The Fork Game: A Graphical Interface for Eliciting Higher-Order Risk Preferences

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Abstract

We introduce the "Fork Game", a graphical interface designed to elicit higher-order risk preferences. In this game, participants connect forked pipes to create a final structure. A ball is then dropped into the top opening of this structure and follows a downward path, randomly turning left or right at each forked joint. This construction is effectively isomorphic to the apportionment of binary-outcome lotteries, allowing participants to construct complex gambles. Furthermore, the game is easily comprehensible, highly modular, and provides a flexible means of assessing risk aversion, prudence, temperance, and even higher-order risk preferences.

Keywords: prudence, temperance, experiment

JEL Classification: C91, C93, D14, D81, E21

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1 Introduction

A major research program in economics focuses on the development of incentivized laboratory tasks to elicit individuals' attitudes towards risk. It has been generally shown that most individuals can be characterized as risk-averse in the gain domain. Risk-averse decision makers are willing to forgo some amount of their initial wealth to avoid certain actuarially fair risks, such as mean-preserving spreads (Rothschild and Stiglitz, 1978). When preferences over risky prospects admit the classical expected utility framework and are represented by an increasing and continuously differentiable von Neumann-Morgenstern utility function, risk aversion can be characterized by the second derivative of this function being negative. The signs of the higher-order derivatives of the utility function have further implications for the behavior of decision makers under uncertainty. Take the case of precautionary savings, realized when an increase in risks to future income is offset by an increase in present day savings. Leland (1968) and Sandmo (1970) show that when the third derivative of this utility function is positive, that is when the marginal utility is convex, a risk-averse individual will increase her demand of precautionary savings.

Kimball (1990) coined the term *prudence* for this type of behavior. In Kimball (1992), a related concept of *temperance* is defined as the willingness to refrain from further risks to income, when the agent is already facing an unavoidable risk. He also mentions that this is similar to the *properness* concept of Pratt and Zeckhauser (1987), which describes an agent facing two undesirable lotteries, to continue classifying one of these as undesirable when he is forced to face the other one.

In their seminal work, Eeckhoudt and Schlesinger (2006) discovered that prudence, temperance, as well as any further risk apportionment of order n, can be characterized by preferences over simple lottery pairs. Furthermore, they showed that these preferences are equivalent to the sign of the higher-order derivatives of the von Neumann-Morgenstern utility function. The nature and simplicity of these lottery pairs have motivated many further experimental studies aiming to assess higher-order risk preferences and their relation to real-life risk-taking behaviors. Their framework also allows for a parameter-free comparison of higher-order risk preferences across individuals by constructing indexes based on the number of certain binary decisions (Trautmann and van de Kuilen, 2018).

In this paper, we introduce the "*Fork Game*", a novel method that utilizes forking pipes to represent the randomization aspect of the experiments. The resulting outcome is represented by a falling ball within those pipes, taking a randomly chosen path at the forks. In the treatments, participants are tasked with placing the pipes to construct the desired lottery, which is equivalent to the lottery pairs used in previous literature. By visualizing the randomization aspect and the chosen lottery clearly, and by designing all games as direct variations of the same underlying concepts, we can extend the games in a straightforward manner to analyze even more complex risk attitudes without significantly increasing the procedural complexity.

Results from our laboratory experiments show that subject behavior in the Fork Game is broadly consistent with previous findings from experiments utilizing different tasks. In particular, we find that risk aversion and prudence are highly prevalent among the subjects, while temperance is less common, and a substantial fraction of subjects are more likely to make intemperate choices. We elaborate on this issue further in the next section, where we review previous findings from laboratory experiments on higher-order risk preferences. Our results are also qualitatively and quantitatively similar to those of Bleichrodt and Bruggen (2022), from whom we borrowed our payoff structure. Specifically, we have identified a positive and statistically significant correlation between the choices made in our experiment and those made in their study. Furthermore, when examining the choices within each task separately, we have observed positive correlations for both risk aversion and prudence. In contrast to risk aversion and prudence, we do not observe a significant correlation for temperance. However, the overall level of temperate choices in our experiment is very similar to that observed in the study conducted by Bleichrodt and Bruggen (2022).

Tasks designed to elicit higher-order risk preferences naturally involve complex gambles. In these environments, research has documented that subjects exhibit significantly divergent decision-making patterns when confronted with complex gambles compared to their reduced counterparts, highlighting the challenge of comprehending the overall consequences of such choices (Haering et al., 2020). Another factor to consider is task difficulty. We believe that our task is relatively simple, supported by the fact that approximately 10% of subjects rated its difficulty as 0 on a scale of 0-10, and all participants rated it 7 or below. The average reported difficulty was 3.4 out of 10.

While risk aversion remains central in the literature on economic decisions under uncertainty, higher-order risk preferences have been demonstrated to complement the complete characterization of economic behavior across various domains. For instance, as stated previously, the precautionary savings motive, which entails increased savings in response to higher future income risks, is associated with the convexity of marginal utility, denoted as $u''' > 0$.[1] Evidence from Esö and White (2004) supports the existence of precautionary behavior in auctions, where the introduction of background risk leads prudent bidders to reduce their bids by a greater extent than the risk premium, termed as precautionary bidding. Treich (2010) establishes a theoretical relationship between risk aversion and rent-seeking behavior, demonstrating that risk aversion reduces rent-seeking only among prudent individuals in the context of rent-seeking games. White (2008) examines the impact of prudence in a bargaining game under risky outcomes. Notably,

[1] Leland (1968); Sandmo (1970); Dreze and Modigliani (1972)

prudence emerges as a more significant determinant of health expenditures compared to risk aversion, as evidenced in studies by Courbage and Rey (2006); Krieger and Mayrhofer (2017). Within the financial literature, Brunnermeier et al. (2007) find that individuals, in line with prudent behavior, tend to overinvest in positively skewed assets. Schneider (2019) introduces a decomposition of forward market returns, revealing that downside risk contributes significantly to the forward premium, aligning with prudent behavior.

The remainder of the paper is organized as follows: Section 2 provides a technical characterization of risk aversion, prudence, and temperance. Section 3 describes the experimental tasks used in the literature to elicit higher-order risk preferences. Sections 4 and 5 outline the design aspects of the "Fork game" and the experimental procedures, respectively, and Section 6 presents an empirical evaluation of the experiment's results. Finally, Section 7 concludes with a summary and discussion of the results.

2 Risk Aversion, Prudence and Temperance

We start with a technical characterization of risk aversion, prudence and temperance using the framework in Eeckhoudt and Schlesinger (2006). Consider a decision maker whose preferences admit the classical expected utility representation, with u being the von Neumann-Morgenstern utility function (Von Neumann and Morgenstern, 1953). Assume further that u is an increasing and continuously differentiable function. Let w be the initial wealth of this decision maker. Let $k, \delta > 0$ be two constants and $\{\overline{\epsilon}_i\}$ be a list of mutually independent and zero-mean random variables. The weak preference relation over lottery pairs is represented by $\succeq$, and we use $[o_1, o_2]$ represent a lottery with two possible and equally likely outcomes o_1 and o_2. The decision maker is risk-averse if $w \succeq w + \overline{\epsilon}_i$, $\forall w$ and $\forall \overline{\epsilon}_i$. This is equivalent to the second derivative of u being negative. Risk-aversion also implies that the individual prefers to face two certain losses at different states of the world, that is, $[w-k, w-\delta] \succeq [w, w-k-\delta]$, $\forall k, \delta > 0$.[2] The decision maker is said to be prudent if she prefers to disaggregate a sure loss and a zero-mean lottery, that is she prefers to face them in different states of the world. Formally, the preferences of a prudent decision-maker imply $[w-k, w+\overline{\epsilon}_i] \succeq [w, w-k+\overline{\epsilon}_i]$, $\forall w$, k, and $\forall \overline{\epsilon}_i$, as demonstrated in Figure 1. Eeckhoudt and Schlesinger (2006) show that this is equivalent to third derivative of u being non-negative, i.e. having a convex marginal utility function. In their words, adding $\overline{\epsilon}_i$ to a higher wealth is less painful for a prudent individual.

On the other hand, the decision is maker is said to be temperate if she prefers to face two statistically independent zero-mean lotteries, $\overline{\epsilon}_i$ and $\overline{\epsilon}_j$, at different states of the world.

[2] As we are assuming a Von Neumann–Morgenstern utility representation, directly follows from Jensen's Inequality Jensen (1906).

