	3	-6	8; 8; 8; 12	9	3	6	16

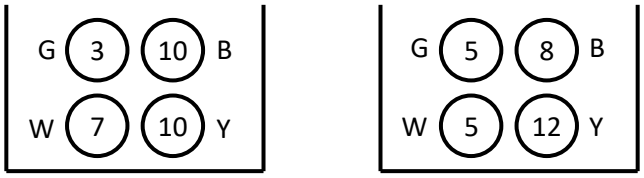
All choices were displayed using four marbles as illustrated in Figure 1. It shows the two options available in Task 11 by Deck and Schlesinger (2014) as it was operationalized in our experiment. Both options have the same expected payoff and the same variance but differ in their skewness. The lottery on the left has lower skewness, i.e. a larger downside risk. The letters indicate the

gerer et al. (2015) and Sutter et al. (2015). Sutter et al. (2013) use the more complicated multiple price list. However, their youngest participants are ten years old, two years older than the youngest in our study.

[5] The tasks were selected, so that the decisions of each order are incentivized approximately equally. Due to time constraints we were not able to use the full sets of lottery pairs used by Deck and Schlesinger (2014) in the respective orders. For the same reason (and because we feared that they would be too complex for the youngest participants), we did not elicit higher-order risk preferences beyond prudence.

color of each marble (green, blue, yellow and white) which were replaced with the symbol for the respective color in the original Chinese version of the instructions.

Figure 1: Prudence lottery task



G: green, B: blue, Y: yellow, W: white; in the original instructions
these letters were replaced with the Chinese symbol for the respective color.

2.2 Experimental procedures

We conducted all experiments during regularly scheduled class times by the same lead experimenter who was supported by six extensively trained assistants. We held all sessions in either the school's library or a classroom.[6] At the beginning of each session, the rules of the experiment were carefully explained by the lead experimenter.[7] We stressed that we wanted participants to understand all procedures, encouraged questions and took ample time to answer them. We also made clear that choices have to be made individually and that talking to other students is forbidden.

All participants had to successfully answer two control questions.to demonstrate comprehension of the tasks. The students proceeded to make their choices by noting them in a paper booklet illustrating the different lotteries.[8] We randomized the presentation of the left and right lotteries between booklets. We use dummy variable *Flipped* to indicate which of the two presentations

[6] See Appendix C for a picture of the experimental setting.

[7] See Appendix B for the complete protocol translated from Chinese.

[8] For the English translation of a primary schools subject's decision booklet see Appendix A. The booklet contained lottery choices in the order shown in Table 1. The advantage of eliciting dominance choices before prudence ones is the increase of complexity over the course of the experiment which can help subjects to get used to the decision environment. See Noussair et al. (2014) and Heinrich and Mayrhofer (2018) for similar arguments.

was used. There was no feedback over the course of decision making. Payments were only determined at the very end. For this purpose, one task was drawn for payment. This task was the same for all participants and it was determined by a draw from bingo cage. After which the assistants approached the students one by one by and determined the outcome of their chosen lottery in the respective task. For this, one marble was drawn from an opaque bag containing the four marbles and then the student was paid accordingly.[9]

The students' grades, their Hukou status and gender were collected directly from the schools' administrations. The Hukou is a household registration system that is used in China to categorize between local and non-local as well as between urban and rural citizens. We use the local/non-local Hukou status as a proxy for migratory experience. As observed by Jaeger et al. (2010), for example, migrants tend to be more risk seeking.[10]

The third data set we collect uses a survey instrument given to the students' parents.[11] After the experiment student participants received an envelope containing a questionnaire for their parents. It was explained that this envelope was to be filled out by their parents, signed by them and returned to the respective teacher. Parents received RMB 40 (approximately US$ 6.45 at the time) for returning the questionnaire. In this questionnaire parents were presented with the same lottery pairs. We were not able to incentivize their decisions but scaled up the hypothetical payoffs by a factor of 1,000 (relative to those of the primary school children) to make payoffs more salient.[12] In addition, we asked who filled out the questionnaire (the mother, the father or someone else)

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[9] Note that there were 13 decisions over all, one of which was selected at random using the bingo cage. We also asked subjects to make six additional decisions in a savings task after they made the seven choices described above. In this task subject could forgo immediate payoffs and earn interest by getting paid two weeks later at a second experiment (unrelated to the current study). However, we found virtually no variation in savings behavior because most subjects saved as much as they could. We therefore do not report these results. By coincidence the savings task was never selected for payment.

[10] See Song (2014) for a review of the Hukou system and Afridi et al. (2015) or Gu et al. (2016) for an experimental study that exploits differences in Hukou status.

[11] See Appendix C for a translated excerpt from this questionnaire.

[12] Note that in their comprehensive study, Noussair et al. (2014) observe no difference in risk aversion and prudence (and temperance) between incentivized and non-incentivized lotteries for adults. However, for hypothetical stakes, framing matters: Larger hypothetical stakes lead to more risk aversion but to no change in prudence.

and how many members of the household have a high school degree and how many have a university degree (none, one, two or more). We also asked about the number of houses or apartments the members of the family owned altogether (none, one, two or more).[13] We use this as a proxy of wealth as this is the primary store of wealth for Chinese citizens.

Table 2 presents our experimental design. We collect data at six grade levels covering children in the age range from 8 to 17 years. Across schools we used the same experimental procedures. After consulting with several teachers, we decided to pay all students in cash (see Brosig-Koch et al., 2015, and Geng et al., 2015 for a similar procedure). Based on these consultations we used the same incentives within each school, but we doubled the primary school's pay for the middle school and tripled it for the high school. That means, lotteries paid between RMB 1 and RMB 19 for 3rd and 5th graders (between US$ 0.16 and US$ 3.06) and between RMB 3 and RMB 57 for 10th and 11th graders (between US$ 0.48 and US$ 9.19). Also, note that Vieider (2012) finds no influence of variations up to 20% in payoffs on second-order risk aversion.

A challenge of cross-sectional studies that compare different age groups consists of finding comparable samples. We selected four schools from urban districts of Xiamen (population of around 2,000,000): a primary school from the Huli district, a middle school from the Haicang district and a high school from the Siming district. The public Xiamen school system has approximately 300 primary, 60 middle and 35 high schools. The primary and middle school one attends depends upon their home address, but the high school they attend depends upon their performance on an entrance exam.

Based on the results from our first sample we also collected data from a second primary school, from the Huli district of Xiamen, due to a strong imbalance between the proportion of local and non-local Hukou holders. Relative to the two other schools a larger share of participants at the first primary school was migrants. Therefore we collected a second sample at another primary school with a share of migrants that is similar to that in the middle and the high school in a follow-up sample. At this school we used exactly the same experimental procedures and the study

[13] See Appendix C for these items of the questionnaire. Note that each child only received one questionnaire. We asked for the responder's relationship to the child but we did not fix which household member had to answer the questionnaire because of single-parent households. Therefore, we cannot exclude self-selection effects, e.g. through children who prefer to give the questionnaire to the parent that is more similar to them in terms of risk preferences.

was conducted by the same lead experimenter. In the following we present results on the full samples including regressions that control for Hukou status. If not mentioned otherwise, our main observations persist when using data from either one of the two primary schools. Appendix E includes additional analyses using only data from one of the two primary schools at a time.

Table 2: Experimental design

Grade	School type	Monetary incentives	Order of events		Sample	*N*
			1: Control questions	2: Tasks		
3	Primary 1	1x	yes	1 to 7	Initial	46
5	Primary 1	1x	yes	1 to 7	Initial	50
7	Middle	2x	yes	1 to 7	Initial	44
8	Middle	2x	yes	1 to 7	Initial	45
10	High	3x	yes	1 to 7	Initial	41
11	High	3x	yes	1 to 7	Initial	40
3	Primary 2	1x	yes	1 to 7	Follow-up	48
5	Primary 2	1x	yes	1 to 7	Follow-up	48

Monetary incentives: Payoffs as shown in Table1 were scaled up by a factor of 2x or 3x.

3 Results

3.1 Summary statistics

Overall 362 subjects were recruited for the experiment as shown in Table 2. However, we excluded six subjects from our analysis because they were not able to answer the control questions correctly (three subjects from grade 3, two from grade 5 and one from grade 8). Furthermore, two more subjects are excluded because of missing personal data (one subject in grade 3 and one in grade 10). This leaves us with 354 subjects at six grade levels. Table 3 summarizes these observations. Next to the number of subjects it displays summary statistics of their individual characteristics, namely the average age in months and their average grade in math. Math performance is graded on a scale from 0 to 100 in primary school (grades 3 and 5) and on a scale from 0 to 150

in middle and high school (grades 7 to 11).[14] Additionally, Table 3 shows the share of female subjects. The last two columns show the average number (out of three) of risk averse or prudent choices.

Table 3: Summary statistics student subjects

Grade	N	Age in months	Grade math	Female	Number risk averse choices	Number prudent choices
3	90	110.78	81.23	0.46	1.57	1.77
5	96	133.53	80.03	0.45	2.15	1.86
7	44	158.93	112.5	0.43	2.43	2.25
8	44	170.39	81.57	0.43	2.39	1.93
10	40	193.53	70.03	0.53	2.38	2.15
11	40	205.93	82.85	0.72	2.42	2.15
Total	354	150.44	83.75	0.49	2.12	1.96

We provide some summary statistics from the survey given to parents. Only nine parents did not return the questionnaire, fifty-one of the 345 returned questionnaires were not filled out completely and five were filled out by someone other than the mother or the father. Table 4 contains the summary statistics of the remaining 289 questionnaires that we use to characterize the children's environment at home. "Low education", "high education" and "house owner" are dummies that are constructed from the answers in the parent questionnaire. All households in which parents indicated that no household member has a high school or university degree are classified as "low education" households. Those households with at least one member having a university degree are classified as "high education" households. The indicator "house owner" takes the val-

[14] The number of subjects the children attend differs by grade. The only two subjects attended by all children are mathematics and Chinese. In the following we focus on the grade in mathematics because it is often used as a proxy for general cognitive ability (see, e.g. Benjamin et al., 2013). The distribution of math grades differs from school to school. In the following we will only use a student's grade quartile (the values 1, 2, 3, 4) within his or her class as a proxy math grade.

ue of one if the parents indicate that the household members own at least one house or apartment altogether.

The Hukou status was collected directly from the official school records. "Local hukou address" takes a value of one if the child has the Hukou of the school's local municipality, i.e. a Hukou from Xiamen for all four schools. The last two columns show the average number (out of three) of risk averse or prudent choices.

The summary statistics reveal some heterogeneity between the households in the different grades and schools. In all grades the minority of questionnaires is answered by the mothers. The asymmetry is most pronounced in grade 7 of the middle school. The share of families with low education ranges from 3 percent in grade 10 to 38 percent in grade 8. Rates of high education and house ownership are less dispersed: They range from 17 to 31 percent and from 74 to 86 percent. After merging the data sets from two primary schools the share of local students is still somewhat lower in grades 3 and 5: 34 percent of children in grade 3 and 31 percent in grade 5 have a local Hukou address while at least 43 percent in higher grades do so. We will control for these differences in our regression analyses.

The summary statistics also reveal that the number of risk averse choices is higher than the number of prudent choices in all grades. Recent evidence would lead us to expect the opposite relationship: Deck and Schlesinger (2014) have observed that lottery choices can be explained surprisingly well by a preference for either combining "good" with "bad" or "good" with "good" implying mixed risk averse and mixed risk loving behavior (Schlesinger et al. 2009; Crainich et al., 2013). People with one of these two preference types differ in their lotteries choices in even orders but coincide in odd orders (e.g., risk averters *and* risk lovers are both prudent).[15] In a related study Haering et al. (2017) observe less temperate *and* less prudent choices in the reduced lotteries, which is consistent with the pattern observed in our study.

[15] The observations by Deck and Schlesinger (2014) however are gathered using compound lotteries that make the combinations "good" with "bad" or "good" with good" salient. To facilitate understanding of the children and to simplify the determination of lottery outcomes we chose to use reduced versions of their compound prudence lotteries. Reducing compound lotteries has been found to influence elicited risk aversion by Harrison et al. (2015) as well as prudence and temperance by Deck and Schlesinger (2018) and Haering et al. (2017). Deck and Schlesinger (2018) observe less temperate choices in the reduced than in the compound lotteries by Deck and Schlesinger (2014).

Table 4: Summary statistics household

Grade	N	Mother	Low education	High education	House owner	Local Hukou address	Number risk averse choices	Number prudent choices
3	67	0.48	0.37	0.22	0.75	0.34	1.78	1.7
5	75	0.48	0.29	0.20	0.75	0.31	1.91	1.53
7	36	0.36	0.25	0.31	0.86	0.50	2.08	1.83
8	37	0.49	0.38	0.19	0.84	0.46	2.43	1.62
10	39	0.46	0.03	0.21	0.77	0.44	2.05	1.74
11	35	0.49	0.14	0.17	0.74	0.43	2.2	1.63
Total	289	0.46	0.26	0.21	0.78	0.39	2.02	1.66

3.2 Are children and adolescents risk averse and prudent?

Risk aversion

Behavior in the risk aversion tasks 2, 3 and 4 suggests that choices are not made randomly but with a general preference for the less risky option. Pooling choices across tasks 2, 3 and 4, binomial tests reject the null hypothesis that only half the choices are risk averse within all grades ($p < 0.001$, two-sided binomial tests) except in grade 3 ($p = 0.503$).[16] Figure 2 displays the distribution of the number of risk averse choices within the six grade levels we examine. The most frequent choice pattern in all grades except grade 3 consists of perfectly risk averse choices.

Observation 1: *Subjects in grades 5 to 11 (but not in grade 3) make predominantly risk averse choices.*

Figure 3 displays the number of risk averse choices by girls and boys across grades. It reveals that female and male students differ only marginally in their behavior. When comparing the number of choices within grades we do not find any significant differences between boys and girls ($p \geq 0.326$, two-sided Mann-Whitney-U tests).

[16] As shown in Table E.1 of Appendix E we find the same pattern in both primary schools.

Figure 2: Distribution of number of risk averse choices within grades

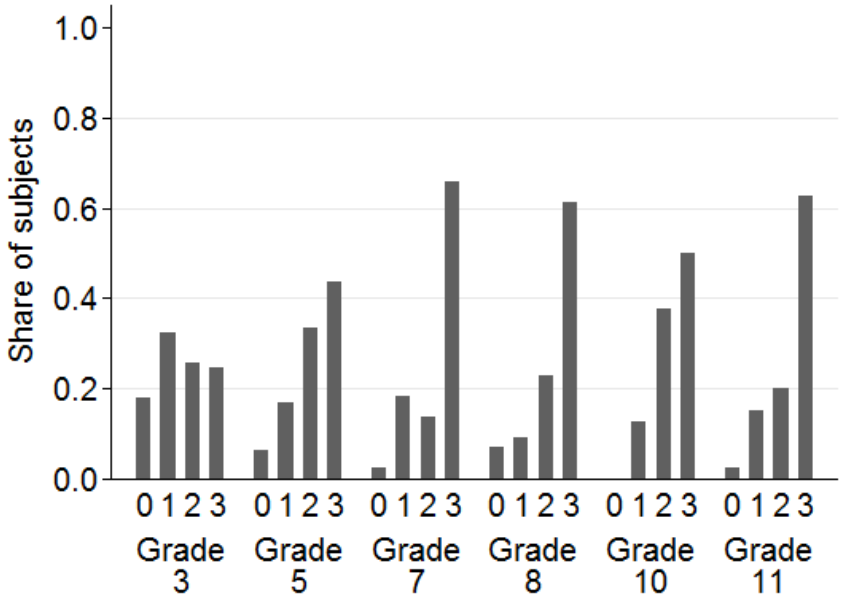
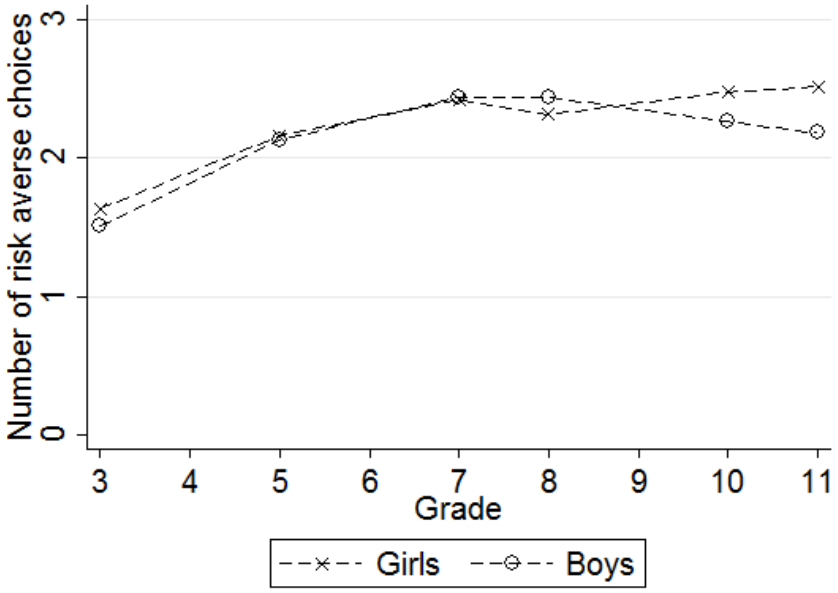


Figure 3: Average number of risk averse choices by gender



Prudence

As in the risk aversion tasks, behavior in the prudence tasks 5, 6 and 7 suggest that choices are not made randomly. Instead most choices are prudent. Pooling choices across tasks 5, 6 and 7, binomial tests reject the null hypothesis that half the choices are prudent within all grades including grade 3 ($p \leq 0.004$, two-sided binomial tests). However, the tendency of 3rd graders to choose

prudently is driven by the second primary school we sampled. Third graders in the second school make prudent choices ($p < 0.001$) while choices of 3rd graders in the first school do not differ from random behavior ($p = 0.929$).[17] Figure 4 displays the distributions of the number of prudent choices within grades of the joint sample. In case of prudence the mode of the choice distributions varies across grades: It is one for 3rd graders, two for 5th and 8th graders and three for 7th, 10th and 11th graders.