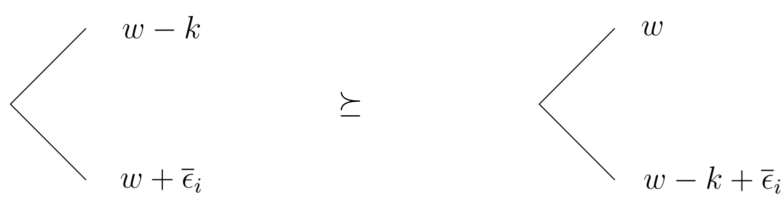


Figure 1: Prudence according to Eeckhoudt and Schlesinger (2006)

Formally, the preferences of a temperate decision-maker imply $[w+\bar{\epsilon}_i, w+\bar{\epsilon}_j] \succeq [w, w+\bar{\epsilon}_i+\bar{\epsilon}_j]$, $\forall w$, $\forall \bar{\epsilon}_i$, and $\forall \bar{\epsilon}_j$, as demonstrated in Figure 2. Eeckhoudt and Schlesinger (2006) show that this equivalent to fourth derivative of u being less than or equal to zero.

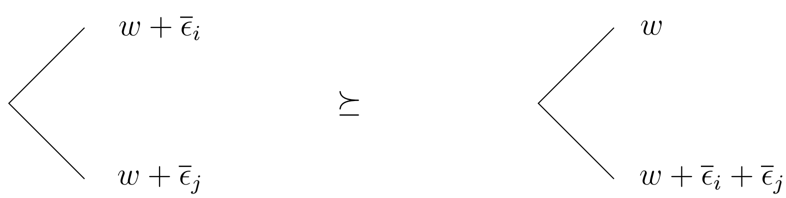


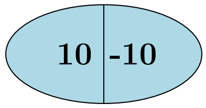
Figure 2: Temperance according to Eeckhoudt and Schlesinger (2006)

3 Experimental Tasks from Previous Literature

We begin by outlining the design aspects of key experimental studies that examine higher-order risk preferences, followed by a summary of their behavioral outcomes.

Deck and Schlesinger (2010) use a text-based design supplemented with figures representing binary lotteries. Let $[+\epsilon, -\epsilon]$ be the zero mean lottery and $k > 0$ be a constant. In their prudence tasks, participants start with an initial amount ($w > 0$) and are presented with two equally likely states, Heads or Tails, determined by a coin flip. They are instructed to (i) choose the state under which the outcome of the zero mean lottery would be added to their initial amount, and (ii) select the state in which they would prefer an additional fixed amount (k) to be added to their earnings. For temperance tasks, a different zero mean lottery is used instead of k, and the choice procedure remains similar. The outcome of binary lotteries is determined by a spinner with a half-green (high payoff) and half-red (low payoff) configuration. Figure 3 provides an example task where participants circle their choices in the underlined sections of the italicized text. By circling "Head" (or "Tails") along with "Same" in this task, participants exhibit prudence as they are willing to face the zero mean lottery in the favorable state. On the other hand, subjects circling "Different" instead of "Same" exhibit imprudence in this task.

You will receive $20 +



if the coin lands on Heads / Tails and $5.00 if the coin lands on the Same / Different outcome

Figure 3: A compound lottery in Deck and Schlesinger (2010)

In Deck and Schlesinger (2014), compound lotteries are depicted using a representation similar to Figure 4 below. The divided portions of a pie shape correspond to different states, while a smaller pie within a larger one represents an additional lottery accompanying the realization of a specific state. The outcomes of these lotteries are determined using a spinner, similar to the approach in Deck and Schlesinger (2010). This design allows for the combination of lotteries by drawing smaller pie shapes inside larger ones, enabling the construction of complex gambles. In their study, participants are presented with a choice between two compound lotteries for each task, resulting in a total of 38 tasks.

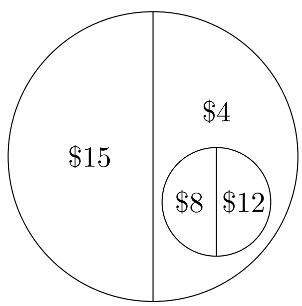


Figure 4: A compound lottery in Deck and Schlesinger (2014)

In Noussair et al. (2014), compound lotteries are represented as shown in Figure 5 below. In this particular compound lottery, subjects first engage in a binary lottery with two equally likely outcomes. The first outcome (€90) occurs if the dice throw is equal to 1,2, or 3, while the second outcome (also €90 in this example) occurs if the dice throw is equal to 4,5, or 6. In the latter case, subjects face two additional binary lotteries, each with two equally likely outcomes determined by separate dice throws. This example illustrates a scenario where two zero mean lotteries are encountered in the same state, representing an intemperate choice. The alternative option involves facing these gambles in different states, with the second zero mean lottery, with respective outcomes €50 and -€50, received in tandem with the realization of the first outcome of the initial lottery (when the first dice throw is equal to 1,2, or 3). This combination would indicate a temperate choice.

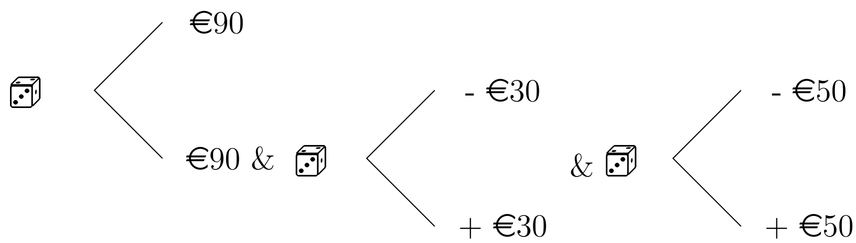


Figure 5: A compound lottery in Noussair et al. (2014)

A simplified representation of the compound lotteries used in Ebert and Wiesen (2011) is shown in Figure 6 : the initial 50/50 gamble is depicted as a ballot box containing two balls labeled “Up” and “Down.” If the “Up” ball is drawn, the subject incurs a loss of 2, and a second zero-mean risk lottery follows. The second lottery is represented by another ballot box containing multiple balls, with 4 balls shown in this simplified version. Yellow balls indicate a loss, while white balls indicate a gain. If the “Down” ball is drawn from the first ballot box, no loss occurs, and no second lottery follows. A preference for this particular compound lottery would indicate an imprudent choice.

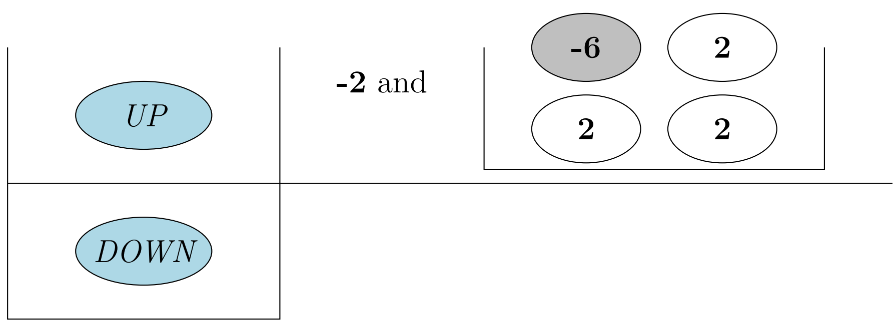


Figure 6: A compound lottery in Ebert and Wiesen (2011)

In a recent experimental study, Bleichrodt and Bruggen (2022) investigate whether higher-order risk preferences exhibit differences between gain and loss domains, and examine the existence of a reflection effect similar to the one observed for risk aversion. Figure 7 presents a simplified representation of the options used in their experiment. In this representation, lotteries with binary outcomes are depicted as the act of drawing a random ball from an urn. In the given example, the subject is confronted with a binary lottery offering a payout of €5 or €10. If the latter outcome is realized, the subject then faces an additional binary lottery where there is an equal probability of winning or losing €3. This combination would indicate a prudent choice since the subject faces the second lottery in tandem with the good outcome of the first lottery.