Observation 2: *Subjects in grades 5 to 11 make predominantly prudent choices. The behavior of subjects in grade 3 differs by school.*

Figure 5 displays the average number of prudent choices made by girls and boys across grades. Again, there appear to be no pronounced gender gaps. Boys and girls do not differ in the number of prudent choices in any of the grades ($p \geq 0.151$, two-sided Mann-Whitney-U tests).

[17] See Table E.2 of Appendix E for the respective test results.

Figure 4: Distribution of number of prudent choices within grades

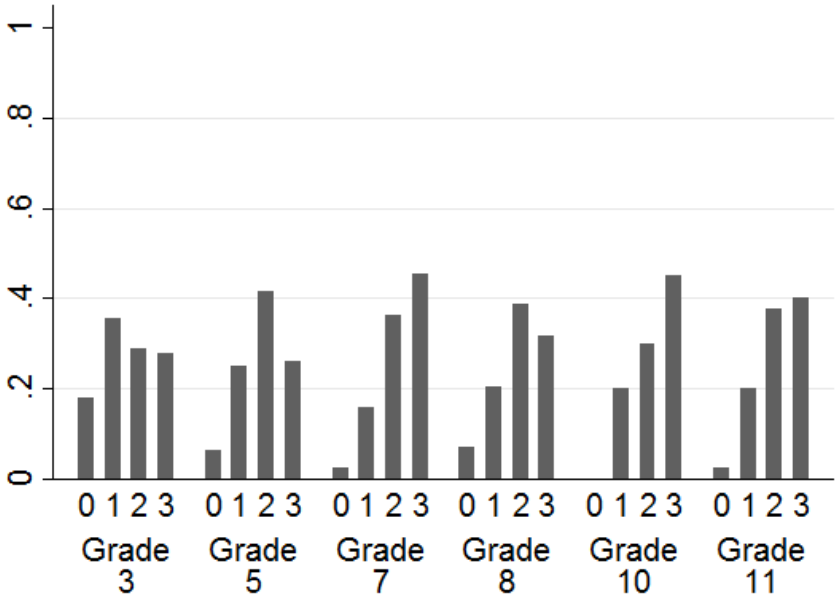
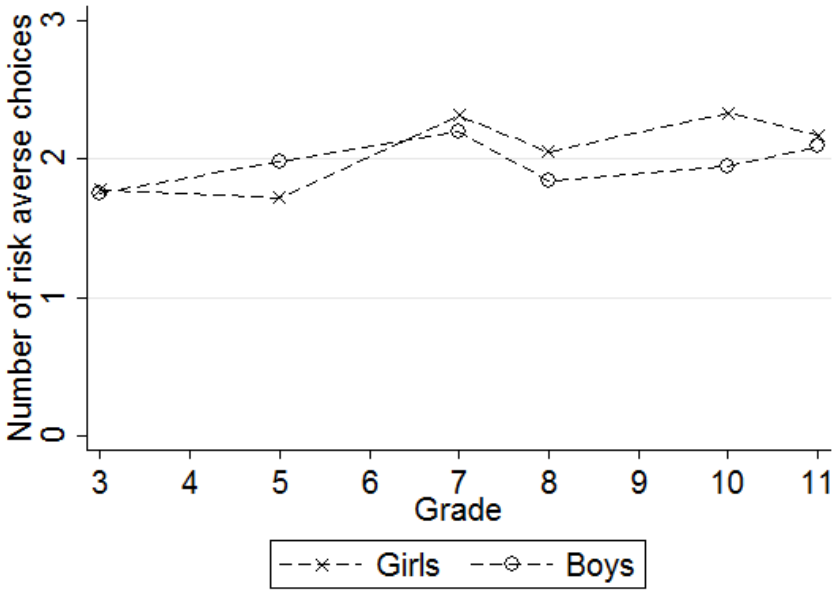


Figure 5: Average number of prudent choices by gender



3.3 How does the household influence risk preferences?

In this subsection we focus on the transmission of preferences while controlling for characteristics of the children's household and for individual differences in regressions. Therefore, the following analyses are based on the subset of subjects for which all household information was available (summarized in Table 4).

Table 5 provides initial evidence on the transmission of preferences by examining the joint distribution of the children's and parents' lottery choices. It shows two contingency tables: number of risk averse choices on the left and number of prudent choices on the right. We observe a small but significant correlation within the risk tasks (Spearman's Rho of 0.248, $p < 0.001$) and within in the prudence tasks (Spearman's Rho of 0.173, $p = 0.003$). Furthermore, Chi-squared tests reject the null hypothesis of independence in both cases ($p \leq 0.036$).

Table 5: Contingency tables for share of risk averse and prudent choices by children and parents

Risk						Prudence					
	Parent						Parent				
Children	0	1	2	3	Total	Children	0	1	2	3	Total
0	7	1	7	5	20	0	2	6	6	4	18
1	7	14	17	14	52	1	15	19	26	13	73
2	11	13	27	29	80	2	22	27	41	17	107
3	8	22	33	74	137	3	11	14	32	34	91
Total	33	50	84	122	289	Total	50	66	105	68	289
Spearman's Rho 0.248 $p < 0.001$, Chi^2 test $p < 0.001$						Spearman's Rho 0.173 $p = 0.003$, Chi^2 test $p = 0.036$					

Additionally, we run several regressions that also shed more light on potential age effects. We run ordered logit regressions to identify the influences on the number of risk averse or prudent choices. We first focus on risk aversion before considering the influences of individual and household characteristics on prudence.

Risk aversion

Table 6 presents three ordered logit regressions on the number of risk averse choices. The results are reported as average marginal effects and standard errors are clustered on the grade level. Model (1) is fitted on the whole sample while models (2) and (3) only consider girls or boys.

The three regression models indicate the existence of age effects within our sample: The joint F-tests of the *Grade* and *Grade 3* coefficients are significant in all models ($p < 0.001$). The regressions also reveal gender-specific age effects: In the overall sample we find third graders to be significantly less risk averse than the remaining children ($p < 0.001$) while the *Grade* effect is insignificant ($p = 0.742$). When splitting the regressions by gender, a significant *Grade 3* effect is observed only in the male sample ($p < 0.001$ for boys and $p = 0.167$ for girls). The *Grade* variable reveals a significantly positive effect for girls and a significantly negative effect for boys ($p \leq 0.038$). We find two differences between the two primary school which are not presented in Table 6. Participants at the second school make significantly less risk averse choices ($p \leq 0.002$). Furthermore, we find a significant positive correlation between math grade and the number of risk averse choices made by girls ($p = 0.015$).

With respect to the household characteristics, we confirm the finding of a positive and significant correlation between the number of risk averse choices made by parents and their children (cf. Table 5). In the whole sample one more parental risk averse choice leads to 0.094 more risk averse choices by their children ($p < 0.001$). For girls the increase is somewhat smaller than for boys (0.075 versus 0.104) but both increases are significant ($p = 0.036$ and $p = 0.008$).[18]

Observation 3: *Risk aversion is significantly correlated between parents and their children after controlling for individual and household characteristics.*

The remaining household characteristics (parental education level, house ownership status and Hukou status) also influence children's choices significantly: The joint F-tests of these remaining variables are significant in all of the three models ($p \leq 0.001$). A high education of parents is associated with more risk taking in the complete sample ($p = 0.048$). Splitting the sample reveals

[18] See Tables E.3 and E.4 in Appendix E for the regression results we obtain when including only one of the two primary schools.

that the effect is driven by the girls in our sample: We find a significant influence for girls ($p = 0.008$) but not for boys ($p = 0.539$). Parents' house ownership is significantly associated with less risk taking in the complete sample ($p < 0.001$). In the subsamples this effect is significant for girls ($p < 0.001$) and weakly significant for boys ($p = 0.090$). A local Hukou address is neither associated with risk taking in the complete sample nor in one of the subsamples ($p \geq 0.220$).

Table 6: Ordered logit regressions on the number of risk averse choices (average marginal effects)

	(1) All	(2) Girls	(3) Boys
Grade	0.003	0.029***	-0.023**
	(0.008)	(0.006)	(0.011)
Grade 3	-0.156***	-0.039	-0.255***
	(0.036)	(0.028)	(0.040)
Second primary school	-0.184***	-0.084***	-0.271***
	(0.025)	(0.027)	(0.039)
Math	0.041	0.047**	0.043
	(0.033)	(0.020)	(0.057)
Female	0.016		
	(0.039)		
Number of risk averse choices	0.094***	0.075**	0.104***
	(0.032)	(0.036)	(0.039)
Low education	-0.001	-0.019	0.026
	(0.062)	(0.062)	(0.095)
High education	-0.112**	-0.195***	-0.052
	(0.057)	(0.074)	(0.084)
House owner	0.146***	0.186***	0.128*
	(0.041)	(0.044)	(0.076)
Local Hukou address	0.052	0.079	0.038
	(0.048)	(0.064)	(0.076)
Flipped booklet	0.045	0.077	0.014
	(0.035)	(0.055)	(0.043)
Observations	289	142	147
Specification tests (*p*-values F-test)			
Grade, Grade 3	0.000	0.000	0.000
Low education, high education, house owner, local Hukou	0.001	0.000	0.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Prudence

While we observe a robust influence of individual and household characteristics with respect to risk aversion, their influence on prudence is less clear. Table 7 presents the regression results of our first specification that regresses the number of prudent choices on these characteristics.

First of all, we also observe some significant age effects on prudence after controlling for further individual differences and for household differences: The joint F-tests of the *Grade* and *Grade 3* coefficients are significant in full data set ($p = 0.002$) and for girls ($p < 0.001$) but insignificant for boys ($p = 0.965$). However, we do not find a significant effect of the *Grade 3* variable ($p \geq 0.627$) in any of the samples. There is a significant positive *Grade* effect in the complete sample ($p = 0.045$). Yet, *Grade* is weakly significant in the female subsample ($p = 0.088$) and insignificant in the male subsample ($p = 0.793$). Even though they affected risk taking, we neither find an systematic effect of the second primary school ($p \geq 0.484$) nor a gender effect with respect to the complete sample ($p = 0.729$). A better math grade, however, is significantly associated with a larger number of prudent choices in the whole sample ($p = 0.004$) and in the female subsample ($p = 0.032$). In the male subsample the correlation is only weakly significant ($p = 0.056$).

Considering the household characteristics, the regressions confirm the positive and significant correlation between the number of prudent choices made by parents and their children (cf. Table 5). In the whole sample one more parental prudent choice leads to 0.061 more prudent choices by their children ($p = 0.064$). But this effect is driven by the girls: It is only significant for them ($p = 0.009$ for girls and $p = 0.302$ for boys) and it is more than twice as large for girls than for boys (0.090 versus 0.041).[19]

Observation 4: *Prudence is significantly correlated between parents and their daughters (but not their sons) after controlling for individual and household characteristics.*

[19] See Tables E.5 and E.6 in Appendix E for the regression results we obtain when including only one of the two primary schools. Note that the influence of parents' number of prudent choices is at least weakly significant in both samples. As the result is not robust to merging the data sets, we opted for the current interpretation of our results.

Table 7: Ordered logit regressions on the number of prudent choices (average marginal effects)

	(1) All	(2) Girls	(3) Boys
Grade	0.023**	0.036*	0.004
	(0.012)	(0.021)	(0.014)
Grade 3	0.024	0.050	0.011
	(0.056)	(0.103)	(0.069)
Second primary school	0.038	-0.002	0.074
	(0.061)	(0.084)	(0.105)
Math	0.053***	0.053**	0.063*
	(0.018)	(0.025)	(0.033)
Female	0.022		
	(0.063)		
Number of prudent choices	0.061*	0.090***	0.041
	(0.033)	(0.034)	(0.040)
Low education	0.013	-0.068*	0.069
	(0.029)	(0.041)	(0.058)
High education	0.048	-0.039	0.128
	(0.061)	(0.080)	(0.080)
House owner	-0.030	-0.013	-0.050
	(0.019)	(0.027)	(0.057)
Local Hukou address	0.040	0.101	0.004
	(0.028)	(0.069)	(0.065)
Flipped booklet	-0.047**	0.047	-0.142***
	(0.020)	(0.043)	(0.025)
Observations	289	142	147
Specification tests (*p*-values F-test)			
Grade, Grade 3	0.002	0.000	0.965
Low education, high education, house owner, local Hukou	0.000	0.534	0.446

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The remaining household characteristics affect children's choices significantly in the whole sample ($p < 0.001$) but not in the separate samples ($p \geq 0.446$) as the F-tests reveal. With respect to the individual effects, we find that girls who grow up in a household with low educational level make weakly significantly less prudent choices ($p = 0.099$). This effect is neither found in the complete sample ($p = 0.648$) nor in the male subsample ($p = 0.228$). None of the remaining household characteristics is found to be significant on its own.[20]

4 Conclusion

In this study we measure risk aversion and prudence of Chinese children and adolescents in two primary schools, one middle school and one high school. Choices by 3rd graders do not differ significantly from choices under risk neutrality, but 5th to 11th graders make significantly risk averse choices. Furthermore, 5th to 11th graders make significantly prudent choices. We also find 3rd graders to make significantly prudent choices. However, this effect is driven by the second primary school we recruited from. We do not find any gender differences with respect to risk aversion or prudence. Yet, risk aversion appears to increase more gradually with age in girls than in boys. In addition we find evidence for the transmission of risk preferences from parents to children: Risk aversion correlates between parents and their sons and daughters while prudence correlates between parents and their daughters (but not their sons).

It is interesting to note that we do not observe any gender differences with respect to risk aversion and prudence. Often adult men are described to be less risk averse than women (see, e.g., the overview by Croson and Gneezy, 2009, and the results from China reported by Gong and Yang, 2012, and Zhang, 2018). Yet the difference appears to be small and depends on the elicitation task as pointed out in the meta-study by Filippin and Crosetto (2016). With respect to children and adolescents, the evidence suggests a similar pattern. Cárdenas et al. (2012) study risk aversion of children aged 9 to 12 years in samples from Columbia and Sweden. They find boys to be less risk averse than girls. A similar observation is made by Borghans et al. (2009) for Dutch ado-

[20] Additionally, we observe that participants who were presented with the flipped booklet are significantly less prudent on aggregate ($p = 0.020$) so they have a preference for the option presented second. Considering both genders separately we observe a significant influence for boys ($p < 0.001$) but not for girls ($p = 0.266$).

lescents aged 15 to 16 years and by Sutter et al. (2013) for Austrian children and adolescents aged 10 to 18 years. In the USA, Harbaugh et al. (2002) find no gender differences in their samples of children and adolescents aged 5 to 20 while Eckel et al. (2012) find male high school students in grades 9 and 11 to be less risk averse than girls. However, risk preferences may be shaped by environmental factors. Booth and Nolen (2012) study risk preferences of adolescents in grades 10 and 11 (15 years old on average) in the UK. They only find a gender difference for students in mixed schools but not when comparing children from single sex schools. Furthermore, they find girls to make somewhat less risk averse choices when preferences are elicited in all-girls groups.

While we do not observe gender differences in the levels of risk aversion and prudence, the transmission of preferences differs by gender: The correlation in the number of prudent choices is driven by the girls in our sample. Alan et al. (2017) report a similar finding for risk aversion. They only find a significant correlation between mothers and their daughters but not between mothers and their sons. We also find differences with respect to prudence between the two primary schools. These may be driven by unobserved differences in the school environment. Eckel et al. (2012) have reported differences between schools in risk aversion between high schools. In an experimental study conducted in nine different high schools in the USA, they find that risk aversion varies with characteristics like class size and teachers' levels of education.

Our findings are important with respect to field behavior and the design and timing of potential policy measures. Risk preferences are not only central to many economic models. They have also been shown to influence outcomes across the lifespan. For example, those who report lower risk aversion in surveys also choose careers with higher variance of income as observed by Bonin et al. (2007) and Fouarge et al. (2014). When measuring risk preferences of children and adolescents between 10 and 18 years, Sutter et al. (2013) find that less risk averse subjects have a higher body mass index (while there is no significant correlation with whether they save money, smoke or spend money on alcohol or with their conduct at school). Furthermore, 7 to 9 year old children who grow up in households with low income or low education are less risk averse as observed by Deckers et al. (2017). In a follow-up survey conducted 4 to 5 years later, they also find that lower risk aversion in the initial experiment is positively correlated with lower grades and juvenile offences. Castillo et al. (2018) also correlate adolescents' experimentally elicited risk preferences with field behavior. They find that less risk averse 8th graders (14 years old on

average) have more disciplinary referrals one to two years later and are less likely to graduate from high school.