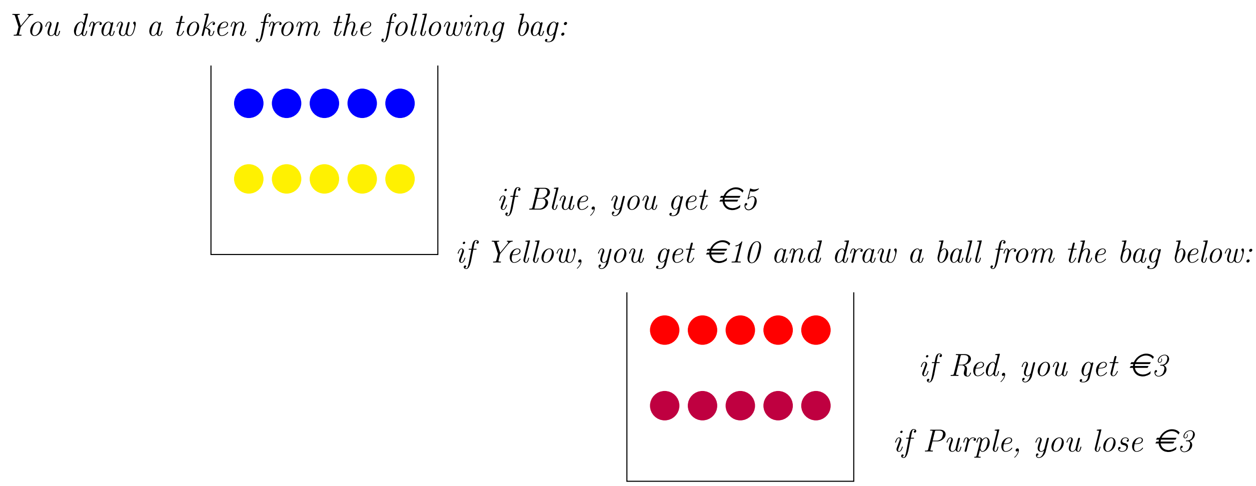


Figure 7: A compound lottery in Bleichrodt and Bruggen (2022)

In addition to the lottery pairs approach described in the previous examples, alternative methods have been employed for the experimental measurement of higher-order risk preferences. In Ebert and Wiesen (2014), a multiple price list approach is utilized, where uncertainties are resolved through draws from ballot boxes. The graphical representations of these lotteries are similar to Figure 6, but each time a subject compares two such lotteries, varying amounts of compensation are added to one of the two lotteries, forming a price list. Another approach is presented in Schneider et al. (2022), where certainty equivalents are initially elicited and used to derive utility points. These utility points are then employed in a spline regression to construct a non-parametric utility function. From this function, n^{th} order derivatives can be obtained, enabling the classification of higher-order risk preferences. This methodology is also applied by Schneider and Sutter (2020).

The experimental findings from Deck and Schlesinger (2010) indicate evidence of prudence among subjects, although to a limited extent. However, intemperate behavior is observed more frequently than temperance. In their subsequent study, Deck and Schlesinger (2014) find that subjects display a strong inclination towards risk aversion, prudence, and a moderate preference for temperance. They also identify a significant correlation between risk-averse and temperate behavior. Haering et al. (2020) replicate this setup among subjects from the USA, China, and Germany and they observe a behavior similar to the findings of Deck and Schlesinger (2014). They also explore the reduced-form equivalents of compound lotteries for a subset of participants, highlighting certain behavioral patterns, such as reduced prevalence of prudent and temperate choices, that are influenced by this framing.

Noussair et al. (2014) reports similar findings in their sample, which includes both individuals from the general population and a group of students. They observe a high degree of prudence among both groups, while temperance is less prevalent. Ebert and Wiesen (2011) observe an aggregate level of prudence comparable to that reported in Deck and Schlesinger (2010). They also find that most prudent individuals exhibit a skewness seeking behavior, while the reverse may not generaly hold. Bleichrodt and Bruggen (2022) examine higher-order risk attitudes under three treatments: losses, 50-50 gains, and small probability gains. The 50-50 gains treatment aligns with previous studies utilizing binary lotteries. In this treatment, subjects exhibit significant risk aversion, and moderate prudence, but also a tendency towards intemperate behavior.

In summary, the general results from these studies suggest that prudence is commonly observed, while the presence of temperance is less consistent. Several studies demonstrate a higher frequency of intemperate behavior. A comprehensive review of the literature on higher-order risk preferences can be found in Trautmann and van de Kuilen (2018).

4 Fork Game: Design

In our experimental design, lotteries are represented by pipes, which were typically forked as in Figure 8, with some variations on their horizontal size. In this figure, a lottery with two equally likely outcomes that has the payments of $[2, -2]$ is represented. [3]

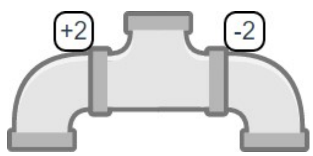


Figure 8: A simple lottery, represented with a pipe

In all the games corresponding to each of the concepts, the resolution of uncertainty is represented by a falling ball which goes left or right with probability 50% whenever it encounters a fork on its path.

The task in each round of the Risk Aversion treatment is straightforward and the subject is asked to choose one forking pipe amongst two, differing in the payoffs shown in their tags. The main advantage of our design does not show itself in this game, but it serves as a nice introduction for the next two games, which will use the same sprites and similar designs.

In a given round of the Prudence treatment, the subject is expected to place a small forking pipe after one of the two ends of a big forking pipe. The first and bigger pipe represents the first lottery with each side assigned a payoff as usual. The slots to place the

[3]We used a modified version of the sprites that are available at `https://www.kenney.nl/assets/puzzle-pack-2` with a Creative Commons CC0 license. Mentioned modifications are done with Inkscape, an open source tool.

smaller pipe are aligned directly under the exits of the bigger pipe, so the ball can continue its path, if it happens to reach the second pipe.

In Figure 9, a sample round for Prudence treatment is shown. The subject can construct one of two distinct lotteries by placing the smaller pipe to the slot at the left end or the right end of the larger pipe: [(3+[2,-2]),9] and [3,(9+[2,-2])]. In this example, we see that the subject went with the former. From the figure, we (and in the experiment the participant) also see the result of this specific round, since the ball reached to the right hand side, gaining the participant payoff of 9 for this specific round.

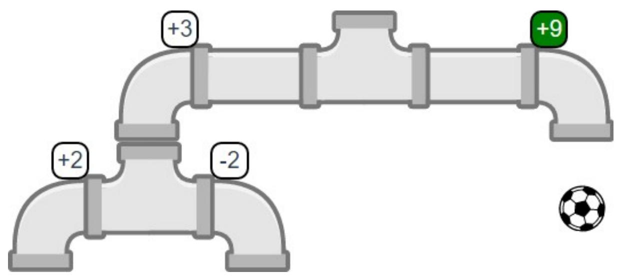


Figure 9: End result for a prudence round

Finally, for our Temperance treatment we introduce another type of pipe, as shown in Figure 10. The main point of introducing this pipe is to allow sublotteries to be placed after one another, independent from their result. While the payoff in this case is same with the case with Figure 8, here there is additional utility that we can chain one lottery after another.

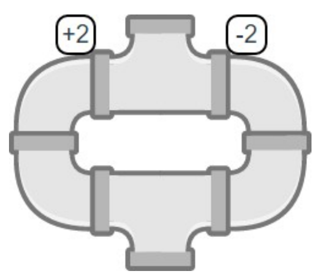


Figure 10: Pipes for the temperance treatment

In the Temperance treatment, the participant has to choose the placement for two forking pipes given, and there are four slots to choose from. However not all subsets of these four slots are available for selection, since the below two slots are only available if the slot directly above is already filled.

In Figure 11, the end of a example temperance round is shown. Here, the participant is presented two lotteries:[(5+[2,-2]),(5 +[2,-2])] and [5,(5+[2,-2] +[2,-2])] and from what we observe they went with the latter one. Note that, the payoffs are symmetric here, so it does

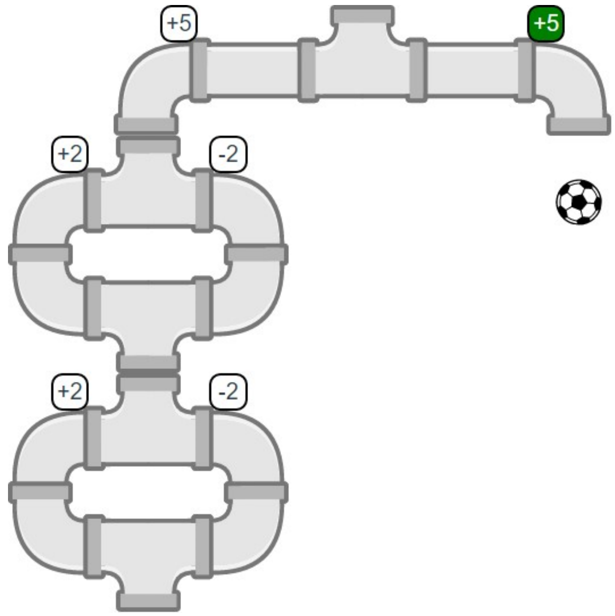


Figure 11: End result for a temperance round

not make a difference if the lotteries are placed one after another in the right side or the left side. The random selection chose the right side, resulting in a total payoff of 5. If left side of this contraption was chosen randomly instead, they would face with two additional lotteries of [2,-2].