There is much less direct evidence on the relevance of prudence for field behavior. Only Noussair et al. (2014) find more prudent lottery choices to be correlated with greater wealth, a greater likelihood of having a savings account and a lower likelihood of credit card debt in a representative survey of the adult Dutch population. Note, however, that our finding of prudence in children adolescents is also important when designing policies that relate to inter-temporal decision making. Sutter et al. (2013), for example, find more impatient children and adolescents to be less likely to save money and more likely to smoke and to spend money on alcohol. More impatient children also receive worse grades for their conduct at school (while there is no significant correlation with their body mass index). But in inter-temporal optimization higher-order risk preferences determine today's reaction to future changes in risk as shown by Leland (1968) and Sandmo (1970). For a given level of risk aversion and a given discount factor an increase in (second-order) risk of future income, for example, yields an increase in today's savings if and only if the decision maker is prudent.

References

Afridi, F., Li, S. X., and Ren, Y. (2015). Social identity and inequality: The impact of China's hukou system. Journal of Public Economics, 123, 17-29.

Alan, S., Baydar, N., Boneva, T., Crossley, T. F., and Ertac, S. (2017). Transmission of risk preferences from mothers to daughters. Journal of Economic Behavior and Organization, 134, 60-77.

Angerer, S., Glätzle-Rützler, D., Lergetporer, P., and Sutter, M. (2015). Donations, risk attitudes and time preferences: A study on altruism in primary school children. Journal of Economic Behavior and Organization, 115, 67-74.

Baillon, A., Schlesinger, H., and van de Kuilen, G. (2018). Measuring higher order ambiguity preferences. Experimental Economics, forthcoming.

Barnea, A., Cronqvist, H., and Siegel, S. (2010). Nature or nurture: What determines investor behavior? Journal of Financial Economics, 98(3), 583-604.

Benjamin, D. J., Brown, S. A., and Shapiro, J. M. (2013). Who is 'behavioral'? Cognitive ability and anomalous preferences. Journal of the European Economic Association, 11(6), 1231-1255.

Black, S. E., Devereux, P. J., Lundborg, P., and Majlesi, K. (2017). On the origins of risk-taking in financial markets. Journal of Finance.

Bleichrodt, H., and van Bruggen, P. (2018). Higher order risk preferences for gains and losses.

Working Paper.

Bonin, H., Dohmen, T., Falk, A., Huffman, D., and Sunde, U. (2007). Cross-sectional earnings risk and occupational sorting: The role of risk attitudes. Labour Economics, 14(6), 926-937.

Booth, A. L., and Nolen, P. (2012). Gender differences in risk behaviour: does nurture matter? Economic Journal, 122(558), F56-F78.

Borghans, L., Heckman, J. J., Golsteyn, B. H., and Meijers, H. (2009). Gender differences in risk aversion and ambiguity aversion. Journal of the European Economic Association, 7(2-3), 649-658.

Breaban, A., Van De Kuilen, G., and Noussair, C. N. (2016). Prudence, emotional state, personality, and cognitive ability. Frontiers in Psychology, 7, 1688.

Cárdenas, J. C., Dreber, A., Von Essen, E., and Ranehill, E. (2012). Gender differences in competitiveness and risk taking: Comparing children in Colombia and Sweden. Journal of Economic Behavior and Organization, 83(1), 11-23.

Castillo, M., Jordan, J. L., and Petrie, R. (2018). Children's rationality, risk attitudes and field behavior. European Economic Review, 102, 62-81.

Cesarini, D., Dawes, C. T., Johannesson, M., Lichtenstein, P., and Wallace, B. (2009). Genetic variation in preferences for giving and risk taking. Quarterly Journal of Economics, 124(2), 809-842.

Cesarini, D., Johannesson, M., Lichtenstein, P., Sandewall, Ö., and Wallace, B. (2010). Genetic variation in financial decision-making. Journal of Finance, 65(5), 1725-1754.

Charness, G., and Gneezy, U. (2010). Portfolio choice and risk attitudes: An experiment. Economic Inquiry, 48(1), 133-146.

Charness, G., Gneezy, U., and Imas, A. (2013). Experimental methods: Eliciting risk preferences. Journal of Economic Behavior and Organization, 87, 43-51.

Courbage, C., and Rey, B. (2006). Prudence and optimal prevention for health risks. Health Economics, 15(12), 1323-1327.

Courbage, C., and Rey, B. (2016). Decision thresholds and changes in risk for preventive treatment. Health Economics, 25(1), 111-124.

Crainich, D., Eeckhoudt, L., and Trannoy, A. (2013). Even (mixed) risk lovers are prudent. American Economic Review, 103(4), 1529-35.

Croson, R., and Gneezy, U. (2009). Gender differences in preferences. Journal of Economic Literature, 47(2), 448-74.

Dahl, R. E. (2004). Adolescent brain development: a period of vulnerabilities and opportunities. Keynote address. Annals of the New York Academy of Sciences, 1021(1), 1-22.

Deck, C., and Schlesinger, H. (2014). Consistency of higher order risk preferences. Econometrica, 82(5), 1913-1943.

Deck, C., and Schlesinger, H. (2018). On the robustness of higher order risk preferences. Journal of Risk and Insurance, forthcoming.

Deckers, T., Falk, A., Kosse, F., Pinger, P., and Schildberg-Hörisch, H. (2017). Socio-economic status and inequalities in children's IQ and economic preferences. Working Paper.

Defoe, I. N., Dubas, J. S., Figner, B., and van Aken, M. A. (2015). A meta-analysis on age differences in risky decision making: Adolescents versus children and adults. Psychological Bulletin, 141(1), 48.

Dohmen, T., Falk, A., Huffman, D., and Sunde, U. (2011). The intergenerational transmission of risk and trust attitudes. Review of Economic Studies, 79(2), 645-677.

Ebert, S., and van de Kuilen, G. (2017). Measuring multivariate risk preferences. Working Paper.

Ebert, S., and Wiesen, D. (2011). Testing for prudence and skewness seeking. Management Science, 57(7), 1334-1349.

Ebert, S., and Wiesen, D. (2014). Joint measurement of risk aversion, prudence, and temperance. Journal of Risk and Uncertainty, 48(3), 231-252.

Eckel, C. C., Grossman, P. J., Johnson, C. A., de Oliveira, A. C., Rojas, C., and Wilson, R. K. (2012). School environment and risk preferences: Experimental evidence. Journal of Risk and Uncertainty, 45(3), 265-292.

Eeckhoudt, L., and Schlesinger, H. (2006). Putting risk in its proper place. American Economic Review, 96(1), 280-289.

Eeckhoudt, L., and Schlesinger, H. (2013). Higher-order risk attitudes. In: Handbook of Insurance, edited by G. Dionne, New York, Springer, 41-57.

Eeckhoudt, L., Schlesinger, H., and Tsetlin, I. (2009). Apportioning of risks via stochastic dominance. Journal of Economic Theory, 144(3), 994-1003.

Esö, P., and White, L. (2004). Precautionary bidding in auctions. Econometrica, 72(1), 77-92.

Fagereng, A., Mogstad, M., and Rønning, M. (2018). Why do wealthy parents have wealthy children. Working Paper.

Falk, A., and Kosse, F. (2016). Early childhood environment, breastfeeding and the formation of preferences. Working Paper.

Fouarge, D., Kriechel, B., and Dohmen, T. (2014). Occupational sorting of school graduates: The role of economic preferences. Journal of Economic Behavior and Organization, 106, 335-351.

Filippin, A., and Crosetto, P. (2016). A reconsideration of gender differences in risk attitudes. Management Science, 62(11), 3138-3160.

Geng, S., Peng, Y., Shachat, J., and Zhong, H. (2015). Adolescents, cognitive ability, and minimax play. Economics Letters, 128, 54-58.

Gong, B., and Yang, C. L. (2012). Gender differences in risk attitudes: Field experiments on the matrilineal Mosuo and the patriarchal Yi. Journal of Economic Behavior and Organization, 83(1), 59-65.

Gu, J., Nielsen, I., Shachat, J., Smyth, R., and Peng, Y. (2016). An experimental study of the effect of intergroup contact on attitudes in urban China. Urban Studies, 53(14), 2991-3006.

Haering, A., and Heinrich, T. (2017). Risk Preferences in China—Results from Experimental

Economics. ASIEN, 142, 68-88.

Haering, A., Heinrich, T., and Mayrhofer, T. (2017). Exploring the consistency of higher-order risk preferences. Working Paper.

Harbaugh, W. T., Krause, K., and Vesterlund, L. (2002). Risk attitudes of children and adults: Choices over small and large probability gains and losses. Experimental Economics, 5(1), 53-84.

Harrison, G. W., Martínez-Correa, J., and Swarthout, J. T. (2015). Reduction of compound lotteries with objective probabilities: Theory and evidence. Journal of Economic Behavior and Organization, 119, 32-55.

Harrison, G. W., and Rutström, E. E. (2008). Risk aversion in the laboratory. In: Risk Aversion, edited by J. C. Cox and G.W. Harrison in Experiments, Emerald Group Publishing Limited, 41-196.