This setup is easily extendable to represent risk apportionment of any degree so as to elicit even higher order risk preferences. In the Appendix D, we describe both theoretically and graphically how the fork game can be used to elicit edginess attitudes, which is equivalent to 5^{th} derivative of the respective von Neumann-Morgenstern utility function, $u(.)$, being positive.

5 Experimental Procedures

The experiment was conducted in Bogazici University Economics Laboratory between December 2022 and March 2023. Participants were recruited through the online recruiting system ORSEE (Greiner, 2015). In total, 135 subjects participated in our experiment over 13 sessions. Each session had between 6 to 12 subjects. All subjects were students of Bogazici University and their average age was 21.48, 55 subjects indicated their gender as female, and 80 indicated their gender as male.

In our implementation, subjects first encountered the Risk Aversion treatment followed by the other two treatments, namely Prudence and Temperance treatments, which were ordered randomly for each agent as in Noussair et al. (2014). The lotteries within each treatment were also presented in a random order, and placements of rewards on all forking pipes were randomized, as well.

Each treatment lasted for 12 rounds, The payoff structure we use is based on 50-50 gains treatments of Bleichrodt and Bruggen (2022), and the full set of parameters are presented in Appendix A. The resulting payoffs were expressed as “points” and each point was equal to 1.5 Turkish Lira (TL). For all three treatments, earnings from one randomly chosen round were used for actual payment and the subjects received an additional 20 TL for participation. The average total earnings in the experiment, including this participation fee, was around 52.5 TL[4] After completing their choices for three treatments, subjects answered a set of demographic questions and they finally completed the full set of Global Preferences Survey. All of the main treatments and the survey questions were presented in Turkish. The experimental software, programmed in JavaScript as a website (using Vue.js framework), was deployed over Github and delivered over standard Chrome browsers in full screen mode.[5] The main introduction and separate instructions for all three treatments were also presented in this software.

6 Results

We begin by presenting the incidence of risk-averse, prudent, and temperate choices in our sample. Table 1 displays the average number of risk-averse, prudent, and temperate choices based on the count of binary choices made out of the 12 tasks in each treatment. To assess the prevalence of each risk attitude, we adopt the approach used in Deck and Schlesinger (2010), Ebert and Wiesen (2011) and Noussair et al. (2014) which allows for ranking individuals based on the strength of their preferences. Our findings indicate that the subject choices in our experiment generally align with risk aversion ($p-value < 0.001$), prudence ($p-value < 0.001$), and intemperance ($p-value = 0.0518$), although intemperance appears to be relatively weaker compared to the other risk attitudes. The count of binary choices is compared to random choice (equal to 6 in our experiment) using the Wilcoxon signed-rank test.

As described in the design section, our experiment's payoff structure corresponds to the 50-50 gains treatment outlined in Bleichrodt and Bruggen (2022) and additional details on parameter values, average choices, and a comparison with choices in Bleichrodt and Bruggen (2022) are provided in the Appendix Tables 6, 7, and 8. The overall correlation

[4]At the time of the experiments, 1 USD was around 19 TL, and an average meal at the school cafeteria costed around 7.50 TL

[5]The code for the experimental software is available at `https://github.com/emrergin/prudence-labversion`. A version that includes translations of all the instructions can be found at: `https://github.com/emrergin/prudencetemperance`.

Table 1: Choices: Risk Aversion, Prudence and Temperance

	Mean	**Standard Deviation**	**Min**	**Max**	**Number of Obs.**
Risk Aversion	7.93***	2.79	0	12	135
Prudence	9.31***	2.96	0	12	135
Temperance	5.64*	3.04	0	12	135

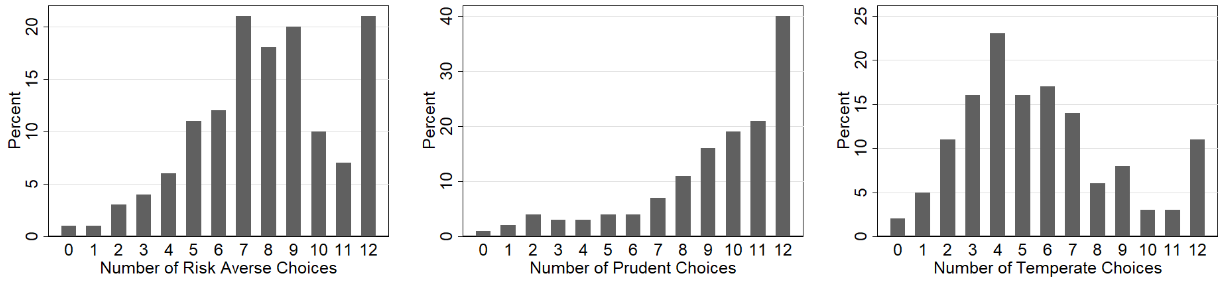
Notes: We report risk-averse, prudent, and temperate choices in our experiment. *, **, and *** indicate the average number of choices significantly different from random choice (6 in our experiment), at 0.1, 0.05, and 0.01 respectively. (Wilcoxon test.)

between the two experiments is 0.56 ($p-value = 0.0001$). The results indicate that the percentage of risk-averse choices is consistently higher in the latter study. There is a significant correlation between the choices made in our experiment and theirs, with a Pearson correlation coefficient of 0.6705 ($p-value = 0.0170$). The propensity of prudent choices is higher in our experiment, and the correlation with the prudent choices in Bleichrodt and Bruggen (2022) is 0.3197 ($p-value = 0.3111$). Similarly, for the temperance treatment, the correlation is not significant (Pearson correlation coefficient = -0.068, $p-value = 0.8338$).[6].

Figure 12 illustrates the distribution of the total number of risk-averse, prudent, and temperate choices observed in our experiment. The distribution of risk-averse choices exhibits a bimodal pattern, with two peaks at 7 and 12, each accounting for 16% of the total observations. The median of this distribution is 8, indicating that a substantial majority of participants (approximately 72%) made risk-averse choices more than 6 times. In the case of prudent choices, the distribution shows a mode at 12, with a median of 10. About 84% of subjects made strictly more than 6 prudent choices, indicating a high prevalence of prudence among participants. Regarding temperance, the mode is observed at 4, and the median stands at 5. Only 33% of subjects made more than 6 temperate choices in this treatment, indicating lower levels of temperance compared to risk aversion and prudence.

In Table 2, the Spearman rank correlations between risk-averse, prudent, and temperate choices at the subject level are presented. We observe a substantial and significant positive correlation between risk aversion and temperance. However, there is a weak and insignificant correlation between risk aversion and prudence, as well as between prudence and temperance. Figure 13 plots the number of prudent and temperate choices based on the number of

[6]We acknowledge the limitation of our sample size in evaluating the significance of the correlation. However, the magnitude of the coefficients for risk aversion and prudence implies a positive relationship with the experiment outcomes. To visually represent this relationship Figures 14, 15, and 16 display scatter plots depicting the percentage of choices in our experiment and in the study conducted by Bleichrodt and Bruggen (2022)



(a) Risk Aversion (b) Prudence (c) Temperance

Figure 12: Histogram of choices

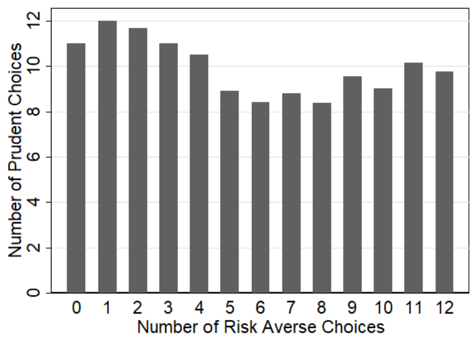
risk-averse choices. The plots show a weak and nonmonotonic relationship between risk aversion and prudence, with relatively risk-loving subjects being slightly more prudent. Additionally, the number of temperate choices tends to increase as the number of risk-averse choices increases, confirming the positive and significant correlation between risk aversion and temperance. Table 3 presents a similar analysis, showing the average number of prudent and temperate choices based on the quantiles of the risk-averse choice distributions. The results indicate that, for each quantile of the risk distribution, the number of prudent choices is significantly higher than what would be expected from random choice (6 out of 12). This suggests that prudence is generally prevalent in our sample, regardless of the extent of risk aversion. On the other hand, temperance appears to be closely related to the degree of risk aversion, as the number of temperate choices increases as we move to the upper quantiles of the distribution of risk-averse choices.

Table 2: Rank Correlations between Risk Aversion, Prudence and Temperance

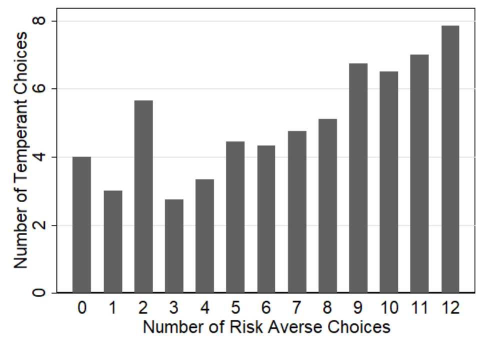
	Risk Aversion	**Prudence**
Prudence	0.018	
Temperance	0.418***	0.085

Notes: Spearman rank correlations. *, **, and *** indicate significance at 0.1, 0.05, and 0.01 levels.

We continue with a parametric analysis of the subject choices in our experiment. We conduct random effects panel logit regressions with binary dependent variables indicating risk-averse, prudent, and temperate choices in each task. We relate these choices to the demographic characteristics and responses to the Global Preferences Survey (GPS) outlined in Falk et al. (2018) and Falk et al. (2022). We further include the endowment-to-risk



(a) Prudence



(b) Temperance

Figure 13: Prudence-Temperance by the Number of Risk Averse Choices

Table 3: Prudence and Temperance by Quantiles of the Risk Averse Choices

	Risk Aversion Quantiles			
	First Quantile	**Second Quantile**	**Third Quantile**	**Fourth Quantile**
Prudence	9.57***	8.61***	9.36***	9.86***
Temperance	4.11***	4.92***	6.67	7.64**

Notes: Average number of prudent and temperant choices for each risk aversion quantile. *, **, and *** indicate the average number of choices significantly different from random choice (6 in our experiment), at 0.1, 0.05, and 0.01 respectively. (Wilcoxon test.)

ratio as an additional covariate to capture potential wealth effects in the choices following Noussair et al. (2014), separately for prudent and temperate choices. Table 4 presents the summary statistics for our explanatory variables. The average age of participants is 21.48, with approximately 40% of our sample comprising females. However, the age variation is not substantial as our sample primarily consists of students. The average GPA of participants is 2.91, and 23% of them have reported previous participation in economic experiments, as indicated by the variable "Experience". The variable "Econ" indicates the number of economics classes taken by the participants which are censored at 4.

In the second block of Table 4, we display information on the GPS items, which are used to elicit risk and time preferences, positive and negative reciprocity, altruism, and trust. There are 12 questions in the survey to elicit preferences of individuals in these five separate domains. More specifically, the first two variables "Willingness to take risks" and "staircase" risk are designed to elicit risk preferences. The variables "Staircase patience" and “Willingness to give up something today” are used to assess the time preferences (i.e. the level of patience) of the participants. “Willingness to return a favor” and “size of gift” measure positive reciprocity, while “Willingness to punish if oneself treated unfairly”, “Willingness to punish if other treated unfairly”, and “Willingness to take revenge” are used to construct negative reciprocity. “Willingness to give for good causes” and “hypothetical donation” are used to elicit preferences for altruism. Finally, trust is measured based on a self-assessment question asking participants to rate their belief that people have only the best intentions, on a level between 1-10. Following the methodology outlined in Falk et al. (2018), we standardized the responses to the survey items using the means and standard deviations from our sample. We then multiplied these standardized responses by their respective coefficients, as specified in Falk et al. (2018), and summed them to obtain the final score for each GPS item. Further details can be found in appendix. While we also included two more items from the survey, namely “Subjective math skills”, and the subject’s self assessment of the statement “I tend to postpone tasks even if I know it would be better to do them right away”, these are not used in the construction of main preference items. In our regressions, we also included “Subjective math skills” as an explanatory variable.

We present our results in Table 5. The GPS risk variable is negatively associated with both risk-averse and temperate choices. However, we do not observe a significant effect on prudence. The results support the correlation between risk aversion and temperance, indicating that risk-averse individuals are more likely to make temperate choices, whereas risk-loving individuals are less likely to make temperate decisions. Higher GPA levels are positively associated with the likelihood of making risk-averse choices, while the perceived difficulty of the experiment has a slightly negative effect on temperance. None of the preference measures elicited through GPS show a significant association with prudence. However, GPS patience and altruism are positively correlated with the likelihood of making temperate choices. Columns 2b, 3b, and 3c of Table 5 present the results of models that include the endowment-to-risk ratio as an additional covariate for prudence and temperance. We define the risk ratio as the ratio of the size of the zero-mean risk to the expected value of the prospect. For the temperance task, we first calculate the background risk by fixing the zero-mean risk, which is larger (or equal) in size, and then use the other zero-mean risk to calculate the risk ratio. In column 2b, we examine the relationship between prudent choices and the risk ratio, given in percentage points. We find no significant evidence of decreasing/increasing absolute prudence in our sample. In columns 3b and 3c, we include the endowment-to-risk ratio and the ratio along with background risk in our regression analysis. Consistent with the findings of Noussair et al. (2014), our results indicate evidence of decreasing absolute temperance, as indicated by the positive and significant effect of the ratio on the likelihood of making temperate choices. Specifically, a one percentage point

Table 4: Summary Statistics

	Mean	**StD**	**Min**	**Max**	**N**
Demographics					
Age	21.48	2.01	18	33	135
Female	0.41	0.49	0	1	135
GPA	2.91	0.52	1.5	3.5	135
Experience	0.23	0.42	0	1	135
Econ	2.44	1.48	0	4	135
Difficulty	3.41	2.07	0	10	135
Confidence	5.85	2.43	0	10	135
GPS Survey					
Will. to take risks	4.96	2.21	0	10	135
Staircase risk	13.2	5.15	1	28	135
Staircase patience	11.06	10.82	1	36	135
Will. to give up sth. today	6.4	2.07	1	10	135
Will. to return favor	8.7	1.14	5	10	135
Size of gift	6.98	3.16	0	12	135
Trust	3.64	2.55	0	10	135
Will. to punish if oneself treated unfairly	6.88	2.27	0	10	135
Will. to punish if other treated unfairly	6.37	2.26	0	10	135
Will. to take revenge	5.25	2.70	0	10	135
Will. to give to good causes	6.98	2.3	0	10	135
Hypoth. donation	382	386	0	2000	135
Subjective Math Skill	6.98	1.97	0	10	135

Notes: Summary of survey responses. See Appendix C for the details.

Table 5: Effect of preference measures, demographics and risk-to-endowment ratio on risk-averse, prudent and temperate choices

	1 **Risk**	**2a** **Prudent Choice**	**2b** **Prudent Choice**	**3a** **Temperate Choice**	**3b** **Temperate Choice**	**3c** **Temperate Choice**
Risk ratio (%)			0.0004		0.003**	0.003***
			(0.001)		(0.001)	(0.001)
Background Risk						0.002
						(0.009)
Female	-0.030	-0.037	-0.037	0.077*	0.077*	0.077*
	(0.038)	(0.048)	(0.048)	(0.043)	(0.044)	(0.044)
Age	-0.005	0.008	0.008	-0.001	-0.001	-0.001
	(0.012)	(0.011)	(0.011)	(0.001)	(0.001)	(0.001)
Difficulty	-0.0002	-0.007	-0.007	-0.019*	-0.019*	-0.019*
	(0.010)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
GPA	0.084**	0.006	0.006	0.044	0.044	0.044
	(0.035)	(0.040)	(0.040)	(0.049)	(0.049)	(0.049)
Experience	0.010	-0.056	-0.056	-0.045	-0.045	-0.045
	(0.043)	(0.054)	(0.054)	(0.047)	(0.048)	(0.048)
Econ	0.005	0.013	0.013	0.013	0.013	0.013
	(0.012)	(0.015)	(0.015)	(0.013)	(0.013)	(0.013)
Confidence	0.014	0.005	0.005	0.014	0.014	0.014
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
GPS Risk	-0.151***	-0.004	-0.004	-0.130***	-0.131***	-0.131***
	(0.023)	(0.025)	(0.025)	(0.028)	(0.028)	(0.028)
GPS Patience	0.008	-0.014	-0.014	0.078***	0.078***	0.078***
	(0.022)	(0.027)	(0.027)	(0.029)	(0.028)	(0.028)
GPS Trust	-0.026	0.004	0.004	0.014	0.016	0.016
	0.016	(0.023)	(0.023)	(0.018)	(0.019)	(0.019)
GPS positive reciprocity	-0.009	-0.038	-0.038	-0.040	-0.041	-0.040
	0.025	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
GPS negative reciprocity	0.0004	-0.016	-0.016	0.010	0.010	0.010
	0.0211	(0.032)	(0.032)	(0.036)	(0.036)	(0.036)
GPS Altruism	0.036	0.010	0.010	0.066***	0.066***	0.066***
	0.022	(0.025)	(0.025)	(0.023)	(0.023)	(0.023)
Math Skill	-0.103	0.036	0.036	-0.021	-0.021	-0.021
	(0.023)	(0.026)	(0.026)	(0.023)	(0.023)	(0.023)
Number of Subjects	135	135	135	135	135	135
Number of Obs.	1620	1620	1620	1620	1620	1620

Notes: Random effects panel logit regressions for the choices in the Risk, Prudence, and Temperance treatments. The risk ratio is calculated as the ratio of zero-mean risk to the expected value of the prospect and background risk is the absolute size of the zero-mean risk. Marginal effects are reported. Error terms are clustered at the participant level.*, **, and *** indicate significance at 0.1, 0.05, and 0.01 levels.

increase in the ratio leads to a 0.3 percentage point increase in the likelihood of making a temperate choice.