Heinrich, T., and Mayrhofer, T. (2018). Higher-order risk preferences in social settings. Experimental Economics, forthcoming.

Jaeger, D. A., Dohmen, T., Falk, A., Huffman, D., Sunde, U., and Bonin, H. (2010). Direct evidence on risk attitudes and migration. Review of Economics and Statistics, 92(3), 684-689.

Khachatryan, K., Dreber, A., Von Essen, E., and Ranehill, E. (2015). Gender and preferences at a young age: Evidence from Armenia. Journal of Economic Behavior and Organization, 118, 318-332.

Kimball, M. S. (1990). Precautionary saving in the small and in the large. Econometrica, 58(1), 53-73.

Kimball, M. S., Sahm, C. R., and Shapiro, M. D. (2009). Risk preferences in the PSID: individual imputations and family covariation. American Economic Review, 99(2), 363-68.

Krieger, M., and Mayrhofer, T. (2012). Patient preferences and treatment thresholds under diagnostic risk. Working Paper.

Krieger, M., and Mayrhofer, T. (2017). Prudence and prevention: An economic laboratory experiment. Applied Economics Letters, 24(1), 19-24.

Leland, H. E. (1968). Saving and uncertainty: The precautionary demand for saving. Quarterly Journal of Economics, 82(3), 465-473.

Levin, I. P., and Hart, S. S. (2003). Risk preferences in young children: Early evidence of individual differences in reaction to potential gains and losses. Journal of Behavioral Decision Making, 16(5), 397-413.

Levin, I. P., Hart, S. S., Weller, J. A., and Harshman, L. A. (2007). Stability of choices in a risky decision-making task: A 3-year longitudinal study with children and adults. Journal of Behavioral Decision Making, 20(3), 241-252.

Maier, J., and Rüger, M. (2012). Experimental evidence on higher-order risk preferences with real monetary losses. Working Paper.

Necker, S., and Voskort, A. (2014). Intergenerational transmission of risk attitudes–A revealed preference approach. European Economic Review, 65, 66-89.

Noussair, C. N., Trautmann, S. T., and Van de Kuilen, G. (2014). Higher order risk attitudes, demographics, and financial decisions. Review of Economic Studies, 81(1), 325-355.

Sandmo, A. (1970). The effect of uncertainty on saving decisions. Review of Economic Studies, 37(3), 353-360.

Slovic, P. (1966). Risk-taking in children: Age and sex differences. Child Development, 169-176.

Song, Y. (2014). What should economists know about the current Chinese hukou system? China Economic Review, 29, 200-212.

Steinberg, L. (2007). Risk taking in adolescence: New perspectives from brain and behavioral science. Current Directions in Psychological Science, 16(2), 55-59.

Sutter, M., Kocher, M. G., Glätzle-Rüetzler, D., and Trautmann, S. T. (2013). Impatience and uncertainty: Experimental decisions predict adolescents' field behavior. American Economic Review, 103(1), 510-31.

Sutter, M., Angerer, S., Rützler, D., and Lergetporer, P. (2015). The effect of language on economic behavior: Experimental evidence from children's intertemporal choices. Working Paper.

Tarazona-Gomez, M. (2004). Are individuals prudent? An experimental approach using lottery choices. Working Paper.

Trautmann, S. T., and van de Kuilen, G. (2018). Higher order risk attitudes: A review of experimental evidence. European Economic Review, 103, 108-124.

Vieider, F. M. (2012). Moderate stake variations for risk and uncertainty, gains and losses: methodological implications for comparative studies. Economics Letters, 117(3), 718-721.

White, L. (2008). Prudence in bargaining: The effect of uncertainty on bargaining outcomes. Games and Economic Behavior, 62(1), 211-231.

Zhang, Y. J. (2018). Culture, institutions, and the gender gap in competitive inclination: Evidence from the communist experiment in china. Economic Journal, forthcoming

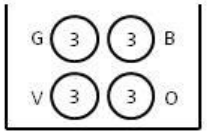
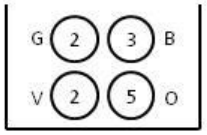
Zhong, S., Chew, S. H., Set, E., Zhang, J., Xue, H., Sham, P. C., Ebstein, R. P., and Israel, S. (2009). The heritability of attitude toward economic risk. Twin Research and Human Genetics, 12(1), 103-107.

Zyphur, M. J., Narayanan, J., Arvey, R. D., and Alexander, G. J. (2009). The genetics of economic risk preferences. Journal of Behavioral Decision Making, 22(4), 367-377.

Appendix A: Primary school decision booklet (translated from Chinese)

Quiz: Please fill in both answers

Please take a look at the following two options and answer the two questions below.

Price bag	Option
	1: ☐
	2: ☐

If you were to observe the two options and selected option 1, how much money would you receive?

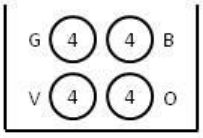
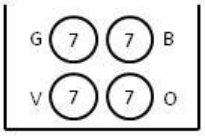
_____ RMB

If you were to observe the two options and selected option 2, the largest amount of money you could earn is

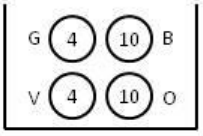
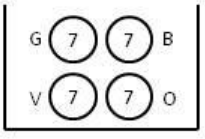
_____ RMB

Tasks

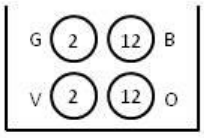
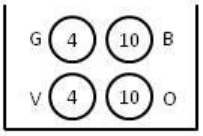
Task 1: Please choose one option

Price bag	Option
	1: ☐
	2: ☐

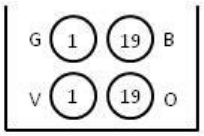
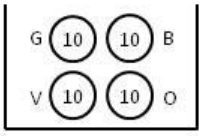
Task 2: Please choose one option

Price bag	Option
	1: ☐
	2: ☐

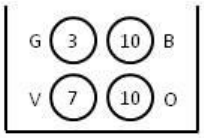
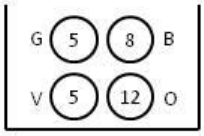
Task 3: Please choose one option

Price bag	Option
	1: ☐
	2: ☐

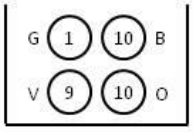
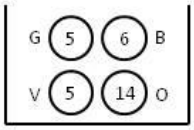
Task 4: Please choose one option

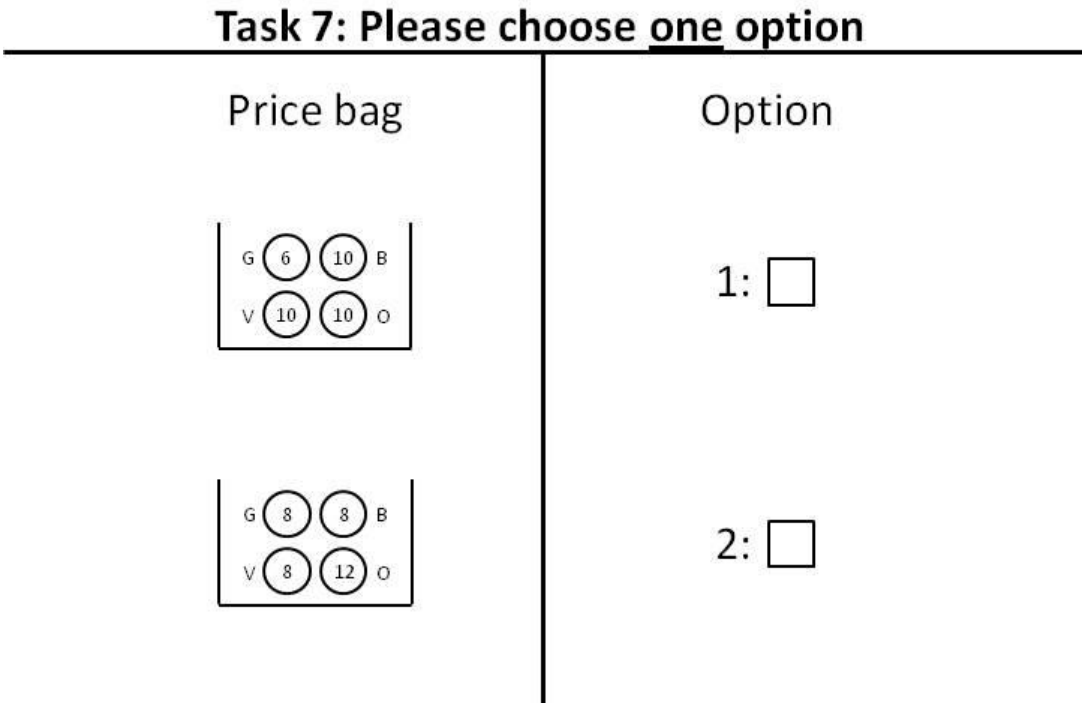
Price bag	Option
	1: ☐
	2: ☐

Task 5: Please choose one option

Price bag	Option
	1: ☐
	2: ☐

Task 6: Please choose one option

Price bag	Option
	1: ☐
	2: ☐



Appendix B: Experimental Protocol (translated from Chinese)

Material

- Twelve non-transparent bag and 48 balls in four different colors
- One bingo cage and 13 balls numbered 1 to 13
- Big envelopes for questionnaire ("To the parents – Please answer before [date two schools days after the experiment]; Student name: _____; Student ID: _____")
- One receipt per class
- Pens
- Session sheet to note the selected task, duration, special occurrences etc. in each session.
- Money for subject payment

Experiment

PREPARATION

- Lead experimenter and assistants fill the envelopes with questionnaires for parents and place them at each desk

- Lead experimenter and assistants place a pen and the two workbooks at each desk
- Lead experimenter and assistants prepare the twelve bags, the four balls for each bag and the bingo cage with 13 balls
- Lead experimenter fill in session parameters (school, grade, date) in session sheet
- Lead experimenter assigns a group of seats to each assistant. Each assistant is responsible for the subjects in their group
- Lead experimenter distributes bags, marbles and money for subject payment among the assistants
- Teachers bring students to the lab, lead experimenter note arrival time in session sheet
- Lead experimenter counts the participants and note in session sheet

INTRODUCTION

- Once everyone took a seat lead the experimenter explains the experiment:

Hello and welcome! Thank you for participating in today's experiment. And we want to remind you that we will return in two weeks and you will participate in a second and different experiment.

Today you are taking part in an experiment in which you will be able to earn money. How much money you will earn depends on your decisions. We will tell you in a moment what the experiment is about. First of all there are two important rules:

1. If you do not understand something raise your hand. Someone will come to answer your question.

2. Do no talk with other students. If don't follow this rule you will be excluded from this experiment, and earn no money. This also means: do not use your phone. If you have one with you, turn it off now and put it away.

In front of you there are two workbooks, one envelope and a pen. Please write your name and student ID on the envelope. Now also write your name and student ID on the two workbooks. Then leave the three things on your desk in front of you. If you need help with this, just raise your hand and one of my assistants will come to help you.

Now let's return to the experiment. Today's experiment will consist of three parts. In the first part you will complete 7 decision tasks. In each of these tasks you will choose one from a pair of rewards. In the second part of the experiment, you will complete an additional 6 decision tasks. In each of these tasks you will choose one from a group of 8 rewards. All rewards are real Chinese dollars. In part three, we will choose your reward. We will choose one of these 13 tasks from parts one and two by spinning this bingo cage containing balls numbered 1 through 13 [spin the cage while saying this]. *Your teacher will help me doing this. Then selecting one of the balls at random* [stop and catch one ball at random] *like this. The number of the selected ball will be the number of the task we select. After we select the task, then an assistant will visit each of you individually to determine your individual prize and pay you.*

- lead experimenter explain urns:

Before we start part one, let me explain how you will earn money during this study. We will pay you a RMB prize that is based on your selection of different balls. For each ball you select or that is selected randomly, you can receive the amount the ball is worth. For each of the tasks in the workbooks in front of you, you will see how much any ball is worth from the numbers on them.

Sometimes balls will also have a certain color. The color of the ball helps to determine the total amount of the RMB prize you receive, if your payment is determined randomly. To determine your payment randomly we have brought price bags and the four colored balls with us. [Hold up a bag and show it to the students.] *For example, suppose the balls correspond to the following prize amount: Green = 1 Kuai, White= 2 kuai, Blue= 3 kuai, and Yellow = 4 kuai. If your payment is determined randomly, we would place the four balls in the bag, shake the bag to mix the balls, and then take one of the balls out of the bag without looking. An assistant would draw a ball as follows* [demonstrate mixing and selecting a ball at random]. *The color is ___ and therefore in this example you will get __ RMB added to your prize.*

Before we start part one, do not forget to keep quiet and to raise your hand whenever you have a question.

Also, we will hand around a list during the experiment. On this list we will need the name and signature of everyone participating. Only if we have your signature, we can pay you in the end. [Hold up receipt and show it to the subjects.]

PART 1

- lead experimenter explains the task of part one:

Now let's start part one. Please take out the workbook with the label 'Part 1.' Do not start completing task sheets inside until we finish explaining the task and we give you the order to start.

In this part, each page in the work book has a single decision task. There will be a choice of two bags. Please select the one you would like to draw a ball from if this task is selected in the end. To do this, you mark the bag you prefer with a check.

Open your workbook to the first page with "QUIZ" written at the top to see an example. In price Bag 1, each of the four balls is matched to the dollar amount 3 kuai. In price Bag 2: Green (G) = 2 kuai, White (W) = 2 kuai, Blue (B) = 3 kuai, and Yellow (Y) = 5 kuai. You must choose one of the two bags. Suppose this task had been selected to determine your prize, then we would select a ball from the bag you choose to determine the value of your prize.

Please answer the two questions at the bottom of this page, and raise your hand when you are done. An assistant will come and check your answers. Also, you can raise your hand if you have a question and the assistant will come to answer your question. When everyone is done with the quiz, we will start part one.

- Lead experimenter checks with the assistants that all subjects have gotten through the quiz correctly. If somebody did not answer correctly ask them to explain their answer. Listen

and then clarify any misunderstandings. Note the Student ID of any subject did not understand the task even after explanation on the session sheet.

We are now ready to complete the decision tasks in workbook one, this should take you no more than 10 minutes. When you are done, or if you have a question, raise your hand and your assistant will come check your work or answer your question. Once everyone is done is we will move to part two. Now complete your decision tasks in workbook 1.

- lead experimenter pass around the receipt list. Make sure that the participants sign it and pass it on.
- Subjects have 10 minutes time, but this is a soft rule. After 10 minutes, assistants approach those still working and encourage them to finish. If they are still working 3 minutes later, decide based on the overall timing. If there is a risk running late with the experiment, move to the next workbook and note the Student ID on the session sheet. If not, give them more time.

PART 2

- lead experimenter explains the workbook 2 tasks in general:

Please put aside workbook 1, and take out the workbook with the label 'Part 2.' Again, do not start completing task sheets inside until we finish explaining the task and we give you the order to start.

You will complete 6 decision tasks in this workbook. In each of these decision tasks you will choose one prize from a set of 8. The prizes here consist of two parts: an amount of money you will receive with certainty today and amount of money you will receive with certainty when we return in two weeks. […]

PART 3

- Lead experimenter determines the payoff-relevant task:

As I explained in the beginning we will select one of the tasks you just did by selecting a ball from this bingo cage with the help of your teacher. Please stay at your seat while I select a ball.

[Let the teacher select a Ball, announce the number on it, and hold it up]

The selected task is ____. Please open workbook ___ to the task __ page.

Please remain seated as the assistants will come up to you one at a time, to determine your payoffs, pay them to you, and collect your workbooks. Please be patient, remain quiet, and do not discuss your prize amount with others during this activity as you will take turns getting visited by the assistant.

- Assistants determine payoff with subjects, write the determined payment on the respective pages of the workbooks and pay the subjects accordingly.

- Lead experimenter writes down the number of the selected task in the session sheet.
- Assistants check that each student wrote his or her student ID correctly on the two workbooks and on the envelope.
- Assistants collect the two workbooks. Then they ask the students to leave the envelope open and to give it to his or her parents after school.
- Lead experimenter look for the receipt list and compare the number of signatures to the number of students. Note number of signatures on the session sheet.

[If there is one or more signatures missing:] *Please raise your hand if you have not signed the receipt yet.* [Then pass the receipt to the respective participants and collect their signatures.]

You all have an envelope in front of you. It is very important that you look carefully after this envelope and hand it to your parents after school! Just like you, your parents can earn some money if they receive the envelope from you today. Inside the envelope is a questionnaire they have to fill it out by [DATE] *The finished questionnaire should be put back into the envelope and returned to your teacher.*

The experiment is now over. Thank you for participating!

- Note the time the class left on the session sheet
- Count the workbooks and note the numbers on the session sheet
- Copy the payoff amounts from the workbooks to the receipt

Appendix C: Excerpt from parent questionnaire (translated from Chinese)

What is your relationship to the child?

☐ Mother ☐ Father ☐ Other

How many people in your household have a high school degree or higher?

☐ None ☐ One ☐ Two or more

How many people in your household have a university degree or higher?

☐ None ☐ One ☐ Two or more

How many houses or apartments do the members of your household own altogether?

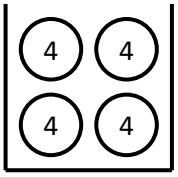
☐ None ☐ One ☐ Two or more

Task

In each of the seven tasks below you can choose between two urns. Each of these urns contains four balls. Please imagine that one of the four balls is randomly drawn from the urn you chose to determine your payoff. Each ball gives you a certain number of points as indicated by the number on the ball.