By including a survey-based measure of risk aversion in our regression analysis, we have further validated the observed link between temperance and risk aversion in our experiment. This observation is related to mixed risk aversion and mixed risk loving, and their general prevalence in the population. The concept of mixed risk aversion, introduced by Caballé and Pomansky (1996), characterizes a subset of risk-averse individuals whose subsequent derivatives of the utility function alternate in sign. This corresponds to the specific lottery preferences described in Eeckhoudt et al. (2009), which involve combining relatively good assets with relatively bad ones. The concept of mixed risk loving is defined by Crainich et al. (2013) to refer to a subset of risk-loving individuals who, unlike mixed risk-averse individuals, prefer to combine relatively good assets with relatively good ones. We describe these concepts in more detail in Appendix B.

An interesting theoretical implication of these constructs is that individuals with mixed risk-averse preferences tend to make not only risk-averse choices, but also prudent and temperate choices. In contrast, individuals with mixed risk-loving preferences would make risk-loving, prudent, and intemperate choices. Given that both types share similar attitudes towards prudence, we would expect prudence to be more prevalent in the population compared to temperance, and a positive association between risk aversion, temperance, and the general willingness to take risks. These are consistent with our experimental findings described above.

7 Summary and Discussion of Results

In this study, we introduce the "Fork Game", a novel graphical device designed to elicit higher-order risk preferences. Our method utilizes forking pipes to represent the randomization aspect of the experiments where the resulting outcome is represented by a falling ball within those pipes, taking a randomly chosen path at the forks. In the treatments, participants are tasked with placing the pipes to construct the desired lottery, which is equivalent to the lottery pairs used in the previous literature. By visualizing the randomization aspect and the chosen lottery clearly, and designing all games as direct variations of the same underlying concepts, we can extend the games in a straightforward manner to analyze even more complex risk attitudes without significantly increasing the procedural complexity.

Tasks aimed at eliciting higher-order risk preferences often involve complex gambles, which can lead to distinct decision-making patterns compared to simplified versions of the tasks. The comprehension of the overall consequences of complex gambles poses a challenge for subjects. Additionally, task difficulty is a relevant factor to consider. In our study, we believe that our task is relatively simple, as the average reported difficulty is 3.4 out of 10 and no participant has reported a rating above 7 in our experiments.

Our laboratory experiments reveal consistent results with previous findings regarding higher-order risk preferences. Subjects in the "Fork Game" exhibit a high prevalence of risk aversion and prudence, while temperance is less common. Intemperate choices are observed among a significant fraction of subjects. Our results align qualitatively and quantitatively with those of Bleichrodt and Bruggen (2022), indicating a positive and statistically significant correlation between our experiment and their study. Although we do not find a significant correlation for temperance, our experiment's overall level of temperate choices is similar to that observed by Bleichrodt and Bruggen (2022).

Furthermore, we relate binary choices in risk-aversion, prudence, and temperance treatments to the demographic characteristics and responses to the Global Preference Survey (GPS). We find that the GPS risk variable is negatively associated with risk-averse and temperate choice, however, we do not observe a significant effect on prudence which further validates the observed relation between risk-aversion and temperance. This observation can be attributed to the presence of mixed risk aversion and mixed risk-loving preferences, which are commonly found in the population. Mixed risk-averse individuals tend to be prudent and temperate and mixed risk-loving preferences are associated with prudence and intemperance. Despite their different risk preferences, both groups show similar attitudes toward prudence, leading to a prevalence of prudence in the population, and a positive association between risk aversion, temperance, and the overall willingness to take risks. These findings are consistent with our experimental results.

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A Parameters

Table 6: Parameters and Choices in Risk Aversion Treatment

Task	w	k	δ	Option pair	Choices (%)	
1	16	8	7	$[8, 9]$ vs. $[1, 16]$	65.9***	83.5
2	14	7	5	$[7, 9]$ vs $[2, 14]$	68.9***	85.1
3	16	7	5	$[9, 11]$ vs $[4, 16]$	70.4***	81
4	13	6	4	$[7, 9]$ vs $[3, 13]$	65.9***	82.6
5	8	4	3	$[4, 5]$ vs $[1, 8]$	59.3**	76
6	10	5	3	$[5, 7]$ vs $[2, 10]$	60.7**	81
7	10	4	3	$[6, 7]$ vs $[3, 10]$	66.7***	77.7
8	12	5	3	$[7, 9]$ vs $[4, 12]$	62.9***	81
9	11	5	3	$[6, 8]$ vs $[3, 11]$	66.7***	78.5
10	12	4	3	$[8, 9]$ vs $[5, 12]$	61.5***	70.2
11	14	6	5	$[8, 9]$ vs $[3, 14]$	71.1***	84.3
12	12	6	5	$[6, 7]$ vs $[1, 12]$	72.6***	86
				Correlation		0.6705**

Notes: This table reports the parameters used in the Risk Aversion treatment and the aggregate choices in this treatment. For each task, risk-averse choice implies $[w - k, w - \delta]$ is preferred over $[w, w - k - \delta]$. The first one of the percentages in the last two columns indicates the choices in our experiment and the second one indicates the choices reported in Bleichrodt and Bruggen (2022) and their Pearson correlation coefficient is provided which is significant at 0.01 level.

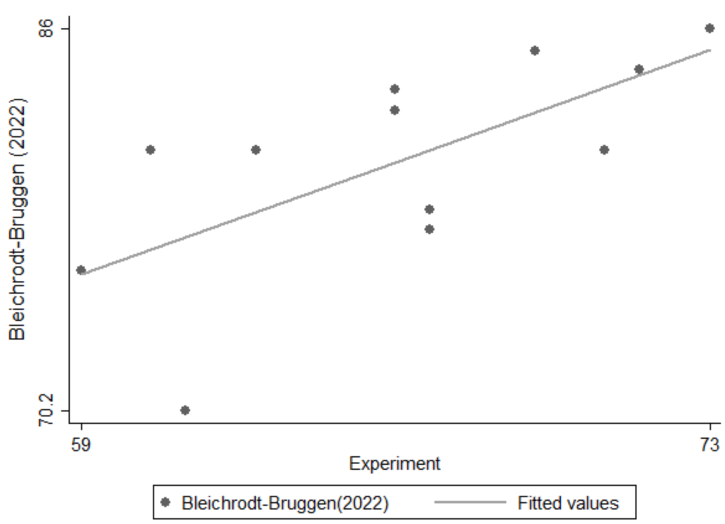

Figure 14: Choices in the Risk Treatment

Table 7: Parameters and Choices in Prudence Treatment

Task	w	k	ϵ	Option pair	Choices (%)	
1	11	7	$[3,-3]$	$[4, 11+[3,-3]]$ vs. $[11, 4+[3,-3]]$	79.3***	63.6
2	9	6	$[2,-2]$	$[3, 9+[2,-2]]$ vs. $[9, 3+[2,-2]]$	81.5***	56.2
3	8	3	$[4,-4]$	$[5, 8+[4,-4]]$ vs. $[8, 5+[4,-4]]$	74.8***	63.6
4	10	5	$[3,-3]$	$[5, 10+[3,-3]]$ vs. $[10, 5+[3,-3]]$	78.5***	57.9
5	8	5	$[1,-1]$	$[3, 8+[1,-1]]$ vs. $[8, 3+[1,-1]]$	77.0***	52.9
6	9	4	$[4,-4]$	$[5, 9+[4,-4]]$ vs. $[9, 5+[4,-4]]$	79.3***	67.8
7	12	6	$[5,-5]$	$[6, 12+[5,-5]]$ vs. $[12, 6+[5,-5]]$	80.0***	63.6
8	10	4	$[5,-5]$	$[6, 10+[5,-5]]$ vs. $[10, 6+[5,-5]]$	81.5***	62.8
9	10	5	$[4,-4]$	$[5, 10+[4,-4]]$ vs. $[10, 5+[4,-4]]$	79.3***	62.8
10	6	2	$[3,-3]$	$[4, 6+[3,-3]]$ vs. $[6, 4+[3,-3]]$	74.1***	66.1
11	6	4	$[1,-1]$	$[2, 6+[1,-1]]$ vs. $[6, 2+[1,-1]]$	72.6***	47.1
12	6	3	$[2,-2]$	$[3, 6+[2,-2]]$ vs. $[6, 3+[2,-2]]$	73.3***	59.5
				Correlation		0.3197

Notes: This table reports the parameters used in the Prudence treatment and the aggregate choices in this treatment. For each task, prudent choice implies $[w-k, w+\epsilon]$ is preferred over $[w, w-k+\epsilon]$. The first one of the percentages in the last two columns indicates the choices in our experiment and the second one indicates the choices reported in Bleichrodt and Bruggen (2022) and Pearson correlation coefficient is provided which is not significant.

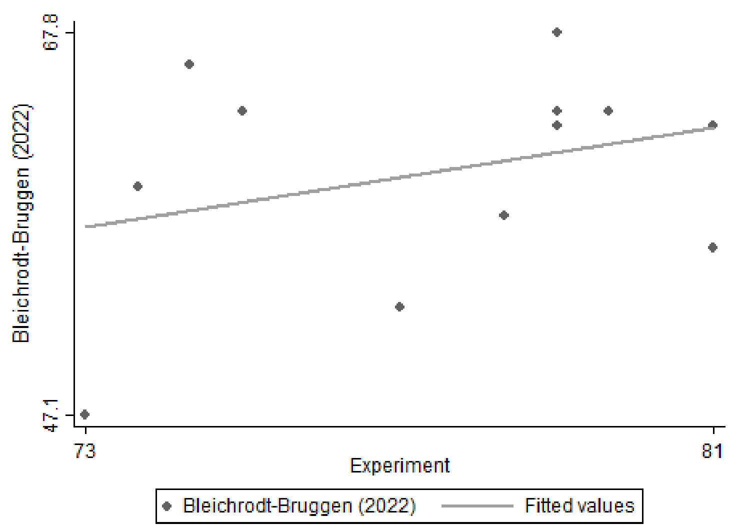

Figure 15: Choices in the Prudence Treatment

Table 8: Parameters and Choices in Temperance Treatment

Task	w	ϵ_1	ϵ_2	Option pair	Choices (%)	
1	7	[2,-2]	[4,-4]	[7+[2,-2] + [4,-4],7] vs. [7+[2,-2] , 7 +[4,-4]]	42.9	45.5
2	7	[3,-3]	[3,-3]	[7+[3,-3] + [3,-3],7] vs. [7+[3,-3] , 7 +[3,-3]]	54.1	43
3	5	[1,-1]	[2,-2]	[5+[1,-1] + [2,-2],5] vs. [5+[1,-1] , 5 +[2,-2]]	43.7	41.3
4	5	[1,-1]	[3,-3]	[5+[1,-1] + [3,-3],5] vs. [5+[1,-1] , 5 +[3,-3]]	43.7	47.9
5	8	[2,-2]	[3,-3]	[8+[2,-2] + [3,-3],8] vs. [8+[2,-2] , 8 +[3,-3]]	49.6	43
6	9	[2,-2]	[6,-6]	[9+[2,-2] + [6,-6],9] vs. [9+[2,-2] , 9 +[6,-6]]	39.3**	40.5
7	8	[3,-3]	[4,-4]	[8+[3,-3] + [4,-4],8] vs. [8+[3,-3] , 8 +[4,-4]]	54.1	42.1
8	8	[2,-2]	[5,-5]	[8+[2,-2] + [5,-5],8] vs. [8+[2,-2] , 8 +[5,-5]]	52.6	41.3
9	10	[3,-3]	[6,-6]	[10+[3,-3] + [6,-6],10] vs. [10+[3,-3] , 10 +[6,-6]]	49.6	43
10	10	[4,-4]	[5,-5]	[10+[4,-4] + [5,-5],10] vs. [10+[4,-4] , 10 +[5,-5]]	48.1	42.1
11	8	[1,-1]	[6,-6]	[8+[1,-1] + [6,-6],8] vs. [8+[1,-1] , 8 +[6,-6]]	42.2*	39.7
12	5	[2,-2]	[2,2]	[5+[2,-2] + [2,-2],5] vs. [5+[2,-2] , 5 +[2,-2]]	44.4	45.5
				Correlation		-0.068

Notes: This table reports the parameters used in the Temperance treatment and the aggregate choices in this treatment. For each task, temperate choice implies $[w + \bar{\epsilon}_1, w + \bar{\epsilon}_2]$ is preferred over $[w, w + \bar{\epsilon}_1 + \bar{\epsilon}_2]$. The first one of the percentages in the last two columns indicates our experiment's choices and the second one indicates the choices reported in Bleichrodt and Bruggen (2022) and the Pearson correlation coefficient is provided.

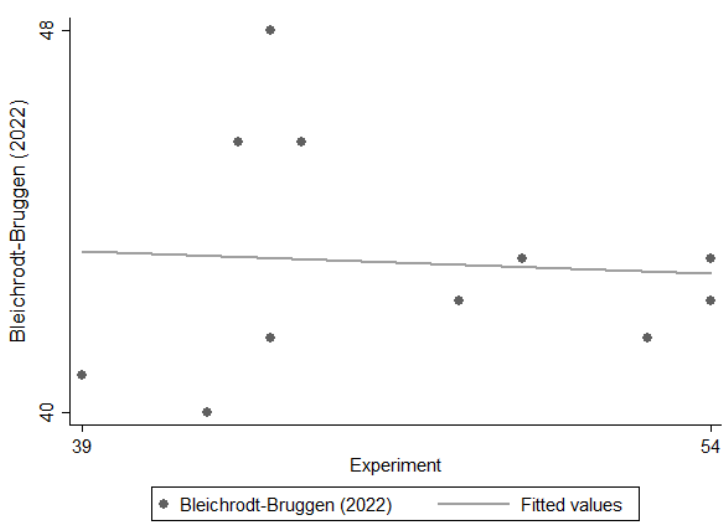

Figure 16: Choices in the Temperance Treatment

B Mixed risk averse and mixed risk loving preferences

The attitude towards risk and its higher order extensions can be understood as a bundling behaviour, that is whether or not an agent would like to spread balance good and bad outcomes as much as possible, or group bad outcomes and good outcomes separately. This understanding is more concretely expressed in the concepts of *mixed risk aversion* and *mixed risk loving* which we define more in the following.[7]

Definition 1 (**Mixed Risk Aversion**). *A decision maker is said to be a* mixed risk averse*, whenever their preferences over lotteries satisfy the following for all lotteries* L_1, L_2, L_3, L_4*:*

$$L_1 \succeq L_2 \wedge L_3 \succeq L_4 \Rightarrow [(L_1 + L_4), (L_2 + L_3)] \succeq [(L_1 + L_3), (L_2 + L_4)].$$

Definition 2 (**Mixed Risk Loving**[8]). *A decision maker is said to be a* mixed risk lover*, whenever their preferences over lotteries satisfy the following for all lotteries* L_1, L_2, L_3, L_4*:*

$$L_1 \succeq L_2 \wedge L_3 \succeq L_4 \Rightarrow [(L_1 + L_3), (L_2 + L_4)] \succeq [(L_1 + L_4), (L_2 + L_3)].$$

Next we comment on the implications of these two definitions. As we will see below, all three of risk aversion, temperance and prudence can be seen as consistent with mixed risk aversion, while all three of risk loving, prudence and intemperance can be seen as consistent with mixed risk loving. This implies three propositions, all of which are consistent with the data from our experiment:

- Prudence will be more commonly observed than both risk aversion and temperance (or their counterparts) as it is a common result between both mixed risk loving and mixed risk aversion.
- Temperance and risk aversion will be commonly observed together.
- Intemperance and risk loving will be commonly observed together.

Note that since any sure event can be seen as a degenerate lottery, risk aversion or risk loving with the usual definition directly implies specific higher order behaviour combined with the mixed definitions here. Concretely, let us define $L_1 : [w]$, $L_2 : [w - k]$ degenerate lotteries. As we assume an increasing utility function, clearly we have $L_1 \succeq L_2$ for both mixed risk averse and mixed risk loving agents.

[7]For a full treatment of these concepts without assuming utility representation, see Schlesinger (2015).

[8]Note that both of these concepts can be defined without assuming any further form on the preference. However, in what follows, monotonicity and independence of irrelevant alternatives are assumed.