Imagine that you would receive 1000 RMB for each point. For example, if (1) would be drawn from an urn, you would receive 1000 RMB. Which urn (top or bottom) would you prefer in each of the seven tasks? Please tick the appropriate box in each task.

Task 1



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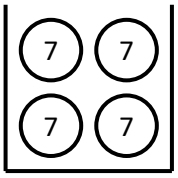

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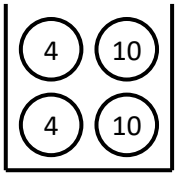
Task 2



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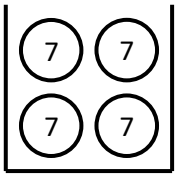

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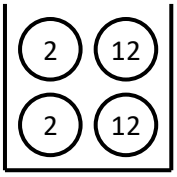
Task 3



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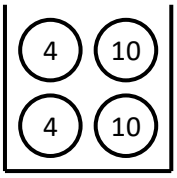

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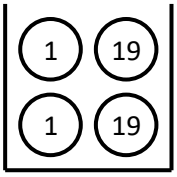
Task 4



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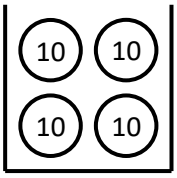

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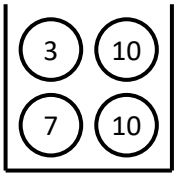
Task 5



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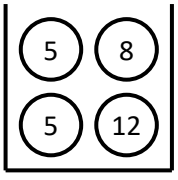

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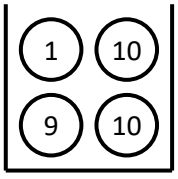
Task 6



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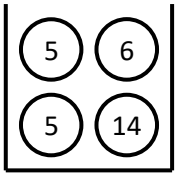

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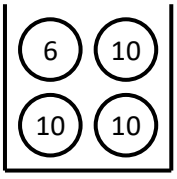
Task 7



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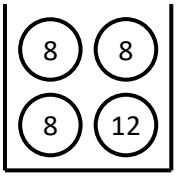

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Appendix D: Picture classroom setting

Appendix E: Robustness Checks

Binomial Tests

Table E.1: Binomial tests p-values for risk aversion

	First primary school (initial sample)		Second primary school (follow-up)		Both primary schools		Middle school		High school		
	Grade 3	Grade 5	Grade 3	Grade 5	Grade 3	Grade 5	Grade 7	Grade 8	Grade 10	Grade 11	All subjects
Task 2	0.878	**0.006**	0.471	0.312	0.461	**0.006**	**0.001**	**0.01**	**0.038**	**0.001**	**0.000**
Task 3	0.878	**0.001**	**0.013**	0.111	**0.045**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**
Task 4	**0.008**	**0.000**	**0.002**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
All tasks	0.247	**0.000**	0.934	**0.000**	0.503	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	

p-values in bold if p < 5%.

Table E.2: Binomial tests p-values for prudence

	First primary school (initial sample)		Second primary school (follow-up)		Both primary schools		Middle school		High school		
	Grade 3	Grade 5	Grade 3	Grade 5	Grade 3	Grade 5	Grade 7	Grade 8	Grade 10	Grade 11	All subjects
Task 5	0.441	**0.029**	**0.001**	**0.006**	**0.002**	**0.000**	**0.000**	**0.023**	**0.017**	**0.000**	**0.000**
Task 6	0.088	**0.000**	**0.002**	**0.013**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.002**	**0.000**
Task 7	**0.020**	0.059	1.000	0.665	0.113	0.358	0.291	0.88	0.268	0.430	0.575
All tasks	0.929	**0.024**	**0.000**	**0.001**	**0.004**	**0.000**	**0.000**	**0.001**	**0.000**	**0.000**	

p-values in bold if p < 5%.

Regressions

Table E.3: Ordered logit regressions on the number of risk averse choices (average marginal effects) – including first primary school (initial sample)

	(1) All	(2) Girls	(3) Boys
Grade	0.005	0.032***	-0.018
	(0.009)	(0.007)	(0.013)
Grade 3	-0.178***	-0.023	-0.292***
	(0.036)	(0.051)	(0.059)
Math	0.043	0.054*	0.047
	(0.034)	(0.029)	(0.061)
Female	-0.027		
	(0.052)		
Number of risk averse choices	0.113***	0.079**	0.134***
	(0.032)	(0.036)	(0.048)
Low education	0.004	-0.008	0.042
	(0.094)	(0.081)	(0.123)
High education	-0.123	-0.221***	-0.040
	(0.078)	(0.082)	(0.114)
House owner	0.179***	0.174***	0.172
	(0.048)	(0.037)	(0.105)
Local Hukou address	0.055	0.151*	-0.023
	(0.062)	(0.081)	(0.090)
Flipped booklet	0.040	0.025	0.036
	(0.039)	(0.077)	(0.056)
Observations	223	109	114
Specification tests (*p*-values F-test)			
Grade, Grade 3	0.000	0.000	0.000
Low education, high education, house owner, local Hukou	0.002	0.000	0.023

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table E.4: Ordered logit regressions on the number of risk averse choices (average marginal effects) – including second primary school (follow-up sample)

	(1) All	(2) Girls	(3) Boys
Grade	0.025	0.030***	0.022
	(0.015)	(0.006)	(0.019)
Grade 3	-0.239***	-0.145***	-0.330***
	(0.086)	(0.041)	(0.109)
Math	0.029	0.066**	-0.000
	(0.033)	(0.032)	(0.046)
Female	0.063*		
	(0.034)		
Number of risk averse choices	0.087**	0.086**	0.087*
	(0.041)	(0.040)	(0.047)
Low education	0.005	-0.062	0.053
	(0.106)	(0.080)	(0.154)
High education	-0.049	-0.093	-0.028
	(0.086)	(0.086)	(0.106)
House owner	0.112***	0.218***	0.006
	(0.024)	(0.044)	(0.098)
Local Hukou address	0.056	0.031	0.071
	(0.055)	(0.058)	(0.085)
Flipped booklet	0.054	0.092*	0.022
	(0.037)	(0.052)	(0.060)
Observations	213	109	104
Specification tests (*p*-values F-test)			
Grade, Grade 3	0.000	0.000	0.000
Low education, high education, house owner, local Hukou	0.000	0.000	0.872

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table E.5: Ordered logit regressions on the number of prudent choices (average marginal effects) – only including first primary school (initial sample)

	(1) All	(2) Girls	(3) Boys
Grade	0.014	0.029	-0.001
	(0.012)	(0.023)	(0.012)
Grade 3	-0.149**	-0.094	-0.197***
	(0.072)	(0.191)	(0.055)
Math	0.028	0.032	0.031
	(0.018)	(0.030)	(0.029)
Female	0.057		
	(0.069)		
Number of prudent choices	0.082***	0.105***	0.063**
	(0.026)	(0.029)	(0.029)
Low education	-0.001	-0.120***	0.076
	(0.047)	(0.041)	(0.078)
High education	0.043	-0.051	0.112
	(0.066)	(0.087)	(0.106)
House owner	-0.041	0.010	-0.060
	(0.042)	(0.058)	(0.061)
Local Hukou address	0.011	0.108	-0.066
	(0.058)	(0.088)	(0.095)
Flipped booklet	-0.048	0.033	-0.118***
	(0.029)	(0.057)	(0.042)
Observations	223	109	114
Specification tests (*p*-values F-test)			
Grade, Grade 3	0.000	0.000	0.000
Low education, high education, house owner, local Hukou	0.000	0.038	0.474

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table E.6: Ordered logit regressions on the number of prudent choices (average marginal effects) – only including second primary school (follow-up sample)

	(1) All	(2) Girls	(3) Boys
Grade	0.020*	0.031	0.002
	(0.012)	(0.027)	(0.005)
Grade 3	0.067	-0.016	0.147***
	(0.077)	(0.162)	(0.032)
Math	0.047**	0.068**	0.051
	(0.021)	(0.034)	(0.052)
Female	0.072		
	(0.061)		
Number of prudent choices	0.086***	0.122***	0.072*
	(0.032)	(0.029)	(0.039)
Low education	0.040	-0.020	0.103
	(0.040)	(0.075)	(0.078)
High education	-0.013	-0.066	0.052
	(0.076)	(0.099)	(0.095)
House owner	-0.017	-0.035	-0.041
	(0.039)	(0.053)	(0.074)
Local Hukou address	0.093***	0.129	0.071
	(0.030)	(0.128)	(0.076)
Flipped booklet	-0.020	0.113**	-0.157***
	(0.016)	(0.054)	(0.051)
Observations	213	109	104
Specification tests (*p*-values F-test)			
Grade, Grade 3	0.054	0.008	0.000
Low education, high education, house owner, local Hukou	0.000	0.756	0.538

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1