Now let us define two more degenerate lotteries: $L_3 : [0]$, $L_4 : [-\delta]$ for some $\delta > 0$. Again, for both type of agents, we have: $L_3 \succeq L_4$. Their preferences would differ about the compound lotteries, though. As the mixed risk averse agent prefers to combine "good" with "bad", $[(L_1+L_4),(L_2+L_3)] \succeq_a [(L_1+L_3),(L_2+L_4)]$ implies, $[w-\delta, w-k] \succeq_a [w, w-k-\delta]$. However, the mixed risk loving agent would prefer to bundle good and bad outcomes separately, which will result in the exact opposite preference: $[w, w-k-\delta] \succeq_l [w-\delta, w-k]$.

Note that, for any ϵ, if we take $w = k = \delta = \epsilon$ the above lotteries reduce to $[0]$ and $[-\epsilon, +\epsilon]$ and it is clear that $[0] \succeq_a [-\epsilon, +\epsilon]$ and $[-\epsilon, +\epsilon] \succeq_l [0]$. Let us denote $L_5 = [0]$, $L_6 = [+\epsilon_1, -\epsilon_1]$, $L_7 = [+\epsilon_2, -\epsilon_2]$.

For a mixed averse decision maker, $L_5 \succeq_a L_6$ was mentioned. We also know that, $L_1 \succeq_a L_2$. Now if we apply Definition 1, $[(L_1 + L_6),(L_2 + L_5)] \succeq_a [(L_1 + L_5),(L_2 + L_6)]$ which is equivalent to: $[w + [+\epsilon_1, -\epsilon_1], w - k] \succeq_a [w, w - k + [+\epsilon_1, -\epsilon_1]]$. In a similar way, for a mixed risk loving agent, we know: $L_6 \succeq_l L_5$. $L_1 \succeq_l L_2$ from above and Definition 2 together imply: $[(L_1 + L_6),(L_2 + L_5)] \succeq_l [(L_1 + L_5),(L_2 + L_6)]$ which is equivalent to: $[w + [+\epsilon_1, -\epsilon_1], w - k] \succeq_l [w, w - k + [+\epsilon_1, -\epsilon_1]]$. Thus, both mixed risk averse and mixed risk loving agents satisfy prudence, since the definition of "good" differs between both types of decision makers.

For temperance, let us first consider the mixed risk averse decision maker. Clearly, we have: $L_5 \succeq_a L_7$. Let us also observe that $L_1 = [w] \sim [w + L_5] \succeq_a [w + L_6]$ and let us denote $L_8 = [w + [+\epsilon_1, -\epsilon_1]] = [w + L_6]$. Using L_1, L_5, L_7 and L_8 together with Definition 1 ensures us, $[(L_1 + L_7),(L_5 + L_8)] \succeq_a [(L_1 + L_5),(L_7 + L_8)]$ which in turn is equivalent to: $[(w + [+\epsilon_2, -\epsilon_2]),(w + [+\epsilon_1, -\epsilon_1])] \succeq_a [w,(w + [+\epsilon_2, -\epsilon_2] + [+\epsilon_1, -\epsilon_1])]$. This implies mixed risk averse decision makers are temperate. Intemperance of mixed risk loving decision makers follows analogously, from combining the observation that $L_8 \succeq_l L_1$ and Definition 2.

C Survey Questions

Variable	Range	Definition
Female	0/1	1 if subject indicates gender as female.
Econ	$[0, 4]$	Number of economics courses taken by the subject, censored at 4.
Age	$[0, 100]$	Subject's age.
GPA	$[0, 4]$	Subject's grade point average.
Experience	0/1	Previous participation in economic experiments.
Difficulty	$[0, 10]$	Response to "How hard did you think the tasks in the experiment were?"
Confidence	$[0, 10]$	Response to "How sure were you about your choices in the experiment?"
GPS Patience		0.7115185 * Staircase patience + 0.2884815 * Willingness to give up something today.
GPS Risk		0.4729985 * Staircase risk + 0.5270015 * Willingness to take risks.
GPS positive reciprocity		0.4847038 * Willingness to return favor + 0.5152962 * Size of gift.
GPS negative reciprocity		0.6261938/2 * Willingness to punish if oneself treated unfairly + 0.6261938/2 * Willingness to punish if other treated unfairly + 0.3738062 * Willingness to take revenge.
GPS Altruism		0.6350048 * Willingness to give to good causes + 0.3649952 * Hypothetical donation.
GPS Trust		Self-assessment: "I assume that people have only the best intentions."

Table 9: Ranges and definitions for control variables used in the regressions.

Notes: GPS refers to the General Preferences Survey reported in Falk et al. (2018, 2022). We refer the reader to their online appendix for a detailed description of the survey items and the aggregation of these items for the computation of specific individual indices.

D Extension to Risk Apportionment of Higher Orders

In this section, we first describe edginess as defined in Deck and Schlesinger (2010) and using the theoretical framework of Section 2. Here, w is the initial wealth of this decision maker. $k > 0$ is a constants, and $\{\bar{\epsilon}_1\}$ and $\{\bar{\epsilon}_2\}$ are two mutually independent and zero-mean random variables.

Consider the lotteries $L_1 = [w, w - k + \bar{\epsilon}_1]$ and $L_2 = [w - k, w + \bar{\epsilon}_1]$. Using these, we define two other lotteries, where $L_3 = [w + L_2, w + \bar{\epsilon}_2 + L_1]$ and $L_4 = [w + L_1, w + \bar{\epsilon}_2 + L_2]$. The decision maker exhibits edginess if $L_4 \succeq L_3$ $\forall w$, k, $\bar{\epsilon}_1$, $\bar{\epsilon}_2$. In Figure 17, we demonstrate an example where $w = 10$, $k = 4$, $\bar{\epsilon}_1 = [3, -3]$, and $\bar{\epsilon}_2 = [2, -2]$. In this example, an agent placing the smaller pipe to the left end of the bigger pipe would demonstrate a preference for edginess.

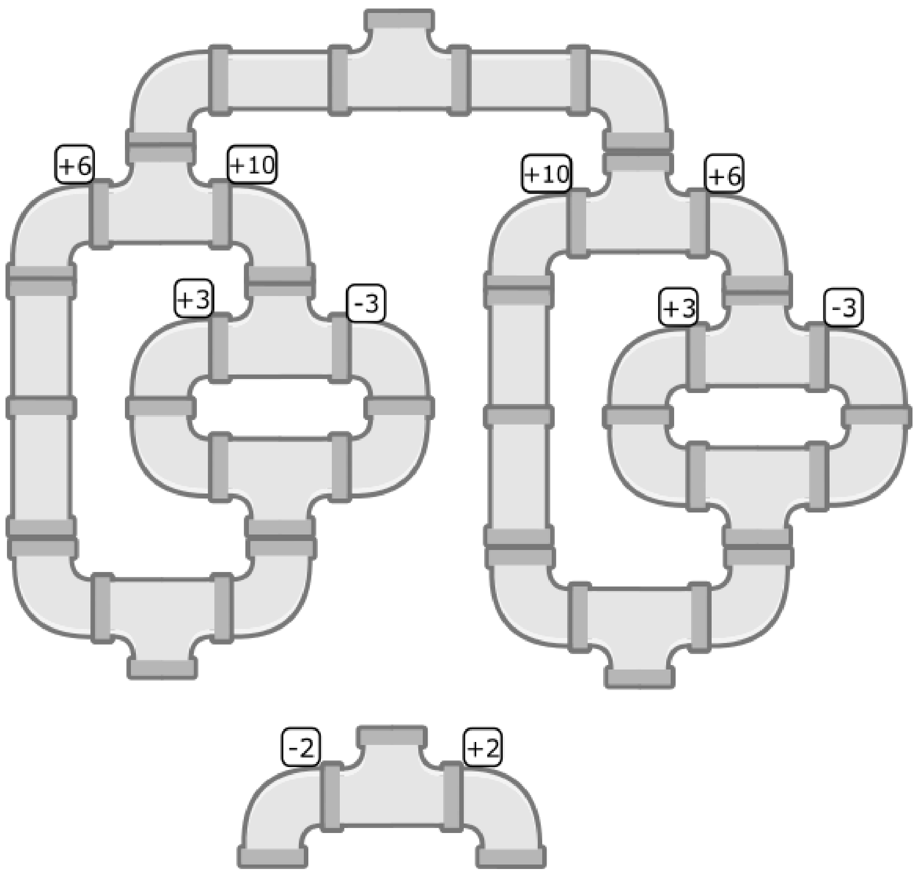

Figure 17: Edginess testing, represented as a fork game